# PENNDOT ASPHALT TECHNICIAN CERTIFICATION PROGRAM

## FIELD TECHNICIAN PROGRAM
COURSE MATERIAL
**2025**

PENN STATE UNIVERSITY
NECEPT/The Thomas D. Larson Pennsylvania Transportation Institute
*201 Transportation Research Building, University Park, PA 16802*
*Phone: 814-863-1293*
*Fax: 814-865-3039*
*Website: www.superpave.psu.edu*
*Email: superpave@psu.edu*

# NECEPT Asphalt Field Technician Review & Certification Course

## Table of Contents

# NECEPT Frequently Asked Questions
# Asphalt Technician Certification Program

1. Which publication covers the initial certification, certification renewal, and application procedures? **PennDOT Publication 351**

2. Where can I find Publication 351? **It can be downloaded from the PennDOT web site ([www.PennDOT.gov/](www.PennDOT.gov/)) by clicking on the link for "Forms, Pubs & Maps", then click the search button and type "Pub 351", then click the magnifying glass, and then select "Publication 351" from the search results. It is also available on the NECEPT website under training: [http://www.superpave.psu.edu/Training/](http://www.superpave.psu.edu/Training/).**

3. The initial certification and subsequent certification renewal periods will be for how many years? **Five (5) years**

4. In order to qualify for a Level 1 Plant Technician – Initial Certification, the applicant must have how many hours of documented experience in asphalt testing? **A minimum 500 hours obtained within the past three (3) years.**

5. What are the requirements for certification renewal of a Field Technician or Level 1 Plant Technician? **The applicant must have 500 hours of documented technician experience in asphalt paving within the previous five (5) years of certification. The applicant must also have attended one (1) NECEPT Update/Refresher Course and one (1) PennDOT approved asphalt-related annual conference, seminar, or workshop within the previous five (5) years or received a Certificate of Training from NECEPT's Technician Update/Refresher Course for two (2) out of the previous five years. Then, submit either an online registration or a completed and PennDOT signed Certification Renewal Application Form after all requirements have been met.**

6. How many retests is each applicant allowed before they have to repeat the corresponding 2-1/2 day review and certification course? **One (1)**

7. I lost my card. What do I do? **Submit a request in writing to NECEPT and include your name, NECEPT ID#, mailing address, and type of certification.**

8. I do not have the 500 hours of documented experience in asphalt paving required for certification renewal. Will I get certification renewal? **No, you will have to apply and attend the appropriate Asphalt Field Technician or Level 1 Plant Technician Initial Review & Certification Course.**

9. This is my one and only Update/Refresher Course. My certification expires in a few months. What do I do? **Attend a PennDOT approved asphalt-related conference, seminar, or workshop before your certification expires or you have to apply and attend the appropriate Asphalt Field Technician or Level 1 Plant Technician Initial Review & Certification Course and meet the requirements for the Review and Certification Course.**

10. What counts as continuing education? **Please refer to PennDOT Publication 351.**

11. How do I document my 500 hours and who is responsible for maintaining those records? **Keep a diary of projects, time & locations, and if possible, have it documented/signed by a Project Supervisor. The individual certified technician is responsible for maintaining their own records.**

12. Who checks my 500 hours? **PennDOT**

13. No one has ever checked my certification on the job site. Why do I need this? **PennDOT may check it tomorrow; however, one of the reasons you may not have been checked is because the District knows your history.**

14. I am the Lead Inspector and I never get out near the paver. What do I do for 500 hours experience? **It is your responsibility to make sure PennDOT works with you to meet the requirements. If not, you have to start the certification process over.**

15. What do I do with my paper certification renewal application after I get it signed by PennDOT? **Submit the signed application, record of hours, list of training, and payment for NECEPT fees to NECEPT c/o PSU/The Larson Transportation Institute, 201 Transportation Research Bldg, University Park, PA 16802.**

# *Excerpts from*
# PennDOT Pub 351

## BITUMINOUS OR ASPHALT
## PLANT AND FIELD TECHNICIANS

**Initial Certification Requirements**
**Certification Renewal Requirements**
**Registration Procedures**
**Performance Review and Code of Ethics**
**Course Administration**

pennsylvania
DEPARTMENT OF TRANSPORTATION
www.penndot.gov

PUB 351 (11-18)

## XI. BITUMINOUS FIELD TECHNICIAN – INITIAL CERTIFICATION

### *A. Field Technician Initial Certification Requirements*

1. Applicant must have a minimum of 500 hours of documented experience in asphalt mixture paving or paving inspection. This experience may consist of any combination of asphalt mixture paving QC or QA inspection experience from surface preparation before asphalt mixture paving, asphalt mixture paving, asphalt mixture compaction, asphalt pavement ride quality measurement or analysis, longitudinal joint density measurement or analysis, or other asphalt mixture related field activities. The experience must come from any combination of experience from PennDOT ECMS projects, PennDOT maintenance projects, PennDOT HOP projects, PennDOT EMA projects, PTC construction or maintenance projects, Pennsylvania municipal government projects which used PennDOT Liquid Fuels Funds, or from projects in other State DOTs participating in MARTCP. Experience must have been obtained within the last three (3) years prior to applying for a certified Bituminous Field Technician.

   *Note: If applicant has a certificate of completion from an annual **Hot-Mix Asphalt (HMA) 101 Course** sponsored by The Asphalt Institute which the applicant attended within the last three (3) years before applying for a Bituminous Field Technician –Initial Certification, the HMA 101 Course can substitute for 100 hours of the minimum required 500 hours of experience in asphalt mixture paving or paving inspection.*

   *Note: The minimum 500 hours of documented experience is waived if applicant previously received sign-off as a **Bituminous Field Technician in Training** and then subsequently received sign-off from an ACE, ACM, or their designate, or a PTC Materials Representative to be temporarily assigned as a Bituminous Field Technician. Both the sign-offs must have occurred on the same Form CS-351F. Submit or attach a copy of the completed and signed-off Form CS-351F when registering for a Bituminous Field Technician – Initial Certification as proof.*

2. Applicant must have a sign-off from a certified Bituminous Field Technician or a Company Field Superintendent.

3. Applicant must have a sign-off from a PennDOT ACE, ACM, or their designee. Alternatively, if the applicant will be performing a majority of their Bituminous Field Technician work for PTC projects, applicant can have a sign-off from a PTC Materials Representative. If the applicant is a PennDOT employee from the BOPD/CMD/CQAS, applicant must have a sign-off from the PennDOT BOPD/CMD/CQAS Section Chief or their designee. If the applicant is a PennDOT employee from the BOPD/CMD/LTS, applicant must have a sign-off from the PennDOT BOPD/CMD/LTS Engineer of Tests or their designee. Applicant is to obtain the sign-off from the PennDOT Organization or the PTC where applicant will be performing a majority of their bituminous field technician project work.

*Note: If applicant is an ACE or ACM, sign-off must be from the ACE's or ACM's supervisor. If applicant is a PTC Materials Representative, sign-off must be from the PTC Materials Representative's supervisor.*

4. Applicant must attend and pass NECEPT's "Bituminous Field Technician Review and Certification" course. The minimum passing certification exam score is 75%.

   *Note: A **Bituminous Field Technician in Training** may temporarily be assigned as a Bituminous Field Technician. This temporary assignment is by sign-off from a PennDOT ACE, ACM, or their designee on the same Form CS-351F where applicant received sign-off from a PennDOT ACE, ACM, or their designee as a Bituminous Field Technician in Training. Alternatively, if the applicant will be performing a majority of their Bituminous Field Technician work for PTC projects, this sign-off for temporary assignment as a Bituminous Field Technician on a Form CS-351F can be from a PTC Materials Representative. Refer to the Bituminous Field Technician in Training Initial Registration requirements.*

### *B. Field Technician Initial Certification Registration Procedures*

1. <u>Using the Online Registration Form:</u>

   a) Using the Internet, go to http://www.superpave.psu.edu/.

   b) From the "TRAINING" menu and listed under "Bituminous", select the "Field Technician Certification" dropdown menu item. Then, from the "Initial Certification" section of webpage, select the link for the "Review & Certification Course Online Registration".

   c) Select the radio button for the specific course date for the Bituminous Field Technician course the applicant is registering to attend. If no radio buttons are available for selection, no courses are currently available or scheduled.

   d) Enter the Quantity of applicants being registered for the selected radio button. If quantity is blank and cannot be selected, it means the course date is full and no further registrations are accepted.

   e) Select the "ADD SELECTED ITEMS" box, then select the "VIEW CART AND CHECKOUT" box, and then select the "ENTER REGISTRATION INFORMATION AND CHECKOUT" box.

   f) Read the Bituminous Plant and Field Technician Certification Program Requirements and then select the "I HAVE READ THE REQUIREMENTS, PROCEED TO REGISTRATION" box.

   g) If applicant already has a NECEPT Certification ID number from a different certification (e.g., certified Aggregate Technician), select the "RECERTIFICATION BOX" and then enter applicant's NECEPT Certification ID number and password. If applicant does not have a NECEPT Certification ID, select the "NEW CERTIFICATION" box and then select the "START REGISTRATION" box.

h) Complete the online registration form including the applicant's selected course, first and last name, affiliation, company/agency name, job title, home address, phone number(s), and e-mail address. For PennDOT employee applicants, ensure the company/agency name is entered as the appropriate "District #" (e.g., District 1-0 or District 12-0) or Central Office Bureau acronym (e.g., BOPD or BOMO).

i) On the online registration form where it indicates to "Select PennDOT District", select the most appropriate PennDOT District and sign-off name, PennDOT Bureau\Section and sign-off name, or the PTC and sign-off name from the dropdown menu. The selected person will receive, review, and sign-off on the applicant's online registration form.

j) On the online registration form and in the form's "Immediate Supervisor Name" and "Immediate Supervisor E-mail" fields, enter the name and email address of either a certified Bituminous Field Technician or the applicant's immediate Supervisor from the applicant's Company, Organization or Agency that can sign-off on the applicant. Ensure that the person entered in this field completes the sign-off on the applicant's registration form.

k) On the online registration form, enter the applicant's work experience, start and end dates, work performed, total hours, and the applicant's immediate Supervisor for the listed work experience where applicant obtained the minimum required hours of technician experience.

l) Upon completion of above information on the registration form, select the "SAVE APPLICANT INFORMATION" box.

m) After applicant information has been saved, select the "EDIT" box to edit any information on the applicant registration form and resave the information. Or, select the "DELETE" box to remove an applicant registration form. Or, scroll down to the Add Applicant section to add additional applicants for this course and course date. The number of additional applicants that can be added is limited to the total Quantity entered when the course radio button is selected [see Step d) above]. After all editing, deleting, or adding of applicant registration forms has been completed, select the "CONFIRM ORDER" box to complete the order for the listed applicant(s) and to make payment.

n) After confirming the order, the course registration is complete. For course fee payment, select either the "PAY WITH CREDIT CARD" box under Option 1 or select the "SELECT" box under Option 2 to open and print the completed registration form to pay with check or money order.

   (1) PennDOT applicants who want NECEPT to direct bill the PennDOT District/Bureau by invoice should select the "SELECT" box under Option 2, print off their course registration form(s) for their records, and then exit from the online registration system.

o) If the "PAY WITH CREDIT CARD" box under Option 1 was selected, enter and submit the credit card information for payment for the course registration fee and then exit from the online registration system.

p) If the "SELECT" box under Option 2 was selected, the completed registration form will open. Print the completed registration form for each applicant. Obtain required sign-off from Supervisor or from Company Field Superintendent. Submit the printed registration forms with sign-off signatures along with check or money order to NECEPT at the address on the registration form.

2. Using the Paper Application Registration Form:

a) From NECEPT's Internet website at http://www.superpave.psu.edu/ and under the "TRAINING" menu and listed under "Bituminous", select the "Field Technician Certification" dropdown menu. Then, from the "Initial Certification" section of webpage, select the link for "Review & Certification Course Paper Application". Print the paper application registration form from NECEPT's website or obtain a paper hardcopy of the appropriate registration form from the annual Bituminous Field Technician packet that is distributed by NECEPT or PennDOT.

b) Complete the NECEPT Paper Application Registration Form indicating the application is for a Bituminous Field Technician. Ensure all applicable blank spaces on the registration form have been completed. NECEPT will reject and return incomplete registration forms. For PennDOT employee applicants, ensure the company/agency name is entered as the appropriate "District #" (e.g., District 1-0 or District 12-0) or Central Office Bureau acronym (e.g., BOPD or BOMO).

c) List applicant's applicable work experience including start and end dates, the work performed, the project locations, total hours, and the name of applicant's immediate Supervisor for the listed work experience where applicant obtained the minimum required hours of asphalt mixture paving or paving inspection experience.

d) Have a certified Bituminous Field Technician or applicant's Company, Field Superintendent sign-off and date the registration form.

e) Contact a PennDOT ACE, ACM, or their designee in a District where the applicant will be performing a majority of their bituminous field technician work. Make arrangements with the ACE, ACM, or their designee to have them sign-off and date the Registration Form. Alternatively, if the applicant will be performing a majority of their Bituminous Field Technician work for PTC projects, contact a PTC Materials Representative to sign-off and date the Registration Form. If the applicant is a PennDOT employee from the BOPD/CMD/CQAS, applicant must contact the PennDOT BOPD/CMD/CQAS Section Chief or their designee to sign-off and date the registration form. If the applicant is a PennDOT employee from the BOPD/CMD/LTS, applicant must contact the PennDOT BOPD/CMD/LTS Engineer of Tests or their designee to sign-off and date the registration form.

f) Submit the completed Paper Application Registration Form to NECEPT as instructed on the registration form. Submit payment by check or money order for the registration fee as instructed on the registration form.

# XIV. BITUMINOUS FIELD TECHNICIAN – CERTIFICATION RENEWAL

## *A. Field Technician Certification Renewal Requirements (Option A – Learning Activities)*

1. Applicant must apply for certification renewal within the normal winter training season (typically January to April) of the same calendar year of their certification expiration date. Certification renewal applications submitted in a calendar year prior to the calendar year of the applicant's certification expiration date will be rejected.

   Note: *If a certified technician has a certification expiration date with a month and day from January 1 to April 30, the certified technician will be considered certified until April 30 of their expiration date year to allow the technician to attend the necessary technician certification program courses in the last year of their certification period. (e.g., a technician with a certification expiration date of February 22 will still be considered certified until April 30 of the same calendar year. After April 30 of the same calendar year, the technician's certification is expired unless the technician has documented proof that they completed the necessary technician certification program renewal requirements and submitted the certification renewal application to NECEPT before or on April 30 of their certification expiration date year, and is waiting to receive their new certification card.*

   Note: *If a certified technician has a certification expiration date with a month and day from May 1 to December 31, the certified technician will be considered not certified or expired beyond their certification expiration date unless the technician has documented proof that they completed the necessary technician certification program renewal requirements and submitted the certification renewal application to NECEPT before or on their certification expiration date (as determined by U.S. Mail postmark, overnight delivery pickup or shipment date, or online registration submittal date), and is waiting to receive their new certification card.*

   Note: *Attendance to a Bituminous Field Technician Annual Update/Refresher Course in the same calendar year as the technician's certification expiration date year does not automatically renew a technician's certification. The technician must submit the appropriate application registration form for certification renewal along with the certification renewal fee.*

2. Applicant must have been a certified Bituminous Field Technician for the previous five (5) years prior to application for certification renewal.

3. Applicant must have a minimum of 500 hours of documented technician experience in asphalt mixture paving or paving inspection since date of last certification. This experience may consist of any combination of QC or QA inspection experience from surface preparation before asphalt mixture paving, asphalt mixture paving, asphalt mixture compaction, asphalt pavement ride quality measurement or analysis, longitudinal joint density measurement or analysis, or other asphalt mixture related field activities. This experience must come from any combination of experience from PennDOT ECMS projects, PennDOT maintenance projects, PennDOT HOP projects,

PennDOT EMA projects, PTC construction or maintenance projects, Pennsylvania municipal government projects which used PennDOT Liquid Fuels Funds, or from projects in other State DOTs participating in MARTCP.

4. Applicant must have a sign-off from their immediate Supervisor in their Company, Organization or Agency.

5. Applicant must have a sign-off from a PennDOT ACE, ACM, or their designee confirming applicant's satisfactory performance during the 500 hours of technician experience. Alternatively, if the applicant performed a majority of their Bituminous Field Technician work for PTC projects, applicant can have a sign-off from a PTC Materials Representative. If the applicant is a PennDOT employee from the BOPD/CMD/CQAS, applicant must have sign-off from the PennDOT BOPD/CMD/CQAS Section Chief or their designee. If the applicant is a PennDOT employee from the BOPD/CMD/LTS, applicant must have sign-off from the PennDOT BOPD/CMD/LTS Engineer of Tests or their designee. Applicant is to obtain the sign-off from the PennDOT Organization or PTC where applicant performed a majority of their project work.

   *Note: If applicant is a PennDOT ACE or ACM, sign-off must be from the ACE's or ACM's supervisor. If applicant is a PTC Materials Representative, sign-off must be from the PTC Materials Representative's supervisor.*

6. Applicant must have attended and received a Completion Certificate from NECEPT's Annual Field Technician Update/Refresher Course for two (2) out of the previous five (5) years <u>or</u>, applicant must have attended and received a Completion Certificate from NECEPT's Annual Field Technician Update/Refresher Course for one (1) out of the previous five (5) years plus attended one (1) asphalt-related learning activity (annual conference, seminar, workshop, or training course) within the previous five (5) years.

   a) <u>Acceptable</u> asphalt-related learning activities are as follows:

      (1) Annual Associated Pennsylvania Constructors (APC) Conference.

      (2) Annual Pennsylvania Asphalt Pavement Association (PAPA) Conference.

      (3) Annual Pennsylvania Asphalt Pavement Association (PAPA) Regional Technical Meeting (Eastern Regional, Central Regional, or Western Regional).

      (4) Annual Asphalt Pavement Association (APA) Conference from another State participating in MARTCP.

      (5) Mid-Atlantic States Quality Assurance Workshop (QAW).

      (6) Nationally recognized conferences or courses [i.e., conferences or courses from the National Asphalt Pavement Association (NAPA), the Asphalt Institute (AI), the National Center for Asphalt Technology (NCAT), the Northeast Asphalt User/Producer Group (NEAUPG), the National Highway Institute (NHI), etc.].

      (7) Department or Industry sponsored training <u>pre-approved</u> by a PennDOT DME or DMM or a PTC Materials Representative.

(8) NECEPT Maintenance Paving Training Course.

b) Unacceptable asphalt-related learning activities are as follows:

(1) PennDOT/NECEPT Bituminous Plant Technician Review and Certification Course.

(2) PennDOT/NECEPT Bituminous Plant Technician Annual Update/Refresher Course.

(3) PennDOT/NECEPT Superpave Volumetric Mix Design Workshop.

(4) The Hot Mix Asphalt (HMA) 101 Course sponsored by The Asphalt Institute.

### *B. Field Technician Certification Renewal Requirements (Option B – Repeat Initial Certification)*

Applicant must meet and follow all the requirements for *Bituminous Field Technician - Initial Certification*, except revise the first requirement completely as follows:

1. Applicant must have a minimum of 200 hours of documented experience in asphalt mixture paving or paving inspection. This experience may consist of any combination of QC or QA inspection experience from surface preparation before asphalt mixture paving, asphalt mixture paving, asphalt mixture compaction, asphalt pavement ride quality measurement or analysis, longitudinal joint density sampling or evaluation, or other asphalt mixture related field activities. The experience must come from any combination of experience from PennDOT ECMS projects, PennDOT maintenance projects, PennDOT HOP projects, PennDOT EMA projects, PTC construction or maintenance projects, Pennsylvania municipal government projects which used PennDOT Liquid Fuels Funds, or from projects in other State DOTs participating in MARTCP. Experience must have been obtained within the last five (5) years prior to applying for a certified Bituminous Field Technician.

*Note: Applicant cannot substitute any of the minimum required hours by attendance and completion of any courses.*

### *C. Field Technician Certification Renewal Registration Procedures (Option A – Learning Activities)*

1. Using the Online Registration Form:

a) Using the Internet, go to http://www.superpave.psu.edu/.

b) From the “TRAINING” menu and listed under “Bituminous”, select the “Field Technician Certification” dropdown menu item. Then, from the “Certification Renewal - Certification Card Only” section, select the link for “Certification Card Renewal Online Registration”.

c) Select the radio button representing the current date for the Bituminous Field Technician.

d) Enter the Quantity of applicants being registered for the selected radio button.

e) Select the "ADD SELECTED ITEMS" box, then select the "VIEW CART AND CHECKOUT" box, and then select the "ENTER REGISTRATION INFORMATION AND CHECKOUT" box.

f) Read the Bituminous Plant and Field Technician Certification Program Requirements and then select the "I HAVE READ THE REQUIREMENTS, PROCEED TO REGISTRATION" box.

g) Enter applicant's NECEPT Certification ID number and password and select the "LOGIN" box or select the "GROUP REGISTRATION" box if a company administrator is registering the technician or multiple technicians. For administrator or Group Registrations, enter the applicant's NECEPT Certification ID number and last name.

h) Complete the online registration form including the applicant's selected Bituminous Field Technician Certification Renewal Card, first and last name, affiliation, company/agency name, job title, home address, phone number(s), and e-mail address. For PennDOT employee applicants, ensure the company/agency name is entered as the appropriate "District #" (e.g., District 1-0 or District 12-0) or Central Office Bureau acronym (e.g., BOPD or BOMO).

i) On the online registration form, where it indicates to "Select PennDOT District", select the most appropriate PennDOT District and sign-off name, PennDOT Bureau\Section and sign-off name, or the PTC and sign-off name from the dropdown menu. The selected person will receive, review, and sign-off on the applicant's online certification renewal registration form.

j) On the online registration form and in the form's "Immediate Supervisor Name" and "Immediate Supervisor E-mail" fields, enter the name and email address of the applicant's immediate Supervisor from the applicant's Company, Organization or Agency.

k) On the online registration form, enter and list the applicant's work experience, start and end dates, work performed, total hours, and the applicant's immediate Supervisor for the listed work experience where applicant obtained the minimum required hours of technician experience since date of last certification.

l) On the online registration form, enter and list the applicant's two (2) required asphalt-related learning activities including the single date or start and end dates, location, and name of each learning activity since date of last certification.

m) Upon completion of above information on the registration form, select the "SAVE APPLICANT INFORMATION" box.

n) After applicant information has been saved, select the "EDIT" box to edit any information on the applicant registration form and resave the information. Or, select the "DELETE" box to remove an applicant registration form. Or, scroll down to the Add Applicant section to add additional applicants for this certification renewal and certification renewal date. The number of additional applicants that can be added is limited to the total Quantity entered when the course radio button is selected [see Step d) above]. After all editing, deleting, or adding of applicant registration forms has been completed, select the "CONFIRM ORDER" box to complete the order for the listed applicant(s) and to make payment.

o) After confirming the order, the certification renewal registration is complete. For certification renewal fee payment, select either the "PAY WITH CREDIT CARD" box under Option 1 or select the "SELECT" box under Option 2 to open and print the completed registration form to pay with check or money order.

   (1) PennDOT applicants who want NECEPT to direct bill the PennDOT District/Bureau by invoice should select the "SELECT" box under Option 2, print off their certification renewal registration form(s) for their records, and then exit from the online registration system.

p) If the "PAY WITH CREDIT CARD" box under Option 1 was selected, enter and submit the credit card information for payment for the certification renewal registration fee and then exit from the online registration system.

q) If the "SELECT" box under Option 2 was selected, the completed registration form will open. Print the completed registration form for each applicant. Obtain required sign-off from Supervisor. Submit the printed registration forms with sign-off signatures along with check or money order to NECEPT at the address on the registration form.

2. Using the Paper Application Registration Form:

   a) From NECEPT's Internet website at http://www.superpave.psu.edu/ and under the "TRAINING" menu and listed under "Bituminous", select the "Field Technician Certification" dropdown menu item. Then, from the "Certification Renewal - Certification Card Only" section of webpage, select the link for "Certification Card Renewal Paper Application". Print the paper application registration form from NECEPT's website. Or, obtain a paper hardcopy of the appropriate registration form ["Bituminous Certification Renewal or Bituminous Level 2 Plant Initial Certification (Card Only)]" from the annual Bituminous Field Technician packet distributed by NECEPT or PennDOT.

   b) Complete the NECEPT Paper Application Registration Form indicating the application is for certification renewal of a Bituminous Field Technician. Ensure all applicable blank spaces on the registration form have been completed. NECEPT will reject and return incomplete registration forms. For PennDOT employee applicants, ensure the company/agency name is entered as the appropriate "District #" (e.g., District 1-0 or District 12-0) or Central Office Bureau acronym (e.g., BOPD or BOMO).

   c) On the paper application registration form, include the applicant's certification ID number.

   d) On the paper application registration form, include the applicant's last exam date or last certification renewal date for a Bituminous Field Technician.

e) On the paper application registration form, include the applicant's first and last name, affiliation, company/agency name, job title, home address, phone number(s), and e-mail address.

f) On the paper application registration form, list the applicant's applicable work experience including start and end dates, the work performed, projects, total hours, and the name of applicant's immediate Supervisor for the listed work experience where applicant obtained the minimum required hours of field technician experience since date of last certification.

g) On the paper application registration form, list the applicant's two (2) required asphalt-related learning activities including the single date or start and end dates, location, and name of each learning activity since date of last certification. Include copies of any completion certificates received through any of these learning activities.

h) Have the applicant's immediate Supervisor from the applicant's Company, Organization, or Agency sign-off and date the Registration Form.

i) Contact a PennDOT ACE, ACM, or their designee in a District where the applicant performed a majority of their field technician work. Make arrangements with the ACE, ACM, or their designee to sign-off and date the Registration Form. Alternatively, if the applicant performed a majority of their field technician work for PTC projects, contact a PTC Materials Representative to sign-off and date the Registration Form. If the applicant is a PennDOT employee from the BOPD/CMD/CQAS, applicant must contact the PennDOT BOPD/CMD/CQAS Section Chief or their designee to sign-off and date the registration form. If the applicant is a PennDOT employee from the BOPD/CMD/LTS, applicant must contact the PennDOT BOPD/CMD/LTS Engineer of Tests or their designee to sign-off and date the registration form.

*Note: If applicant is an ACE or ACM, sign-off must be from the ACE's or ACM's supervisor. If applicant is a PTC Materials Representative, sign-off must be from the PTC Materials Representative's supervisor.*

j) Submit the completed Paper Application Registration Form to NECEPT as instructed on the registration form. Submit payment by check or money order for the registration fee as instructed on the registration form.

### *D. Field Technician Certification Renewal Requirements (Option B – Repeat Initial Certification)*

1. Same procedure as for initial certification of a Bituminous Field Technician.

## XX. BITUMINOUS TECHNICIAN CODE OF ETHICS.

The Bituminous Technician Certification Board (BTCB) has found that the following rules are necessary to establish and maintain the high standard of integrity and dignity in the bituminous technician profession and are necessary in the public interest to protect the public against unprofessional conduct on the part of the bituminous technician. Certified Bituminous Technicians are put on notice that an ethical violation by themselves or by an individual rendering or offering to render bituminous technician services under their supervision, as provided by this Publication, may result in disciplinary procedures against them in accordance with Department Publication 351, Section XIX.B.2.

### *A. Principle 1. Beneficence/autonomy.*

A certified bituminous technician will demonstrate a concern for the welfare and dignity of the recipients of the services, including PennDOT, PTC, and other Owner Agency personnel.

1. A certified bituminous technician will provide services without discriminating on the basis of race, creed, national origin, sex, age, handicap, disease, social status, financial status, or religious affiliation.

2. A certified bituminous technician will act for his client or employer in professional matters as a faithful agent or trustee, and will not accept a direct fee for services rendered as a certified bituminous technician from other than the technician's employer.

3. A certified bituminous technician will not attempt to injure falsely or maliciously, directly or indirectly, the professional reputation, prospects, or business of anyone.

4. A certified bituminous technician will not attempt to supplant another bituminous technician after definite steps have been taken toward his employment.

5. A certified bituminous technician will not compete with another bituminous technician for employment by the use of unethical practices.

6. A certified bituminous technician will not review the work of another bituminous technician for the same client, except with the knowledge of such bituminous technician, or unless the connection of such bituminous technician with the work has terminated.

7. A certified bituminous technician will not attempt to obtain or render technical services or assistance without fair and just compensation commensurate with the services rendered: Provided, however, the donation of such services to a civic, charitable, religious, or eleemosynary organization will not be deemed a violation.

8. A certified bituminous technician will not advertise in self-praising language, or in any other manner, derogatory to the dignity of the profession.

9. A certified bituminous technician will not create or participate in a threatening, intimidating or hostile environment toward any recipients of services, including PennDOT, PTC, or other Owner Agency personnel.

### B. *Principle 2. Competence.*

A certified bituminous technician will maintain high standards of professional competence.

1. A certified bituminous technician will not attempt to practice in work in which the bituminous technician is not proficient or practice in work outside the standards of the profession.

2. A certified bituminous technician will consult with other service providers when additional knowledge and expertise is required.

3. A certified bituminous technician will accurately record and report information related to bituminous technician services provided to the Department.

4. A certified bituminous technician will require those whom the technician supervises in the provision of bituminous technician services to adhere to this Code of Ethics.

### C. *Principle 3. Public Information.*

A certified bituminous technician will provide accurate information about bituminous technician services.

1. A certified bituminous technician will accurately represent their competence and training.

2. A certified bituminous technician will not use or participate in the use of a form of communication that contains a false, misleading, or deceptive statement or claim.

3. A certified bituminous technician will not use or permit the use of their signature on work over which the technician was not in responsible charge.

### D. *Principle 4. Professional Relationships.*

A certified bituminous technician will function with discretion and integrity in relations with colleagues and other professionals.

1. A certified bituminous technician will report illegal, incompetent or unethical practice by colleagues or other professionals to the appropriate authority.

2. A certified bituminous technician who employs or supervises colleagues will provide appropriate supervision as necessary to provide bituminous technician services in conformance with this Code of Ethics.

# NECEPT

## Northeast Center of Excellence for Pavement Technology

# Asphalt Field Technician Review & Certification Course

## 2025

# NECEPT

## Northeast Center of Excellence for Pavement Technology

## Asphalt Field Technician Review & Certification Course

## 2025

NECEPT

1

PennDOT Technician Certification Program was developed to satisfy the requirements of the Code of Federal Regulations, 23 CFR, Part 637, Quality Assurance (QA) Procedures for Construction, issued June 29, 1995. These Federal Regulations contained the following statement; "After June 29, 2000, all sampling and testing data to be used in the acceptance decision or the independent assurance program will be executed by qualified sampling and testing personnel."

## NECEPT

**Website:** www.superpave.psu.edu

**Email:** superpave@psu.edu

**Covers PENNDOT Certification Program**

**Click on Training to Access Course Information:**

**Courses, Registration, Schedule & Agenda, Pub 351, FAQ**

**Program Assistant**

**(814-863-1293)**


2

## Instructors' Contact Information

- Gary Hoffman
  garyhoffman2030@comcast.net
- Al Leonori
  ALeonori@Pennoni.com
- Tim Montag
  tjmontag@ptd.net

NECEPT

3

## Housekeeping

1. Work Experience Requirements
2. Attendance and Participation
3. Course Schedule and Breaks
4. Quiz at the end of each Module
5. Course Material
6. Videos
7. Written Test
8. Course Objective
9. Course Agenda

NECEPT

4

## 1. Work Experience Requirements for Certification Renewal (See Pub 351)

- **Minimum of** ***500 hours*** *of documented experience in asphalt mixture paving or paving inspection since date of last certification.*
- ***Type of Experience:***
  - *asphalt mixture paving*
  - *QC or QA inspection experience*
  - *Surface preparation before asphalt mixture paving*
  - *asphalt mixture paving, compaction, ride quality measurement*
  - *analysis, longitudinal joint density measurement or analysis*
- ***Source of Experience:***
  - *PennDOT ECMS, and maintenance,*
  - *HOP, EMA projects, PTC construction or maintenance projects,*
  - *Pennsylvania municipal government projects which used PennDOT Liquid Fuels Funds,*
  - *or from projects in other State DOTs participating in MARTCP."*

5

## 2. Attendance and Participation

- Attendance in the course is required.
- Attend ALL the course period.

6

## 3. Course Schedule and Breaks

- Part 1: Today, finish at 4:30 P.M.
- Part 2: Tomorrow – one day
- Breaks: Breaks: A morning break and an afternoon break

7

## 4. Quiz at the end of each module

- Short Quiz – Self Graded
- 5 to 10 Questions
- 4 to 6 minutes

8

## 5. Course Material

**Course Material:**

In addition to the printed copy, a digital copy is available online at Superpave.psu.edu

NECEPT

9

## 6. Videos

There are seven videos to be shown during the course.

They are:

- Sampling prior to Compaction (1 min, Module 3)
- Surface Preparation (13 min, Module 4)
- Sawing and Sealing of Asphalt Pavement (6 min, Module 4)
- Proper Truck Loading (1.5 min, Module 5)
- Delivery Ticket for Asphalt (6 min, Module 5)
- Longitudinal Joint Construction (12.5 min, Module 7)
- Recap of Asphalt Laydown and Construction (13 min, All Modules)

We will show the first six during the relevant modules but all are available at Superpave.psu.edu. Click on Training.

NECEPT

10

## 7. Written Exam

- Exam has 60 multiple choice questions.
- Passing grade is 75% correct answers
- One retest is allowed after 30 days from the date of the first test but completed within 120 days from the date of the first test.

NECEPT

11

## 8. Course Objectives

- This is a *review* course for certification as an Asphalt Field Technician.
- The course objectives are
  - To provide a *review* of essential PennDOT Specifications
  - To provide a *review* of operations and procedures for asphalt paving
  - To provide testing for participants to become certified as an Asphalt Field Technician.

NECEPT

12

## 9. Course Agenda

- Module 1– Field Technician & Superpave Overview
- Module 2– PennDOT Specifications
- Module 3– Pennsylvania Test Methods (PTM)
- Module 4– Surface Preparation
- Module 5– Delivery
- Module 6– Placement
- Module 7– Joint Construction
- Module 8– Compaction
- Module 9– Segregation

13

## Powers of Observation

- Do you think this is important for you as a certified field technician?
- How would you rate yourself on a scale of 1 to 10, with 10 being the best!

14

FINISHED FILES ARE THE RESULT OF YEARS OF SCIENTIFIC STUDY COMBINED WITH THE EXPERIENCE OF MANY YEARS.

NECEPT

15

## Can you read this?

I cdnuolt blveiee that I cluod aulaclty uesdnatnrd what I was rdanieg. The phaonmneal pweor of the hmuan mnid, aoccdrnig to a rscheearch at Cmabrigde Uinervtisy, it dseno't mtaetr in what oerdr the ltteres in a word are, the olny iproamtnt tihng is that the frsit and last ltteer be in the rghit pclae. The rset can be a taotl mses and you can still raed it whotuit a pboerlm. This is bcuseae the huamn mnid deos not raed ervey lteter by istlef, but the word as a wlohe. Azanmig huh? Yaeh and I awlyas tghuhot slpeling was ipmorantt! If you can raed this forwrad it

NECEPT

16

# R34D 7H15

17

7H15 M3554G3 53RV35 70 PROV3
7H47 OUR M1ND5 C4N DO
1MPR3551V3 TH1NG5!
1N 7H3 B3G1NN1NG 17 WA5
H4RD BU7 NOW, ON 7H15 LIN3
YOUR M1ND 15 R34D1NG
4UTOM471C4LLY W17HOU7
3V3N 7H1NK1NG 4BOU7 17.
ONLY C3R741N P3OPL3 C4N
R34D 7H15!

18

## ACRONYMS

- Definition for each acronym will be provided as an additional handout.
- Make sure you get familiar with these terms as many of them are frequently used in everyday practice of production and construction of asphalt mixes.

NECEPT

19

## ACRONYMS

| | | | |
|---|---|---|---|
| AASHTO | HMA | NMAS | RPS |
| ACE | IRI | NTT/ CNTT | RAM |
| AET | JMF | OSHA | RAP / RAS |
| AI | LTS | PAPA | SRL |
| ATPBC | MTV | PG | SMA |
| ASTM | MUTCD | PTM | TAC |
| ESAL | NAPA | PWL(T) | VMA |
| FHWA | NECEPT | QC/QA | WMA |

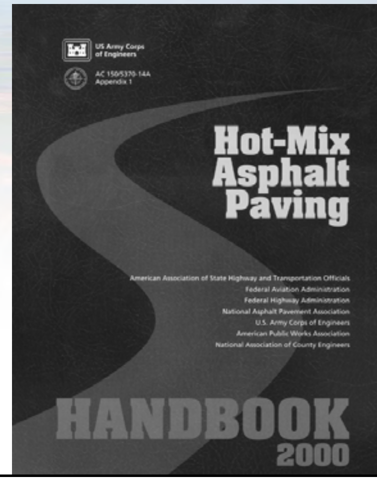
NECEPT

20

Quickly review the meaning for each of the acronyms on the list (5-10 minutes total). Don't get too far into the weeds explaining any one of these.

## Excellent Resource

- Hot-Mix Asphalt Paving Handbook 2000 (July 2001)
- Available from NAPA* Online Store
  - List Price: $12
  - 231 Pages
  - 65 MB

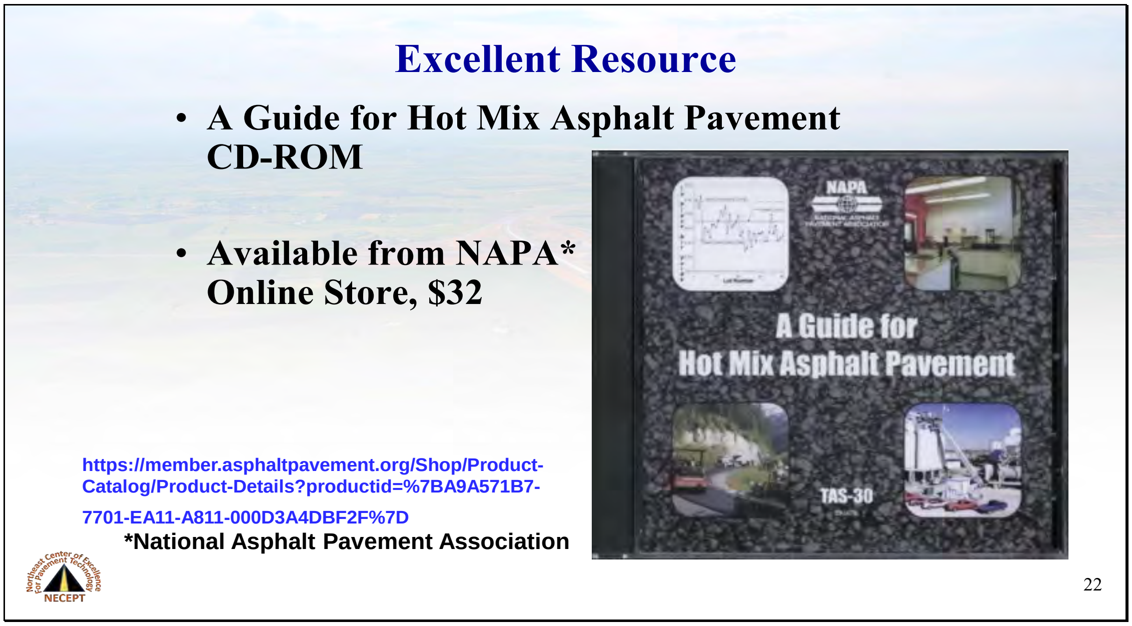



https://member.asphaltpavement.org/Shop/Product-Catalog/Product-Details?productid={47A571B7-7701-EA11-A811-000D3A4DBF2F}

*National Asphalt Pavement Association

21

Resource: This comprehensive handbook covers HMA project organization, mix design and job mix formulas, types of HMA manufacturing facilities, aggregate storage and handling, asphalt cement storage and distribution, batch and drum mix facility operations, surge and storage silos, emission controls, mix delivery, surface preparation, mix placement, automatic screed controls, joint construction, compaction, and equipment and mat problems/solutions. This second edition addresses recent developments including SHRP, new paving equipment, advances in recycling, new quality control practices, and the introduction of new techniques from Europe and elsewhere. A practical guide for all connected with specifying paving materials and/or involved in the manufacturing/paving process. (231pp)

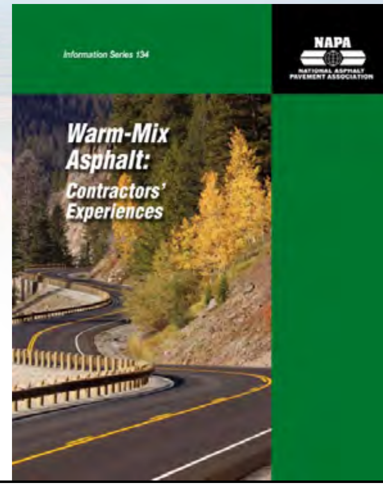



Resource: A Complete Overview of Hot Mix Asphalt on one CD-ROM! The information contained on this CD is the equivalent of a 350-page textbook on Hot Mix Asphalt technology. It gives a complete overview including materials, mix design, mix selection, structural design, construction, pavement evaluation, and pavement maintenance and rehabilitation. There are photos, photo galleries, animations, and movie clips to hold the user's interest and illustrate key points. The text contains links between terms and other portions of the CD where the terms are discussed. It also has topic search capability as well as a glossary.


Resource: Constructing Quality Hot-Mix Pavements in Pennsylvania Checklist from the Pennsylvania Asphalt Pavement Association (PAPA). The information contained on this booklet is essential for the Certified Asphalt Field Technician for Pennsylvania Projects. Contents include all of the following: How Far Does One Ton Go?; Square Yard Formulas; Role of Field Technician; Project with Ride Spec; Pre-Construction; Surface Preparation; Balance Plant/Trucks /Paver/Rollers; Mix Delivery; Mix Placement; Possible Segregation Locations; Compaction; Acceptance/Quality Control; Time Available for Compaction (TAC); Using Random #s for Box Sample Location; Mat Trouble Shooting Guide. It can be downloaded from the PAPA website.

## Excellent Resource

- **Warm-Mix Asphalt: Contractor's Experiences (July 2008)**




- **Available from NAPA* Online Store**
  – List Price: $20
  – Gov't/Ed: $15
  – Members: Free

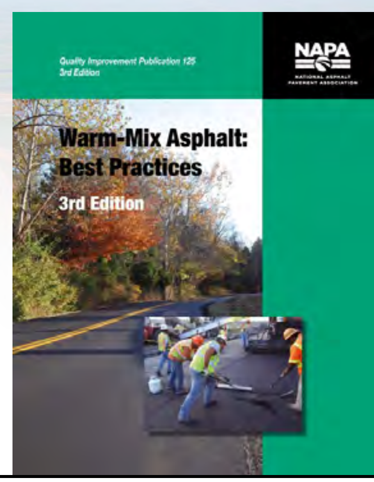
https://store.asphaltpavement.org/index.php?productID=630

***National Asphalt Pavement Association**

24

## Excellent Resource

- **Warm-Mix Asphalt: Best Practices (January 2012)**




- **Available from NAPA* Online Store**
  – List Price: $45
  – Gov't/Ed: $35
  – Members: $25

https://member.asphaltpavement.org/Shop/Product-Catalog/Product-Details?productid={79A571B7-7701-EA11-A811-000D3A4DBF2F}

***National Asphalt Pavement Association**

25

# HMA Construction Program

## Certified Asphalt Field Technician

Module 1a

Field Technician Responsibilities

NECEPT

Northeast Center of Excellence for Pavement Technology

# HMA Construction Program

## Certified Asphalt Field Technician

Module 1a
Field Technician Responsibilities

NECEPT

1

Module 1a will serve as an introduction to the course with defining the job and responsibilities of a Certified Asphalt Field Technician. This overview will provide essential information regarding asphalt technician certification requirements and provide time for questions and clarification.

## Module 1a - Objectives

- Review of Technician Certification Program
- What is a Certified Asphalt Field Technician?
- What are his/her responsibilities?

2

## Technician Certification Program

- PennDOT Pub 351 Covers
  - Background on Certification
  - Certification & Recertification Requirements
  - Application Procedures
  - Exam Review & Retest
  - Code of Ethics
  - Revised version published in 2018

BITUMINOUS OR ASPHALT TECHNICIAN CERTIFICATION PROGRAM

BITUMINOUS OR ASPHALT PLANT AND FIELD TECHNICIANS

Initial Certification Requirements
Certification Renewal Requirements
Registration Procedures
Performance Review and Code of Ethics
Course Administration

pennsylvania
DEPARTMENT OF TRANSPORTATION
www.penndot.gov

NECEPT

3

# Frequently Asked Questions

***Handout in Binder***

NECEPT

4

**NECEPT Frequently Asked Questions**
**Asphalt Technician Certification Program**

1. Which publication covers the initial certification, certification renewal, and application procedures? **PennDOT Publication 351.**
2. Where can I find Publication 351? **It can be downloaded from the PennDOT web site (www.PennDOT.gov/) by clicking on the link for "Forms, Pubs & Maps", then click the search button and type "Pub 351", then click the magnifying glass, and then select "Publication 351" from the search results. It is also available on the NECEPT website under training: http://www.superpave.psu.edu/Training/.**
3. The initial certification and subsequent certification renewal periods will be for how many years? **Five (5) years**
4. In order to qualify for a Level 1 Plant Technician – Initial Certification, the applicant must have how many hours of documented experience in asphalt testing? **A minimum 500 hours obtained within the past three (3) years.**
5. What are the requirements for certification renewal of a Field Technician or Level 1 Plant Technician? **The applicant must have 500 hours of documented technician experience in asphalt paving within the previous five (5) years of certification. The applicant must also have attended one (1) NECEPT Update/Refresher Course and one (1) PennDOT approved asphalt-related annual conference, seminar, or workshop within the previous five (5) years or received a Certificate of Training from NECEPT's Technician Update/Refresher Course for two (2) out of the previous five years. Then, submit either an online registration or a completed and PennDOT signed Certification Renewal Application Form after all requirements have been met.**
6. How many retests is each applicant allowed before they have to repeat the corresponding 2-1/2 day review and certification course? **One (1)**
7. I lost my card. What do I do? **Submit a request in writing to NECEPT and include your name, NECEPT ID#, mailing address, and type of certification.**
8. I do not have the 500 hours of documented experience in asphalt paving required for certification renewal. Will I get certification renewal? **No, you will have to apply and attend the appropriate Asphalt Field Technician or Level 1 Plant Technician Initial Review & Certification Course.**
9. This is my one and only Update/Refresher Course. My certification expires in a few months. What do I do? **Attend a PennDOT approved asphalt-related conference, seminar, or workshop before your certification expires or you have to apply and attend the appropriate Asphalt Field Technician or Level 1 Plant Technician Initial Review & Certification Course and meet the requirements for the Review and Certification Course.**
10. What counts as continuing education? **Please refer to PennDOT Publication 351**
11. How do I document my 500 hours and who is responsible for maintaining those records? **Keep a diary of projects, time & locations, and if possible, have it documented/signed by a Project Supervisor. The individual certified technician is responsible for maintaining their own records.**
12. Who checks my 500 hours? **PennDOT**
13. No one has ever checked my certification on the job site. Why do I need this? **PennDOT may check it tomorrow; however, one of the reasons you may not have been checked is because the District knows your history.**
14. I am the Lead Inspector and I never get out onto the paver. What do I do for 500 hours experience? **It is your responsibility to make sure PennDOT works with you to meet the requirements. If not, you have to start the certification process over.**
15. What do I do with my paper certification renewal application after I get it signed by PennDOT? **Submit the signed application, record of hours, list of training, and payment for NECEPT fees to NECEPT c/o PSU/The Larson Transportation Institute, 201 Transportation Research Bldg, University Park, PA 16802.**

NECEPT

5

# PennDOT Publication 351 - FAQs

1. Which publication covers the initial certification, certification renewal, and applications procedures? PennDOT Pub 351
2. Where can I find Publication 351? It can be downloaded from the PennDOT web site (www.PennDOT.gov/) by clicking on the link for "Forms, Pubs & Maps", then click the search button and type "Pub 351", then click the magnifying glass, and then select "Publication 351" from the search results. It is also available on the NECEPT website under training: http://www.superpave.psu.edu/Training/.
3. The initial certification and subsequent certification renewal periods will be for how many years? Five (5) years

NECEPT

6

## PennDOT Publication 351 - FAQs

4. In order to qualify for a Level 1 Asphalt Plant Technician – Initial Certification, or for Asphalt Field Technician – Initial Certification, the applicant must have how many hours of documented experience in asphalt testing? A minimum 500 hours obtained within the past three (3) years.

5. What are the requirements for certification renewal of a Field Technician or Level 1 Plant Technician? The applicant must have 500 hours of documented technician experience in asphalt paving within the previous five (5) years of certification. The applicant must also have attended one (1) NECEPT Update/Refresher Course and one (1) PennDOT approved asphalt-related annual conference, seminar, or workshop within the previous five (5) years or received a Certificate of Training from NECEPT's Technician Update/Refresher Course for two (2) out of the previous five years. Then, submit either an online registration or a completed and PennDOT signed Certification Renewal Application Form after all requirements have been met.

7

## PennDOT Publication 351 - FAQs

6. How many retests is each applicant allowed before they have to repeat the corresponding 2-1/2 day review and certification course? **One (1)**

7. I lost my card. What do I do? Submit a request in writing to NECEPT and include your name, NECEPT ID #, mailing address, and type of certification.

8. I do not have the 500 hours of documented experience in asphalt paving required for certification renewal. Will I get certification renewal? No, you will have to apply and attend the appropriate Asphalt Field Technician or Level 1 Plant Technician Initial Review & Certification Course.

8

# PennDOT Publication 351 - FAQs

9. This is my one and only Update/Refresher course. My certification expires in a few months. What do I do? Attend a PennDOT approved asphalt-related conference, seminar, or workshop before your certification expires or you have to apply and attend the appropriate Asphalt Field Technician or Level 1 Plant Technician Initial Review & Certification Course and meet the requirements for the Review and Certification Course.

10. What counts as continuing education? Refer to PennDOT Publication 351.

11. How do I document my 500 hours and who is responsible for maintaining those records? Keep a diary of projects, time & locations, and if possible, have it documented/signed by a Project Supervisor. The individual certified technician is responsible for maintaining his or her own records.

NECEPT

9

# PennDOT Publication 351 - FAQs

12. Who checks my 500 hours? PennDOT

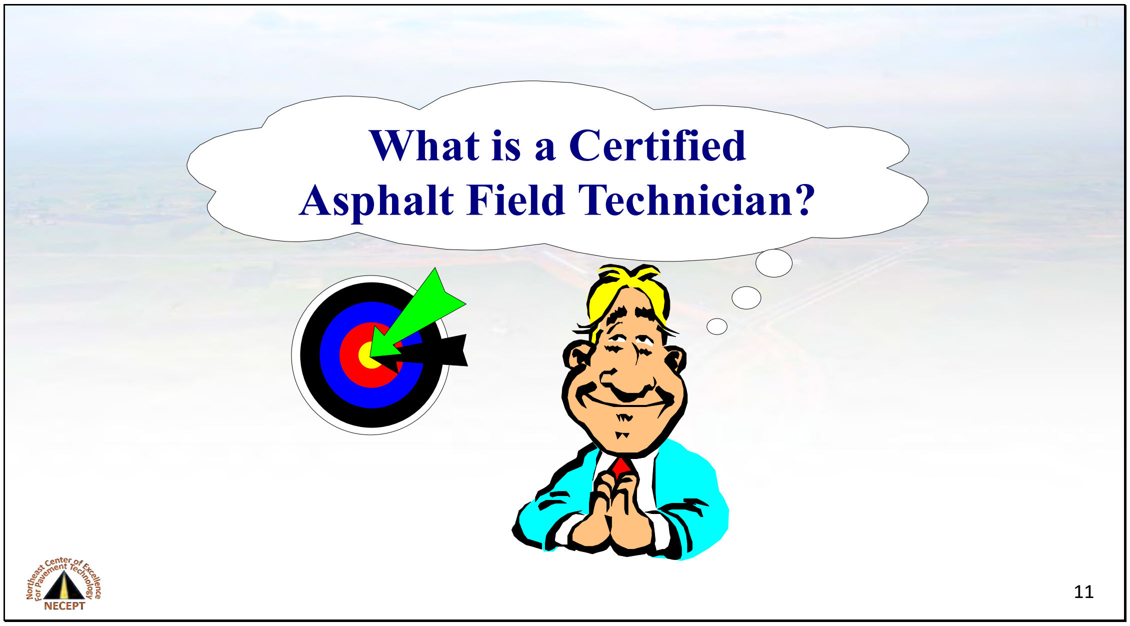
13. No one has ever checked my certification on the job site. Why do I need this? PennDOT may check it tomorrow; however, one of the reasons you may not have been checked is because the District knows your history.

14. I am the Lead Inspector and I never get out near the paver. What do I do for 500 hours experience? It is your responsibility to make sure PennDOT works with you to meet the requirements. If not, you have to start the certification process over.

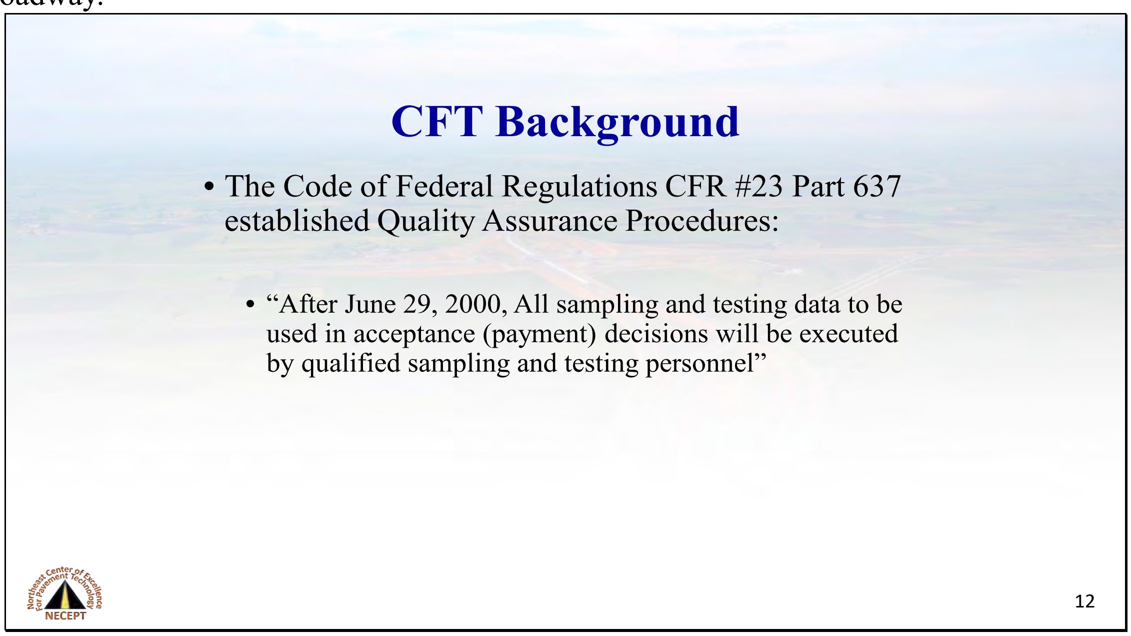
15. What do I do with my certification renewal application after I get it signed by PennDOT? Submit the signed application, record of hours, list of training, and payment for NECEPT fees to NECEPT c/o PSU/The Larson Transportation Institute, 201 Transportation Research Bldg., University Park, PA 16802.

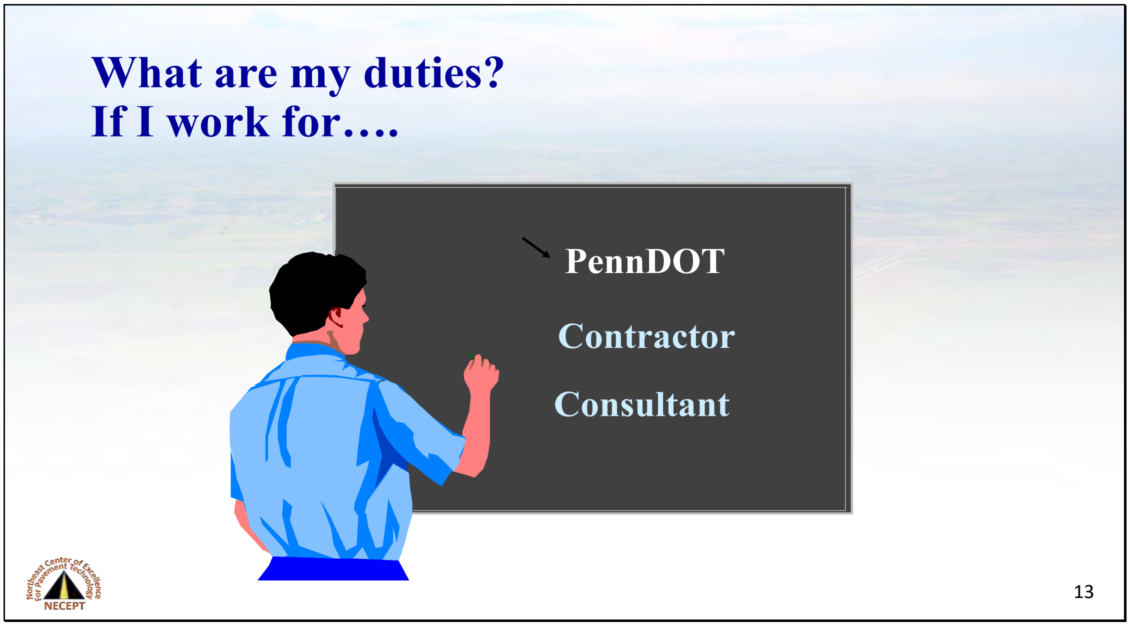
NECEPT

10

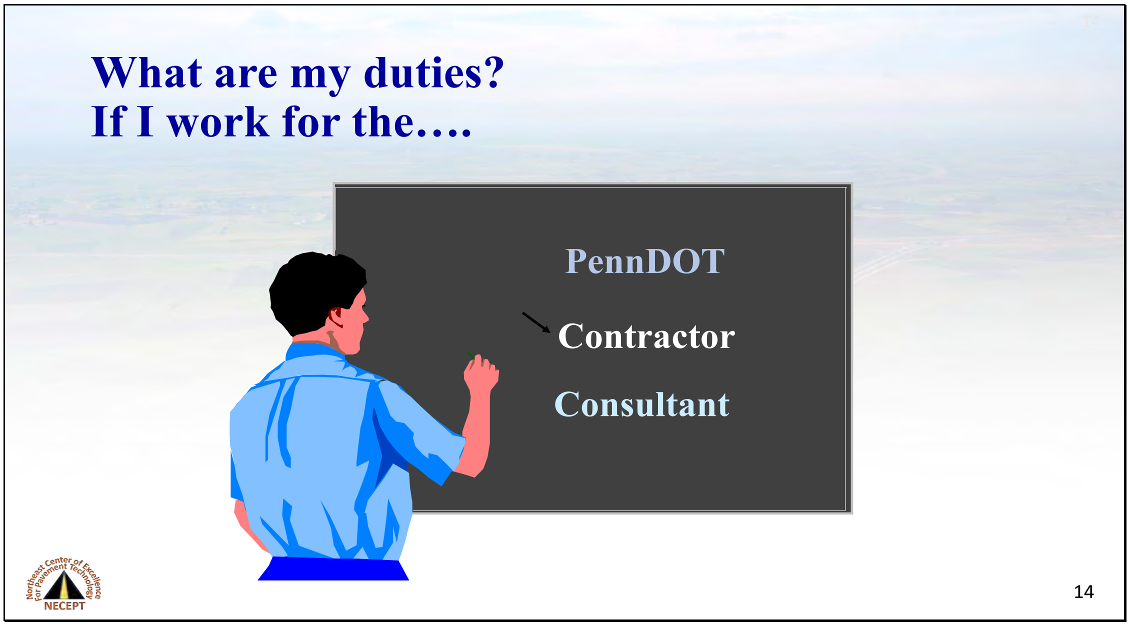



A Certified Asphalt Field Technician is an individual with at least 500 hours experience in the placement or construction of Asphalt Paving Mixtures. They have to have an understanding of asphalt mixes and asphalt terminology. Their goal is to ensure that a quality pavement is placed on the roadway.






If the technician works for PennDOT it is his responsibility to make sure the Contractor fulfills all of the requirements spelled out in the contract. This includes meeting all the applicable specifications, material quality requirements, and quantity of material called for in the contract. It is his responsibility to ensure that the contractor follows his quality control plan. Failure to meet all these conditions will lead to the loss of his certification and the possible loss of his position.




If he is employed by the Contractor, he may answer to the foreman, the superintendent, the person in charge of quality control, or he may have the authority to make changes. His job is to ensure that the company fulfills the requirements of the contract and follows the quality control plan. If problems occur it is his responsibility to inform the proper individual who then can initiate corrective action, or if it is his responsibility move to correct the problem. Failure to react in a acceptable manner can lead to loss of certification and/or be deemed fraudulent.


In most cases, the certified technician working for the Consultant will be on the project representing PennDOT, however, he could be representing the Contractor. Once again depending on who he is representing will govern his actions. The goal of all technicians on a project is to ensure that a quality product is being produced.

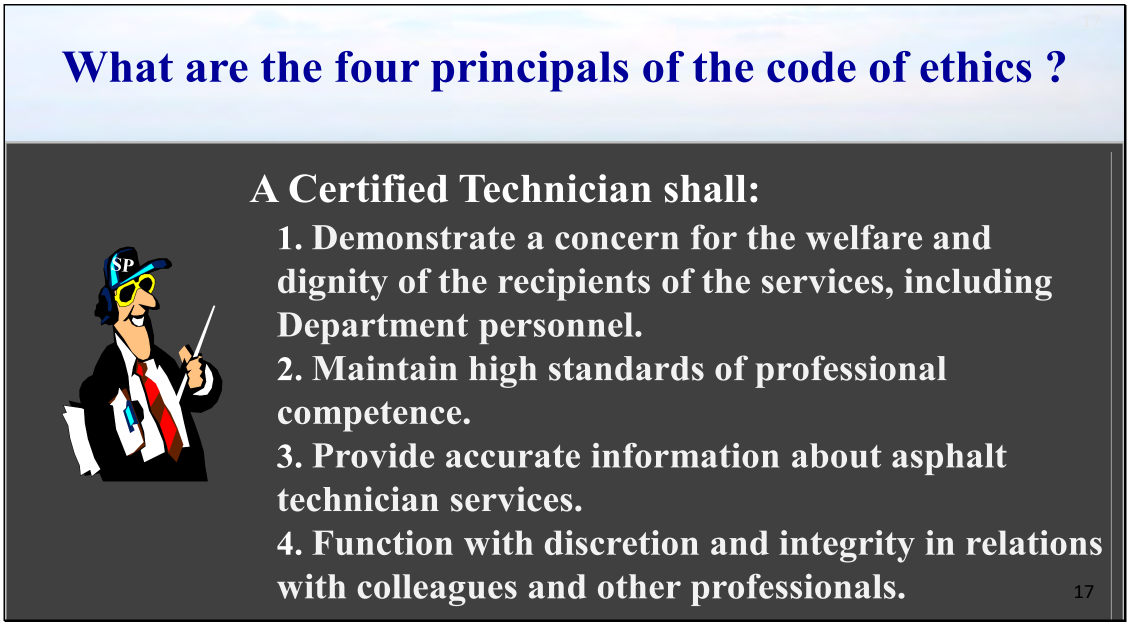
## What are your responsibilities ?

### A Certified Technician shall:

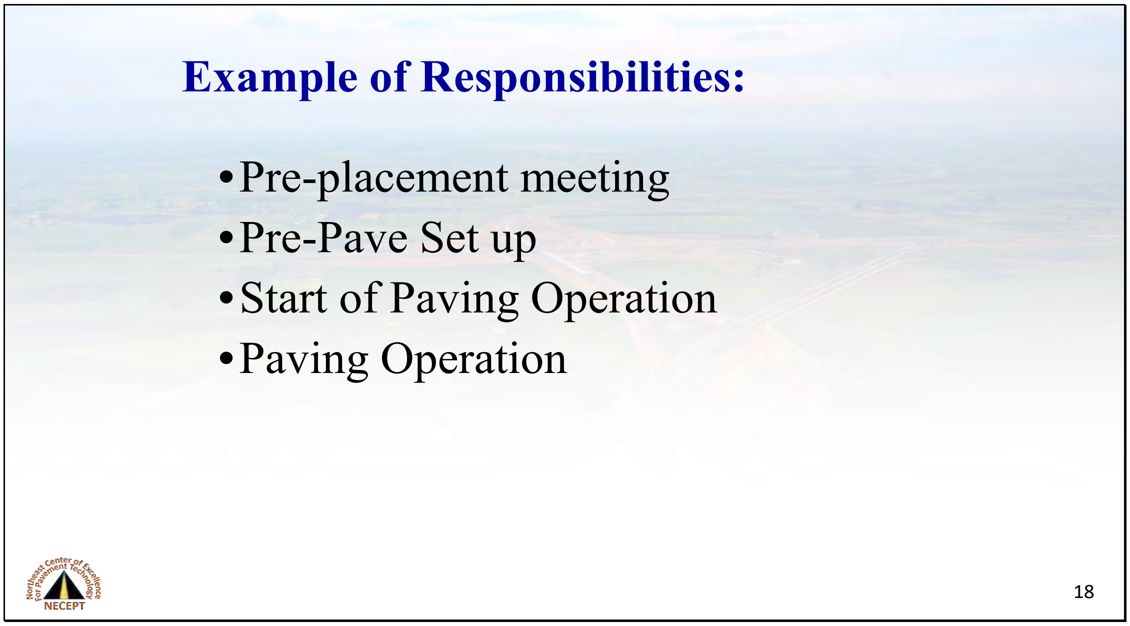

1. Know the specifications
2. Know the PTMs needed to ensure quality control
3. Be familiar with paving operations
4. Recognize mix and paving deficiencies
5. Be able to recommend corrective action
6. Adhere to the four principals of the code of ethics

16

The duties of a certified field technician (CFT) may vary depending on his employer, however his responsibilities as a CFT should remain the same, to ensure a quality paving project. In order to function, the CFT must have a working knowledge of the Specifications and the field PTM's that are used to check and ensure a quality project. The CFT must be familiar with all stages of the paving operation; must be able to recognize mix and paving defects; and should also be able to RECOMMEND any needed corrective action.

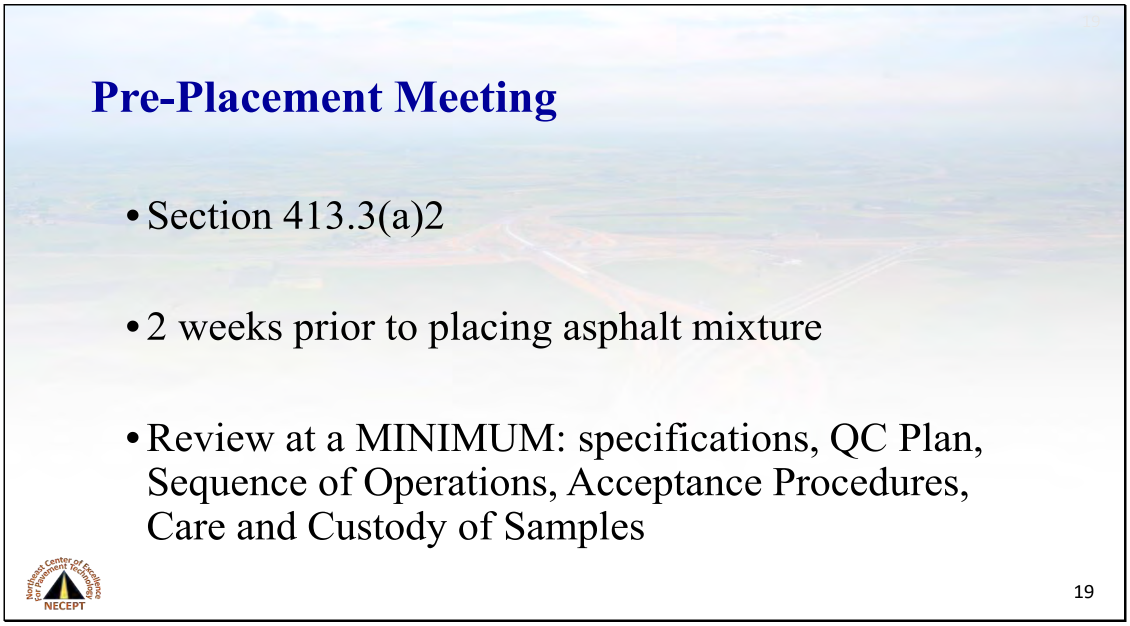



The CFT should at all times adhere to the four principles of the code of ethics which are stated in Pub 351 with expanded discussion on each one. The basic four principles as stated in Pub 351 are shown on the slide.

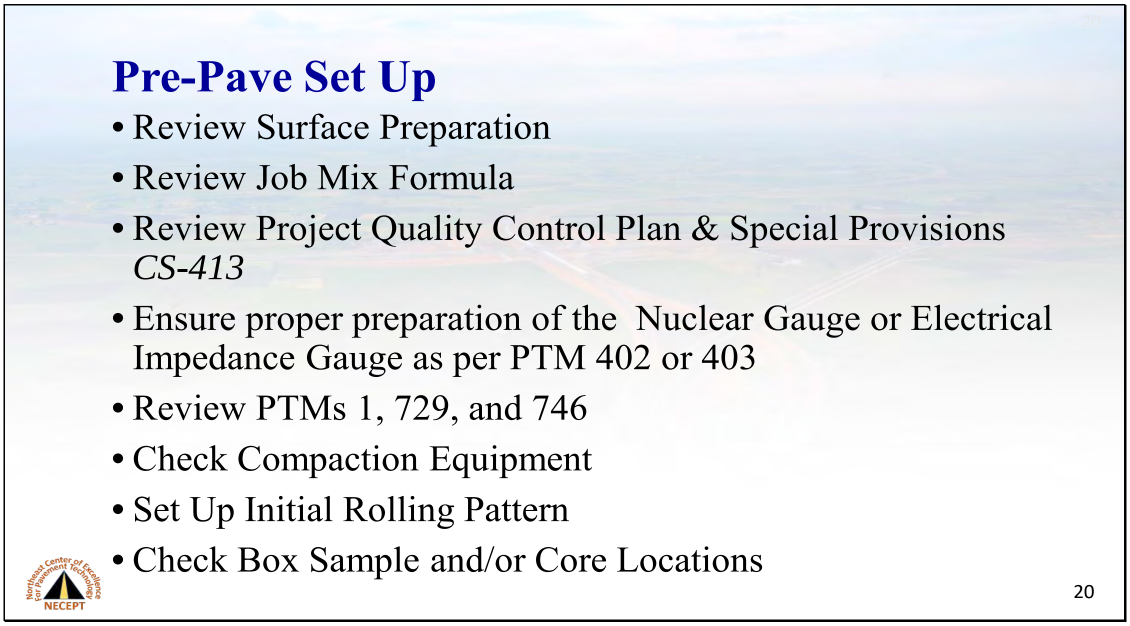



The following few slides are an illustration of one companies certified technician's duties. It also illustrates the commitment the company has made to quality. Remember that this example will vary from company to company and also within the Department.

Pre-placement Meeting Ref Pub 408 Sec. 413.3 (a) 2 Effective April 6, 2012




This meeting should also cover monolithic paving of shoulders/mainline, non-testable areas, AET sampling procedures, and any other issues that experience has shown to be problematic.




Each field technician should have an basic understanding of the information provided on a job mix formula. This will provide him with a starting point in the compaction process as well as giving a hint as to how the mix might behave in general and what type of appearance to expect. This is information the technician needs to know if he is going to successfully manage the mix and, if necessary, troubleshoot a problem. The technician could keep a correlation Log where he could check if the material being used, had been placed before. How did it react, how did the core results compare to the gauge.

Review the project Quality Control Plan and the Project Item Summary Sheet and any Special Provisions, as necessary.

Regarding the nuclear or electrical impedance gauges; check gauge, clean and lubricate if necessary; run standard count if necessary and record in log; fill out Report (ambient and surface temperature, subgrade or road surface condition , equipment in use, field Inspector in charge); plug density number into gauge.

Check over compaction equipment (or make sure the operator or mechanic has): water systems; amplitude settings; drums, scrapers and pads; on pneumatic rollers check tire pressure, scrapers and pads, ballast if applicable, water/soap if applicable.

Set up initial rolling pattern with operators: number of passes, distance from paver or other rollers/rolling zone/temperature zone, overlap, speed, frequency/amplitude settings, vibratory/static, both drums/one drum.

Make the necessary arrangements if someone other than you is pulling box samples. Complete the necessary paperwork, checking locations for box samples and cores.

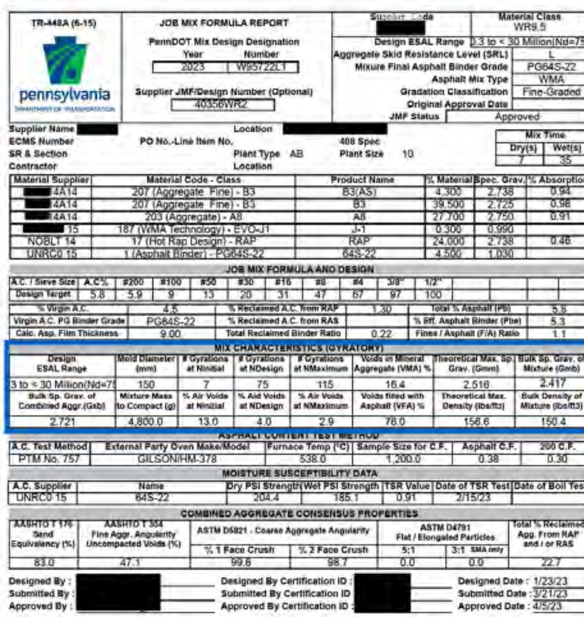
## Surface Preparation

- Paving notches according to RC-28
- All base repairs completed
- All surfaces clean
- Tack Distributor calibrated (PTM 747)

NECEPT

21

## Job-Mix Formula



TR-448A (6-15)

pennsylvania DEPARTMENT OF TRANSPORTATION

**JOB MIX FORMULA REPORT**

PennDOT Mix Design Designation

| Year | Number |
|---|---|
| 2023 | W95722L1 |

Supplier JMF/Design Number (Optional): 40356WR2

Supplier Code: [redacted]

Material Class: WR9.5

| | |
|---|---|
| Design ESAL Range | 0.3 to < 30 Million(Nd=75 |
| Aggregate Skid Resistance Level (SRL) | L |
| Mixure Final Asphalt Binder Grade | PG64S-22 |
| Asphalt Mix Type | WMA |
| Gradation Classification | Fine-Graded |
| Original Approval Date | |
| JMF Status | Approved |

Supplier Name [redacted] Location [redacted]
ECMS Number PO No.-Line Item No. 408 Spec
SR & Section Plant Type AB Plant Size 10
Contractor Location

| Mix Time | |
|---|---|
| Dry(s) | Wet(s) |
| 7 | 35 |

| Material Supplier | Material Code - Class | Product Name | % Material | Spec. Grav. | % Absorption |
|---|---|---|---|---|---|
| [redacted] 4A14 | 207 (Aggregate Fine) - B3 | B3(AS) | 4.300 | 2.738 | 0.94 |
| [redacted] 4A14 | 207 (Aggregate Fine) - B3 | B3 | 39.500 | 2.725 | 0.98 |
| [redacted] 4A14 | 203 (Aggregate) - A8 | A8 | 27.700 | 2.750 | 0.91 |
| [redacted] 15 | 187 (WMA Technology) - EVO-J1 | J-1 | 0.300 | 0.990 | |
| NOBLT 14 | 17 (Hot Rap Design) - RAP | RAP | 24.000 | 2.738 | 0.46 |
| UNRC0 15 | 1 (Asphalt Binder) - PG64S-22 | 64S-22 | 4.500 | 1.030 | |

**JOB MIX FORMULA AND DESIGN**

| A.C. / Sieve Size | A.C.% | #200 | #100 | #50 | #30 | #16 | #8 | #4 | 3/8" | 1/2" | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Design Target | 5.8 | 5.9 | 9 | 13 | 20 | 31 | 47 | 67 | 97 | 100 | | | | |

| | | | | | |
|---|---|---|---|---|---|
| % Virgin A.C. | 4.5 | % Reclaimed A.C. from RAP | 1.30 | Total % Asphalt (Pb) | 5.8 |
| Virgin A.C. PG Binder Grade | PG64S-22 | % Reclaimed A.C. from RAS | | % Eff. Asphalt Binder (Pbe) | 5.3 |
| Calc. Asp. Film Thickness | 9.00 | Total Reclaimed Binder Ratio | 0.22 | Fines / Asphalt (F/A) Ratio | 1.1 |

**MIX CHARACTERISTICS (GYRATORY)**

| Design ESAL Range | Mold Diameter (mm) | # Gyrations at Ninitial | # Gyrations at NDesign | # Gyrations at NMaximum | Voids in Mineral Aggregate (VMA) % | Theoretical Max. Sp. Grav. (Gmm) | Bulk Sp. Grav. of Mixture (Gmb) |
|---|---|---|---|---|---|---|---|
| 3 to < 30 Million(Nd=75 | 150 | 7 | 75 | 115 | 16.4 | 2.516 | 2.417 |
| **Bulk Sp. Grav. of Combined Aggr.(Gsb)** | **Mixture Mass to Compact (g)** | **% Air Voids at Ninitial** | **% Aid Voids at NDesign** | **% Air Voids at NMaximum** | **Voids filled with Asphalt (VFA) %** | **Theoretical Max. Density (lbs/ft3)** | **Bulk Density of Mixture (lbs/ft3)** |
| 2.721 | 4,800.0 | 13.0 | 4.0 | 2.9 | 76.0 | 156.6 | 150.4 |

**ASPHALT CONTENT TEST METHOD**

| A.C. Test Method | External Party Oven Make/Model | Furnace Temp (°C) | Sample Size for C.F. | Asphalt C.F. | 200 C.F. |
|---|---|---|---|---|---|
| PTM No. 757 | GILSON/HM-378 | 538.0 | 1,200.0 | 0.38 | 0.30 |

**MOISTURE SUSCEPTIBILITY DATA**

| A.C. Supplier | Name | Dry PSI Strength | Wet PSI Strength | TSR Value | Date of TSR Test | Date of Boil Test |
|---|---|---|---|---|---|---|
| UNRC0 15 | 64S-22 | 204.4 | 185.1 | 0.91 | 2/15/23 | |

**COMBINED AGGREGATE CONSENSUS PROPERTIES**

| AASHTO T 176 Sand Equivalency (%) | AASHTO T 304 Fine Aggr. Angularity Uncompacted Voids (%) | ASTM D5821 - Coarse Aggregate Angularity | | ASTM D4791 Flat / Elongated Particles | | Total % Reclaimed Agg. From RAP and / or RAS |
|---|---|---|---|---|---|---|
| | | % 1 Face Crush | % 2 Face Crush | 5:1 | 3:1 SMA only | |
| 83.0 | 47.1 | 99.6 | 98.7 | 0.0 | 0.0 | 22.7 |

Designed By : [redacted] Designed By Certification ID : [redacted] Designed Date : 1/23/23
Submitted By : Submitted By Certification ID Submitted Date : 3/21/23
Approved By : Approved By Certification ID : Approved Date : 4/5/23

NECEPT

22

Here is an example of a Job Mix Formula Report. It has several sections and we will focus on the blocked section shown. A full-size version is available at the end of this module.

## Job-Mix Formula

| MIX CHARACTERISTICS (GYRATORY) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Design ESAL Range | Mold Diameter (mm) | # Gyrations at Ninitial | # Gyrations at NDesign | # Gyrations at NMaximum | Voids in Mineral Aggregate (VMA) % | Theoretical Max. Sp. Grav. (Gmm) | Bulk Sp. Grav. of Mixture (Gmb) |
| 0.3 to < 3 Million | 150 | 7 | 75 | 115 | 13.8 | 2.537 | 2.436 |
| Bulk Sp. Grav. of Combined Aggr.(Gsb) | Mixture Mass to Compact (g) | % Air Voids at Ninitial | % Aid Voids at NDesign | % Air Voids at NMaximum | Voids filled with Asphalt (VFA) % | Theoretical Max. Density (lbs/ft3) | Bulk Density of Mixture (lbs/ft3) |
| 2.701 | 4,740.0 | 14.5 | 4.0 | 2.6 | 71.0 | 157.9 | 151.6 |

Note that:
Theoretical Maximum Density (157.9 lbs/ft$^3$) = 62.24 × Theor. Max. Sp. Gr. (2.537)

This value is noted on the JMF and is the number to be entered into the nuclear density gauge.

Northeast Center of Excellence for Pavement Technology NECEPT

23

This portion of the report shows the gyratory mix characteristics which indicate the mix was designed for a project with traffic loads of 0.3 million to less than 3 million ESALS and 75 gyrations. The Ndes 75 is the number of gyrations required to produce a density in the mix that is equivalent to the expected density in the field after the indicated amount of traffic. In the mix design process, an asphalt content is selected that will provide 4 percent air voids when the mix is compacted to design number of gyrations.

# Form CS-413 Quality Control Plan

CS-413 (4-20)

pennsylvania
DEPARTMENT OF TRANSPORTATION

**MINIMUM QUALITY CONTROL PLAN FOR FIELD ASPHALT PAVING OPERATION**

(Attach additional sheets as necessary)

Project # ______ State Route (S.R.) ______ Section ______ County ______

Project Name ______ Specification ______ Change ______

**I. ORGANIZATIONAL CHART** Contractor ______

| Personnel | Full Name | Responsibilities |
| --- | --- | --- |
| A. Company Representative | ______ | Oversees entire project |
| B. Superintendent | ______ | Oversees paving operations |
| C. Paving Foreperson | ______ | Oversees placement of material and related operations. |
| D. Certified Nuclear Gauge Operator | ______ | Develops rolling pattern and compaction data and acts as a point of contact for PennDOT personnel for all field testing and sampling. (Nuclear Gauge Operator does not need to be NECEPT Certified) |
| Operator's Certification No. | ______ | |
| E. Asphalt Field Technician | ______ | |
| NECEPT Certification No. | ______ | Expiration Date: ______ |

Note: Problems related to asphalt mixture or paving operations shall be directed to the paving foreperson. If problems are still unresolved they will be elevated to the superintendent then directed to the company representative if needed.

NECEPT

24

A Quality Control Plan is required by the specifications. Form CS-413 is used to provide the Quality Control Plan. If field operations or personnel deviate from the plan, changes should be noted and initialed by both the contractor and the Department representatives. A full-size version is included in the course material.

## Form CS-413 Quality Control Plan

| Equipment List | Quantity | Manufacturer and Model |
|---|---|---|
| A. Distributer Truck | | |
| B. Paver | | |
| C. Breakdown Roller | | |
| D. Intermediate Roller | | |
| E. Pneumatic-Tire Roller | | |
| F. Finish Roller | | |
| G. Material Transfer Vehicle (As specified) | | |

**II. TESTING PLAN**

A. Compaction Control
   1. Compaction will be controlled in accordance with Section 413.3(i).
      a. Pneumatic-tire rollers will be used for compacting scratch courses.
      b. Mechanical tampers will be utilized in areas inaccessible to rollers.

B. Temperature Control
   1. Temperature will be controlled in accordance with Section 413.2 (e) Table A, by checking the first three trucks or until control is established, and a minimum of every fifth truck thereafter. The first three trucks will be tested after any plant breakdowns or production stoppages.
   2. The plant will be contacted when any single check reaches within 5 degrees of the specification limits and the testing frequency will be increased to every load until control is reestablished.

Page 1

C. Segregation will be addressed in accordance with Section 413.3(h)3.

D. Tests for Depth in accordance with Section 413.3(m) and 313.3 (m).

E. The inspector and the contractor's representative will both measure the depth of each sublot according to PTM 737 using the density acceptance samples.
   1. For courses with a designed course depth and accepted by non-movement or optimum rolling pattern, the inspector and the contractor's representative will both calculate the weight per square yard for yield.

F. Density cores will be extracted as soon as possible but no later than the day following the placement in the presence of the inspector. Mat density will be accepted in accordance with 413.3(j).

G. Mixture Acceptance
   1. Lot Acceptance will be performed in accordance with Section 413.3 (h)2.
   2. Certification Acceptance will be in accordance with Section 413.2(i).

Northeast Center of Excellence for Pavement Technology NECEPT

25

Equipment to be used throughout the whole operation must be listed including the details as required in the form. Testing Plan and Acceptance procedures for ALL materials are to be discussed at the pre-placement meeting. Crucially important if shoulders and mainline are paved at the same time with same material. Lot sizes can also be established at this time using plan quantity.

# CS-413 Quality Control Plan

**III. MIX DELIVERY**

A. Trucks will be clean of all foreign materials.
B. No petroleum oils, solvents, or other materials will be used as a release agent in the haul vehicles. The release agent used will be supplied by ______________________ having a trade name of ______________________.
C. Delivery of material will be protected in accordance with 413.3(d)
D. Material will be released for the day's operation according to the details discussed at the pre-pave meeting.
E. An adequate number of trucks will be utilized to facilitate paving continuity.
F. All delivery trucks will be cleaned out at a designated location, not on the roadway in advance of the paving train.
G. Trucks will be loaded, unloaded and handled using practices and procedures that will help prevent segregation.

**IV. SURFACE PREPARATION**

A. All areas will be cleaned of surface debris.
B. Existing vertical and horizontal surfaces will be treated according to 413.3(g)1., or contract requirement.
C. Certification of asphalt materials will be provided as specified.
D. ____________ will be used and applied in accordance with Section 460 or unless indicated otherwise.

| Application Rates for Tack Coat | | Residual Rates for Tack Coat | |
|---|---|---|---|
| New Asphalt Paving | ________ | New Asphalt Paving | ________ |
| Existing Asphalt Paving | ________ | Existing Asphalt Paving | ________ |
| Milled Surface | ________ | Milled Surface | ________ |
| Portland Cement Concrete | ________ | Portland Cement Concrete | ________ |

E. Asphalt mixture will not be placed until the tack coat has adequately cured.

**V. MIX PLACEMENT**

A. Pavers will comply with the requirements of Section 413.3(e) and will be used and operated in accordance with same.
B. Automatic screed controls capable of producing a finished surface of specified evenness and texture will also be used in accordance with Section 413.3(e).

NECEPT

26

# CS-413 Quality Control Plan

**VI. COMPACTION**

A. A sufficient quantity and type of rollers and compaction equipment will be used in accordance with Sections 413.3(f) and 413.3(i).

**VII. JOINT CONSTRUCTION AND COMPACTION**

A. Joints will be offset by approximately 150 mm (6") from the previously placed layer.
B. Surface course longitudinal joints will be placed at the approximate centerline of the roadway for 2 lane roadways and within 300 mm (12") of lane lines for roadways with more than 2 lanes.
C. When specified or otherwise used notched wedge joints will be constructed according to RC-28M of the standard drawings.
D. All transverse joints will be constructed perpendicular to the centerline of the roadway.
E. All joints will meet the required surface tolerances as specified in Section 413.3(l).
F. The entire area of all joint faces will be painted with a coating of the appropriate asphalt material. In accordance with Section 413.3(k)1 & 2.

Page 2

G. Joints will be compacted by the following means: (E. g. - Rolling Hot to Cold Side, etc.)

**VIII. SPECIAL PAVING CONDITIONS**

A. Method of placement and traffic control for intersections and other incidental work will be discussed and agreed upon by the project IIC and paving foreperson no less than 3 days prior to the start of work.
   1. List those work items and agreements as discussed (Attached on a separate sheet).
B. Safety Edge required (RC-25) for binder and wearing courses in accordance with Section 413.3 (h)1e.

NECEPT

27

# CS 413 Quality Control Plan

**IX. PROTECTION OF THE COURSES**
Traffic will not be placed on fresh material unless the temperature is 60° C (140 °F) and stable or lower, as determined by surface thermometers.

**X. AMENDMENTS**
If at any time during the course of the project a change to this quality control plan is agreed necessary by Company Representative (________________) and the Project IIC, it can be amended by strike out and replacement followed by signatures in initial form. A description of the change and reason for amendment should be noted in the Inspector's field diary for confirmation.

**XI. PRE-PAVE MEETING**
Conduct a preplacement meeting with department, contractor and supplier, as well as any other appropriate parties at least two weeks prior to placing asphalt paving mixtures.

**Check All That Apply:**

☐ MTV Required ☐ Saw and Seal Joints ☐ Heavy Duty Membranes ☐ PWL - LTS
☐ Pavement Ride Quality (Section 404) ☐ Longitudinal Joint Density (Section 405) ☐ PWL - HOLA

Complete "Item Number and Mix Designs / Placement and Sampling Details" form on page 4 (additional sheets provided if needed). This form provides details of asphalt placements, mix designs to be used and other valuable information such as proposed Mixture and Density acceptance.

Submitted By: ______________________ Date: __________
Reviewed By: ______________________ Date: __________

NECEPT

28


The Technician should be familiar with the specifications that establish the delivery temperature and check the delivery ticket. Check temperature at paver initially and whenever necessary throughout the day. Check temperature of the mat in the rolling zones and correlate with temperature at paver.

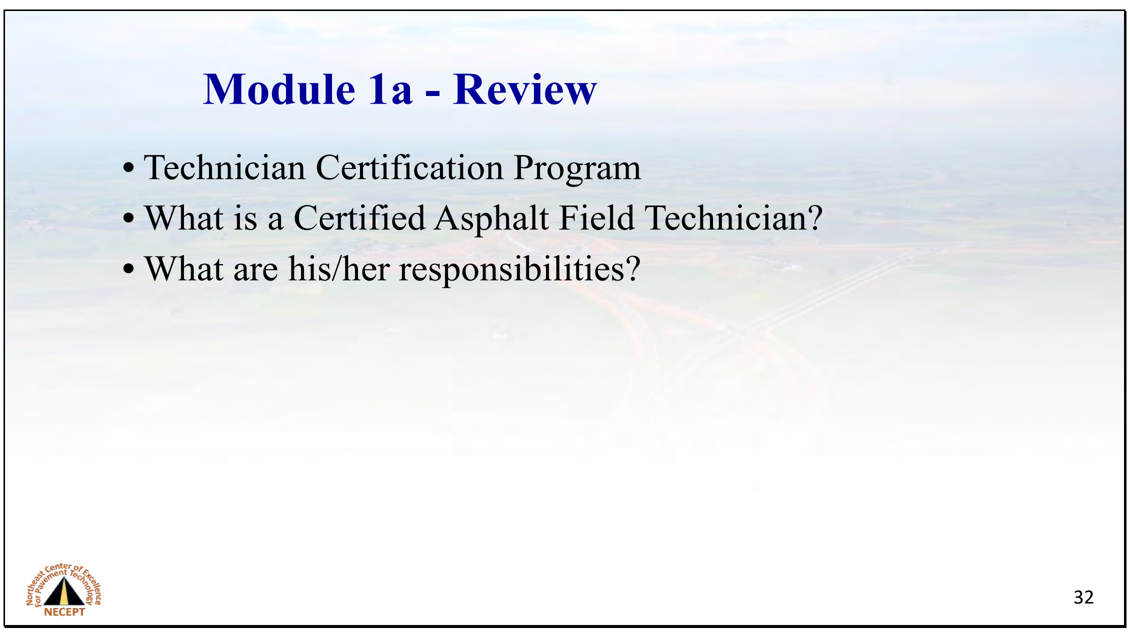
Check initial gauge readings behind primary breakdown roller, check for compacted depth, check for roll out or roll down at free edge of pavement. Work with foreman to consistently achieve the specified depth and width of pavement.

Check mat's general appearance and any irregularities: Excessive movement, creasing, segregation, flushing, screed marks, etc.

Check Transverse and Longitudinal Joints: Make adjustments as necessary in rolling procedures to provide a tight, consistent joint or report to paving foreman when changes are necessary. Witness construction of joints, ensuring proper procedures are followed.
Make any adjustments as required for appearance or compaction purposes or inform the person in charge if the problem is related to paving techniques or equipment. Inform the plant if the problems appear to be material related and do not correct themselves within a reasonable time. If part of the chain of command, inform the Quality Control Manager of any problems encountered during the days production. Always make notes of problems and any corrective action taken, inform QC manager if applicable immediately if corrective actions are not taken or if the problem persists after action has been taken.
Record initial rolling pattern and equipment used.


Continue to monitor the startup operations as necessary and monitor truck exchanges. Continue to monitor compaction and record readings. Take readings following breakdown rolling. Experience has shown that taking readings at more locations in your rolling zone yields better information than taking multiple readings in one spot. Experience and past correlations become an important factor and your confidence in your experience is important. Record any changes in initial rolling pattern and note possible reason for change: ambient temperature, paving speed, etc. Note any equipment problems and inform the proper person. Monitor Paver speed if necessary and note stoppages. Check with plant for change in theoretical density ( morning and mid-day). Check finished product, behind the finish roller. As applicable, determine acceptance coring locations, and make sure acceptance cores are properly taken and packaged for shipment.

Good communications are imperative in making informed decisions in the field. Seek information and communicate with : plant technicians, paving foremen, mechanics, roller operators, QC manager, and the field inspector.


**Module recap.**


PennState
Discussion
pennsylvania
DEPARTMENT OF TRANSPORTATION
NECEPT

# HMA Construction Program

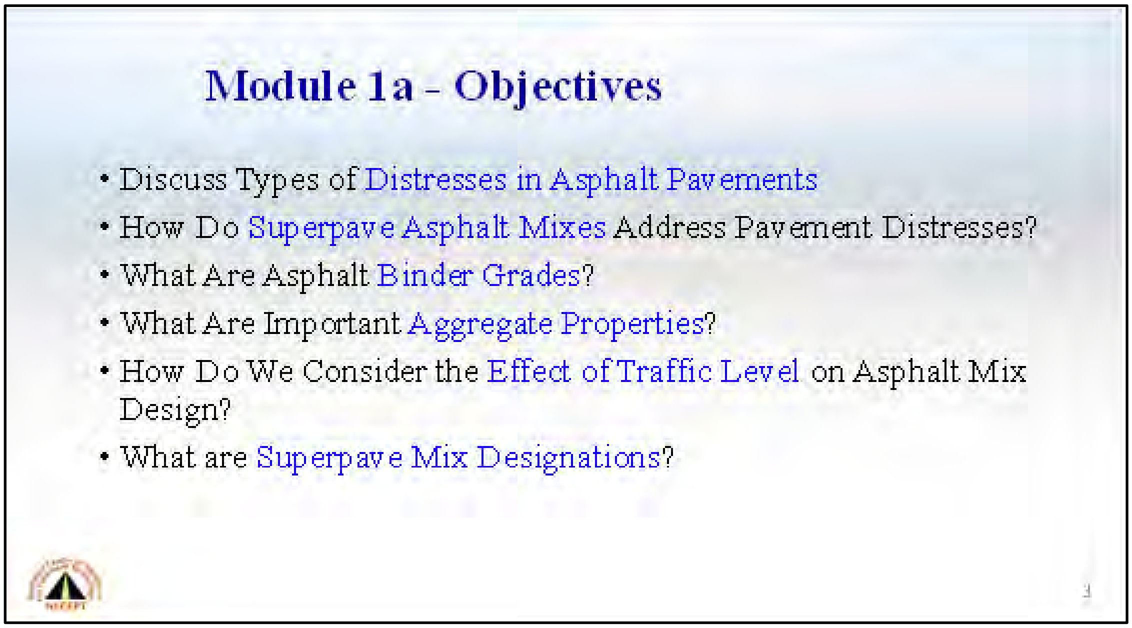
## Certified Asphalt Field Technician

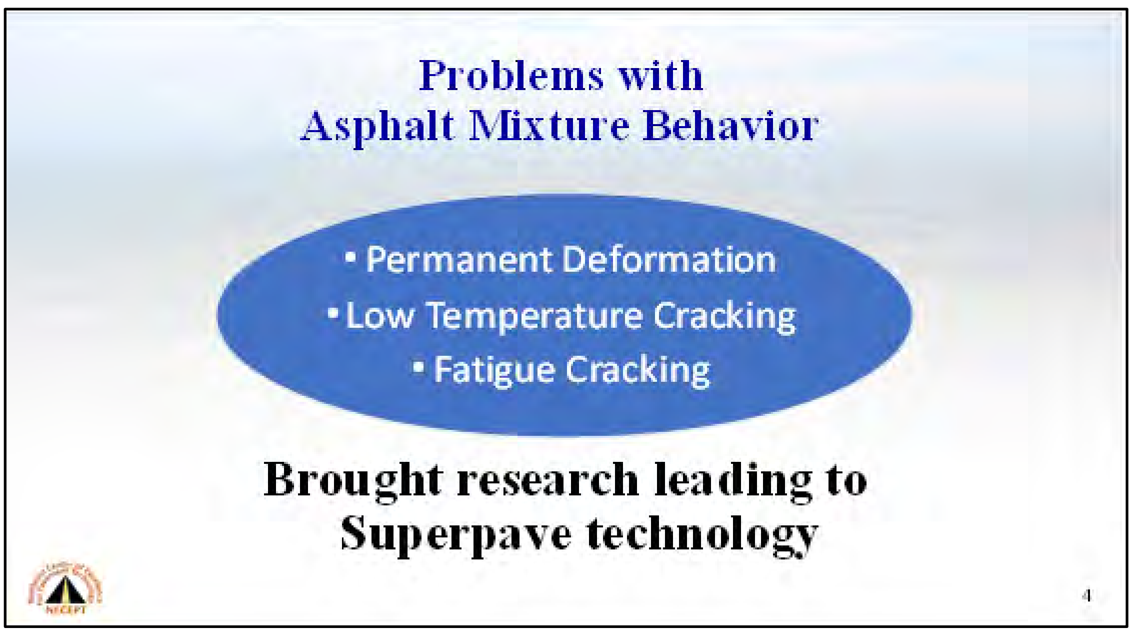
Module 1b
Overview of Superpave
Asphalt Binders & Mixtures


Module 1b will serve as an overview of Superpave. Course participants should be aware of Superpave asphalt mixes that are now specified for Pennsylvania projects. This overview will provide essential information and provide time for questions and clarification.

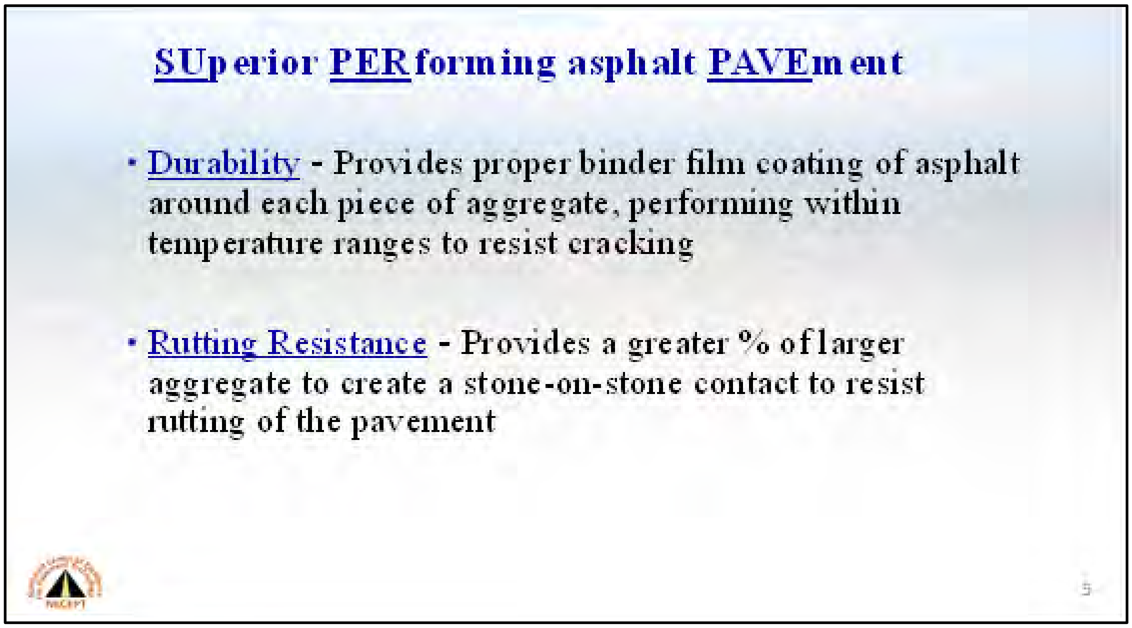

Module 1 will serve as an introduction to the course defining the job and responsibilities of a Certified Asphalt Field Technician followed by an overview of Superpave. Course participants should be aware of Superpave asphalt mixes that are now specified for Pennsylvania projects. This overview will provide essential information and provide time for questions and clarification.


Superpave represents an improved system for specifying asphalt binders and mineral aggregates, developing asphalt mixture design, and analyzing and establishing pavement performance predictions. Although it is a giant step forward in mix design, it is not the end point in our efforts to achieve a better asphalt mixture. We will probably be modifying Superpave for many years to come.

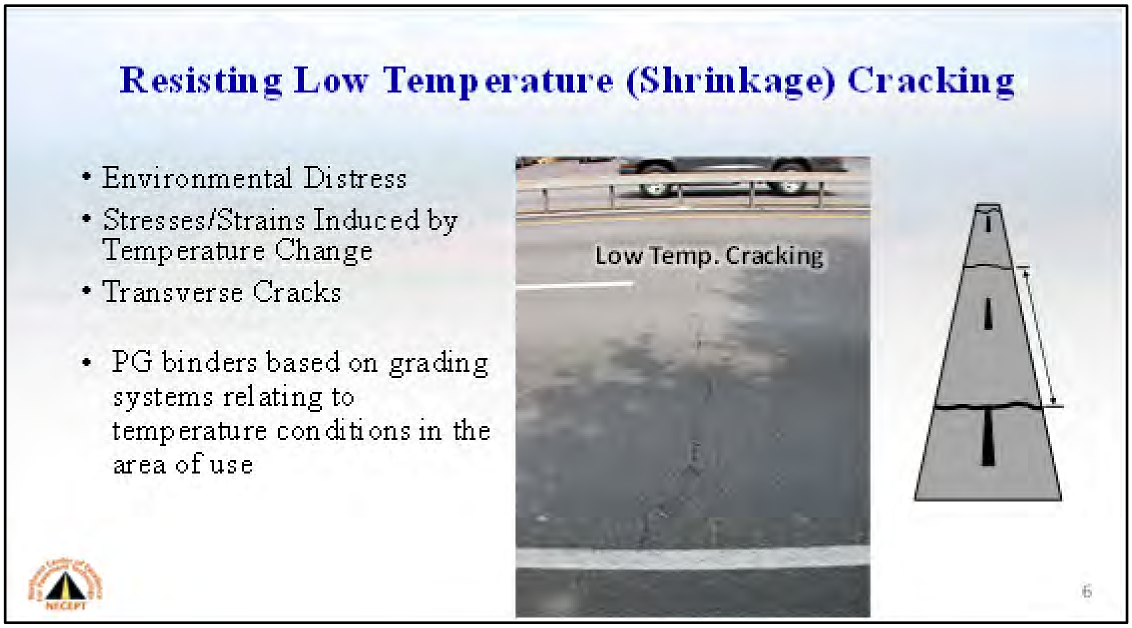


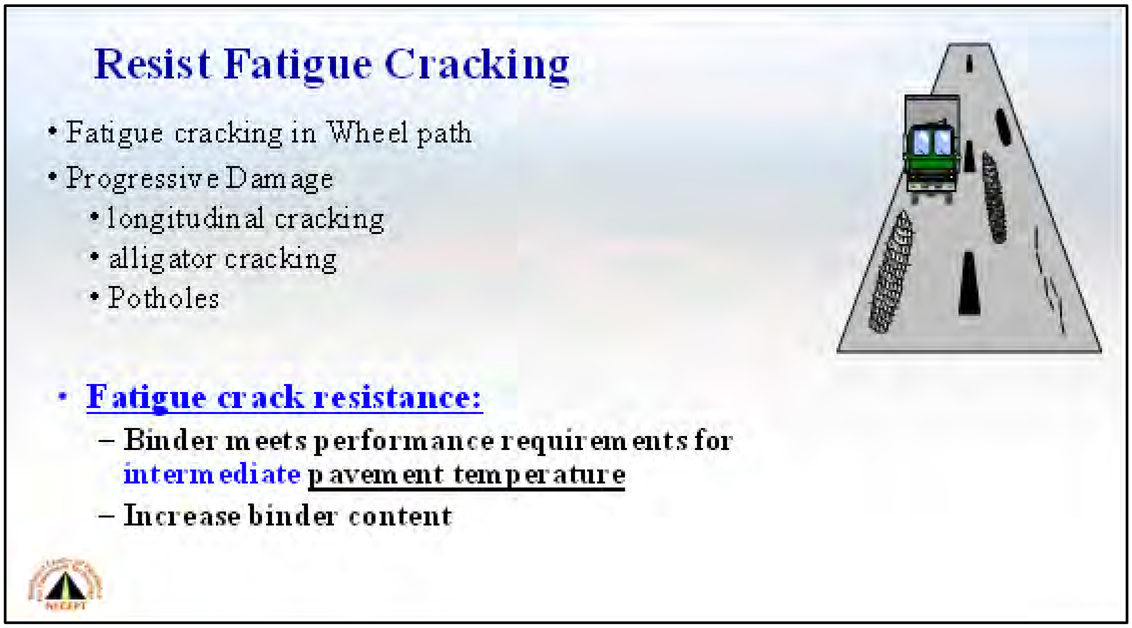

The research that led to the Superpave technology was conducted due to a nationwide problem with rutting and premature cracking of asphalt pavements.




Superpave – Superior Performing Asphalt Pavement – gives us increased durability by providing the proper binder film coating of asphalt around each piece of aggregate with enhanced performance within specified temperature ranges. Superpave also resists rutting by providing a greater percentage of larger aggregates to create more stone-on-stone contact.




Superpave provides an asphalt binder that must maintain stiffness during extended periods of hot weather and remain flexible during very cold temperatures in order to resist low temperature cracking of the pavement. Superpave PG binders are selected based on grading systems that relate to the temperature and traffic conditions of the specific project.

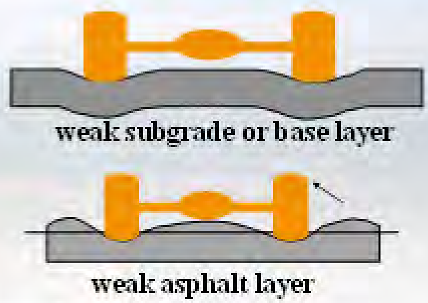



Repeated loading of the asphalt pavement with heavy trucks results in cracks of different shapes in the pavement. Fatigue cracking heavily depends on the amount and quality of the asphalt binder used in the asphalt mixture. The pavement thickness also plays a major role in resistance to fatigue cracking. Heavier loads and higher traffic levels generally require thicker layers of asphalt pavements. It is in the hands of traffic engineers with their ability to predict future traffic loads. Engineers determine the thickness of a given pavement based on vehicle and truck traffic estimates using Equivalent Single Axle Loads (ESALs), sub-grade values and environmental factors.

## Fatigue Cracking

## Resist Rutting

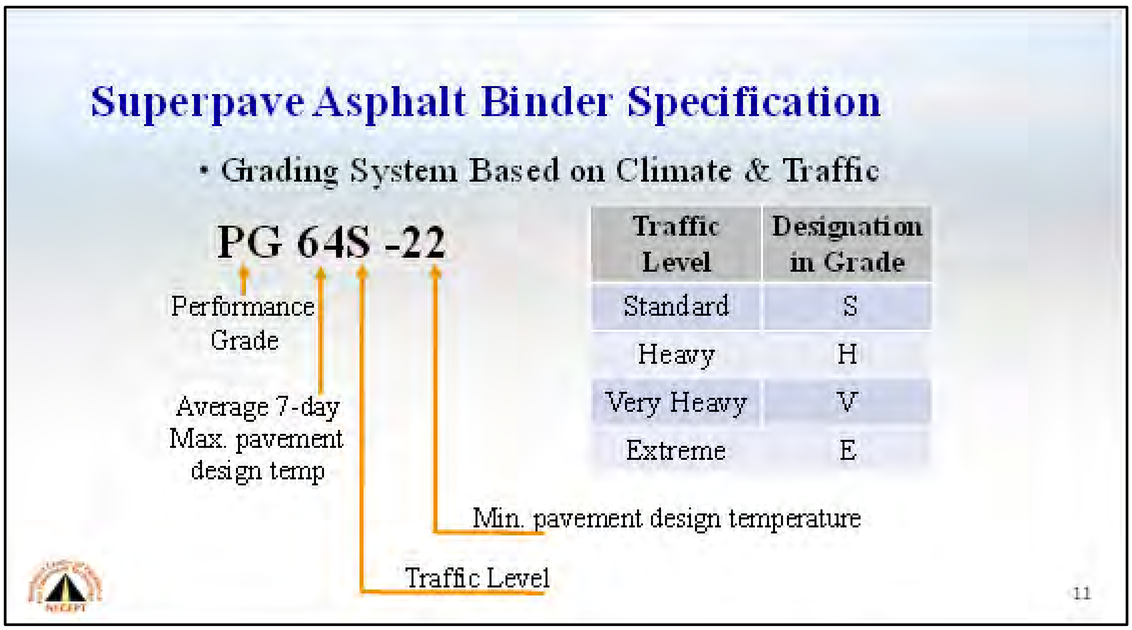
- Rutting in Wheel path
- Progressive Damage




- **Rutting resistance:**
  - Binder meets performance requirements for high pavement temperature
  - High percent of crushed aggregate
  - Stone-to-stone contact

Rutting can occur due to a weak subgrade or base, or it can occur in the top layer over a strong base. The type and amount of binder and aggregate in the mixture can help alleviate rutting. Heavier loads and higher traffic can cause higher permanent deformation in the pavement.


"Plastic flow" due to high loading and high ambient temperatures.




| Traffic Level | Designation in Grade |
|---|---|
| Standard | S |
| Heavy | H |
| Very Heavy | V |
| Extreme | E |

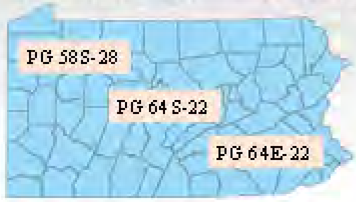
The standard PG (Performance Grade) binder used in Pennsylvania is a PG 64-22 which is similar to the old AC 20 . The PG of binder is defined in degrees Celsius. Below is a conversion of degrees Celsius (°C) to Fahrenheit (°F). For example, -22C is equivalent to -7.6F.

**64 -22C = 147.2-7.6°F**
**58-28C = 136.4-18.4 °F**
**76-22C = 168.8-7.6 °F**

## Superpave Asphalt Binder Specification

- **Grades available**

3 Standard Performance Grade (PG) Binders




PG 58S-28 ≈ AC - 10

PG 64S-22 ≈ AC - 20

PG 64E-22 (PG 76-22)
≈Polymer
Modified Asphalt Binder for High Traffic Volume Highways

**Note: Other grades available per PennDOT special provision*

12

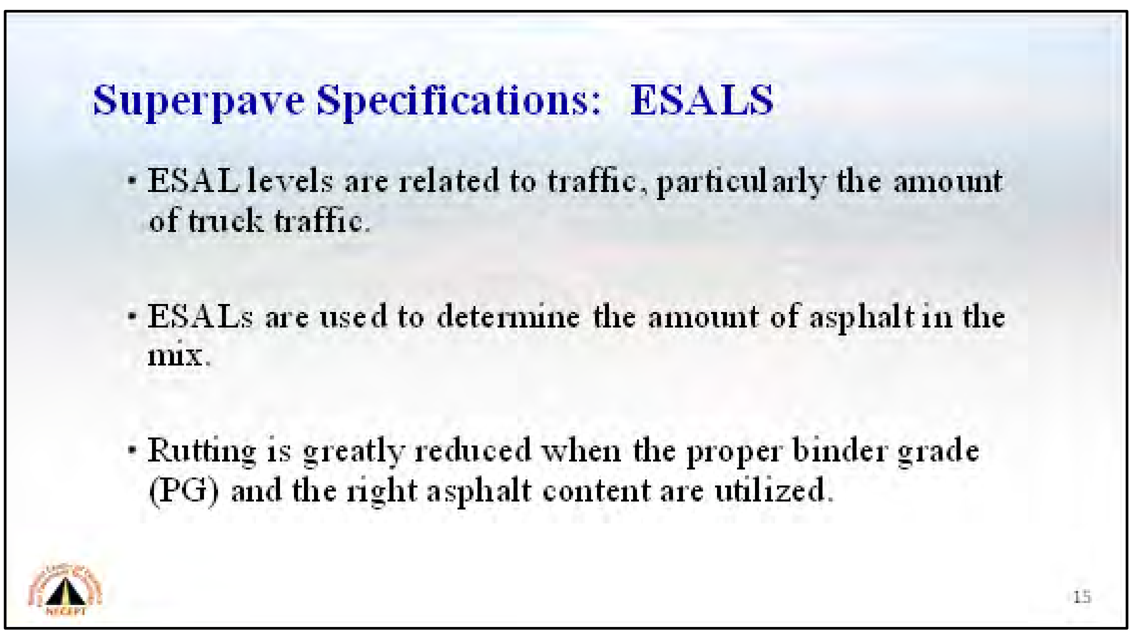
In the colder regions of the state a PG 58-28 can be used to help with the temperature changes. This material is softer than PG 64-22 and is for **non-heavy duty** traffic situations. The PG 64E-22 binder is an asphalt on steroids that can be used in areas with heavier truck traffic to alleviate rutting. This is a polymer modified asphalt binder that can increase the cost of material but is needed for enhanced performance with heavy truck traffic and high-volume highways.

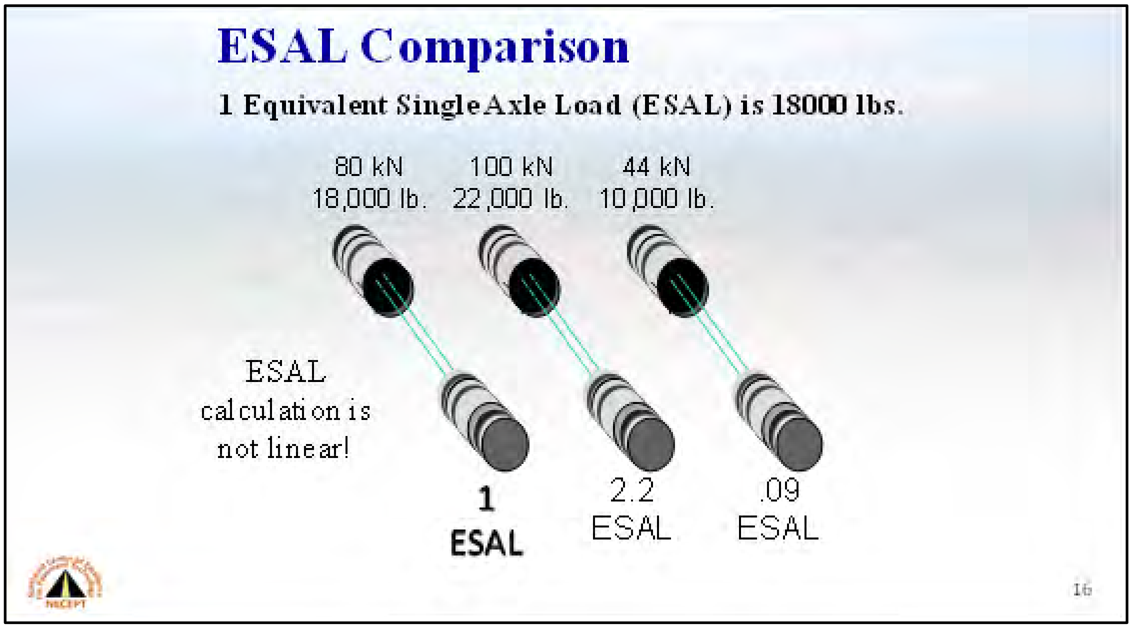
## PennDOT MSCR Specification (AASHTO M 332)

| Traffic Level (million ESAL | Jnr @ 3.2 KPa Stress Test Temp. = 64°C | Binder Grade |
|---|---|---|
| < 3 | < 4.5 | Standard (S) |
| >3 and < 10 | < 2.0 | Heavy (H) |
| >10 and < 30 | < 1.0 | Very Heavy (V) |
| > 30 | < 0.5 | Extreme (E) |

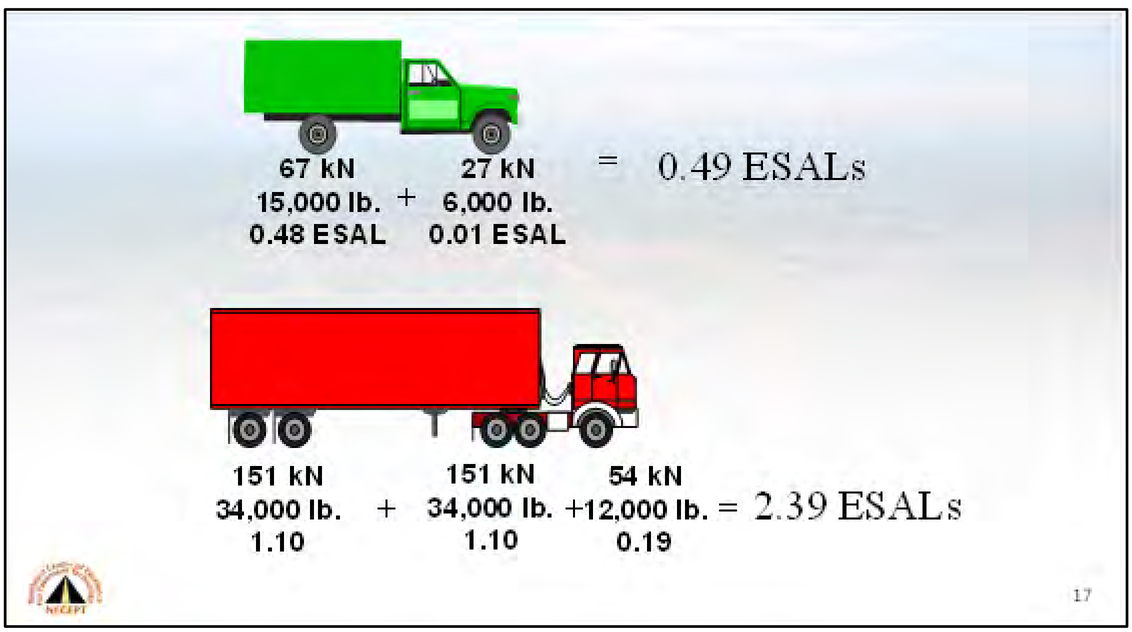
**Determine $J_{nr}$ (Creep Compliance)**


With aggregates, the consensus and source properties are necessary for building a good aggregate interlock into the structural skeleton of the asphalt mixture. The level of these requirements varies with the amount of traffic, again making the ESAL estimates for the pavement extremely important. Source properties can be specified based on local experience and availability.






An ESAL is an (18,000 pound) Equivalent Single Axle Load.
DO NOT TRY TO DUPLICATE THE MATH !!!!!!!!!!!!!!




Not all trucks are the same. A typical 80,000 pound tractor trailer would have 2.39 ESALs while the box truck shown at the top would be 0.49 ESALs.

## ESAL Comparison

- In road design, for a 20-year pavement life, one fully loaded tractor-trailer per day would equal approximately 17,450 ESALs

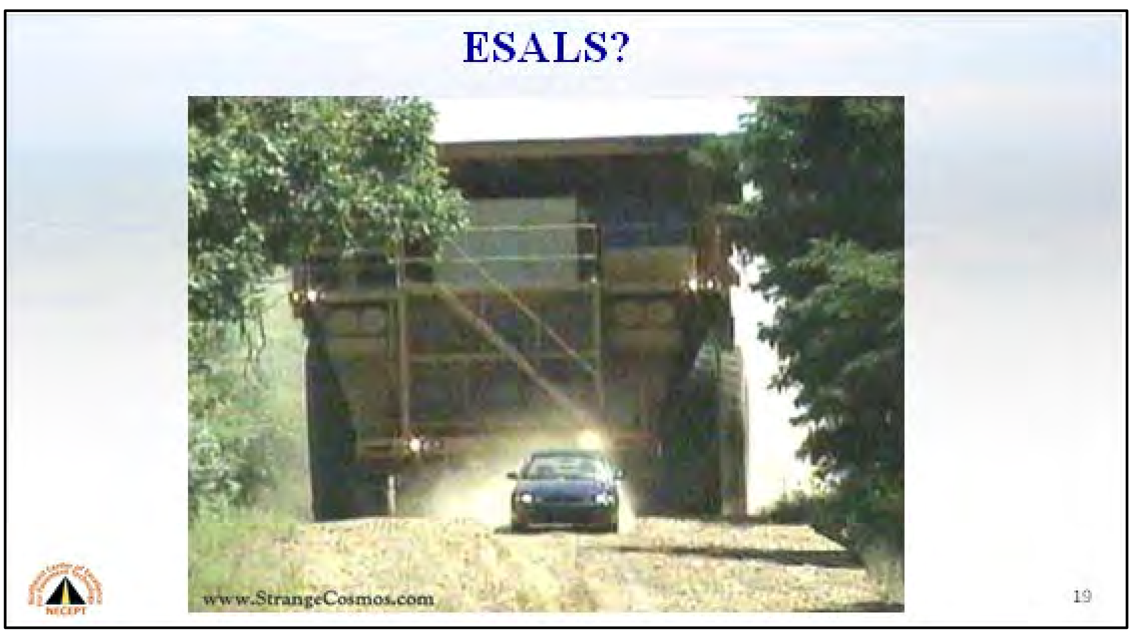
(To get this value, it is assumed that growth rate is 0%)

**Typical ESAL ranges for Asphalt Mixes**

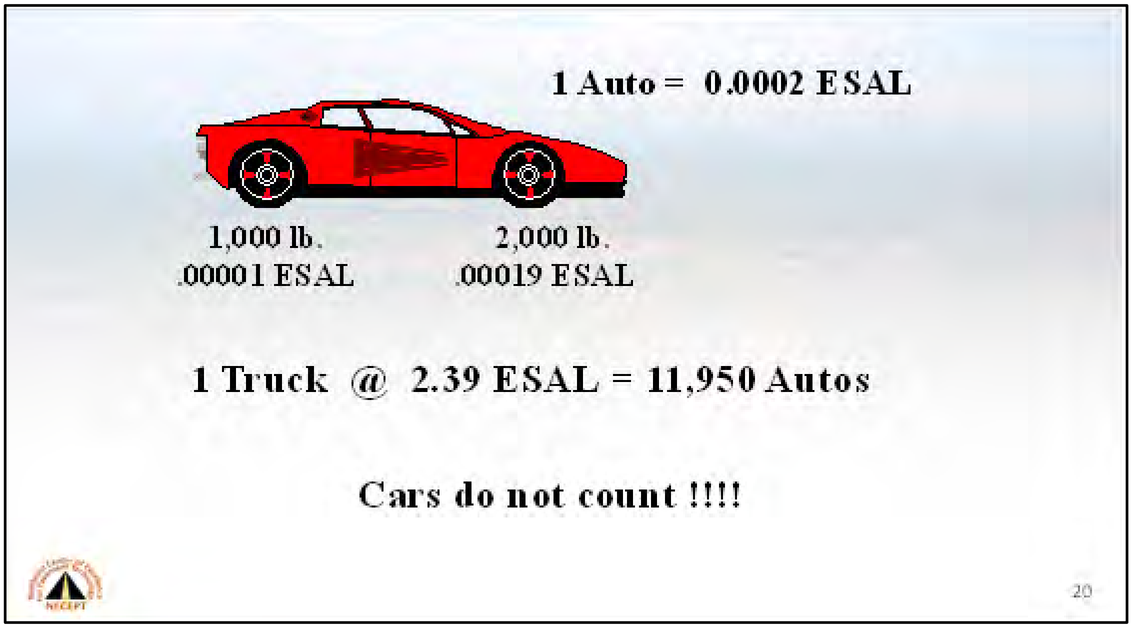
| | | |
|---|---|---|
| ▪ 0.0 – 0.3 million | ~ 0 to 17 trucks | light |
| ▪ 0.3 – 3.0 million | ~ 17 to 172 | medium |
| ▪ 3.0 – 10.0 million | ~ 172 to 573 | high |
| ▪ 10.0 – 30.0 million | ~ 573 to 1720 | heavy |

18

The higher the ESAL count the less binder is in the mixture for the stone-on-stone contact to prevent rutting. The mix designer also uses the ESAL count to determine the specifications for the required level of angularity of the aggregate in the mix.
Do not substitute mixes with different ESAL counts. More is not necessarily better due to the variance in the binder content.
20 years X 365 days X 2.39 ESALS per truck = 17,447 ESALS
17 trucks per day X 17,477= 296,599 ESALS during the 20-yr service life. This gives a traffic level under 0.3 million (300,000), which will be considered light traffic.




How many cars equal the ESALS from one semi mounted tractor trailer???




Cars do not count when calculating ESALs. However, they do count when determining the SRL of the aggregate used in the mix.

## Although Some Cars Can Also Be a Problem

22

## PennDOT
## Laboratory Gyratory Compaction Levels

| Design ESALs (million) | $N_{initial}$ | $N_{design}$ | $N_{max}$ |
|---|---|---|---|
| < 0.3 | 6 | 50 | 75 |
| ≥ 0.3 to < 3 | 7 | 75 | 115 |
| 3 to < 30 | 7 | 75 | 115 |
| ≥ 30 | 7 | 75 | 115 |
| All ESAL Levels for Base Course Mixtures | 7 | 75 | 115 |

## Sieving

Individual Sieve

Stack in Mechanical Shaker

24

## Superpave uses the Nominal Maximum Aggregate Size

Aggregate Size Definitions

- *Nominal Maximum* Aggregate Size

  One size larger than the first sieve to retain more than 10% of the sample and is the "name" of the mix.

- *Maximum* Aggregate Size

  One size larger than nominal maximum size

25

In definition of maximum aggregate size in Superpave, we must distinguish between maximum aggregate size and nominal maximum aggregate size. Nominal maximum aggregate size is defined as one size larger than the first sieve to retain more than 10% of aggregate. Maximum aggregate size is defined as one size larger than the nominal maximum size. MAXIMUM size is LARGER than nominal maximum size!

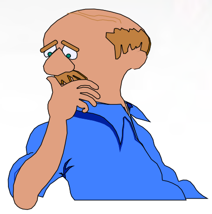
**NOTE:** NMAS is now the reference term in most asphalt sections in Pub 408.

# Quiz

## Module 1

## Introduction/Superpave Overview

?





**1. Who can the Certified Field Technician represent?**

a. PENNDOT
b. Contractor
c. Consultant
d. All of the above

**Answer:**

**2. A Certified Field Technician has to renew his/her certification every**

a. 3 years
b. 4 years
c. 5 years
d. 6 years

**Answer:**



**3. To become recertified, the Field Technician has to have how many documented hours?**

a. 50
b. 100
c. 500
d. 1000

**Answer:**

## 4. The Certified Field Technician should

a. Know the specifications & PTMs needed to ensure quality control
b. Be familiar with paving operations
c. Recognize mix and paving deficiencies and recommend corrective actions
d. All of the above

**Answer:**



## 5. How many times is the applicant for certification allowed to retake the test before they have to repeat the 2-day course?

a. 1
b. 2
c. 3
d. 4

**Answer:**

**6. Superpave mixes were developed because of nation-wide asphalt pavements problems of**

a. rutting and premature cracking
b. corrugations and potholes
c. surface drainage and sub drainage
d. raveling and bleeding

**Answer:**



**7. Superpave mixes all use**

a. ID binders
b. FJ binders
c. PG binders
d. FB binders
e. None of the above

**Answer:**

**8. Superpave mix design is based on**

a. Aggregate size
b. Geographic Location
c. ESALS
d. All of the Above

**Answer:**



**9. 12.5 mm aggregate is the largest size acceptable in a 9.5 mm wearing course.**

a. True
b. False

**Answer:**

**10. Which ESAL range may be substituted in place of a 0.3 to 3 million ESAL design mix?**

a. 10.0 to 30.0 million ESALS

b. 0.0 to 0.3 million ESALS

c. None of the above

**Answer:**

| TR-448A (6-15) | JOB MIX FORMULA REPORT | Supplier Code | Material Class |
|---|---|---|---|
| pennsylvania DEPARTMENT OF TRANSPORTATION | PennDOT Mix Design Designation | [redacted] | WR9.5 |
| | Year: 2023 | Design ESAL Range | 0.3 to < 30 Million(Nd=75 |
| | Number: W95722L1 | Aggregate Skid Resistance Level (SRL) | L |
| | Supplier JMF/Design Number (Optional) | Mixure Final Asphalt Binder Grade | PG64S-22 |
| | 40356WR2 | Asphalt Mix Type | WMA |
| | | Gradation Classification | Fine-Graded |
| | | Original Approval Date | |
| | | JMF Status | Approved |

**Supplier Name** [redacted] **Location** [redacted]
**ECMS Number** **PO No.-Line Item No.** **408 Spec**
**SR & Section** **Plant Type** AB **Plant Size** 10
**Contractor** **Location**

| Mix Time | |
|---|---|
| Dry(s) | Wet(s) |
| 7 | 35 |

| Material Supplier | Material Code - Class | Product Name | % Material | Spec. Grav. | % Absorption |
|---|---|---|---|---|---|
| [redacted]14A14 | 207 (Aggregate Fine) - B3 | B3(AS) | 4.300 | 2.738 | 0.94 |
| [redacted]14A14 | 207 (Aggregate Fine) - B3 | B3 | 39.500 | 2.725 | 0.98 |
| [redacted]14A14 | 203 (Aggregate) - A8 | A8 | 27.700 | 2.750 | 0.91 |
| [redacted] 15 | 187 (WMA Technology) - EVO-J1 | J-1 | 0.300 | 0.990 | |
| NOBLT 14 | 17 (Hot Rap Design) - RAP | RAP | 24.000 | 2.738 | 0.46 |
| UNRC0 15 | 1 (Asphalt Binder) - PG64S-22 | 64S-22 | 4.500 | 1.030 | |

## JOB MIX FORMULA AND DESIGN

| A.C. / Sieve Size | A.C% | #200 | #100 | #50 | #30 | #16 | #8 | #4 | 3/8" | 1/2" | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Design Target | 5.8 | 5.9 | 9 | 13 | 20 | 31 | 47 | 67 | 97 | 100 | | | | |

| | | | | | |
|---|---|---|---|---|---|
| % Virgin A.C. | 4.5 | % Reclaimed A.C. from RAP | 1.30 | Total % Asphalt (Pb) | 5.8 |
| Virgin A.C. PG Binder Grade | PG64S-22 | % Reclaimed A.C. from RAS | | % Eff. Asphalt Binder (Pbe) | 5.3 |
| Calc. Asp. Film Thickness | 9.00 | Total Reclaimed Binder Ratio | 0.22 | Fines / Asphalt (F/A) Ratio | 1.1 |

## MIX CHARACTERISTICS (GYRATORY)

| Design ESAL Range | Mold Diameter (mm) | # Gyrations at Ninitial | # Gyrations at NDesign | # Gyrations at NMaximum | Voids in Mineral Aggregate (VMA) % | Theoretical Max. Sp. Grav. (Gmm) | Bulk Sp. Grav. of Mixture (Gmb) |
|---|---|---|---|---|---|---|---|
| 3 to < 30 Million(Nd=75 | 150 | 7 | 75 | 115 | 16.4 | 2.516 | 2.417 |
| **Bulk Sp. Grav. of Combined Aggr.(Gsb)** | **Mixture Mass to Compact (g)** | **% Air Voids at Ninitial** | **% Aid Voids at NDesign** | **% Air Voids at NMaximum** | **Voids filled with Asphalt (VFA) %** | **Theoretical Max. Density (lbs/ft3)** | **Bulk Density of Mixture (lbs/ft3)** |
| 2.721 | 4,800.0 | 13.0 | 4.0 | 2.9 | 76.0 | 156.6 | 150.4 |

## ASPHALT CONTENT TEST METHOD

| A.C. Test Method | External Party Oven Make/Model | Furnace Temp (°C) | Sample Size for C.F. | Asphalt C.F. | 200 C.F. |
|---|---|---|---|---|---|
| PTM No. 757 | GILSON/HM-378 | 538.0 | 1,200.0 | 0.38 | 0.30 |

## MOISTURE SUSCEPTIBILITY DATA

| A.C. Supplier | Name | Dry PSI Strength | Wet PSI Strength | TSR Value | Date of TSR Test | Date of Boil Test |
|---|---|---|---|---|---|---|
| UNRC0 15 | 64S-22 | 204.4 | 185.1 | 0.91 | 2/15/23 | |

## COMBINED AGGREGATE CONSENSUS PROPERTIES

| AASHTO T 176 Sand Equivalency (%) | AASHTO T 304 Fine Aggr. Angularity Uncompacted Voids (%) | ASTM D5821 - Coarse Aggregate Angularity | | ASTM D4791 Flat / Elongated Particles | | Total % Reclaimed Agg. From RAP and / or RAS |
|---|---|---|---|---|---|---|
| | | % 1 Face Crush | % 2 Face Crush | 5:1 | 3:1 SMA only | |
| 83.0 | 47.1 | 99.6 | 98.7 | 0.0 | 0.0 | 22.7 |

**Designed By :** [redacted] **Designed By Certification ID :** [redacted] **Designed Date :** 1/23/23
**Submitted By :** [redacted] **Submitted By Certification ID** [redacted] **Submitted Date :** 3/21/23
**Approved By :** [redacted] **Approved By Certification ID :** [redacted] **Approved Date :** 4/5/23

CS-413 (4-20)

pennsylvania
DEPARTMENT OF TRANSPORTATION

# MINIMUM QUALITY CONTROL PLAN FOR FIELD ASPHALT PAVING OPERATION

(Attach additional sheets as necessary)

Project # ______________ State Route (S.R.) ______________ Section ________ County ______________

Project Name ________________________________________ Specification __________ Change ____

## I. ORGANIZATIONAL CHART

Contractor ______________________________

| Personnel | Full Name | Responsibilities |
|---|---|---|
| A. Company Representative | ______________________ | Oversees entire project |
| B. Superintendent | ______________________ | Oversees paving operations |
| C. Paving Foreperson | ______________________ | Oversees placement of material and related operations. |
| D. Certified Nuclear Gauge Operator | ______________________ | Develops rolling pattern and compaction data and acts as a point of contact for PennDOT personnel for all field testing and sampling. (Nuclear Gauge Operator does not need to be NECEPT Certified) |
| Operator's Certification No. | ______________________ | |
| E. Asphalt Field Technician | ______________________ | |
| NECEPT Certification No. | ______________________ | Expiration Date: ______________ |

Note: Problems related to asphalt mixture or paving operations shall be directed to the paving foreperson. If problems are still unresolved they will be elevated to the superintendent then directed to the company representative if needed.

| Equipment List | Quantity | Manufacturer and Model |
|---|---|---|
| A. Distributer Truck | ______ | ______________________ |
| B. Paver | ______ | ______________________ |
| C. Breakdown Roller | ______ | ______________________ |
| D. Intermediate Roller | ______ | ______________________ |
| E. Pneumatic-Tire Roller | ______ | ______________________ |
| F. Finish Roller | ______ | ______________________ |
| G. Material Transfer Vehicle (As specified) | ______ | ______________________ |

## II. TESTING PLAN

A. Compaction Control
   1. Compaction will be controlled in accordance with Section 413.3(i).
      a. Pneumatic-tire rollers will be used for compacting scratch courses.
      b. Mechanical tampers will be utilized in areas inaccessible to rollers.

B. Temperature Control
   1. Temperature will be controlled in accordance with Section 413.2 (e) Table A, by checking the first three trucks or until control is established, and a minimum of every fifth truck thereafter. The first three trucks will be tested after any plant breakdowns or production stoppages.
   2. The plant will be contacted when any single check reaches within 5 degrees of the specification limits and the testing frequency will be increased to every load until control is reestablished.

C. Segregation will be addressed in accordance with Section 413.3(h)3.
D. Tests for Depth in accordance with Section 413.3(m) and 313.3 (m).
E. The inspector and the contractor's representative will both measure the depth of each sublot according to PTM 737 using the density acceptance samples.
   1. For courses with a designed course depth and accepted by non-movement or optimum rolling pattern, the inspector and the contractor's representative will both calculate the weight per square yard for yield.
F. Density cores will be extracted as soon as possible but no later than the day following the placement in the presence of the inspector. Mat density will be accepted in accordance with 413.3(j).
G. Mixture Acceptance
   1. Lot Acceptance will be performed in accordance with Section 413.3 (h)2.
   2. Certification Acceptance will be in accordance with Section 413.2(i).

## III. MIX DELIVERY

A. Trucks will be clean of all foreign materials.
B. No petroleum oils, solvents, or other materials will be used as a release agent in the haul vehicles. The release agent used will be supplied by ________________________ having a trade name of ________________________.
C. Delivery of material will be protected in accordance with 413.3(d)
D. Material will be released for the day's operation according to the details discussed at the pre-pave meeting.
E. An adequate number of trucks will be utilized to facilitate paving continuity.
F. All delivery trucks will be cleaned out at a designated location, not on the roadway in advance of the paving train.
G. Trucks will be loaded, unloaded and handled using practices and procedures that will help prevent segregation.

## IV. SURFACE PREPARATION

A. All areas will be cleaned of surface debris.
B. Existing vertical and horizontal surfaces will be treated according to 413.3(g)1., or contract requirement.
C. Certification of asphalt materials will be provided as specified.
D. ____________ will be used and applied in accordance with Section 460 or unless indicated otherwise.

| Application Rates for Tack Coat | | Residual Rates for Tack Coat | |
|---|---|---|---|
| New Asphalt Paving | ____________ | New Asphalt Paving | ____________ |
| Existing Asphalt Paving | ____________ | Existing Asphalt Paving | ____________ |
| Milled Surface | ____________ | Milled Surface | ____________ |
| Portland Cement Concrete | ____________ | Portland Cement Concrete | ____________ |

E. Asphalt mixture will not be placed until the tack coat has adequately cured.

## V. MIX PLACEMENT

A. Pavers will comply with the requirements of Section 413.3(e) and will be used and operated in accordance with same.
B. Automatic screed controls capable of producing a finished surface of specified evenness and texture will also be used in accordance with Section 413.3(e).

## VI. COMPACTION

A. A sufficient quantity and type of rollers and compaction equipment will be used in accordance with Sections 413.3(f) and 413.3(i).

## VII. JOINT CONSTRUCTION AND COMPACTION

A. Joints will be offset by approximately 150 mm (6") from the previously placed layer.
B. Surface course longitudinal joints will be placed at the approximate centerline of the roadway for 2 lane roadways and within 300 mm (12") of lane lines for roadways with more than 2 lanes.
C. When specified or otherwise used notched wedge joints will be constructed according to RC-28M of the standard drawings.
D. All transverse joints will be constructed perpendicular to the centerline of the roadway.
E. All joints will meet the required surface tolerances as specified in Section 413.3(l).
F. The entire area of all joint faces will be painted with a coating of the appropriate asphalt material. In accordance with Section 413.3(k)1 & 2.

G. Joints will be compacted by the following means: (E. g. - Rolling Hot to Cold Side, etc.)

| |
|---|
| |

**VIII. SPECIAL PAVING CONDITIONS**

A. Method of placement and traffic control for intersections and other incidental work will be discussed and agreed upon by the project IIC and paving foreperson no less than 3 days prior to the start of work.

1. List those work items and agreements as discussed (Attached on a separate sheet).

B. Safety Edge required (RC-25) for binder and wearing courses in accordance with Section 413.3 (h)1e.

**IX. PROTECTION OF THE COURSES**

Traffic will not be placed on fresh material unless the temperature is 60° C (140 °F) and stable or lower, as determined by surface thermometers.

**X. AMENDMENTS**

If at any time during the course of the project a change to this quality control plan is agreed necessary by Company Representative (________________________) and the Project IIC, it can be amended by strike out and replacement followed by signatures in initial form. A description of the change and reason for amendment should be noted in the Inspector's field diary for confirmation.

**XI. PRE-PAVE MEETING**

Conduct a preplacement meeting with department, contractor and supplier, as well as any other appropriate parties at least two weeks prior to placing asphalt paving mixtures.

---

**Check All That Apply:**

☐ MTV Required ☐ Saw and Seal Joints ☐ Heavy Duty Membranes ☐ PWL - LTS

☐ Pavement Ride Quality (Section 404) ☐ Longitudinal Joint Density (Section 405) ☐ PWL - HOLA

---

Complete "Item Number and Mix Designs / Placement and Sampling Details" form on page 4 (additional sheets provided if needed). This form provides details of asphalt placements, mix designs to be used and other valuable information such as proposed Mixture and Density acceptance.

Submitted By: ______________________________ Date: ______________

Reviewed By: ______________________________ Date: ______________

## ITEM NUMBER AND MIX DESIGNS / PLACEMENT AND SAMPLING DETAILS

| ITEM NUMBER | COURSE E.g.-Base (8"), Binder (level) | MATERIAL E.g. - 25MM, 9.5MM | ASPHALT BINDER | DESIGN ESALS | S.R.L. | JMF NUMBER | SUPPLIER CODE | U.O.M. E.g. - Sy, Ton | QUANTITY | TONNAGE NEEDED | AREAS OF PLACEMENT | * MIXTURE ACCEPTANCE (Certification or Lot) | * DENSITY ACCEPTANCE (Cores, Optimum Rolling Pattern or Non-Movement) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |

* Proposed Mixture and Density Acceptance will be discussed at Pre-Pave Meeting

## ITEM NUMBER AND MIX DESIGNS / PLACEMENT AND SAMPLING DETAILS

| ITEM NUMBER | COURSE E.g.-Base (8"), Binder (level) | MATERIAL E.g. - 25MM, 9.5MM | ASPHALT BINDER | DESIGN ESALS | S.R.L. | JMF NUMBER | SUPPLIER CODE | U.O.M. E.g. - Sy, Ton | QUANTITY | TONNAGE NEEDED | AREAS OF PLACEMENT | * MIXTURE ACCEPTANCE (Certification or Lot) | * DENSITY ACCEPTANCE (Cores, Optimum Rolling Pattern or Non-Movement) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |

* Proposed Mixture and Density Acceptance will be discussed at Pre-Pave Meeting

## ITEM NUMBER AND MIX DESIGNS / PLACEMENT AND SAMPLING DETAILS

| ITEM NUMBER | COURSE E.g.-Base (8"), Binder (level) | MATERIAL E.g. - 25MM, 9.5MM | ASPHALT BINDER | DESIGN ESALS | S.R.L. | JMF NUMBER | SUPPLIER CODE | U.O.M. E.g. - Sy, Ton | QUANTITY | TONNAGE NEEDED | AREAS OF PLACEMENT | * MIXTURE ACCEPTANCE (Certification or Lot) | * DENSITY ACCEPTANCE (Cores, Optimum Rolling Pattern or Non-Movement) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |

* Proposed Mixture and Density Acceptance will be discussed at Pre-Pave Meeting

## ITEM NUMBER AND MIX DESIGNS / PLACEMENT AND SAMPLING DETAILS

| ITEM NUMBER | COURSE E.g.-Base (8"), Binder (level) | MATERIAL E.g. - 25MM, 9.5MM | ASPHALT BINDER | DESIGN ESALS | S.R.L. | JMF NUMBER | SUPPLIER CODE | U.O.M. E.g. - Sy, Ton | QUANTITY | TONNAGE NEEDED | AREAS OF PLACEMENT | * MIXTURE ACCEPTANCE (Certification or Lot) | * DENSITY ACCEPTANCE (Cores, Optimum Rolling Pattern or Non-Movement) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |

* Proposed Mixture and Density Acceptance will be discussed at Pre-Pave Meeting

## ITEM NUMBER AND MIX DESIGNS / PLACEMENT AND SAMPLING DETAILS

| ITEM NUMBER | COURSE E.g.-Base (8"), Binder (level) | MATERIAL E.g. - 25MM, 9.5MM | ASPHALT BINDER | DESIGN ESALS | S.R.L. | JMF NUMBER | SUPPLIER CODE | U.O.M. E.g. - Sy, Ton | QUANTITY | TONNAGE NEEDED | AREAS OF PLACEMENT | * MIXTURE ACCEPTANCE (Certification or Lot) | * DENSITY ACCEPTANCE (Cores, Optimum Rolling Pattern or Non-Movement) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |

* Proposed Mixture and Density Acceptance will be discussed at Pre-Pave Meeting

## ITEM NUMBER AND MIX DESIGNS / PLACEMENT AND SAMPLING DETAILS

| ITEM NUMBER | COURSE E.g.-Base (8"), Binder (level) | MATERIAL E.g. - 25MM, 9.5MM | ASPHALT BINDER | DESIGN ESALS | S.R.L. | JMF NUMBER | SUPPLIER CODE | U.O.M. E.g. - Sy, Ton | QUANTITY | TONNAGE NEEDED | AREAS OF PLACEMENT | * MIXTURE ACCEPTANCE (Certification or Lot) | * DENSITY ACCEPTANCE (Cores, Optimum Rolling Pattern or Non-Movement) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |

* Proposed Mixture and Density Acceptance will be discussed at Pre-Pave Meeting

N
E
C
E
P
T

# Asphalt Pavement Construction Program

Certified Asphalt Field Technician
Course of 2025

# Module 2:
# PennDOT Specifications

# Asphalt Construction Program

**Certified Asphalt**
**Field Technician - 2025**

Module 2:
PennDOT Specifications

NECEPT

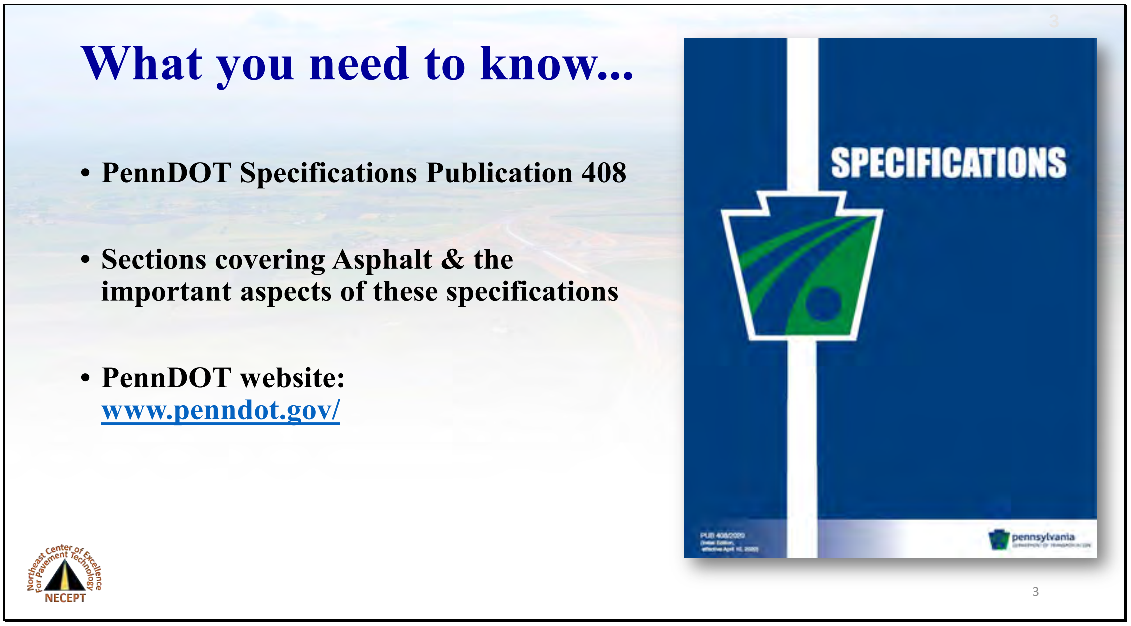
1

## Module 2 – Objectives

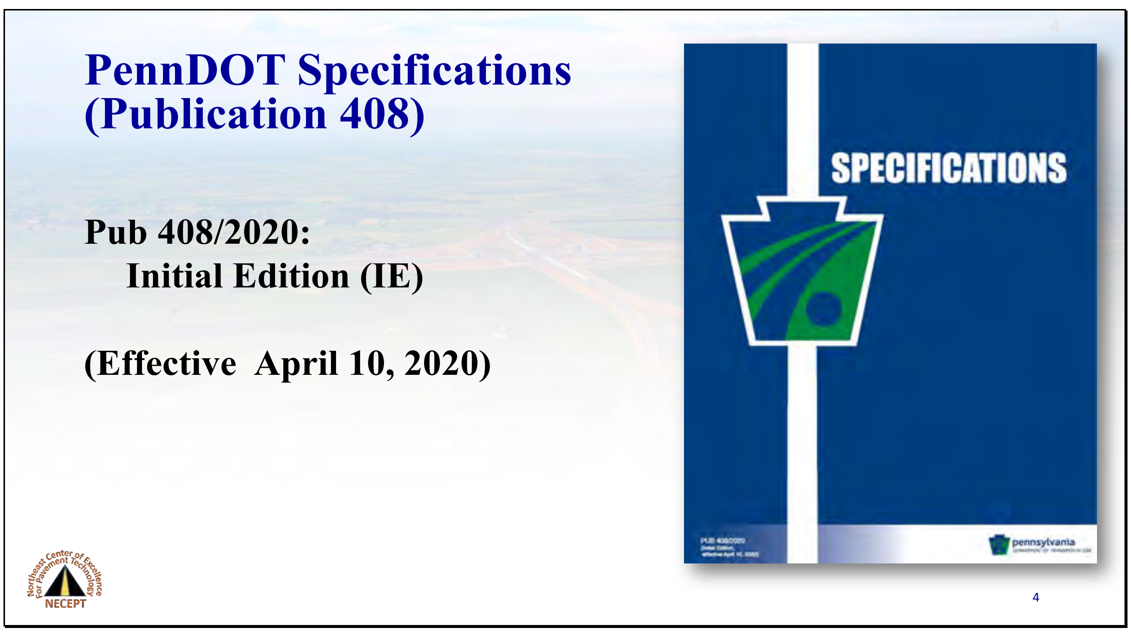
- **PennDOT Specifications**
  - Which specifications are the most significant?
  - Review relevant specifications

2

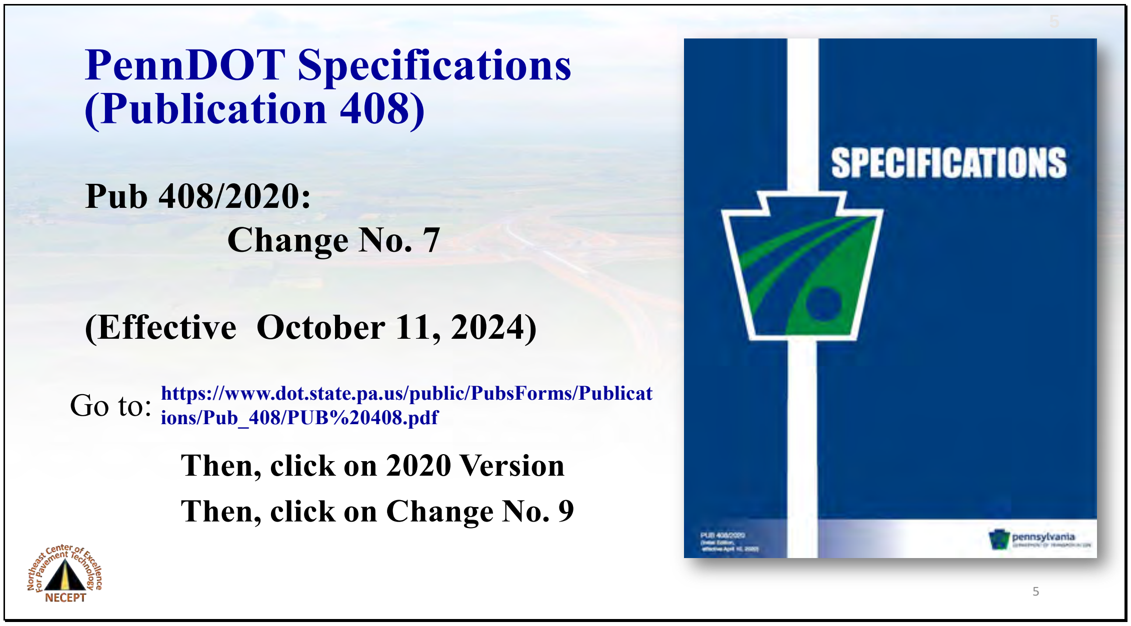
The specifications that govern you and your current project are the most important! Be aware of Changes to all Pubs and their effective dates.

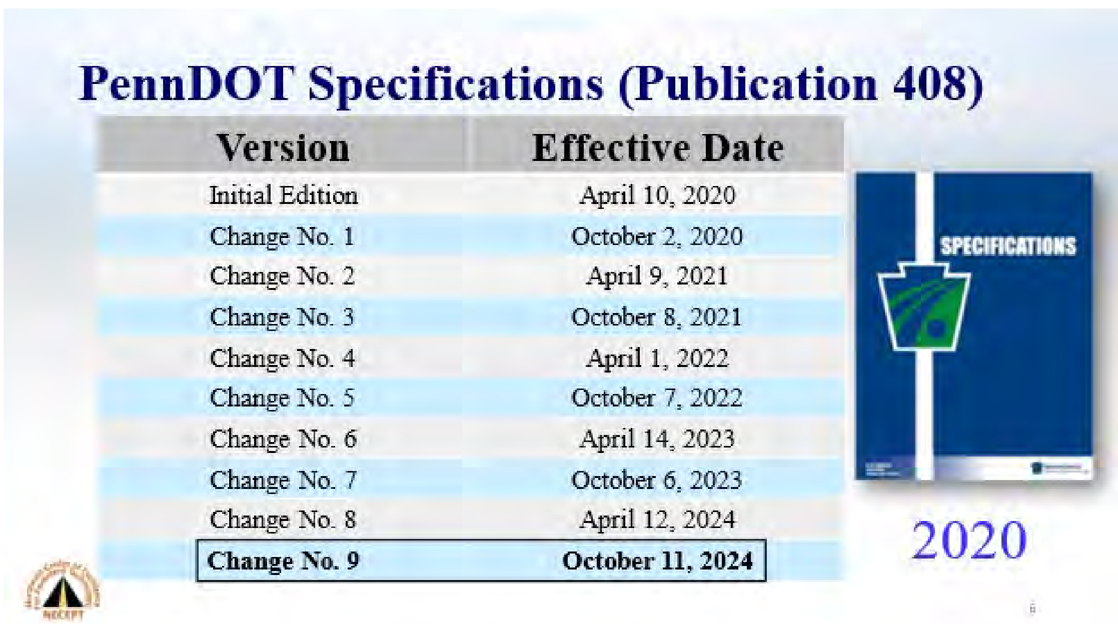



PennDOT Asphalt Specifications are found in Publication 408. Changes, which include new Sections, updates and corrections are issued twice yearly.




This is what you will see on PennDOT's website for the 2020 edition. The PennDOT Project will specify the version of the PennDOT Publication 408 Specifications that applies. Make sure you know which version refers to your project as that is the version to use.




At the time of this course, Change No. 9 is in Effect.

## Pub 408 Table of Contents

| Section | Title |
|---|---|
| 100 | General Provisions ← |
| 200 | Earthwork |
| 300 | Base Courses ← |
| 400 | Flexible Pavements ← |
| 500 | Rigid Pavements |
| 600 | Incidental Construction |
| 700 | Material ← |
| 800 | Roadside Development |
| 900 | Traffic Accommodation & Control |
| 1000 | Structures |
| 1100 | Manufactured Material |
| 1200 | Intelligent Transportation System (ITS) Devices |

7

The Certified Field Technician should be familiar with the 408 Specifications section that govern their project. The arrows call attention to the sections most relevant to asphalt construction. Section 100 covers :abbreviations and terms, control of work and materials and measurement of quantities and payments. Section 300 Base Course and Section 400 Flexible Pavements contains the Specifications for Superpave projects and also refer to the Materials Section 700.

## Pub 408 Asphalt Specifications

| | |
|---|---|
| 106 | Control of Material |
| 313 | Superpave Asphalt Mixture Design, Standard Construction, Base Course |
| 314 | Asphalt Rich Base Course (ARBC) |
| 316 | Flexible Base Replacement |
| 344 | Full Depth Reclamation |
| 360 | Asphalt Treated Permeable Base Course |
| 404 | Evaluation of Asphalt Pavement Ride Quality and Payment of Incentive |
| 405 | Evaluation of Asphalt Pavement Longitudinal Joint Density And Payment of Incentive/Disincentive |

8

This slide and the next contain a listing of the Sub-Sections of Publication 408 that cover the requirements for Superpave projects. The Certified Field Technician should be very familiar with these specifications. Note: Section 108.05(c) also covers equipment requirements.

## Pub 408 Asphalt Specifications

| | |
|---|---|
| 410 | Superpave Mixture Design, Standard & RPS Construction of Plant-Mixed Fine-Graded Courses |
| 412 | Superpave Mixture Design, Construction of Plant-Mixed 6.3 mm Thin Asphalt Overlay Courses |
| 413 | Superpave Mixture Design, Standard & RPS Construction of Plant-Mixed Courses with PWL and LTS Testing |
| 419 | Stone Matrix Asphalt Mixture Design, RPS Construction of Plant-Mixed Wearing Courses |
| 420 | Pervious Asphalt Pavement System |
| 460 | Asphalt Tack Coat |
| 483 | Polymer-Modified Emulsified Asphalt Paving System (Micro-surfacing) |
| 489 | Ultra-Thin Bonded Wearing Course |
| 491 | Milling of Asphalt Pavement Surface |
| 496 | Asphalt Concrete Pavement, 60-Month Warranty |

NECEPT

9

## Other Related Pub 408 Specifications

| | |
|---|---|
| 210 | Subgrade |
| 350 | Subbase |
| 450 | Manual Asphalt Patching |
| 461 | Asphalt Prime Coat |
| 469 | Asphalt Joint & Crack Sealing |
| 491 | Milling of Asphalt Paving Surface |
| 492 | Profile Milling of Asphalt Paving Surfaces |

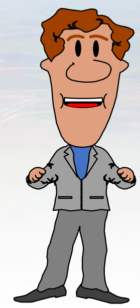
NECEPT

10

These specifications apply to the surface preparation for a Superpave project, whether that be a new subgrade and/or subbase or an existing surface in need of repairs or reconditioning.

## Remember…

- Keep familiar with Pub 408 specifications and project special provisions.
- Learn where to find particular specifications in Pub 408 and contract specific details.
- Be sure that you are utilizing the appropriate version of spec (Change No.) for your project.



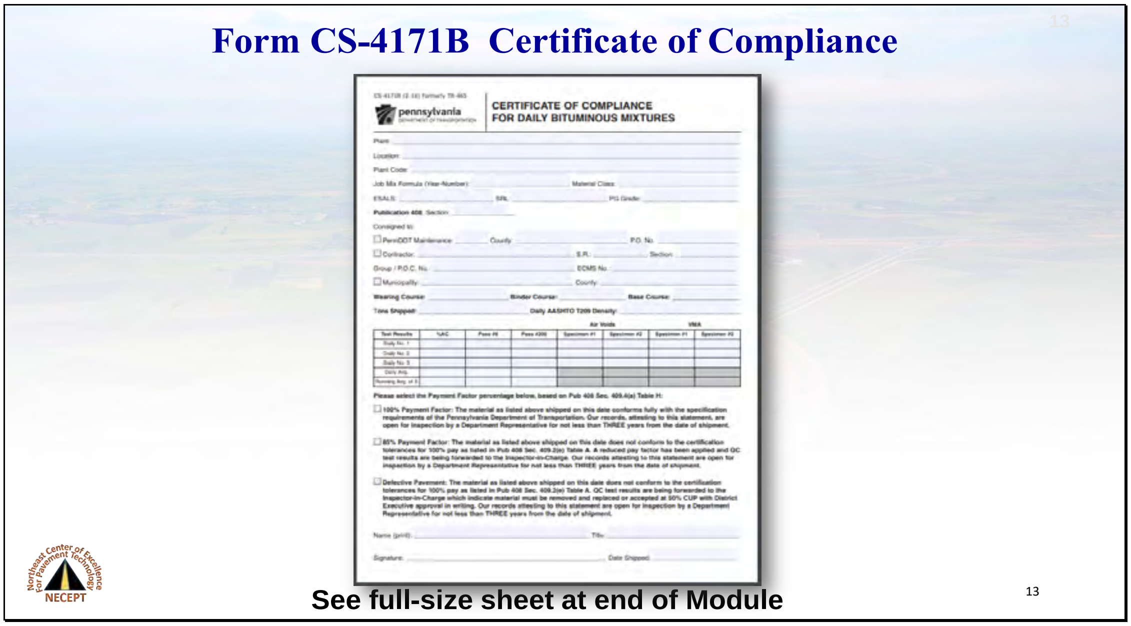
It is important that you are very familiar with PennDOT 408 and how to use it effectively to find details. We will review the more significant aspects of the Specifications dealing with Superpave asphalt projects.

## Section 106: Control of Materials

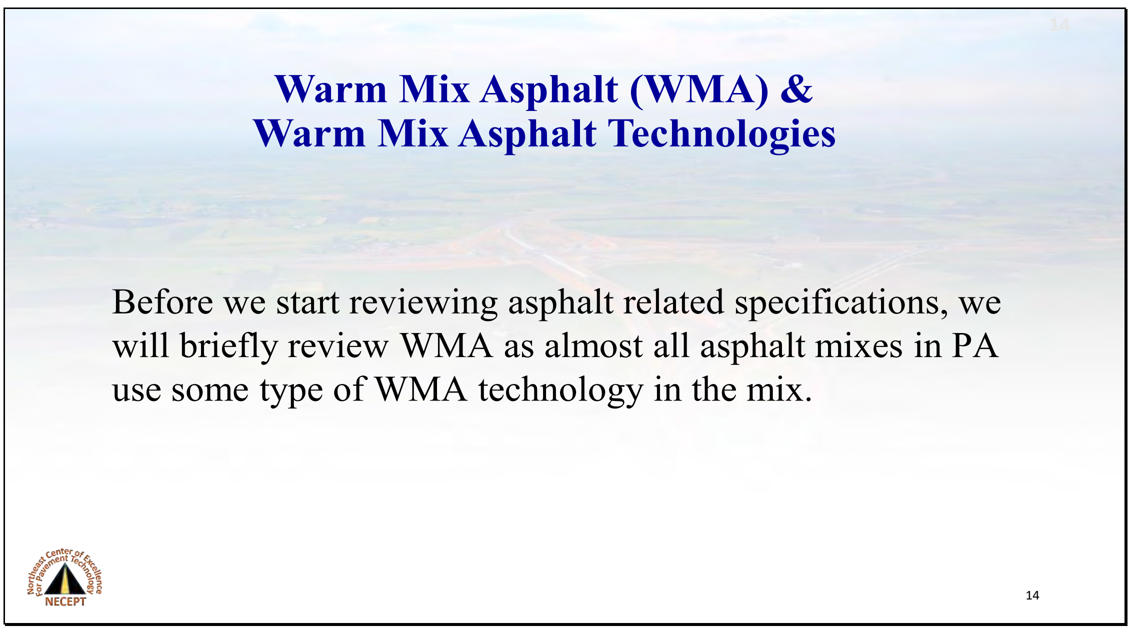
- General Requirements
- Test and Acceptance of Material
  - Form **CS-4171** Certificate of Compliance
- Storage of Material
- Handling and Transportation of Material
- Unacceptable Material
- Several Other Subsections.

12

Section 106 covers: acceptance and approval of materials, preapproved sources, material inspection, testing, and documentation (CS-4171 Certificate of Compliance). Also covers Department's responsibility to determine the acceptability of material and construction and contractor's responsibility for the quality control (QC) of the material and construction. The section also furnishes instructions as to the purchase, storage, and handling of materials and the disposition of failed materials.




A full-size copy of the instructions and form can be found in your handout at the end of this module. ANY material *incorporated* into a PENNDOT project must be certified.




**THIS MATERIAL NOT ON TEST**

## Warm Mix Asphalt

- A generic term for various technologies allowing asphalt paving materials to be produced and placed at lower temperatures.

15

Warm-mix asphalt is the generic term for a variety of technologies that may allow the producers of hot-mix asphalt pavement material to lower the temperatures at which the material is mixed and placed on the road. New Specification (2020 Edition) refers to asphalt mixes in general, to cover both hot mix and warm mix asphalt. Both are merged under the same section number.

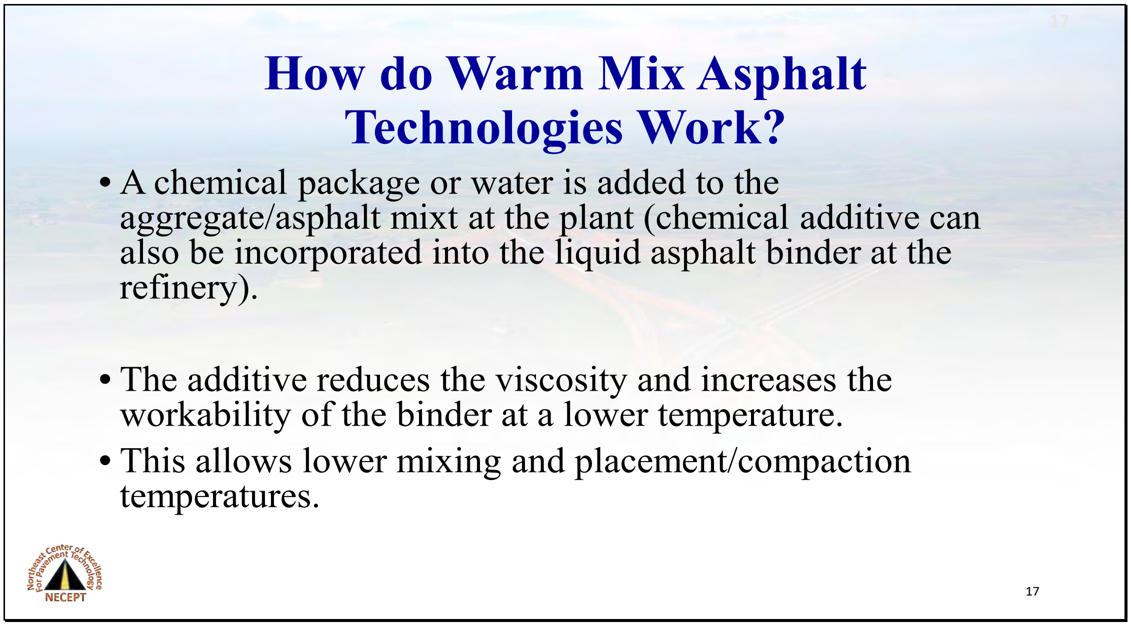
## What are WMA Technologies?

Broken down into 3 classes:

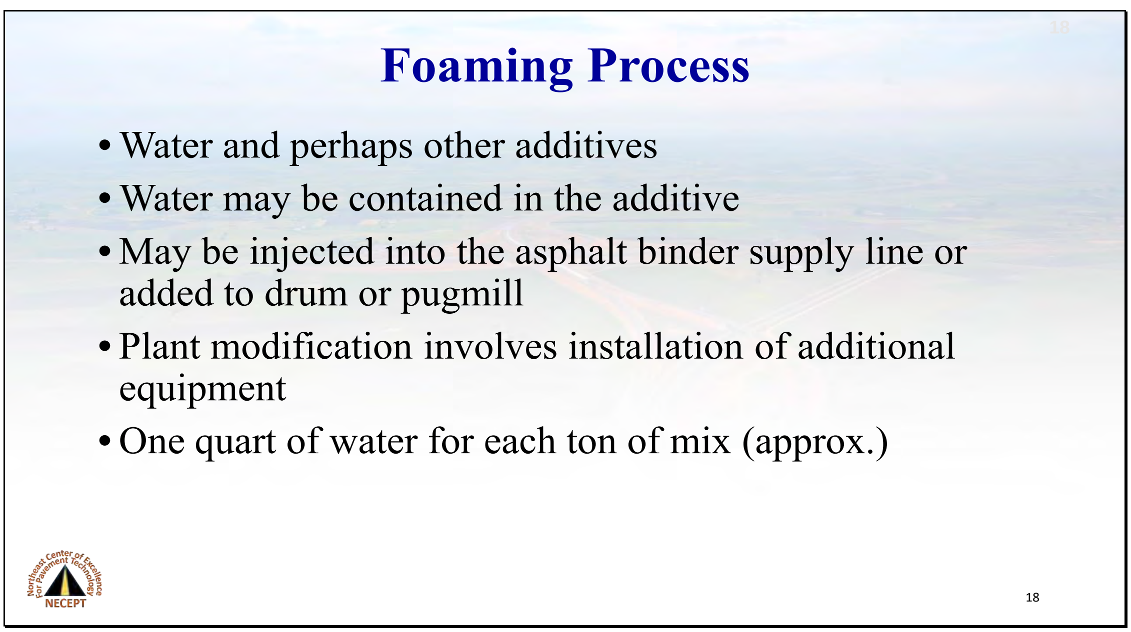
- Organic/Waxy Additives
- Foaming Processes (Water)
- Chemical Additives (Emulsions)

16

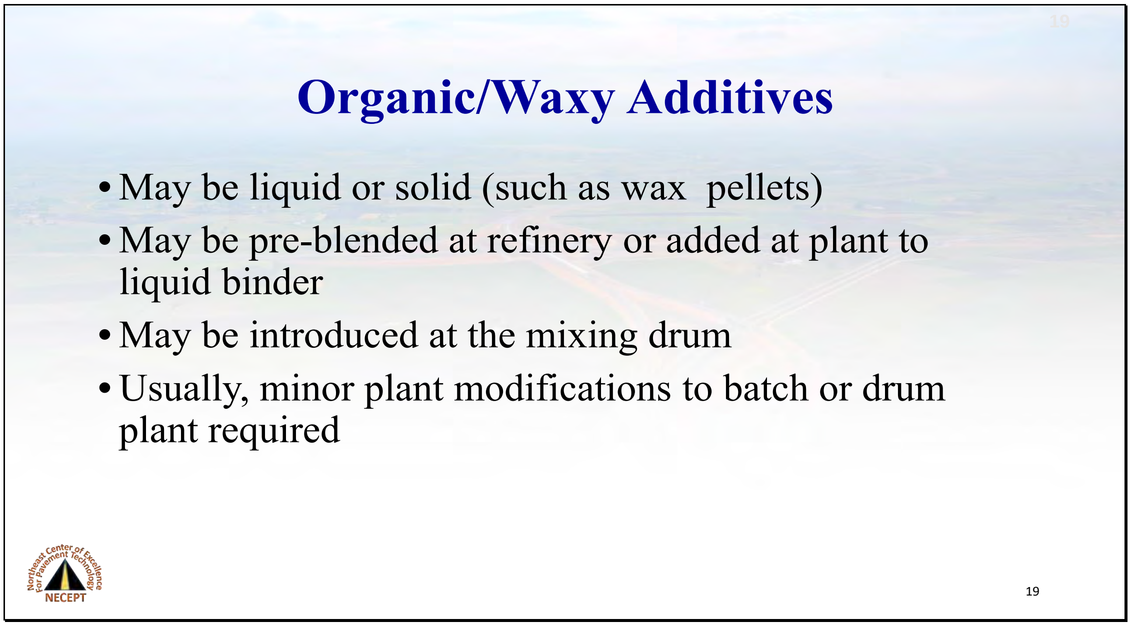
These 3 classes may be combined in some of the processes, especially when using higher RAP content.

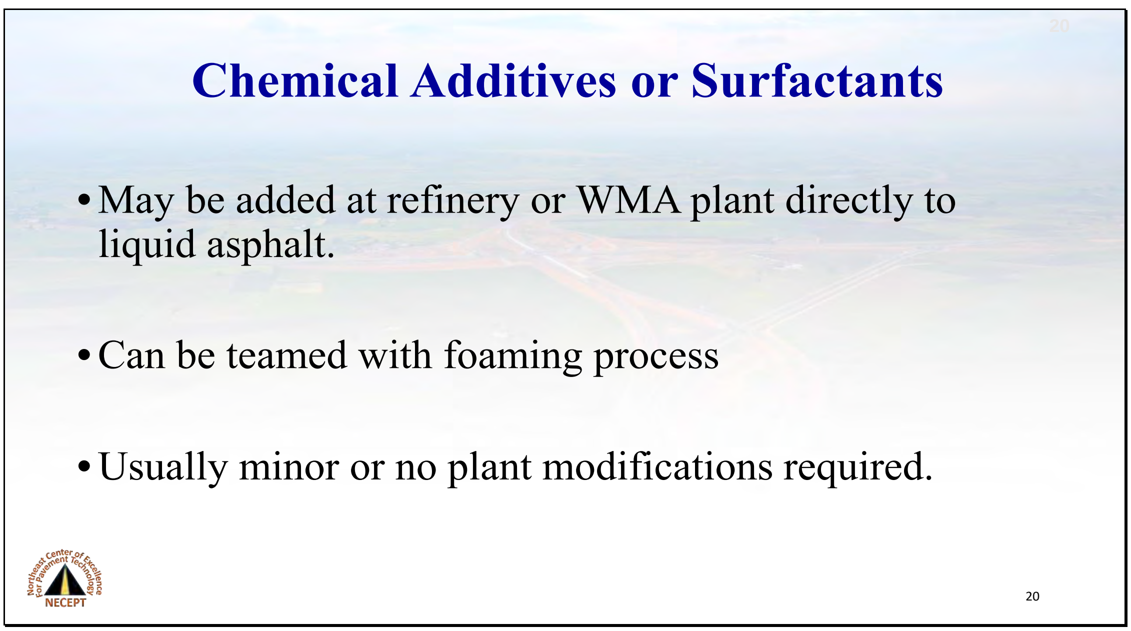



WMA Technologies have been shown to be a definite aid to compaction and assist with achieving density.



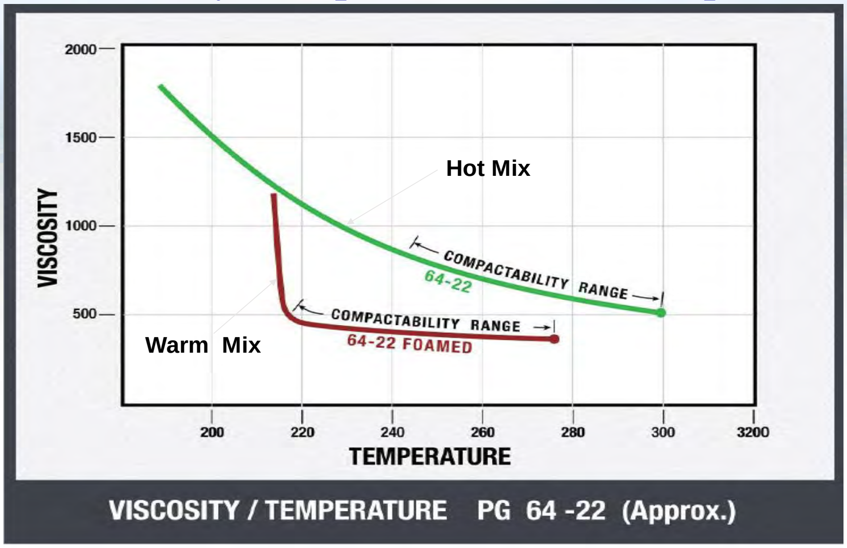

WMA produced by the foaming process has been used in majority of applications.




These additives may be mixed at the refinery or asphalt terminal and be delivered right in the tanker.

## Viscosity /Temperature Relationship




21

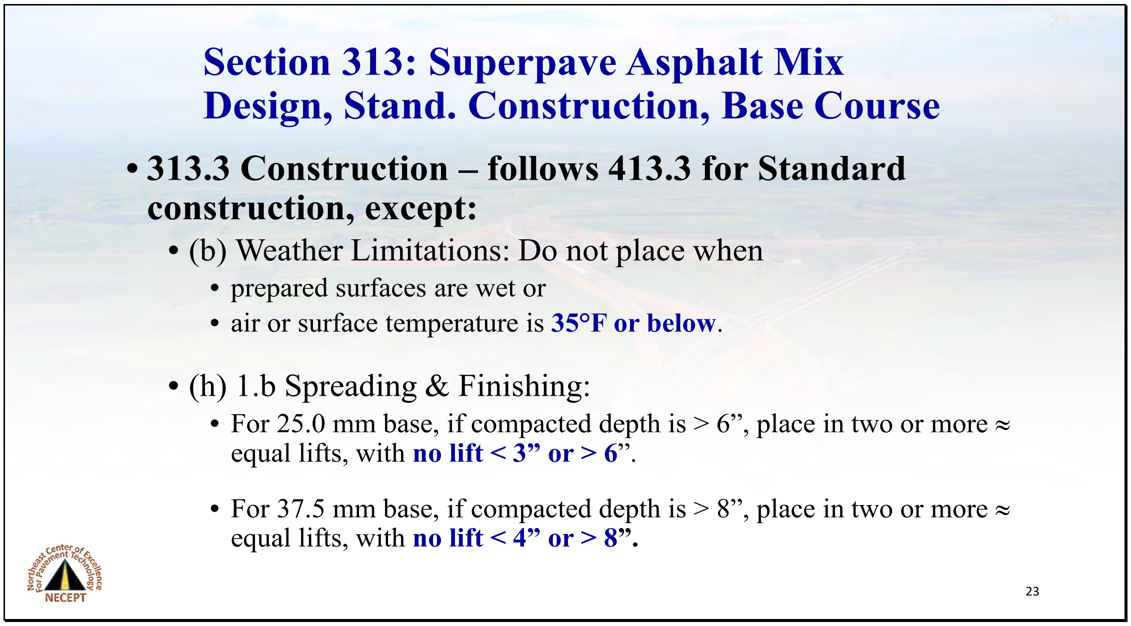
This chart shows the viscosity-temperature relationship of a PG 64 -22 asphalt binder in hot mix asphalt compared to a foamed PG 64 -22 binder in warm mix asphalt (WMA). Notice the greater temperature range for workability with the WMA mix. As the viscosity increases, workability decreases, and compaction becomes much more difficult.

## Review & Discussion of Asphalt Related Specifications

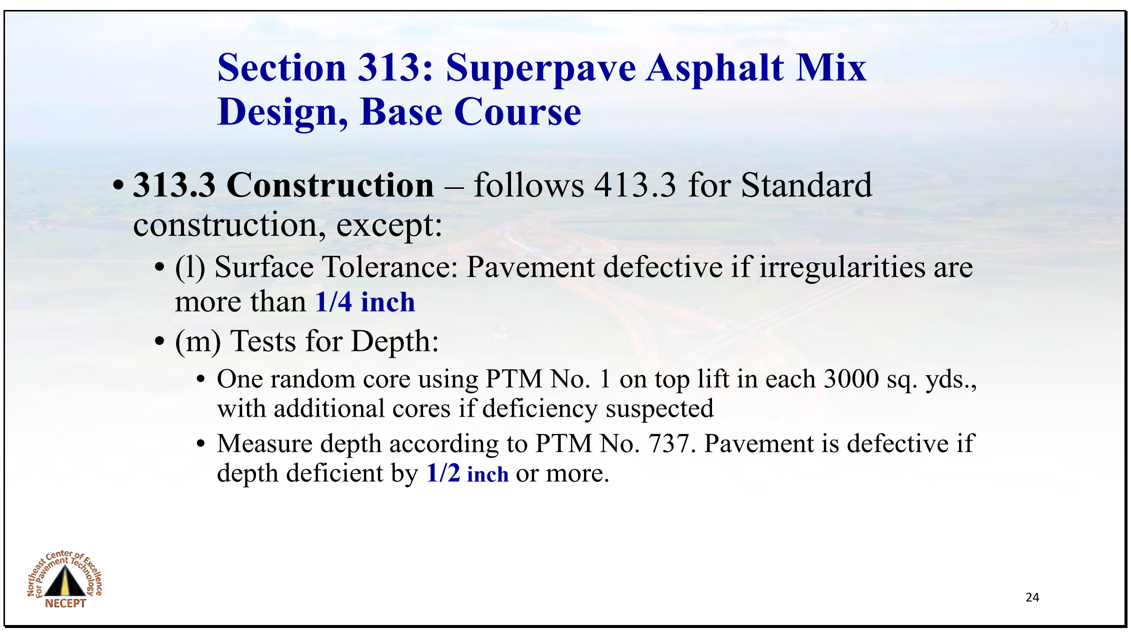
In the following slides, we will discuss asphalt related sections of 408 Construction Specification.

**Section 413** is the main asphalt section and the most comprehensive of all.

22




All Superpave construction will generally follow Section 413, with exceptions as noted , including weather limitations and spreading and finishing specific Superpave mixes as shown.



## Section 314: Rich Base Courses

- Asphalt Rich Base Course (ARBC)
- Max. RAP ≤ 20% by weight of mix
- No RAS Allowed
- Mix Design Requirements for ARBC for all Traffic Levels:

| Volumetric Mix Design Property | 25 mm NMAS |
|---|---|
| $N_{design}$ | 50 |
| Design Air Void | 2.5 |
| VMA for all Production QC Samples | 13.0 |
| VFA | 80-85 |

NMAS: Nominal Maximum Aggregate Size
$N_{design}$: Design Number of Gyrations

VMA: Voids in the Mineral Aggregate
VFA: Voids Filled with Asphalt

## Section 316
## Flexible Base Replacement

- Ref: RC 28M, RC 30M for Drawings
- SAW or MILL perimeter of area to be replaced
- Vertical Edges clean and coated with PG 64S-22
- Material placed to minimize segregation

26

Saws may be handheld, motorized on wheels, or vermeer wheel type mounted on skid-steer.

## Section 341: Cold Recycled Asphalt Base Course, Cold-In-Place

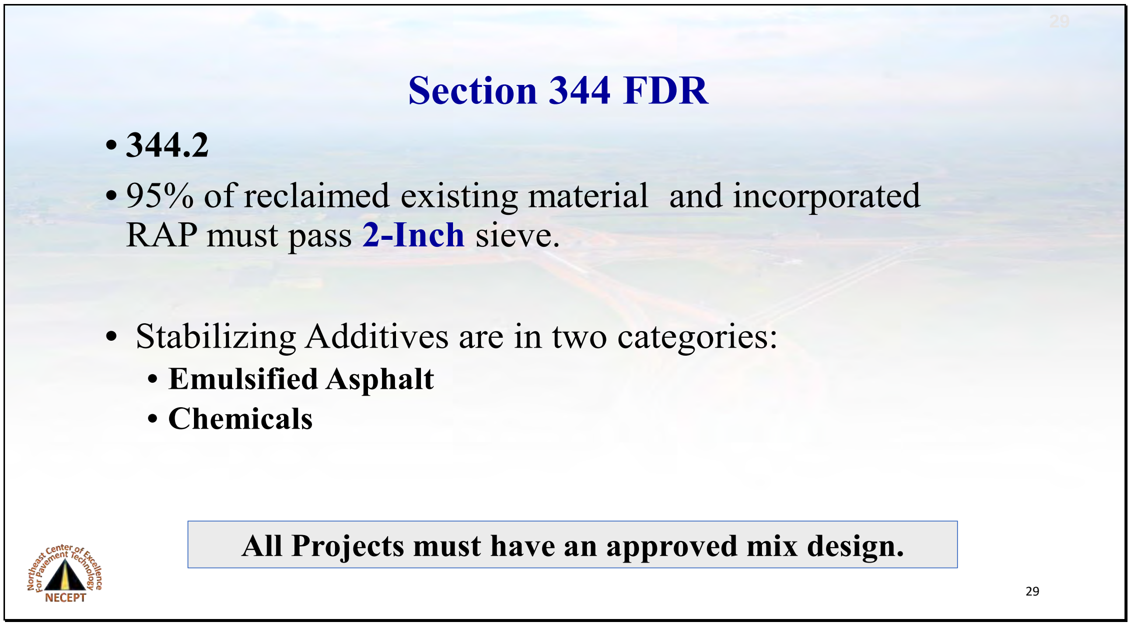
- **Can use**
  - Emulsified asphalt, or
  - Foamed asphalt stabilizing agents
- **Mix Design**
  - For emulsified asphalt, follow Bulletin 27
  - For foamed asphalt, follow AASHTO MP 38
    - Standard Specification for Materials Used in Cold Recycled Mixtures with Foamed Asphalt

## Section 344 Full Depth Reclamation (FDR)

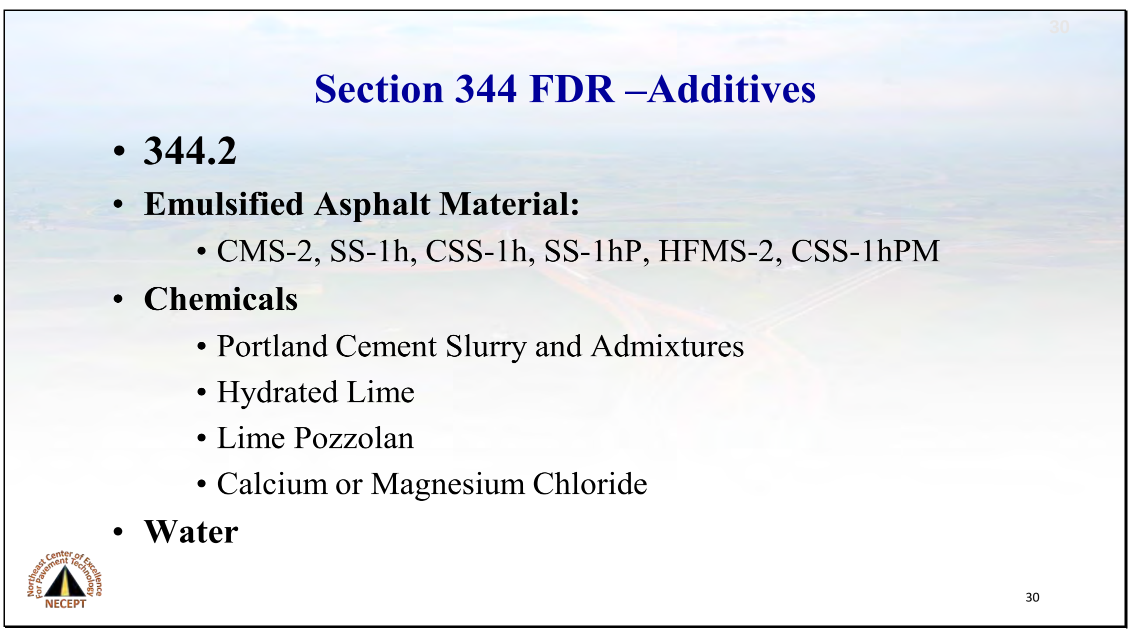
- **344.1** In-place pulverizing and mixing of existing roadway materials, stabilizing additives and imported aggregate or RAP as required to specified depths - to form a new pavement base layer upon which an asphalt overlay or surface treatment is applied.

28

This method came into wide use during the Marcellus Shale gas activity. Over 500 miles of road were rehabilitated with FDR in two years in only two counties. Drainage upgrades were of primary importance, as the hydration of the roadway must be carefully controlled.




Design strength will vary on each project and will be meticulously tested.




Daily applications of water, or a surface treatment of emulsified asphalt may be a project requirement.

## Section 344 FDR- Compaction

- 20-ton pneumatic tire roller for **8”** depth or less, and for final compaction of depths **> 8”**
- Vibratory pad foot roller for depths **> 8”**
- 12 to 14-ton static steel drum roller for finish rolling
- Allowed to cure until 7-day design strength is met

NECEPT

31

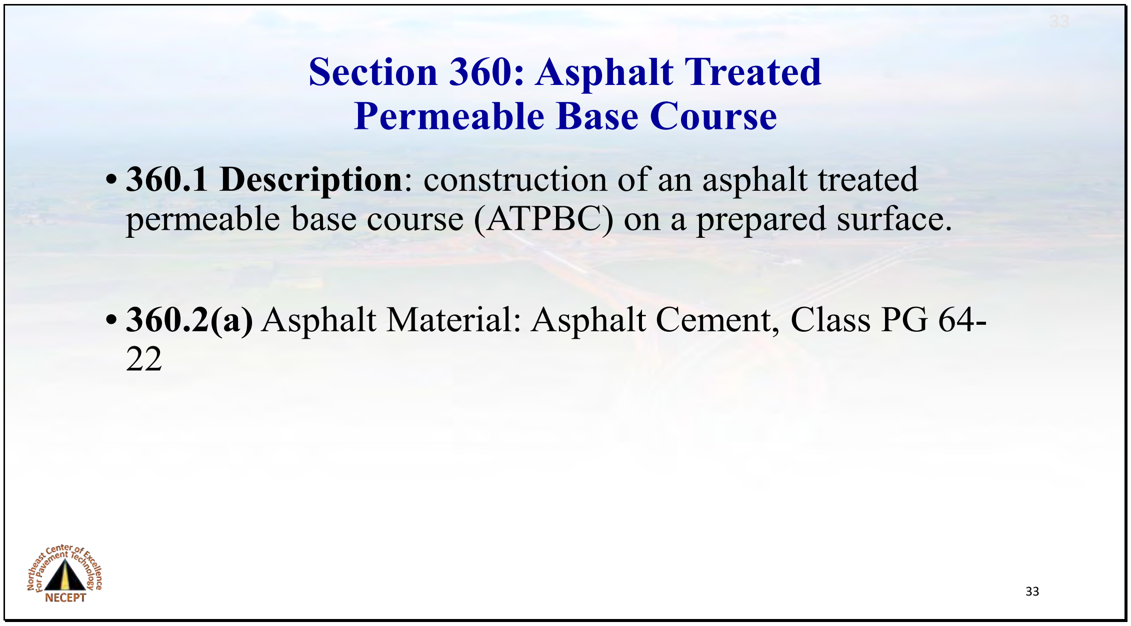
## Section 344 FDR— Compaction and Acceptance

- One test for each 3,000 sq. yd.– must be 95% of lab results using PTM 402
- Not to exceed 3/4 inch of irregularity for line, grade, or cross slope
- Surface tolerance shall not exceed **1/2 inch** under 10-foot straight edge.
- Acceptance by surface tolerance and project density specs.

NECEPT

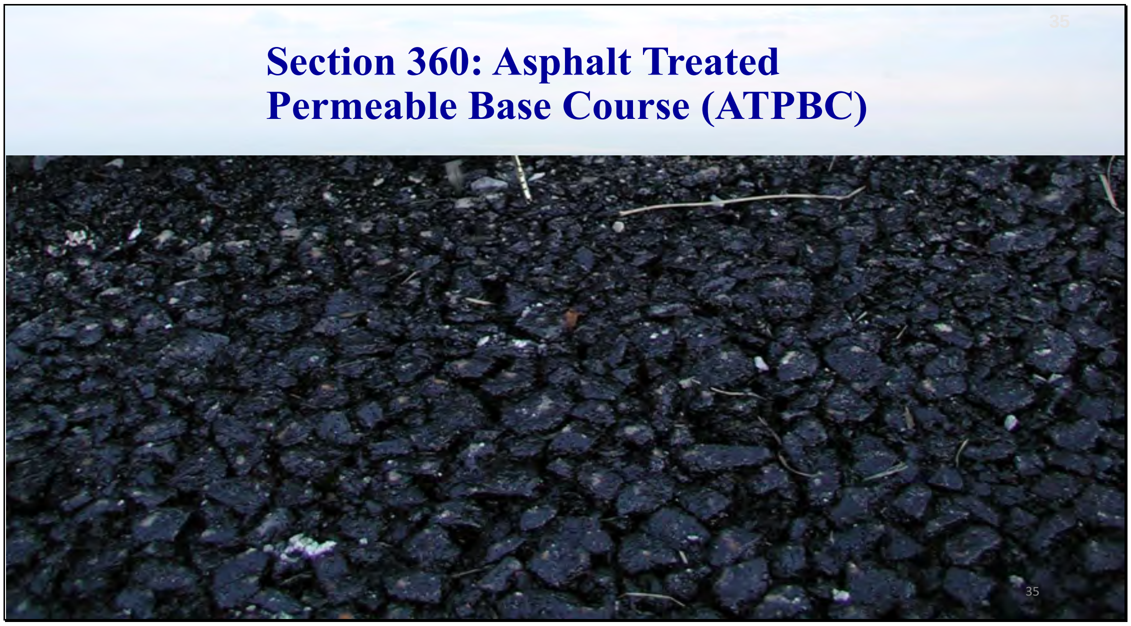
32

Profile and grade of the completed FDR must be carefully monitored to prevent varying depths of asphalt mat in the finished courses.




ATPBC is designed to be a stable platform layer that dramatically increases drainage.


**This ATPBC material has a load transfer unit (dowel bars) staked in place, ready for the rigid concrete pavement to be constructed on top.**




In this photo you can see the open texture of the ATPBC mix which allows water to drain through and travel to the subsurface drains.

## Section 360: Asphalt Treated Permeable Base Course

- **360.3 Construction: follows 413.3 for construction, except:**
  - (b) Weather Limitations: Placement prohibited when prepared surfaces are unstable, frozen, or when air or surface temperature is below **35°F**
  - (c)4. Preparation of Mixture: Produce ATPBC below **320°F** providing suitable viscosity for adequate coating; do not stockpile; place within 8 hours

36

Construction of this base course again follows Section 413 with exceptions noted.
NOTE: *Construction* specifications are in the “ .3 “ section for any item in Pub 408

## Section 360: Asphalt Treated Permeable Base Course

- 360.3 (f): Use steel-wheel power rollers with manufacturer's certified metal weight of 8 to10 tons.
- Perform rolling  as soon as the mat has cooled sufficiently to avoid shoving or lateral movement.

37

## Section 360: Asphalt Treated Permeable Base Course

- **360.3 Construction: follows 413.3 for construction, except:**
  - (h) Spreading & Finishing: Maximum **4"** compacted lifts, mixture to cool to **100°F** before placing subsequent layers or pavement courses
  - (i) Compaction: Seat ATPBC with 8- to 10-ton steel wheeled rollers (static mode only). Compact by 4 roller passes. Do not over compact.

38

ATPBC must be free draining after compaction. Do not compact the material to the point that the compacted material is no longer free draining or the aggregate is crushed.

## Section 360: Asphalt Treated Permeable Base Course

- **360.3 Construction: follows 413.3 for construction, except:**
  - (j) Mat Density Acceptance: No Density Requirements
  - (l) Surface Tolerance:
    - Testing with 10-foot straightedge in stages of 5 linear feet.
    - Pavement irregularities **more than ½ inch** need correction
    - DO NOT mill or grind the ATPBC

NECEPT

39

For irregularities developed after compaction is completed, correction must be by a method that does not produce contaminating fines or damage the base.

## Section 360: Asphalt Treated Permeable Base Course

- **360.3 Construction: follows 413.3 for construction, except:**
  - (m) Tests for Depth:
    - Dig or drill one 6" diameter test hole in each 3,000 sq. yds. or less, with additional cores if deficiency suspected
    - Measure depth , remove & replace if depth deficient by **½ inch or more**
  - (n) Protection of Courses: Traffic not permitted on ATPBC except to place next layer

NECEPT

40

## Section 404: Evaluation of Asphalt Pavement Ride Quality and Payment of Incentive

**404.1 Description** – Evaluate an asphalt pavement surface profile & determine ride quality incentive

41

The International Roughness Index (IRI) is a close determination of how the motor public decides if the new pavement smoothness (ride) is good or bad. THE PAVING QUALITY CONTROL PLAN should include surface testing procedure, the evaluation procedures, the frequency of testing, and action points to initiate corrective measures. This spec will be project specific, be aware.

## Section 404: Evaluation of Asphalt Pavement Ride Quality and Payment of Incentive

### 404.1(a) General Requirements

- Determine ride quality of finished surface
- At least **two** of the following operations must be indicated if ride quality is measured in a lot.
  - Profile milling (Section 492)
  - Asphalt Base Course
  - Asphalt Scratch course
  - Asphalt Leveling Course
  - Asphalt Binder Course
  - Asphalt Wearing Course

42

## Section 404: Evaluation of Asphalt Pavement Ride Quality and Payment of Incentive

### 404.1(a) General Requirements

- Measure surface profile according to PTM No. 428
- Information to be provided to the Representative with 24 hours:
  - Raw unfiltered data files
  - Summary printout of International Roughness Index (IRI) and Mean Ride Index (MRI)
  - Representative will determine payment for each lot based on MRI

NECEPT

43

This spec will be project specific, be aware.

## Section 404: Evaluation of Asphalt Pavement Ride Quality and Payment of Incentive

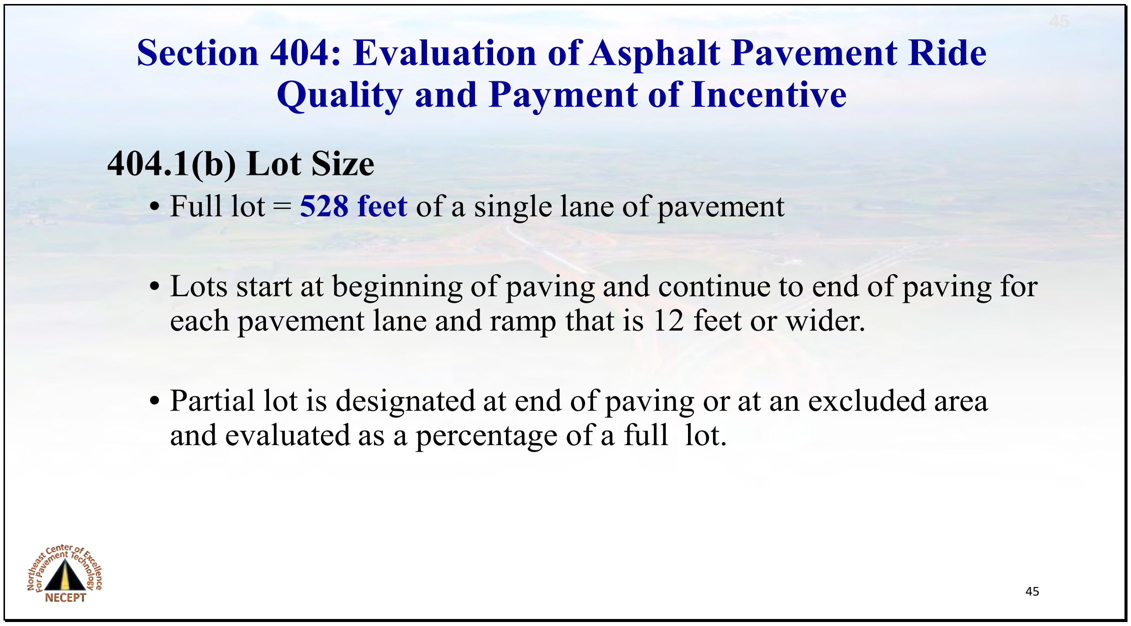
### 404.1(a) – General Requirements

Excluded areas (not included in determination of lot incentive payment)

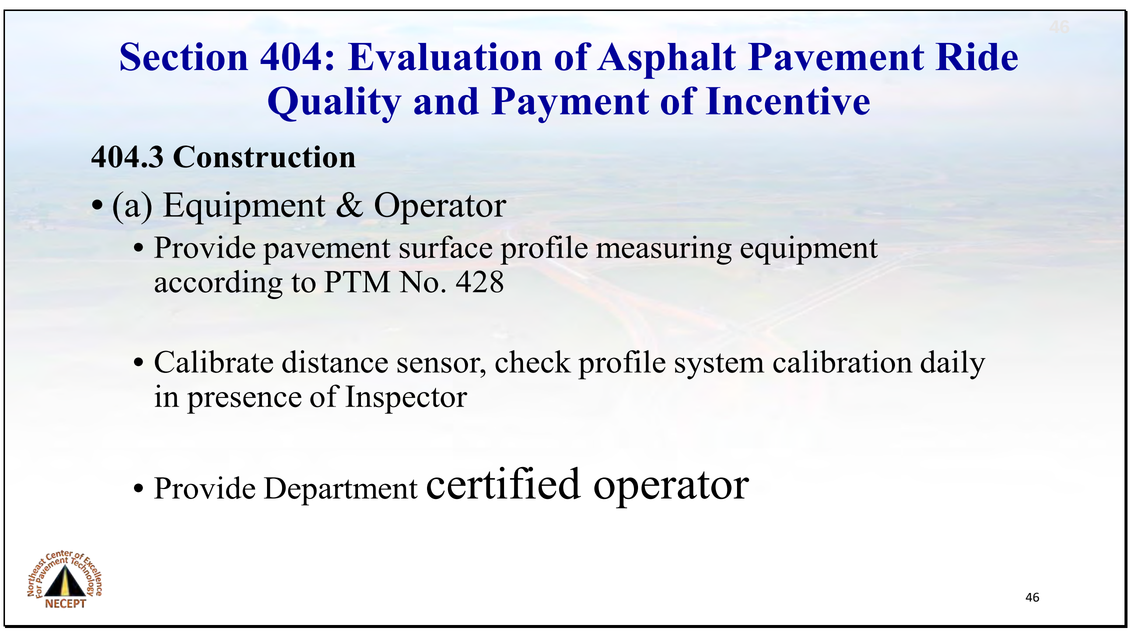
- Surface not constructed as full depth (example: transition areas and bridge approaches)
- Bridge decks unless overlaid
- Ramps less than 1,500 feet in length
- Tapered pavements
- Shoulders, medians
- Pavement from 5 ft before and 5 ft after any appurtenances (example: manholes)
- Partial lots less than 100 feet
- Roadways with posted speed limit of 40 miles per hour or lower

NECEPT

44




Example (500ft/528ft x bonus = partial lot payment). Lots are measured in the direction of traffic and include both wheel paths.




Both the equipment and the operator must be certified.

## Section 404: Evaluation of Asphalt Pavement Ride Quality and Payment of Incentive


47

Photo of a lightweight profiler. Note the PennDOT sticker on the front of the vehicle showing that it has been certified.

## Section 404: Evaluation of Asphalt Pavement Ride Quality and Payment of Incentive

### 404.3(b) Testing

**(1) Lots**

- Provide traffic control, clean pavement as necessary.
- Determine surface profile of each lot according to PTM No. 428, in presence of Inspector.

**(2) Excluded Areas**

- Measure with 12-foot straightedge, parallel to centerline.
- Advance in five-foot increments.

48

## Section 404: Evaluation of Asphalt Pavement Ride Quality and Payment of Incentive

### 404.3(c) Acceptance

**1. Lots**. Lot IRI compared to Table A in Section 404.4

- Perform corrective action if indicated by the Table, or if any individual bump (irregularity) is greater than 3/16 inch tested with a 12-foot straightedge.

**2. Excluded Areas**. Not included for incentive payment

- To be corrected if irregularities are more than 3/16 inch.

NECEPT

49

**Acceptance of Lots:**
Acceptance is conducted lot by lot and will be determined by the average of two wheelpath measurements within the lot and will be evaluated for compliance with the requirements of Table A in Section 404.

## Section 404: Evaluation of Asphalt Pavement Ride Quality and Payment of Incentive

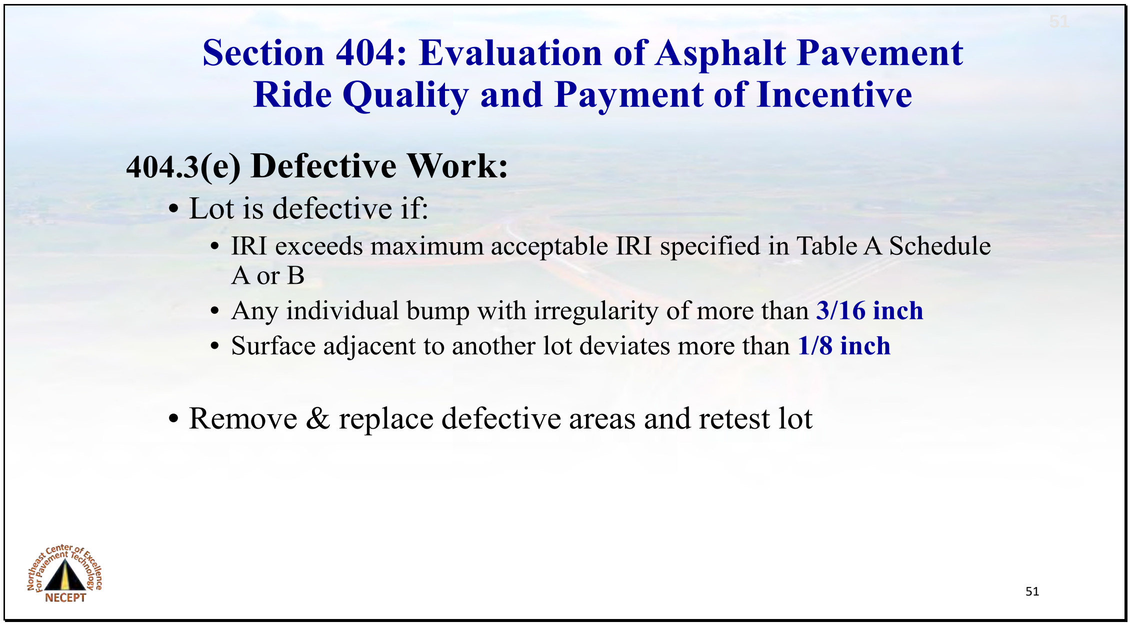
### 404.3(d) Corrective Action

- Perform **before** testing for pavement depth.
- Use carbide grinding, diamond grinding, or remove & replace.
- Produce surfaces that are neat, of uniform texture, with not more than **1/8-inch** deviation with existing pavement.

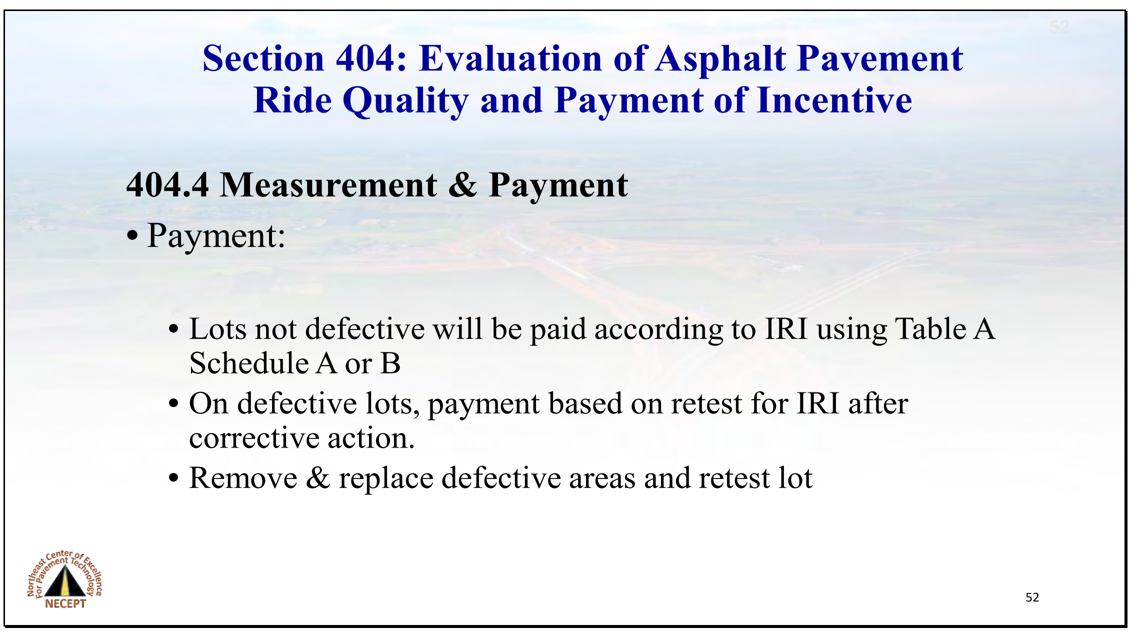
NECEPT

50

Corrective action retest must produce an acceptable IRI (Section 404, Table A) , and results are eligible for bonus.




Remove and replace the full lane width of pavement determined defective unless otherwise directed in writing by the District Engineer.




Payment determined on the final IRI (retest) after performing any corrective work.

## Section 404: Evaluation of Asphalt Pavement Ride Quality and Payment of Incentive

### Table A

### Schedule for Ride Quality Incentive

**Schedule A**

**For Expressway Work Using Three Operations**

| IRI inches/mile/lot | Amount |
|---|---|
| ≤ 35 | $600 |
| ≤ 50 | $300 |
| ≤ 60 | $150 |
| ≤70 | $0 |
| >70 | Corrective Action Required |

53

The IRI is a roughness index – the higher the number, the rougher the pavement and the lower amount of incentive to be paid, the smaller the number the smoother the pavement and the higher amount of incentive. Smoothness expectations increase with the number of operations ( layers).

## Section 404: Evaluation of Asphalt Pavement Ride Quality and Payment of Incentive

### Table A

### Schedule for Ride Quality Incentive

**Schedule B**

**For Expressway Work Using Two Operations And Non-Expressway Work Using Two or More Operations**

| IRI inches/mile/lot | Amount |
|---|---|
| ≤ 45 | $600 |
| ≤ 55 | $300 |
| ≤ 70 | $150 |
| ≤90 | $0 |
| >90 | Corrective Action Required |

54

## Section 405
## Evaluation of Asphalt Pavement Longitudinal Joints Density and Payment of Incentive/Disincentive

- **Usage:** For use on any project meeting ALL of the following criteria:
  - RPS ( regardless of network) or Standard pavements on the National Highway System (NHS)
  - Density acceptance by cores
  - Length of testable longitudinal joint >12,500 feet

NECEPT

55

Reference Section 405 and PTM 729 for further information.

## Section 405
## Evaluation of Asphalt Pavement Longitudinal Joints Density and Payment of Incentive/Disincentive

- **405.1 Description:** Evaluating longitudinal joint samples on the surface wearing course for determining densities and the incentives/disincentive, including necessary corrective actions required as result of evaluation.

NECEPT

56

## Section 405
## Evaluation of Asphalt Pavement Longitudinal Joints Density and Payment of Incentive/Disincentive

- **405.3 Construction:**
  (a) General Requirements: Lots for this spec completely independent from lots defined in other sections of the Specs for pavement acceptance

NECEPT

57

## Section 405
## Evaluation of Asphalt Pavement Longitudinal Joints Density and Payment of Incentive/Disincentive

- **405.3 (b) Lot Size**
  - Full lot is **12,500 feet** of longitudinal joint
  - 5 sublots of **2,500 feet** per full lot
  - One joint core drilled per sublot as paving progresses until full lot obtained
  - Single lot need not be contiguous & may include multiple joints within project

NECEPT

58

The Representative will determine the payment addition or deduction along with any necessary corrective actions for each longitudinal joint lot based on the test results of the density cores.

## Section 405
## Evaluation of Asphalt Pavement Longitudinal Joints Density and Payment of Incentive/Disincentive

- **405.3 (c) Quality Control Strip**
  - On first day paving of longitudinal joint, in addition to incentive/disincentive payment sublot joint cores, obtain 5 randomly located core samples on longitudinal joint for QC density testing
  - Cores to be tested and results supplied within 24 hours in order to make any adjustments to ensure adequate in place density is achieved

NECEPT

59

QC cores are to be tested by the contractor for the first day that a joint is constructed to ensure that necessary adjustments to procedures are accomplished ASAP.

## Section 405
## Evaluation of Asphalt Pavement Longitudinal Joints Density and Payment of Incentive/Disincentive

- **405.3 (d) Excluded Areas. Following joint areas excluded from lots:**
  - Joints where one or both sides pavement were accepted for density by other means
  - Joints where one side is formed by existing pavement not constructed under this project
  - Areas within 1 foot longitudinally of an obstruction
  - Small areas (intersections, gores, transitions) not allowing for consistent joint construction

NECEPT

60

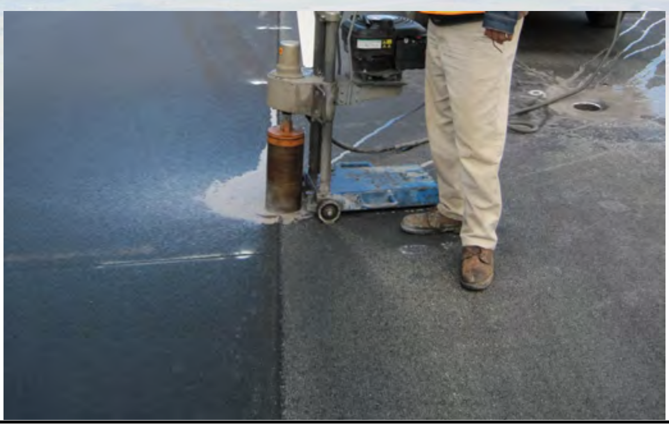
## Section 405
## Evaluation of Asphalt Pavement Longitudinal Joints Density and Payment of Incentive/Disincentive

- **One 6-inch core** in each sublot located using PTM 1 and PTM 729 no later than day following placement
- For vertical joints center core over surface joint.
- For notch-wedge joints, center core **6 inches** or one half of joint taper width away from joint line in direction of wedge.

NECEPT 61

PTM (Pennsylvania Test Methods) will be covered later in Module 3.

## Section 405
## Evaluation of Asphalt Pavement Longitudinal Joints Density and Payment of Incentive/Disincentive



NECEPT 62

Coring of a vertical joint

## Section 405
## Evaluation of Asphalt Pavement Longitudinal Joints Density and Payment of Incentive/Disincentive

- **405.3 (e) Sampling (continued)**
  - Identify by lot & sublot, location, placement date, mixture type, & as acceptance samples (Sample Class AS)
  - Cores tested by LTS
  - If damaged, replacement obtained from within **12 inches** of original
  - Hole backfilled with same JMF & sealed within 24 hours

63

## Section 405
## Evaluation of Asphalt Pavement Longitudinal Joints Density and Payment of Incentive/Disincentive

- **405.3 (e) Sampling (Continued)**
  - Provide Theoretical Max Specific Gravity (Gmm) for the mix on each side of the joint.
  - Use average of the two values for density calculations
  - Package and Deliver the samples to the Representative

64

## Section 405
## Evaluation of Asphalt Pavement Longitudinal Joints Density and Payment of Incentive/Disincentive

NECEPT

65

**Close-up of overband with PG 64S-22**

## Section 405
## Evaluation of Asphalt Pavement Longitudinal Joints Density and Payment of Incentive/Disincentive

- **405.3 (e) Sampling (continued)**
  - Joint core comprised of portions of two lanes
  - May have two JMFs within each core (one for cold lane and one for hot lane)
  - Report average Gmm for the joint core in eCAMMS or on form TR-447.

NECEPT

66

## Section 405
## Evaluation of Asphalt Pavement Longitudinal Joints Density and Payment of Incentive/Disincentive

- **405.4 Measurement and Payment**
  - Uses the Percent within Limits (PWL) from Section 106.03(a)3 in Table A of Section 405.4 for payment by lot.
  - Partial lots with fewer than 3 sublots are combined with the previous lot.
  - Partial lots with three or more sublots will stand as a separate lot.

NECEPT

67

## Section 405
## Evaluation of Asphalt Pavement Longitudinal Joints Density and Payment of Incentive/Disincentive

Table A (Section 405.4)

| Lot by Lot Payment Schedule for Longitudinal Joint Incentive/Disincentive | |
|---|---|
| **Lot PWL** | **Amount** |
| PWL ≥ 81 | (PWL – 80)/20 × $7,500 (Incentive) |
| PWL = 50 to 80 | $0 |
| PWL ≤ 49 | (50 – PWL)/50 × $12,500 (Disincentive) |

| Incentive/disincentive payment for a lot containing other than 5 sublots | |
|---|---|
| N = 3 (i.e., three Sublots) | 60% of the Table A amount |
| N = 4 (i.e., four sublots) | 80% of the Table A amount |
| N = 6 (i.e., six sublots) | 120% of the Table A amount |
| N = 7 (i.e., seven sublots) | 140% of the Table A amount |

NECEPT

68

Joints constructed when paving in *echelon* are included unless project specifications dictate otherwise.

## Are you keeping up with me?

69

## Section 413: Superpave Mixture Design, Standard & RPS Construction of Plant-Courses with Percent Within Limits and LTS Testing (PWL-LTS)

- **413.1 Description**: Standard and RPS construction of plant mixed asphalt on a prepared surface using a volumetric mixture design developed with the Superpave Gyratory Compactor

70

This Section 413 is for Superpave wearing and binder courses, it is the largest section of 408 specification as related to asphalt construction and is frequently referred to by other asphalt sections for construction requirements.

## Section 413: Superpave Mixture Design, Standard & RPS Construction

- **413.2 Materials**
  - Refers to Sections 106 & 700
  - Discusses material sources – Bulletins 14 &15, and aggregate SRL
  - Addresses use of RAP, RAM, and RAS
  - Discusses Job-Mix Formula tolerance requirements for completed mix

NECEPT

71

The material section discusses Bulletin 14 (approved aggregate sources) and Bulletin 15 (approved Asphalt binder sources). In addition, tables are provided for the Job-Mix Formula Composition and Tolerance.

## Section 413: Superpave Mixture Design, Standard & RPS Construction

- **413.2(i) Mixture Acceptance:**
  - RPS Construction accepted by lots
  - For Standard Construction, use Table C:
- **Table C Mixture Acceptance**

| Acceptance Level | Acceptance Method |
|---|---|
| Certification Acceptance | Producer Certification of Mixture (Section 4139.2(i)2) |
| Lot Acceptance | Mixture Acceptance Sample Testing (Section 413.3(h)2) |

NECEPT

Acceptance level MUST be discussed at the pre-placement meeting.

## Section 413: Superpave Mixture Design, Standard & RPS Construction

- **413.2(i)2 Certification Acceptance. Appropriate for**
  - Scratch or Leveling <2”, driveway adjustments.
  - Mixtures used by Dept. maintenance forces.
  - Mixtures used by municipal governments.
  - Small quantities <500 tons in a continuous operation.
  - Mixtures used for parking lots
  - All 4.75 mm NMAS asphalt mixtures
  - Other mixtures, conditions, or applications as approved

**All others by Lot Acceptance!**

NECEPT

73

**These are the requirements for Acceptance by Certification under Table “C“ of Section 413, Standard Construction.**

## Loose Box Samples < 500 tons

- No loose box samples for JMF quantity **< 500 tons** (i.e., less than 500 tons)
- Coring allowed for density acceptance on materials accepted by Certification

*Should be discussed at pre-placement meeting*

NECEPT

74

## Section 413: Superpave Mixture Design, Standard & RPS Construction

- **413.3 Construction**

  - (a) Paving operation QC Plan:

  Contractor must submit a paving operation QC plan for the project (Form CS-413)

NECEPT

75

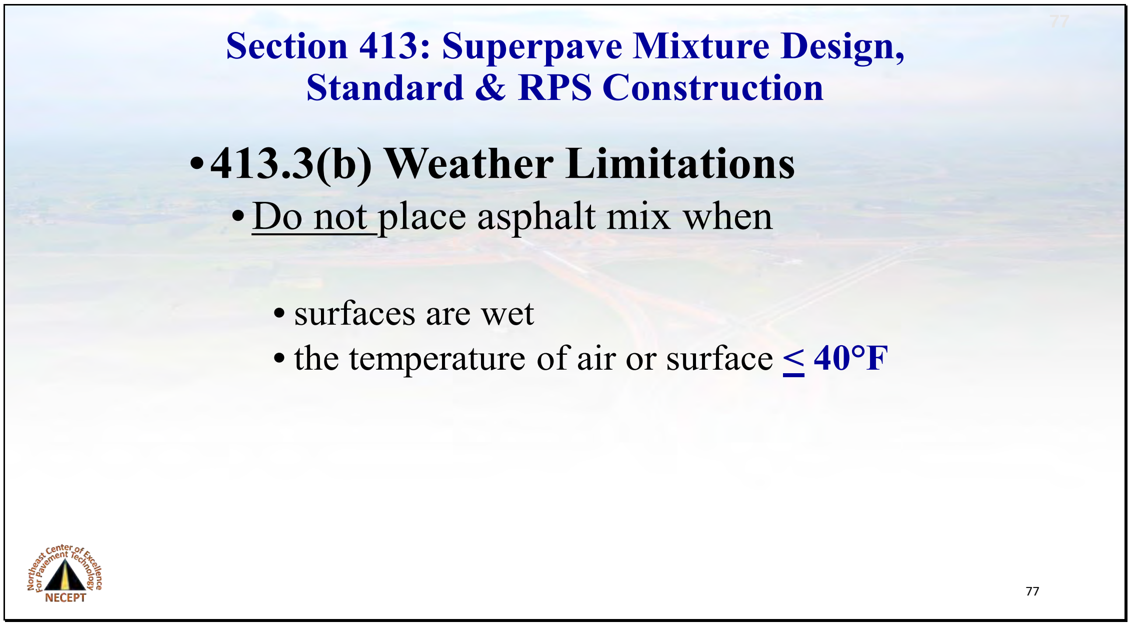
Form CS-413 was reviewed in Module 1. If work is halted because of weather conditions, the contractor "MAY" be allowed "to place limited quantities of mixture that are en route to the project" as determined by the Department's representative.

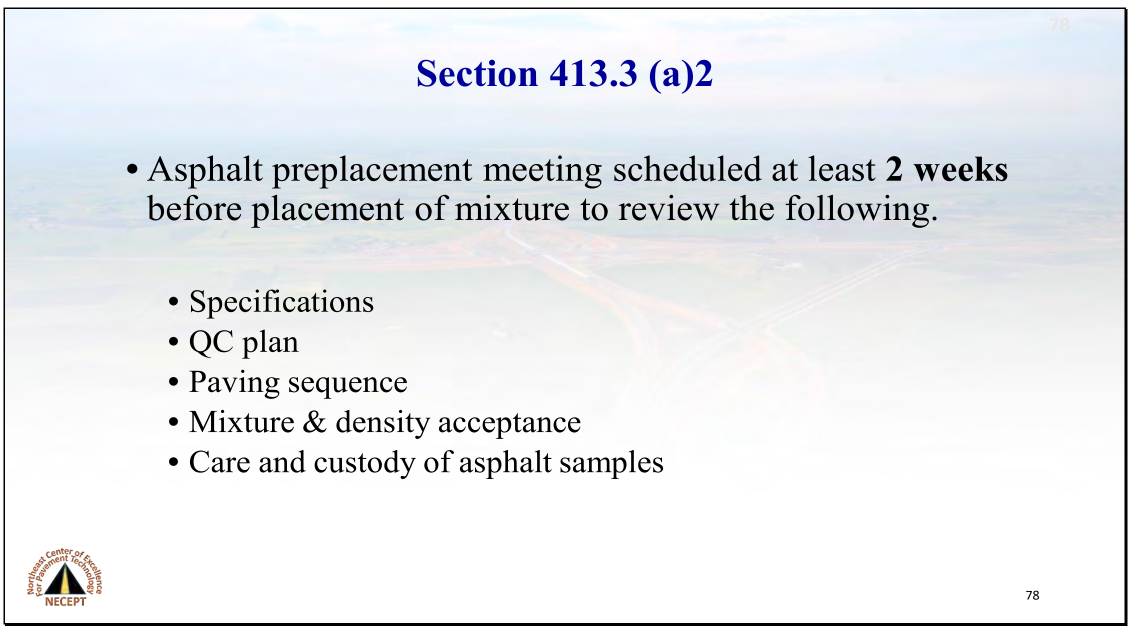
## Section 413: Superpave Mixture Design, Standard & RPS Construction

- **413.3(b) Weather Limitations**
  - ❑ Paving allowed from April 1 to October 15 for the following wearing courses:
    - PG 64E-22 (PG 76-22)
    - >10M ESALs
    - 4.75 mm mix
    - Other mixes compacted less than 1.5 inches.
  - ❑ Paving allowed from April 1 to October 31 for all other courses:

NECEPT

76




This meeting provides the time and place to discuss monolithic placement of mainline and shoulders, non-testable areas, and who makes the call on rain stoppages, as well as any other "lack of communication issues" that you have experienced.

# Section 413.2(e), Table A

| Temperature of Mixture (F) | | | | |
|---|---|---|---|---|
| Class of Material | Type of Material | Chemical, Organic, Foaming Additives, Minimum | Mechanical Foaming Equip/Process Minimum* | Maximum* |
| PG 58S-28 | Asphalt Binder | 215 | 230 | 310 |
| PG 64S-22 | Asphalt Binder | 220 | 240 | 320 |
| PG 64E-22 | Asphalt Binder | 240 | 260 | 330 |
| All other binders | Asphalt Binder | The higher of 215 or the minimum temp. specified in Bulletin 25 minus 45°F | The higher of 230 or the minimum temp. specified in Bulletin 25 minus 30°F | As specified in Bulletin 25 |

* Outline in the Producer QC Plan and follow more restrictive temperature requirements provided by the WMA technology manufacturer or Technical Representative(s) for production and placement of the mixture. Determine the SGC compaction temperature for the production QC which yields the same target air voids as the designed JMF . Include the SGC compaction temperature in the Producer QC Plan. Compact the completed mixture in the SGC for QC volumetric analysis at the SGC compaction temperature according to the guidelines provided by the Technical Representative.

79

# Extended-Season Paving

- Written request at 14 calendar days prior to extended season paving
  - ❑ Paving allowed from April 1 to November 15 for the following wearing courses:
    - PG 64E-22 (PG 76-22)
    - >10M ESALs
    - 4.75 mm mix
    - Other mixes compacted less than 1.5 inches.
  - ❑ Paving allowed from March 1 to December 15 for all other courses:
- Must use MTV for lengths > 1,500 ft.

80

81

## Extended Season Paving

- Project Representative MUST release Material
- Extended season pre-placement meeting at least 5 days prior to review details of Extended Season Paving Plan (CS-413 ES)
- MUST follow Plan or STOP PAVING

NECEPT

82

## Extended Season Paving

- Density acceptance for RPS and standard paving on stable/uniform bases at Table G depths will be by pavement cores.

NECEPT

82

## Extended Season Paving

- **CS-413ES** to be completed and provided to Dept. within 24 hours of completion of paving.
- Extended Season Fall paving will be subject to Spring Evaluation by May 1 as described in Pub 336.

83

## Section 413: Superpave Mixture Design, Standard & RPS Construction

- **413.3 Construction**
  - (d) Hauling Equipment
    - Tightly sealed vehicles
    - Provide covers to protect entire load
    - Provide insulation/heated or double-walled truck bodies when air temp is **below 50°F** from October 1 to April 30.

84

Specific details of asphalt delivery, lay down and compaction will be provided in later modules.

## Section 413: Superpave Mixture Design, Standard & RPS Construction

- **413.3 Construction**
  - (e) 1 Asphalt Pavers
    - Self-contained power-propelled units with automatic screed controls.
    - Hydraulic or other extensions only fed & activated same as main screed
  - (e) 2 Asphalt Wideners
    - Self-contained power-propelled units
    - Strike off assembly capable of producing finished surface of specified evenness and texture.
    - Capable of placing the mix uniformly in front of the strike off assembly

NECEPT 85

Auger extensions are required when screed extensions will not be adjusted in and out throughout the placement. A good rule to follow is that auger extensions should be used in fixed width applications to bring the material as close to the end gate as possible, but a maximum of 18 inches from the end gate. Also, note that a skid steer loader is not listed as paving equipment. Their use should be minimal and only to move material, not to pave.

## Section 413: Superpave Mixture Design, Standard & RPS Construction

- **413.3 Construction**
  - (f) Rollers
    - Steel-wheel, pneumatic tire, vibratory or oscillating rollers as specified in Section 108.05(c)3 with separate controls for frequency and amplitude.

NECEPT 86

**Section 108.05 also addresses many of the specific details.**

## Section 413: Superpave Mixture Design, Standard & RPS Construction

- **413.3 Construction**
  - (g) Preparation of Existing Surface
    - Clean
    - Correct irregularities in binder course
    - Paint existing vertical surfaces with asphalt Class TACK, NTT/ CNTT in two or more applications or hot asphalt of class & type designated for course.

87

**All of these topics will be covered in later modules.**

## Section 413: Superpave Mixture Design, Standard & RPS Construction

- **413.3 Construction**
  - (g) Preparation of Existing Surface
    - Apply a tack coat, Section 460
    - Place scratch and leveling courses as indicated
    - ❖ Paving Notches: Mill existing pavement surface at tie-in with wearing course (use Std Drawing RC - 28M & Milling Section 491)

88

All of these topics will be covered in later modules.

## Scratch & Leveling courses

- Use **scratch course** to fill wheel ruts & other local small depressions to make even with surrounding pavement.
- Use **leveling course** to provide a relatively uniform working platform for placing binder or wearing courses

NECEPT

89

Surface Preparation will be covered in more detail in Module 4.

## Section 413: Superpave Mixture Design, Standard & RPS Construction

- **413.3 Construction**
  - (h) Spreading and Finishing
    - Deliver and place at laying temperatures specified in Table A (Section 413.2(e)1.d.)
      - **PG 58S-28** **215 °F to 310 °F**
      - **PG 64S-22** **220 °F to 320 °F**
      - **PG 64E-22** **240 °F to 330 °F**

      Asphalt Temperatures
    - Courses > 6” in compacted depth, place in 2 or more equal layers
    - No layer should be <3” or > 6” compacted depth when placing a course > 6”
    - Do not use rakes.

NECEPT

90

Asphalt lutes are to be used for handwork. Garden-type rakes cause segregation of the aggregate in the mix.

## Section 413: Superpave Mixture Design, Standard & RPS Construction

- **413.3 Construction**
- MTV required for RPS pavement
  - (h)1.d Field Technician
    - Provide Certified Asphalt Field Technician
    - Must be onsite
    - Must carry valid certification card

NECEPT

91

**The CFT should have control of the quality of the operation, not just the quantity!**

## Section 413: Superpave Mixture Design, Standard & RPS Construction

- **413.3 Construction**
- **(h)1e** Safety Edge
  - Use for binder and wearing courses that are ≥ **1 ½ inches**
  - Do not place safety edge at total depth > **5 inches**
  - No safety edge at curbs or where guiderail directly on the pavement edge
  - No safety edge for scratch, leveling, or base course
  - Requires extrusion device at edge of paver (not just a strike-off )
  - 26-40 degree angle from adjacent pavement.
  - May require additional prework
  - Incidental to the course being laid

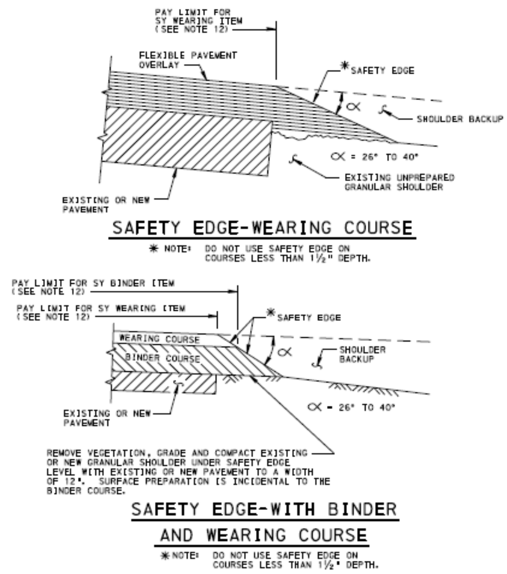
NECEPT

92

## Safety Edge

PennDOT Publication 72M
Construction Drawings

RC-25M




NECEPT

## Safety Edge

Adjustable Safety Edge Device

Safety Edge Placement

NECEPT

## Safety Edge

Use of Angle Measuring Device

## Section 413: Superpave Mixture Design, Standard & RPS Construction

- **413.3 Construction**
  - (h)2 Mixture Lot Acceptance (Standard & RPS Construction)
  - (h)2.a Lots and sublots
    - Lots established & specific for each JMF
    - Normal lot size = 2,500 Tons
    - Normal sublot size = 500 Tons (5 per lot)
    - 1 box sample + 1 core sample obtained from each sublot (PTM No. 1)

96

**Lot acceptance procedures and practice exercises will be covered in Module 3: PTM's.**

## Section 413: Superpave Mixture Design, Standard & RPS Construction

- **413.3(h)2.a Lots and Sublots**
  - If project size or operational conditions dictate. Lot *(final lot)* will be adjusted as in Table D
  - Stoppages of 5 days or more, last lot will be adjusted as in Table D.
  - New lot established when work resumes after 5-day stoppage.

**Full Size Table D at End of Module 3**

97

## 413.3(h)2.a Lots and Sublots: Table D

Re-adjustment of Lot Size & Associated Number of Sublots

| Remaining Quantity* Following Last Full Lot | Action |
|---|---|
| Less than 500 tons without a combination of one mixture acceptance sample and one core | Quantity combined with previous lot, (n=5) |
| Less than 500 tons with a combination of one mixture acceptance sample and one core | One new sublot defined & quantity combined with previous lot, (n=6) |
| 500 tons to less than 1000 tons without a combination of two mixture acceptance samples and two cores | One new sublot defined & quantity combined with previous lot, (n=6) |
| 500 tons to less than 1000 tons with a combination of two mixture acceptance samples and two cores | Two new sublots defined & quantity combined with previous lot, (n=7) |
| 1000 tons to less than 1500 tons without a combination of three mixture acceptance samples and three cores | Two new sublots defined & quantity combined with previous lot, (n=7) |
| 1000 tons to less than 1500 tons with a combination of three mixture acceptance samples and three cores | New lot defined, (n=3) |

Use of Table D is limited to JMF project quantities of 2,500 tons or greater and ONLY after completion of last full lot. Examples at end of PTM module.

## 413.3(h)2.a: Table D *continued*

Re-adjustment of Lot Size & Associated Number of Sublots

| Remaining Quantity* Following Last Full Lot | Action |
|---|---|
| 1500 tons to less than 2000 tons without a combination of four mixture acceptance samples and four cores | New lot defined, (n=3) |
| 1500 tons to less than 2000 tons with a combination of four mixture acceptance samples and four cores | New lot defined, (n=4) |
| 2000 tons to less than 2500 tons without a combination of five mixture acceptance samples and five cores | New lot defined, (n=4) |
| 2000 tons to less than 2500 tons with a combination of five mixture acceptance samples and five cores | New lot defined, (n=5) |

- **413.3(h)2.a.1**
  - Partially Completed Lot (n=2 or less): When partially completed lot (2 sublots or less) cannot be combined with most recent completed lot, samples will be independently evaluated

## Section 413: Superpave Mixture Design, Standard & RPS Construction

- **413.3(h)2.a.2 JMF's less than 2500 tons**
  - JMF's > 500 tons and < 2500 tons, tonnage considered a lot and divided into 5 equal sublots
  - JMF's ≤ 500 tons, tonnage may be considered a lot and divided into 3 equal sublots, if density acceptance by pavement cores ( an option) mixture acceptance is only by certification

***For total JMF less than 2,500 tons, Table D does not apply, do not use!***

100

These specs MUST be adhered to when computing sample frequency.

## Lot – Sublot Definitions

- *Normal lot* size is **2500 tons** with **5 sublots** of 500 tons each.
- A *complete lot* will have at least 3, but no more than 7 sublots
- Lots with less than 3 sublots are “incomplete”
- A *complete sublot* MUST have a core and a loose (mixture or box) sample

NECEPT

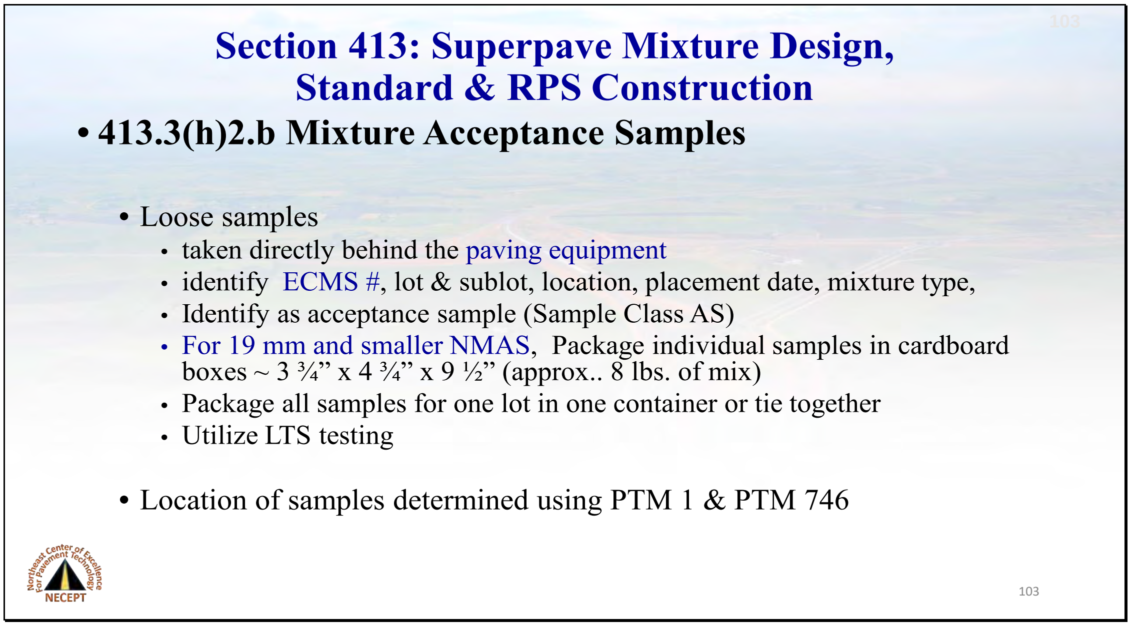
101

A complete sublot must have both a box and core when both mixture acceptance is by loose box and density acceptance is by pavement cores.

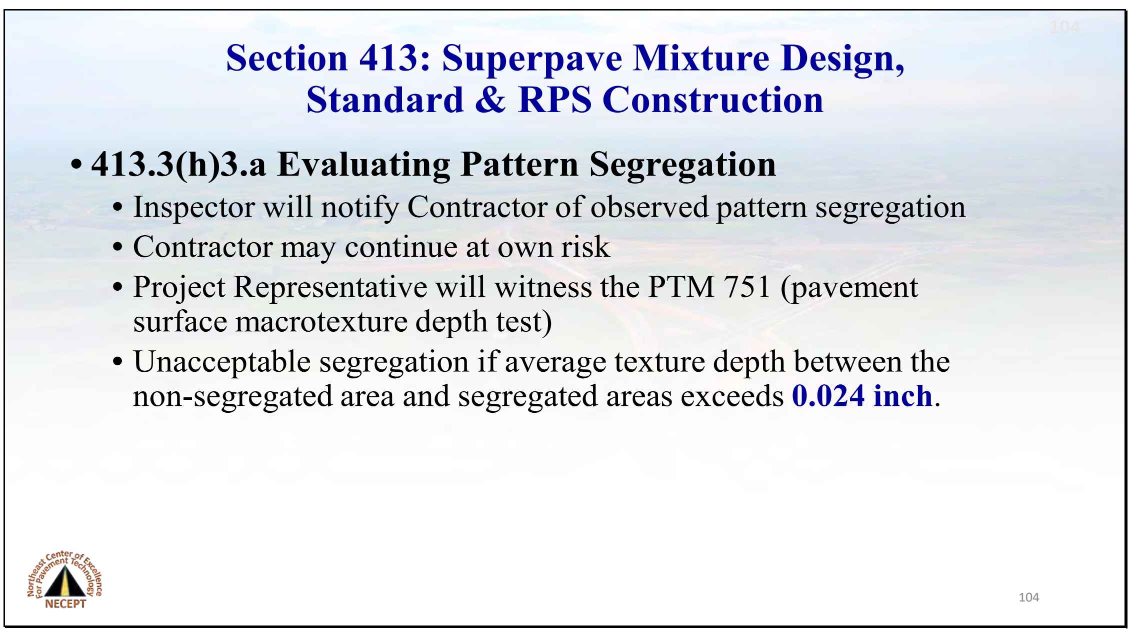
## Section 413.3(h): 2.a Lots and Sublots

- Once the sublot size for JMF has been established, the sublot size will remain unchanged throughout the project.

NECEPT



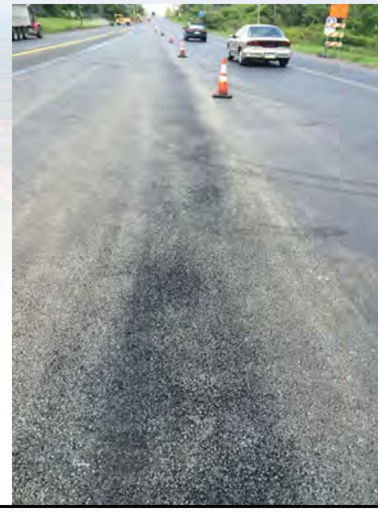

Procedure for Box Samples: Pub 408/2020 covers box sizes for mixes >25mm and gives further instructions on packaging and identification. PTM 746 from PUB 19 contains additional information and illustrative examples and will be covered in module 3.




Pattern segregation will be discussed in detail in Module 9.

## Section 413: Superpave Mixture Design, Standard & RPS Construction

- **413.3(h)3.b Test Section**
  - If segregation identified, stop paving!
  - Department will evaluate segregation to determine corrective work
  - Test section then placed, <200 tons
  - Resume normal paving after successful test section



NECEPT

105

These procedures will be covered in module 3.

## Section 413: Superpave Mixture Design, Standard & RPS Construction

- **413.3(h)3.c Defective Pavement**
  - Cores taken – 3 from segregated area & 3 from non-segregated area , tested for density, asphalt content and gradation
  - If tests determine pavement is defective, remove & replace full width of affected lane plus minimum of 5 feet beyond each end of unaccepted area.

NECEPT

106

## Section 413: Superpave Mixture Design, Standard & RPS Construction

- **413.3(h)4. Flushing**
  - Provide a mix that will not flush
  - Flushing is continuous or repeated areas of excessive asphalt on the pavement surface

NECEPT

107

Flushing is evaluated by PTM 751 which will be covered in Module #3.

## Section 413: Superpave Mixture Design, Standard & RPS Construction

- **413.3(h)4.a. Evaluating Flushing**
  - When flushing is observed, Project Representative will notify Contractor.
  - Contractor may continue at its own risk while adjusting to eliminate further flushing.
  - Average pavement surface macrotexture depth is determined by PTM 751 in suspected flushing area.
  - Average texture depth ≤ 0.006 inches, pavement considered flushed & defective.

NECEPT

108

The procedure for evaluating flushing is similar to the procedure for segregation and again uses PTM 751.

## Section 413: Superpave Mixture Design, Standard & RPS Construction

- **413.3(h)4.b. Test Section**
  - If flushing identified, stop paving!
  - Department will evaluate flushing to determine corrective work
  - Remove & replace defective wearing course for full lane width + minimum 5 feet beyond each end of defective area
  - After Project Representative allows paving to resume, place test section not to exceed 200 tons.
  - Normal paving can be resumed after construction of an entire test section without flushing.

109

## Section 413: Superpave Mixture Design, Standard & RPS Construction

- **413.3 Construction**
  - (i) Compaction
    - Compact to achieve required density & eliminate all roller marks
    - Adjust speed, amplitude, frequency, etc., to eliminate displacement, shoving, cracking, or aggregate breakage.
    - Use pneumatic-tire for compacting scratch courses.
    - For roller inaccessible areas, use mechanical vibrating hand tampers

110

Compaction is the single most important factor that affects the ultimate performance of an asphalt pavement. Compaction will be covered in detail in Module #8.

## Section 413: Superpave Mixture Design, Standard & RPS Construction

- **413.3 Construction**
  - (j) Mat Density Acceptance
    - Standard Construction (non-RPS): Density acceptance according to one of the levels in Table F
    - RPS: Density acceptance by Pavement Cores (lot acceptance)
    - Department determines density-acceptance level (QC Paving Plan)

111

QC paving plan should be IN YOUR POSSESION while paving and must be discussed at the pre-placement meeting!!!!!!

## Section 413: Superpave Mixture Design, Standard & RPS Construction

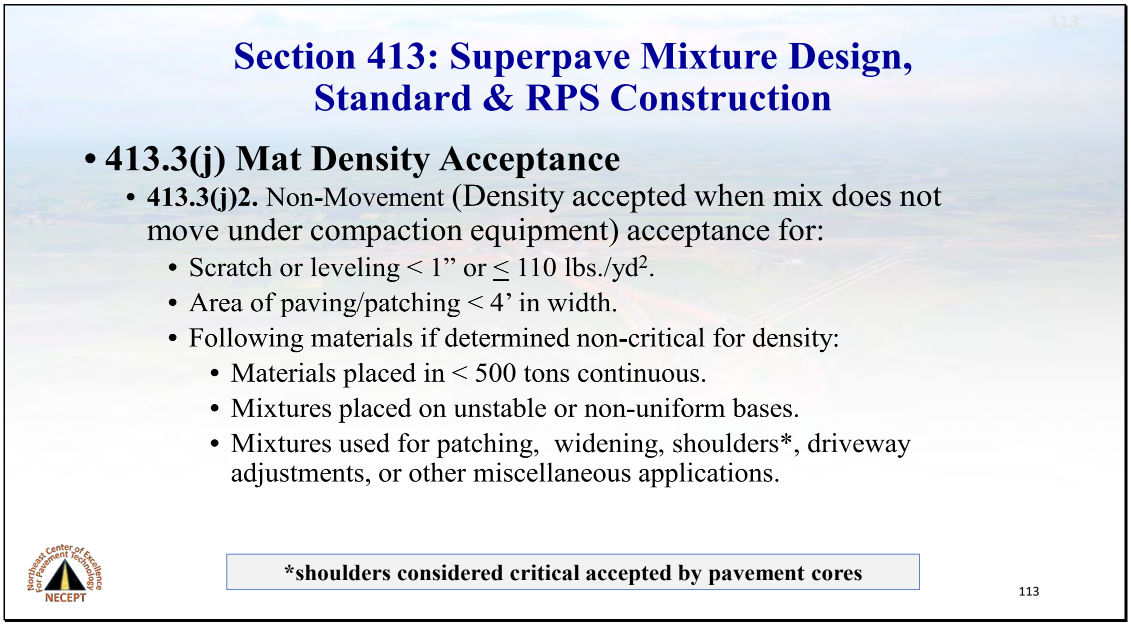
- **413.3(j) Mat Density Acceptance**
  - Standard Construction (non-RPS)

**Table F: Density Acceptance**

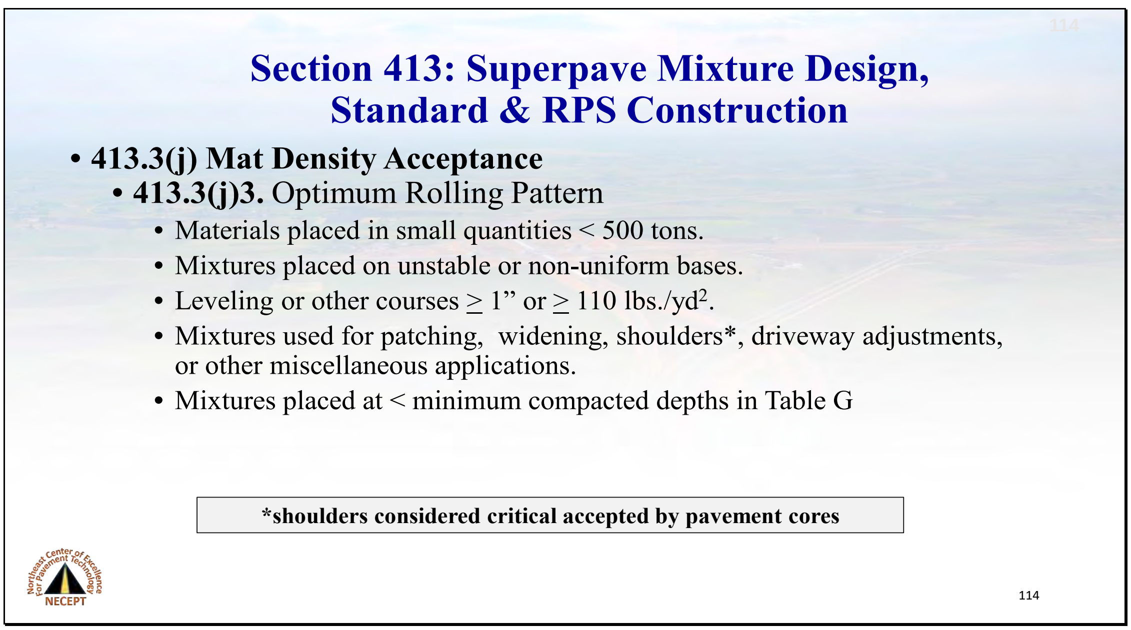
| Density Acceptance Level | Acceptance Criteria |
|---|---|
| Non-movement | Table H |
| Optimum Rolling Pattern | Table H |
| Pavement Cores* | Table I |
| *Only when mixture is accepted by lots | |

Cores may be used for density acceptance for quantities < 500 tons.

112




Again, these topics must be discussed at the pre-placement meeting.




Materials placed in small quantities refers to a continuous placement.
*Shoulders where density is critical (as decided at the pre-placement meeting) will be accepted by pavement cores as specified in section 413.3(j)4.a

An Optimum Rolling Pattern is an accurate measure of the compaction characteristics of the material and capabilities of the equipment under ANY given field condition with reasonably uniform depth.

## Section 413: Superpave Mixture Design, Standard & RPS Construction

- **413.3(j)3. Optimum Rolling Pattern**
  - Density tested by nuclear gauge (PTM 402) or electrical impedance gauge (PTM 403)
  - Inspector & contractor's certified field technician present
  - Nuclear gauge must have licensed operator
  - Use approved gauges or approved equal
  - Use procedure and forms in PTM 402/403

115

The approved gauges are listed in the specifications and will be covered in modules 3 and 8.

## Section 413: Superpave Mixture Design, Standard & RPS Construction

- **413.3(j) Mat Density Acceptance**
  - **413.3(j)4**. Pavement Cores (Standard or RPS).
    - Material placed at minimum compacted depths according to Table G.
    - Materials placed on stable and uniform bases

116

Coring procedures will be covered in Module 3.

## Section 413: Superpave Mixture Design, Standard & RPS Construction

- **413.3(j) Mat Density Acceptance**
  - **413.3(j)4. Pavement Cores (Std or RPS)**

**Table G: Mixture Minimum Compacted Depths**

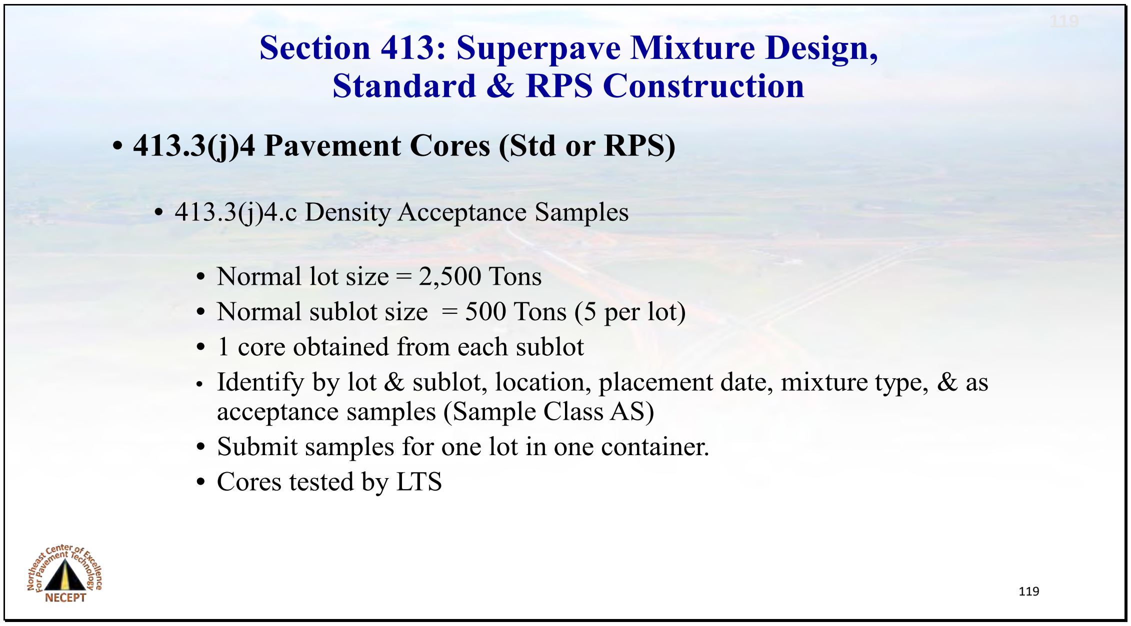
| Mixture | Minimum Depth |
|---|---|
| 9.5 mm Wearing Course | 1 ½”(40 mm) |
| 12.5 mm Wearing Course | 2”(50 mm) |
| 19 mm Wearing and Binder Courses | 2 ½” (60 mm) |
| 25 mm Binder Course | 3”(80 mm) |

## Section 413: Superpave Mixture Design, Standard & RPS Construction

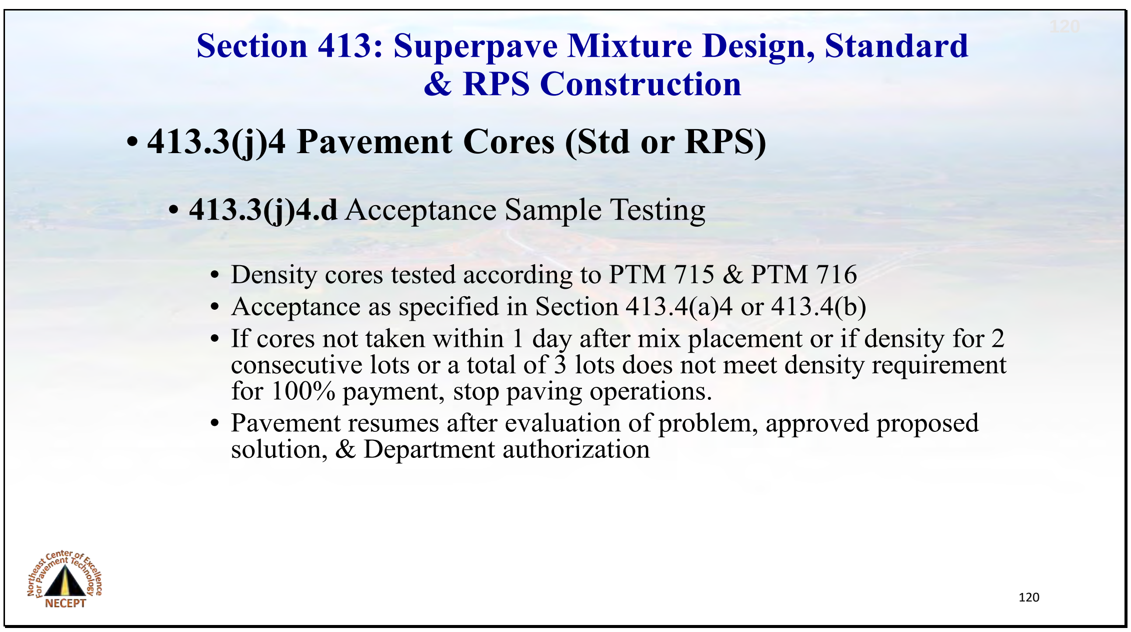
- **413.3(j)4 Pavement Cores (Std or RPS)**
  - **413.3(j)4.c** Density Acceptance Samples
    - Locations selected by PTM 1, PTM 729, &PTM 746
    - 6-inch cores no later than day following placement
    - If damaged, replacement obtained from within 12 inches of original
    - Hole backfilled with same JMF & sealed within 24 hours

118

PTMs are from PENNDOT Pub. 19 and are revised periodically. They will be covered later in Module 3.




The LTS will test the density acceptance samples to determine the percent of compaction (density), *unless* Local Acceptance is approved for the project.




CORES ARE TO BE TAKEN WITHIN 1 DAY OF PLACEMENT. This should be discussed at the preplacement meeting.

## Section 413: Superpave Mixture Design, Standard & RPS Construction

- **413.3(k) Joints**
  - **413.3(k)1.** Longitudinal Joints
  - **413.3(k)1.a** General
    - Offset joints ~ 6 inches
    - Joint in top layer at centerline of 2-lane roadways & within 12” of lane in multilane roadways
    - Avoid joints directly beneath planned pavement markings
    - Before placing abutting lanes, paint joint face with PG binder in mix or PG 64S-22.
    - All longitudinal joints need to be overbanded with PG 64S-22.
    - Overband must be 4±1 inches.

121

*Longitudinal* and *transverse* joint construction will be covered in Module 7.

## Section 413: Superpave Mixture Design, Standard & RPS Construction

- **413.3(k)1. Longitudinal Joints**
  - **413.3(k)1.a** General
    - Adhere to the following additional requirements for the construction of longitudinal joints that will NOT be evaluated as specified in Section 405.

122

## Section 413: Superpave Mixture Design, Standard & RPS Construction

- **413.3(k)1. Longitudinal Joints**
  - **413.3(k)1.a** General
    - Assure a true line of paving
    - When compacting unsupported edge, make first roller pass with edge of drum overhanging edge by 3 to 6 inches

NECEPT

123

Later modules cover these operations in depth. Do not allow pneumatic-tire rollers to cause lateral movement at any unsupported edge.

## Section 413: Superpave Mixture Design, Standard & RPS Construction

- **413.3(k)1. Longitudinal Joints**
  - **413.3(k)1.a** General
    - Placement of mix adjacent to compacted lane, operate paver to overlap previously placed lane by **1 to 1 ½ inches**
    - DO NOT bump back or lute overlapped material
    - Compact joint with first forward pass of roller **6 to 12 inches** from the joint; then overlapping the joint **2 to 6 inches** on the backward and subsequent passes

NECEPT

124

More info in Module 7. Ensure that the joint receives as many roller passes as the rest of the mat.

**Section 413: Superpave Mixture Design, Standard & RPS Construction**

- **413.3(k)1. Longitudinal Joints**
  - 413.3(k)1.b Vertical Joints
    - For base, binder and wearing courses
    - Place abutting lane same day, leaving less than 25 lineal feet of exposed edge

NECEPT

125

**Section 413: Superpave Mixture Design, Standard & RPS Construction**

- **413.3(k)1. Longitudinal Joints**
  - **413.3(k)1c** Notched Wedge Joints
    - For wearing & binder course with nominal maximum aggregate size of 19.0mm or smaller
    - Use Standard Drawing RC-28
    - If joint next to opposing traffic, place abutting lane within 1 day
    - If next to traffic in same direction, place abutting lane within 2 days

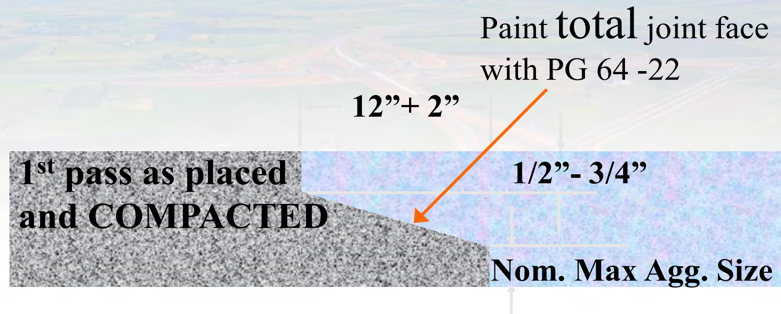
NECEPT

126

Discussion of “working days” versus “days” at the pre-placement meeting may help to avoid problems.

## PA's Notched Wedge Joint

Pub 72M, Standard RC-28




127

RC (road construction) Standards contain generic details (drawings AND notes) for reference measurements.

Note: This is the profile of first pass AFTER rolling, not "as laid".

## Section 413: Superpave Mixture Design, Standard & RPS Construction

- **413.3(k) Joints**
  - 413.3(k)2. Transverse Joints
    - Perpendicular to centerline
    - Use temporary bulkheads or saw joint
    - Paint joint face with PG binder in mix or PG 64S-22.
  - 413.3(k)3. Other Joints
    - Seal joint for new wearing course abutting existing pavement; apply min 6 inches on both sides of joint, using PG binder in mix, PennDOT Material Class Tack or NTT/CNTT.

128

Construction of transvers joints will be covered in module 7.

**Section 413: Superpave Mixture Design, Standard & RPS Construction**

- **413.3(l) Surface Tolerance**
  - Test with 12-foot straightedge
  - Defective if irregularities >3/16”
- **413.3(m) Tests for Depth**
  - Density acceptance by lots, measure depth of each sublot core (PTM 737)
  - Defective if depth deficiency **>1/4”** or depth deficiency in 3 or more adjacent cores **>1/8”**

NECEPT

129

The extent of the defective work is the entirety of all sublots represented by the deficient core samples.

**Section 413: Superpave Mixture Design, Standard & RPS Construction**

- **413.3(n) Protection of courses**
  - No traffic for 24 hours or mat temp is 140$^{o}$F or less *and adequate stability and adhesion is obtained*
- **413.3(o) Defective work**
  - Remove, replace or repair defective work as directed

NECEPT

130

## Section 413: Superpave Mixture Design, Standard & RPS Construction

- **413.4 Measurement & Payment**
  - **413.4(a)3** Mixture Acceptance by Certification & Density Acceptance by Non-Movement and Optimum Rolling Pattern

    **TABLE H**: Contract unit price adjustments - Mixture Acceptance by Certification

  - **413.4(a)4** Mixture Acceptance by Lot and & Density Acceptance by Non-Movement, Optimum Rolling Pattern, or Pavement Cores

    **TABLE I**: Upper & Lower Spec Limits for Calculating Percent Within Limits

    **TABLE J**: Dispute Resolution Retest Cost Table

NECEPT

131

*RPS*--- Restricted Performance Specifications

## 413.4 Measurement and Payment

- **413.4(a)4.**
  - o Mixture Acceptance by Lot

  and
  - o Density Acceptance by
    - ✓ Non-Movement
    - ✓ Optimum-Rolling Pattern
    - ✓ Pavement Cores

**Adjust Payment according to PWL.**
**Use Upper and Lower Spec Limits in Table I.**

NECEPT

132

## Section 410
## Superpave Mixture Design, Standard & RPS Construction of Plant-Mixed Asphalt Fine-Graded Courses

- **410.1 Description**. construction of a plant-mixed asphalt wearing course on a prepared surface using a volumetric mixture design developed with the Superpave Gyratory compactor and modified to be a fine-graded (FG) mixture.

NECEPT

133

This is basically a 9.5-mm mix modified to use as a wearing course which can be laid at a minimum thickness of 1 inch.

## Section 410
## Superpave Mixture Design, Standard & RPS Construction of Plant-Mixed Asphalt Fine-Graded Courses

- **410.2 Materials**. Refers to Section 413.2 using the 9.5-mm mix with modifications
- **410.3 Construction**. Refers to Section 413.3 using a 9.5-mm mix with modifications and a revised Table G.

**Mixture Minimum Compacted Depths**

| Mixture | Minimum Depth |
|---|---|
| 9.5 mm Fine Grade Wearing Course | 1” |

NECEPT

## Section 412, Superpave Mixture Design, Construction of Plant Mixed Asphalt 6.3 mm Thin Overlay Courses

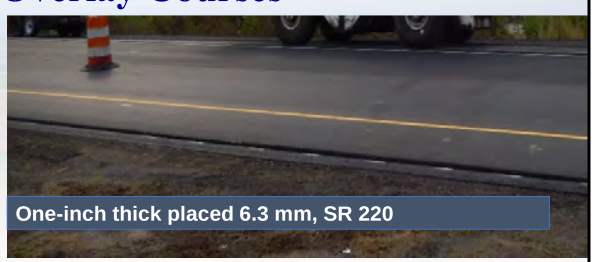
- Used in Thin Lifts (3/4" min. to 1 ¼")
- Useful Tool for Pavement Preservation
- An alternative to micro-surfacing and seal coats.

NECEPT

135

Recently, Pennsylvania Department of Transportation (PennDOT) has been promoting the use of 6.3 mm Superpave mixes in thin wearing courses as a useful pavement preservation strategy. Several states in the Northeast region including New York, New Jersey, and Virginia have already developed specifications for the use of ultra fine mixes (i.e., mixes finer than 9.5 mm). Some have special names for such mixes. For example, Ohio has been using 4.75 mm mix under the name of smooth seal.

## Section 412
## 6.3 mm Thin Overlay Courses

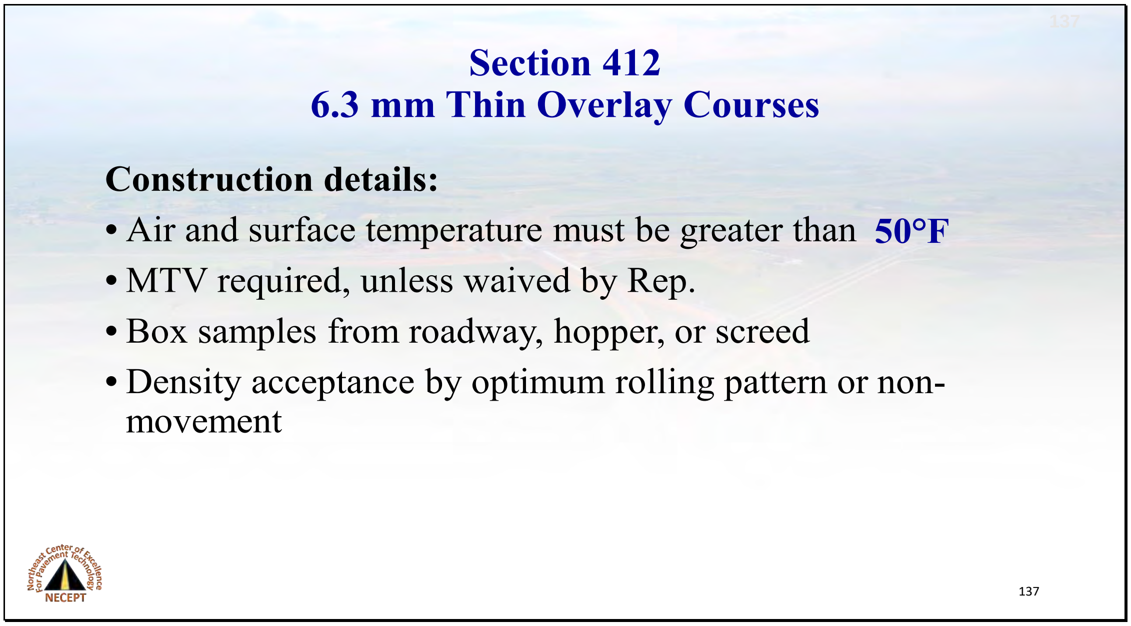

One-inch thick placed 6.3 mm, SR 220

### Mixture Details

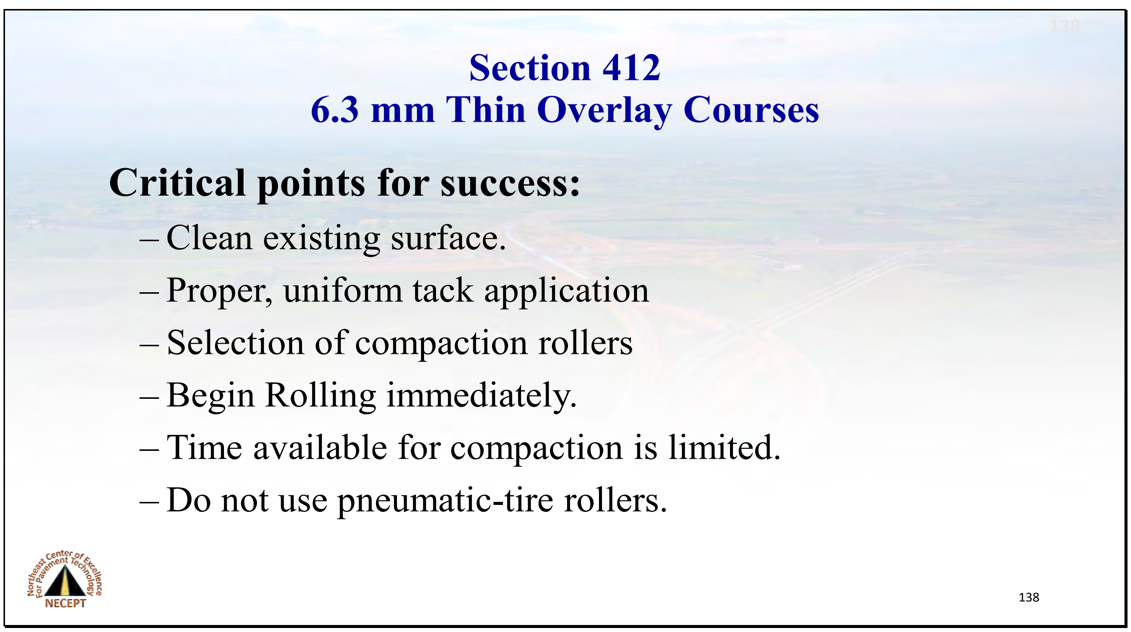
- PG 64E-22 binder required
- Coarse aggregate: Type A
- Sand fine aggregate must be from the same source as coarse aggregate with SRL rating in Bulletin 14
- No RAP or RAS in mix (virgin)

NECEPT

136




Note that some details of specifications for 6.3 mm courses are different from those of Section 413.




With a very thin lift and a very stiff binder, the Time Available for Compaction is limited.

## Section 419 Stone Matrix Asphalt Mixture Design, RPS Construction of Plant-Mixed Asphalt Wearing Courses

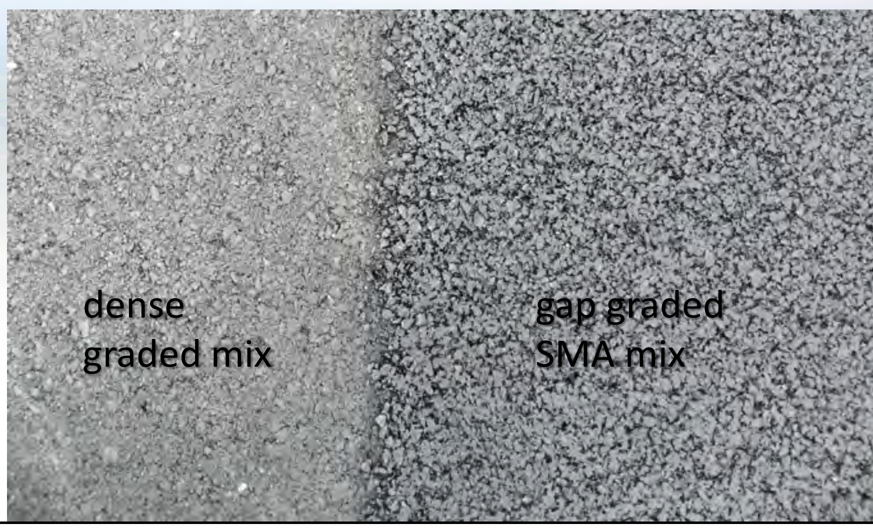
- **419.1 Description**: This work is the RPS construction of plant-mixed Stone Matrix Asphalt (SMA) on a prepared surface using a volumetric mixture design developed with the Superpave Gyratory Compactor

- **419.2 Materials**: Refers to Sections 106 & 700; discusses aggregates, SRL, use of stabilizers, Job-Mix Formula and tolerance requirements for completed mix

NECEPT

139

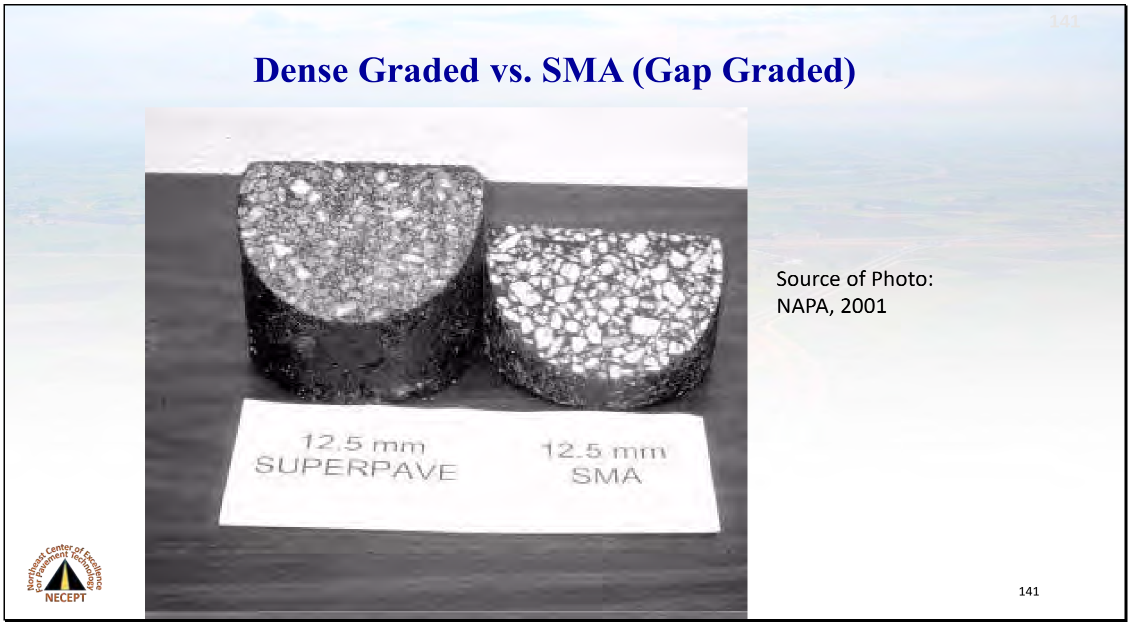
## Dense Graded vs. SMA (Gap Graded)




NECEPT

140

Dense graded mix on the left, SMA on the right. Just gives a visual of how much more open the surface texture looks on SMA.




Dense graded mix on the left, SMA on the right. Just gives a visual of how much more open the surface texture looks on SMA.


Close up photo of SMA pavement after compaction.

## Section 419: Stone Matrix Asphalt, RPS Construction

- **419.2(e) Mixture Composition:**
  - Table D (Section 413.2(e)1.d.6) Temperature of Mixture

    **PG 64E-22 240°F to 330°F**

- **419.2(f) Mixture Acceptance:**
  - By lot acceptance only unless **tonnage < 150**
  - Can use either LTS or HOLA

## Section 419: Stone Matrix Asphalt, RPS Construction

- **419.3 Construction**
  - (a) Paving operation QC Plan: Refers to 413.3(a), Contractor must submit a paving operation QC plan for the project (Use PennDOT Form CS-413)
  - (b) Weather Limitations: Paving prohibited when:
    - surfaces are wet
    - the temperature of air or surface is **≤ 50°F**

144

Construction : Follow Section 413.3 with noted exceptions.

## Section 419: Stone Matrix Asphalt, RPS Construction

- **419.3(b)4 HOLA - Lab Testing Facility (identified by Producer)**:
  - Lab meets requirements of Bulletin 27
  - Lab has gone through AASHTO re:source on-site lab assessment within the last 2 years and has demonstrated proficiency

## Section 419: Stone Matrix Asphalt, RPS Construction

- **419.3 Construction**
  - (b) Weather Limitations: Paving prohibited:
    - Oct. 1 to March 31 in Districts 1-0, 2-0 (except Juniata Co & Mifflin Co), 3-0, 4-0, 5-0 (Monroe Co & Carbon Co only), 9-0 (Cambria Co & Somerset Co only) and 10-0
    - Oct 16 to March 31 in Districts 2-0 (Juniata Co & Mifflin Co only), 5-0, (except Monroe and Carbon Co.) 6-0, 8-0, 9-0 (except Cambria and Somerset Co.) , 11-0, 12-0.

146

## Section 419: Stone Matrix Asphalt, RPS Construction

- **419.3 Construction**
  - (d) Hauling Equipment: Refers to 413.3(d)
  - (e) Asphalt Pavers: Refers to 413.3(e)
  - (f) Rollers
    - Minimum 3 steel-wheeled rollers, each with 10-ton weight
    - Do not operate in vibratory mode unless demonstrated and approved that no breaking of aggregate or flushing of asphalt binder results

NECEPT

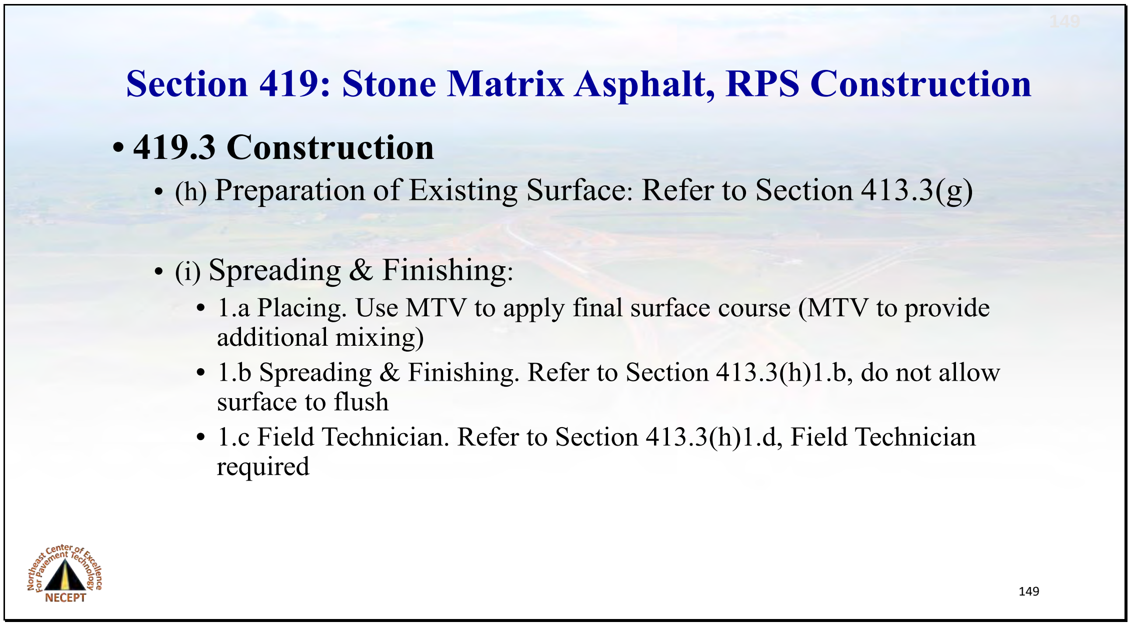
147

## Section 419: Stone Matrix Asphalt, RPS Construction

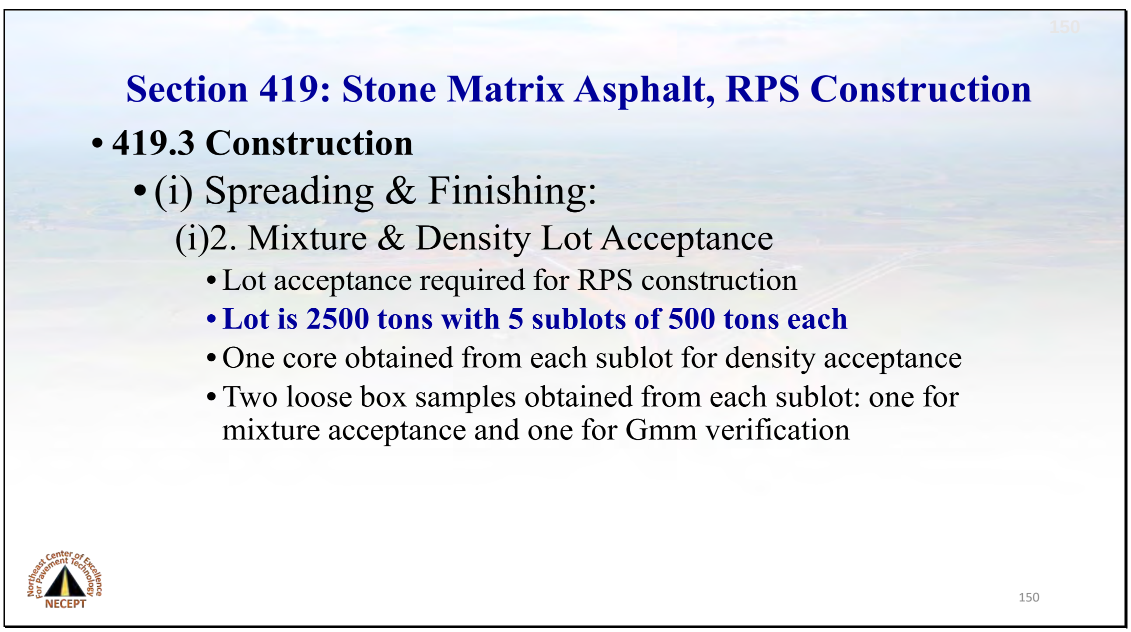
- **419.3 Construction**
  - (g) Demonstration
    - Before paving, perform trial demonstration outside projects limits by placing minimum of 100 tons.
    - Simulate actual hauling time for project
    - Obtain & test 3 loose mixture samples at plant for asphalt content, gradation, & draindown & 3 cores from demo pavement for density
    - If vibration is to be used, demo vibratory rolling

NECEPT

148




MTV units are described in Section 108.




Lot/sub-lot computations will be covered in Module 3.

## Section 419: Stone Matrix Asphalt, RPS Construction

- **419.3 Construction**

NOTE: A completed sublot will contain one core sample and two loose mixture (box) samples

WHY?
This spec is to address the need for the Gmm verification sample

NECEPT

151

## $G_{mm}$ Verification Samples

May be taken from auger tunnel or UNCOMPACTED MAT and may require an additional random sampling procedure.
This must be discussed at the pre-placement meeting and may vary by project and District.

NECEPT

152

Loose Samples are NOT normally taken from the mat on SMA projects.

## Section 419: Stone Matrix Asphalt, RPS Construction

- **419. Construction**
  - (i) Spreading & Finishing:

    (i)2. Mixture & Density Lot Acceptance

    - Project quantities of > 500 to < 2500 tons: the quantity will be divided into 5 equal sublots.
    - Project quantities of 500 tons or less: the quantity will be divided into 3 equal sublots.

153

## Section 419: Stone Matrix Asphalt, RPS Construction

- **419.3 Construction**
  - A completed LOT must have a minimum of 3 sublots.
  - An incomplete (PARTIALLY COMPLETED) lot may have one or two sublots and are tested under different criteria.

154

Lot/sub-lot computations will be covered in Module 3.

## Section 419: Stone Matrix Asphalt, RPS Construction

- **419.3 Construction**
  - (j) Compaction: Follows Section 413 with rollers as specified in Section 419.3(j)
  - (k) Mat Density Acceptance
    - All individual test results must have 93%-98% for 100% payment (Table F for partially completed lots and Table I for full lots)
  - (l) Joints: Follows Section 413.3(k) (Vertical or Notched Wedge Joint allowed)

NECEPT

155

## Section 419: Stone Matrix Asphalt, RPS Construction

- **419.3 Construction**
  - (m) Surface Tolerance: Section 413.3(l)
  - (n) Tests for Depth: Section 413.3(m)
  - (o) Protection of Courses: Section 413.3(n)
  - (p) Defective Work: Remove & replace as specified for Section 413 (Flushing, surface tolerance, depth, etc.)

NECEPT

156

## Section 420 Pervious Asphalt

- Allows infiltration of surface water
- Use 9.5- or 19-mm mixes
- Ambient temperature > 50°F
- NO tack between layers

157

## Section 420 Pervious Asphalt

- 4 passes with static steel drum roller
- No pneumatic tire roller allowed
- DO NOT over compact or crush aggregate
- Surface irregularities > 3/8 inch are unacceptable
- Do NOT grind or mill
- Cool to 100°F between layers

158

## Section 460 Asphalt Tack Coat

- **460.1 Description** –conditioning & treating of an existing surface with an application of bonding material
- **460.2 Material**

159

## Section 460 Asphalt Tack Coat

- Ambient Temp. of 40°F, and rising and surface is CLEAN and DRY
- Test section for each course to determine coverage and uniformity
- Tack to be 6 inches wider than paving panel on BOTH sides
- Tack to "break" before being disturbed or start of paving
- Tack all layers

160

## Section 460 – TABLE A
### Emulsified Asphalt Materials

| Class of Material | Type of Material | Application Temperature, °F | |
|---|---|---|---|
| | | Minimum | Maximum |
| TACK | Anionic or Cationic Emulsified Asphalt | 90 | 150 |
| NTT/CNTT | Anionic or Cationic Emulsified Asphalt | 140 | 180 |

161

## Section 460 – TABLE B
### Uniform Asphalt Residual Rates by Surface Type

| Surface Type | Uniform Asphalt Residual Rates (RR) (gallons per square yard) |
|---|---|
| New Asphalt Paving | 0.03 to 0.05 |
| Existing Asphalt Paving | 0.04 to 0.07 |
| Milled Surface (Asphalt & Portland Cement Concrete) | 0.04 to 0.08 |
| Portland Cement Concrete | 0.04 to 0.07 |

162

Computations for application rates to obtain required residue will be covered in module 3.

## Section 483
## Polymer-Modified Emulsified Asphalt Paving System (Micro Surfacing)

- **483.1 Description**: construction of a polymer modified emulsified asphalt paving system commonly known as micro-surfacing, to fill ruts and/or resurface existing pavements.

163

## Section 483
## Polymer-Modified Emulsified Asphalt Paving System (Micro Surfacing)

164

View of the back of the micro surfacing train. Note the brown color of the emulsion coming out behind the equipment. This emulsion will break as the water evaporates and the remaining asphalt material will turn black in appearance.

## Section 483 Polymer-Modified Emulsified Asphalt Paving System (Micro Surfacing)

- **483.1 Description** (continued) Three mix types of micro-surfacing:
  - Type A. Used to seal cracks, fill voids and shallow ruts (<1/2 inch) & provide a scratch course or surface seal.
  - Type B. Used to fill moderate ruts (1/2 to 1¼ inch) & provide a scratch course, a leveling course, a seal coat, or surface course
  - Type Rut fill (RF). Used to fill deep ruts (up to 2 inch) in a single pass

NECEPT

165

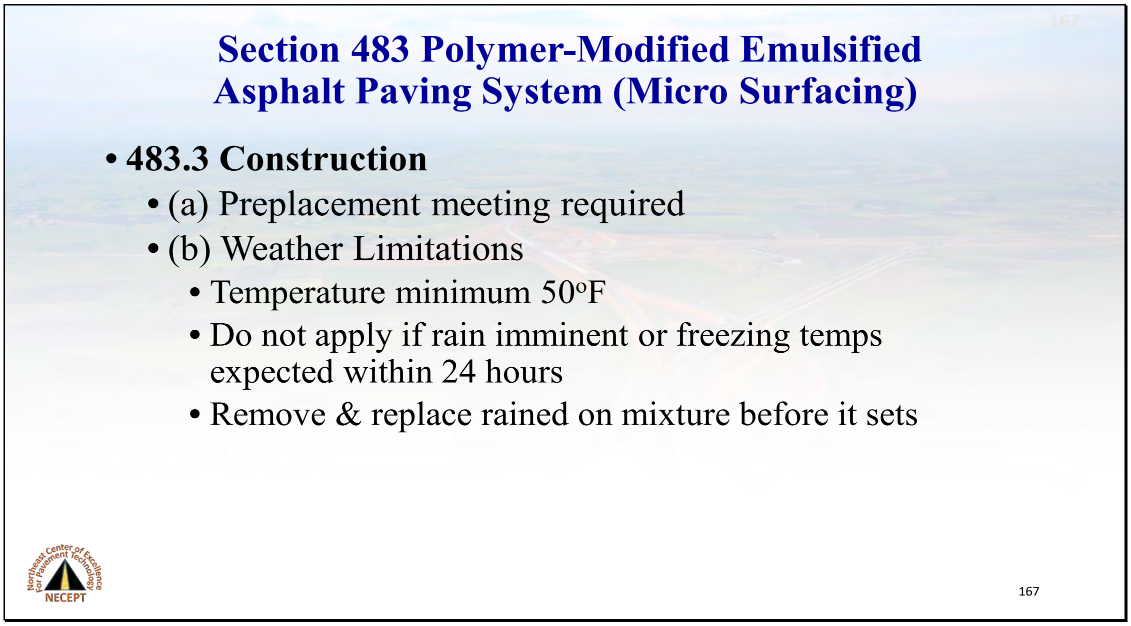
Type A and Type B can use a double application when specified, to meet total design pounds per square yard for surface courses.

## Section 483 Polymer-Modified Emulsified Asphalt Paving System (Micro Surfacing)

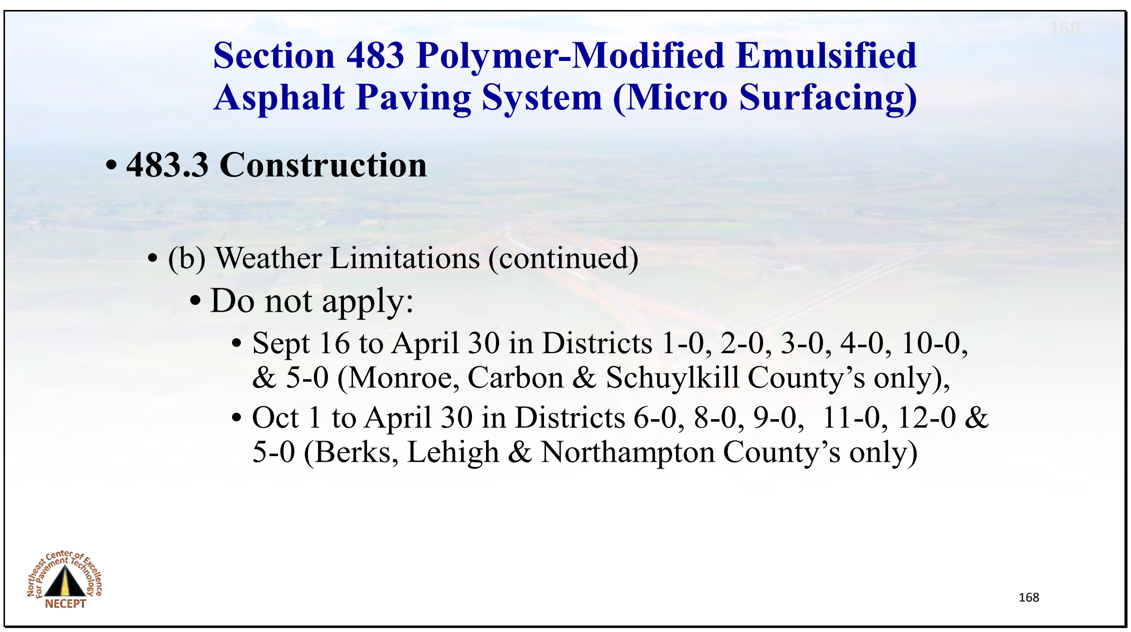
- **483.2 Material**
  - Asphalt material Class CSS-1hPM (E-8CPM)
  - Polymer Modifier, latex based, capable of making mix cure for traffic within 1 hour.
  - Aggregate, filler (cement or hydrated lime), water, other additives as specified.
  - Approved QC Plan & JMF required

NECEPT

166




Apply when entire surface is in a condition to allow satisfactory penetration and adhesion and the atmospheric temperature is 50° F minimum during the entire placement. More details of Micro-Surfacing will be covered in Module 4.



## Section 483 Polymer-Modified Emulsified Asphalt Paving System (Micro Surfacing)

- **483.3 Construction**
  - (c) Aggregate Delivery Plan
    - Plan required with # of trucks for continuous operation
    - All aggregates must be screened directly into truck

NECEPT

169

## Section 483 Polymer-Modified Emulsified Asphalt Paving System (Micro Surfacing)

- **483.3 Construction**
  - (d) Mixing Equipment
    - Self propelled, front feed, continuous loading mixing machine with chain-dragged conveyor belt aggregate delivery system with positive displacement, water-jacketed gear pump to accurately proportion ingredients.
    - Continuous-flow, twin-shafted, multi-bladed pug mill at least 50 inches long
    - Equip machine with water pressure nozzle spray system to provide water spray ahead of spreader box

NECEPT

170

## Section 483 Polymer-Modified Emulsified Asphalt Paving System (Micro Surfacing)

- **483.3 Construction**
  - (e) Spreading Equipment
    - Mechanical type squeegee box attached to mixer & equipped with paddles on adjustable shafts to continually agitate & distribute material throughout box
    - Attach flexible front & rear seals in contact with road to prevent loss of material from box
    - Provide rut filling equipment with moveable steel strike-off bar
    - Operate to achieve uniform consistence without skips, lumps, or tears in finished surface

NECEPT

171

## Section 483 Polymer-Modified Emulsified Asphalt Paving System (Micro Surfacing)

- **483.3 Construction**
  - (f) Conditioning of Existing Surface. Section 413.3(g)1 & as follows:
    - Clean surface immediately before placing material
    - Remove all pavement markings & legends
    - For existing concrete surfaces, Apply tack coat (Section 460). Do not apply tack coat on existing asphalt surfaces
    - Apply water to dampen entire surface immediately before placing mixture

NECEPT

172



Close up view of the material as it flows under the mechanical squeegee box. Note the pavement markings have been eradicated. A slight residue of moisture can be seen from dampening the surface ahead of the operations.

## Section 483 Polymer-Modified Emulsified Asphalt Paving System (Micro Surfacing)

- **483.3 Construction**
  - (g) Spreading & Finishing. Section 413.3(h)1 & as follows:
    - Spread to seal cracks, fill voids, leaving uniform surface
    - Avoid excess crowning of rutted areas
    - Lumps, balls or unmixed aggregate in the finished surface is not allowed.
    - Adjustments to additive may be required to slow set time when hand spreading is needed
    - When hand spreading, form small windrow of mix along one edge of surface to be covered & spread uniformly by hand squeegee or lute

NECEPT

175

## Section 483 Polymer-Modified Emulsified Asphalt Paving System (Micro Surfacing)

- **483.3 Construction**
  - (g) Spreading & Finishing (continued)
    - Make a neat seam where two passes join.
    - Immediately remove excess material from ends of each run
    - Ensure mixture sets within 1 hour of placement or make appropriate adjustments
    - If mixture takes longer than 1 hour 20 minutes, stop operations. Remove & replace mixture.

NECEPT

176

If mixture has not set within one hour, representative is to notify contractor who may continue to place material and adjust mixture, if material is not set for traffic within 1 hour and 20 minutes, stop placement and remove and replace defective mixture.

## Section 483 Polymer-Modified Emulsified Asphalt Paving System (Micro Surfacing)

- **483.3 Construction**
  - (h) Compaction
    - Compact using pneumatic tire roller (Section 108) having tire pressure of 40 to 60 psi
    - Roll entire surface area
    - On double application, roll entire surface area of each application.

NECEPT

177

## Section 483 Polymer-Modified Emulsified Asphalt Paving System (Micro Surfacing)

- **483.3 Construction**
  - (l) Defective Work. Satisfactorily correct pavement not meeting following criteria:
    - 1. Application Rate – Calculate yield at end of each day's application
    - 2. Finished surface
      - No areas of excess asphalt (flushing) >5% of finished surface
      - Bleeding at joints not allowed
      - No tear or drag marks >1/2" wide & 4" long per 10 foot of lane

NECEPT

178

## Section 483 Polymer-Modified Emulsified Asphalt Paving System (Micro Surfacing)

- Finished surface (continued)
  - No clumps &/or foreign objects >1 ½ inch diameter
  - No washboard or ripple patterns exceeding 100 linear feet
  - No longitudinal streaks >1/4” ridge, bump or depression, as measured with 10-foot straightedge

NECEPT

179

## Section 483 Polymer-Modified Emulsified Asphalt Paving System (Micro Surfacing)

- **483.3 Construction**
  - (1) Defective Work. Satisfactorily correct pavement not meeting following criteria: (continued)
    - 3. Longitudinal Joints – make a neat seam with no bump, ridge or depression >1/4” measured with 12-foot straightedge. Do not overlap joints more than 4”
    - 4. Longitudinal Edges – Make neat longitudinal edge with no more than ±3” horizontal variance in any 100 feet of roadway

NECEPT

180

## Section 483 Polymer-Modified Emulsified Asphalt Paving System (Micro Surfacing)

- **483.3 Construction**
  - (l) Defective Work. Satisfactorily correct pavement not meeting following criteria: (continued)
    - 5. Transverse Profile – fill ruts with no depressions as measured with 12-foot straightedge
  - (m) Opening to Traffic. No traffic allowed until mix has sufficiently set to prevent pick-up & until directed by Representative

NECEPT

181

## Section 489
## Ultra Thin Bonded Wearing Course (UTWC)

- Formerly known as Ultra-Thin Friction Course
- Plant mixed *UTWC*
- Apply only from April 1 to November 1, with ambient temperature ≥ 50°F
- Placed on polymer-modified emulsified asphalt membrane (UTWCEM)
- Paver with built in spray bar, *UTWCEM* material applied directly in front of the paving screed within 5 seconds of placing *UTWC*
- Roll without vibration at 185°F or greater (vibrations may be used on joint)
- May use pneumatic tire roller
- Cracks sealed at least 24 hours prior

NECEPT

182


Photo on I-80 of truck dumping plant mix into spray paver and laying hot material directly on emulsion.


Close up shows the emulsion being spray applied directly before the hot UTBWC material is applied.

## Section 489
## Ultra Thin Bonded Wearing Course

- Good tool for pavement preservation
- Used to provide **friction**, reduce oxidation, and extend life
- Maybe also used on concrete pavements with any aggregate susceptible to rapid polishing
- Three Types
  - *Type A (NMAS: 6.3 mm) – placed about 0.5 inches thick, 45 to 65 lbs/yd$^2$*
  - *Type B (NMAS: 9.5 mm) – placed about 0.75 inches thick, 55 to 80 lbs/yd$^2$*
  - *Type C (NMAS: 12.5 mm) – placed about 0.75 inches thick, 60 to 85 lbs/yd$^2$*

185

# Section 496
# Asphalt Concrete Pavement
# 60-month warranty

186

THIS MATERIAL NOT ON TEST

## Section 496.3
## Construction Depth Checks

- Combination of two or more courses
- One core 4” or larger for each 2,000 linear feet of pavement lane by PTM 1 through all courses.
- Defective work if Depth deficiency
  - > 1/4 inch in. one location or
  - > 1/8 inch in. three consecutive locations
- Limits of defective work to be determined by additional coring.

NECEPT

187

THIS MATERIAL NOT ON TEST

## Section 496.3
## Information Samples

- *IF* directed and in the presence of the Inspector---
- Random locations using PTM 1
- One core for each 1,000 ton within 24 hours of placement
- Backfilled and sealed within 24 hours
- Delivered to LTS by Department

NECEPT

188

THIS MATERIAL NOT ON TEST

## Section 496
## Performance Criteria

- Evaluated as per PUB 336 for 5 years
- Remedial action-- Table A of Sec. 496
- 12-foot straight edge to determine rutting
- No routine maintenance by Dept.
- ESAL levels monitored by Dept.
- Repairs to be square or rectangular and if distance between repairs is < 100 feet ; repair is to be continuous.
- Must meet surface tolerance of 413.3

NECEPT

189

THIS MATERIAL NOT ON TEST

## Section 422 Asphalt Wearing Course FJ-1 and FJ-1C34

- This material was primarily used during bridge deck waterproofing operations. Now, it is removed from Spec. 408.
- The 4.75-mm asphalt mix, covered in Section 413, is the new material to be used as scratch course for the bridge box culvert and filling in shoulder rumble strips.

NECEPT

190

## Questions?


- Was Everything Clear?

PennState

# Discussion

pennsylvania
DEPARTMENT OF TRANSPORTATION

192

CS-4171B (6-20) Formerly TR-465

pennsylvania
DEPARTMENT OF TRANSPORTATION
www.penndot.gov

# CERTIFICATE OF COMPLIANCE FOR DAILY BITUMINOUS MIXTURES

Plant: ____________________

Location: ____________________

Plant Code: ____________________

Job Mix Formula (Year-Number): ____________________ Material Class: ____________________

ESALS: ____________ SRL: ____________ PG Grade: ____________

**Publication 408**, Section: ____________

Consigned to:

☐ PennDOT Maintenance: ________ County: ____________ P.O. No. ____________

☐ Contractor: ____________________ S.R.: ________ Section: ________

Group / P.O.C. No.: ____________________ ECMS No.: ____________________

☐ Municipality: ____________________ County: ____________________

**Wearing Course:** ____________ **Binder Course:** ____________ **Base Course:** ____________

**Tons Shipped:** ____________________ **Daily AASHTO T209 Density:** ____________________

| | | | | Air Voids | | VMA | |
|---|---|---|---|---|---|---|---|
| **Test Results** | **%AC** | **Pass #8** | **Pass #200** | **Specimen #1** | **Specimen #2** | **Specimen #1** | **Specimen #2** |
| Daily No. 1 | | | | | | | |
| Daily No. 2 | | | | | | | |
| Daily No. 3 | | | | | | | |
| Daily Avg. | | | | | | | |
| Running Avg. of 5 | | | | | | | |

**Please select the Payment Factor percentage below, based on Pub 408 Sec. 409.4(a) Table H:**

☐ **100% Payment Factor: The material as listed above shipped on this date conforms fully with the specification requirements of the Pennsylvania Department of Transportation. Our records, attesting to this statement, are open for inspection by a Department Representative for not less than THREE years from the date of shipment.**

☐ **85% Payment Factor: The material as listed above shipped on this date does not conform to the certification tolerances for 100% pay as listed in Pub 408 Sec. 409.2(e) Table A. A reduced pay factor has been applied and QC test results are being forwarded to the Inspector-in-Charge. Our records attesting to this statement are open for inspection by a Department Representative for not less than THREE years from the date of shipment.**

☐ **Defective Pavement: The material as listed above shipped on this date does not conform to the certification tolerances for 100% pay as listed in Pub 408 Sec. 409.2(e) Table A. QC test results are being forwarded to the Inspector-in-Charge which indicate material must be removed and replaced or accepted at 50% CUP with District Executive approval in writing. Our records attesting to this statement are open for inspection by a Department Representative for not less than THREE years from the date of shipment.**

Name (print): ____________________ Title: ____________________

Signature: ____________________ Date Shipped: ____________________

# Quiz

## Module 2
## Specifications



**1. PennDOT Publication 408 contains all of the asphalt specifications.**

a. True

b. False

**Answer:**

**2. All Superpave Standard mixes have to be delivered and placed at a laying temperature range of 220°F to 320°F.**

a. True

b. False

**Answer:**



**3. A contractor can receive incentive bonus compensation depending on the smoothness of the new pavement surface.**

a. True

b. False

**Answer:**

**4. Section 413 is the main specification for SuperPave asphalt mixtures.**

a. True
b. False

**Answer:**



**5. The normal lot size and number of sublots for Standard and RPS paving is**

a. 1500 tons and 3 sublots
b. 2000 tons and 4 sublots
c. 2400 tons and 6 sublots
d. 2500 tons and 5 sublots

**Answer:**

## 6. Section 413 contains which of the following.

a. Standard specifications
b. RPS specifications
c. Placement temperatures
d. Weather restrictions
e. All of the above

**Answer:**



## 7. Existing vertical surfaces may be treated with NTT/CNTT prior to asphalt placement.

a. True
b. False

**Answer:**
a. True, but require two applications

8. WMA viscosity reducing technologies are divided into three groups.

a. True
b. False

Answer:



9. The maximum temperature of WMA is always less than HMA using the same PG grade of Asphalt.

a. True
b. False

Answer:

**10. NTT or CNTT application rates will vary according to**

a. Existing surface conditions

b. Percentage of Asphalt in the product

c. Residual Asphalt requirements

d. All of the above

**Answer:**

CS-4171B (6-20) Formerly TR-465

pennsylvania
DEPARTMENT OF TRANSPORTATION
www.penndot.gov

# CERTIFICATE OF COMPLIANCE FOR DAILY BITUMINOUS MIXTURES

Plant: ______

Location: ______

Plant Code: ______

Job Mix Formula (Year-Number): ______ Material Class: ______

ESALS: ______ SRL: ______ PG Grade: ______

**Publication 408**, Section: ______

Consigned to:

☐ PennDOT Maintenance: ______ County: ______ P.O. No. ______

☐ Contractor: ______ S.R.: ______ Section: ______

Group / P.O.C. No.: ______ ECMS No.: ______

☐ Municipality: ______ County: ______

**Wearing Course:** ______ **Binder Course:** ______ **Base Course:** ______

**Tons Shipped:** ______ **Daily AASHTO T209 Density:** ______

| | | | | Air Voids | | VMA | |
|---|---|---|---|---|---|---|---|
| **Test Results** | **%AC** | **Pass #8** | **Pass #200** | **Specimen #1** | **Specimen #2** | **Specimen #1** | **Specimen #2** |
| Daily No. 1 | | | | | | | |
| Daily No. 2 | | | | | | | |
| Daily No. 3 | | | | | | | |
| Daily Avg. | | | | | | | |
| Running Avg. of 5 | | | | | | | |

**Please select the Payment Factor percentage below, based on Pub 408 Sec. 409.4(a) Table H:**

☐ **100% Payment Factor: The material as listed above shipped on this date conforms fully with the specification requirements of the Pennsylvania Department of Transportation. Our records, attesting to this statement, are open for inspection by a Department Representative for not less than THREE years from the date of shipment.**

☐ **85% Payment Factor: The material as listed above shipped on this date does not conform to the certification tolerances for 100% pay as listed in Pub 408 Sec. 409.2(e) Table A. A reduced pay factor has been applied and QC test results are being forwarded to the Inspector-in-Charge. Our records attesting to this statement are open for inspection by a Department Representative for not less than THREE years from the date of shipment.**

☐ **Defective Pavement: The material as listed above shipped on this date does not conform to the certification tolerances for 100% pay as listed in Pub 408 Sec. 409.2(e) Table A. QC test results are being forwarded to the Inspector-in-Charge which indicate material must be removed and replaced or accepted at 50% CUP with District Executive approval in writing. Our records attesting to this statement are open for inspection by a Department Representative for not less than THREE years from the date of shipment.**

Name (print): ______ Title: ______

Signature: ______ Date Shipped: ______

# Asphalt Pavement Construction Program



N
E
C
E
P
T

Certified Asphalt Field Technician
Course of 2025

# Module 3:
# Pennsylvania Test Methods (PTMs)

Northeast Center of Excellence for Pavement Technology

NECEPT

# Asphalt Construction Program

## Certified Asphalt
## Field Technician - 2025

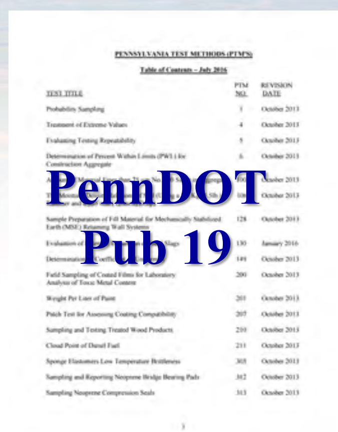
## Module 3:
## Pennsylvania Test Methods (PTMs)

NECEPT

1

## What you need to know...
## Which Pennsylvania Test Methods apply to the asphalt field work?

- The P.T.M.'s in the Asphalt paving operations
- The purpose of each of these important test methods




2

PennDOT Pub 19 Pennsylvania Test Methods contain the full descriptions of all the PTMs and is updated regularly. Be sure that you are using the current version.
The Pub 19 website is as follows:

(ftp://ftp.dot.state.pa.us/public/pdf/BOCM_MTD_LAB/PUBLICATIONS/PUB_19/PTM_TOC.pdf)

## P.T.M.'s for Field Technicians

- **PTM 001:** Probability Sampling
- **PTM 402:** Determining In-Place Density by Use of Nuclear Gauges
- **PTM 403:** Determining In-Place Density Using Electrical Impedance Measurement Methods
- **PTM 428:** Measuring Pavement Profile Using a Lightweight Profiler
- **PTM 715/716:** Determination of Bulk Specific Gravity of Compacted Asphalt Mixtures
- **AASHTO T209:** Theoretical Maximum Specific Gravity of Asphalt Mixtures (Vacuum Method)

NECEPT

3

The PTMs are included in PennDOT Pub 19 and get updated as needed.

## P.T.M.'s for Field Technicians

- **PTM 729:** Sampling Roadway Asphalt Concrete
- **PTM 737:** Measuring Thickness of Asphalt Concrete Courses
- **PTM 746:** Sampling Asphalt Paving Mixtures
- **PTM 747:** Determination of Distributor Application Rate in the Field
- **PTM 751:** Measuring Surface Macrotexture Depth Using a Volumetric Technique & Determining Pattern Segregation

NECEPT

4

PTM's will also be covered in applicable modules.

## PTM #1: Probability Sampling

- Selecting samples using probability sampling techniques.
- Selecting all Department samples in an unbiased manner, **based entirely on chance.**
- Production divided into **Lots and Sublots** and random samples taken from Sublots

NECEPT

5

The importance of ***random*** sampling cannot be over emphasized and PTM 1 is used for *ALL random sampling.*

## Lots and Sublots

- ***Lot*****--**a quantity of specified material from a single source or produced by the same process.
- ***Sublot*****--**a portion of a lot; location from which a sample is taken.
- Lot size, sublot size, and number of sublots per lot specified by *PTM* and/or specifications.
- Lot and Sublot sizes are described in Pub 408

NECEPT

6

Lots and sublot size are not always the same size. Relevant section of Pub 408 must be consulted for determination of the lot and sublot size.

## Sampling Procedures

- Procedures are based on project quantity (tonnage) of each material produced.
- Sample size increments do NOT change.
  (if a sublot size is determined to be 500 tons, it remains 500 tons for all computation purposes throughout the project).
- **3 rules as determined by tonage**:
  - **500 ton or less,**
  - **> 500 ton to < 2500 ton,**
  - **and 2500 ton or more**

NECEPT

7

## Sampling Made Simple

**Acceptance sampling for any RPS or any Standard paving project**
**Pub 408, Sect. 413.3(h) 2.b**

**Rule #1: Assume Project quantity is 2500 ton or greater.**

- ❖ Divide quantity by 500 and ROUND UP to establish the number of sublots. All sampling computations will be based on 500-ton increments.
- ❖ Completed Lots MUST have 3 sublots and CANNOT have more than 7 sub-lots.
- ❖ Lots which have only 1 or 2 sublots are incomplete, or partially completed and will be noted as such and tested under different criteria.
- ❖ A sublot does not exist unless it has a combination of one (1) loose box and one (1) core The final sublot could contain as much as 994 tons, mathematically.
- ❖ The final lot could contain as much as 3,994 tons, mathematically.

NECEPT

8

## Sampling Made Simple

**Example:**
**Production Quantity: 3,750 tons**

- 3,750 tons ÷500 tons = 7.5 or 8 sampling locations to be computed for loose box and 8 for core.
- Table D (Section 413) does not alter sublot size for computation. ALL sublots are computed in 500-ton increments.
- Table D applies ONLY to quantities placed AFTER the last complete 2,500-ton lot (at the end of project and before work stoppage of 5 days or more) and regulates both sublot and lot tonnage depending on whether you were or were not able to get both a loose box sample and a core from the quantity of material placed in the final partial sublot (Table D: with or without a combination of acceptance samples).

NECEPT

9

## Sampling Made Simple

**Rule #2: Assume Project quantity is > 500 to < 2,500 tons**
- Divide entire quantity by 5 and there will be 5 equal sublots
- **Table D does not apply**

**Example:**
**Production Quantity: 2240 tons**

- 2,240 ÷ 5= 448 tons. So, 5 equal sublots of 448 tons.
- Use X value of PTM 1 (first column) and multiply by 448 to determine the sampling tonnage.

NECEPT

10

## Sampling Made Simple

**Rule #3: Assume Project quantity is 500 tons or less**

- ❖ Divide by 3 to determine 3 equal sub-lots for core locations
- ❖ Material acceptance for Lots of 500 ton or less is by certification. Taking/using cores is included as an option.
- ❖ **Table D does not apply**

**Example:**
**Production Quantity: 475 tons**

- ❖ 475 ÷ 3 = 158.3 tons. So, 3 equal sublots of 158.3 tons.
- ❖ Use X value from PTM 1 (first column) and multiply by 158.3 to determine the sampling tonnage.

NECEPT

11

## Random Number Table PTM 1

| | X | | Y |
|---|---|---|---|
| 1. | 0.29 | R | 0.66 |
| 2. | 0.74 | R | 0.49 |
| 3. | 0.89 | L | 0.79 |
| 4. | 0.60 | R | 0.39 |
| 5. | 0.88 | R | 0.31 |
| | . | | . |
| | . | | . |

**Procedure:**

- Determine lot size and number of sublots per lot from the specifications.
- Select a set of consecutive numbers from random number table: one for each sublot.
- For roadway sampling, values in X and Y columns give coordinates of sample.
- X is TONS or length, Y is offset in feet from edge of **TESTABLE** area.

NECEPT

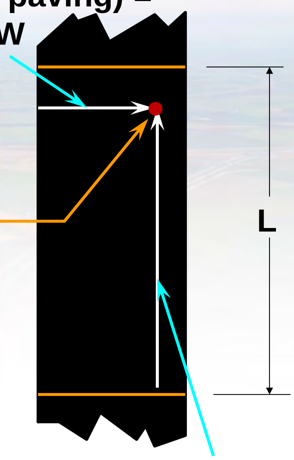
12

## Random Number Table

Y x W (testable width of paving) = 0.79 x W

| | X | | Y |
|---|---|---|---|
| 1. | 0.29 | R | 0.66 |
| 2. | 0.74 | R | 0.49 |
| 3. | 0.89 | L | 0.79 |
| 4. | 0.60 | R | 0.39 |
| 5. | 0.88 | R | 0.31 |

*R or L indicates measurement from Right or Left edge of paved lane OR testable width




X x L (Length of sublot) = 0.89 x L

13

Example: if you select random number 3: The number in the X column is multiplied by the length of the sublot to give you a distance from the beginning of that sublot to the sample. The number in the Y column is multiplied by the *testable width* of the sublot to give you a distance from the Left edge (L in this case) of the testable width to the sample. The L or R determines whether the distance is measured from the left or right edge.

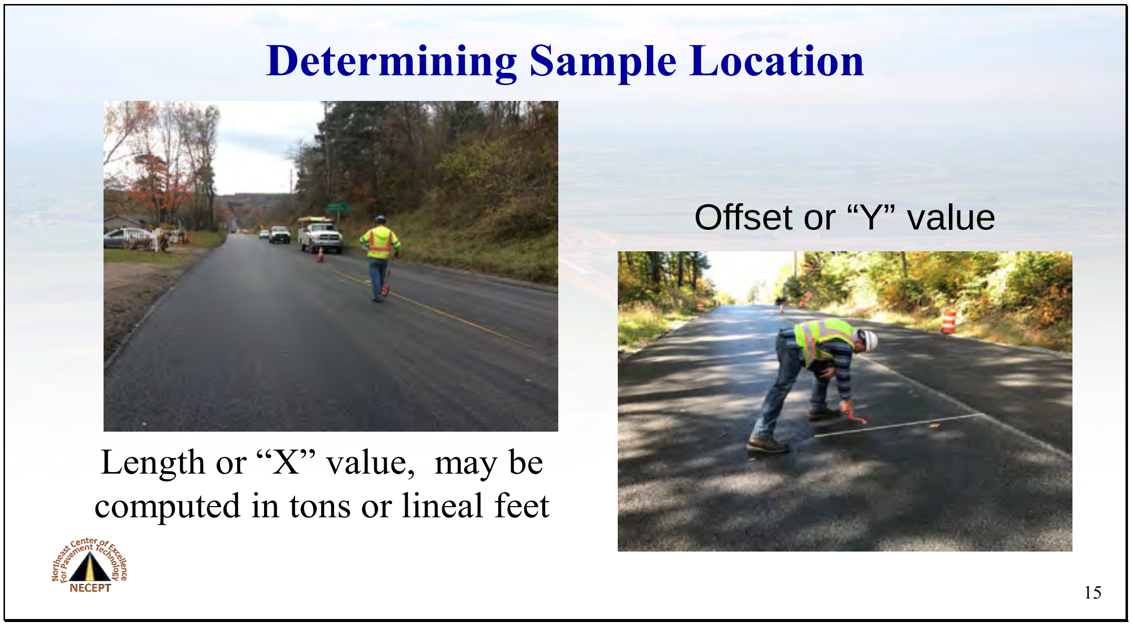
## What would be the tonnage sampled within the third 500-ton sublot?

**Refer to previous slide**

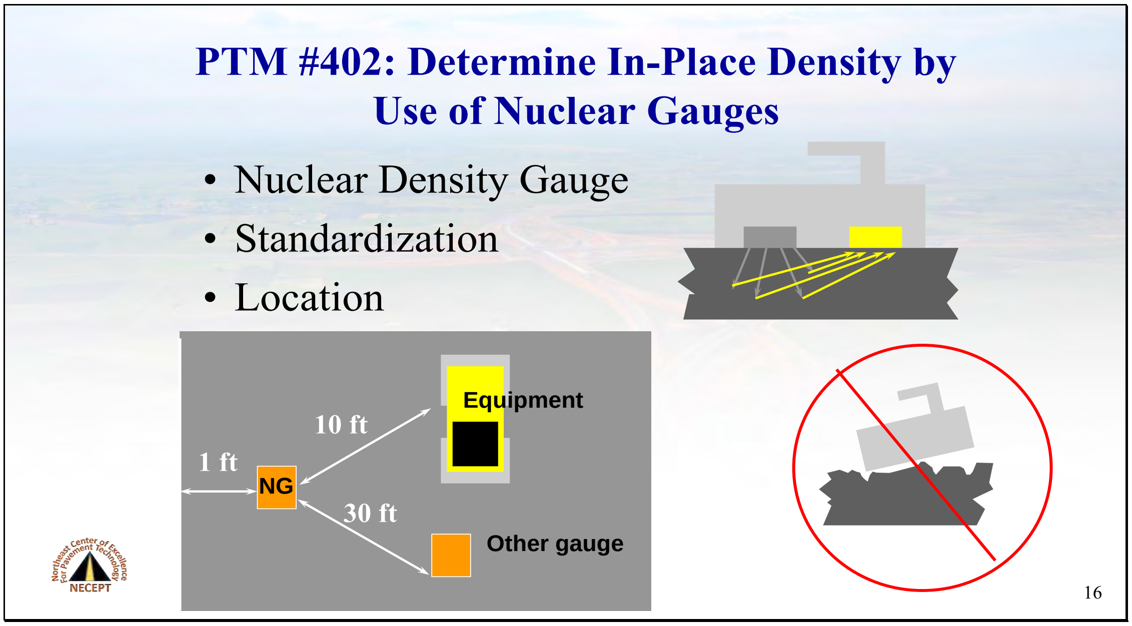
- **0.89 × 500 tons = 445 tons**

- **Where would this sample fall within the entire lot?**
- **500 tons + 500 tons+ 445 tons = 1,445 tons**

14




Measuring the distances longitudinally along the pavement *in the direction of placement* and transverse from the designated edge determines the exact location for the sample to be taken.




PTM 402: The pavement is exposed to a very small amount of gamma radiation. Reflected, or back-scattered radiation is measured by a detector. The density is calculated from the amount of reflected radiation. Gauge must be calibrated to mixture, standardized every day, and operate within manufacturers parameters. Some gauges give counts, which are converted to density, while others are direct readout

Standardization- Gauge must be standardized every day. Follow guidelines as given by manufacturer or Nuclear Operator's Testing Manual. Warm up the Gauge, set up with proper standard, take standard count and compare to specified limits, then record and report on TR-4276A. Locate gauge away from equipment, other gauges, curbs, and sides of excavations There should be total contact between Gauge and pavement surface.

## PTM #402: Determine In-Place Density by use of a Nuclear Gauge

- Test Site Preparation
- Taking Counts

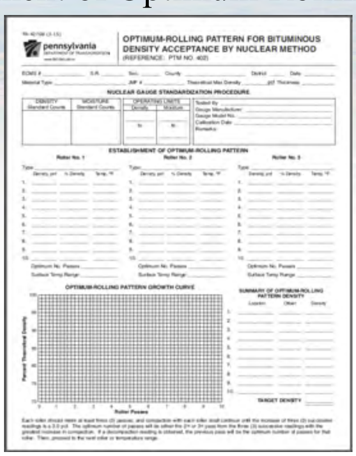
- Operator must be licensed & gauge must be type approved by PennDOT

17

Test site Preparation: Surface texture will affect reading. A binder or asphalt base course may need to be prepared by leveling with a small amount of native fines or sand. One-minute counts are more accurate than 15 second counts, rotating the gauge 180$^{O}$, and taking a second reading may give a different value. Record results on Form TR-4276B.
Although the operator must be licensed, being a CFT is not required. The Gauge must be PennDOT approved type and be calibrated annually. Documentation includes copies of license and annual calibration report. Gauge values may not be the same as lab tested density results

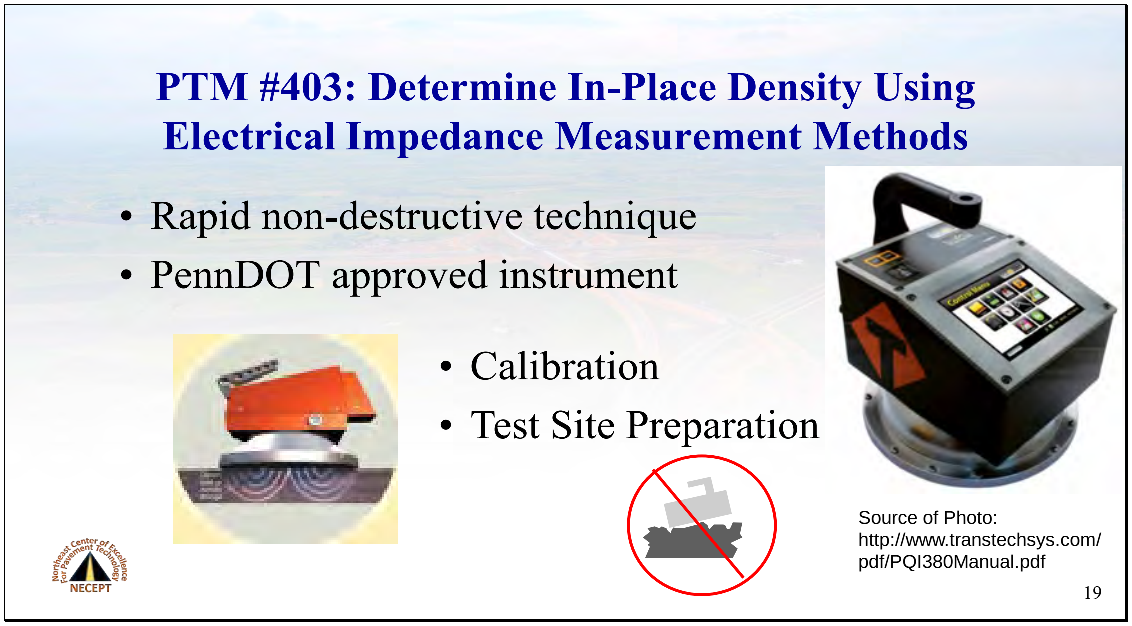
## PTM #402: Determine In-Place Density by Use of Nuclear Gauges

- Establishment of Optimum Rolling Pattern


OPTIMUM-ROLLING PATTERN FOR BITUMINOUS DENSITY ACCEPTANCE BY NUCLEAR METHOD

18

PTM 402 gives you procedure for establishing an *optimum rolling pattern* by taking nuclear density readings on a control strip. Roller Patterns will be discussed further in module 7.



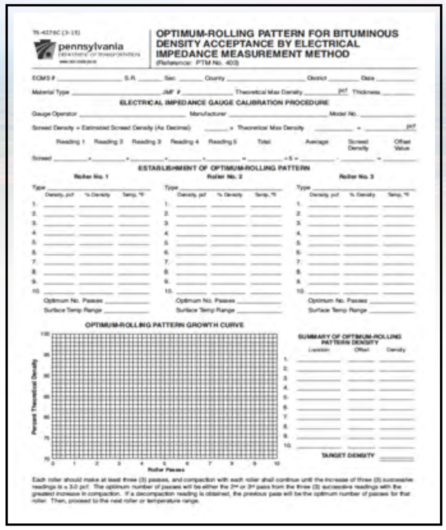

This is a rapid nondestructive technique for determining density of compacted asphalt mixtures. Impedance (resistance to flow) spectroscopy is used to measure the electric current (the electrical response) in the asphalt layer from which the density is calculated. Density results are relative and require calibration with a known density sample.

An average of five density readings, as described in PTM 403, should be taken to minimize variations in readings.

The instrument shall be PennDOT approved, calibrated and operated according to manufacturer's recommendations and PTM 403 procedure. Surface conditions will affect readings and values obtained may not be the same as lab tested specimens.

## PTM 403 For Electrical Impedance Gauge

Record form:
TR-4276C (3-15)




20

Record all data on "Report on Compaction Density By Electrical Impedance Measurement Method" (PTM 403 Appendix B).

## Optimum Roller Pattern

- The intent is to achieve the maximum density possible under: existing conditions, material characteristics, ambient temperature and roller capabilities.
- 3 successive passes that do NOT increase density by 3 lbs/cu. ft. indicate further rolling is ineffective at that temperature with that machine

21

## Optimum Roller Pattern

- Electrical Impedance or Nuclear gauge must be calibrated DAILY
- Readings must be taken from *same location after each pass* of the roller.
- Each roller must make AT LEAST 3 passes, record results of each pass.

NECEPT

22

## Optimum Roller Pattern

- If the density increase for 3 successive passes is less than 3 lbs./cu. ft., the optimum pass will be the one with the greatest increase of the 3 passes.
- No readings required until after 2nd pass of pneumatic tire roller.
- Record results on proper form, document ten random readings and average density.
- Should be performed DAILY, and may be required more than once per day.

NECEPT

23

## PTM #428: Measuring Pavement Profile Using A Lightweight Profiler

Terminology

- **International Roughness Index (IRI)**
- Excluded Areas

NECEPT

24

PTM 428 Measuring Pavement Profile Using a Lightweight Profiler (LWP). Used to determine the pavement ride quality from the longitudinal profile, as the International Roughness Index (IRI) for acceptance and payment.

International Roughness Index (IRI) – a scale of roughness based on the response of a generic motor vehicle to roughness of the road surface. IRI is determined by obtaining a suitably accurate measurement of the profile of the road, processing it through an algorithm that simulates the way a vehicle would respond.

Excluded Areas – an area that is not included in the measurement used to determine lot payment.

## PTM #428: Measuring Pavement Using A Lightweight Profiler

- **Sampling**
  - Pavement profiles taken in each lane, lot size is **528 feet** of a single lane
- **Calibration**
  - Operational systems allows distance and profile systems calibration
- **Procedure**
  - Data Collection

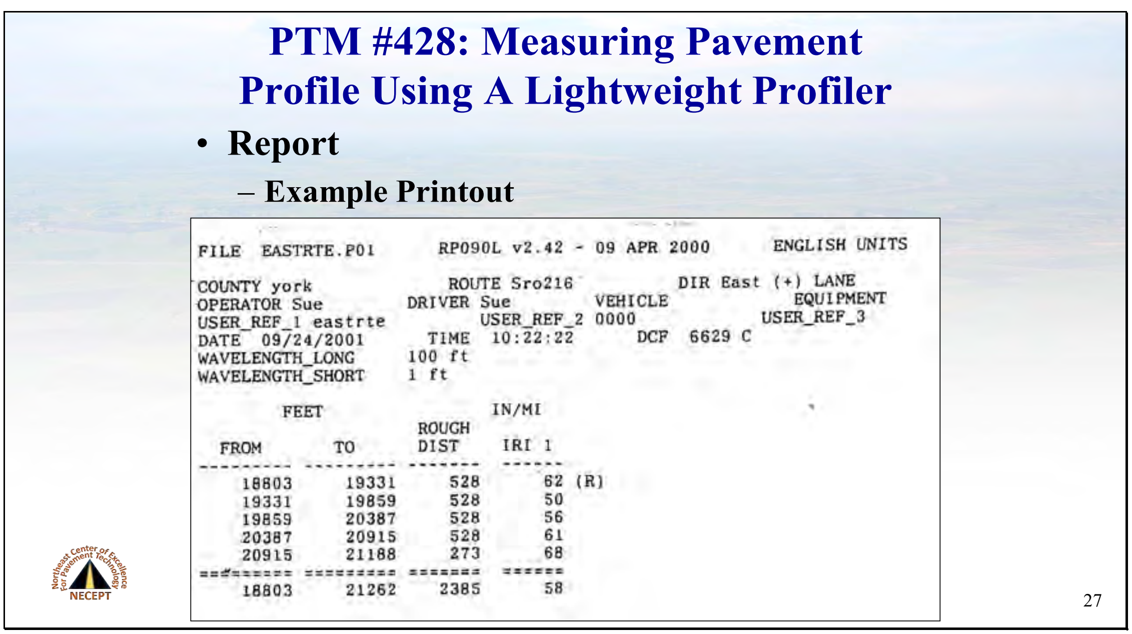
25

Procedure: Test each wheel path for acceptance only once. Re-run lot for payment after corrections. Measure *Excluded Areas* separately. Produce print out of IRI Data and Settings required for analysis.

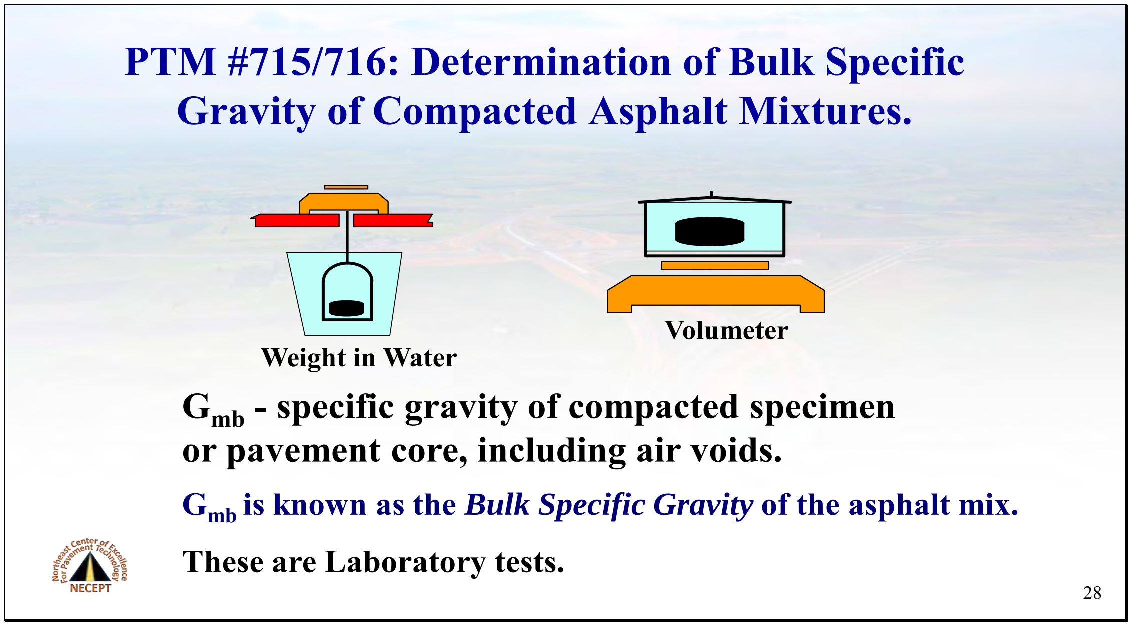

The Lightweight Profiling System shall be an all-terrain or golf-cart type vehicle equipped with various hardware and software that together allow the measurement and recording of the longitudinal profile of a traveled wheel track. The device and software shall meet the requirements of the “Generic Specifications for Lightweight Profiling System”.

Yearly Verification for LWP Decal Shows: Date of Check; # Of Sensors; Device Make; Software Version

An Operator must be Certified, by PENNDOT, every 3 Years for the LWP Model used and Company.

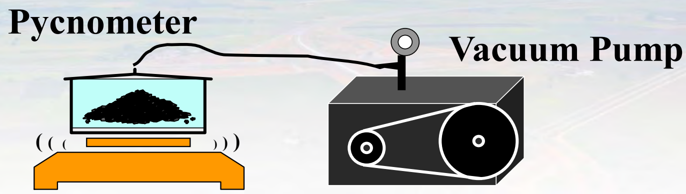



IRI readings are used to determine payment as per table A, schedule A or B.




PTM 715 Determination of Bulk Specific Gravity of Compacted Asphalt Mixtures and PTM 716 Determination of Bulk Specific Gravity of Compacted Asphalt Mixtures that Absorb more than 3.0 Percent Water by Volume: Specific gravity of mixture is used to calculate air voids. Dry specimen weighed in air; specimen soaked in water for at least 10 minutes, blotted dry, and weighed again.

## AASHTO T209: Determining the Maximum Specific Gravity of Paving Materials (Laboratory Test)




$G_{mm}$ – theoretical maximum specific gravity or "*Rice*" specific gravity of asphalt-coated aggregated or *specific gravity of mix at zero air voids*.

29

**AASHTO T 209 Determining Maximum Specific Gravity of Paving Materials**: Heat the specimen if necessary, separate into small particles, and cool; place sample into a pycnometer and weigh; cover with water, apply vacuum and agitate for 8 to 12 minutes; fill pycnometer with water and weigh. The maximum specific gravity (100% compaction) is calculated from these weights.

## AASHTO T209: Theoretical Maximum Specific Gravity of Paving Materials (Lab Test)

Water Temperature is Important.

- Water batch temperature must be in the range of **77°±2°F**.
- If test temperature differs significantly correct for thermal effects.

30

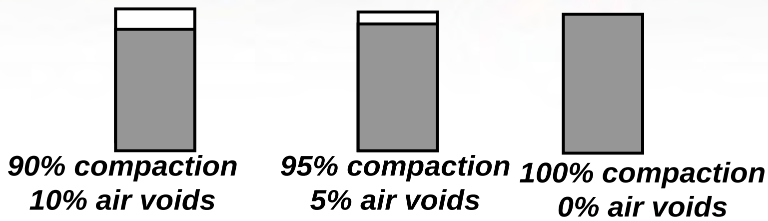
## Using PTM 715/716 & AASHTO T209 to find Percent Compaction and % Air Voids

% Comp. = $(G_{mb} / G_{mm}) \times 100$

$P_a = \{1-(G_{mb}/G_{mm})\} \times 100$ (or 100 - % Comp.)

$G_{mb}$ = bulk spec. gr.; $G_{mm}$ = max. spec. gr.;

$P_a$ = air void content, percent by volume.




31

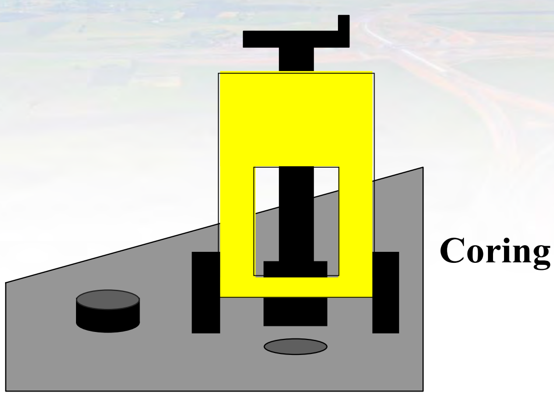
From these tests, we can determine percent compaction and/or percent of air voids in the mix. To find the percent compaction (% comp): use % Comp.

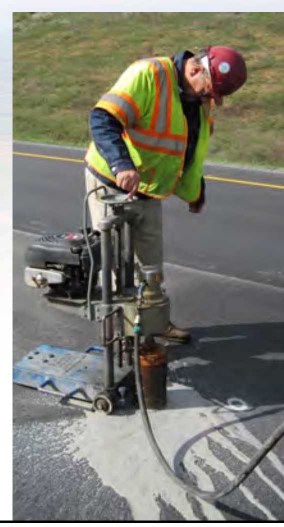
**$= (G_{mb} / G_{mm}) \times 100$**

**To find percent air voids ($P_a$): use $P_a = \{1-(G_{mb}/G_{mm})\} \times 100$**

**Where $G_{mb}$ = *bulk specific gravity* and $G_{mm}$ = *Theoretical maximum specific gravity***

## PTM #729: Sampling Roadway Asphalt Concrete



32

NOTE: Revision includes directions on equipment, procedures, packing and custody!!!!!!!!!

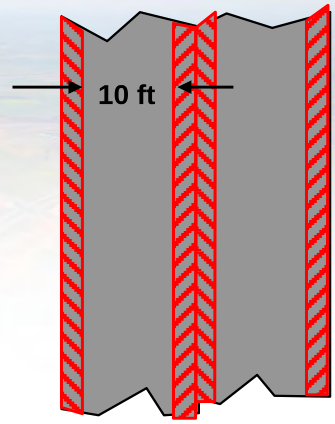
## PTM #729: Sampling Roadway Asphalt Concrete

**TESTABLE width** will equal the nominal paving width (paving width less one foot from each supported edge and each unsupported edge)

- **Example: 12-foot paving lane:**

**12 feet - 1 foot - 1 foot = 10 feet**

sampling width to be used with random number table to establish "y" value



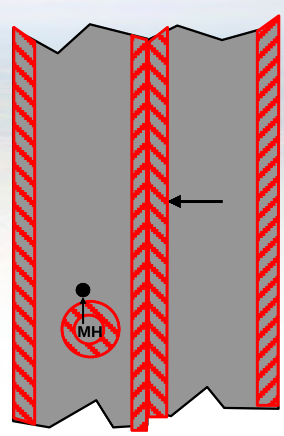

NECEPT

33

**PTM 729** provides information for coring sample location procedures. Non-testable areas defined as 1 foot from both supported and unsupported edges. Reference examples in the appendix for examples and full instructions

## PTM #729: Sampling Roadway Asphalt Concrete

- Defines non-testable areas as one-foot from the edge of obstructions such as manholes, inlets, and utility valve covers.
- If sample location falls within, adjust location longitudinally in direction of paving to just outside the non-testable area.




NECEPT

34

## PTM #729: Sampling Roadway Asphalt Concrete

- **Equipment:**
  - Core drill, water cooled, equipped to core
  - Diamond drill bits
  - Extraction tool specifications
  - A rigid plate or suitable container to hold sample without distortion after removal (Concrete cylinder molds)
  - Masking tape
  - Marking pencil
  - Incidental materials & equipment

NECEPT

35

Concrete cylinder molds have proven to be satisfactory and convenient for shipping cores. Cores placed in molds should be cushioned/separated with crumpled newspaper. If other containers are used, they should not exceed 24” in length and shall not weigh more than 50 lbs.

## PTM #729: Sampling Roadway Asphalt Concrete

- Random sampling using **PTM #1** with one sample from each sublot. See PTM 746 appendix for examples.
- Density samples to be cross referenced to corresponding loose mix acceptance (box) samples on Form TR-447. *BY DATE PLACED in comments.*
- Place increment bar code sticker from Form TR-447 on outside container.
- Secure cored samples with masking tape.
- Store in safe, cool place and transport in a timely manner.

NECEPT

36

## PTM #729: Sampling Roadway Asphalt Concrete

- **PTM 729 Appendix** provides examples for locating samples
  - Example 1: Location adjustment for edges
  - Example 2: Location adjustment for obstructions

NECEPT

37

## PTM #729: Sampling Roadway Asphalt Concrete

**4. Selection of Longitudinal Joint Incentive/Disincentive Samples (Section 405)**

- Samples by random sampling using PTM #1 Random Numbers, X value only
- Lots determined as paving progresses and new joints are formed
- Full lot = **12,500 linear feet**
- 5 sublots of **2,500 feet per lot**
- One sample from each sublot.

NECEPT

38

For projects meeting all the criteria for longitudinal joint density testing and incentive/disincentive payments, the random samples will be located by PTM #1, and extracted as per PTM 729 using the X value only to determine the longitudinal distance from the beginning of the sublot. For longitudinal joint cores, the word "lot" takes on a new definition. A lot is equal to 12,500 linear feet of longitudinal joint with 5 sublots of 2,500 linear feet each. One sample shall be taken from each sublot.

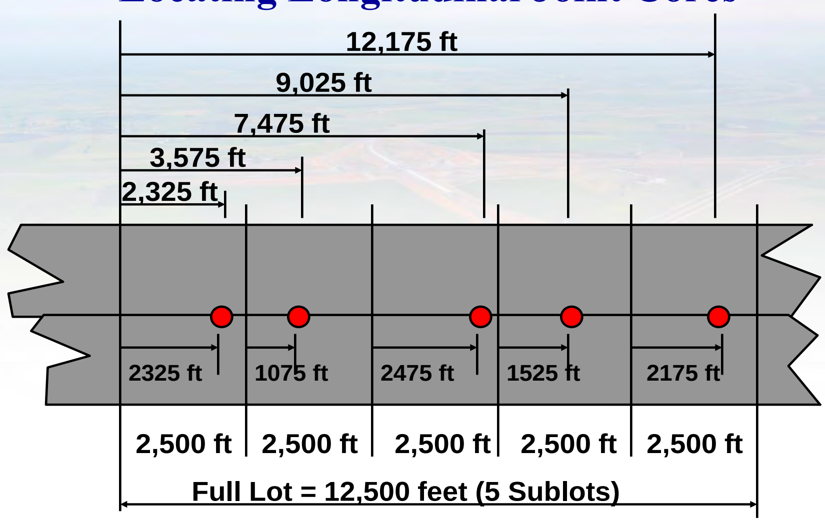
## PTM #729
## Locating Longitudinal Joint Cores

| | X | Y | Linear Feet by Sublot | Total Lot LF |
|---|---|---|---|---|
| 47 | 0.93 | N/A | 0.93 x 2,500 ft. = 2,325 | 2,325 |
| 48 | 0.43 | N/A | 0.43 x 2,500 ft. = 1,075 | 3,575 |
| 49 | 0.99 | N/A | 0.99 x 2,500 ft. = 2,475 | 7,475 |
| 50 | 0.61 | N/A | 0.61 x 2,500 ft. = 1,525 | 9,025 |
| 51 | 0.87 | N/A | 0.87 x 2,500 ft. = 2,175 | 12,175 |

39

Remember, for longitudinal joint cores, a lot = 12,500 feet with 5 sublots of 2,500 feet each. As a sample location, if you select random number 47, the number in the X column (0.93) is multiplied by the length of the sublot (2,500 ft.) to give you a distance from the beginning of that sublot to the sample (2,375). The next random number 48 gives you an X 0f 0.43 multiplied by the length of the sublot to give you a distance of 1075 feet from the beginning of that sublot to the sample or, a total distance from the beginning of the full lot of 3,575 feet (2,500 +1,075).

## PTM #729
## Locating Longitudinal Joint Cores




40

## PTM #729

### Locating Longitudinal Joint Cores

### Example from PTM Appendix – Example No. 3

| Sampling Sequence for LOT (12,500 linear feet) | | | |
|---|---|---|---|
| Sublot 1 | 2,325 | = | Station 23+25 |
| Sublot 2 | 2,500 + 1,075 | = | Station 35+75 |
| Sublot 3 | 5,000 + 2,475 | = | Station 74+75 |
| Sublot 4 | 7,500 + 1,525 | = | Station 90+25 |
| Sublot 5 | 10,000 + 2,175 | = | Station 121+75 |

NECEPT

41

This is from Example No. 3 of the PTM #729 appendix showing location of longitudinal joint cores by stationing.

## PTM #729
## Location of Longitudinal Joint Cores

- Length of final lot is adjusted to ensure final lot has between 3 to 7 sublots (**See Example #3 in PTM 729 Appendix**)
- For final sublot, use a length of 2,500 feet and multiply by the x-value of the random number
- If sample falls beyond actual length of joint, sublot not counted and No sample taken.
- If sample falls within actual length of joint, sample taken and sublot added to the final lot.

NECEPT

42

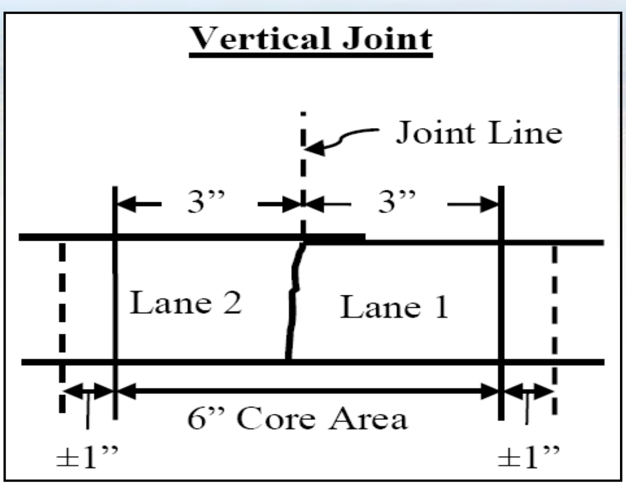
## PTM #729
## Location of Longitudinal Joint Cores

- **Location of cores on joint**
  - With vertical joints, cores centered on surface joint line
    - Center of core to be within 1 inch of joint line
  - With notch wedge joints, cores centered 6 inches or half the wedge width of the joint taper away from the joint line in direction of wedge
  - If $G_{mm}$ of each lane differs by more than 0.050, ensure half of core is from each lane
  - If not, adjust lateral location for replacement core within 12 inches longitudinally

43

Vertical joint cores shall be centered on the line where the joint between the two adjacent lifts abut at the surface. The center of all vertical joint cores shall be within ± 25 mm (1 inch) of this joint line. Center notched wedge joint cores 150 mm (6 inches) or one-half the width of the joint taper away from the joint line in the direction of the wedge. When the two lanes forming the joint have $G_{mm}$ values more than 0.050 apart, examine each core to ensure that approximately half of the core is from each lane. If the materials in the core are unbalanced, adjust the location of the core drill relative to the joint line to ensure approximately equal material. Take a replacement sample within 300 mm (12 inches) longitudinally of the original sample location.

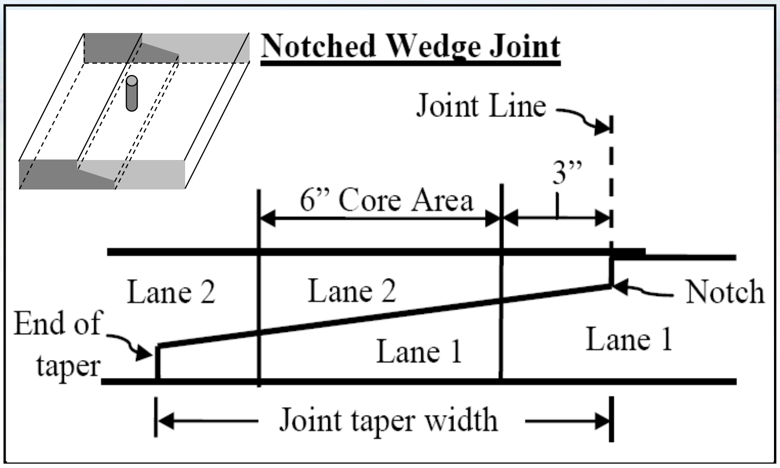
## PTM #729
## Location of Longitudinal Joint Cores




44

Vertical Placement of Longitudinal Joint Cores

## Location of Longitudinal Joint Cores




45

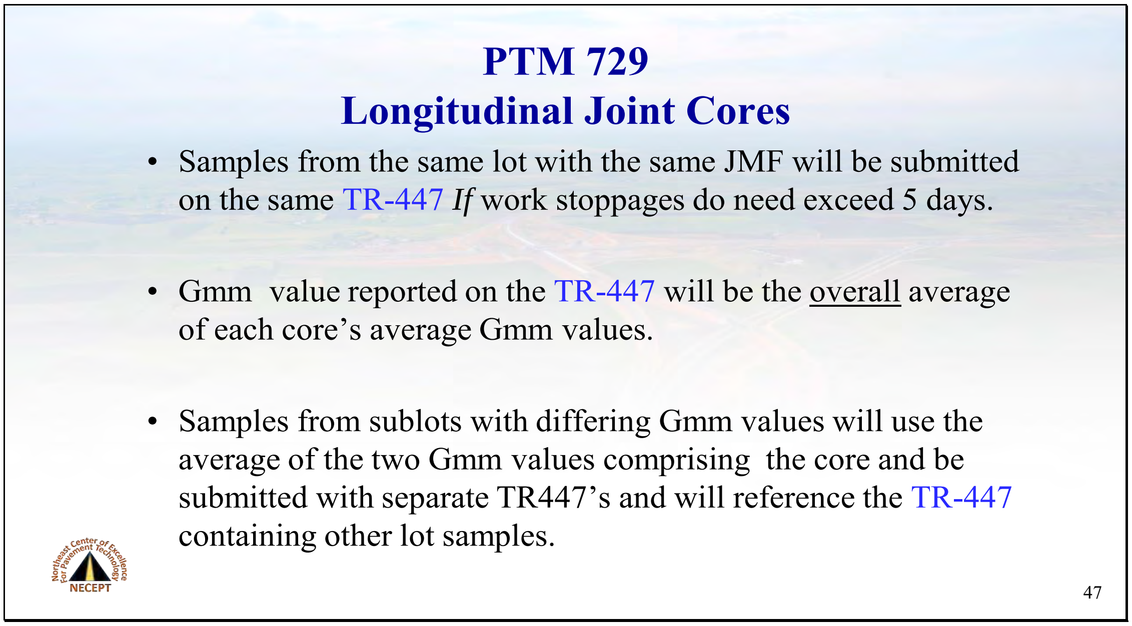
Joint cores for notch wedge joints should be centered over the wedge of the joint.

## Change 5- TR 447’s for Longitudinal Joint Cores

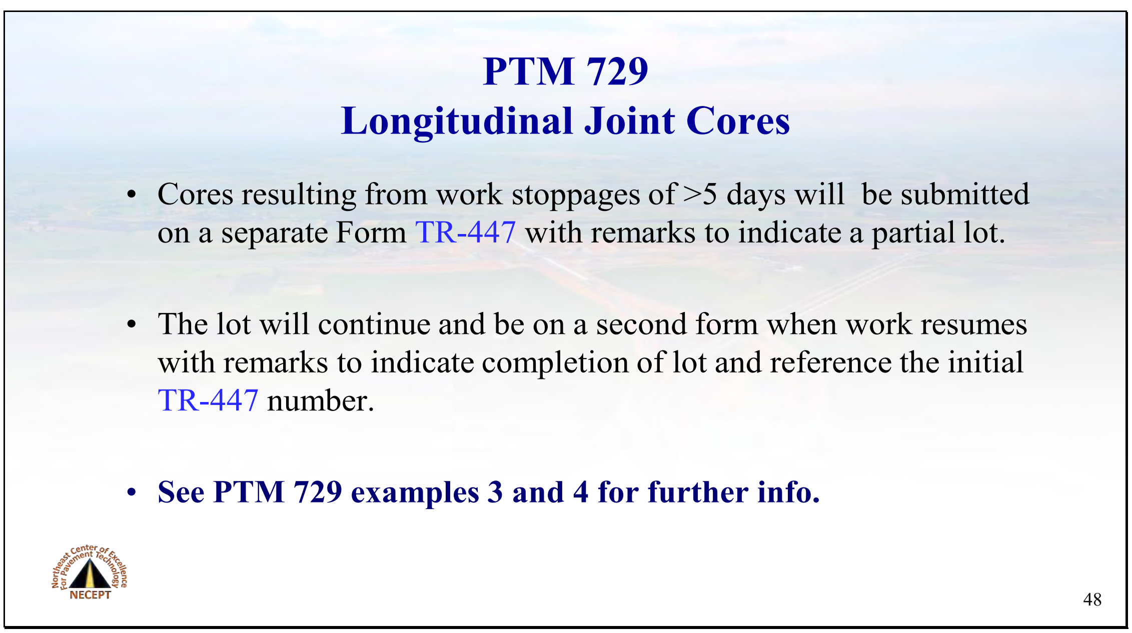
- Cores taken from the same lot with the same JMF are packaged and recorded on the same TR-447
- Cores from Different JMF’s on separate TR-447.
- Cores from Paving Break > 5 days placed on Separate TR-447
- Document the date material was *PLACED.*

46

Different JMF’s could occur at shoulder/mainline joint.



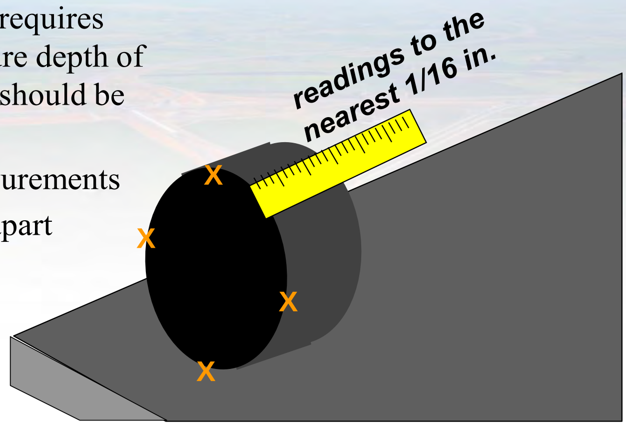

Theoretical maximum density is reported in pounds/cubic foot, found on mix design, Certifications (CS 4171), and some delivery slips.




Stoppages of work more than 5 days will still be contained in the same lot.

## PTM #737: Measuring Thickness Of Asphalt Concrete Courses

- **Section 413.3(m)** requires inspector to measure depth of cores. Contractor should be present!
- Average of 4 measurements *minimum* @ 90º apart
- Depth recorded to nearest 1/8 inch

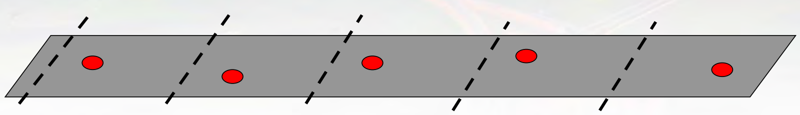



NECEPT

49

If bottom of core is uneven, take at least two additional measurements. Thickness shall be recorded on the TR-447 to the nearest 1/8 inch.

## PTM #746
## Sampling Asphalt Paving Mixture



***Location of samples determined as described in PTM 1: Probability Sampling***

NECEPT

50

## PTM #746
## Sampling Asphalt Paving Mixture
## # of Sublots

- **Normal lot defined as 2,500 tons with 5 sublots of 500 tons.**
- **Section 413.3h-2.a.2** covers sampling of projects with less than 2,500 tons total of a JMF per project:
  - o If production is >500 tons & <2500tons:
    Then, total quantity divided into 5 sublots
  - o If production is <500 tons:
    Then, total quantity divided into 3 sublots if density acceptance is by cores
    And mixture acceptance is by certification

NECEPT

51

Note the different size of the lots and number of sublots.

## PTM #746
## Sampling Asphalt Paving Mixture

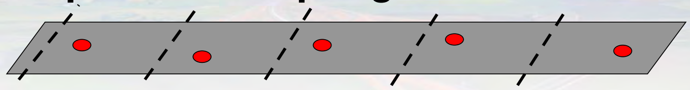
- For large NMAS mixes, contractor may obtain larger size samples and then reduce in size; Here is the language in PTM 746
- 5.1.1: for 3/4" (19 mm) and larger NMAS mixtures, a sample larger than is required in section 4.1 may be obtained and placed on a mixing board, thoroughly mixed, formed into a flat pile and carefully quartered to provide a representative sample of the required size. Scrape the inside of the scoop at each transfer point to incorporate any fines sticking to the inside of the scoop.

NECEPT

52

## PTM #746
## Sampling Asphalt Paving Mixture

### Acceptance Sampling on the Roadway



- One sample from each sublot using PTM #1
- Equipment:
  - Flat-bottom, high sided scoop
  - Boxes approx.. 3 ¾" x 4 ¾" x 9 ½" (approx. 8 lbs. of material) ( ≤ 19 mm)
  - Putty knife for scraping INSIDE of scoop
  - Incidental materials & equipment

NECEPT

53

## PTM #746
## Sampling Asphalt Paving Mixture

### Acceptance Sampling on the Roadway

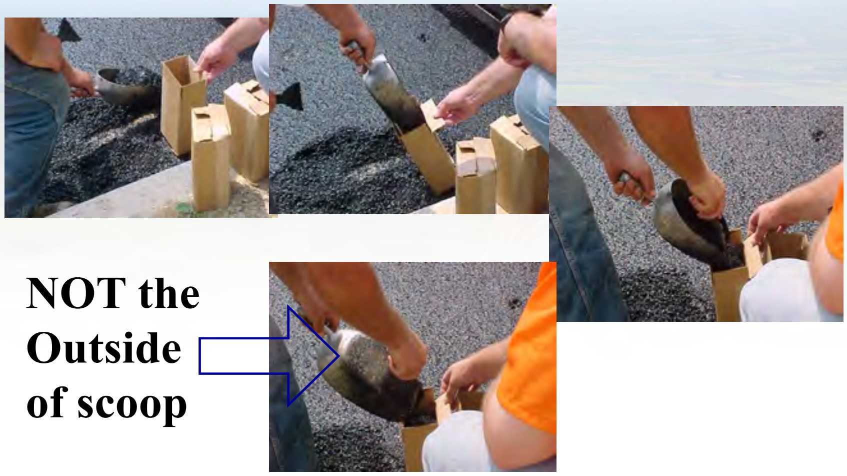
- Samples taken from uncompacted mix directly behind the paver (paving equipment)
- TR-447 for pavement cores cross referenced to mix acceptance TR-447
- Examples of non-testable areas
- Instructions for sampling, identification, and packaging in appendix of PTM 746

NECEPT

54

Use flat-bottomed scoop, scrape **inside of scoop only**.

## PTM #746
## Sampling Asphalt Paving Mixture



**NOT the Outside of scoop**

55

When removing material from the scoop to the box, be careful NOT to include the material from outside of the scoop.

## PTM #746
## Sampling Asphalt Paving Mixture

**Watch the Video**

56

## PTM #746: Sampling Asphalt Paving Mixtures

### Acceptance Sampling on the Roadway

- Sampling scoop should pass completely through entire depth of material lift, transferring material to box, scraping any remaining fines from INSIDE scoop.
- PTM Appendix provides examples for locating samples
  - Example 1: Based on tonnage – addresses procedure with MTV
  - Example 2: Based on square yards

NECEPT

57

PTM 746 has illustrative examples for using PTM #1 and locating samples on the roadway based on tonnage or on square yards.

## PTM #746: Sampling Asphalt Paving Mixtures

### PTM also includes:

- Sampling at the production plant under a quality a control program with appropriate illustrative example
- Quality assurance sampling from hauling units with appropriate illustrative example
- Date *PLACED* must be noted on TR-447

NECEPT

58

Note that production sampling does not directly correlate to field lots.

## PTM #747: Determination of Distributor Application Rate in the Field

- Calibration of distributor prior to test required
- Equipment
  - 48" Carpenter's level
  - Dipstick for tank
  - Manufacturer's certificate of calibration
- Application rate of higher temperature materials determined by correcting temperature using Bulletin 25 conversion chart

NECEPT

59

## PTM #747: Determination of Distributor Application Rate in the Field

- **Procedure**
  - Level tank with level on top of manhole
  - Use dipstick to measure material level in tank, calculate gallons from calibration table
  - Select test strip length according to Table 1

**Table 1. Length of Test Strip**

| App. Rate, gal/sq.yd. | Length of Test Strip, feet |
|---|---|
| Less than or = 0.01 | 1,000 |
| More than 0.01 | 500 |

NECEPT

60

Dipstick should agree with gauge and be marked with serial number of distributor unit. Wheel or infra-red unit on truck should agree with measured distance.

## PTM #747: Determination of Distributor Application Rate in the Field

- **Procedure (continued)**
  - Apply material to test strip
  - Level tank again and measure level of material with dipstick
  - Calculate application rate
  - Multiply length X width and divide by 9 to calculate square yards.
  - Divide gallons placed by square yards covered to determine Application rate.
  - Multiply Application rate by % of asphalt in tack to determine yield

NECEPT

61

Calculations will be covered again in module 4.

## Segregated or Flushed Pavement

- Inspector notifies contractor that segregation or flushing is suspected
- Contractor may elect to proceed at their own risk from that point while trying to rectify the problem
- PTM 751 will be performed to evaluate the condition.

NECEPT

62

## PTM #751: Measuring Surface Macrotexture Depth Using A Volumetric Technique & Determining Pattern Segregation

- Also known as **Hockey Puck Test**
- Used to determine degree of segregation or flushing
- Measures voids in pavement surface and indicates segregation or gradation change

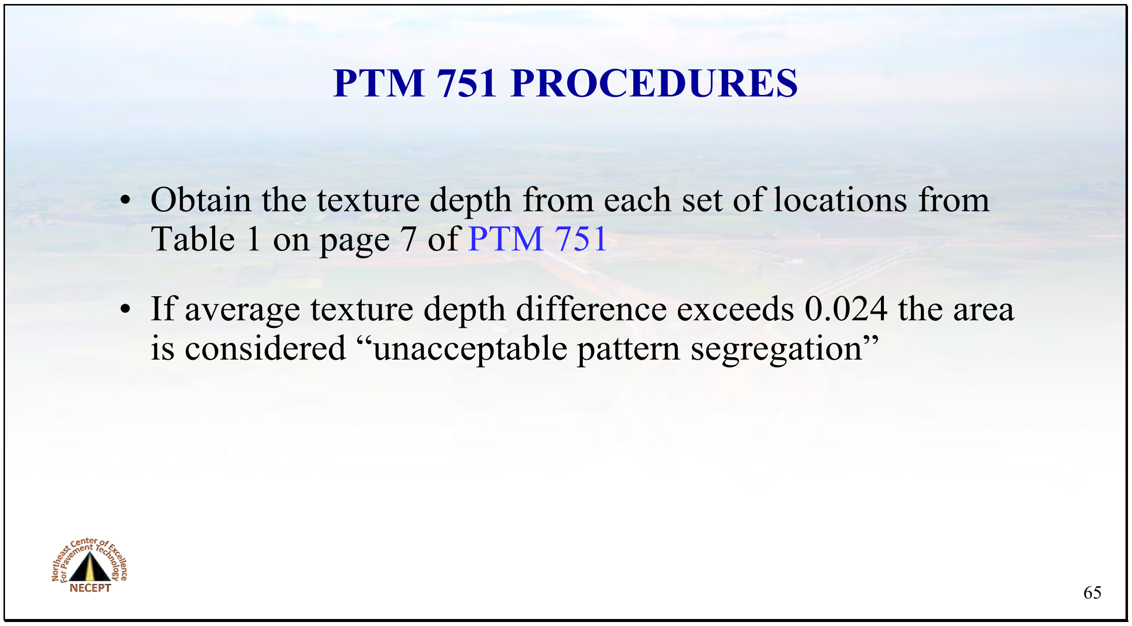
63

## PTM 751 PROCEDURES

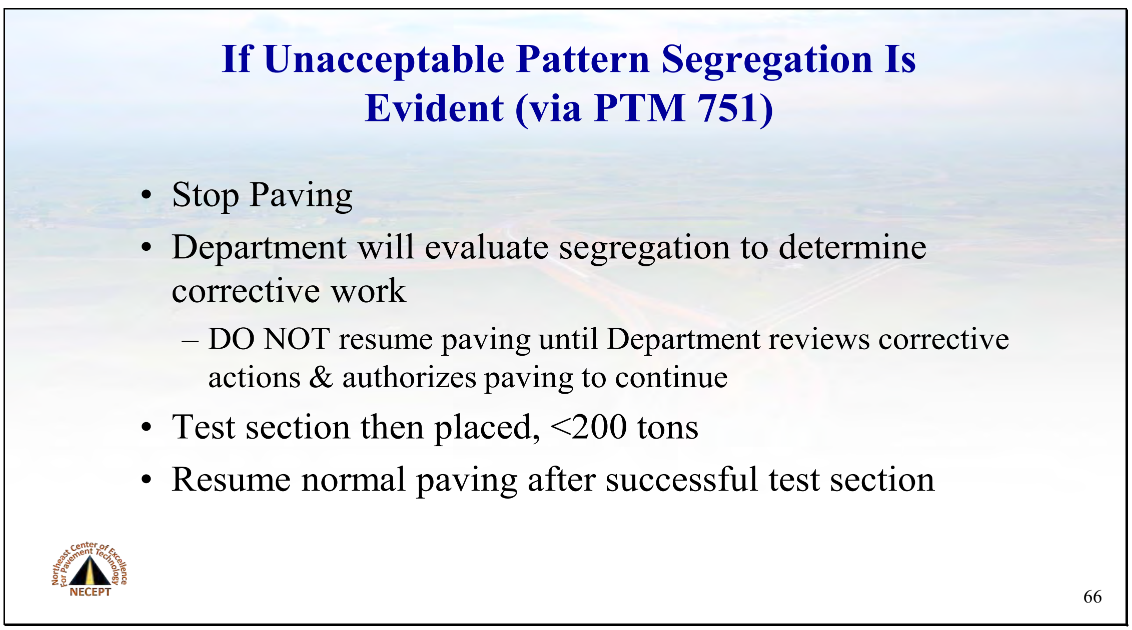
- Areas must be clean and dry with no loose debris
- Test will be performed in 3 suspect and three acceptable locations
- A measured quantity of material is applied to mat surface and spread to largest possible diameter circle
- Difference in diameter is used to determine average surface texture depth

64

Initial procedure for determining Pattern Segregation: Inspect the pavement surface and select a dry homogeneous area. Thoroughly clean the surface with brush.




Perform an equal number of tests in an acceptable area. Calculate the average radius for each area and determine the average texture depth.




Immediately stop all paving. The Department will evaluate the pattern segregation to determine the extent of the corrective work. This work will be in accordance with the Quality Control Plan or as directed by the Engineer. <u>Do Not Restart paving until the corrective action is accepted by the Department</u>. When the Engineer permits work to resume, place a test section limited to 200 tons. If the corrective action corrects the problem, work will be allowed to continue.

## Evaluating Segregated Area

- **Evaluating Segregation [PennDOT Specs Section 413.3(h)3.c]:**
  – Take 6" Cores
  – Remove & Replace Segregated Areas if sum of any 2 sieves vary 20% or more from the JMF or core Density is less then 90%
  – Remove full lane width of segregated area plus 5 feet minimum beyond each end

NECEPT

67

**Evaluate Segregation-** Take 6-inch cores from the unacceptable areas. The Inspector will deliver them to the plant and observe the testing for density, extraction and gradation analysis. Remove and replace any area if the summation of absolute deviations from any two sieves is 20% or more from the job mix formula, or the core density indicates less than 90% of Maximum Theoretical Density. Remove not less than full width of the affected lane and 5 feet minimum beyond each end of the affected area. New replacement area should meet surface tolerance requirements. When the test results exceed the above limitations, the pavement is accepted. <u>(This does not mean that surface Segregation does not exist. In fact, in most cases the surface is segregated and during the life of the pavement will ravel.)</u>

## Module 3 – Review Objectives

- Which Pennsylvania Test Methods (or AASHTO) tests apply to the asphalt pavement construction (field work)?
- Specifically, we discussed PTMs related to
  – Sampling/Random Numbers
  – Determination of lot and sublot size
  – Density measurement protocols
  – Joint cores
  – Thickness Measurement
  – Pavement profile Measurement
  – Distributor Application Rate
  – Pattern Segregation

NECEPT

68

# Questions?


**Did I go too fast?**

69

PennState

# *Discussion*

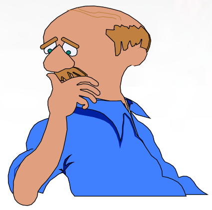
pennsylvania
DEPARTMENT OF TRANSPORTATION

70

# Quiz

## Module 3
## PTMs

?





**1. PTM 751 can be used to help determine pattern segregation or flushing.**

a. True

b. False

**Answer:**

**2. PTM 746 is used for loose samples only.**

a. True
b. False

**Answer:**

NECEPT



**3. Loose box (mixture acceptance) samples require that all fines be removed from the scoop and replaced in the box.**

a. True
b. False

**Answer:**

NECEPT

**4. Nuclear density testing procedures are outlined in PTM 403.**

a. True
b. False

**Answer:**



**5. Random sampling procedures are covered in PTM #1.**

a. True
b. False

**Answer:**

**6. The operator of a light-weight profiler does not have to have a separate certification.**

a. True
b. False

**Answer:**



**7. Sub-lots for longitudinal joint cores are 12,500 feet in length.**

a. True
b. False

**Answer:**

**8. The "R" in PTM #1 designates that the measurement is from the right edge of the pavement mat.**

a. True
b. False

**Answer:**



**9. Pub. 19 contains all the PTMs for testing of asphalt roadways.**

a. True
b. False

**Answer:**

**10. A project quantity of 1900 ton placed in one day will have how many lots and sublots?**

a. 3 lots and 6 sublots

b. 1 lot and 3 sublots

c. 1 lot with 5 sublots

d. 1 lot with 4 sublots

**Answer**



# Determining Lots & Sublots, and Sampling Locations

## Contents:

# Three Major Rules

- 1 2500 TON OR MORE OF ANY JMF PER PROJECT: DIVIDE BY 500 TONS AND ROUND UP TO DETERMINE THE NUMBER OF *Possible* SUBLOTS
- 2 >500 TON BUT < 2500: DIVIDE INTO 5 EQUAL SUBLOTS
- 3 500 TON OR LESS: DIVIDE INTO 3 EQUAL SUBLOTS

NECEPT



# 413.3(h)2.a Lots and Sublots: Table D

Re-adjustment of Lot Size & Associated Number of Sublots

| Remaining Quantity* Following Last Full Lot | Action |
|---|---|
| Less than 500 tons without a combination of one mixture acceptance sample and one core | Quantity combined with previous lot, (n=5) |
| Less than 500 tons with a combination of one mixture acceptance sample and one core | One new sublot defined & quantity combined with previous lot, (n=6) |
| 500 tons to less than 1000 tons without a combination of two mixture acceptance samples and two cores | One new sublot defined & quantity combined with previous lot, (n=6) |
| 500 tons to less than 1000 tons with a combination of two mixture acceptance samples and two cores | Two new sublots defined & quantity combined with previous lot, (n=7) |
| 1000 tons to less than 1500 tons without a combination of three mixture acceptance samples and three cores | Two new sublots defined & quantity combined with previous lot, (n=7) |

NECEPT

| | |
|---|---|
| **1000 tons to less than 1500 tons <u>with</u> a combination of three mixture acceptance samples and three cores** | **New lot defined, (n=3)** |
| **1500 tons to less than 2000 tons <u>without</u> a combination of four mixture acceptance samples and four cores** | **New lot defined, (n=3)** |
| **1500 tons to less than 2000 tons <u>with</u> a combination of four mixture acceptance samples and four cores** | **New lot defined, (n=4)** |
| **2000 tons to less than 2500 tons <u>without</u> a combination of five mixture acceptance samples and five cores** | **New lot defined, (n=4)** |
| **2000 tons to less than 2500 tons <u>with</u> a combination of five mixture acceptance samples and five cores** | **New lot defined, (n=5)** |



**PennDOT**
**TABLE I**
**<u>RANDOM POSITIONS IN DECIMAL FRACTIONS (2 PLACES)</u>**

| | X | Y | | X | Y | | X | Y |
|---|---|---|---|---|---|---|---|---|
| 1. | 0.29 | R 0.66 | 34. | 0.61 | L 0.87 | 67. | 0.93 | R 0.17 |
| 2. | 0.74 | R 0.49 | 35. | 0.76 | R 0.16 | 68. | 0.40 | R 0.50 |
| 3. | 0.89 | L 0.79 | 36. | 0.87 | L 0.10 | 69. | 0.44 | R 0.15 |
| 4. | 0.60 | R 0.39 | 37. | 0.41 | L 0.10 | 70. | 0.03 | L 0.60 |
| 5. | 0.88 | R 0.31 | 38. | 0.28 | R 0.23 | 71. | 0.19 | L 0.37 |
| 6. | 0.72 | L 0.54 | 39. | 0.22 | L 0.18 | 72. | 0.92 | L 0.45 |
| 7. | 0.12 | R 0.08 | 40. | 0.21 | L 0.94 | 73. | 0.20 | L 0.85 |
| 8. | 0.09 | L 0.94 | 41. | 0.27 | L 0.52 | 74. | 0.05 | R 0.56 |
| 9. | 0.62 | L 0.11 | 42. | 0.39 | R 0.91 | 75. | 0.46 | R 0.58 |
| 10. | 0.71 | R 0.59 | 43. | 0.57 | L 0.10 | 76. | 0.43 | R 0.91 |
| 11. | 0.36 | L 0.38 | 44. | 0.82 | L 0.12 | 77. | 0.97 | L 0.55 |
| 12. | 0.57 | R 0.49 | 45. | 0.14 | L 0.94 | 78. | 0.06 | R 0.51 |
| 13. | 0.35 | R 0.90 | 46. | 0.50 | R 0.58 | 79. | 0.72 | L 0.78 |
| 14. | 0.69 | L 0.63 | 47. | 0.93 | L 0.03 | 80. | 0.95 | L 0.36 |
| 15. | 0.59 | R 0.68 | 48. | 0.43 | L 0.29 | 81. | 0.16 | L 0.61 |
| 16. | 0.06 | L 0.03 | 49. | 0.99 | L 0.36 | 82. | 0.29 | R 0.47 |
| 17. | 0.08 | L 0.70 | 50. | 0.61 | R 0.25 | 83. | 0.48 | R 0.15 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 18. | 0.67 | L 0.68 | 51. | 0.87 | L 0.36 | 84. | 0.73 | R 0.64 |
| 19. | 0.83 | R 0.97 | 52. | 0.34 | L 0.19 | 85. | 0.05 | L 0.94 |
| 20. | 0.54 | R 0.58 | 53. | 0.37 | R 0.33 | 86. | 0.43 | L 0.05 |
| 21. | 0.82 | R 0.50 | 54. | 0.97 | L 0.79 | 87. | 0.87 | R 0.98 |
| 22. | 0.66 | R 0.73 | 55. | 0.13 | R 0.56 | 88. | 0.37 | L 0.71 |
| 23. | 0.06 | L 0.27 | 56. | 0.85 | R 0.64 | 89. | 0.94 | L 0.26 |
| 24. | 0.03 | L 0.13 | 57. | 0.14 | L 0.04 | 90. | 0.57 | L 0.63 |
| 25. | 0.55 | L 0.29 | 58. | 0.99 | R 0.74 | 91. | 0.26 | R 0.80 |
| 26. | 0.64 | L 0.77 | 59. | 0.40 | L 0.76 | 92. | 0.01 | L 0.79 |
| 27. | 0.30 | R 0.57 | 60. | 0.37 | L 0.09 | 93. | 0.83 | R 0.59 |
| 28. | 0.51 | R 0.67 | 61. | 0.90 | R 0.74 | 94. | 0.71 | L 0.21 |
| 29. | 0.29 | R 0.09 | 62. | 0.09 | L 0.70 | 95. | 0.65 | L 0.63 |
| 30. | 0.63 | R 0.82 | 63. | 0.66 | L 0.97 | 96. | 0.65 | L 0.87 |
| 31. | 0.53 | L 0.86 | 64. | 0.89 | L 0.55 | 97. | 0.72 | R 0.92 |
| 32. | 0.99 | R 0.22 | 65. | 0.67 | L 0.44 | 98. | 0.85 | L 0.78 |
| 33. | 0.02 | R 0.89 | 66. | 0.02 | R 0.65 | 99. | 0.04 | L 0.46 |
| | | | | | | 100. | 0.29 | L 0.95 |

**X = Decimal fraction of the total length measured along the road from the starting point.**
**Y = Decimal fraction measured across the road from either outside edge towards the centerline of the paved lane.**
**R = Indicates measurement from the right edge of the paved lane.**
**L = Indicates measurement from the left edge of the paved lane.**



## Determining Lots & Sublots and Sampling Locations

### Problem 1 :

- **Part A:** **You are the inspector on a paving project using 1-½ inches of 9.5 mm wearing surface. The project calls for placing 3745 tons for a 12-foot lane. You intend to take a combination of mixture acceptance and core samples. How many LOTS and SUBLOTS will be involved?**

# How Many Sublots ?

- 3745 tons > 2500 So, Rule #1
- DIVIDE BY 500 AND ROUND UP
- 3745 / 500 = 7.49 OR 8 *POSSIBLE* sublots to compute for sampling locations
- IF no paving delays > 5 days
- A sublot exists ONLY if you get both a loose and core sample



# HOW MANY LOTS?

- We do not yet know how many Lots
- LOT sizes are decided by actual paving schedules and Table D
- *Completed* lots must have 3 sublots ( one loose and one core per sublot) and NEVER have more than 7 sublots

## Problem 1 :

### Part A: How many Lots and Sublots will be involved?



**Answer 1:**
**3745 tons**
**1st LOT = 2500 TONS = 5 SUBLOTS @ 500 TONS**
**3745 tons – 2500 tons = 1245 tons**
**Using Table D, if you got a combination of 3 box samples and 3 core samples:**

- **New lot defined with 3 sublots**
- **2nd LOT = 1245 TONS = 3 SUBLOTS**
- **TOTAL: 2 LOTS and 8 SUBLOTS**

**Or….**
**Using Table D, if you did not get a combination of 3 box samples and 3 core samples:**

- **Two new sublots defined & put in previous lot**
- **1st Lot = 5 lots + 2 new defined lots**
- **TOTAL: 1 LOT and 7 SUBLOTS**

## Problem 1 :
## Part A: How many Lots and Sublots will be involved?

**Answer 1:**
**3745 tons**
**1st LOT = 2500 TONS = 5 SUBLOTS @ 500 TONS**
**3745 tons – 2500 tons = 1245 tons**
**Using Table D, if you got a combination of 3 box samples and 3 core samples:**
  **New lot defined with 3 sublots**
  **2nd LOT = 1245 TONS = 3 SUBLOTS**
  **TOTAL: 2 LOTS and 8 SUBLOTS**
**Or….**
**Using Table D, if you did not get a combination of 3 box samples and 3 core samples:**
  **Two new sublots defined & put in previous lot**
  **1st Lot = 5 sublots + 2 new defined sublots**
  **TOTAL: 1 LOT and 7 SUBLOTS**

## 413.3(h)2.a Lots and Sublots: Table D

**Re-adjustment of Lot Size & Associated Number of Sublots**

| Remaining Quantity* Following Last Full Lot | Action |
|---|---|
| Less than 500 tons without a combination of one mixture acceptance sample and one core | Quantity combined with previous lot, (n=5) |
| Less than 500 tons with a combination of one mixture acceptance sample and one core | One new sublot defined & quantity combined with previous lot, (n=6) |
| 500 tons to less than 1000 tons without a combination of two mixture acceptance samples and two cores | One new sublot defined & quantity combined with previous lot, (n=6) |
| 500 tons to less than 1000 tons with a combination of two mixture acceptance samples and two cores | Two new sublots defined & quantity combined with previous lot, (n=7) |
| 1000 tons to less than 1500 tons without a combination of three mixture acceptance samples and three cores | Two new sublots defined & quantity combined with previous lot, (n=7) |
| 1000 tons to less than 1500 tons with a combination of three mixture acceptance samples and three cores | New lot defined, (n=3) |



## Problem 1 :

- **Part B:** On the same project, the length of the sublots need to be determined. The first sublot contains 500 tons. What distance will the 500 tons of asphalt pave if we are placing a 12-foot wide lane at 1 ½ inches thick? We are assuming a mix density of 110 lbs./sq. yd./inch.

## Problem 1 :

**Part B: What distance will the 500 tons of asphalt pave?**

÷





## Problem 1 :

**Part C: Find the location on the pavement where the first box sample would be taken. The first sublot random number is 25.**

## Problem 1 :

**Part D:** Find the location on the pavement where you would take the third core sample. This will represent the third sublot. The first sublot random number is 61.



## Problem 2 :

- A Contractor is placing 18000 $yd^2$ of Superpave Asphalt Wearing Course with a PG76-22, 3 to <10 million ESALS, 9.5mm mix, 1½" depth, 12-foot lane.
- Assume yield of 115 lbs./$yd^2$/inch of pavement

**Part A:** Calculate tonnage and total number of lots and sublots.

**Part B:** What will be the length of each sublot?

## Problem 3:

- A Contractor is placing approximately 6500 tons of Superpave asphalt Wearing Course with a PG64-22, 3 to <10 million ESALS, 9.5mm mix, 1 ½" depth, 12-foot lane over 4 days of paving.
- Acceptance by lots required
- The actual daily placement is as follows:
  - 1st Day: 1532.12
  - 2nd Day: 1511.14
  - 3rd Day: 1876.51
  - 4th Day: 1532.25
- Assume yield of 110 lb./inch/yd$^2$ of pavement
- Calculate total number of lots and sublots, assuming you obtained the required combination of both box and core samples on the last partial lot.



## How many sublots

- 6500 ÷ 500 = 13 possible sublots
- How many lots?
- We do not yet know
- Why Not?

## 413.3(h)2.a Lots and Sublots: Table D

**Re-adjustment of Lot Size & Associated Number of Sublots**

| Remaining Quantity* Following Last Full Lot | Action |
|---|---|
| Less than 500 tons without a combination of one mixture acceptance sample and one core | Quantity combined with previous lot, (n=5) |
| Less than 500 tons with a combination of one mixture acceptance sample and one core | One new sublot defined & quantity combined with previous lot, (n=6) |
| 500 tons to less than 1000 tons without a combination of two mixture acceptance samples and two cores | One new sublot defined & quantity combined with previous lot, (n=6) |
| 500 tons to less than 1000 tons with a combination of two mixture acceptance samples and two cores | Two new sublots defined & quantity combined with previous lot, (n=7) |
| 1000 tons to less than 1500 tons without a combination of three mixture acceptance samples and three cores | Two new sublots defined & quantity combined with previous lot, (n=7) |
| 1000 tons to less than 1500 tons with a combination of three mixture acceptance samples and three cores | New lot defined, (n=3) |

NECEPT



## Chart to help determine

| | Tons | Lot 1 | Lot 2 | Lot 3 |
|---|---|---|---|---|
| Day 1 | 1532.12 | 1532.12 | | |
| Day 2 | 1511.14 | 967.88 | 543.26 | |
| Day 3 | 1876.51 | | 1876.51 | |
| Day 4 | 1532.25 | | 80.23 | 1452.02 |
| Total Tons | 6452.02 | 2500 | 2500 | 1452.02 |
| Sublots | | 5 | 5 | 3 |

NECEPT

**Chart for determining lots.**

## Problem 4: Paving Delay

- A Contractor is placing approximately 6500 tons of Superpave asphalt Wearing Course with a PG64-22, 3 to <10 million ESALS, 9.5mm mix, 1 ½" depth, 12 foot lane over 4 days of paving.
- Acceptance by lots required
- The actual daily placement is as follows:
  - 1st Day: 1532.12
  - 2nd Day: 1511.14
  - 3rd Day: 1876.51
  - Delayed 7 days
  - 10th Day: 1532.25
- Assume yield of 110 lb./inch/yd$^2$ of pavement



## Problem 4: Paving Delay

- Calculate total number of lots and sublots
- Assume a full combination of samples obtained on last lot at end of 3rd day
- Assume NOT a full combination of samples obtained on the last lot of the 10th day.

# Table "D" at Change from 1 Lot to 2 Lots

**Re-adjustment of Lot Size & Associated Number of Sublots**

| | |
|---|---|
| **1000 tons to less than 1500 tons <u>without</u> a combination of three mixture acceptance samples and three cores** | **Two new sublots defined & quantity combined with previous lot, (n=7)** |
| **1000 tons to less than 1500 tons <u>with</u> a combination of three mixture acceptance samples and three cores** | **New lot defined, (n=3)** |





PennState

# *Discussion*

pennsylvania
DEPARTMENT OF TRANSPORTATION

NECEPT

# Determining Lots & Sublots, and Sampling Locations

## Contents:

# Determining Lots & Sublots, and Sampling Locations

## 413.3(h)2.a  Lots and Sublots: Table D

**Re-adjustment of Lot Size & Associated Number of Sublots**

| Remaining Quantity* Following Last Full Lot | Action |
|---|---|
| Less than 500 tons without a combination of one mixture acceptance sample and one core | Quantity combined with previous lot, (n=5) |
| Less than 500 tons with a combination of one mixture acceptance sample and one core | One new sublot defined & quantity combined with previous lot, (n=6) |
| 500 tons to less than 1000 tons without a combination of two mixture acceptance samples and two cores | One new sublot defined & quantity combined with previous lot, (n=6) |
| 500 tons to less than 1000 tons with a combination of two mixture acceptance samples and two cores | Two new sublots defined & quantity combined with previous lot, (n=7) |
| 1000 tons to less than 1500 tons without a combination of three mixture acceptance samples and three cores | Two new sublots defined & quantity combined with previous lot, (n=7) |
| 1000 tons to less than 1500 tons with a combination of three mixture acceptance samples and three cores | New lot defined, (n=3) |
| 1500 tons to less than 2000 tons without a combination of four mixture acceptance samples and four cores | New lot defined, (n=3) |
| 1500 tons to less than 2000 tons with a combination of four mixture acceptance samples and four cores | New lot defined, (n=4) |
| 2000 tons to less than 2500 tons without a combination of five mixture acceptance samples and five cores | New lot defined, (n=4) |
| 2000 tons to less than 2500 tons with a combination of five mixture acceptance samples and five cores | New lot defined, (n=5) |

## TABLE I
## RANDOM POSITIONS IN DECIMAL FRACTIONS (2 PLACES)

| | X | Y | | X | Y | | X | Y |
|---|---|---|---|---|---|---|---|---|
| 1. | 0.29 | R 0.66 | 34. | 0.61 | L 0.87 | 67. | 0.93 | R 0.17 |
| 2. | 0.74 | R 0.49 | 35. | 0.76 | R 0.16 | 68. | 0.40 | R 0.50 |
| 3. | 0.89 | L 0.79 | 36. | 0.87 | L 0.10 | 69. | 0.44 | R 0.15 |
| 4. | 0.60 | R 0.39 | 37. | 0.41 | L 0.10 | 70. | 0.03 | L 0.60 |
| 5. | 0.88 | R 0.31 | 38. | 0.28 | R 0.23 | 71. | 0.19 | L 0.37 |
| 6. | 0.72 | L 0.54 | 39. | 0.22 | L 0.18 | 72. | 0.92 | L 0.45 |
| 7. | 0.12 | R 0.08 | 40. | 0.21 | L 0.94 | 73. | 0.20 | L 0.85 |
| 8. | 0.09 | L 0.94 | 41. | 0.27 | L 0.52 | 74. | 0.05 | R 0.56 |
| 9. | 0.62 | L 0.11 | 42. | 0.39 | R 0.91 | 75. | 0.46 | R 0.58 |
| 10. | 0.71 | R 0.59 | 43. | 0.57 | L 0.10 | 76. | 0.43 | R 0.91 |
| 11. | 0.36 | L 0.38 | 44. | 0.82 | L 0.12 | 77. | 0.97 | L 0.55 |
| 12. | 0.57 | R 0.49 | 45. | 0.14 | L 0.94 | 78. | 0.06 | R 0.51 |
| 13. | 0.35 | R 0.90 | 46. | 0.50 | R 0.58 | 79. | 0.72 | L 0.78 |
| 14. | 0.69 | L 0.63 | 47. | 0.93 | L 0.03 | 80. | 0.95 | L 0.36 |
| 15. | 0.59 | R 0.68 | 48. | 0.43 | L 0.29 | 81. | 0.16 | L 0.61 |
| 16. | 0.06 | L 0.03 | 49. | 0.99 | L 0.36 | 82. | 0.29 | R 0.47 |
| 17. | 0.08 | L 0.70 | 50. | 0.61 | R 0.25 | 83. | 0.48 | R 0.15 |
| 18. | 0.67 | L 0.68 | 51. | 0.87 | L 0.36 | 84. | 0.73 | R 0.64 |
| 19. | 0.83 | R 0.97 | 52. | 0.34 | L 0.19 | 85. | 0.05 | L 0.94 |
| 20. | 0.54 | R 0.58 | 53. | 0.37 | R 0.33 | 86. | 0.43 | L 0.05 |
| 21. | 0.82 | R 0.50 | 54. | 0.97 | L 0.79 | 87. | 0.87 | R 0.98 |
| 22. | 0.66 | R 0.73 | 55. | 0.13 | R 0.56 | 88. | 0.37 | L 0.71 |
| 23. | 0.06 | L 0.27 | 56. | 0.85 | R 0.64 | 89. | 0.94 | L 0.26 |
| 24. | 0.03 | L 0.13 | 57. | 0.14 | L 0.04 | 90. | 0.57 | L 0.63 |
| 25. | 0.55 | L 0.29 | 58. | 0.99 | R 0.74 | 91. | 0.26 | R 0.80 |
| 26. | 0.64 | L 0.77 | 59. | 0.40 | L 0.76 | 92. | 0.01 | L 0.79 |
| 27. | 0.30 | R 0.57 | 60. | 0.37 | L 0.09 | 93. | 0.83 | R 0.59 |
| 28. | 0.51 | R 0.67 | 61. | 0.90 | R 0.74 | 94. | 0.71 | L 0.21 |
| 29. | 0.29 | R 0.09 | 62. | 0.09 | L 0.70 | 95. | 0.65 | L 0.63 |
| 30. | 0.63 | R 0.82 | 63. | 0.66 | L 0.97 | 96. | 0.65 | L 0.87 |
| 31. | 0.53 | L 0.86 | 64. | 0.89 | L 0.55 | 97. | 0.72 | R 0.92 |
| 32. | 0.99 | R 0.22 | 65. | 0.67 | L 0.44 | 98. | 0.85 | L 0.78 |
| 33. | 0.02 | R 0.89 | 66. | 0.02 | R 0.65 | 99. | 0.04 | L 0.46 |
| | | | | | | 100. | 0.29 | L 0.95 |

**X = Decimal fraction of the total length measured along the road from the starting point.**
**Y = Decimal fraction measured across the road from either outside edge towards the centerline of the paved lane.**
**R = Indicates measurement from the right edge of the paved lane.**
**L = Indicates measurement from the left edge of the paved lane.**

## Determining Lots & Sublots, and Sampling Locations

**Problem 1:**

**Part A: You are the inspector on a paving project using 1-½ inches of 9.5 mm wearing surface. The project calls for placing 3745 tons. You intend to take a combination of mixture acceptance and core samples. How many LOTS and SUBLOTS will be involved?**

**Part B: On the same project the length of the sublots need to be determined. The first sublot contains 500 tons. What distance will the 500 tons of HMA pave if we are placing a 12-foot wide lane at 1 ½ inches thick? We are assuming a mix yield of 110 lbs./ sq.yd./ inch**

**Part C: Find the location on the pavement where the first box sample would be taken. The first sublot random number is 0.25.**

**Part D: Find the location on the pavement where you would take the third core sample. This will represent the third sublot. The first sublot random number is 0.61.**

## Determining Lots & Sublots, and Sampling Locations

**Problem 2:**

**A Contractor is placing 18000 $yd^2$ of Superpave Asphalt Wearing Course with a PG76-22, 3 to <10 million ESALS, 9.5mm mix, 1 ½" depth, 12-foot lane. Assume yield of 115 lbs./ sq.yd./inch of pavement.**

**Part A: Calculate tonnage and total number of lots and sublots.**

**Part B: What will be the length of each sublot?**

## Determining Lots & Sublots, and Sampling Locations

**Problem 3:**

**A Contractor is placing approximately 6,500 tons of Superpave asphalt Wearing Course with a PG64-22, 3 to <10 million ESALS, 9.5mm mix, 1 ½" depth, 12-foot lane over 4 days of paving. Certification by lots required.**

**The actual daily placement is as follows:**

- **1st Day: 1532.12 tons**
- **2nd Day: 1511.14 tons**
- **3rd Day: 1876.51 tons**
- **4th Day: 1532.25 tons**
-

**Assume yield of 110 lbs./sq. yd/inch of pavement**

**Calculate total number of lots and sublots, assuming you obtained the required combination of both box and core samples on the last partial lot.**

## Determining Lots & Sublots, and Sampling Locations

### Problem 4: Paving Delay

**A Contractor is placing approximately 6500 tons of Superpave HMA Wearing Course with a PG 64-22, 3 to <10 million ESALS, 9.5 mm mix, 1 ½" depth, 12-foot lane over 4 days of paving. Certification by lots required.**

**The actual daily placement is as follows:**

- **1st Day: 1532.12 tons**
- **2nd Day: 1511.14 tons**
- **3rd Day: 1876.51 tons**
- **Delayed 7 days**
- **10th Day: 1532.25 tons**
-

**Assume yield of 110 lbs./sq. yd./inch of pavement**

**Calculate total number of lots and sublots.**

- **Assume a full combination of samples obtained on last lot at end of 3rd day.**
- **Assume not a full combination of samples obtained on the last lot of the 10th day.**

## SAMPLING MADE SIMPLE

**Pub 408, Sect. 413.3(h)** Covers Acceptance Sampling for any RPS or any **Standard** paving project. Follow the three rules discussed below.

### *RULE #1*

**IF project quantity of ANY JMF is 2500 ton or greater:**

**Then divide by 500 and ROUND UP to establish the number of sub-lots. All sampling computations** will be based on 500-ton increments

**Completed** Lots MUST have 3 sub-lots and CANNOT have more than 7 sub-lots.

Lots which have only 1 or 2 sublots are **incomplete, or partially completed** and will be noted as such and tested under different criteria.

A sublot **does not exist unless** it has a ***combination*** of 1 loose box and 1 core.

The final *sub-lot* could contain as much as 994 tons, mathematically.

The final **lot** could contain as much as 3,994 tons, mathematically.

Example: 3750 tons ÷500 tons = 7.5. Round up to **8 sampling locations to be computed for loose box and 8 for cores.**

**Table D** does not alter sub-lot size for computation. ALL sublots are computed in 500- ton increments.

Table D applies ONLY to quantities placed AFTER the last complete 2500-ton lot *(before a ≥ 5 day break or end of project*) and regulates both sublot and lot tonnage depending on whether you **were** or **were not** able to get both a loose and a core from the quantity of material placed in the final partial sublot (Table D's-- with or without)

### *RULE #2*

**IF project quantity of ANY JMF is greater than 500 tons (> 500 tons) and less than 2,500 tons (< 2,500 tons)**

**Then divide the entire quantity by 5 and there will be 5 equal sublots.**

**Table D does not apply.**

Example: 2240÷5= 448 tons. That means **5 equal sublots of 448 tons.**

X value from PTM 1 is multiplied by **448 to find the sampling tonnage.**

**RULE #3**

**IF project quantity of ANY JMF is 500 tons or less (≤ 500)**

**Then divide by 3 to determine 3 equal sub-lots for core locations only.**

**Material acceptance for Lots of 500 ton or less is by certification. Cores are an option.**

**Table D does not apply.**

Example: 475÷3 = 158.3. That means **3 equal sublots of 158.3 tons.**

X value of PTM 1 is multiplied by **158.3 to find the sampling tonnage.**

N
E
C
E
P
T

# Asphalt Pavement Construction Program

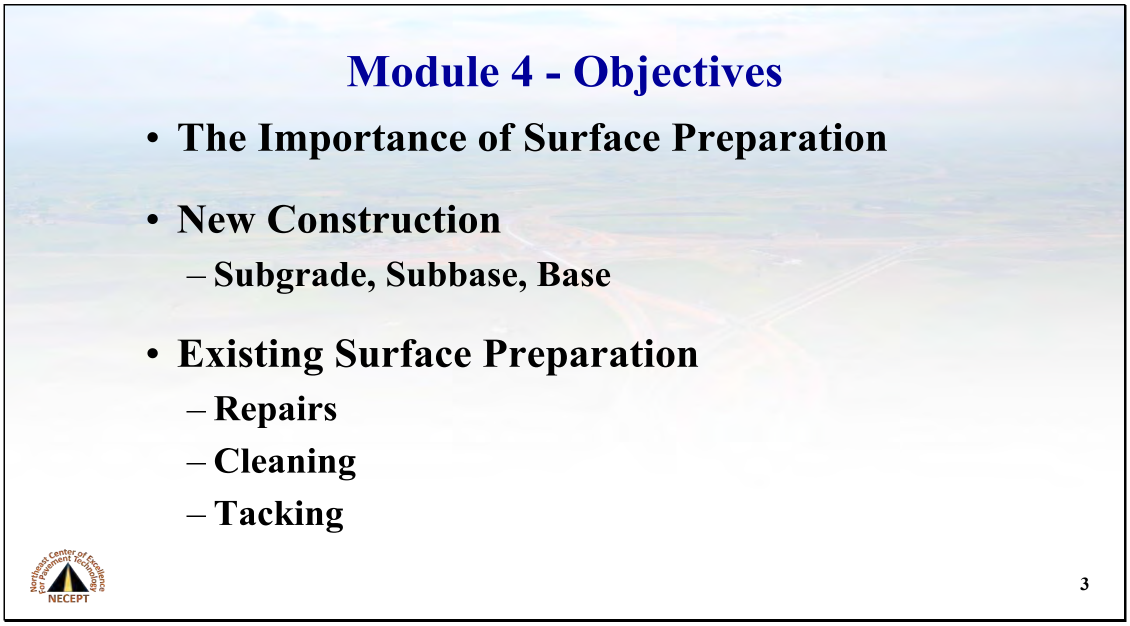
Certified Asphalt Field Technician
Course of 2025

# Module 4: Surface Preparation

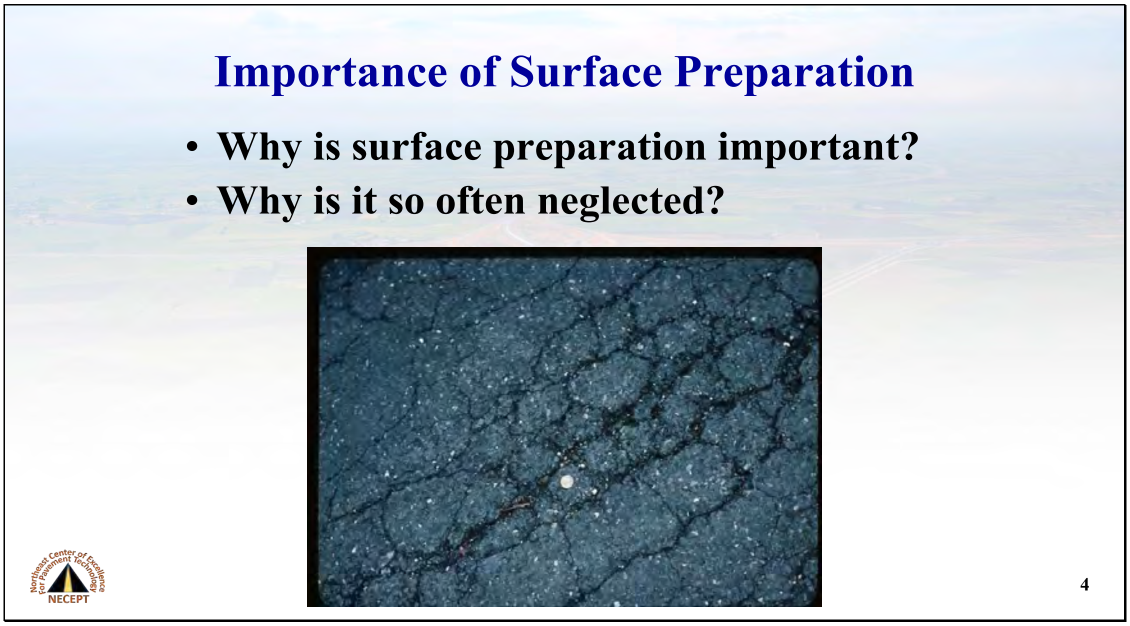
Northeast Center of Excellence for Pavement Technology
NECEPT


The preparation of the surface that will receive a new asphalt pavement is an important element in the overall construction project. Even the best asphalt placed on a poorly prepared foundation is susceptible to premature failure.

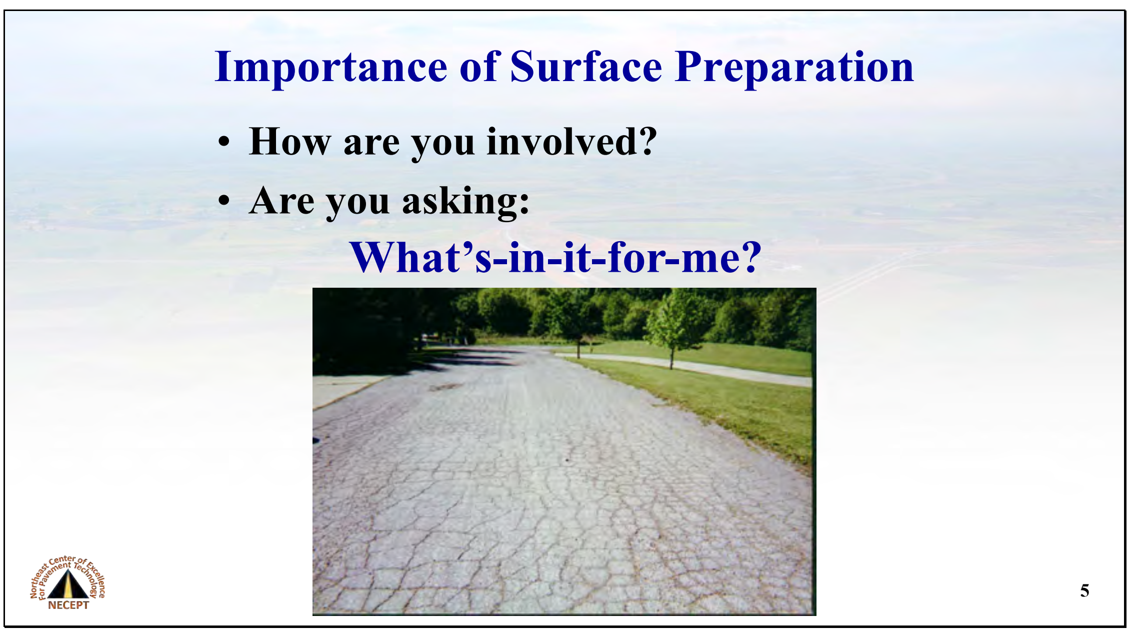

The surface can be subgrade, aggregate base, existing asphalt pavement or existing cement concrete pavement. The surface can also be prepared using full depth reclamation (FDR). Materials for FDR may include Portland Cement, Hydrated Lime, Fly Ash, Pozzolans, Calcium Chloride, Magnesium Chloride, and RAP from other roads mixed with existing roadway material.




In this module, we will discuss the importance of surface preparation and then look at the steps involved in preparing base or sub-base for new construction and the steps involved in preparing existing pavements for asphalt overlays. Topics will include materials and techniques for crack sealing, patching, milling, scratch/leveling courses and tack coat applications.



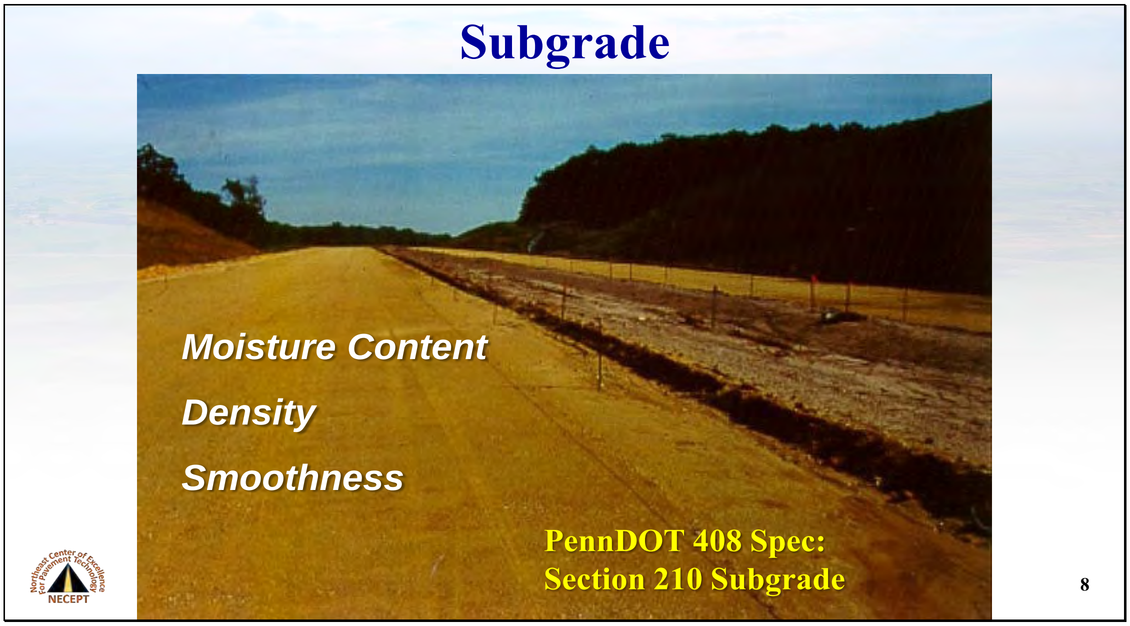

The performance of any pavement under traffic is directly related to the condition of the existing surface. If the condition of this surface is poor, the ultimate life of the roadway may be significantly reduced. Surface preparation rarely gets the attention it needs and no one ever sees what you have done, so why bother? Proper preparation is viewed like traffic control, a necessary evil, and it is time consuming to repair pavements. We will cover it with the first lift, BUT---




"What's in it for me?": Proper surface preparation means fewer problems you will have to come back to later and fix, and less time in the hot seat explaining why you didn't fix it when you had the chance.


It is easy to cover up problems with asphalt, but rarely do the problems go away. In fact, many times the entire situation becomes worse and it is always more expensive to fix the second time around. In addition, it often involves change orders because more problems are found by the time the job actually gets started. **Fix it right the first time.**
Remember the old saying "You can pay me now or pay me later." The same motto applies to pavement construction. The building is only as good as its foundation!

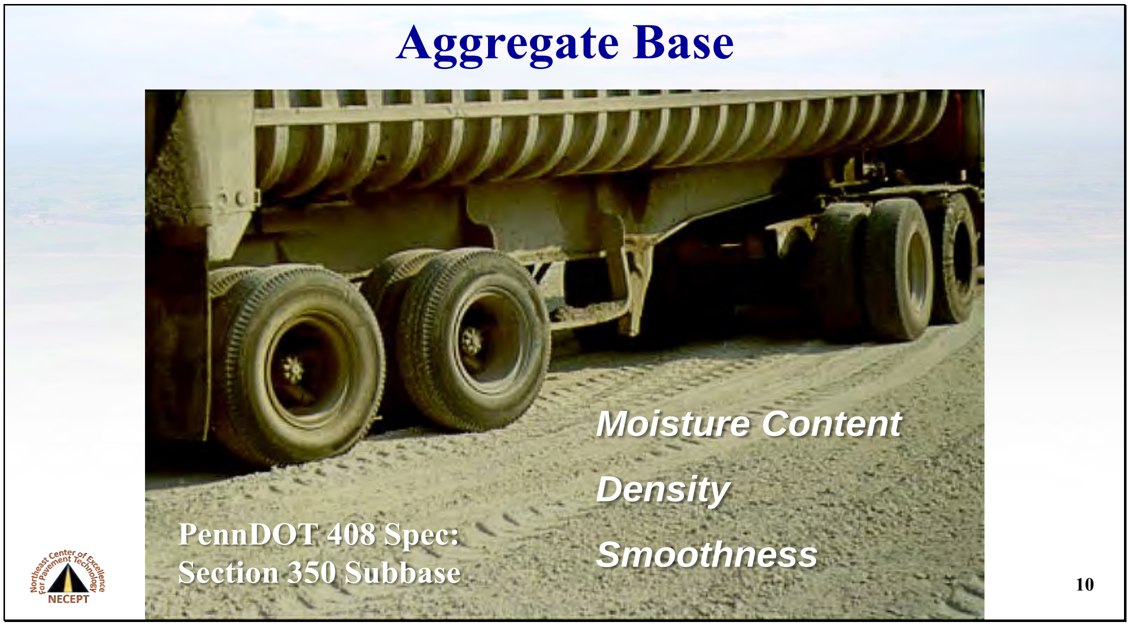

For preparation of a new base, the technician has to be aware of the type of base being prepared to receive the new asphalt pavement. The <u>'new base'</u> can be subgrade soil, an aggregate base, and/or stabilized base.




**Subgrade must meet the Pub 408 Section 210 requirements:**

- Maintain moisture content within **-3% of optimum** during compaction.
- Except for the top 3 feet, compact to **not less than 97%** of the maximum dry density.
- Compact the top 3 feet to **100%** of maximum dry density or non-movement under compaction equipment.
- Smoothness: correct surface irregularities **exceeding 1/2 inch** in a 10-foot length (i.e., as measured by a 10-ft straightedge). Loosen the surface, remove or add material, and compact again.


The subgrade must not distort under traffic or during paving operations. Proof rolling is required.




**An aggregate base course must meet the requirements of Section 350, Subbase**

- **Material:** Type S or better, No. 2A & No. OGS (Open Graded Subbase)
- Use material containing enough moisture to prevent segregation during stockpiling, hauling, and placing.
- **Density:** density based on non-movement of material under compaction equipment (See Section 206.3(b)).
- **Smoothness :** correct surface irregularities exceeding 1/2 inch in 10 feet length (i.e., when measured with a 10-ft straight edge).


The proper equipment and materials must be available to repair any problems discovered during proof-rolling. Repair subbase if disturbed by traffic before paving. The pavement structure needs every inch of stone to be in place. To correct low areas in the subbase, the existing surface must be scarified to a depth of three inches to assist the incorporation of the new material into the previously placed layer—AVOID SEGREGATION.

Many of the Marcellus related roadway construction projects involve full depth reclamation (FDR), which is the addition of cement to the pulverized existing materials, and the roadway profile must be correct prior to the entrainment/ hardening process.

## Segregation Problems

- Longitudinal joint
- End of load
- Checkerboard or spot segregation
- “Low” areas that are improperly repaired

NECEPT 12

Longitudinal joints need to be trimmed. Spreading devices need uniform supply/flow of material. Material loaded from different faces of a stockpile can exhibit greater range of aggregate sizes and filling low spots with thin (< 3 inches) of material can create open areas capable of retaining water **Ref: 408 section 350.**

## Compaction of Subbase

NECEPT 13

Density must be achieved on the subbase prior to placing the Asphalt Base Course. Density is accepted by non-movement of the material under the compaction equipment with no rutting, displacement or shear wave under the roller leaving a stable condition.

## Asphalt Bases

**PennDOT 408 Specifications:**

- Section 313 Superpave Asphalt Mixture Design, Standard Construction, Base Course
- Section 314 Superpave Rich Base Asphalt
- Section 360 Asphalt Treated Permeable Base Course

NECEPT

14

These topics are covered in depth in Module 2, Specifications.

## Existing Pavement Preparation

Preparing an existing pavement for an overlay may be as simple as milling the paving notches, sweeping the surface and spraying a tack coat...


NECEPT

15

Existing surface preparation may sometimes seem simple, but careful examination is necessary to avoid early and expensive failures.

## Existing Pavement Preparation

**… or it may involve a myriad of other procedures:**

- crack sealing
- patching
- leveling
- milling
- drainage repairs

NECEPT

16

It is the technician's responsibility, however, to see that all deteriorated areas or unsuitable material is repaired or removed prior to the overlay work. Conditions can change from the time of the contract to the actual start of the construction project.

## Prep Work

Pavement preparation may involve replacing someone else's handwork.

NECEPT

17


Pavement repair techniques must match the repair technique to the existing conditions by utilizing the proper materials and procedures to achieve long term performance. If the pavement failure is load related, the pavement material must be removed and replaced all the way down to sound material.

## Marking

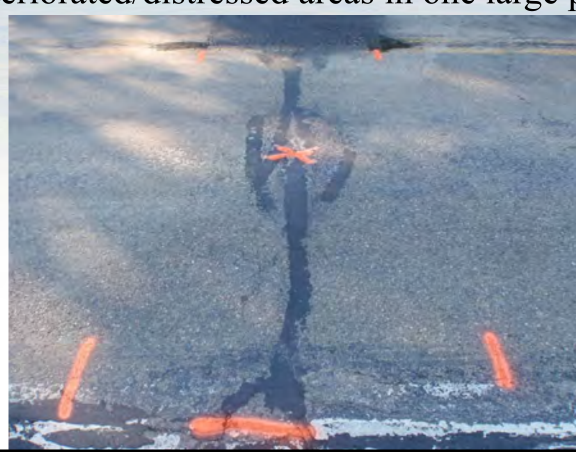
- Identifies the failed area
- Affects cutting costs, materials & crew hours
- Insufficient cutting means poor repair

20

The first step is marking the outline for the repair. The failed area should be cut back **at least 6 to 8 inches** into sound pavement. Marking doesn't have to mean squares or rectangles. We can follow the contour of the distressed area, but acute angles should be avoided.

## Marking

- We may include several adjacent potholes or deteriorated/distressed areas in one large patch.



21

## What Is Wrong?

*Keep joints out of wheel path!*

**Will these corners last during rolling?**

22

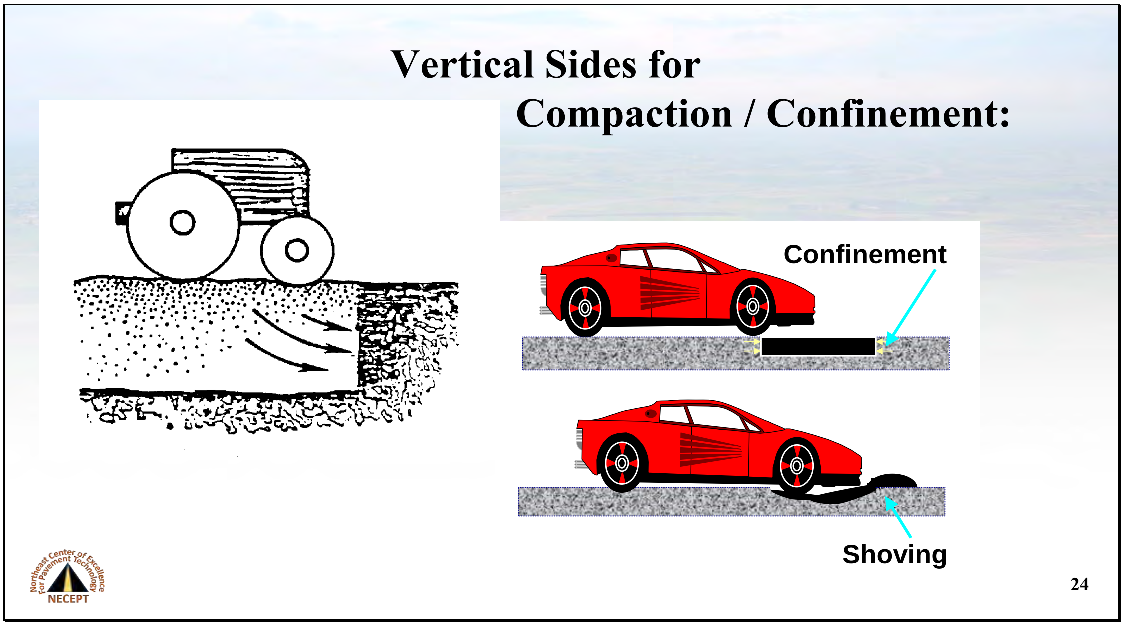
This patch would have been easier to repair if the edges were straight. The left edge is ok, since it follows the edge of a lane. The right edge, however, is not only NOT STRAIGHT, but much of it falls within a wheel path. It will be more difficult to compact the materials in these corners.

## Cutting

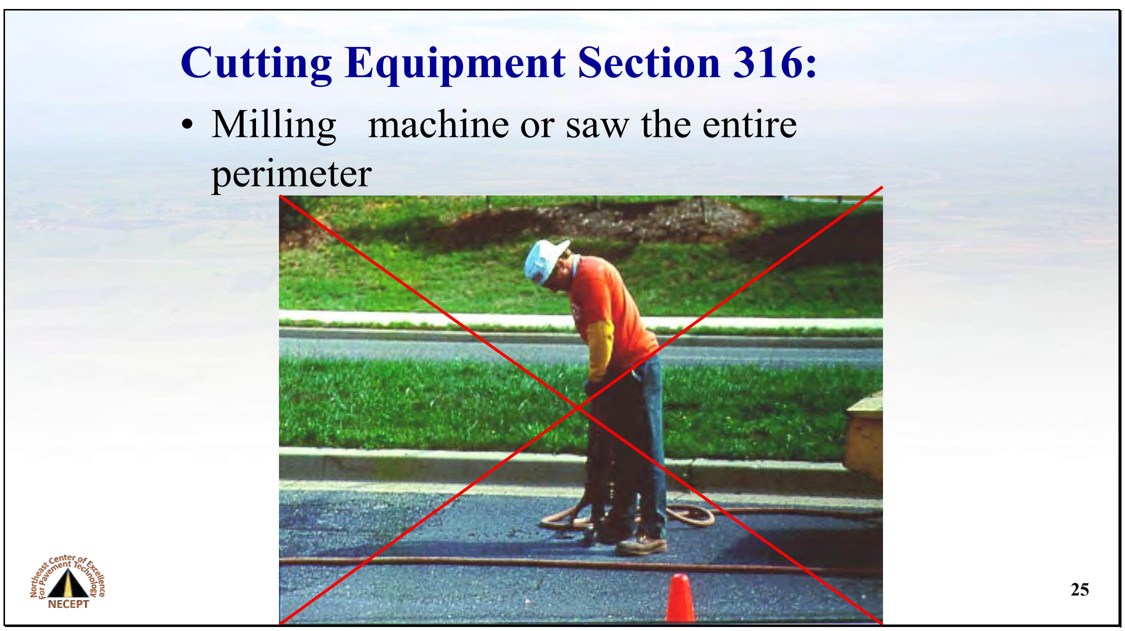
- Remove all weak, deteriorated area
- Cut…. "vertical sides"
- Section 316 : saw or mill the perimeter

23

The next step is to cut the patch, removing all deteriorated material. Cut edges should be as vertically as possible. Why? Does a milling machine create vertical edges?



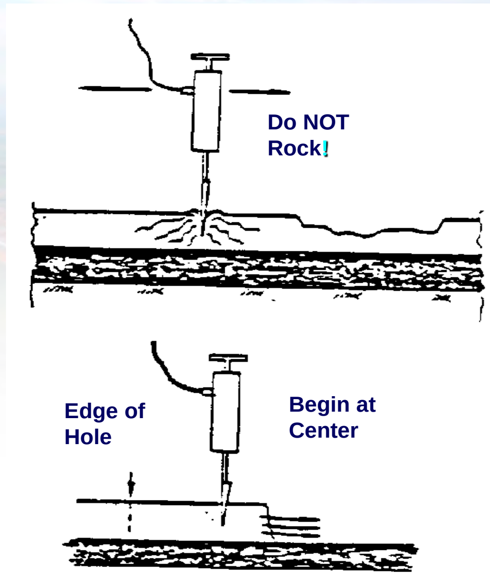

To attain required density, the material must be confined with vertical edges. In a bowl-shaped pothole, traffic loads will shove the patch material.




The type of cutting equipment used will depend on the type and size of the repair. Backhoe or Gradall operators should NOT lift pavement that will remain in place!

Cutting IF jackhammer is allowed:

- Leave firm material around repair
- Do not outline area with cutting tool, begin at center of hole

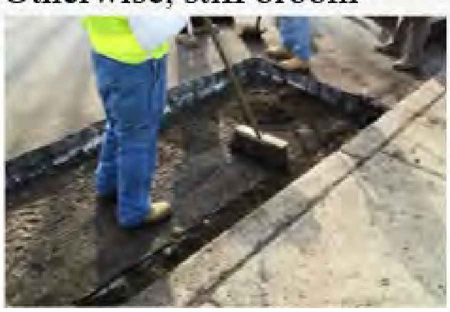


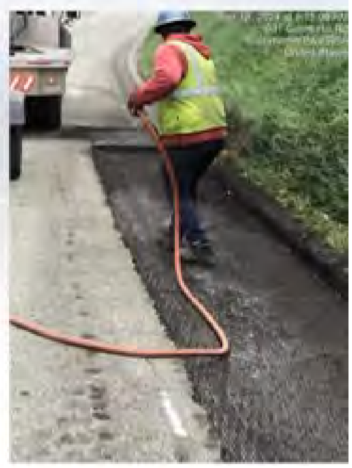

26

When cutting with a jack hammer, don't rock the hammer, and always start at the center of the hole. This technique will do less damage to the remaining asphalt edge leaving firm material to patch against.

## Cleaning

- remove loose material
- remove water
- pay attention to corners and vertical edges
- use air if available and safe to use (silica)
- Otherwise, stiff broom



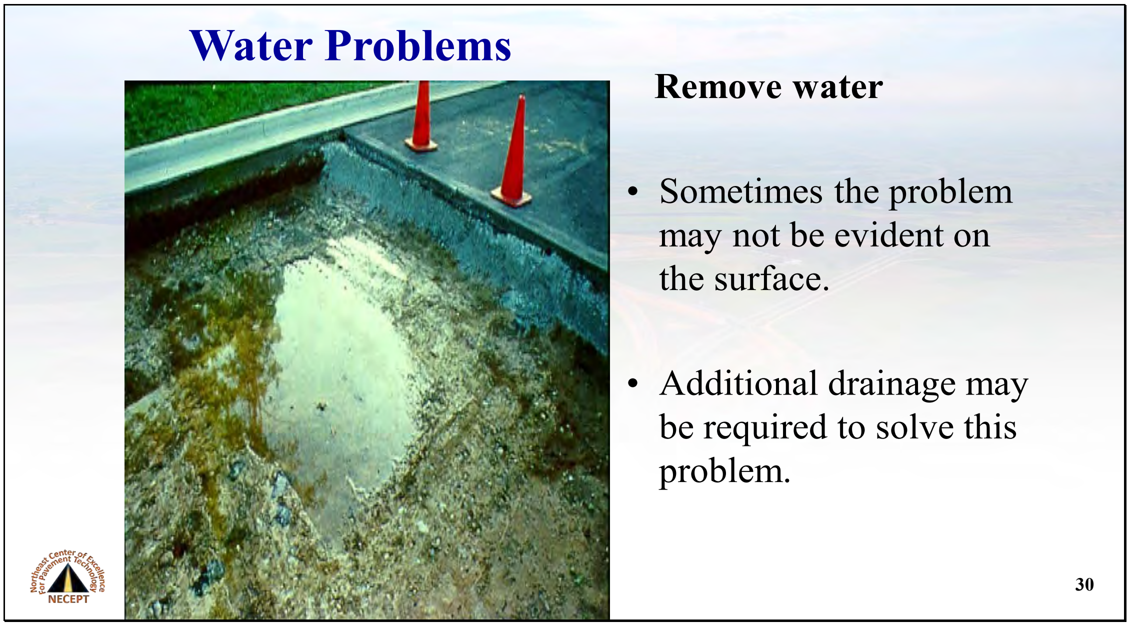


27

Base repairs that are deeper than the pavement structure are bathtubs!



Remove the failed pavement. You need to remove as much material as necessary to find the problem, and then fix it.




**Problem Identified** - Water seepage into excavated patch. Sometimes, the source of the problem may not be evident on the surface and additional drainage is required to solve the problem. What about repairing wheel ruts and leaving long narrow areas at edge of pave?


Note the water seeping out of the terribly failed base repair that was previously made to this roadway. The repair failed because it was not deep enough (did not get down to sound material) and drainage was not addressed as can be seen from water flowing out of the roadway at the low end of the failed patch.

## Backfilling

- Replace with good material similar to the original material.
- Deteriorated aggregate base or subbase material plus subgrade soils may need to be replaced.

32

New subgrade material, granular base material, stabilized base course layers, and asphalt mix should be placed and compacted in order to bring the strength of the pavement structure in the failed area to the same level as the surrounding good pavement layers.

## Compact Each Layer

33

Compaction is crucial. The patches become a permanent part of the pavement. Each layer must be as strong as the surrounding material or problems may come up later.

## Quality Control

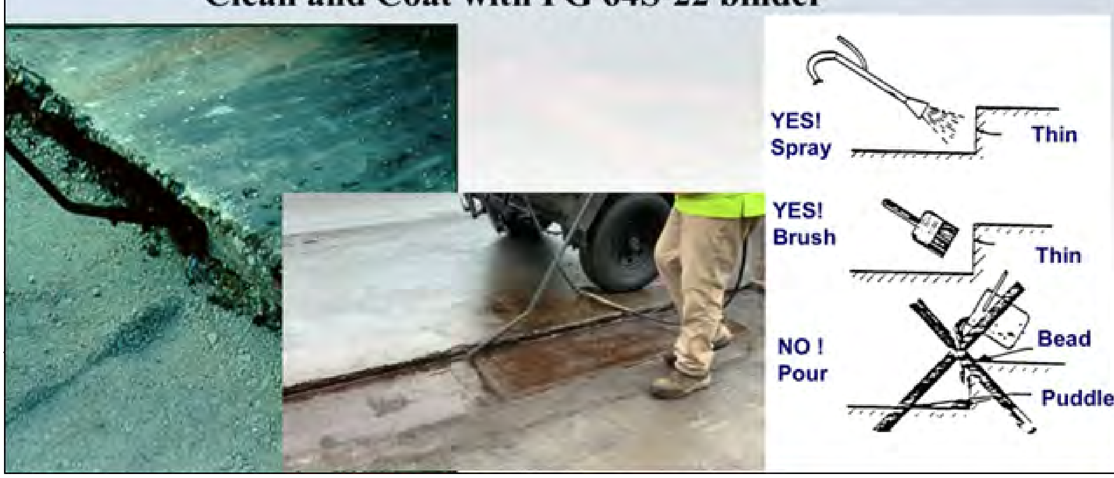
- Density Testing for quality control may be required.
- Moisture content of aggregate material is critical
- Just dumping water on the top is ineffective, the entire lift MUST have the proper moisture content.

34

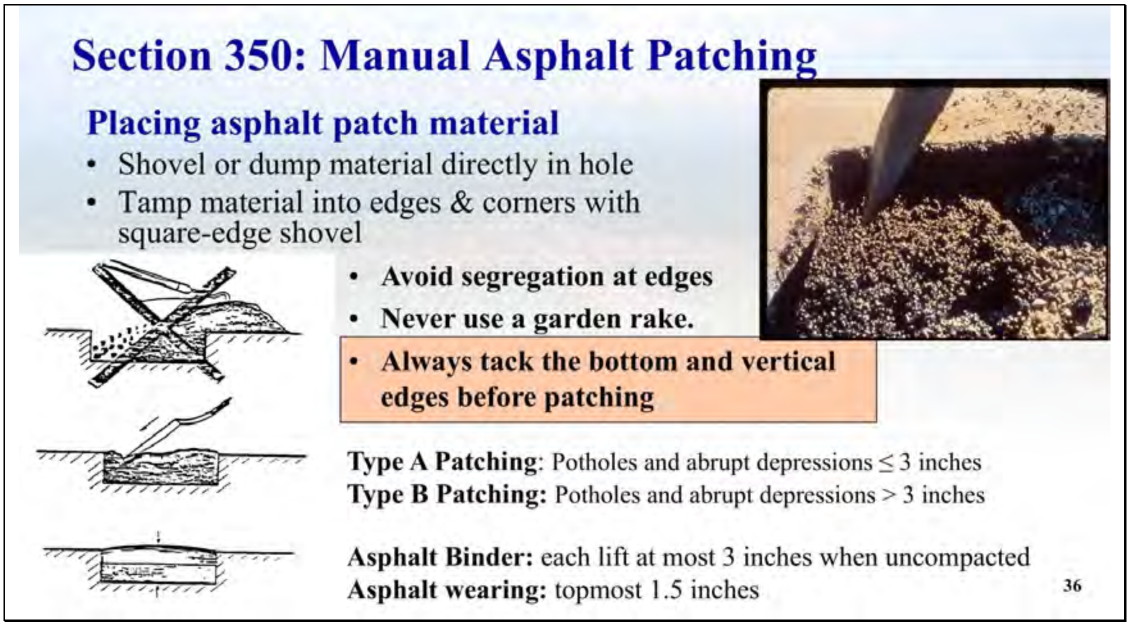
## Section 316: Flexible Base Replacement

**Vertical Edge Preparation:**

**Clean and Coat with PG 64S-22 binder**




Tack coat should be sprayed on the bottom of the patch.




The material should be shoveled or dumped directly into the hole. A square-edge shovel tamps the material into the edges and corners. Do not rake the material into the hole. Raking should be performed with a lute, not a garden rake, to minimize segregation.


If the patch is large, a paver should be used to place the asphalt. This will allow for better compaction and a more level surface for rideability. Always monitor the condition of the protruding corners as work progresses.

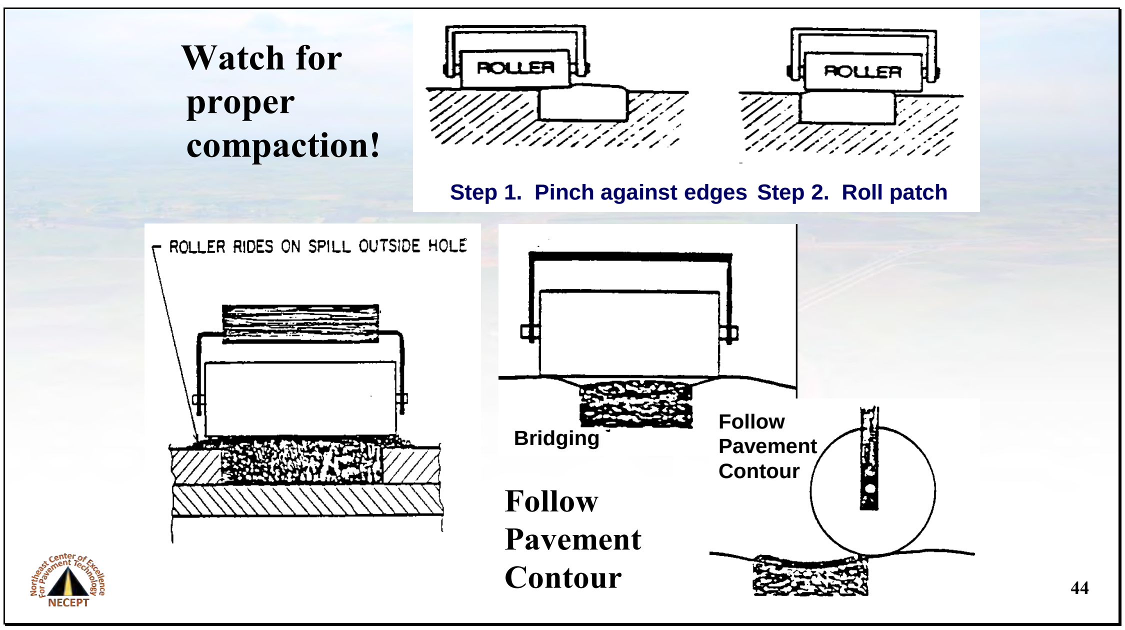

Compaction is crucial, regardless of the size of the patch. Pay special attention to all vertical edges.


There is various compaction equipment available. But the equipment should match the job! Hand compaction is often necessary in tight corners and hard-to-reach areas, which need the same attention as the larger, machine compacted areas.


Note: Drum roller was used for main area, this operator is ensuring good edge compaction.


Compact edges and ends first to confine material.


Deep asphalt patches require the first layer to cool before the 2nd  lift is placed.


The edges of the patch should be pinched first and then the patch should be rolled. Depending on the type of compactor, watch the spillage of patch material around the hole. If the compactor rides on this material, the material in the hole is not being compacted. Drum compactors may need to follow the contours of the road surface for proper compaction.  This will generally occur in wheel rutted areas.

## A Properly Constructed Permanent Utility Cut

NECEPT

45

Properly constructed patches will perform well, regardless of whether the patch is part of pavement preparation prior to an overlay.
Pre-construction meeting item: Utility repair coordination

## Asphalt Spray Injection Patching

One of the popular method of pothole repair

- Cleans, tacks, fills and compacts with a one-person operation
- Eliminate 'cold patch'
- Year-round emergency adverse weather patching
- Improved productivity and safety
- Used for both asphalt and cement  concrete pavements

NECEPT

46


This method can be conducted using different equipment options, such as self-contained spray patching vehicles, trailer-mounted models and truck-mounted units that can be retrofitted to a pre-existing vehicle.


One reason for the increasing popularity of spray patching is the simple, four-step process involved with this repair.

**Step 1:** Clean the pothole with a high-powered blower incorporated into the same nozzle that will apply the filling materials later in the process. This blower cleans the pothole of all loose rock, debris, dust and moisture. The cleaning step ensures that the tack coat and pothole filling materials that follow will effectively bond to the existing pavement surface. Depending upon the size of the pothole, this step typically takes 10 to 20 seconds.


**Step 2:** Using the same nozzle positioned over the pothole, hot emulsion (typically cationic rapid setting) is applied to the entire pothole and the surrounding area. The tack coat provides the bond between the aggregate filler and the pavement surface. If the tack coat is not sufficient, the repair will not be successful. Again, depending on the size of the pothole, this step takes roughly 20 to 30 seconds.

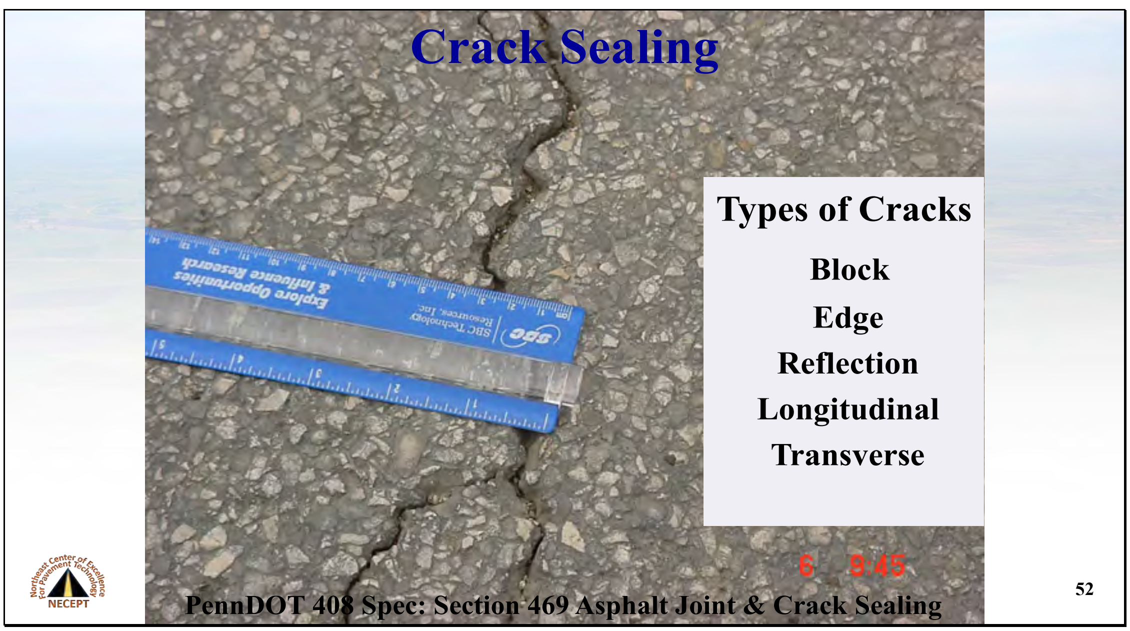
**Fill with aggregate /emulsion mix**

**(No compaction needed)**

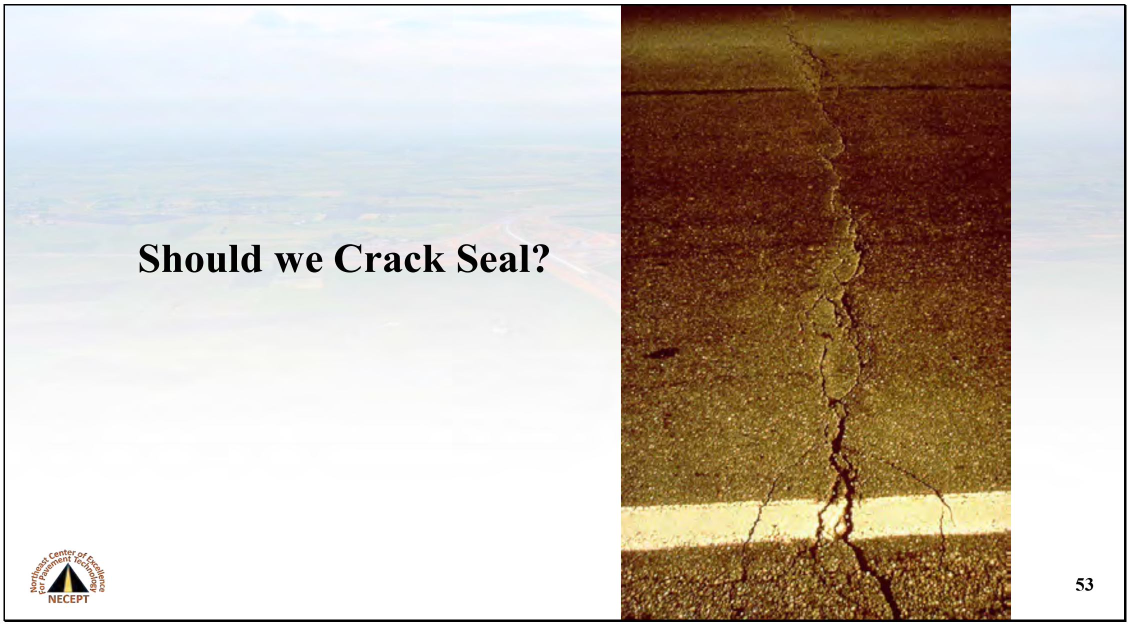
50

**Step 3:** Fill the pothole. After visible saturation of the applied tack emulsion, aggregate is added to the hot emulsion. Most operations use 0.25-inch or 0.375-inch granite or limestone aggregate. The material is blown into the hole with enough force that further compaction is not required. Material should be applied to fill the entire pothole to a point where it is level with the surrounding pavement surface. This step takes roughly 15 to 30 seconds, depending on the size of the patch.


**Step 4:** Protect the patch by applying dry aggregate on top of the patch. Dry aggregate should be applied until the dark asphalt emulsion is barely visible. This helps prevent the oncoming traffic's tires from adhering to the emulsion and tearing up the repair. This is the quickest step in the process taking roughly five to 10 seconds.




Cracks in the existing pavement surface need to be sealed. This is an average size crack, a candidate for sealing. Cracks must be cleaned and prepared properly prior to sealing. Cracking is defined by different types, and all of these can be sealed. (Notice that alligator cracking is not listed).




This was once a single crack and should have been sealed at that time. Further cracking has now developed, radiating out from the original crack. Notice the cupping of the pavement as the area further deteriorates. This condition requires a repair patch, it is beyond crack sealing.


This crack is too large to be sealed and needs to be treated as a patch repair. Generally, cracks greater than 1” will need to be filled with an asphalt mix (or cut out and treated as a patch).

## *Alligator/Fatigue Cracking*

**Recommended Treatment: Base Repair**

**DO NOT CRACK SEAL!**

**This is NOT crack sealing!**

55

This is not a candidate for crack sealing. A base repair is needed.

If we were overlaying this road, what should be done, if anything, in preparation for the overlay?

## Crack Sealing?

56

## Crack Sealing Program Materials

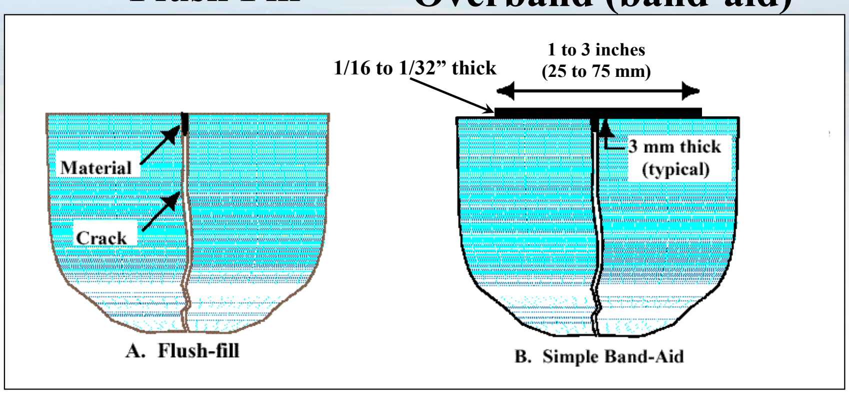
- Hot asphalt & rubber: Prepackaged materials
- Do <u>not</u> field mix.
- PennDOT 408 **Sec. 469**: Asphalt Joint & Crack Sealing
- Manufacturers should be listed in Bulletin 15
- For cracks **1/4” to 1” wide**, use
  - Rubberized Joint Sealing Material: ASTM D6690-Type I
  - Asphalt Rubber Sealing Compound: ASTM D5078

NECEPT 57

Much research and experience in crack sealing has led to the use of hot asphalt and rubber crack sealants as the most cost effective and longest lasting materials. There are various manufacturers that have good prepackaged materials available.

## Configurations

- **Flush Fill**
- **Overband (band-aid)**

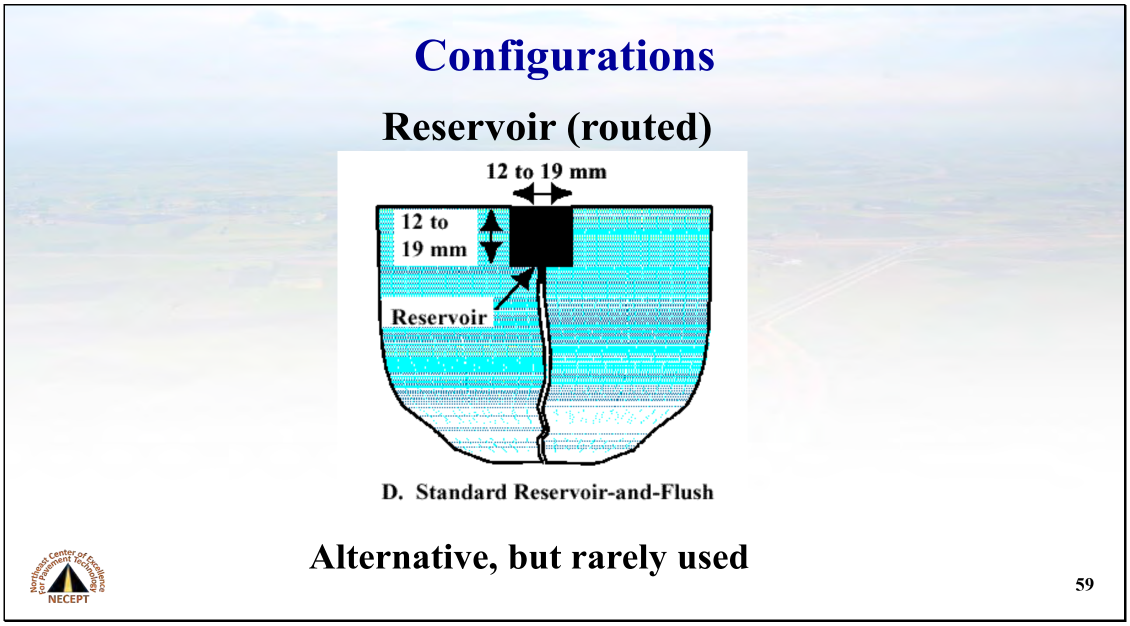



**Which do you find was used prior to overlay?**

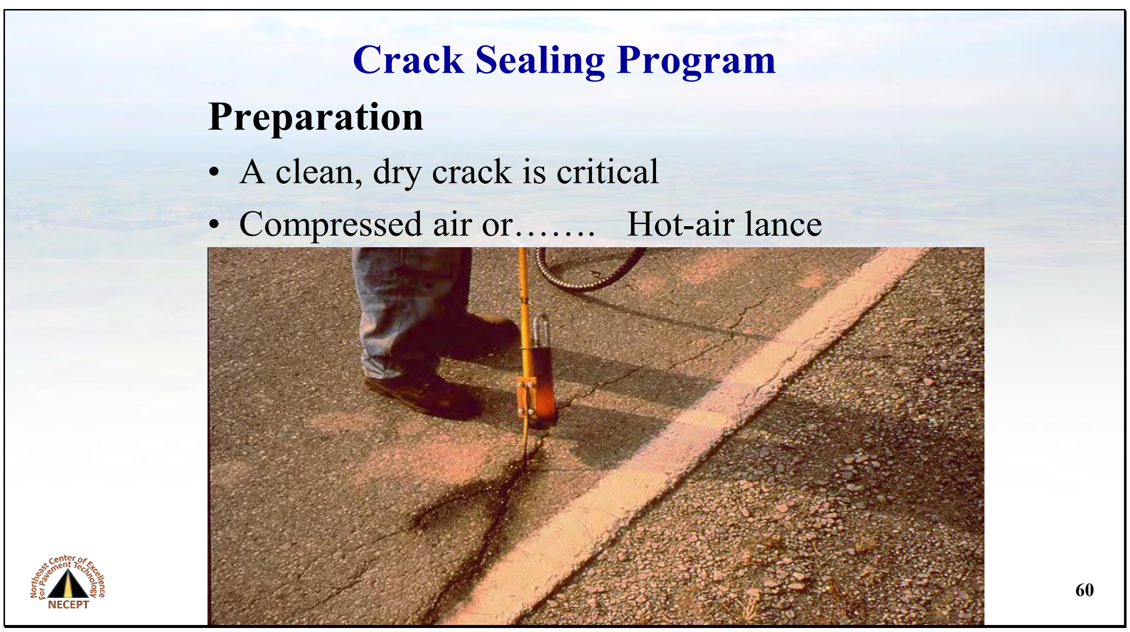
NECEPT 58

The proper configuration will depend on what is being done and when. If we are preparing for an overlay, a flush fill configuration is all that we need.
If there is going to be an extended period of time until further surface work will take place, an overband or band-aid configuration may be more effective.

Pub 408 Section 469 requires a 1” to 3” wide film.




For narrow cracks, routing can provide the needed reservoir for enough sealant to keep the crack sealed.




A 100-psi air compressor is used to clean the cracks or supply the HCA lance.
A Hot Compressed Air Lance (HCA) should be used to dry damp pavement. Used properly, an HCA lance helps the sealant adhere to the pavement crack. Care must be taken not to damage the asphalt surface.

## Crack Sealing Program

- Temperature of sealant is critical.
- Follow manufacturer's recommendations.


- **Two important temperatures**
  - Recommended application temperature
  - Safe Heating Temperature (generally 20°-30°F higher than application temp)

NECEPT

Be aware of temperature drops after refilling. Breaks are for AFTER refilling. Overheating can destroy the bonding properties of the material and increases safety hazards as temperatures approach the safe heating temperature.

## Crack Sealing Program

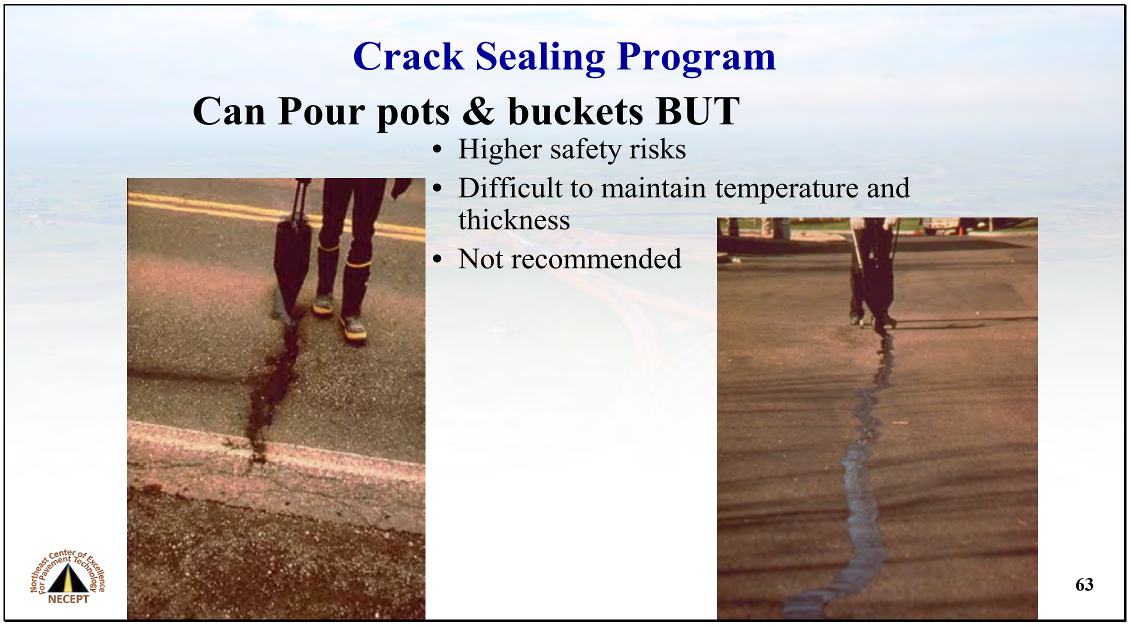
### Sealing

- Air temperature must be above 40°F & below 90°F.
- Wait 24 hours after rainfall.
- Seal Cracks from **1/4" to 1"** wide with **asphalt sealant**
- Seal Cracks **over 1 inch** wide with Asphalt Wearing Course 4.75 mm
- Make sure Material is at proper temperature.

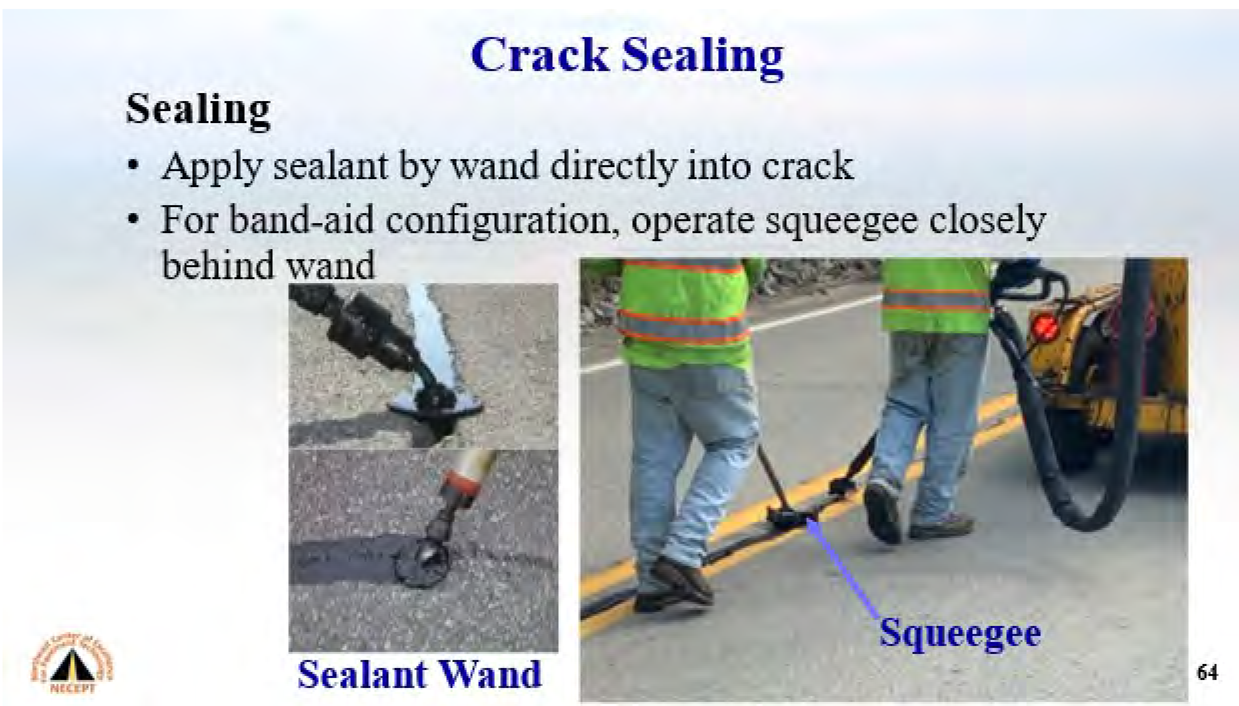
NECEPT

62

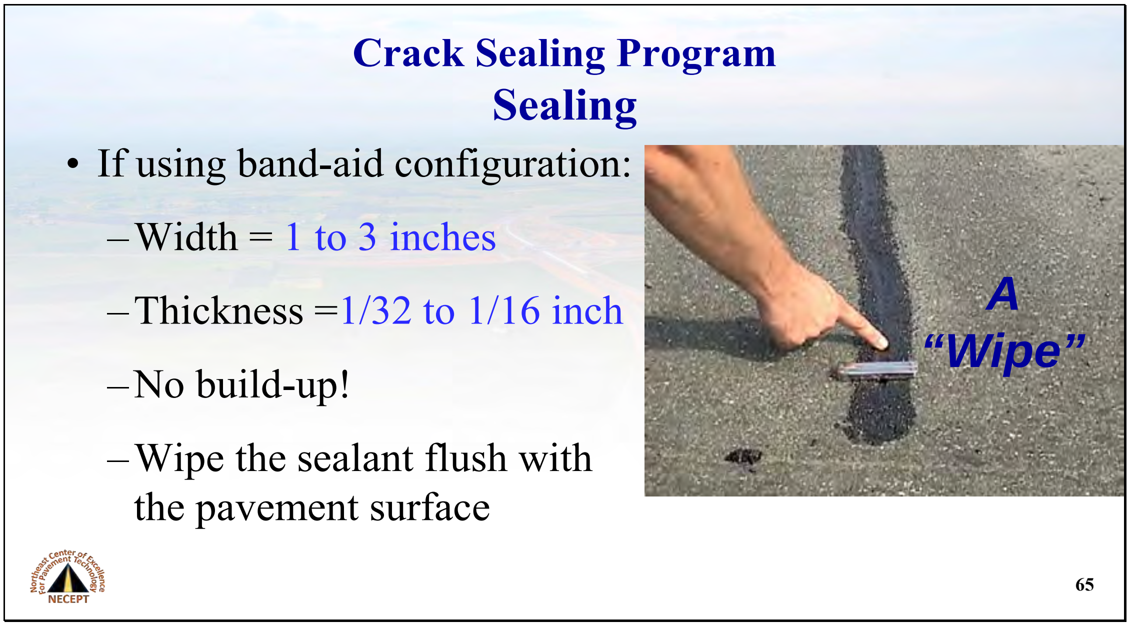
Crack sealing should be performed when the air and surface temperatures are above 40° F and below 90° F. The pavement needs to be dry. The hot air lance can help dry damp pavements. With the material at the proper temperature, all cracks from ¼ inch to 1 inch are sealed.




The use of pour pots and buckets is not recommended.




For overlay preparation, a flush fill configuration is used and a squeegee is usually not needed. If using a squeegee, the sealant is wiped off flush with the pavement surface, to create the overband. The squeegee should be operated immediately behind the wand.




If using a band-aid configuration, a maximum width of 3 inches with no build-up should be the goal to prevent bumps during and after scratch or binder courses!!


**Saw and Seal** means sawing and sealing joints in NEW asphalt pavement to control cracking and can be used on new asphalt pavements and overlays on cement concrete or asphalt pavements.

## Section 515: Saw & Seal for NEW PAVEMENT

- **Should NOT be used on:**
  - Overlays on concrete pavements with high frequency of mid-panel cracks or badly deteriorated cracks
  - Overlays on concrete pavements with badly deteriorated joints or joint patching
  - Overlays on asphalt pavements with meandering transverse cracks
  - Overlays on asphalt pavements with severe load related distress - alligator cracking, potholes, etc.

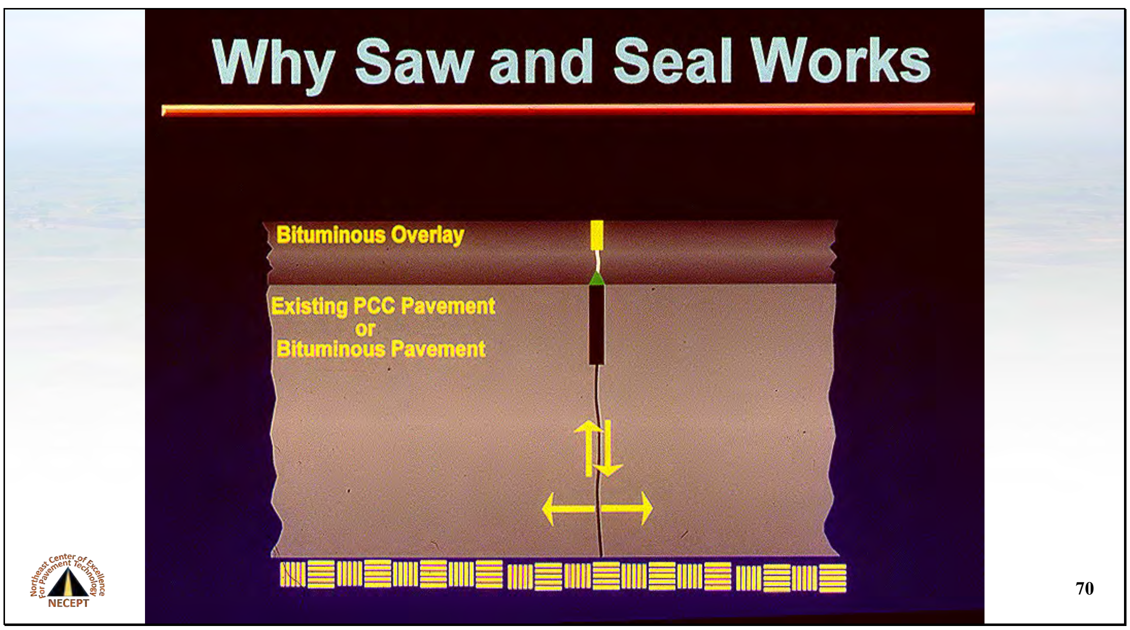
67

## Section 515 Saw and Seal

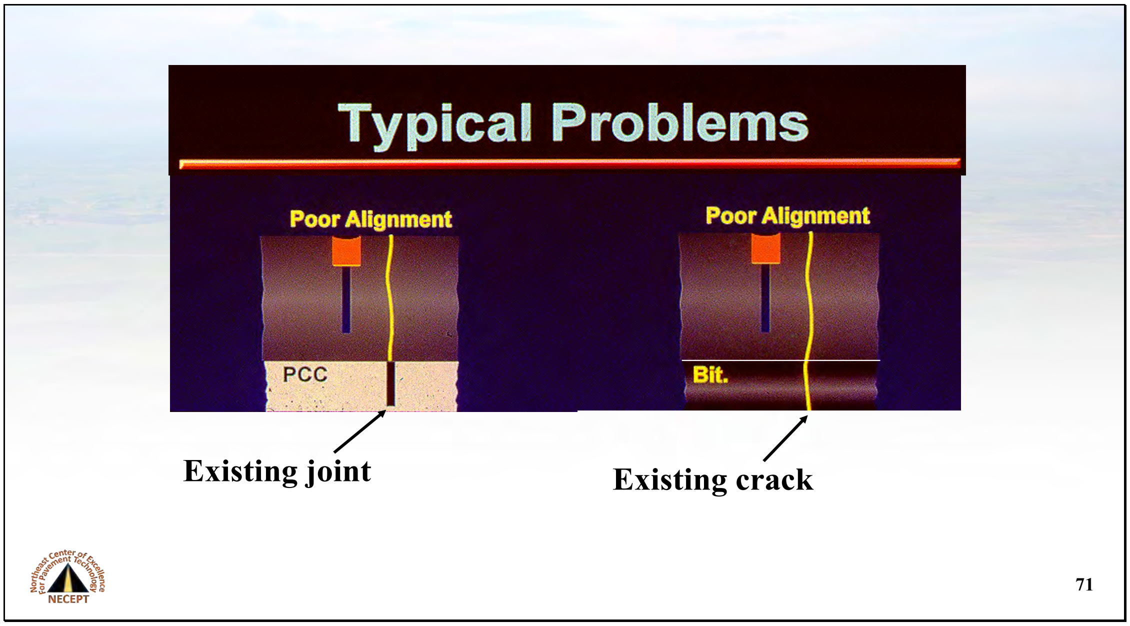
- Performed within 7 days of placement
- Directly above existing transverse joint **±1 inch**
- Overlay Depth vs. Sawing depth
- IF 1 ½ inch depth or less: Use ½ X ½ inch
- IF >1 ½ inch depth : Use 1 X ½ inch
- IF 3 ½ inch depth or greater: Use 1 ½ inch or 1/3 the depth of overlay, whichever is greater.
- Fill to within 1/8 to 1/4 inch below surface

68


Saw and seal can make the difference between having multiple cracks develop or reflective cracking controlled like this!




With saw and seal, we create a weak plane for cracking to occur and we already have it sealed.




Typical problems that develop are usually due to poor alignment of the saw cut over the existing joint or crack.


The joint was not correctly located when laying out for the sawing operation. As a result, the cracks reflected up adjacent to the sawed and sealed location.

Does this saw/seal meet specifications?

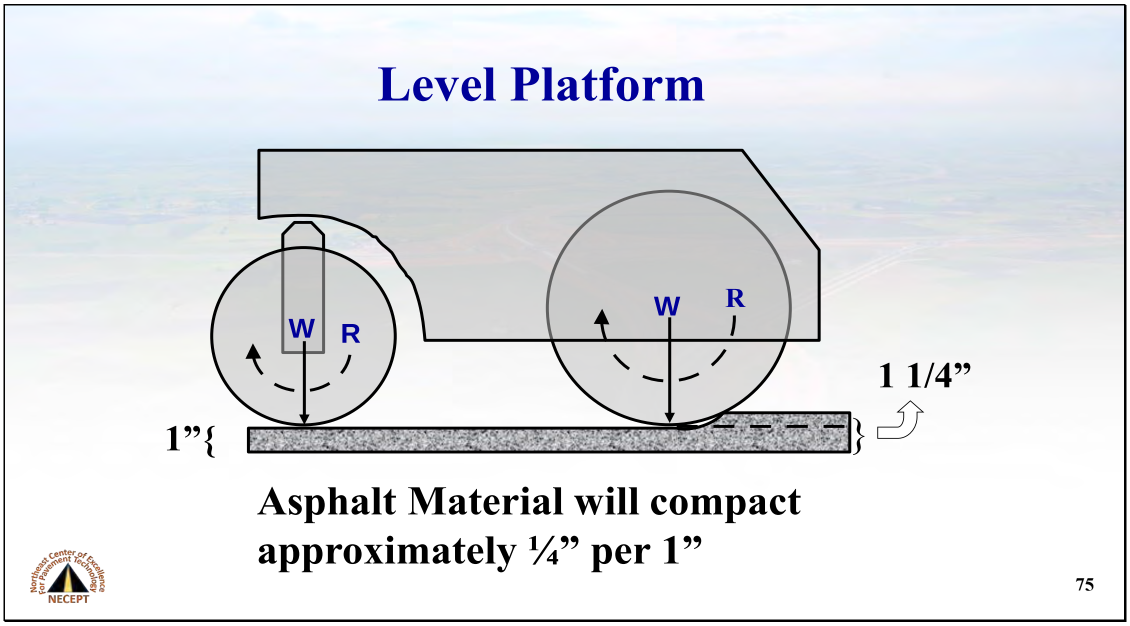
Overlay Sawcut not within 1 inch of original joint


NECEPT

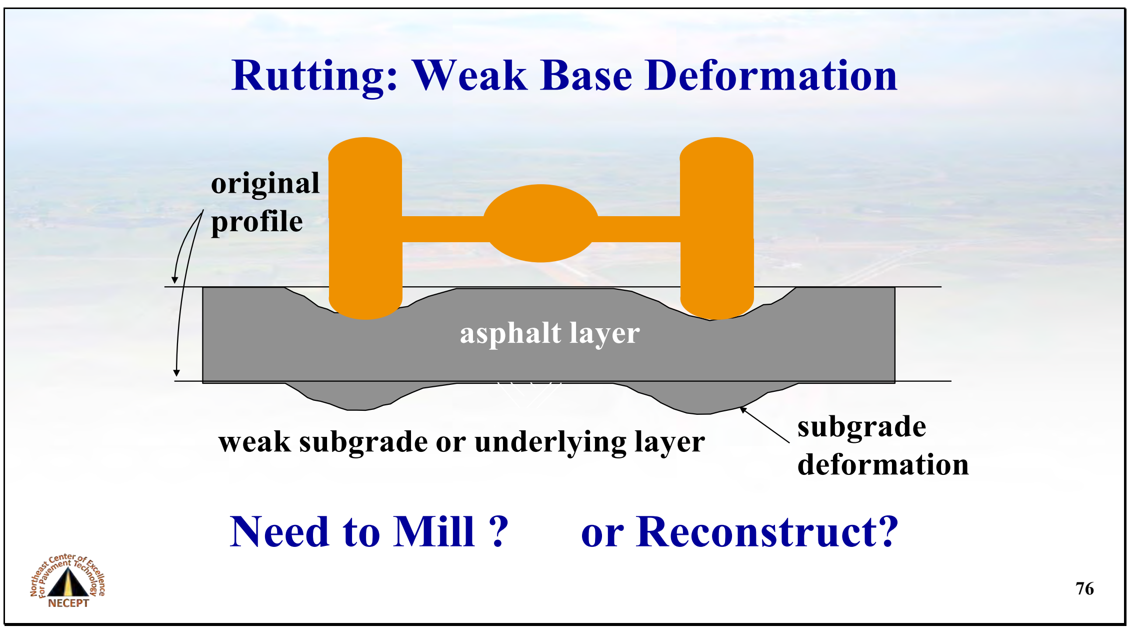
Developing [a uniform, level, and stable platform] ensures placing a consistent thickness on final course and obtaining uniform densities and a long pavement life.

NECEPT

74

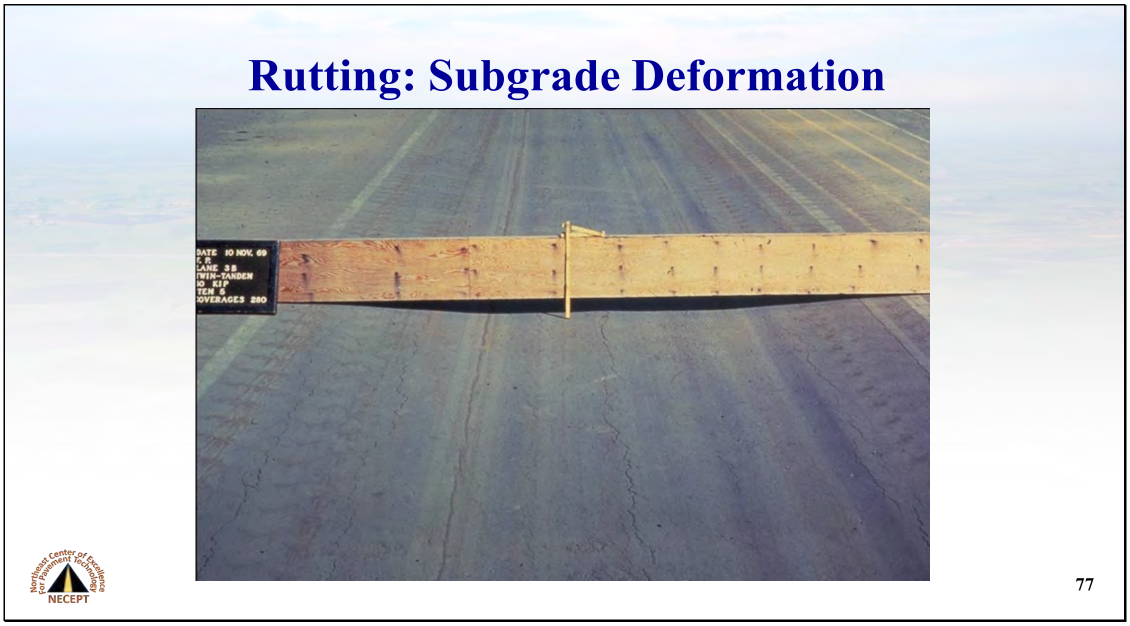



If the thickness of the mat being placed is not uniform the pavement density will vary leading to differential compaction, an uneven surface, and poor ride.

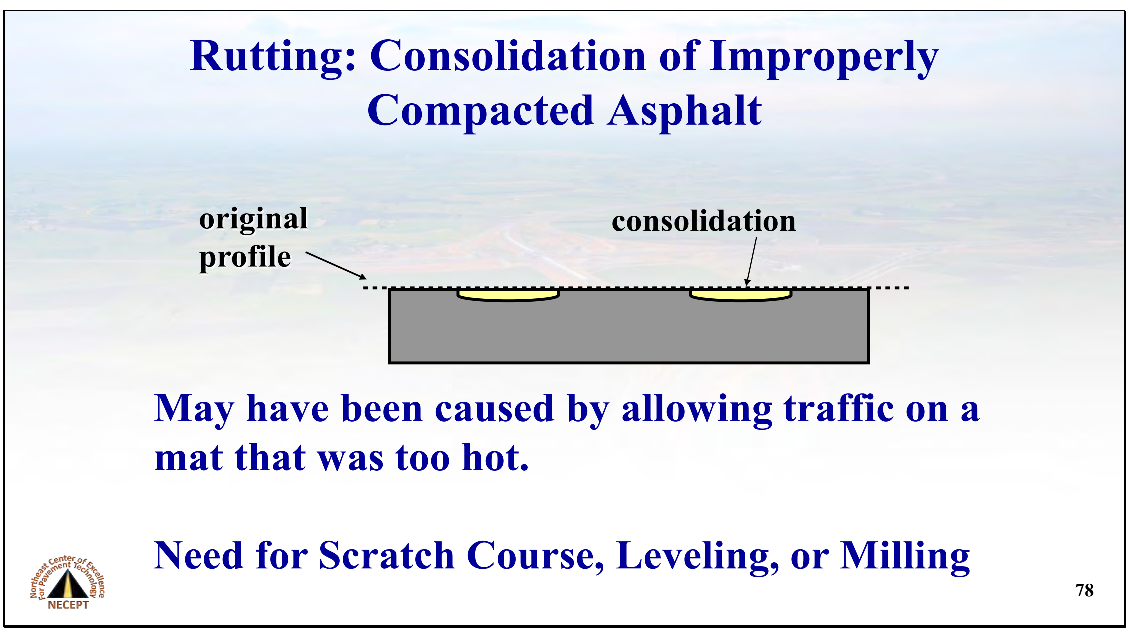



If the pavement is rutted and the ruts fall below the original profile, the weak subgrade or underlying layer has deformed. The foundation is too weak for the loading. This pavement could be milled, however, if you mill you are removing some of the strength of the pavement, and the base is already insufficient to carry the load.

This problem could be corrected by reconstructing the base course and/or using geogrid or geotextile for reinforcement. The subgrade could also be stabilized with lime, fly ash, cement or other pozzolan, or a combination of these materials as per Section 344.

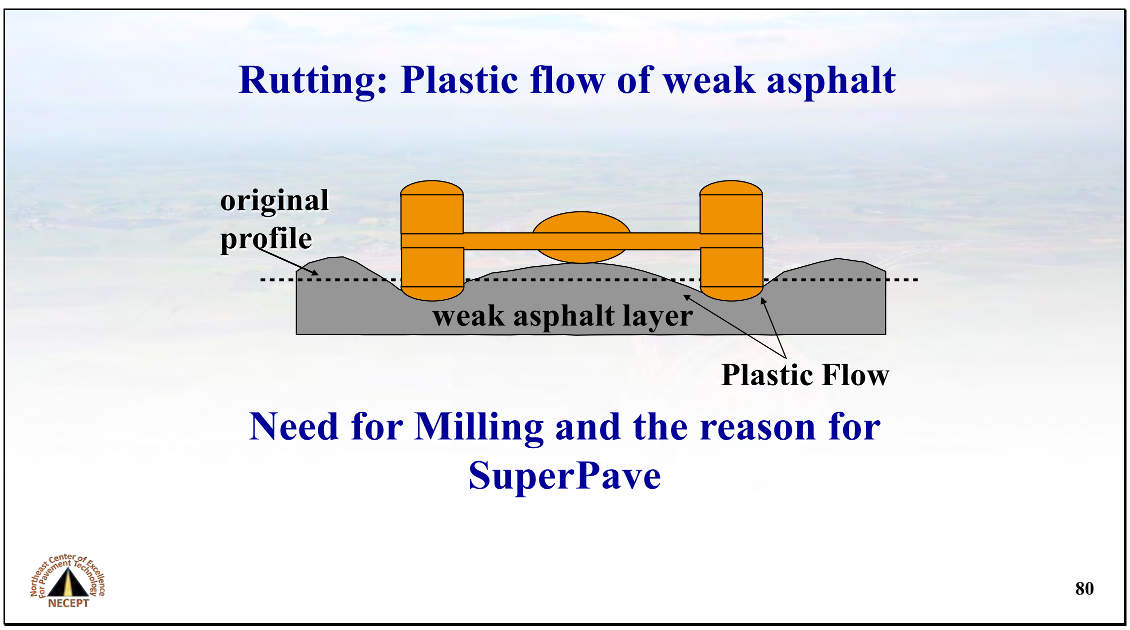



This photo shows rutting due to a weak subgrade which has deformed under traffic loads. If subgrade is the issue, the pavement will show no upward movement on each side of wheel rut.

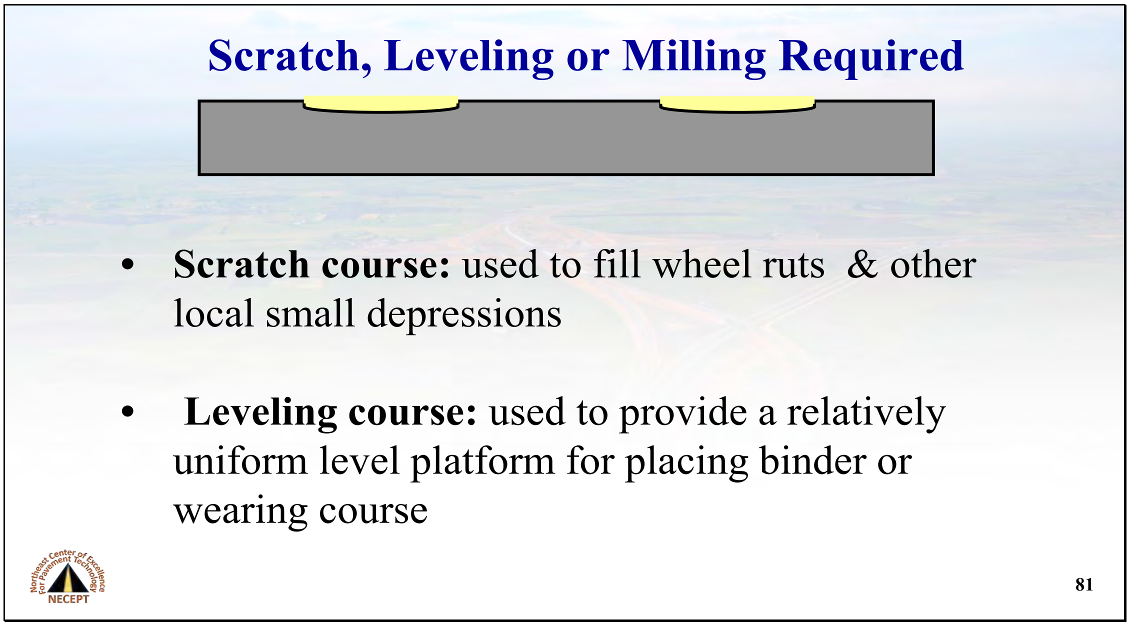



The technician should also know the difference between plastic flow and consolidation. This rutting can be from improper compaction of the mix during placement. Traffic loads then further compact the pavement forming the ruts within the wheel paths with no upward flow of material.

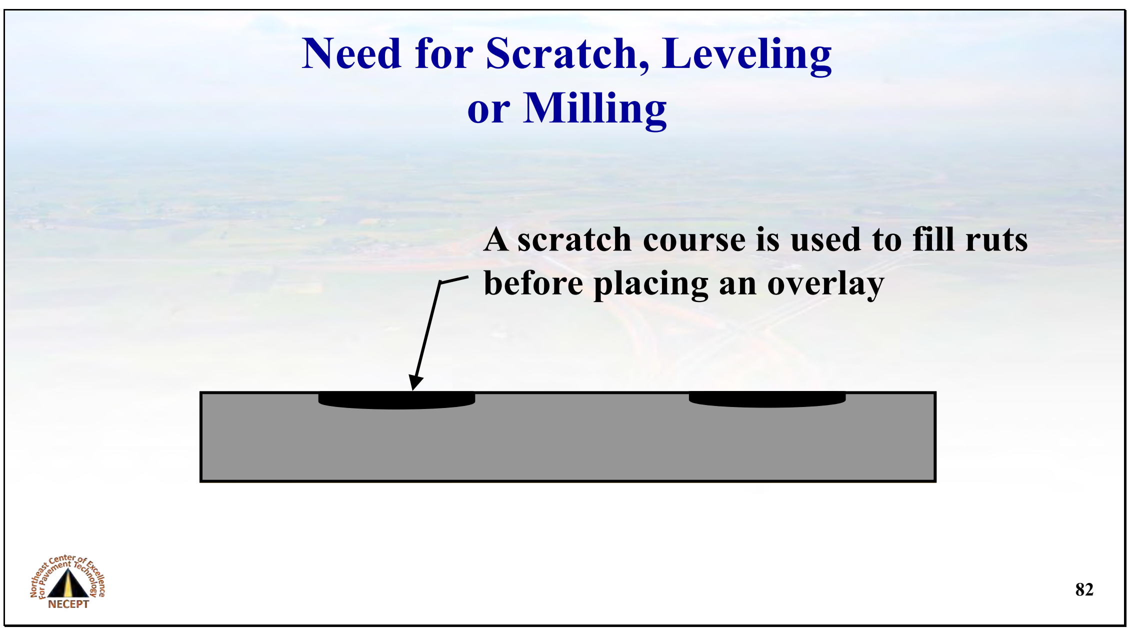

This photo shows consolidation rutting. Notice that the base has not deformed. The rutting is totally in the asphalt layer, and the material between the wheel tracks has been deformed upward.



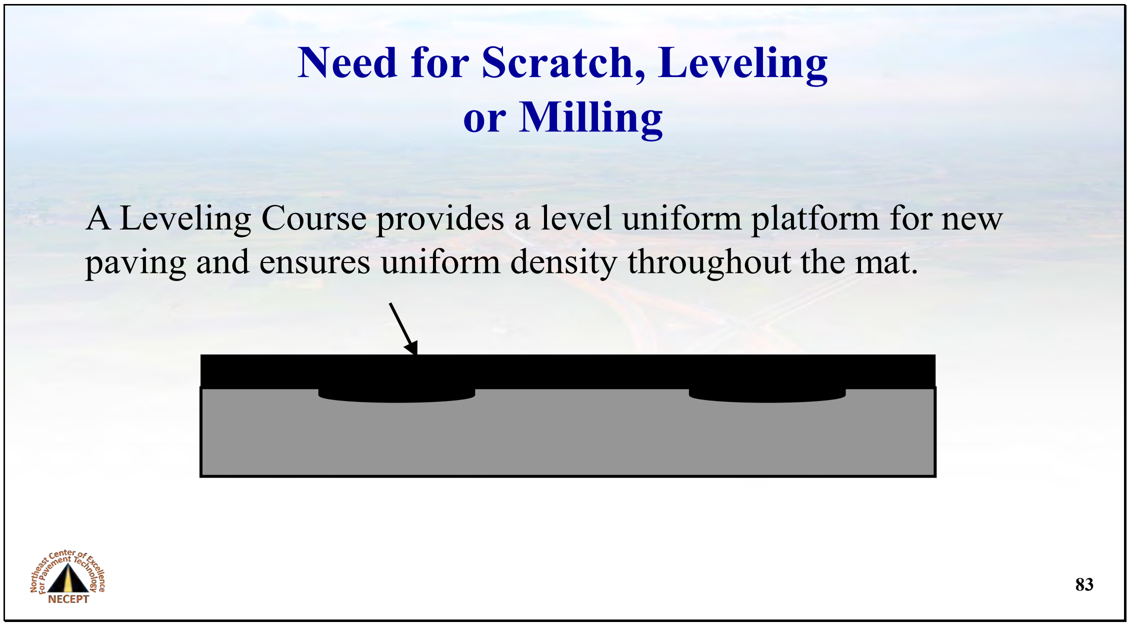

When the mix has too much asphalt, we can get plastic flow. Traffic loads tend to move the asphalt mix out and away from the load contact area forming waves or humps of raised asphalt above the original profile, with the rutting extending below the original profile. If the goal is to eliminate rutting, it is important to remove the plastic flow material. This usually is accomplished by milling to remove the entire affected layer.



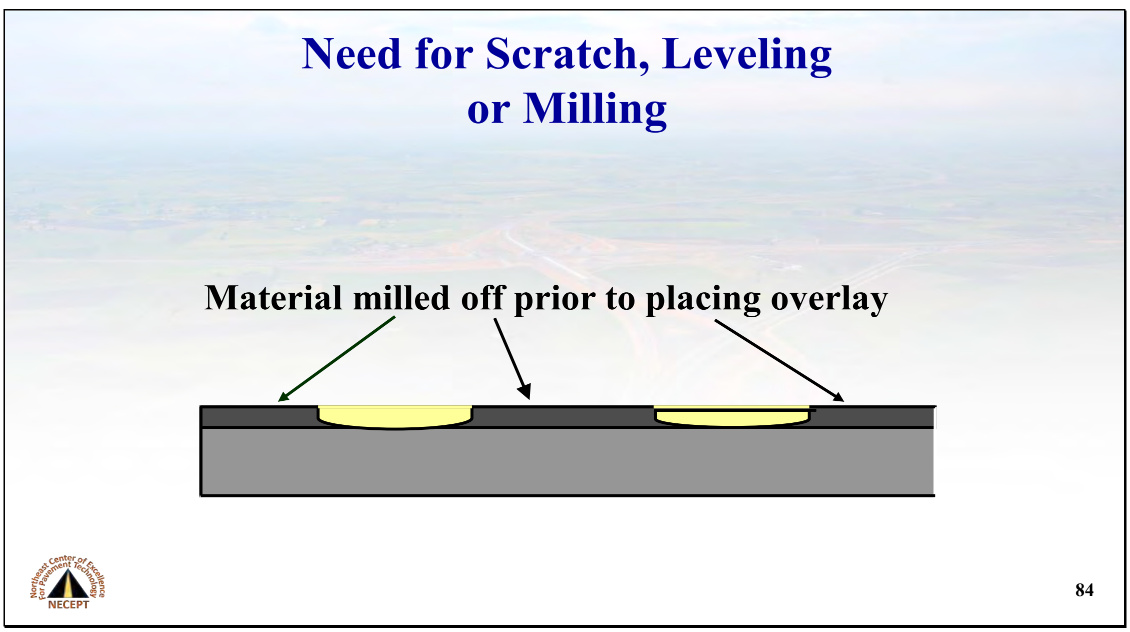

Roadways that show rutting will have to be leveled or milled.



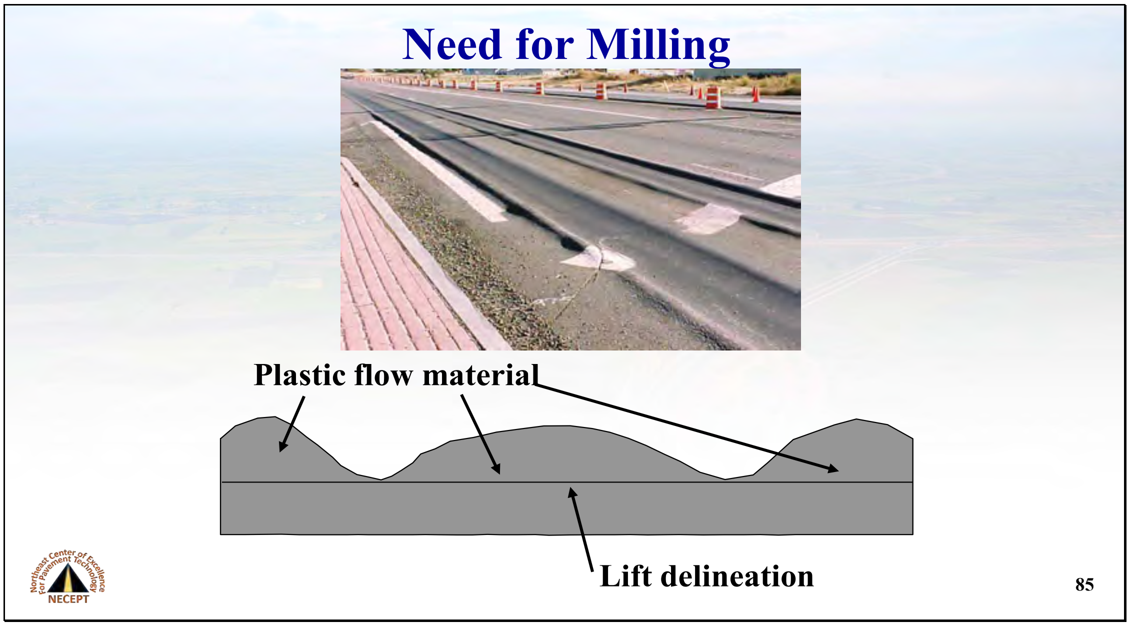

Rolling must be with a pneumatic (rubber) tired roller to ensure that the material is adequately compacted. A steel wheeled roller may bridge the area, leaving an area of lower density and a reoccurrence of the wheel rut.



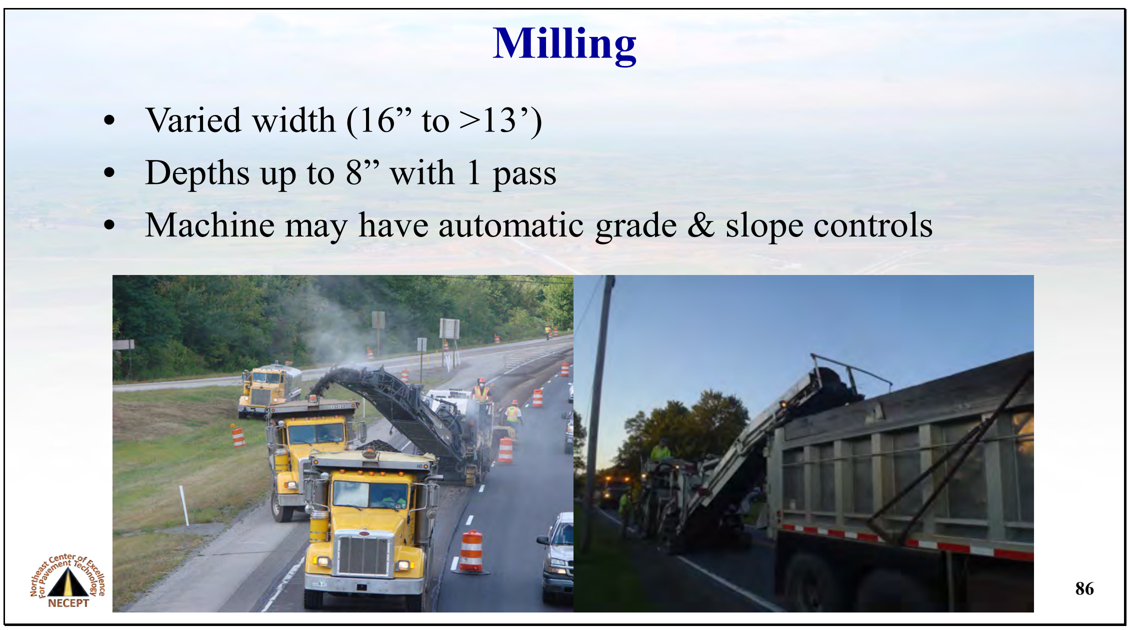

In order to ensure uniform density throughout the pavement, a pavement may need to be leveled or milled to provide a uniform platform for the new surface. Differential in thickness will lead to differences in density and additional rutting.




For an effective scratch/leveling course, the surface may need to be milled. Remember, however, if you mill you are removing some of the strength of the pavement. Milling must be to the lowest point in the pavement surface.




In this situation in order to prevent future rutting it would be necessary to mill out the material experiencing plastic flow. Remember that would be the best practice but may not be in the scope of the project. Milling must be to the lowest point in the faulty layer.




A milling machine may be capable of producing a level surface in one pass over the existing pavement, and the material is recyclable.

## Milling

- Maintains or creates surface profile & elevation for curb & gutter.
- Provides surface texture to enhance bonding of new layer.
- RAP can be recycled.

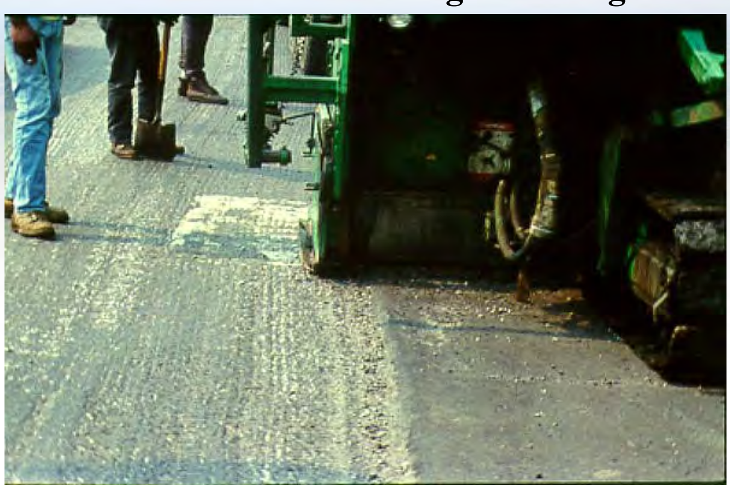
NECEPT

87

Milling may be to a specified depth or, much more technical profile milling to improve cross-slope, drainage or ride.

## Milling

**Milled surfaces need thorough cleaning**



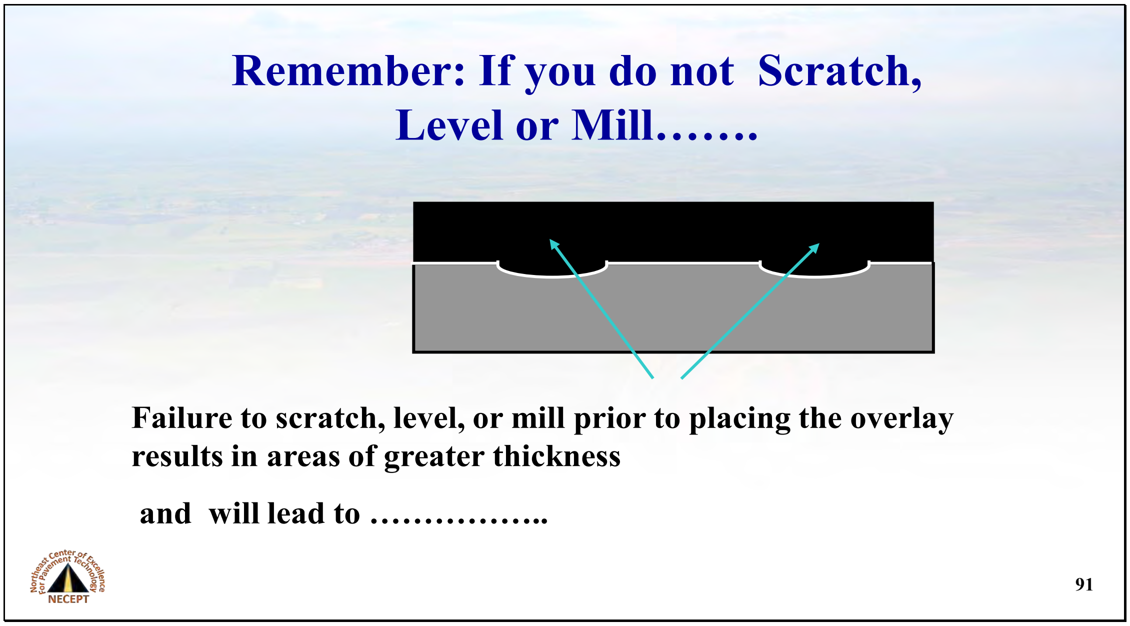
NECEPT

88

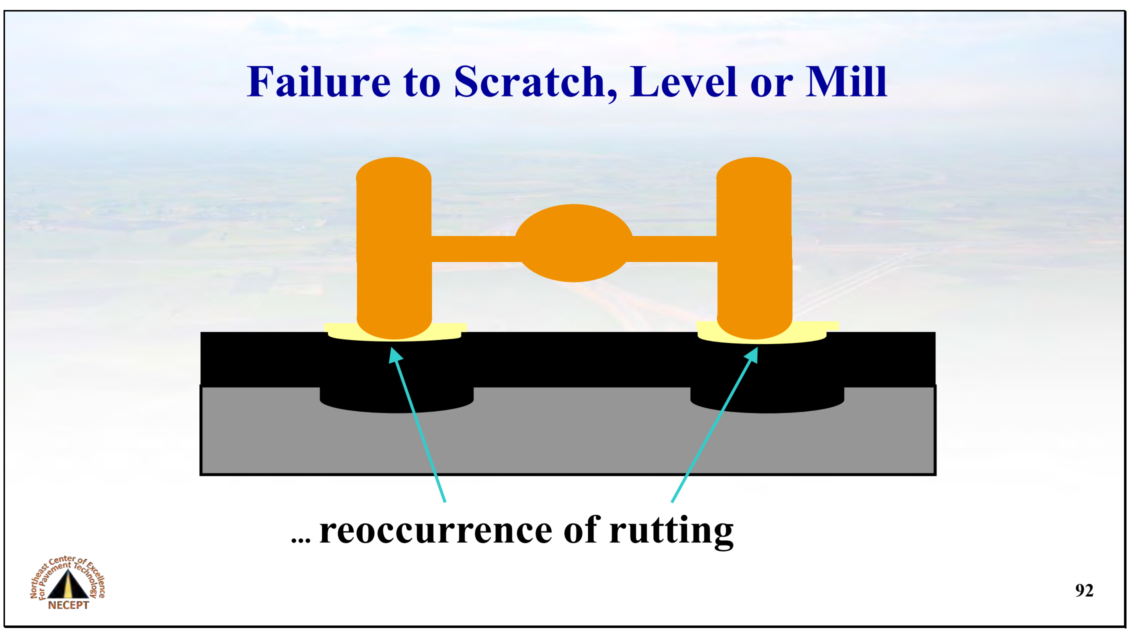
Proper pavement repairs become even more important when milling and overlaying are involved. This is the case since milling removes some of the pavement structure and underlying pavement problems may be uncovered during milling. Milling leaves a very dirty and dusty surface and multiple sweepings are often necessary to make sure all of the dust and dirt is removed. Be sure to remove thin scabs of remaining material from previous overlays.


Proper pavement repairs become even more important when milling and overlaying are involved. This is the case since milling removes some of the pavement structure and underlying pavement problems may be uncovered during milling. Milling leaves a very dirty and dusty surface and multiple sweepings are often necessary to make sure all of the dust and dirt is removed. Be sure to remove thin scabs of remaining material from previous overlays.


Milling that is at a prescribed depth can lead to scabby areas that are impossible to keep clean and will lead to early failures. Milling MUST remove ALL of the affected layer.




A pneumatic tire roller must be utilized in this operation.

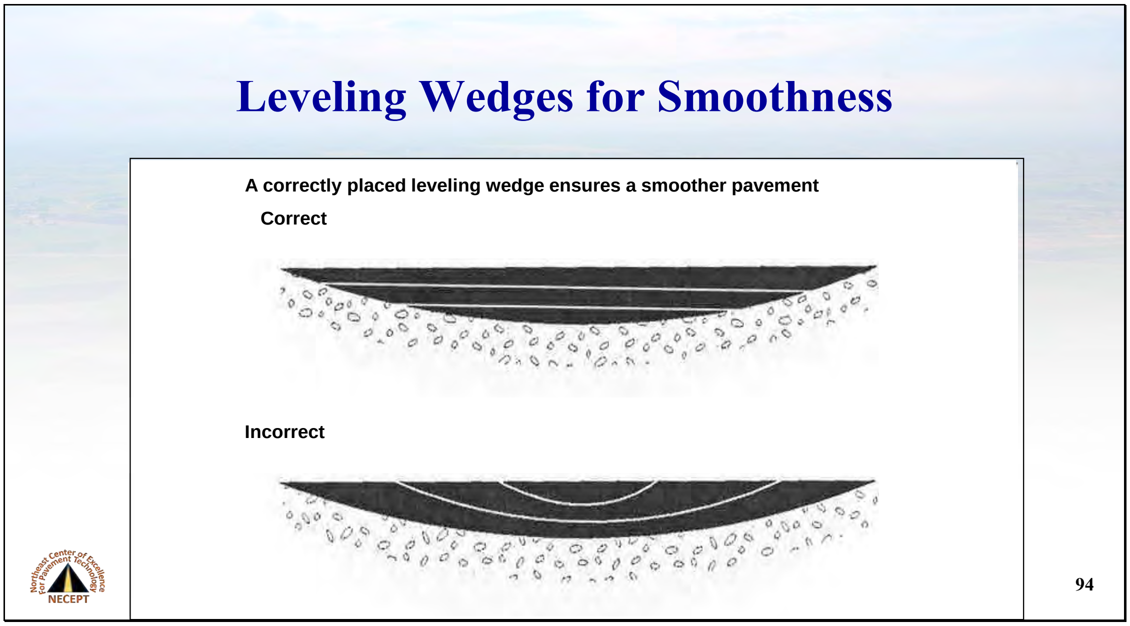



WOW! We just built a new wheel rut!!!!

## Filling In A Low Area

93

Here several passes of the paver have been applied to remove the dip in the pavement to the right of the slide. Sometimes referred to as mechanized patching What about a mill notch? ………At least on the top layer?




Leveling wedges are patches of Asphalt used to level sags and depressions in an old pavement prior to the surfacing operation. The placing of leveling wedges is part of the leveling-course operation. Leveling wedges should be placed in compacted layers of not more than 3 inches. In placing multiple layers, the shortest length layer should be placed first, with the successive layer or layers extending over or covering the short ones. If the incorrect method were used there would be multiple surface joints and the difficulty of feathering out the mix could cause bumps all of which could reflect through to the new overlay as bumps or cracks.


Be careful with the maximum aggregate size in the Asphalt mix and leveling course thickness. The center was thinner than the edges – larger aggregate pieces are being dragged and the white aggregate pieces were being crushed. BUT, we held the yield!!!!!


**After** patching, sealing, and leveling and **prior to** applying the tack coat any foreign material (dried mud, spilled asphalt, etc.) must be removed.

## Section 483: Polymer-Modified Emulsified Asphalt Paving System "micro- surfacing"

**Used as:**

- **Scratch Course:** Type A for sealing cracks and surface voids **< 1/2 inch**
- **Leveling Course:** Type B for filling ruts **up to 1 ¼ inch** deep, and surface treatment
- **Rut fill:** Type RF for filling ruts **up to 2 inches** deep in a single pass

NECEPT 98

Microsurfacing uses a polymer-modified emulsified binder and high-quality aggregates with additives that allow control over cure time and performance.

## Microsurfacing

**Purpose:**

- Improve surface friction
- Fill ruts/minor surface irregularities
- Seal pavement surface
- **Designed to be open to traffic in 1 hour**

NECEPT 99

This technique addresses oxidation and raveling, surface, seals minor cracks, fills voids, and is used to fill wheel ruts. Microsurfacing specs were covered in module 2 Section 483. This is a very fast-paced operation.

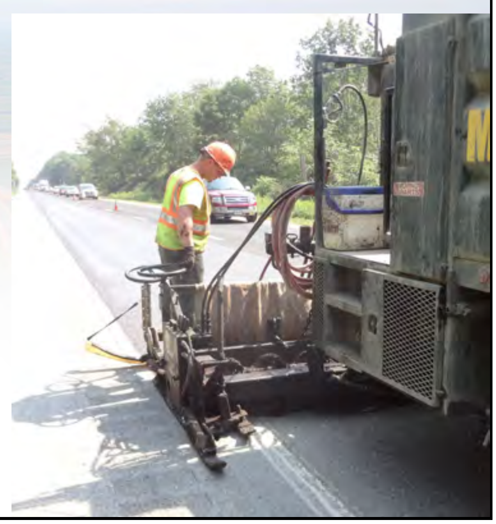
## Microsurfacing

- Applied as a semi-liquid Mixture
- Polymers & Other Additives
- Lower Cost Compared to Overlay
- Relatively Long Service Life
- Specialized Equipment Needed

Microsurfacing is applied as a liquid mixture with specialized equipment.

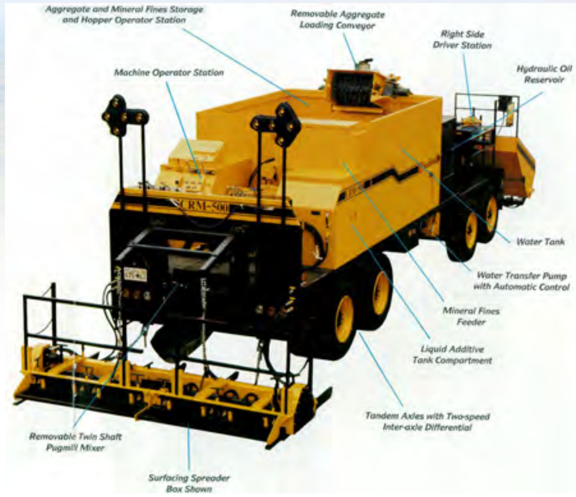
## Microsurfacing

- **Mixture of materials**
  - Polymer-modified emulsion asphalt binder: CSS-1hPM (E-8CPM)
  - High-quality aggregates
  - Filler (Portland cement or hydrated lime)
  - Water
  - Other additives to control mix set time



The “CSS” indicates a cationic, slow setting emulsion, the “1” its relative viscosity (a “-2” is more viscous than a “-1”), the “h” meaning a harder grade of base asphalt was used in the production of the emulsion, and the “PM” meaning polymer-modified.

## Microsurfacing Equipment

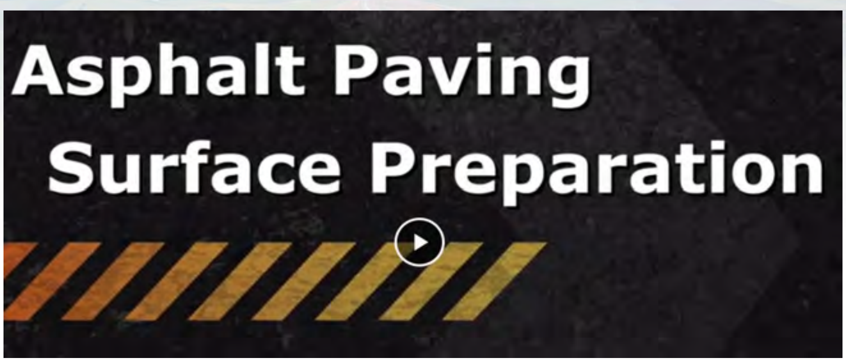



102

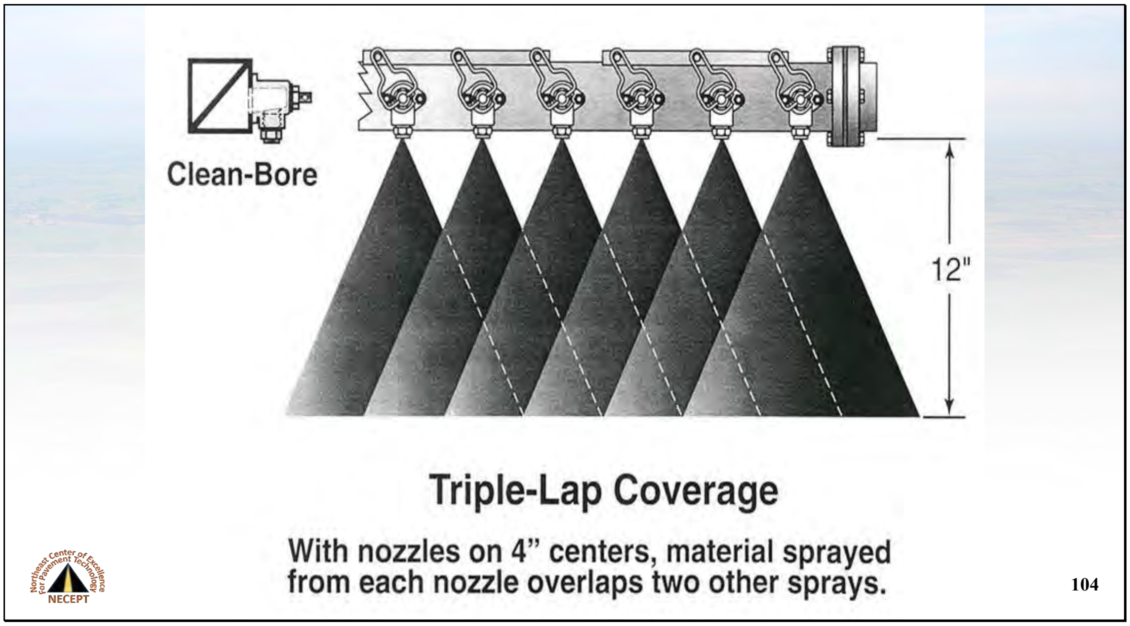
Microsurfacing requires specialized equipment for its placement.

## PennDOT Surface Prep Training Module

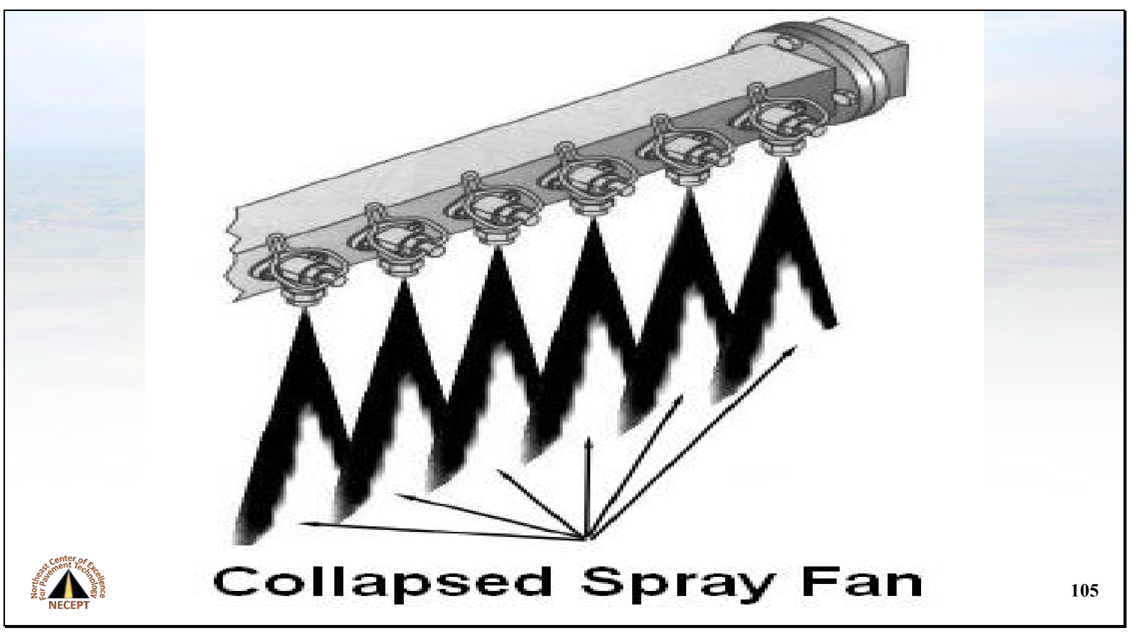
- **WATCH THE VIDEO**




103




**Note the lack of complete coverage at two outside nozzles.**




Nozzles that are too large will cause reduced pressure at the bar resulting in an unsatisfactory spray pattern.


This bar will not turn on/off uniformly between main bar and wings.

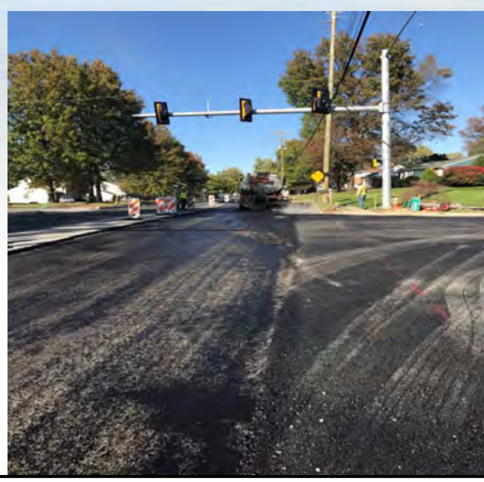

Note heavily overlapped area. Too much tack is as detrimental as too little. Uniformity of application is important and required.

## "Broken" tack
## Stored improperly or too long

108

Tank circulation will NOT revive this material!!

## Examples of Spotty Tack and
## Poor Tack Application



109

## Uncured Tack

**Tack must break (cure) before placing pavement**

110

## Excessive Tack
## On previously seal-coated roadway.

111


The application rate is too high and the curb and gutter have been sprayed only as an accident. Vertical surfaces in contact with new pavement need to be coated, Section 409.3 (g).
Make sure the tack coat goes where it is needed.

## Uniformly & Well-Placed Tack

114

## Uniformly & Well-Placed Tack

115

## Tack in relation with the NW Joint

**Tack extended 6" beyond the NW Joint**

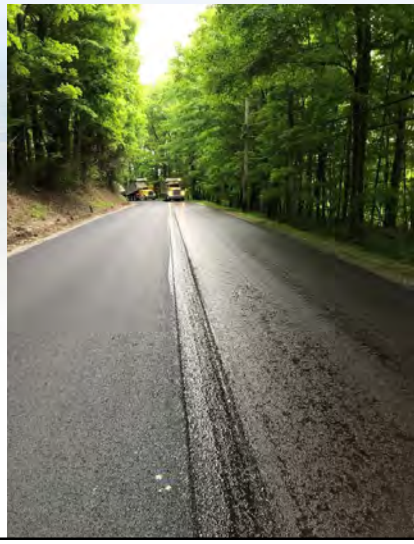
116

## Tack in relation with the NW Joint

**No extension of the tack 6" beyond the NW Joint**

117

## Uniformly & Well-Placed Tack



**Make sure the joint has tack and that it extends the recommended 6” beyond the edge of the lane being placed**

118

## Application Rate Calculation for 60% Residue TACK or NTT/CNTT

**Find Emulsion Application Rate (AR)**

AR= (required residue ÷ asphalt content as a decimal)

Assume 0.03 RESIDUE required /sq. yd.

Emulsion has 60% asphalt. So, asphalt content is 0.60.

**AR=0.03 ÷ 0.60 (60%) OR AR = 0.05 /sq.yd.**

Check: 0.05 applied X 0.60 asphalt content =0.03 residue per square yd.

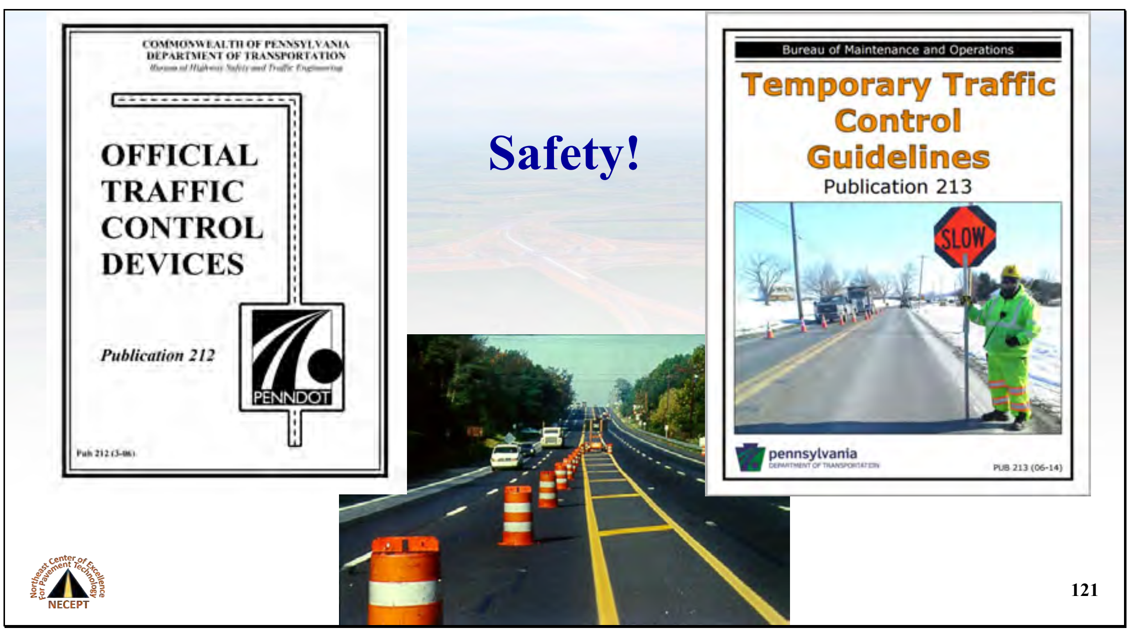
119

## Painting Vertical Surfaces

- Paint existing vertical surfaces of curbs, gutters, structures in contact with asphalt mixtures
- Use one of the following:
  - PG designated for the asphalt course
  - Two applications of NTT/CNTT or TACK

NECEPT 120

Treat all vertical surfaces, such as curbs, structures, gutters, and pavements that will be in contact with asphalt mixtures with a uniform applications What about base repairs? (section 316).




Traffic control may be more critical in repair operations. Closures may be short, in many locations, with frequent equipment moves.

Refer to: PennDOT Pub 212, Official Traffic Control Devices and PennDOT Pub 213, Temporary Traffic Control guidelines for work zone traffic controls regulations and requirements.

## Safety

122

Extreme caution must be stressed to help prevent accidents in these situations. Even though traffic control may be more difficult due to frequent moves or the number of locations, it must not be compromised.

## Module 4 – Review of Objectives

- The Importance of Surface Preparation
- New Construction
  - Subgrade, Subbase, Base
- Existing Surface Preparation
  - Repairs
  - Cleaning
  - Tacking

123

**Module recap**

# Discussion

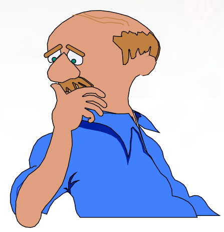
124

# Quiz

## Module 4

## Surface Preparation

?





**1. Surface preparation may include which of the following?**

a. Crack sealing
b. Patching
c. Milling
d. Leveling
e. Cleaning

**Answer:**

2. A yielding subgrade allows the pavement to be more flexible and thereby enhances pavement life.

a. True
b. False

Answer:



3. Subgrade and aggregate base both have to meet specification requirements for

a. Moisture content
b. Density
c. Smoothness
d. All of the above

Answer:

**4. The tack application calls for 0.04 gallons per square yard of asphalt residue of CNTT which has 60% Asphalt (40% water). What should the tack application rate?**

a. 0.05
b. 0.07
c. 0.24

**Answer:**



**5. Which of the following apply to base repairs?**

a. Remove failed pavement to sound material
b. Additional drainage may be required
c. Compact each layer
d. Cut or mill to vertical edges
e. Coat clean edges with PG 64S-22

**Answer:**

**6. Rutting can occur within a weak subgrade or underlying layer, or in a weak asphalt layer.**

a. True
b. False

**Answer:**





**7. Correction of a rutted asphalt pavement may include**

a. Filling the ruts and placing a leveling course
b. Milling and overlay
c. Placing an overlay with enough extra material to fill the ruts at the same time
d. a & b, but not c
e. all of the above

**Answer:**

**8. According to PENNDOT specifications, there is no difference between a scratch and leveling course.**

a. True
b. False

**Answer:**



**9. A thoroughly cleaned and repaired asphalt surface will not require a tack coat prior to overlay.**

a. True
b. False

**Answer:**

**10. The water in the Emulsion TACK helps the asphalt binder stick to the pavement surface.**

a. True
b. False

**Answer:**

N
E
C
E
P
T

# Asphalt Pavement Construction Program

Certified Asphalt Field Technician Course
of 2025

# <u>Module 5</u>: Delivery

Northeast Center of Excellence for Pavement Technology
NECEPT

# Asphalt Construction Program

Certified Asphalt
Field Technician - 2025

Module 5:
Delivery

NECEPT

Northeast Center of Excellence for Pavement Technology

1

As a CFT, your goal is to ensure that asphalt mixture delivery be a smooth, uninterrupted, and continuous operation to the fullest extent possible. The haul vehicle is to transport the asphalt mixture from the plant to the paver without delay and with minimal *segregation*.

## Module 5 – Objectives

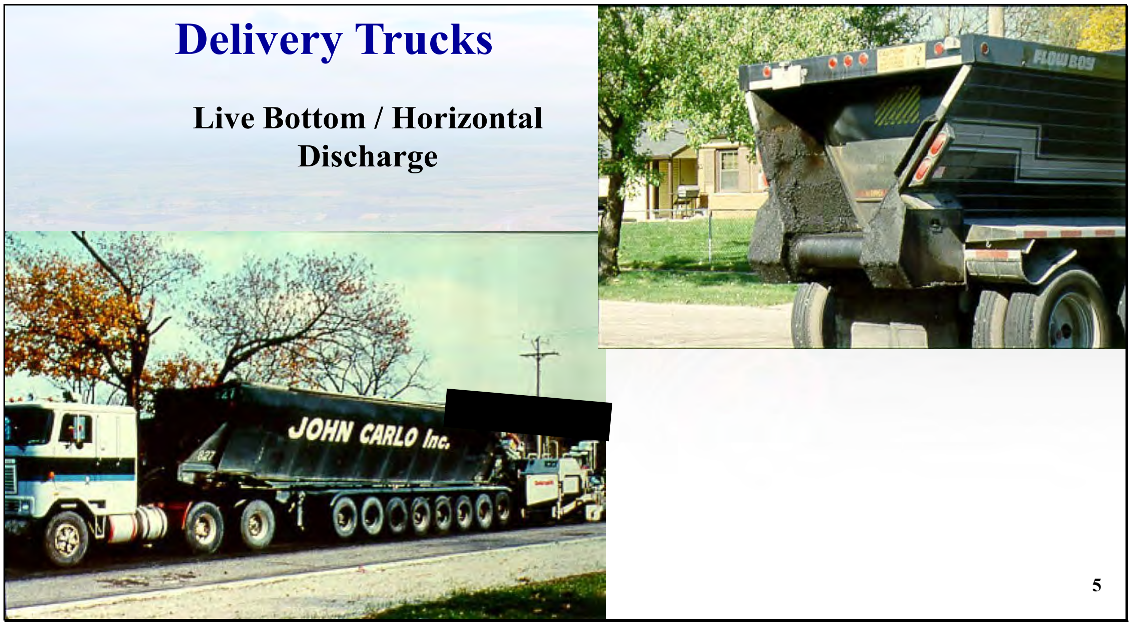
**To Discuss and Learn about**

- Types of Trucks
- Loading the Truck
- Delivery to the Site
- Unloading at the Paving Site
- Issues and Problems

2


There are three primary types of trucks as shown.


The semi-circular curved shaped bed in the tri-axle dump truck stands up to impacts better than the flat floor. The force of asphalt mix at impact is deflected when it is dropped into the body as opposed to a flat floor that takes a direct impact. This design serves two purposes: 1) the minimization of segregation of the mixture due to larger particles rolling into the corners of the bed, and 2) the concentration of material into the center portion of the bed to assist guiding the material to the center of the paver and onto the slat conveyors.




This is not a PennDOT approved mix delivery vehicle.

## Loading the Truck

**Are we ready?**

7

Trucks are here, but have they been inspected and prepared and ready to load?

## Before Loading!

- Truck bed needs to be clean.
- Bed needs to be smooth and free of dents and depressions.
- The bed must be sprayed with a proper biodegradable release agent.

**What about insulation?**

8

PennDOT Pub 408 Specs: 413 Construction, 3(d) Hauling Equipment: Provide insulation on all sides of the truck body, a double-walled truck body, or a heated truck body when the air temperature is below 10°C (50°F) from October 1 to April 30.

## Truck Release Agent

- Allows mix to flow from truck bed to paver hopper
- Do not use diesel fuel – softens mix
- Use lime water mix or commercially available release agents


**DIESEL SMELL FROM DELIVERY TRUCKS?**

NECEPT

9

Apply an acceptable release agent: non-petroleum materials sprayed uniformly on the sides and bottom – just enough to coat the bed without runoff. What types of release agents have you used or witnessed?????????

## Manual Application of Release Agent

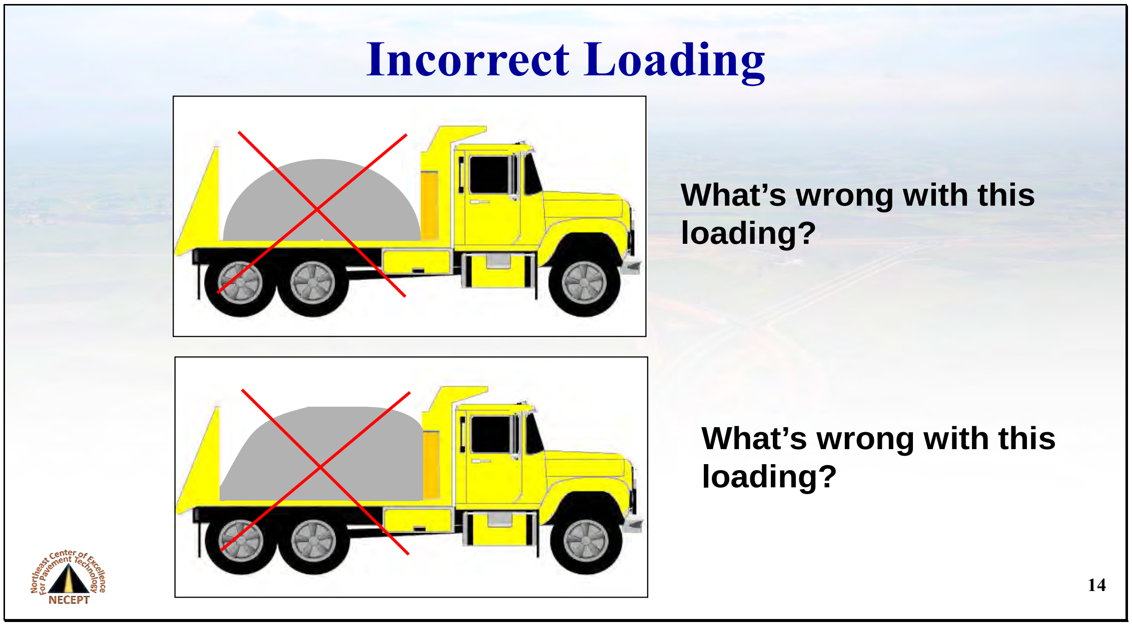
NECEPT

10


An automated system for applying the correct amount of release agent.

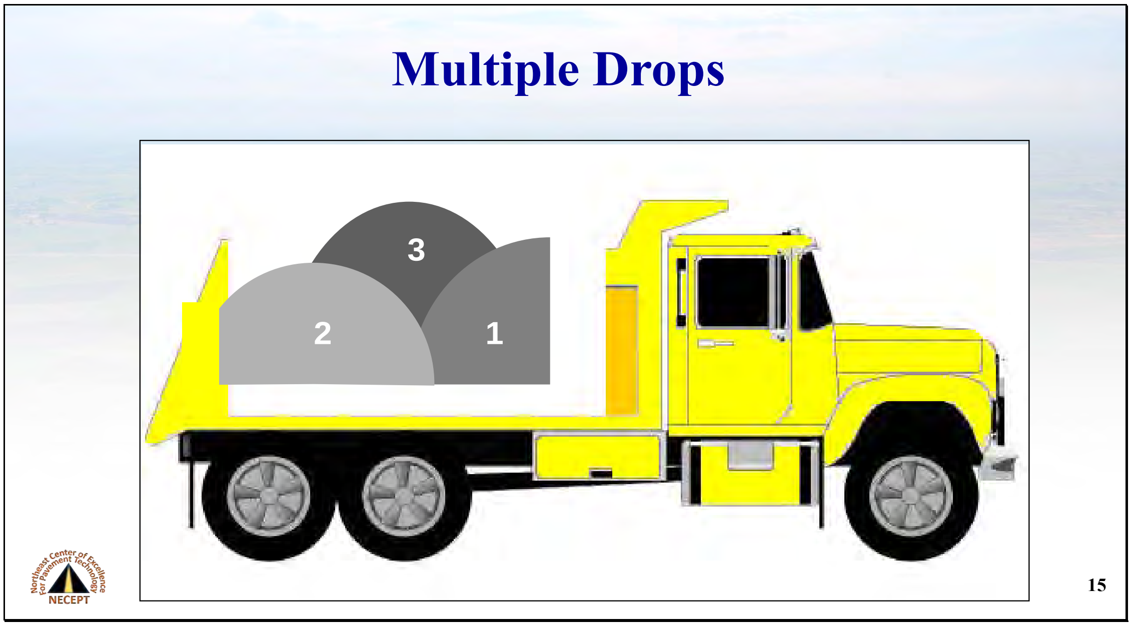

If excess material is applied, it MUST be drained. The outside of the truck should also be free of extraneous materials. Look for loose rock and dirt near the truck taillights.


Discharging mix into the truck may seem to be fairly simple, but improper loading is a prime source for mix segregation. Correct loading procedures can help eliminate to segregation.




Single dumps to load trucks results in segregation. When the single dump is in the center of the truck bed, the material builds into a conical pile and the coarsest aggregate particles roll toward the front and the back of the truck bed. Truckload–to-truckload segregation is a combination of what comes out of one truckload last and the next truckload first.

Even a single dump to the front of the truck, although eliminating weight on the rear axles and reducing the distance that coarse aggregate can roll to the front, increases the distance that coarse aggregates can roll toward the tailgate and again results in segregation. Most of this truckload-to-truckload segregation will occur from what comes out of the truck bed first.




The objective of truck loading is to get the mix loaded into the truck as uniformly as possible. The greatest concern in uniformity is segregating the mix as it is loaded. Segregation can be minimized by moving the asphalt mix in a mass and by reducing the distance that the coarse aggregate can roll. Thus, segregation can be significantly minimized by dividing the loading of the asphalt mix into multiple drops, each delivered to a different section of the truck.

Getting the asphalt mix against the front and back is an important consideration in preventing segregation. If the mix is not crowded to the ends, the larger rocks in the mix can roll down the slopes and gather in one place. Especially for segregation-prone mixes, multiple drop procedures should be used. With multiple drops, end dump trucks are loaded at the front and rear of the bed, and then in the middle (usually 40% front, 40% rear, and then 20% center). This will be covered again under the segregation module.

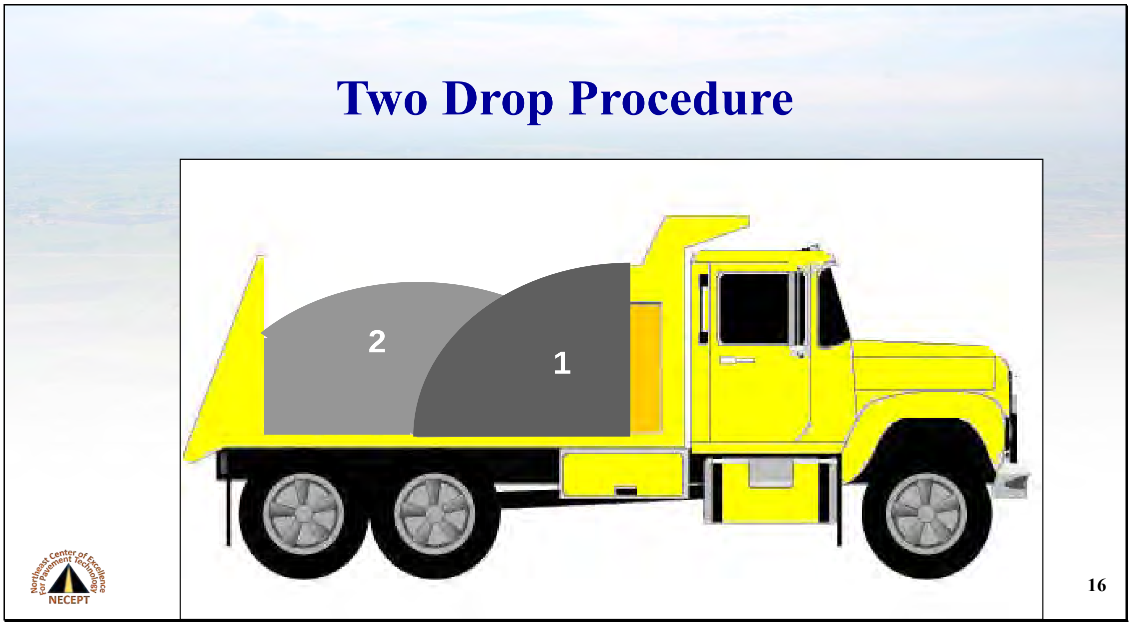
What are the normal complaints regarding multiple dumps?

Note: Semi-Trailer End Dump Trucks – 1st dump at front, 2nd dump at rear, 3rd dump in center, 4th dump between 1 & 3, 5th dump between 2 and 3.

Bottom Dump Trucks with single discharge gate –1st dump directly over gate, 2nd dump between 1st dump and front wall of truck, 3rd dump between 1st dump and back wall of truck

Bottom dump Trucks with double discharge gate –1st dump directly over front discharge gate, 2nd dump over rear discharge gate, 3rd dump between gate and back wall of truck, 4th dump between 1st dump and front wall of truck.

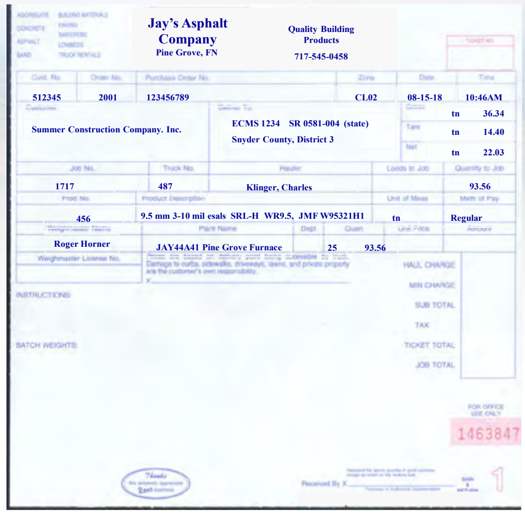
Live Bottom Trucks - 1st dump at back of bed as close to discharge gate as possible, 2nd dump at front of bed, remainder deposited as truck moves slowly forward.




Depending on the size of the truck, a two-drop procedure may be appropriate. This might also work for pugmill loading, if two batches would fill the truck.

## Documentation

**Delivery Slip Pickup At Plant**

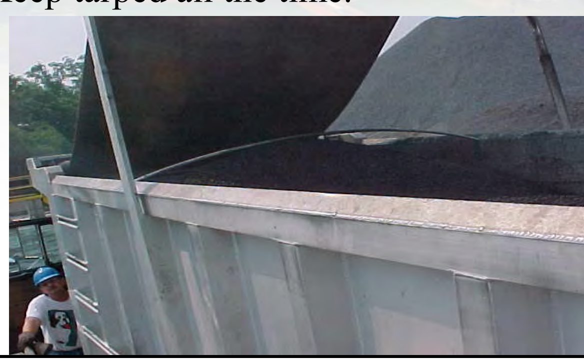



NECEPT 18

Upon completion of the loading sequence, the driver obtains a delivery slip. The delivery slip is a very important document. It not only contains the name of the company, but also the type of mix, the loading temperature, etc.

## Trucks Must Have Tarps

- Keep water/dust out of mix.
- Keep mix hot during delivery.
- Avoid thermal segregation and cold lumps.
- Keep tarped all the time.



NECEPT 19

Haul trucks must be equipped with tarps to protect the mix during inclement weather, maintain the heat to help prevent surface crust from forming during delivery. The tarps should be water-repellent, resist tearing, and not have any holes. Mechanically extendable tarps are preferred (to keep the driver off the side of the truck) as long as they extend over the entire load and totally cover the load. Photo depicts initial tarping of load at plant.

## Applied Tarp

20

The tarp should cover the entire load and extend down over the sides of the truck body. Unless the tarp extends over the sides of the truck, airflow under the tarp will increase the rate of cooling of the mix, allowing water into the truck bed.

If there is water on the tarp when the truck is ready to discharge mix into the paver hopper, the water should first be removed by raising the bed of the truck and letting the water run off before the truck backs into the hopper. This should not be done on the pavement in front of the paver.


The truck slowly backs toward the paver as the paver continues to move forward. (Notice, the paver is folding its wings while continuing to move forward. This procedure need not be done every time there is a truck change.)
How often and when is your crew folding the wings????????


The key is that the truck does not back into the paver and bump it. Bumping the paver can leave a screed mark and roughen the mat. Once the paver picks up the truck, it pushes the truck forward. A light touch on the brakes keep the truck against the paver. What should happen before the tailgate is released?


The truck brakes to a halt in front of paver, ready to be picked up on the fly. It is important that the truck be centered on the paver before contact is made to prevent damage to the mat and paver. The area between the truck and paver is off limits to personnel. Too many accidents occur in this area.


Get and check the weigh ticket before the mix is dumped into the paver. The Certified Field Technician or an individual so designated should get and check the delivery ticket to make sure it contains the right mix for the project. Several mixes may be on the jobsite, and it is important to get the right mix in the right location. It also is important to make sure the truck belongs on this project!!

## Electronic Ticketing System (e-Ticketing) Active SSP (# c00062)

- Effective Date: 12/21/2020
- Report delivered material using electronic ticketing system

NECEPT

25

## Electronic Ticketing System (e-Ticketing) Reporting Information

- ECMS Number or Purchase Order Number
- Plant Supplier Code
- Material Type/Class/Number
- JMF Number
- Date and Time Ticketed
- Unique Truck ID
- Mass (Weight), Gross, Tare, Net
- Running Daily Total in Tons of material being transported
- Name and license number of Licensed Public Weighmaster

NECEPT

26

## Asphalt Temperature Check from Truck (POM April 2020 Edition, Change 1 (5/4/21))

- Check temperature from one of the 3/8” diameter holes drilled on each side of the truck bed before unloading.
- Use a calibrated dial or digital thermometer
- Take reading when the temperature stabilizes

**This is under review and may be removed.**

NECEPT

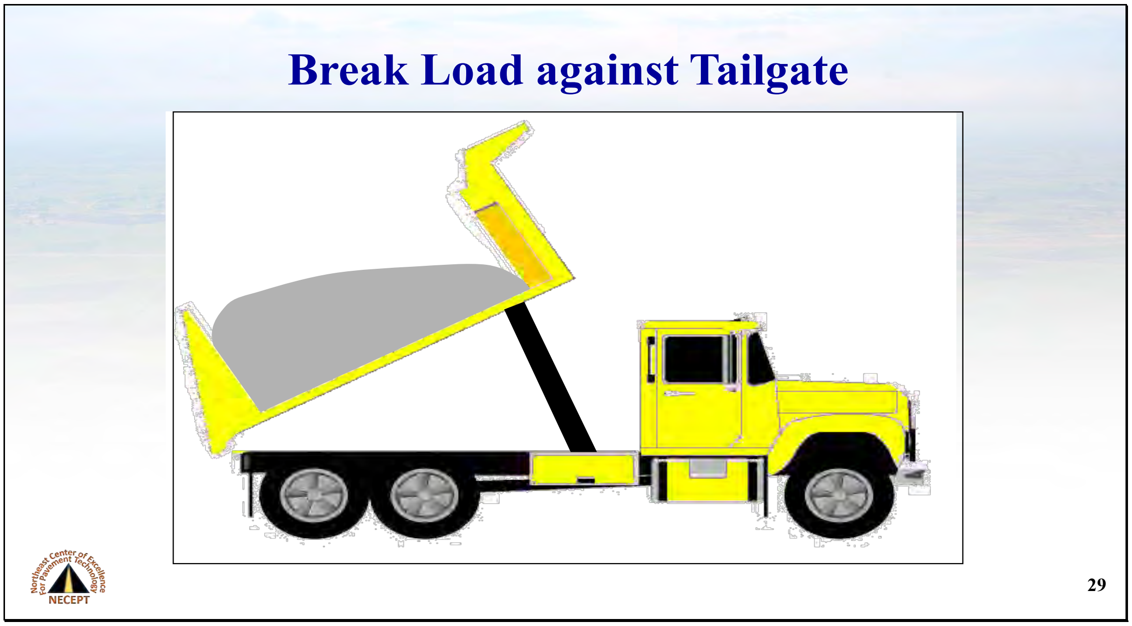
27

## Asphalt Temperature Check from Truck

- **What if temperature cannot be taken because of truck bed liner?**
  - Do not allow the truck to unload.
  - Check the temperature of the next truck.
  - If within spec, then allow the truck with blocked truck bed holes to unload.
  - Notify the supplier’s plant of the problem providing the truck number.

NECEPT

28




With end dump trucks, the proper procedure for dumping the mix into the hopper is to raise the truck bed slightly and allow the mix to break and slide against the tailgate before it is released. This procedure will allow the mix to flood the hopper–not allowing mix to dribble from the truck into the hopper before the bed is raised. With live bottom trucks, try to use the same procedure to flood the hopper from the truck – on some trucks the belt or slat conveyor can be started a few seconds before the gate is open.


After the load is broken against the tailgate, the tailgate is released allowing the material to flood the hopper. After the hopper is filled, the truck bed is gradually raised, continually charging the hopper, and maintaining a smooth operation.

## Proper Truck Exchange
### Watch the Video

NECEPT

31

In this photo the hopper wings are being folded as the truck leaves to help eliminate cold material build-up in the wings.

## Best Hopper Use at Truck Exchange

- Always keep hopper partially full.
- Never expose slat conveyors at the bottom of hopper.
- Rule of thumb - Fold wings frequently or not all until end of day clean out

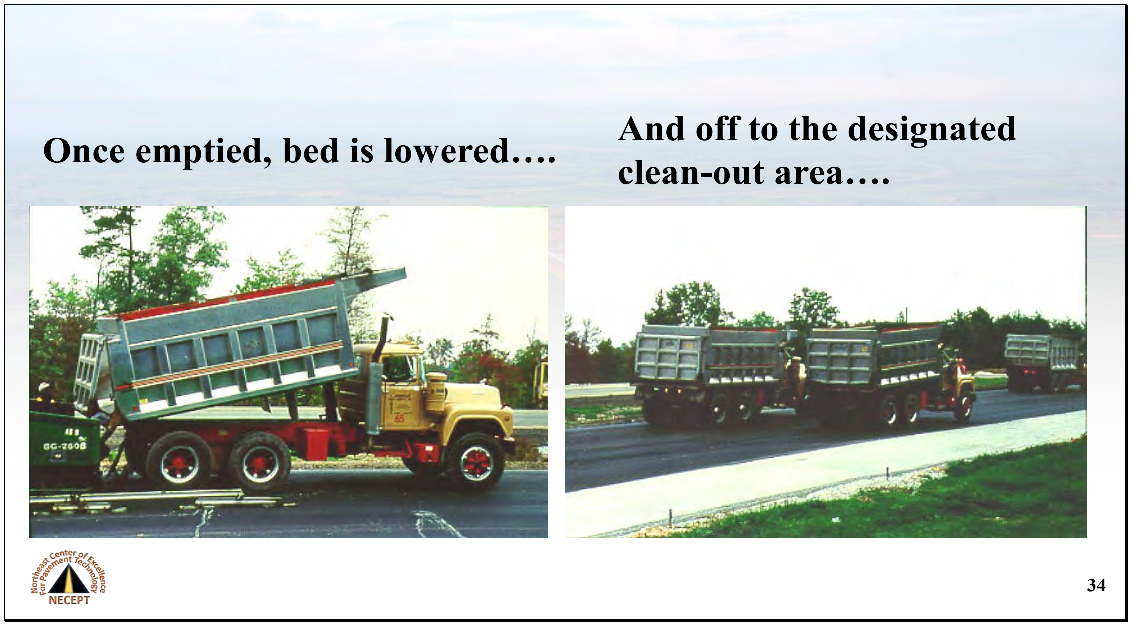

NECEPT

32

**Hopper**


This truck has baffles just inside the tailgate in order to

- direct the mix to the middle of the hopper.
- force the mix from the truck's sides to the middle.
- ultimately, help reduce segregation.




As the truck empties the mix, the driver follows signals from the truck dumper to raise the bed and discharge all of the mix.

Once the truck is empty, the bed must be lowered before pulling away. Lowering the bed will allow the truck apron to clear the hopper guards.

Once the truck has cleared the paver, it should immediately depart from the area to a cleanup station and let the next truck back up. Cleanup locations should be designated to avoid having trucks pull from tack into dirt and back onto the tack.


This is <u>NOT THE PLACE TO CLEAN OUT</u>.


There should be a designated cleanup area for the drivers to clean any remaining mix from the rear of the truck, the apron, and the tailgate. The cleanup area is NOT ON THE ROADWAY. Modified asphalt can make this a more troublesome task. If the clean-out site is large enough, the trucks will not bunch up!!!!!!!!!


This truck is ready to leave the jobsite for another load. The back of the truck is clean. No mix is left to spill from the truck. Once the truck has completed on-site cleanup, it should proceed immediately back to the asphalt plant. The trucks should not delay departure; otherwise, the smooth and continuous nature of the entire operation could be affected.

## Delivery to a Material Transfer Vehicle

38

Mix can also be dumped into a material transfer vehicle.

## Feeding the MTV

- Dumping procedures are critical at an MTV
- Segregation may occur with improper dump angle
- Dump apron can force hopper into roadway surface.
- Excessive dump rate can clog conveyor

39

## MTV Requirements

- Covers to protect material
- Capable of continuous rate of transfer
- Equipped with remixing augers
- Hopper insert to provide mass flow to conveyor slats at paver.

NECEPT

40

Some MTVs are self-contained units; others have the remixing chamber built into the hopper insert and the hydraulic power to operate the remixing augers is provided by the MTV unit. This operation necessitates two hoses connected from MTV to Paver and may limit maneuverability. DO NOT walk between ANY MTV unit and the paver. Operator visibility is very limited in this area.!!!!!!!

Paver Hopper Insert receives material from MTV

Drop height should be minimized

Hopper should always be at least ½ full


41

On the other end of the material transfer vehicle, a conveyor discharges the mix into the paver hopper, usually equipped with an oversized hopper insert to properly receive the mix. If a gap occurs in delivery, the MTV should be stopped without being completely emptied, so that a consistent minimum amount of mix is retained on the augers to mix with the new material delivered from the next haul truck. The paver should also be stopped with the hopper at least half full.

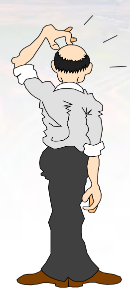
## Technician's Responsibilities & Problem Identification

NECEPT

42

We will review the responsibilities of the field technician, who may be representing the contractor or the agency, as related to delivery of the asphalt mixture. We will discuss the potential problems associated with the mix delivery and how a technician could identify those problems and what type of solutions exist as remedy to those problems. Sometimes, a technician may need to look into the delivery operation from start to finish to identify the source of the problem.

## What are a Field Technician's Responsibilities Concerning Delivery?



NECEPT

43

One of the first responsibilities in this area is documentation. The haul trucks also need to be examined along with the total delivery operations.

## Documentation – Delivery Slip

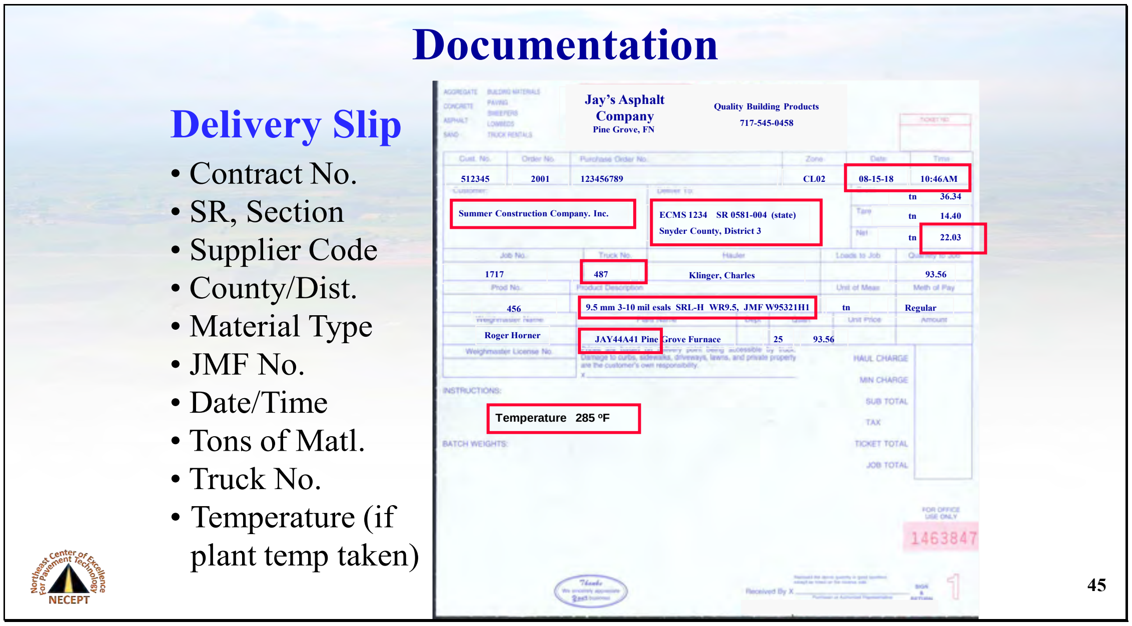
**Watch the Video**
**On Delivery Tickets**

- Inspect/Collect Delivery Slips.
- Ensure that the proper mix at the proper temperature is being delivered.

NECEPT

44

It is the trucker's responsibility to make sure he receives a delivery slip before leaving the plant to ensure payment. At the job site the technician or designated individual will collect the  delivery slip and check the mix type and temperature of the mix. The trucker gets an initialed copy, the Agency gets a copy, and the technician gets a copy.




The delivery slip is used to identify the contract number, the state route and section, the supplier, county and District, the type of material, the JMF, date and time, tons of mix on the truck, truck number, and the temperature of the mix when the plant technician takes a reading. Check the ticket to make sure it contains the right mix for the job, and that the truck is on the correct project. Several mixes may be on the jobsite, and it is important to get the right mix in the right location.

## Documentation - Temperature

### Technician's Responsibility

- Check Temperature **SAFELY**

NECEPT

46

It is the technician's or his designated representative's responsibility to check the delivery temperature. This will be performed as stated in the Quality Control Plan. Usually, it is the first three trucks and then every fifth one. The area where trucks are dumping into the MTV or Paver is VERY dangerous. Infrared (non-contact) thermometers are notoriously unreliable at the tailgate. Checking temperature through the truck body may or may not be an option.

Where do YOU check the temperature??

# Documentation –Delivery Temperature

**Mix Temperature shall not be outside the range given in Section 413, Table A**

| Temperature of Mixture (F) | | | | |
|---|---|---|---|---|
| Class of Material | Type of Material | Chemical, Organic, Foaming Additives, Minimum | Mechanical Foaming Equip/Process Minimum* | Maximum* |
| PG 58S-28 | Asphalt Binder | 215 | 230 | 310 |
| PG 64S-22 | Asphalt Binder | 220 | 240 | 320 |
| PG 64E-22 | Asphalt Binder | 240 | 260 | 330 |
| All other binders | Asphalt Binder | The higher of 215 or the minimum temp. specified in Bulletin 25 minus 45F | The higher of 230 or the minimum temp. specified in Bulletin 25 minus 30F | As specified in Bulletin 25 |

* Outline in the Producer QC Plan and follow more restrictive temperature requirements provided by the WMA technology manufacturer or Technical Representative(s) for production and placement of the mixture. Determine the SGC compaction temperature for the production QC which yields the same target air voids as the designed JMF . Include the SGC compaction temperature in the Producer QC Plan. Compact the completed mixture in the SGC for QC volumetric analysis at the SGC compaction temperature according to the guidelines provided by the Technical Representative.

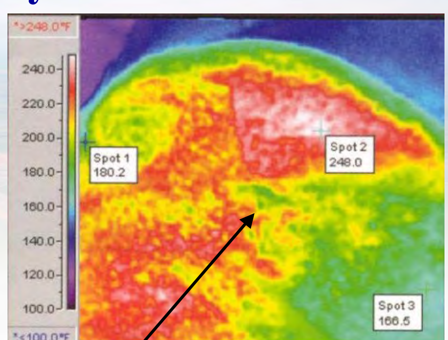
NECEPT 47

The mixture delivery temperatures as given in the specifications.
Compare plant temperatures with delivery temperatures; sometimes, the mix temperature raises on the truck as it picks up more heat??

# Delivery

## Problems

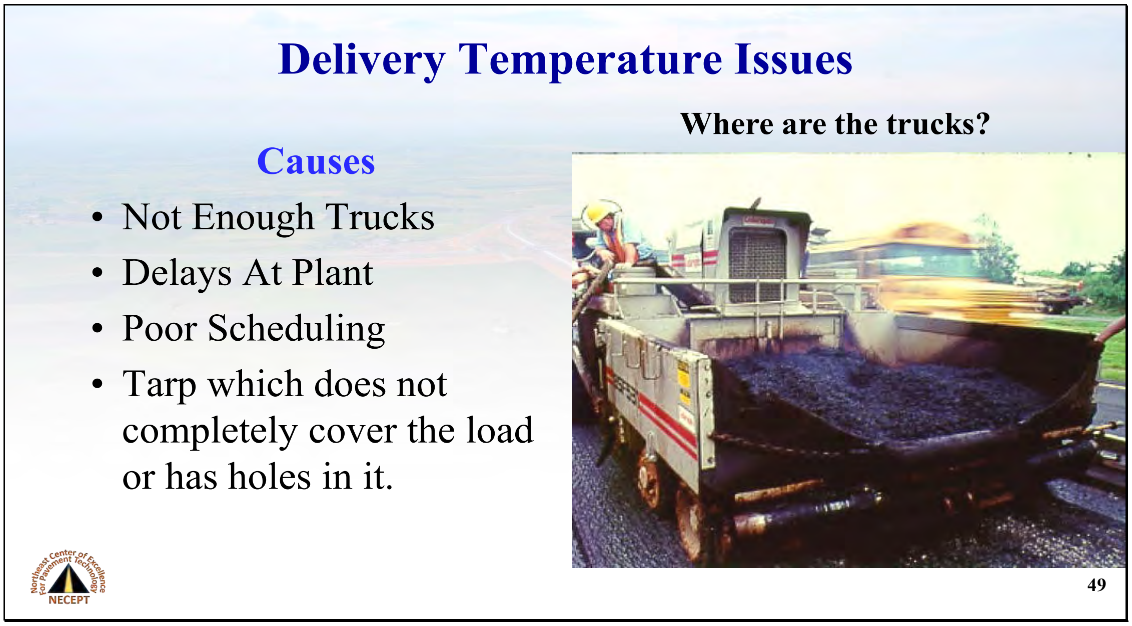
- Crusting
- Temperature Variability
- Lumps In Mix



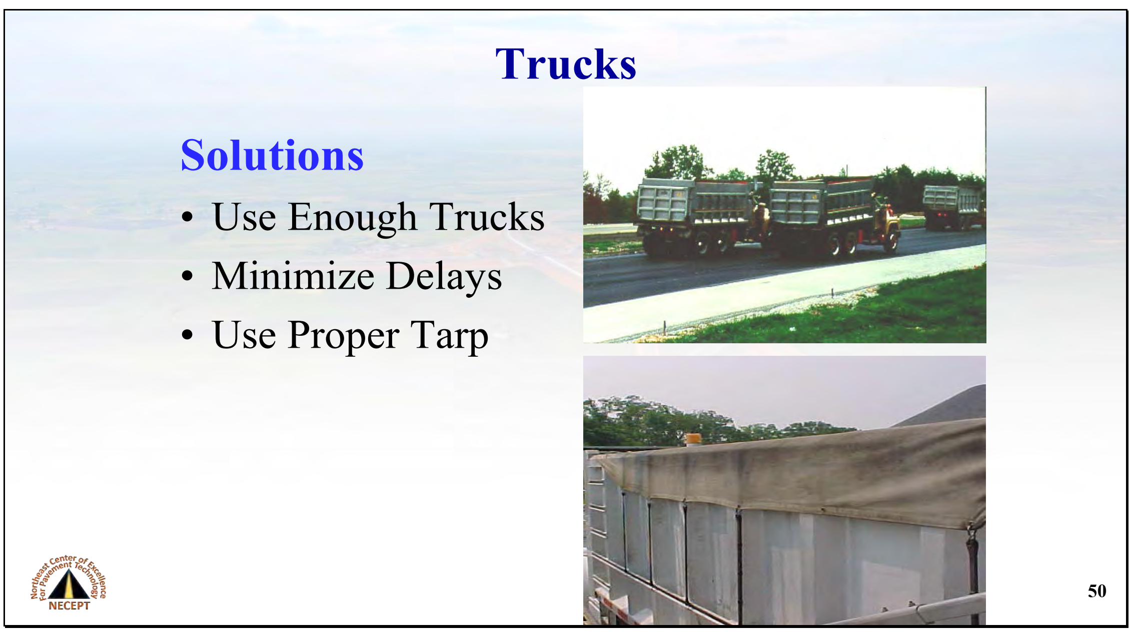

Temperature Difference **> 60°F**
This is a large temperature difference with potential to cause thermally-induced mix segregation

NECEPT 48

If the truck is poorly tarped and the mix is hauled long distances, the hot or warm asphalt material will cool and develop a crust on the top or sides. The crust serves as an insulating layer for the rest of the mix and reduces the rate of cooling for the remaining material. Thus, within limits, crust formation can be beneficial. The crust, however, must be completely broken before reaching the paver.




**Other reasons???????**




Asphalt mixtures in a mass on the truck will maintain a reasonable temperature for several hours depending on the efficiency of insulation in the truck. As long as chunks of asphalt mix are not generated to affect the quality of the mat behind the paver, the crust should not be detrimental to the long-term performance of the mix. If chunks of mix are seen behind the screed, remove them, DO NOT broadcast material to hide them. Changes need to be made in the mix production temperature, the amount of insulation on the truck bed, the covering of the load with the tarp, the paving schedule, or any combination of these factors to fix the problem.


The hauling equipment must meet the specification requirements. The technician should be aware of the requirements and, if problems are present, necessary steps must be taken to resolve the issue.

**Mechanically unsound condition and leaking hydraulic fluids or diesel or diesel fuel will lead to premature failures.**

52

Trucks must be in a mechanically sound condition. Items to maintain include engine, drive train, hydraulic system, brakes, and lights. Hydraulics and brake lines must be checked **daily**. The truck's hydraulics system raises and lowers the truck bed and problems with this system are dangerous and may impact the asphalt mix quality. The hydraulic fluid comes from the same barrel of oil as the asphalt (i.e., both originate from the crude oil), and as such will dissolve the asphalt from the aggregate and lead to a premature maintenance problem.

Hydraulic oil leak may only be visible when pressure is applied to raise the load. The effect on the mix will be evidenced two or three years later in the form of small circular failures in the top layer of the pavement. A few of them may be concentrated in a 150-200 sq. ft. area.

## Trucks

### Solution

Inspect Daily and Correct Any Mechanical Deficiencies

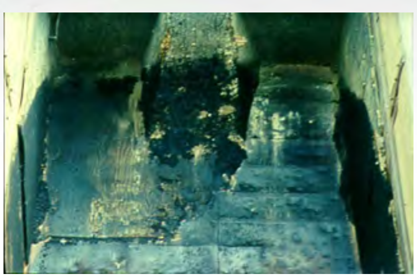
53

It is the Certified Asphalt Field Technician's responsibility to make sure that the trucks are in good condition for dumping and to be alert for hydraulic fluid leaks and any detrimental materials that may be deposited on the highway.

## Truck Bed

### Problems

- Dent or Damaged
- Wrong or excessive truck release agent
- Unclean Bed

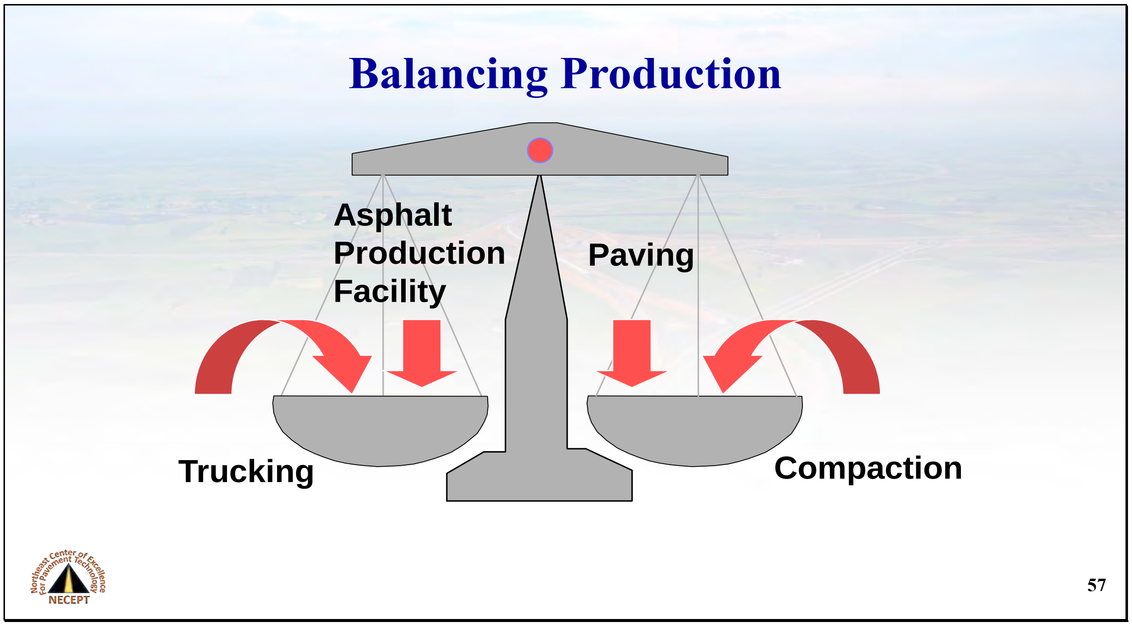


54

Be SAFE when checking the bed condition of an empty truck at the paver or MTV hopper after unloading!!!


The solution is to prepare a smooth, clean truck bed with the use of proper release agents.


Dumping the asphalt mix on the mat is another problem that can occur on the project. The truck box needs to be lowered before pulling out of the hopper to avoid having the tailgate drag the asphalt mix onto the mat which will then be driven over by MTV or Paver. Trucks must clean out at designated areas, NOT on the roadway.




This may not be the technician's responsibility; however, it is something that should be known by the technician. Paving is a constant balancing act. Mix production and delivery must be balanced with laydown and compaction to ensure smooth operation and a high-quality mat. Remember, the purpose of the haul vehicle is to transport the asphalt mixture from the asphalt plant to the paver without delay and with minimal change in the characteristics of the mix during the delivery process and without segregation.

## Scheduling Problem

**How do you determine the number of trucks needed to balance production rates?**

NECEPT

58

Average Truck Capacity (SIZE): 20 net tons

Total Truck Trips Needed (TRIPS):
= MIX ÷ SIZE = 1800 ÷ 20 = 90 trips = TRIPS

Truck Cycle (in minutes):
Delay at Facility : 8
Load Time : 5
Ticket & Tarp : 3
Haul to Job : 15
Delay on site : 7
Dump/clean up : 7
Return Haul : 15
=============================
Total cycle in minutes = 60 ÷ 60 min/hr
= Truck Cycle (CYCLE): 1 hours/trip

Number of Trips per Truck (LOADS):
= TIME ÷ CYCLE
= 10 ÷ 1 = (Round down) 10 trips/truck = LOADS

Number of Trucks Needed (TRUCKS):
= TRIPS ÷ LOADS
= 90 ÷ 10 = (Round up) 9 total trucks = TRUCKS

Is TRUCKS x LOADS ≥ TRIPS? ( 9 ) x ( 10 ) = ( 90 ) ≥ ( 90 )

59

Use the Mix Delivery Production Calculation Form

## Extenuating Circumstances

**What kind of situations**

**have you experienced?**

**What about rain?**

60

Can you think of any other extenuating circumstances that can cause a disruption in the delivery process thereby disrupting the continuity of the paving project? What do you do when it rains? How do you prepare for the possibility of rain ? What about the tack coat?


Judgment is required when rain occurs during paving. If the existing pavement surface contains puddles of water, placement of the asphalt should not be continued.


Safety is THE top priority concern. Keep the site clean and traffic controlled.

# They could use these guys!


NECEPT

65

## Module 5 - Review of Objectives

**We discussed**

- Types of Trucks
- Loading the Truck
- Delivery to the Site
- Unloading at the Paving Site
- Issues and Problems

NECEPT

66

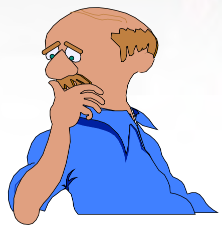

PennState
Discussion
pennsylvania
DEPARTMENT OF TRANSPORTATION
NECEPT
67

# Quiz

## Module 5

## Delivery

?





**1. Trucks used to haul asphalt mixes are special trucks that should not be used for any other purpose.**

a. True

b. False

**Answer:**

**2. An improved truck design that is now being used to haul asphalt mixes features a semi-circular shaped bed.**

a. True
b. False

**Answer:**



**3. Tarps are not required on clear sunny days.**

a. True
b. False

**Answer:**

**4. Fuel oil is an excellent truck release agent that is recommended by the Department.**

a. True
b. False

**Answer:**





**5. How the truck is loaded at the plant may cause segregation in the mat.**

a. True
b. False

**Answer:**

## 6. Information included on a delivery slip includes

a. Supplier Code
b. SRL
c. Design ESALs
d. All of the above

**Answer:**

NECEPT



## 7. When backing into the paver, the truck driver should back in until he hits the push rollers on the paver.

a. True
b. False

**Answer:**

NECEPT

**8. When the air temperature is below 50$^{o}$F from October 1 to April 30, haul trucks should be insulated or have a double-walled body, or have a heated truck body.**

a. True
b. False

**Answer:**

NECEPT



**9. Poorly maintained trucks with hydraulic leaks can lead to pavement maintenance problems.**

a. True
b. False

**Answer:**

NECEPT

## 10. Before loading, truck beds should be

a. Clean

b. Smooth and free of dents and depressions

c. Sprayed with proper release agent and properly drained

d. All of the above

**Answer:**

AGGREGATE BUILDING MATERIALS
CONCRETE PAVING
ASPHALT SWEEPERS
SAND LOWBEDS
TRUCK RENTALS

# Jay's Asphalt Company

**Pine Grove, EN**

**Quality Building Products**

**717-545-0458**

TICKET NO.

| Cust. No. | Order No. | Purchase Order No. | Zone | Date | Time |
|---|---|---|---|---|---|
| 512345 | 2001 | 123456789 | CL02 | 08-15-02 | 10:46 |

| Customer: | Deliver To: | | | |
|---|---|---|---|---|
| Summer Construction Company. Inc. | SR 0581 (004) state | Gross | tn | 36.34 |
| | | Tare | tn | 14.40 |
| | | Net | tn | 22.03 |

| Job No. | Truck No. | Hauler | Loads to Job | Quantity to Job |
|---|---|---|---|---|
| 1717 | 487 | Klinger, Charles | | 93.56 |

| Prod No. | Product Description | Unit of Meas | Meth of Pay |
|---|---|---|---|
| 456 | 9.5mm 3-10 million esals SRL H SP 9.5) | tn | Regular |

| Weighmaster Name | Plant Name | Dept | Quan | Unit Price | Amount |
|---|---|---|---|---|---|
| Roger Horner | Pine Grove Furnace | | | | |

Weighmaster License No.

Prices are based on delivery point being accessible by truck. Damage to curbs, sidewalks, driveways, lawns, and private property are the customer's own responsibility.

X

HAUL CHARGE
MIN CHARGE
SUB TOTAL
TAX
TICKET TOTAL
JOB TOTAL

INSTRUCTIONS:

BATCH WEIGHTS:

FOR OFFICE USE ONLY

1463847

Thanks
We sincerely appreciate your business

Received the above quantity in good condition except as noted on the reverse side

Received By X

Purchaser or Authorized Representative

SIGN & RETURN

1

**MIX DELIVERY PRODUCTION CALCULATION FORM:** **(U.S. Units)**

Date:______________________ Project #: _______________

Project:__________________________________________________

**Tons scheduled to be placed today (MIX):** __________ tons

**Hours of paving scheduled (TIME):** _________hours

**Rate of mix needed to be delivered to jobsite (H-RATE):**
= MIX ÷ TIME = _______ ÷ _______ = _______ tph

**Rate of mix available from HMA facility (F-RATE): =** ______ tph

STOP: Is the H-RATE slightly greater than or equal to the F-RATE?

**Average Truck Capacity (SIZE):**_______net tons

**Total Truck Trips Needed (TRIPS):**
= MIX ÷ SIZE = _______ ÷ _______ = _________ trips = TRIPS

**Truck Cycle (in minutes):**
Delay at Facility :_____
Load Time :_____
Ticket & Tarp :_____
Haul to Job :_____
Delay on site :_____
Dump/clean up :_____
Return Haul :_____
==============================
Total cycle in minutes = _______ ÷ 60 min/hr
= **Truck Cycle (CYCLE):** ______ hours/trip

**Number of Trips per Truck (LOADS):**
= TIME ÷ CYCLE
= _______ ÷ _______ = (Round down) _______ trips/truck = LOADS

**Number of Trucks Needed (TRUCKS):**
= TRIPS ÷ LOADS
= _______ ÷ _______ = (Round up) _______ total trucks = TRUCKS

Is TRUCKS x LOADS ≥ TRIPS? (______) x (______) = (_______) ≥ (______)

N
E
C
E
P
T

# HMA Pavement Construction Program

Certified Asphalt Field Technician
Course of 2025

# Module 6:
# Asphalt Mixture Placement

Northeast Center of Excellence for Pavement Technology
NECEPT

# Asphalt Construction Program

## Certified Asphalt
## Field Technician - 2025

## Module 6:
## Asphalt Mixture Placement

NECEPT

1

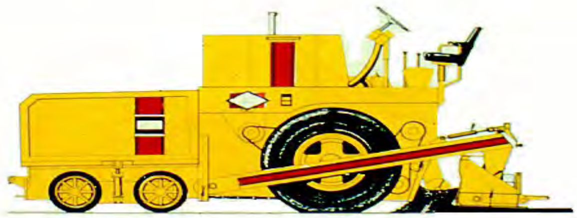
In this module, we will discuss the placement of the Asphalt Mixture on the prepared base using an asphalt paver.

## Module 6 – Objectives

- **Asphalt Paver**
  - Components & Function
  - Grade & Slope Control Systems
- **Operating Techniques**
  - Initial Paver Preparation
  - Operational Principles of Screed
  - Paver Operation
- **Paving Issues & Problems**

2

- **Two Components:**
  - Tractor Unit: supplies all power
  - Screed Unit: simply pulled behind paver



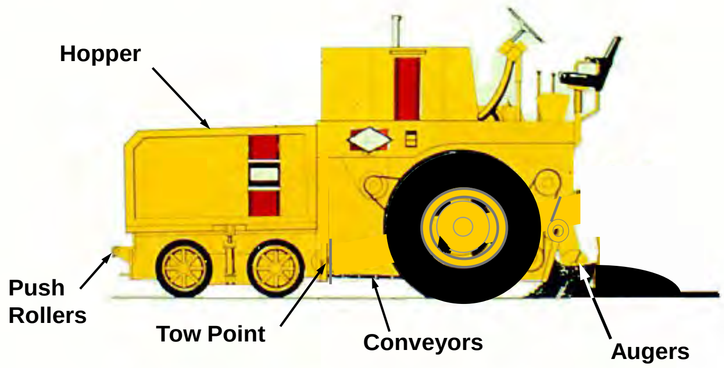
NECEPT

3

The Paver is the primary piece of equipment on any paving project and its main function is to transfer the material from the truck to the pavement surface and place the asphalt material at the required width, thickness, and cross-slope, while producing a satisfactory mat texture.

## Tractor

- **Provides power**
- **Carries mix from hopper to screed.**




NECEPT

4

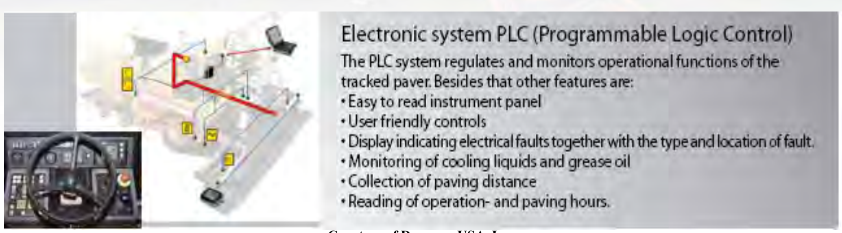
The tractor unit provides all of the power for the paver and delivers the mix to the screed unit.

## Tractor Unit Components

- **Paver Controls**
- **Drive Systems**
- **Push Rollers and Truck Hitches**
- **Material Feed System**
  - Hopper
  - Slat Conveyer
  - Conveyer Flow Gates
  - Augers
- **Tow Points**

NECEPT 5

## Paver Operation Controls




Courtesy of Dynapac USA, Inc.

NECEPT 6

Many new pavers are equipped with programmable control systems to regulate and monitor all operational functions of the unit, and record paving data (operation hours, paving hours, paving distance, etc.)

## Paver Drive Systems



- **Rubber tired pavers**
  - moved more readily
  - faster paving speeds
- **Track pavers**
  - spread weight over larger area, better on soft base
  - more effective on paving grades.
  - More maneuverability

NECEPT 7

The tractor engine provides hydraulic and mobile power to the tires or tracks. Tires may be ballasted with a calcium chloride solution to increase traction. The tracks can be all steel, steel with rubber pads, or flexible bands with steel shoes and rubber pads.

## Front Wheel Assist

**Increases tractive power**

NECEPT 8

Many rubber tire pavers also include a front wheel assist option, WOW--- 6-wheel Drive.

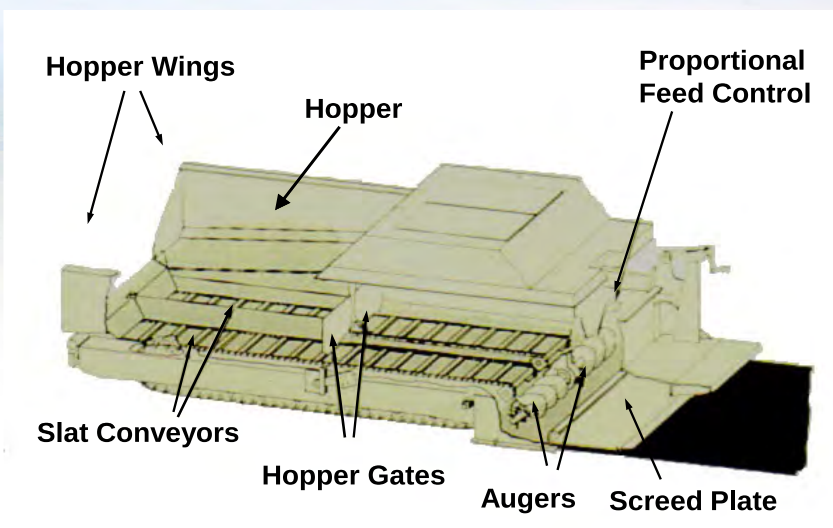
## Push Rollers & Truck Hitches


- Truck rests against push rollers, paver pushes truck
- Kept clean and free to rotate while pushing
- Truck hitches maintain contact with paver

9

On the front of the paver are the rollers for pushing the truck, and the hitches to prevent the truck from drifting out of the hopper. Hitches are to be released before allowing truck to leave the area!!!!!!!!

## Material Feed System Components




10

The goal of the material feed system is to get a constant head of material in front of the screed. If the material feed system is operating properly, the slat conveyors and augers will rarely shut off. This is accomplished by setting the proper position on the hopper flow gates and using the correct speed on the slat conveyors and augers. If the conveyors and augers are at constant speed (only on or off), the flow gate settings control the flow. For variable speed augers and conveyors, material flow is controlled by all three.

## Hopper

Hopper receives mix from truck to feed conveyors

Flashing Or Overflow Guards

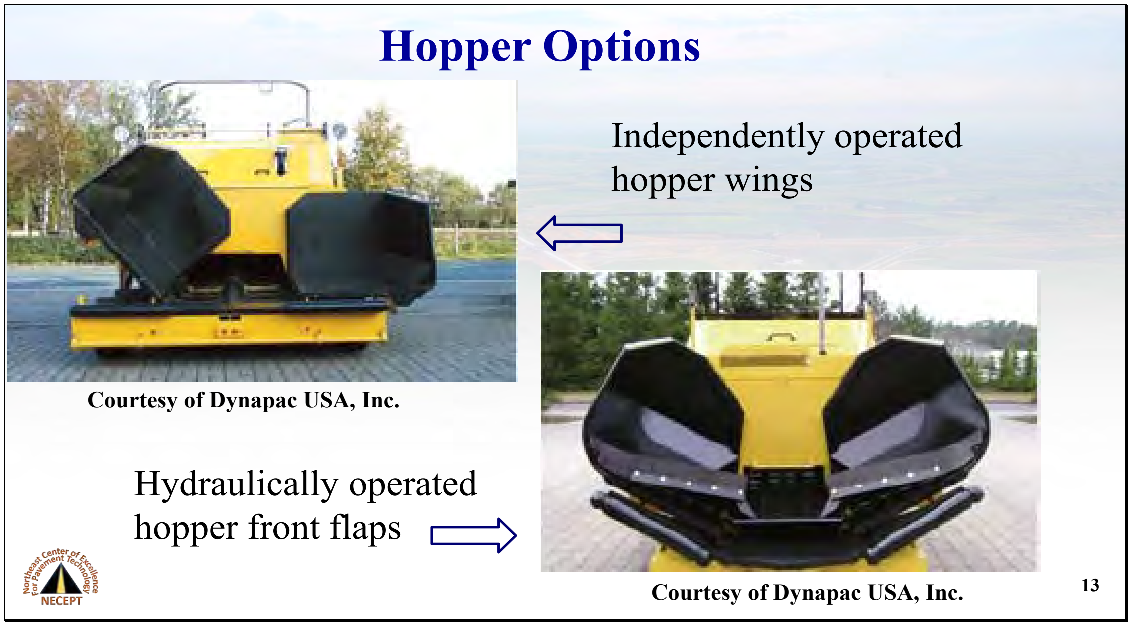
NECEPT 11

The hopper must be wide enough to allow the bed of the truck to fit inside and low enough to allow the truck bed to be raised without placing weight on the front of the hopper.
Flashing or overflow guards on the front of the hopper keep mix from spilling onto the pavement. The flaps are a thick, flexible rubber or polymer and must be replaced when damaged or worn. Folding the hopper wings of the paver should be avoided when the hopper is nearly empty, and the slat conveyors are exposed.

## This needs to be cleaned up!!!

NECEPT 12

This should clean easily, NO TACK!!!!!!!




Options available include independently operated hopper wings and hydraulically operated front hopper flaps.


At the bottom of the hopper are slat conveyors. They transport the mix from the hopper back through the tunnel in the tractor unit to the augers, each of them feeding one side of the screed.

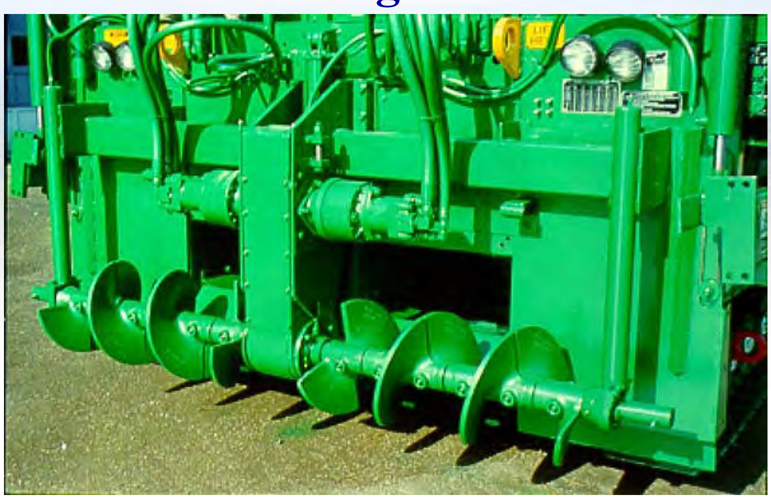
## Conveyer Flow Gates

Gates regulate amount carried to augers

15

Above the slat conveyors at the back wall of the hopper are the adjustable flow gates which regulate the amount of mix carried to the augers The goal is to have the flow gates set during the paving operation so that the slat conveyors keep running continuously. On some pavers, a sensor is located behind the flow gates to monitor the amount of mix passing into the tunnel and alert the operator of a low material flow or no flow condition. One paver manufacturer has replaced the slat conveyors with auger screws running from the hopper back to the screw augers.

## Augers



Augers spread mix laterally in front of screed.

16

The augers operate independently of each other, and the optimum depth of material is best controlled by a sensor at each end plate. Note that there are no kickback paddles installed on these augers.

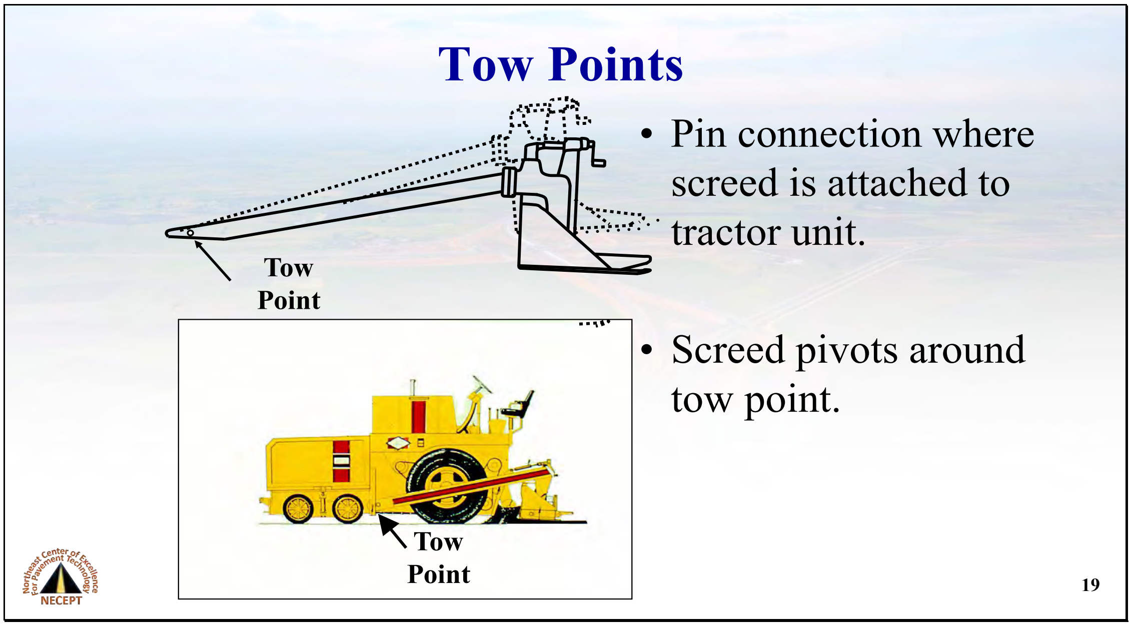
## Kick Back Auger Paddles

17

## Material Feed System

- **Goal:**
  - Provide constant head of uniform and unsegregated material in front of screed
- **Approach:**
  - Provide sufficient supply of material with proper position on flow gates and correct conveyor and auger speed
- **Controlling Factors:**
  - Speed of the paver
  - Depth and width of mat

18

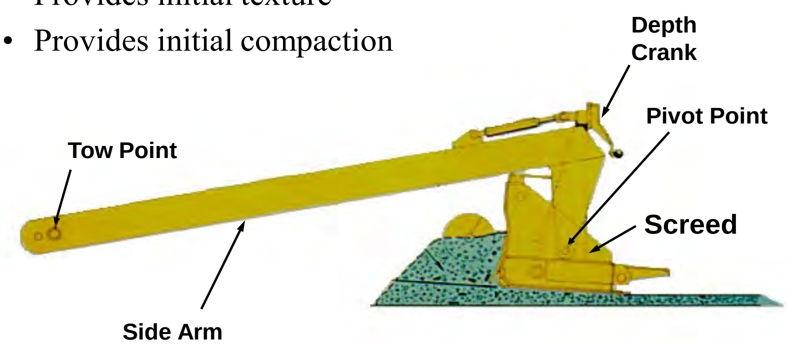



The screed is merely towed behind the tractor, “free floating”


The tow points can be hydraulically raised or lowered as necessary and are usually connected to an automatic grade and slope control system. The position of the tow point can affect screed performance, mat appearance and pavement life.

## Screed

- Establishes thickness
- Provides initial texture
- Provides initial compaction




NECEPT

21

The second component of the paver is the screed unit which is towed by the tractor and controls the thickness, initial density, and smoothness of the mat.

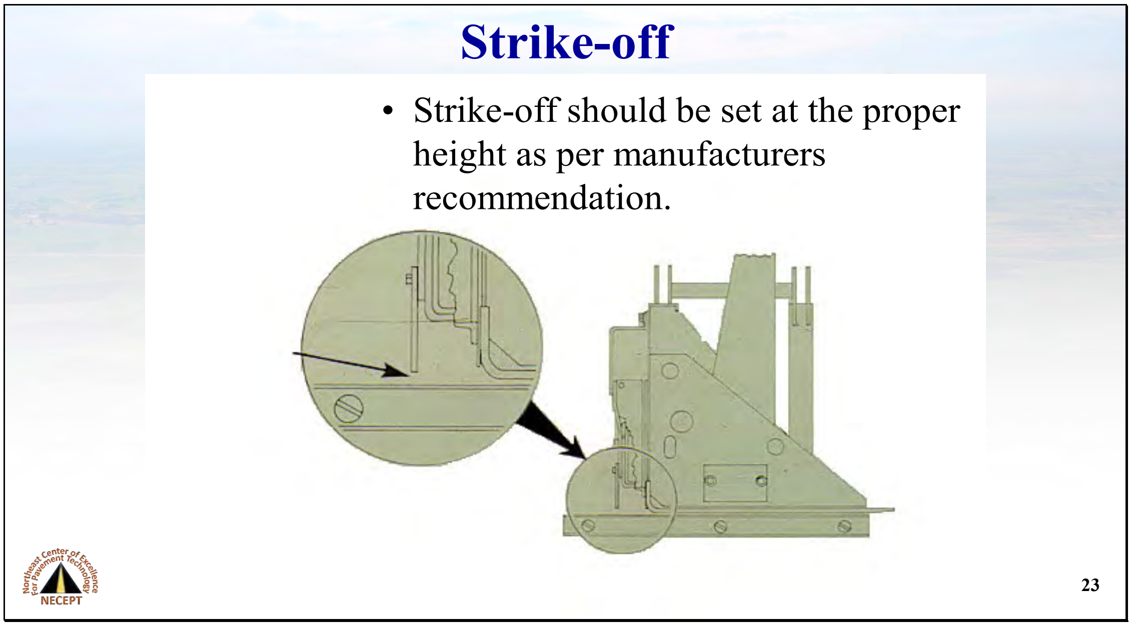
## Screed Unit

- Screed plate
- Strike-off
- Crown control
- Screed Vibrator
- Screed Heater
- Thickness Control Screws

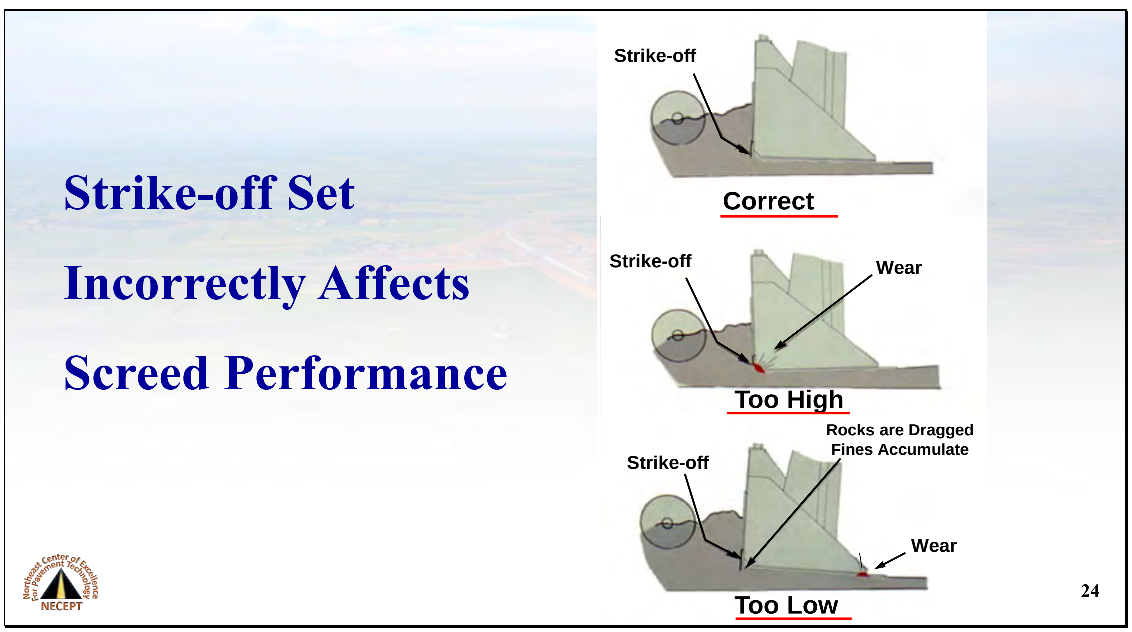
- Screed Arm
- Extensions & end plates
- Electronic Controls

NECEPT

22



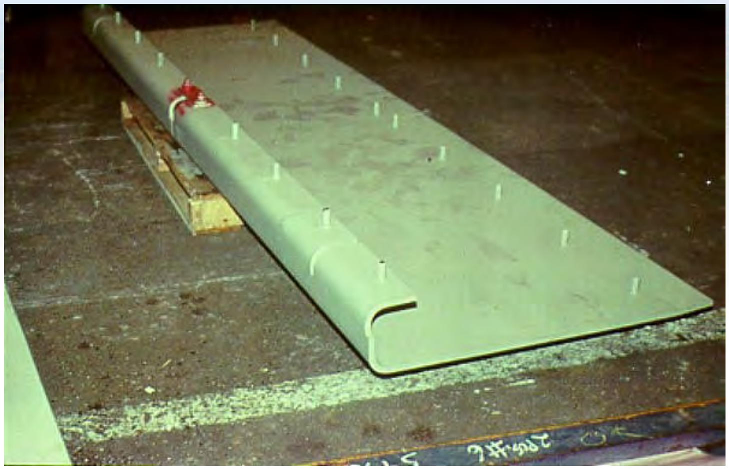

Typically, a strike-off (or pre-strike-off) plate is mounted in front of the leading edge of the screed to regulate the amount of mix fed under the screed. This plate also reduces wear to the leading edge of the screed.




If the strike-off is too high, too much material is fed under the screed, causing it to rise. The screed would have to be pivoted forward around the tow point to compensate, causing high nose plate wear. If the strike-off is too low, too little material goes under the screed. The screed would have to be pivoted backward, causing high tail wear. Correct setting is needed for a quality mat appearance and maximum density.

## Screed Plate

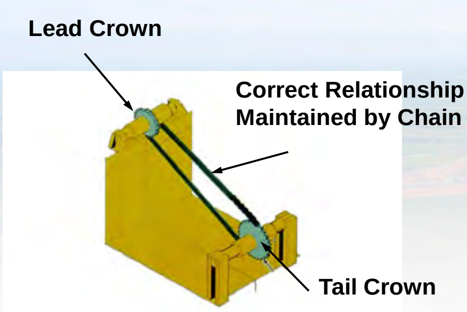
Screed Plate should be smooth & not warped



25

The screed plate is bolted to the bottom of the screed and works much like a hot iron to smooth out the surface of the mat and creates the initial texture and density of the mat. The cut at the center of the nose of the screed allows the plate to be flexed to form a crown in the mat.

## Crown Control



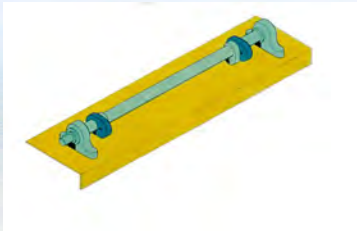

Positive & negative crown profiles

-2% to +4%

Courtesy of Dynapac USA, Inc.

The screed plate can be flexed at its center to provide a variable amount of positive or negative crown to the mat. A turnbuckle device is used to obtain the desired profile. *Lead crown* is the relationship between the front and rear edge of the screed and should be adjusted according to the manufacturer's specifications.

## Screed Vibrators



Vibratory Shaft with Weights

- Initial compaction
- Vibration created with rotating shaft that contains eccentric weights.
- Compaction controlled by speed of rotation and position of weights.
- Frequency usually set at maximum.

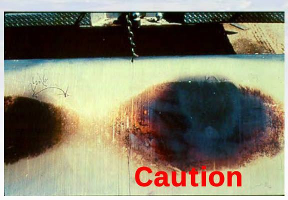
Controls to adjust tamper and vibration frequencies

**Courtesy of Dynapac USA, Inc.**

NECEPT

27

Screed vibrators provide initial compaction of the mix as it passes under the screed. The position of the weight (if changeable) is more eccentricity for thicker lifts. Typically, initial compaction = 70 to 85% of maximum density. Some new screeds are now being outfitted with both vibrators and vibrating tamper bars with controls to adjust frequencies for both.




## Screed Heaters

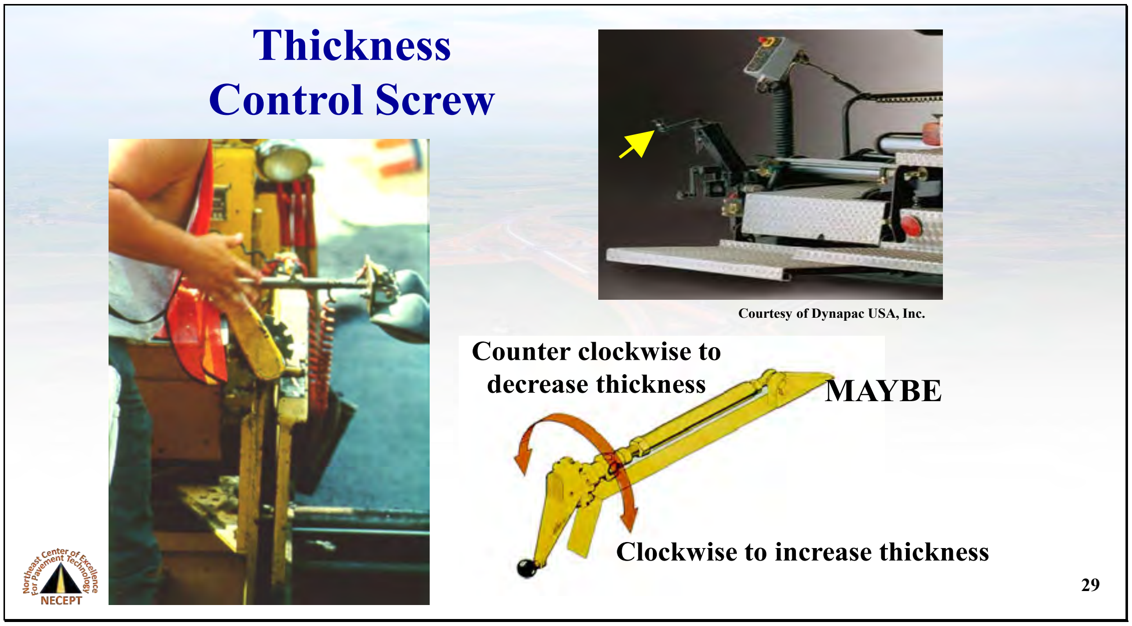
- Heat cold screed to about 300 °F prior to paving.
- Provides a more uniform surface texture.
- Prevents mix from sticking to screed plate.

Propane or electric heating with automatic temperature controls available

NECEPT

28

Screed heaters <u>cannot</u> be used to raise the heat of the mix. (The mix is not under the screed long enough.)
Don't overheat or let the heaters on too long, you can damage the screed plate.
Newer pavers have automatic controls which maintain a constant screed temperature throughout the paving operation.




The thickness control screws rotate the screed about its pivot point. The rotation changes the screed's *angle of attack*; as the *angle of attack* changes, the screed rises or falls to balance the forces acting on the screed, thereby changing the mat thickness

The lower picture may not hold true for all manufacturers. Many paving teams use the hydraulic controls on the toe-point to control depth, which may result in a smoother ride. The correct usage of either system is--- NO MORE THAN NECESSARY!!!!!!!!!!


The basic width of the screed (8 to 10 ft.) can be increased with rigid screed extensions. It is important that the extensions be set at the same elevation and angle of attack as the main screed and should be added to both sides equally to keep the dynamic load balanced. Auger and auger tunnel extensions should also be added when using rigid extensions, along with a strike-off extension assembly.


Hydraulic extensions can be used to create changes in slope (shoulders) . Hydraulic extensions may be in front of or behind the main screed. It is important that the extendable portion of the screed is set at the same angle of attack and aligned with the main screed to prevent a longitudinal line or a difference in mat surface texture between the main screed and extension may occur. Strike-off assemblies and auger and tunnel extensions should also be utilized with any screed extension.


In this model, both the left and right extension parts of the screed are equipped with remote control units for control functions like extending, screed leveling and auger-turning direction. In addition, to produce an even homogeneous surface, grade and slope controllers are being used to check the position of the screed to a default reference.

## Remote Control for Visibility and Safety

33

## Screed End Plates

Attached to end of screed to keep mix contained.

- Held tightly to existing surface to retain mix and control width of spread.

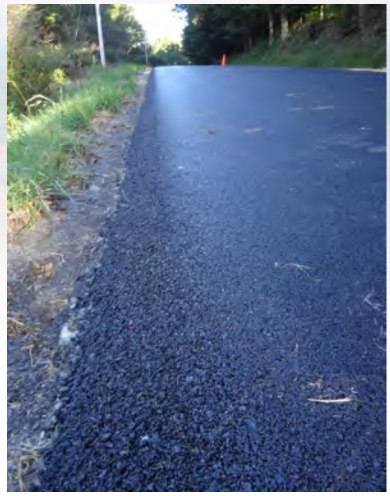
34

Some end plates are spring loaded to exert down pressure, others merely drag, and some are controlled by screw type height adjustment and are virtually rigid.



Various shaped edge plates are also available to form a required edge profile  One example is *Notched Wedge Joints*  (NWJ) *which* will be covered in Module 7.

## Safety Edge as Placed

37

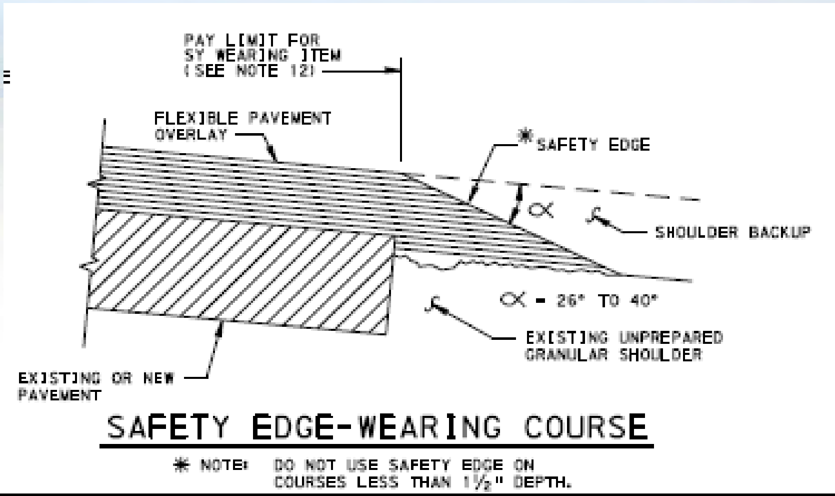
## Safety Edge

### Pavement Design Manual (Pub 13M, Chap. 12.13)

- Safety Edge formed during paving
- 30° taper at the edge of the pavement (with 26° to 40° construction tolerance)
- Device to constrain material and increase density
- Single plate strike-off is not allowed.
- Applied to both wearing and binder courses with depth of 1.5 inches or greater.
- Total depth of safety edge ≤ 5 inches
- Asphalt material incidental to the paving item

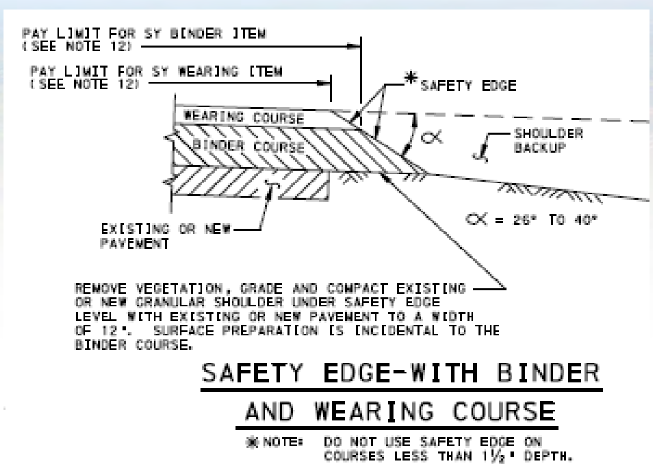
38

## Safety Edge
## Pub 72M – RC-25M




39

## Safety Edge
## Pub 72M – RC-25M




40

## Paver Maintenance

- Owner's Manual
- Routine Checks
- Routine lubrication

Courtesy of Dynapac USA, Inc.

Courtesy of Dynapac USA, Inc.

**Automatic Central Lubrication**

- Spray all parts in contact with asphalt mixtures with approved release agent before & after paving

NECEPT

41

Paver maintenance is critical to maintain optimum operations. The owner's manual should be read and followed. Routine checks and lubrication are essential, along with proper cleaning of all parts of the paver.

## Grade & Slope Controls

Courtesy of Dynapac USA, Inc.

- **Sensors**
  - Mechanical
  - Ultrasonic
  - Laser
- **Grade References**
  - Stringline
  - Mobile reference
  - Joint matching shoe

NECEPT

42

Automatic grade and slope controls  produce a smoother asphalt pavement by using a reference point to maintain the tow point elevation. Differences in pavement elevation are averaged out over longer distances by use of a stringline, ski, or sensor for reference  Grade references can be used alone on either side of the paver, or on both sides. One type can be used on one side (e.g., stringline) and another type on the other side (e.g., ski). Ultrasonic and laser technology is widely applied for grade and slope control..

## Stringline

- **Longest grade control reference**
  - Can be very accurate
- **Drawbacks**
  - Survey crew needed to set elevation
  - Difficult to use on horizontal curves
  - Easily disturbed on job site

NECEPT

43

Stringlines are no longer typically used. Laser and sonic controls are the norm, and the use of GPS technology is rapidly becoming commonplace on larger projects.

## Mobile Reference (Ski)

- Various styles
- Up to 50' length
- Non-contact styles also available

Tube with wire stretched between ends

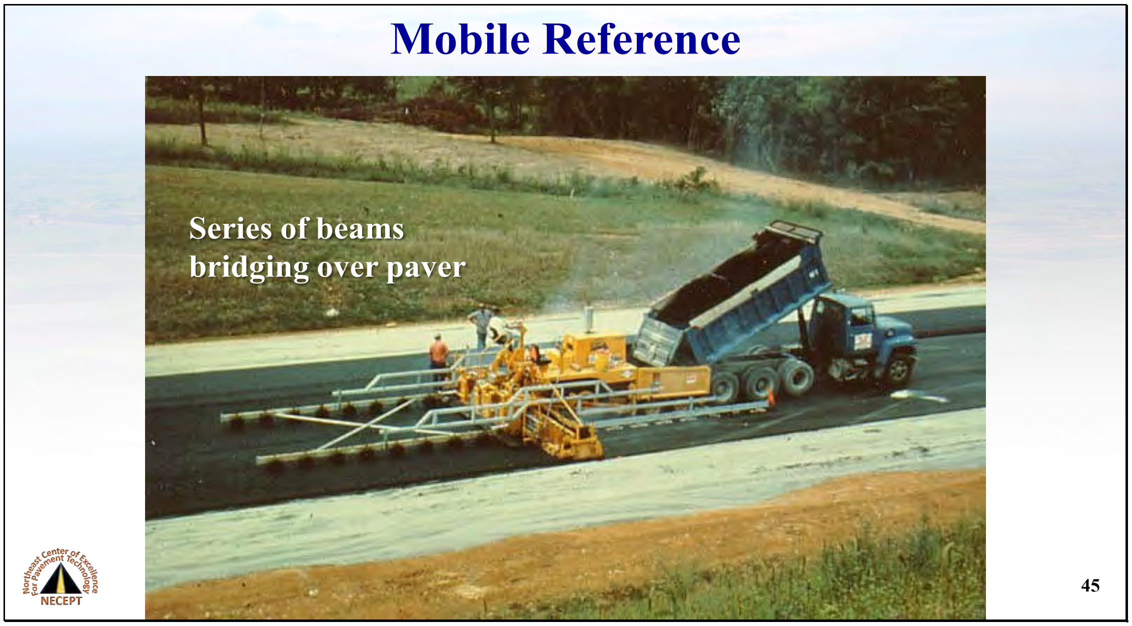
Floating beam with series of shoes

NECEPT

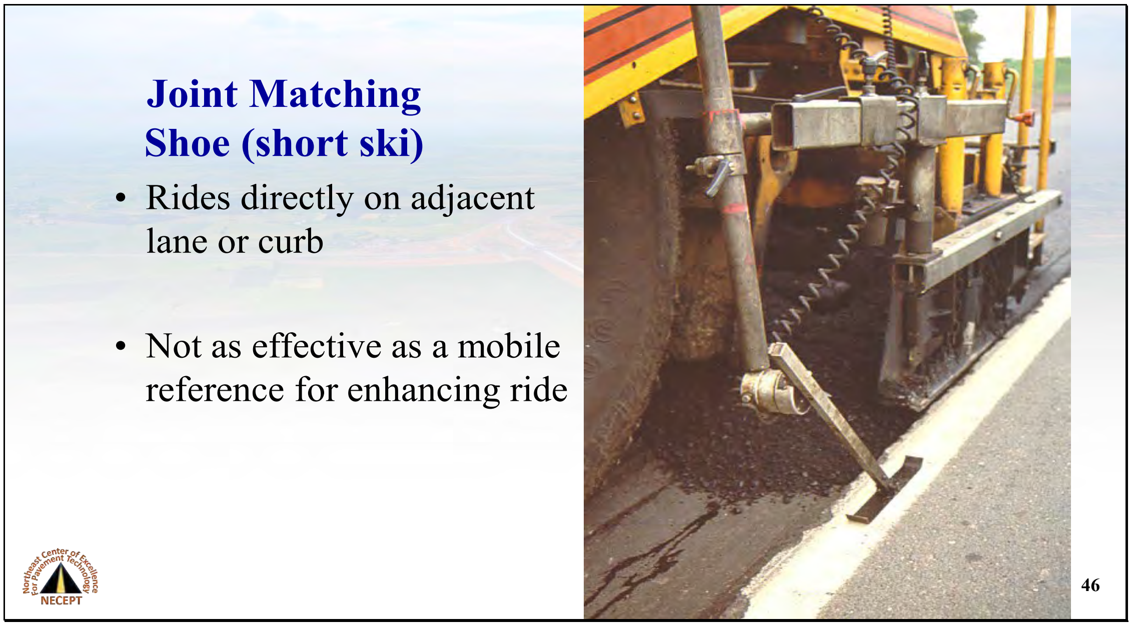
44

A mobile reference (ski) can come in various styles, although they function in the same manner. The tube rides directly on the surface, and the grade sensor rides on the wire to detect changes in elevation.

A floating beam shown in the lower photo with shoes or skis are attached to the bottom with grade sensor riding directly on the beam. Lengths up to 50 ft. are often used resulting in a smoother pavement.

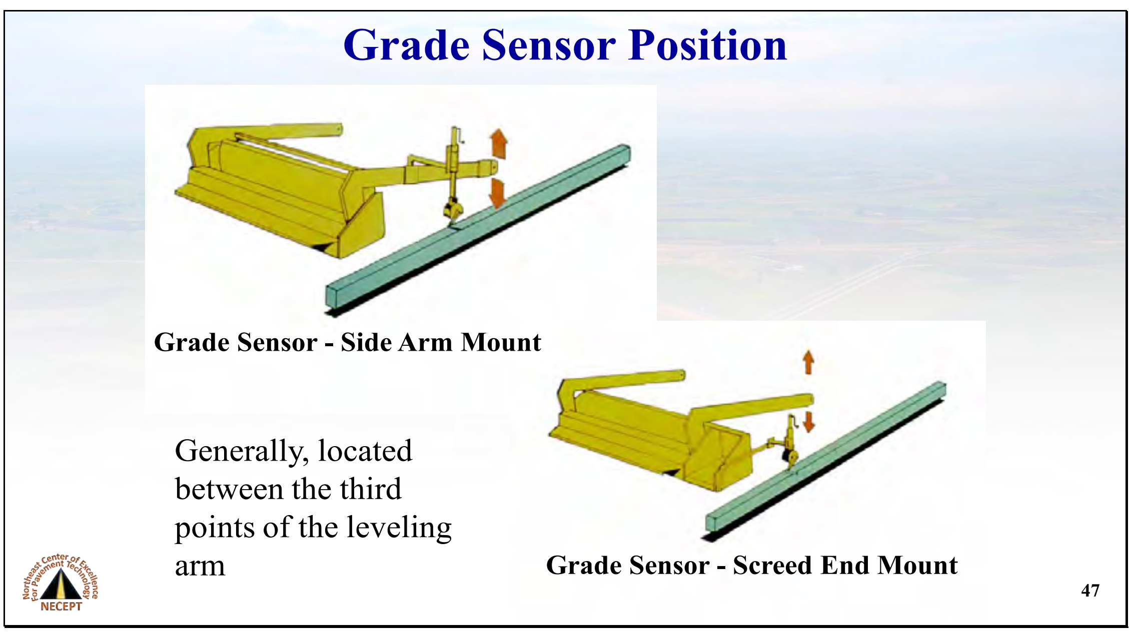



One manufacturer developed a mobile reference that bridges over the paver. One beam references the grade of the existing surface and one references the wheels behind the screed. Intermediate beams connect the two reference beams, and the grade sensors ride on them. This type of mobile reference was used on I-80 in District 3-0. The contractor received a maximum smoothness bonus on this project. Care must be exercised so that the wheels behind the paver are hot, otherwise the mixture will stick to them.

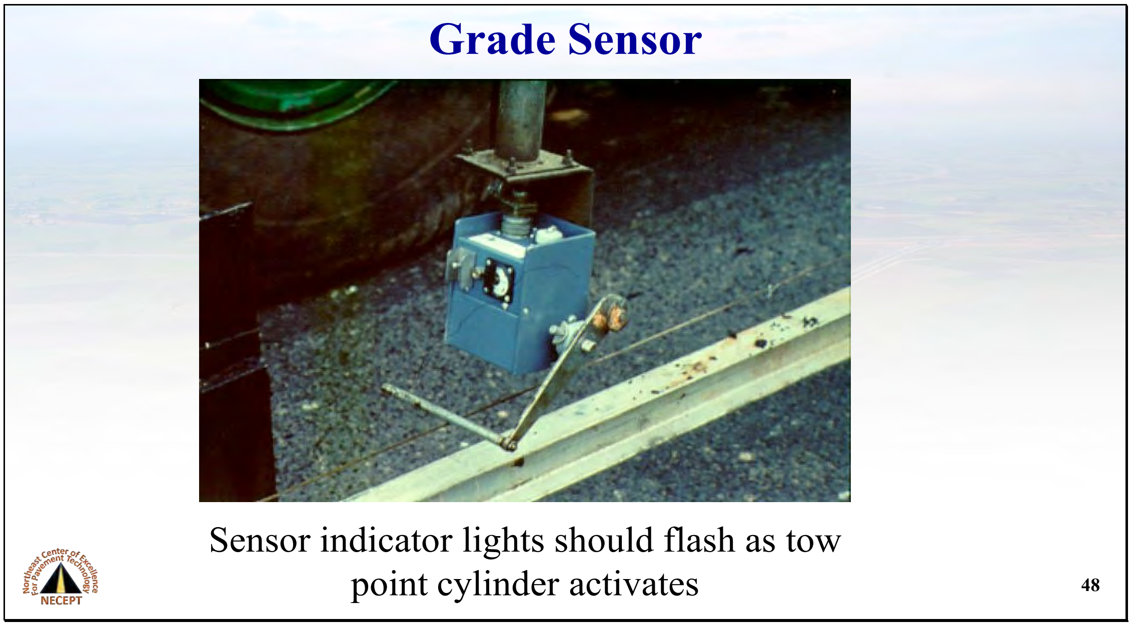



This reference is a short (1 ft.) ski that rides directly on the adjacent surface or curb. The joint shoe will provide a matching elevation across the longitudinal joint and can be teamed with an automatic slope sensor on the other side of the screed.

**NOTE:** All types of mobile reference points work on a "hunt" mode which creates a mild wave (sinusoidal) which undulates from plus to minus 1/8 inch and is visible in 30 to 50-feet repetitions.

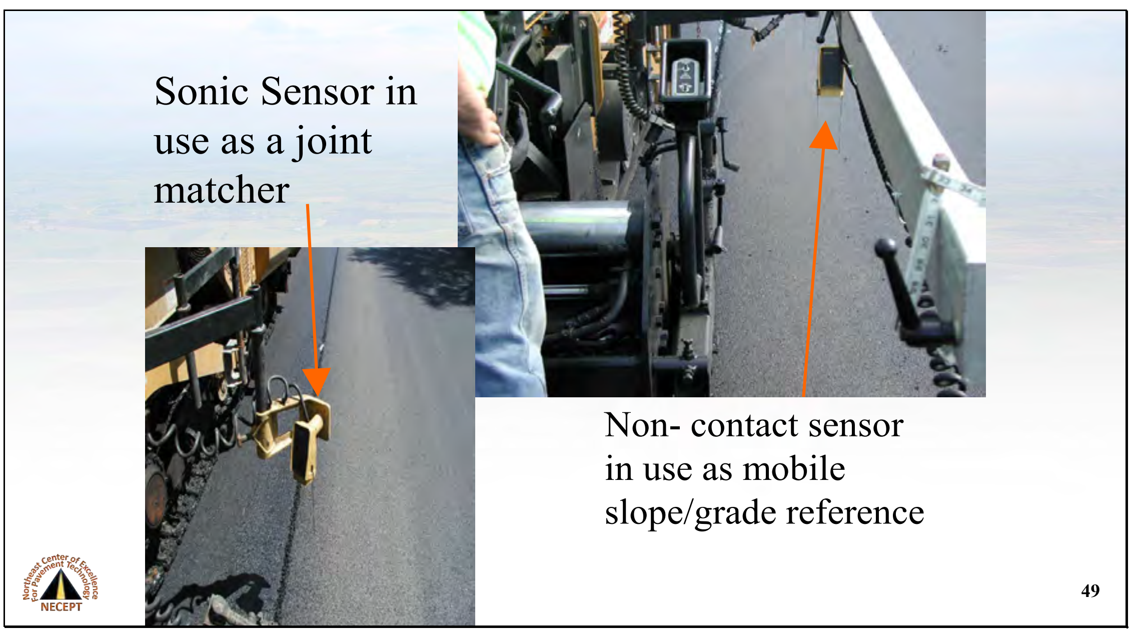



Rely on the manufacturer's paver or technology recommendations for the location of the grade control sensor. In all cases, the sensor should be in front of the screed's pivot point.




The operation of the sensor should be checked regularly. When the paver is placing a mix, the sensor indicator (either lights or a meter) should indicate movement. The tow point should also be moving in response to changes in elevation.

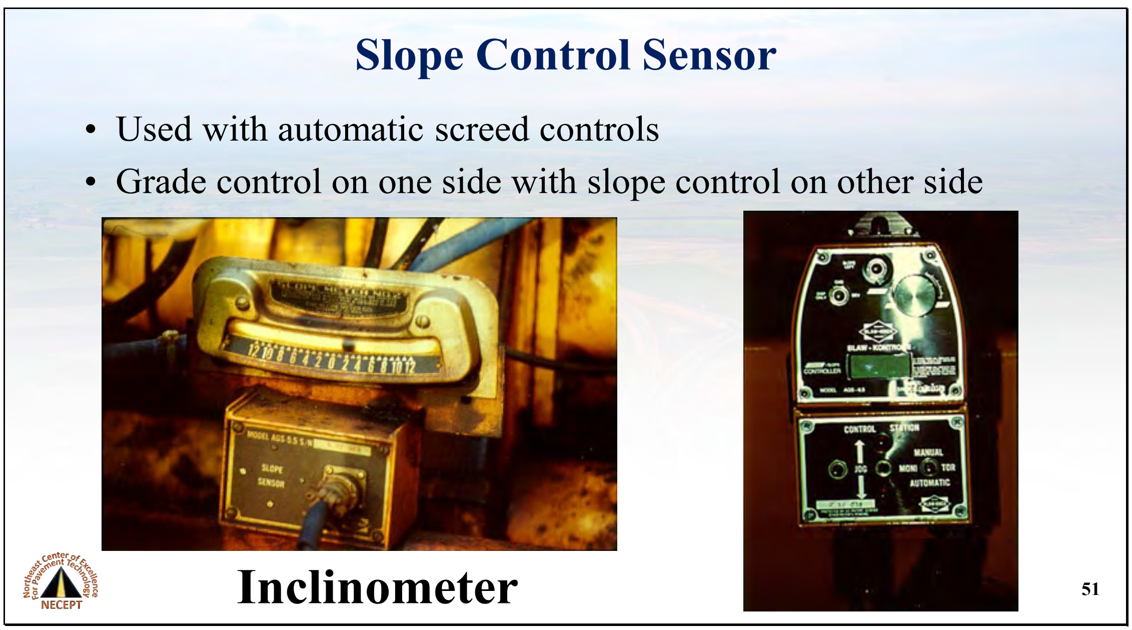
**NOTE:** A black ring will form and will be visible on the cylinder ram which controls the tow point. This ring will usually be just below the seal on the hydraulic cylinder and will vary in distance from the seal depending on action of the controls.




The use of sonic grade sensors continues to grow rapidly.

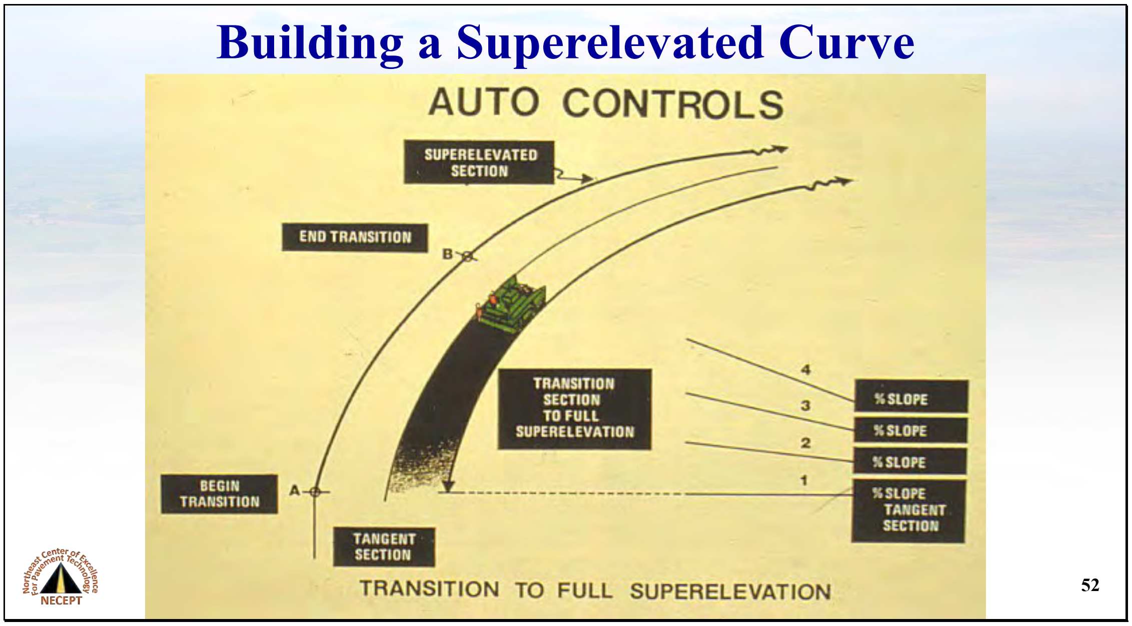
**NOTE:** A small amount of spilled material (or the toe of a shoe) can cause unwanted adjustments.


Because of their weight, these units can start to bounce!!!!!!!! What caused the white line?




Slope control is determined by a sensor attached to the cross beam between the two side arms of the screed. Typically, the grade control sensor and its mobile reference is placed along the pavement centerline, and the slope sensor controls the slope at the outside edge.

**NOTE:** If used, this system should be employed on all layers, scratch/leveling is not a layer.




For building a transition into a superelevated curve, it is good practice to supply the screed operator with a list of the station numbers and cross slopes, or have them visibly marked on the grade stakes. In superelevations, the grade (or depth) sensor is operated automatically on one side of the machine, and the slope sensor is operated manually on the other.

**NOTE:** Be aware that the percent of cross slope needs to be attained at the appropriate grade stake, It must NOT be dialed in at the stake to avoid moving the transition longitudinally.

## Operating Techniques

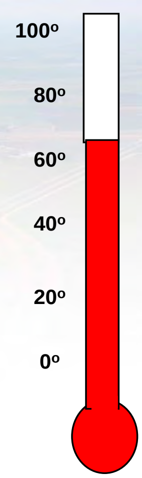
- Weather conditions
- Warming up Machine
- Positioning on Joint
- Nulling the Screed
- Initial Settings
- Charging Hopper, Tunnels, Screed
- Pulling off Joint
- Checking Mat
- Truck Exchanges

- Mainline Paving
- Transitions
- Temporary Paving
- Echelon Paving
- Night Paving
- Checking Yield
- Speed of Paver
- Screed Density

54

## Weather Conditions

- **Temperature above 40°F**
  - Air temperature
  - Surface temperature
- **No rain**




55

Weather condition must be considered. Reference Module 2 for temperature ranges for different paving courses.

## Warming up Machine

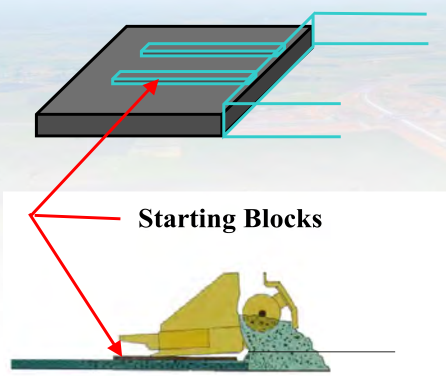
- **Warm up tractor**
- **Heat the screed**
  - Screed should not be in contact with the mat during heating
  - Screed heaters are not to be used to heat the mix!

NECEPT

56

This is a good time to give all of the equipment a thorough inspection to make sure everything is ready.
**NOTE:** Use a stringline to check screed and extensions for alignment, (both front and rear), as well as strike-off and extension height.

## Positioning Paver

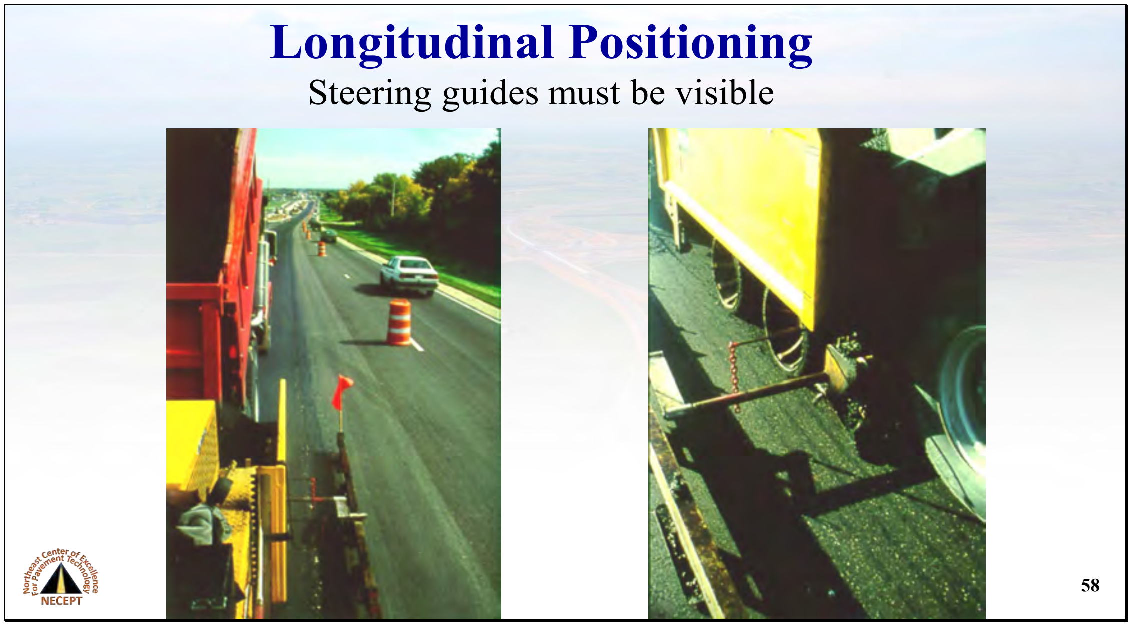



- Temporary joint is removed, cleaned, and tacked
- Straightedge cold joint
- Strike-off a little behind the cold joint ~1”.
- Starting blocks placed under the screed.
- Rule of thumb - raise screed 20 to 25% more than compacted thickness.

NECEPT

57

After the temporary joint is removed, cleaned, and tacked, the paver is ready to be positioned. Remember to raise the screed 1/4 inch for every inch of compacted mat thickness.




The first pass will determine the layout of all subsequent passes as well as the joint construction so it must be effectively and visibly referenced. The steering guide (painted orange here) must be positioned so that the operator can see the guide, any reference on the pavement, and some distance down the mat. The closer the guide is to the paver, the easier it is for the operator to utilize.

## Nulling The Screed

59

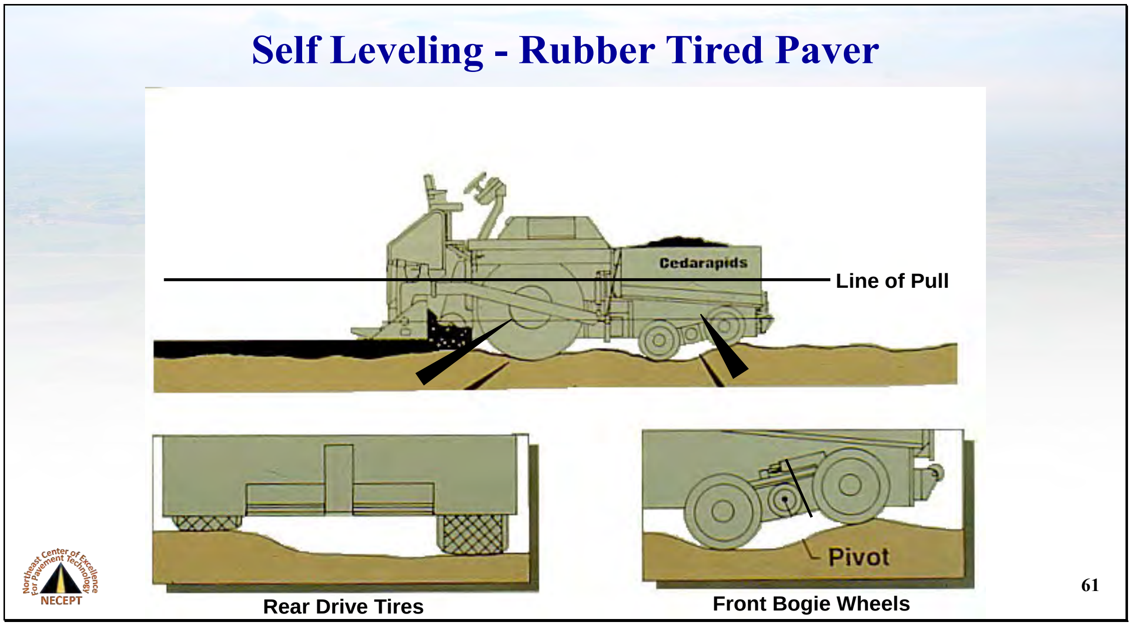
The screed must be properly nulled after setting down on the starting blocks, prior to paving. Nulling the screed removes all the tension in the screed and makes it "free-floating" on the mix. This is done by turning the thickness control screws in both directions until the screw shows some free play. Nulling is done on one side of the screed, then the other, and then the first side is checked again. Freeing up one side often induces some force on the other side.

**NOTE:** After being hauled, and sometimes when constructing a transverse joint on superelevated curves, it may be beneficial to lift the screed and set it down again and check for need to re-null. Slack take-up will vary from unit to unit as the screed contacts the resistance of the material .

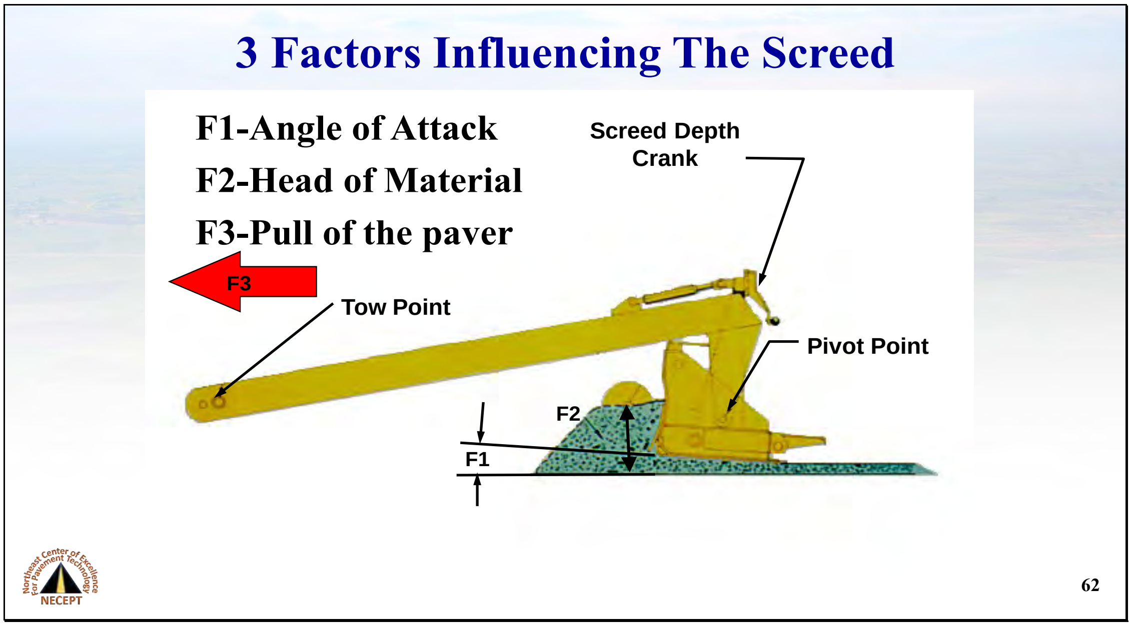
## Operational Principles of the Screed

- Self-leveling Concepts
- Screed Response versus Distance
- Forces Acting on a Screed

60

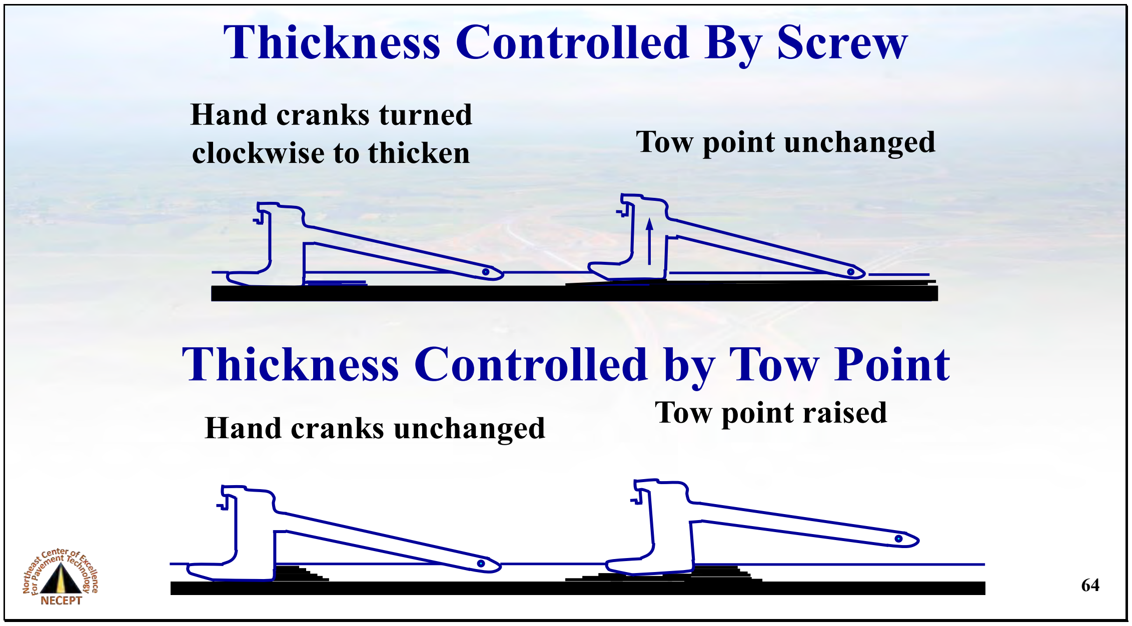



As the paver moves along the road, the tractor unit follows the ups and downs of the existing surface. While the tow point moves with the tractor, the screed reacts slowly to this and follows along relatively unchanged. In effect, the screed averages out and levels itself over these changes. Hence the term, “self-leveling screed.” One further step toward producing a level surface is setting up a reference unattached to the paver. The tow point is guided by the reference, instead of the motion of the tractor unit, to keep the screed level. Use of the reference is guided by automatic grade controls, as discussed earlier.

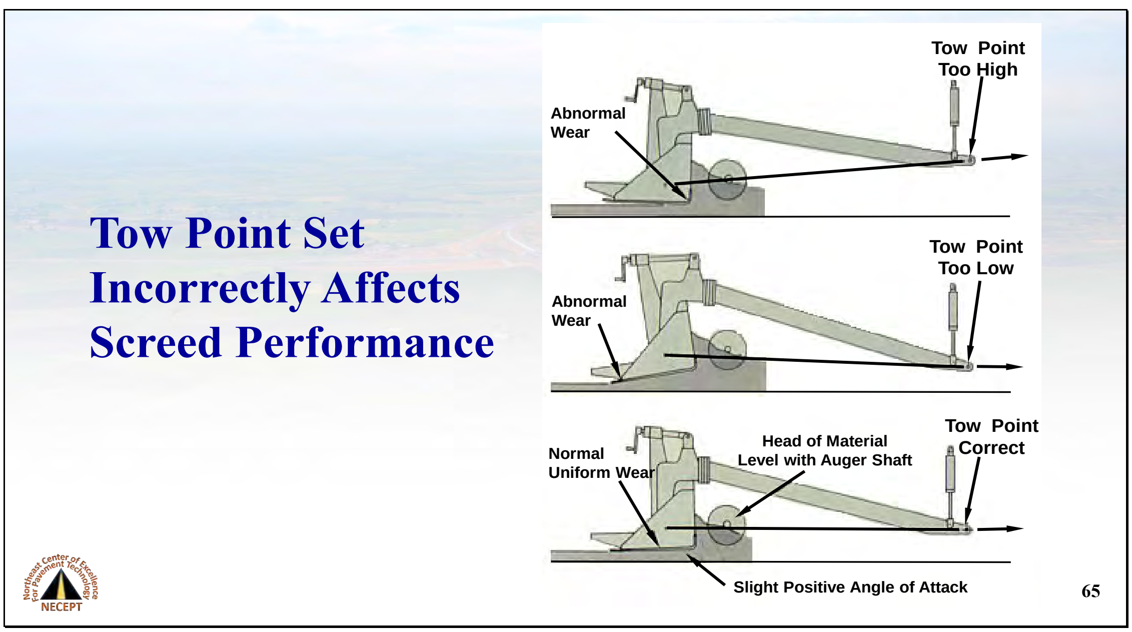



The self-leveling action of the screed means it will respond to the various factors acting on it to find its balance or equilibrium. Other factors are pre-compaction and screed weight, both of which will be influenced by the speed of the paver. The Angle of Attack is part of the initial setup, the Head of Material and Speed of Paver will be covered later.


The thickness of the mat can be controlled one of two ways: with the thickness control screws, or with the tow points.



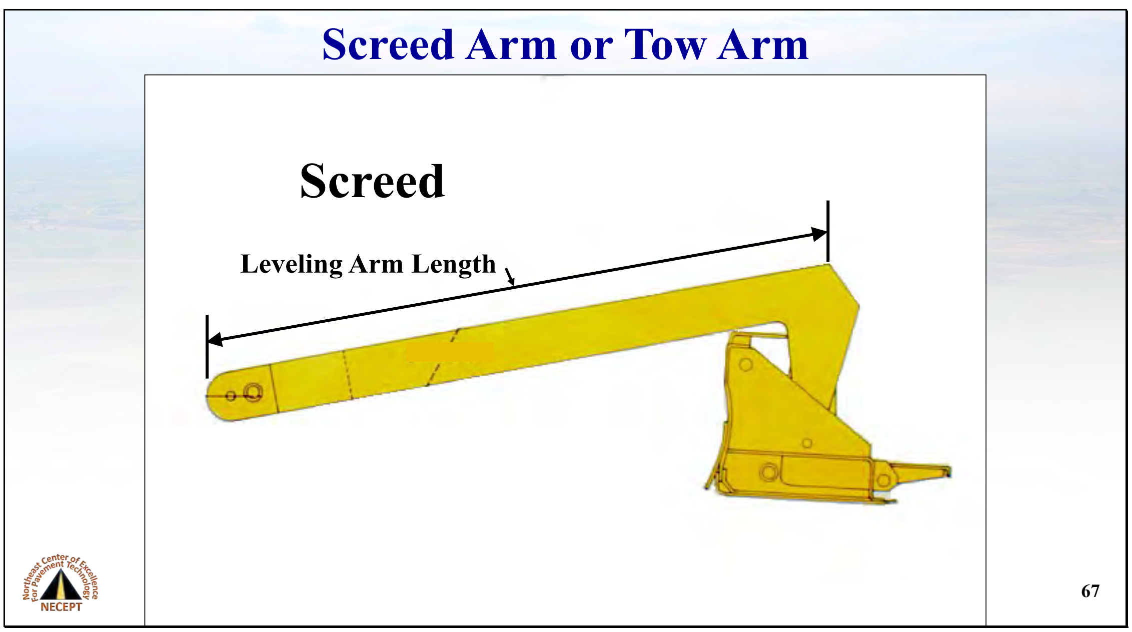

To increase depth, the hand cranks are turned clockwise (on some units), and the front of the screed is pivoted up, and the screed rises. The change in thickness is not instantaneous and happens over a length of paving. The thickness of the mat can also be controlled with tow points. To increase thickness, raise the tow point.  The screed arm (or tow arm) attaches the screed to the tow point.



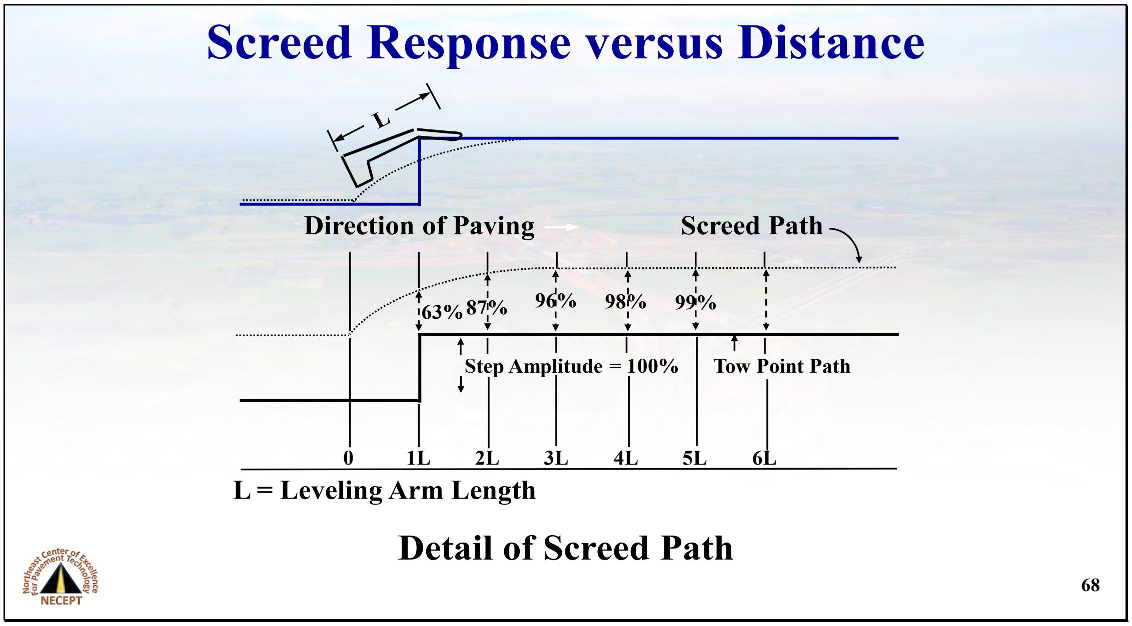

The tow point location will affect screed performance. The proper angle of attack with the screed is where the nose is slightly above the tail. The wear on the screed will be uniform if the angle of attack is adjusted properly.

**NOTE:** Usually after nulling, satisfactory performance can be accomplished by using the tow point technique


The biggest maintenance item with the screed is uneven wear on the screed plate. Heavy wear on the nose of the screed plate will result if the screed is too "nose down" in the mat.
**NOTE:** this condition is evident in the mat as a more open appearance as the weight of the tail of screed is not smoothing the mat, occasionally there will be in streaks also caused by extensions and main screed not being in proper adjustment.

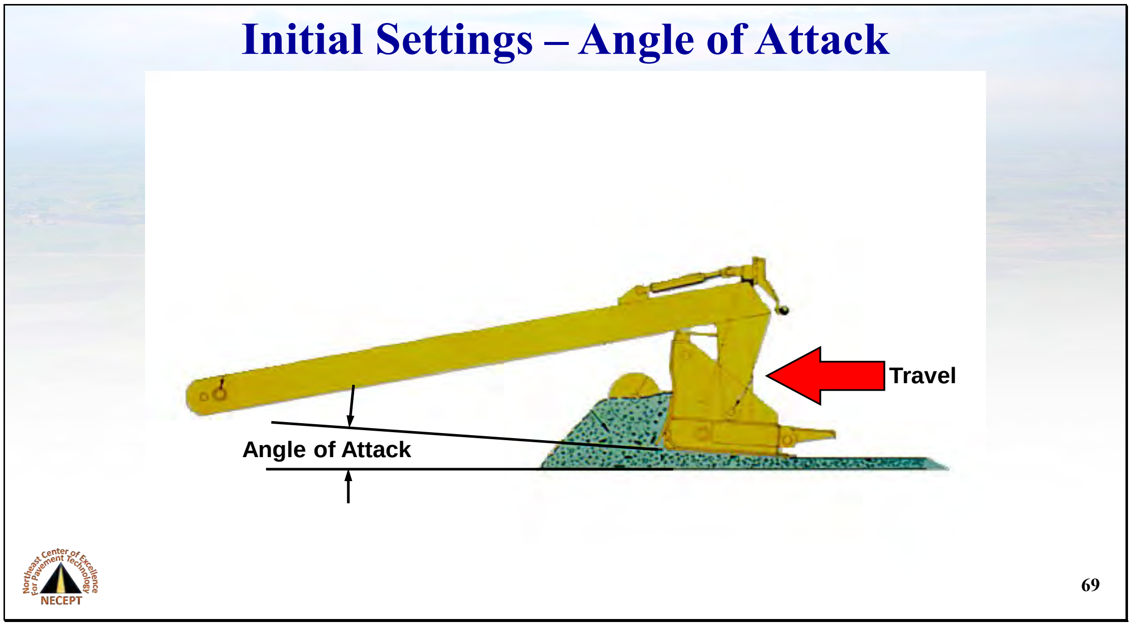



Even without automatic paver controls, the leveling or averaging effect places more mix in the low spots and less mix in the high spots. The screed levels the surface due to the fact that the screed must travel about **FIVE** lengths of the tow arm before fully reacting to any adjustments of the control screws or the tow point. After initial set-up, all adjustments should be <u>minor and infrequent</u>.

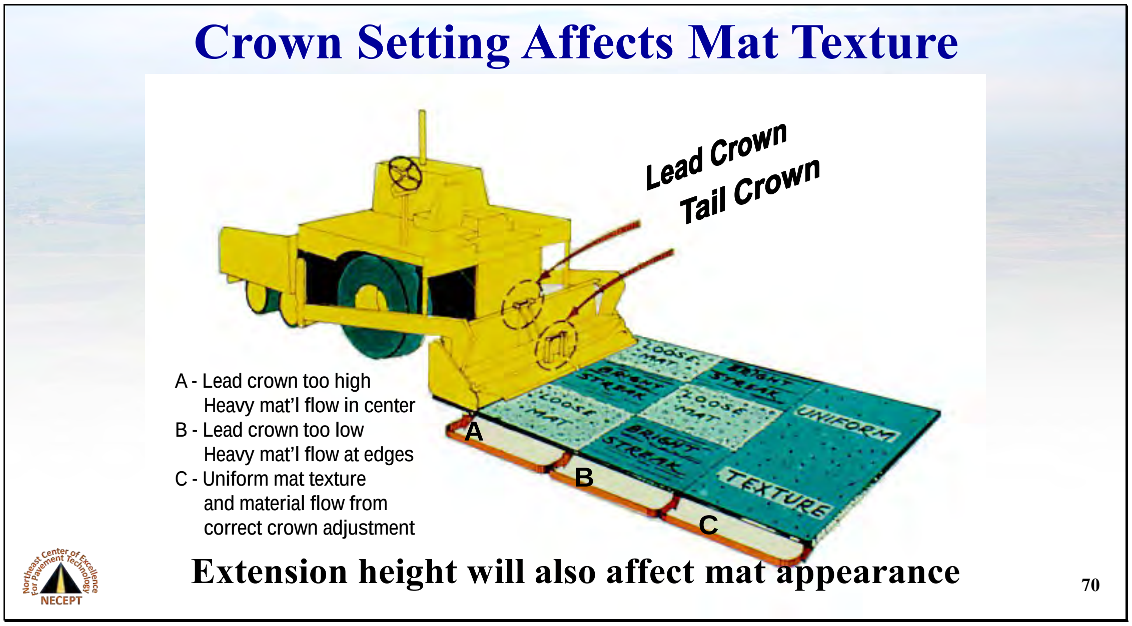



For example, if the tow arm is 8 feet long, the paver would have to move about 40 feet before the screed fully reacts to a change in thickness input into the system. From the initial set-up, all adjustments should be minor and infrequent.

**Note:** that 96% effect is attained in 3 lengths

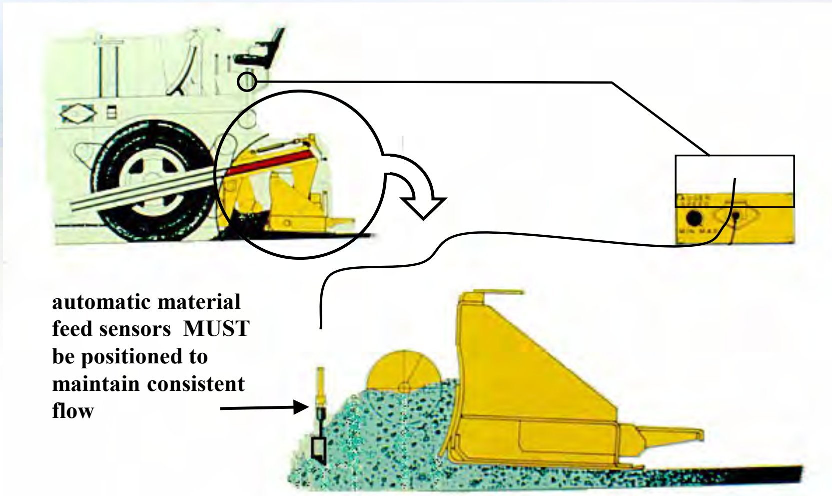



Increasing the angle of attack will increase the thickness. Decreasing the angle of attack will decrease the thickness. The initial angle of attack is induced into the screed on both sides. Extensions may also have to be adjusted, whether they are extended or kept at the main screed. If the pavement is to be crowned, the amount of crown must be induced into the screed. If hydraulic extensions are being used, any change in slope must also be made prior to starting. When paving one lane, the rear of the screed should always be straight (no crown).




If the lead crown is too high, more material will be forced under the center of the screed, and the mat will be shinier there. If the lead crown is too low, more mix will be forced under the screed at the edges. A difference in texture will result from either–the loose mat texture is caused by the lower amount of material in that location. This difference in texture may also be caused by strike-off or extension height adjustment. These open or loose areas will also affect density readings. *Lead Crown* is always set as per individual manufacturer's specifications and the mat texture produced.

## Initial Settings




71

If automatic material feed sensors are being used, they must be in place and operating properly. The proper location is as close to the end of the augers as possible, just inside the end plate. The primary key to a smooth pavement layer is maintaining a head of material level with the auger shaft in front of the screed. The need to ***eliminate rolldown at the endplate*** cannot be over emphasized.

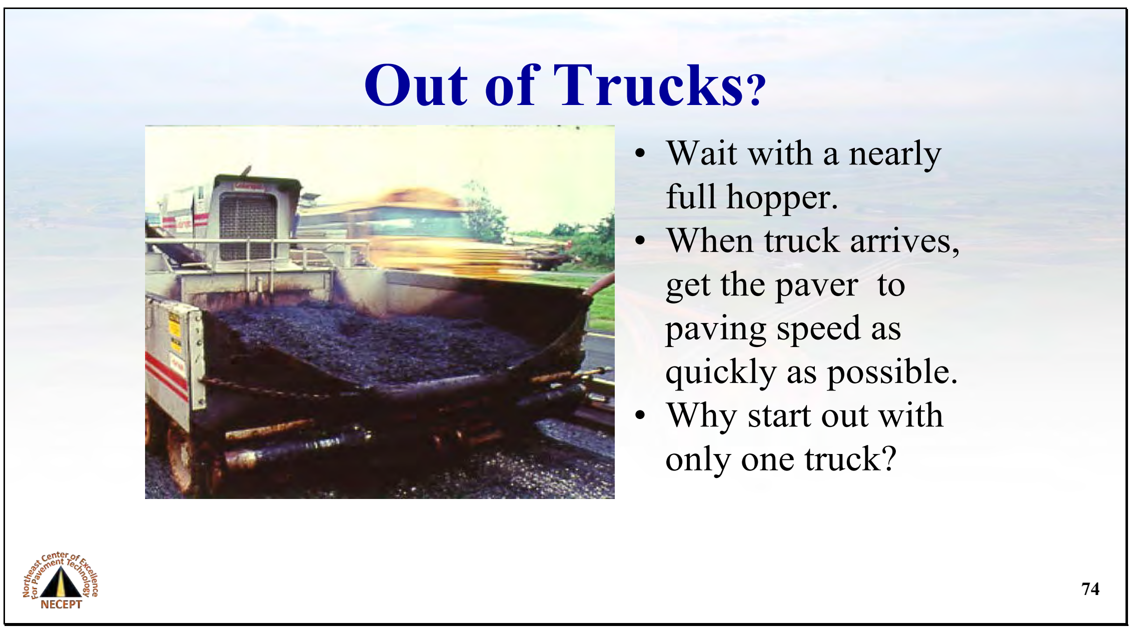
## Truck Exchanges Without an MTV

- Exchanges are important to uniform operations
- Once one truck is empty, the next is ready to back up to paver.
- The paver "picks up" the truck and pushes it forward as the box is being raised
- The truck DOES NOT back into the paver or bump it.
- Keep paver moving, no stopping

72

As we discussed earlier, truck exchanges are important to uniform production. Once the truck is empty, another should be ready to immediately back up to the paver.

Do not forget truck rule #1… "**DON'T BACK INTO PAVER**." When initially charging the paver, sometimes the second or third truckload is used because it may be hotter. Flood the hopper and begin pulling the mix to the augers with the slat conveyors.




This keeps the mix and paver warm, and the screed charged with a full head of material. When the truck arrives, have the bed raised and ready to flood the hopper. When the truck is picked up by the paver, release the gate and flood the hopper. If the paver stops frequently, a speed adjustment may be necessary.

**NOTE:** It is **NOT** recommended to start when only one truck is in front of the paver!!!!!!!!!!!!!!!!!!

## Charging the Screed

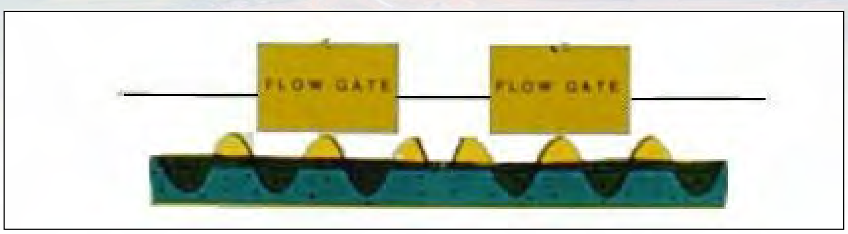
- Need a uniform head of material
- The ideal head of material covers the center of the screw augers

NECEPT 75

The second and maybe most important factor affecting the screed **is the *head of the material***. As the amount of asphalt material in the auger chamber against the screed changes the net force acting on the screed also changes. Some paving experts maintain that 90 to 95 % of the mat problems can be solved by maintaining **a uniform head of material during operations**.

## Charging The Screed:

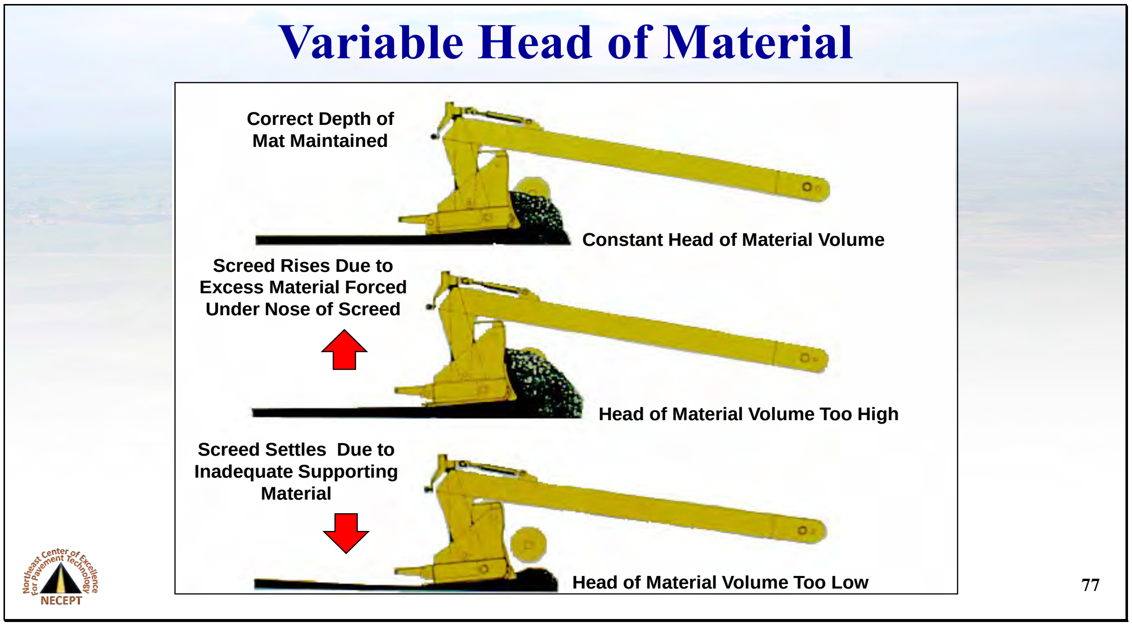
## Head of Material




**Uniform Material Volume Flow**

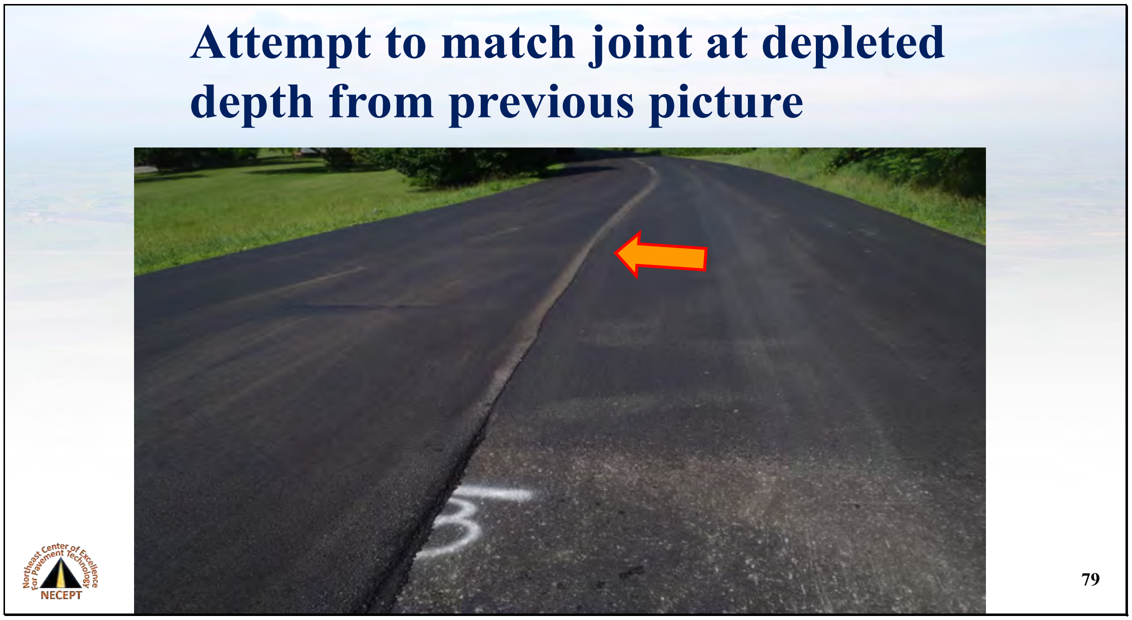
NECEPT 76

Enough mix must be run back to provide a uniform head of material across the screed and **just cover the center of the auger shafts**. When enough material has reached the end plate to ensure a uniform head of material across the entire width of the screed, the automatic screed control can be adjusted.

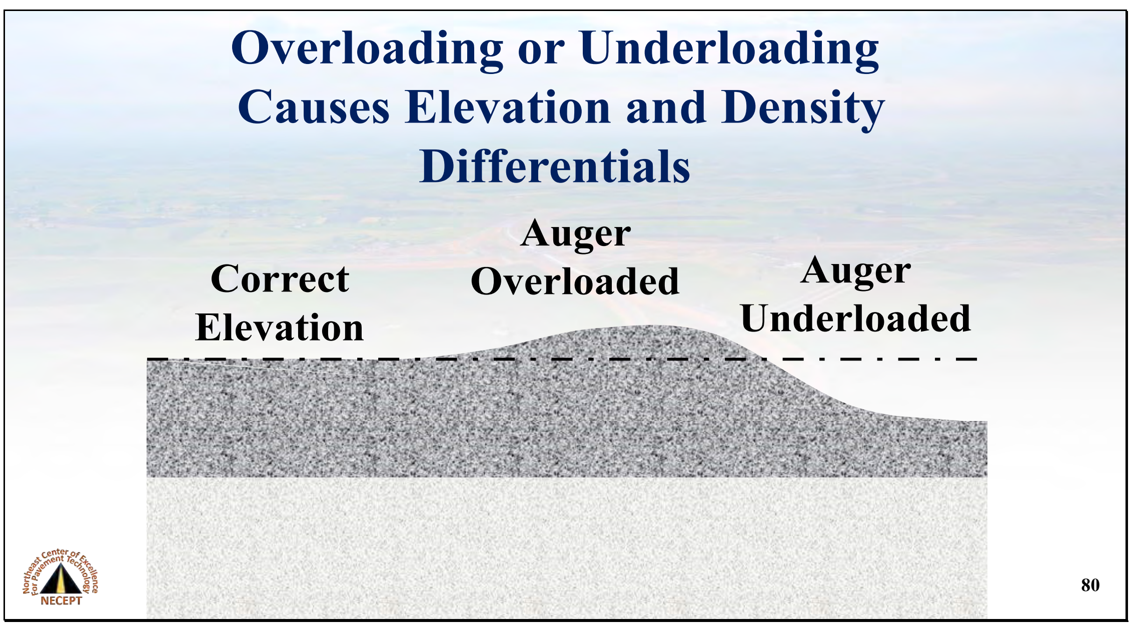



As discussed, the ideal head of material covers the center of the screw augers. If the head of material is too high, then the force on the front of the screed increases, and the screed compensates by moving upward. If the head of material is too low, then the force on the screed decreases, and the screed compensates by moving downward. The bottom picture shows a case that occurs all too frequently at the end of the day!!!!!!!!!


Insufficient thickness at the end of the day can be seen. This issue is due to a depleted head of material. Matching depth in the second pull will be impossible.




Note crushed white line is no longer on the first pass. To correct the issue the right-hand lane will need to be milled back to where material is at specified depth. This also creates a very poor centerline joint as well as a rough ride.




A typical location for underloading is at the end of the day, The head of material is allowed to drop, thickness suffers and the take off for the next day will be under depth, causing a lot of cranking and a very noticeable dip in the roadway. Proper use of a straightedge to determine the location for the transverse joint will eliminate the removal of a lot of cold, hard material.

## Pulling off Joint

- Once all the settings are in place, the paver moves forward
- Start fairly rapidly, then move quickly up to paving speed

NECEPT

81

Once the screed is charged, the sensors are switched from standby to on. Transverse joint construction will be covered in module 7.
**Note:** typical operation would have more blocks.

## Verifying the Settings

**Checking Cross Slope**

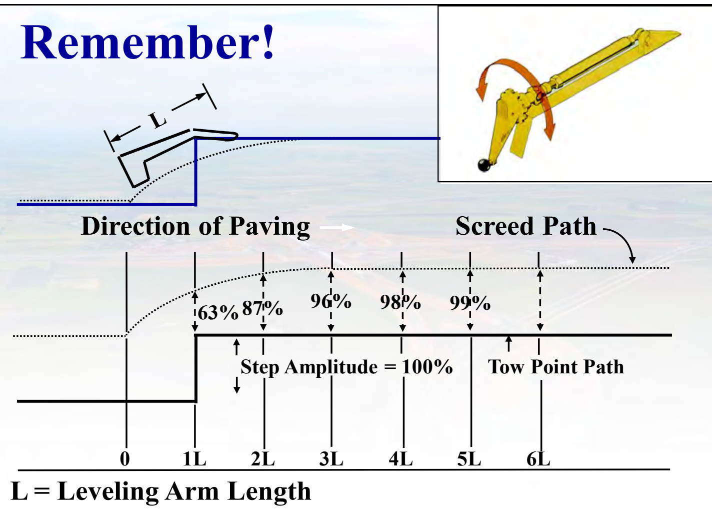
- Is the slope correct?
- How is the mat texture?
- Is the thickness correct?
- Some screed adjustments may be needed.

NECEPT

82

Recheck settings as the paving begins. Is there a crown before or after rolling?
Required adjustments should be minor and infrequent. Mat texture with SMA and Superpave mixes will look much more open than conventional mixes. However, still look for a uniform appearance.

## Remember!




**Detail of Screed Path**

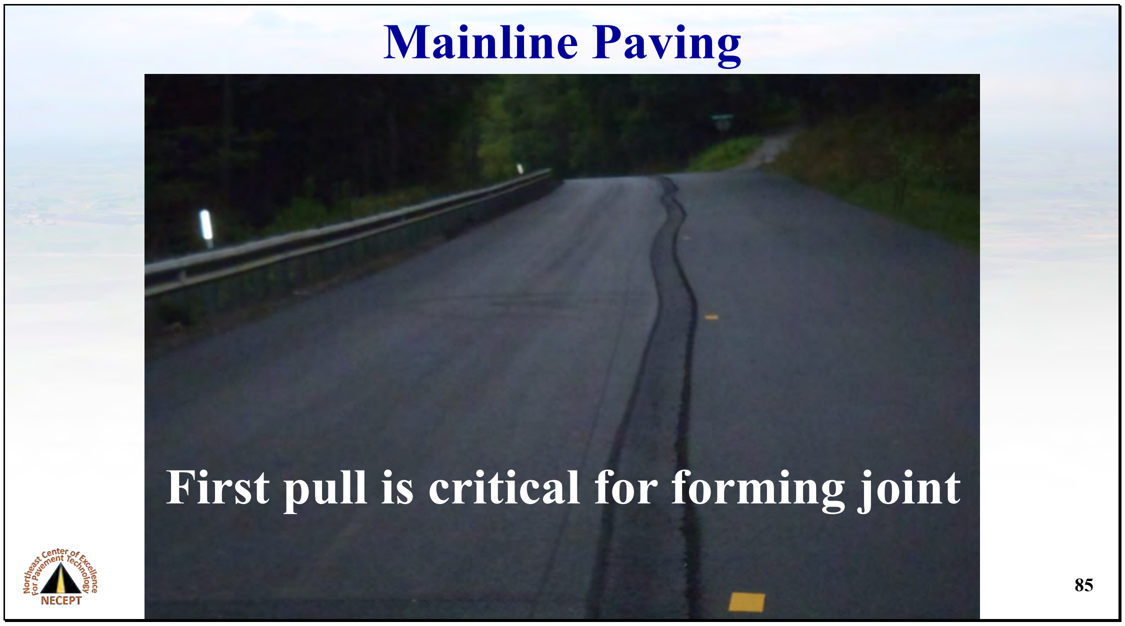
83

Remember, the thickness of the mat can be controlled one of two ways: with the thickness control screws, or with the tow points. The screed must travel about five lengths of the tow arm before fully reacting to the thickness adjustment.

## Types of Paving Operations

- **Mainline Paving**
  - Planning Pulls
  - Variable Width Paving
  - Transitions
- **Temporary Paving**
- **Echelon Paving**
- **Night Paving**

84




Mainline paving is typically 12 feet wide, although greater widths are used to minimize paving joints. The first pull is critical in that the next lane needs to be placed tight against the first lane to form a tight dense joint.

## Paving Layout

- Best to pave as wide as practical
- Paving layout should be efficient
- Keep paving joints out of wheel paths

87

The paving layout should be both practical and as wide as possible. Excessive extension on one side may cause ripples in the mat. Optimal joint spacing will place the surface course joint along the lane stripes. For placement of multiple lifts, the longitudinal joints should be staggered, or offset from one another. In this photo of new paving, the joint layout was not done correctly.


It is common to see a narrow shoulder paved with the driving lane, especially with hydraulically extendable screeds. One extension is used to pave the shoulder, and it can be set at a different cross slope than the main screed. This is good practice as it eliminates one longitudinal joint and an additional pass of the paver. Auger extensions should be added with screed extensions  One caution:  If this combination is being used, careful attention must be given to the layout of the temporary and permanent striping. Splits or tears in the mat may result from rollers crossing the break at shoulder joint


With hydraulically extendable screeds, it is tempting to construct variable width sections "on-the-fly." Be wary–these changes affect the forces on the screed. The hydraulic extension may be used if texture and smoothness are matched and if it would replace handwork, it should be considered. For wide turnouts and tapers, do the mainline first to keep density and smoothness uniform. Then come back to do the tapers and turnouts.


As mentioned earlier, transitions into superelevated curves need to be carefully planned. Temporary ramps and crossovers need even more attention to grade and slope. Traffic usually goes too fast in construction zones, and these pavements often have sharper curves and stronger slopes than normal.

## Echelon Paving

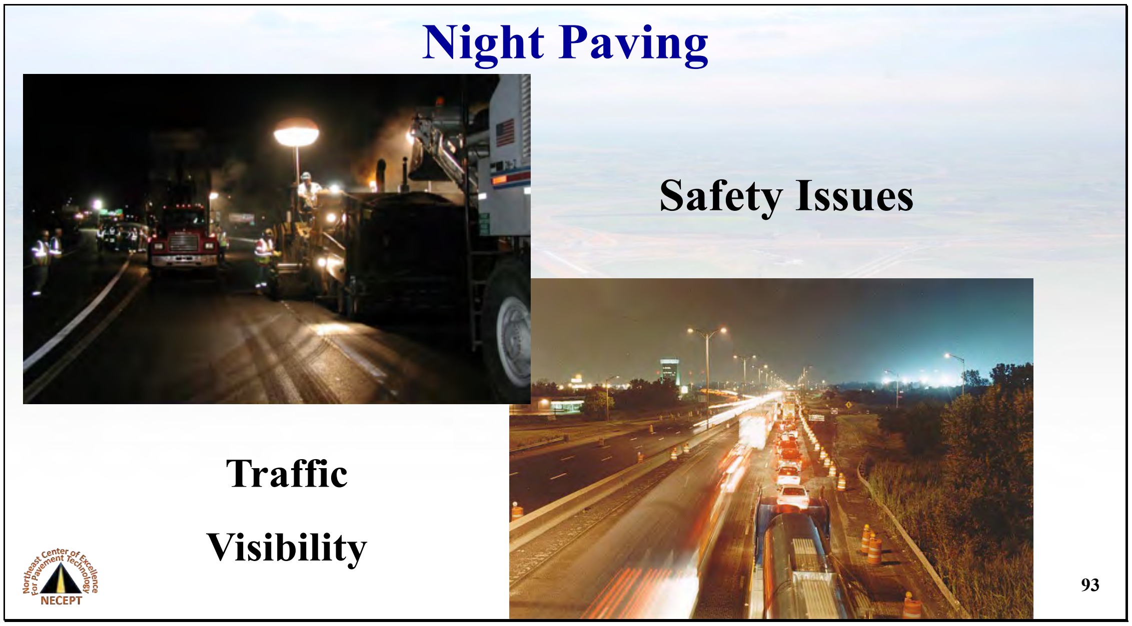
**Do we tack the joint?**

91

Echelon paving is when two pavers are running next to one another. The cold joint between the two paving lanes is eliminated. Properly lapped and compacted, the longitudinal joint is usually difficult to see. Normally, the density in this joint will be similar to the density of the adjacent mat.

## Echelon Paving

92




Night paving happens frequently, and for urban area highways it is often the standard practice. At night, everything typically needs more attention due to limited visibility, cooler weather, different paving, and trucking crews plus many other variables. Sufficient supplemental lighting for all equipment is a big need, especially pavers and rollers. **Safety is probably the biggest issue in night paving**. Traffic and motorists' driving habits are always a concern. Add to that the additional drunk drivers that may be on the road especially after the bars close and the safety risks may increase significantly.

## Night Paving

What experiences have you had?

How Did Your Mat Look At Night?


NECEPT

94

Equipment operators must be aware of all personnel moving around them. Equipment maintenance is particularly important since parts and replacement equipment may not be available. Testing personnel need to be extra careful at night. A new mat looks quite different at night. Personnel must be aware of what a quality pavement looks like under different lighting. All personnel must wear safety vests and be clearly visible. What about leggings??

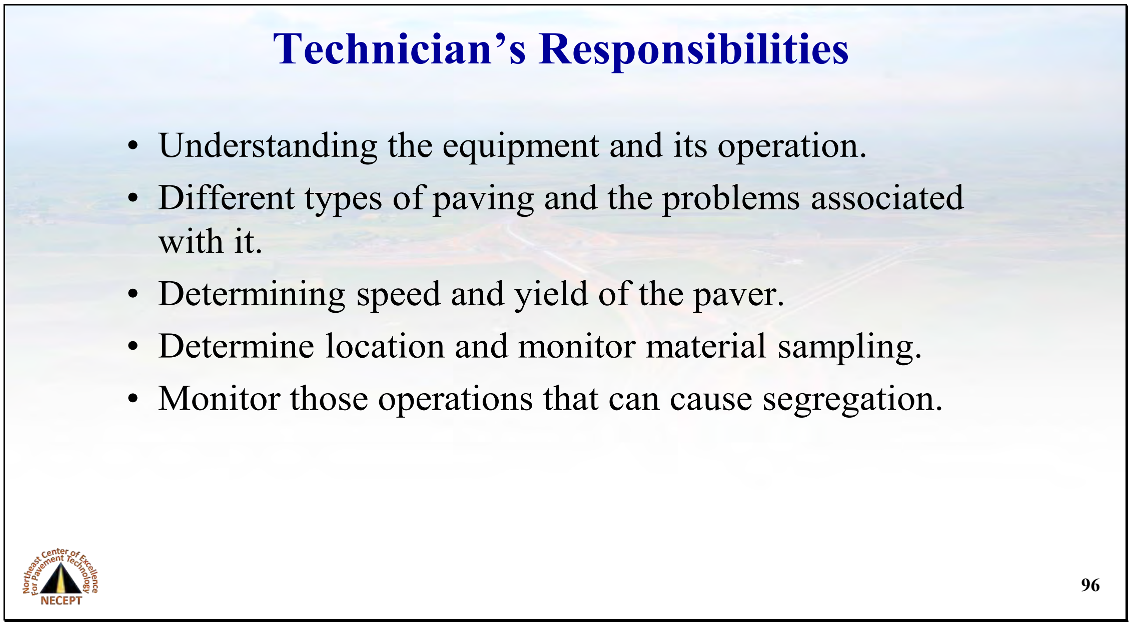
## Technician's Responsibilities & Problem Identification

**What are a Field Technician's Responsibilities Concerning Placement?**

NECEPT

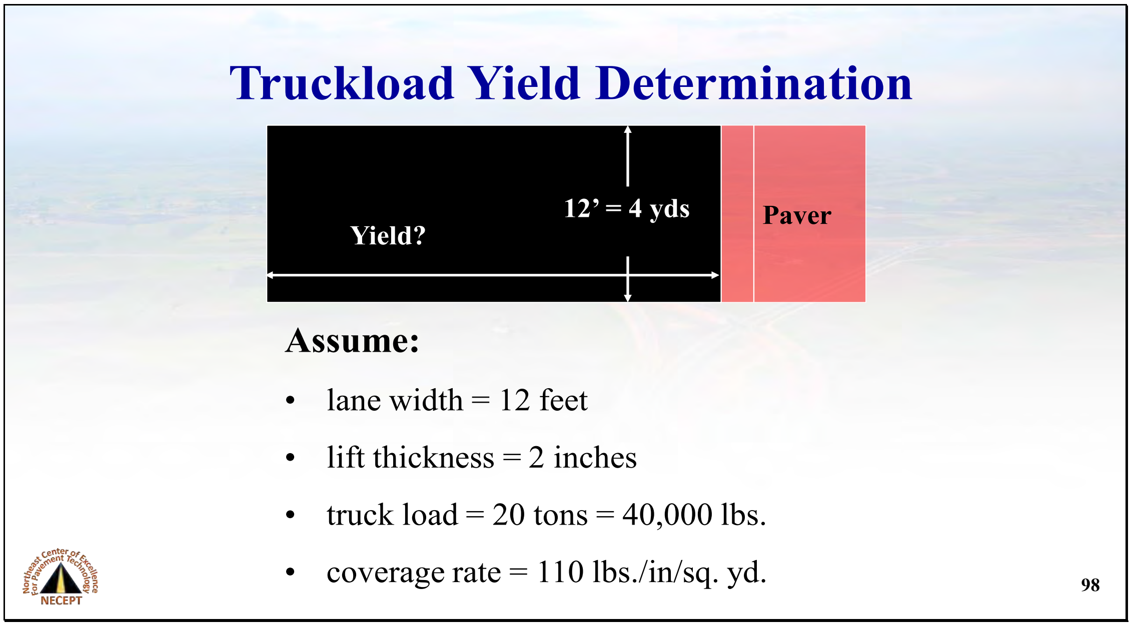
95

Everything, you must constantly be checking to see who is checking!!!!!!!!

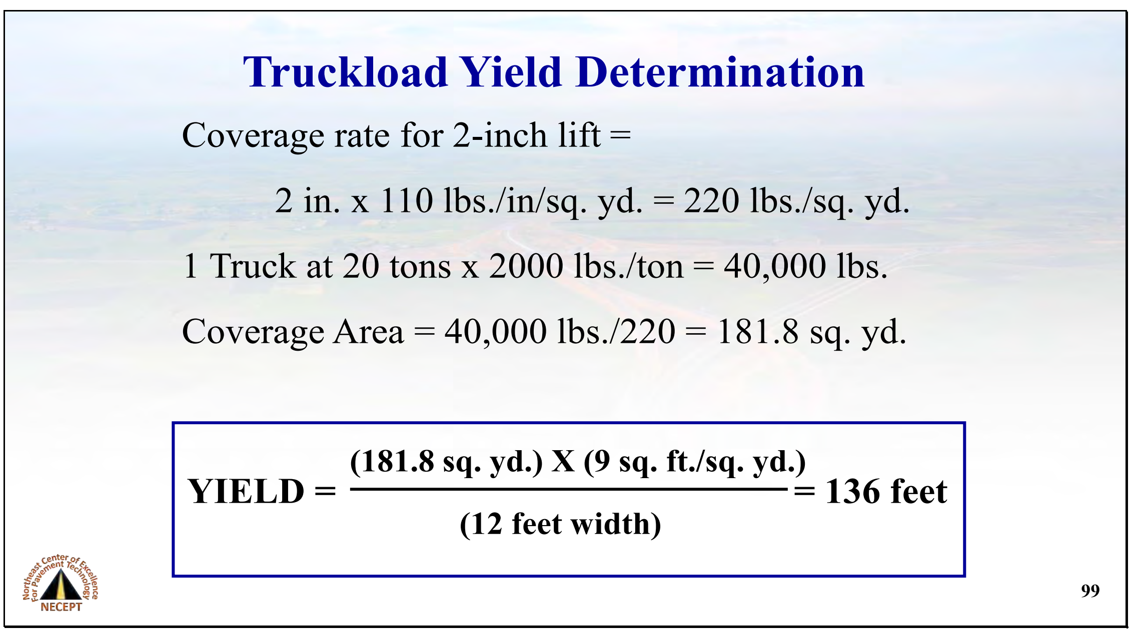



You should keep accurate records of mix design, ambient temperature, roller pattern, successes, and failures for reference needs for your own sanity.


If you are paving with a yield specification, periodically check how far each truckload is going. Every truckload is typically too often; it may result in too many thickness changes. A longer distance (say, 1000 feet) may be more appropriate for checking yield.




How do we check yield per truckload? Let us assume you are paving a 12-foot lane with 2 inches of Asphalt mixture. Each truck holds 20 tons, and the coverage rate is 110 pounds per inch per square yard.




Depending on the specific gravity of your mix, 110 lbs./in./S.Y. may need to be adjusted up or down slightly (the heavier the stone in the mix, the higher the number). 110/lbs./in./S.Y. is a good rule of thumb as a starting point.

## Issues and Problems

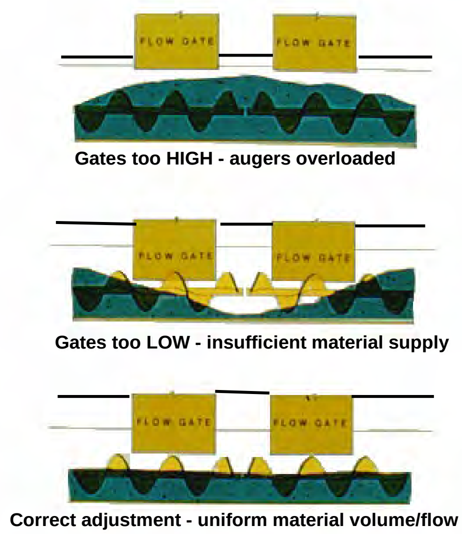
- **Goal:** A uniform mat with proper cross slope and thickness with a uniform surface of proper texture.
- **Main Issue:** Maintaining a continuously moving operation with a constant head of material ahead of the screed

NECEPT

100

Some of the main problems involving paving deal with the constant supply of material and maintaining a constant head of material ahead of the screed. Other issues deal with excessive wear to the paver.

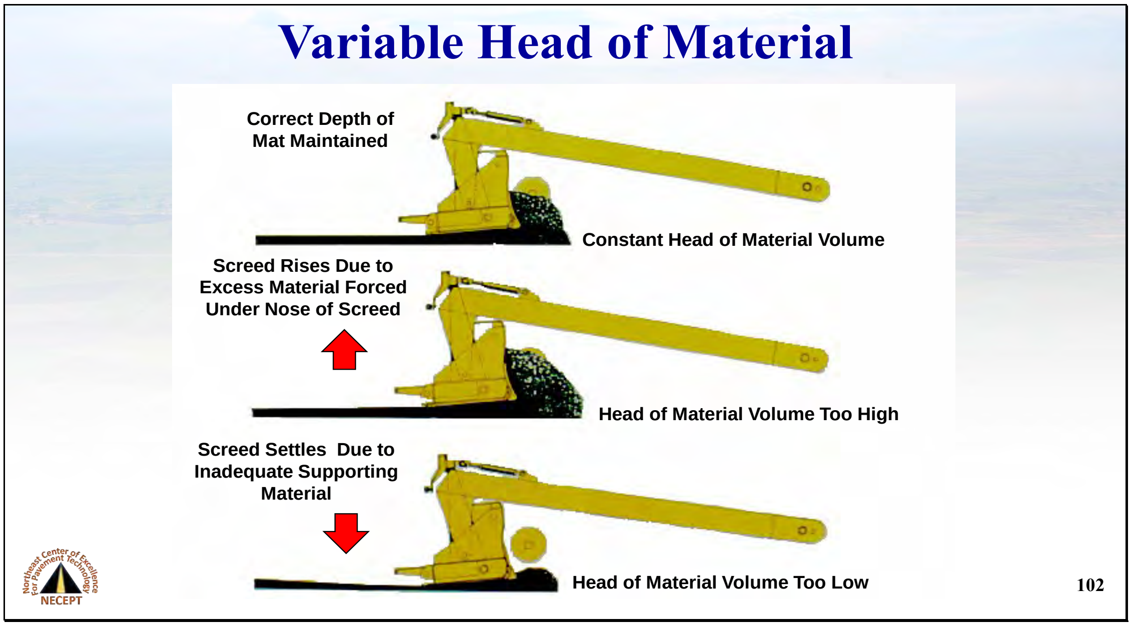
## Variable Head Of Material



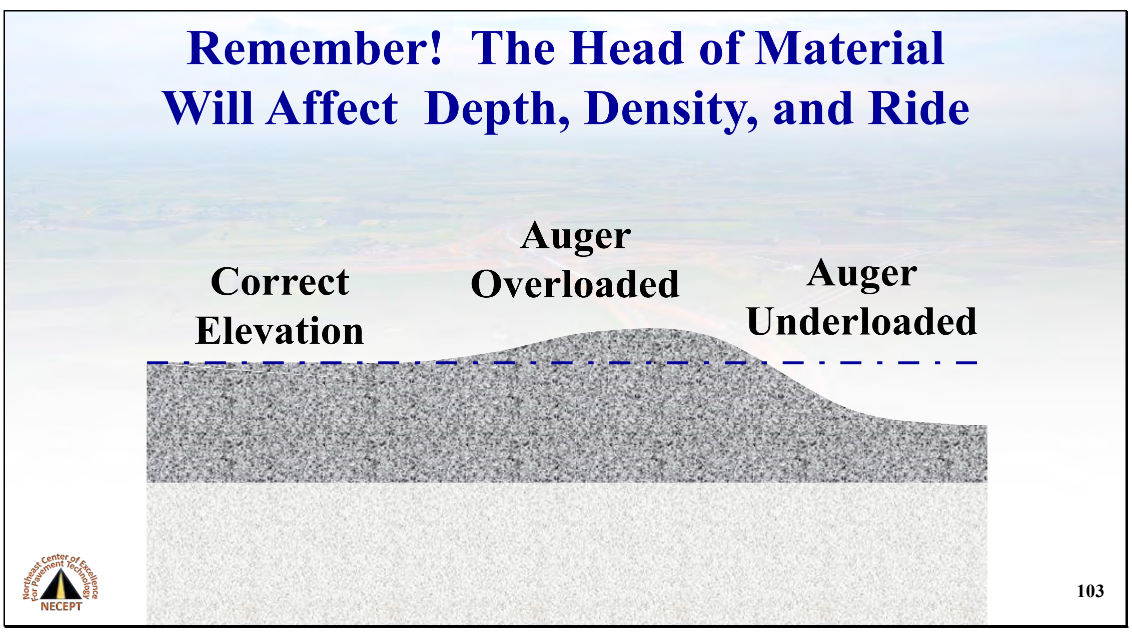

NECEPT

101

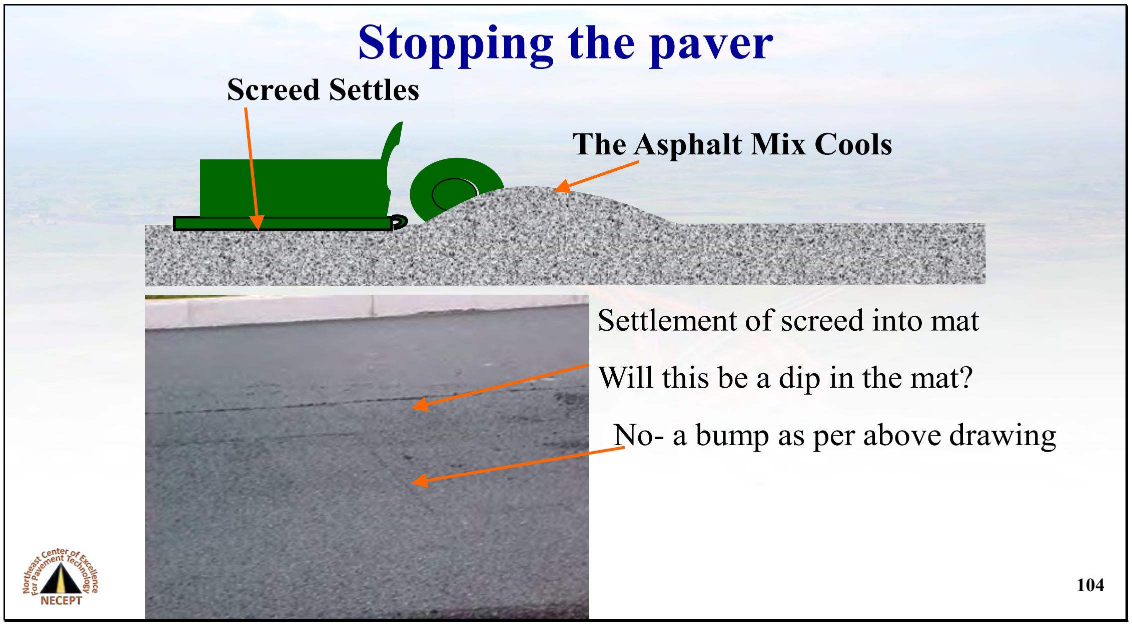
Not getting the head of material set properly in the beginning will only lead to problems later on. Problems with flow gate height are highlighted here. The ideal head of material just covers the center of the augers. If extensions are being used improperly, some mix may need to be shoveled to the corners of the end plates. Again, the key (and it cannot be overemphasized) is to **create a uniform head of material and keep it constant**.



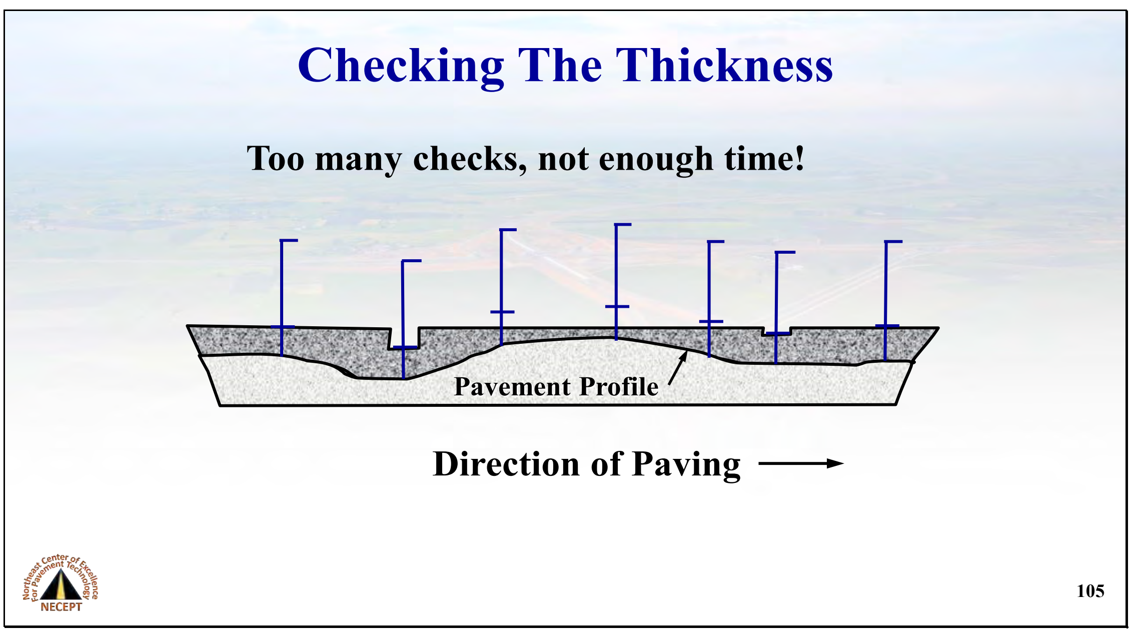

As discussed earlier, the ideal head of material covers the center of the screw augers. If the head of material is more than ideal, then the force on the front of the screed increases, and the screed compensates by moving upward. If the head of material is less than ideal, then the force on the screed decreases, and the screed compensates by moving downward.



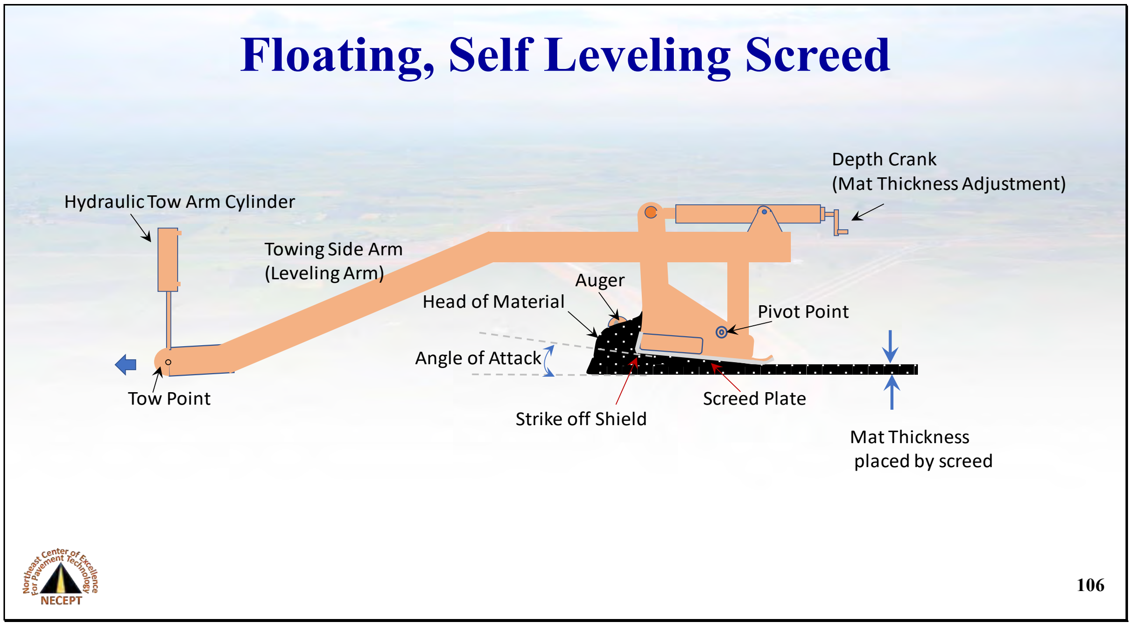

If the augers are underloaded, the thickness placed is too thin. If the augers are overloaded, the thickness placed is too thick.



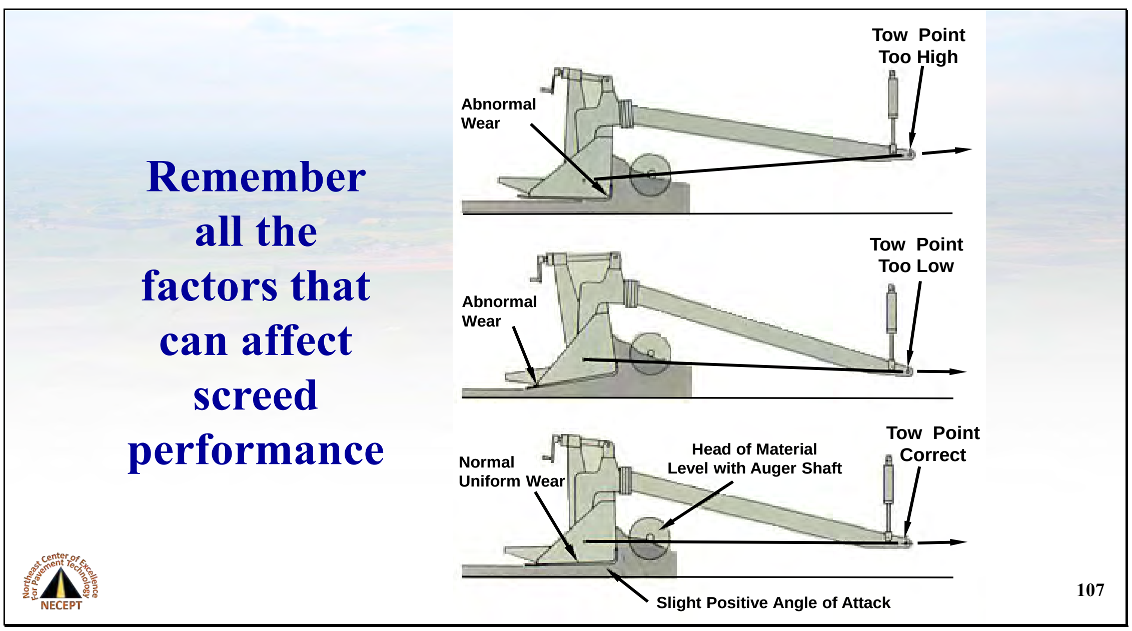

If the paver stops for an extended length of time, any mix in the paver (head of material, conveyors, hopper) can cool, requiring more force to move the paver. In addition, screed can settle, causing bump in the mat.
**NOTE:** Many new pavers have a locking screed which tends to eliminate settling, but the force required to pull the screed through the pile of material (which HAS settled) will cause the screed to rise and necessitate cranking.



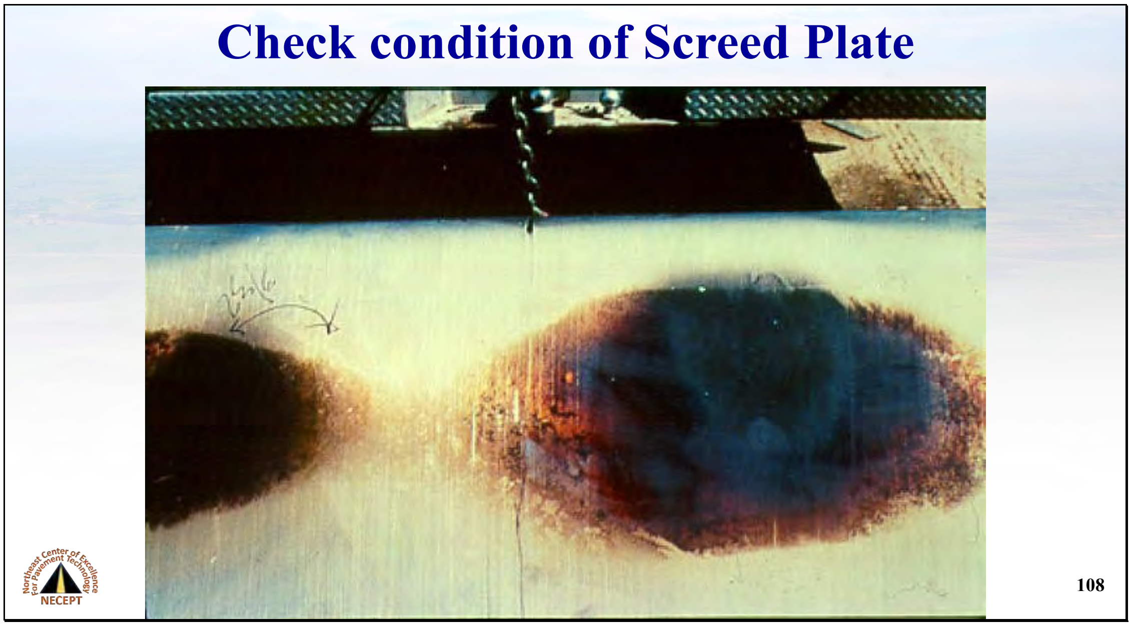

Remember: **5 lengths of the tow arm for corrections to be 100% complete.**




The more the operator tries to assist the self-leveling action of the screed, the rougher the new surface will be. Remember, the screed takes a distance of five times the tow arm length to react to a change in thickness. If the paver and thickness controls are being operated manually, the distance-response concept is even more important to understand. If a second change is made before the first one is accomplished, the first change will never be completed.

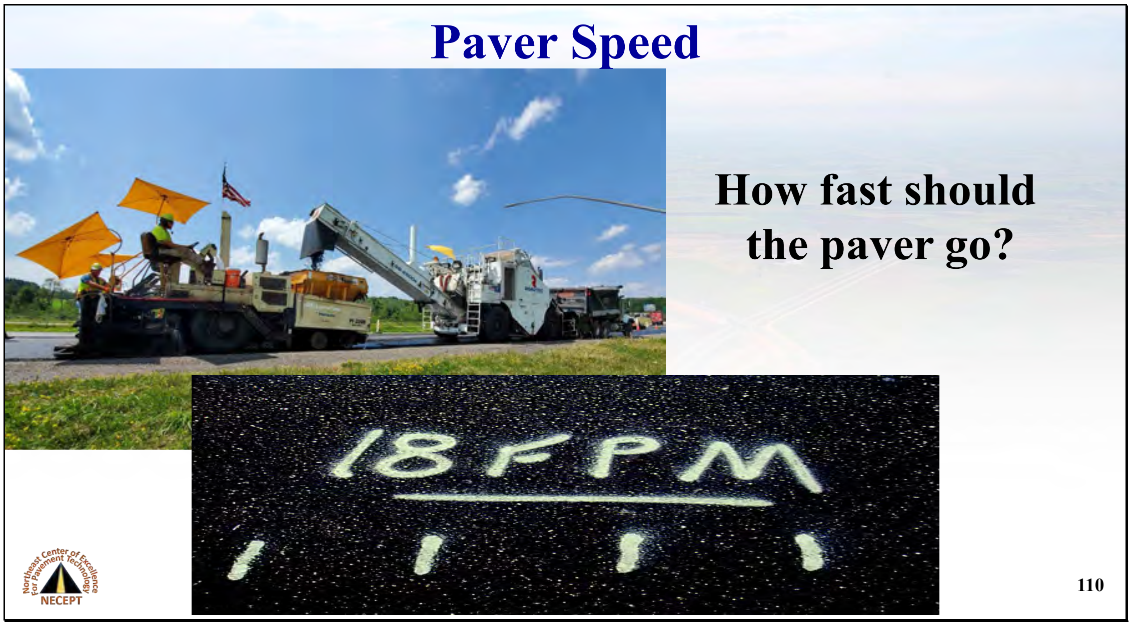



Remember, the proper angle of attack with the screed is where the nose is slightly above the tail. The wear on the screed will be uniform if the angle of attack is adjusted properly.




Screed should be smooth, not warped or dented. Over-heating the screed can lead to the screed plate warping. Again, check the screed for straightness regularly. Also check extension height before pulling off joint, preferably before setting the screed on the starting blocks.

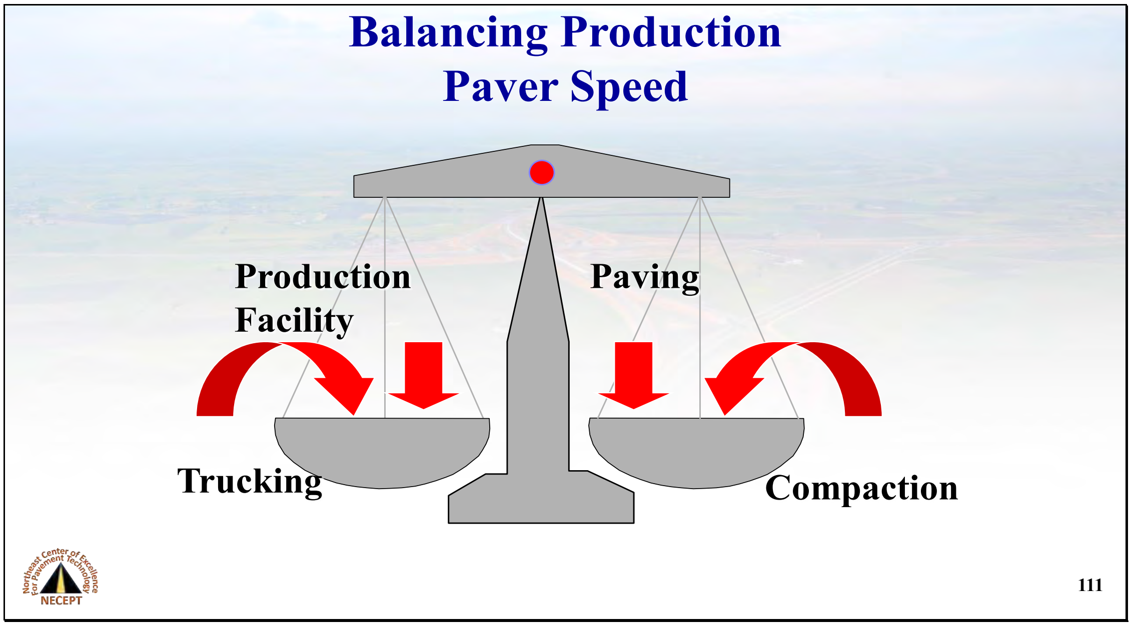

How is the mat texture? This crew failed to heat the screed uniformly prior to pulling off the joint and produced a ragged open mat. Screed extensions were not properly adjusted as evidenced by open streaks  Rolling, raking, or broadcasting material will NOT correct this situation.




When we pull off the joint or start from a stopped position, we need to bring the paver up to speed as rapidly as possible to initiate the smooth paving operation. But what about the paver speed? How fast should the paver go?

Before you begin paving, you should calculate an ideal paver speed. This speed should be checked and maintained.

**NOTE:** check the total tonnage delivered on the ticket from **the fifth truck of the second round** and calculate tons per hour delivered. With some exceptions, this will allow you to determine best case scenario of paver speed, as you will already know yield per square yard.




As was discussed in the previous modules, the entire paving operation is a balancing act. It starts at the Asphalt facility with how much the producer can supply to the project and how many trucks will be available to transport the asphalt to the paver. Now we have to determine the speed of the paver to ensure a constant flow of material with a minimal number of stops. Schedule ahead of time to balance all of these rates. Understanding the variables that can affect each rate is the key to adjusting the others when changes occur–and be assured, changes will occur. Keeping the rates in balance will lead to a better pavement, and more production. If you have a number of trucks waiting, should you speed up the paver to empty them? Not necessarily -- the roller operator may not be able to achieve compaction if the paver speeds ahead. Also, if you change the speed of the paver, you may need to change the amount of mix delivered to the augers to compensate for the change. Automatic material flow control will adjust for these changes. Speeding up the paver will change the *pre-compactive* effort by the screed, requiring more compactive effort from the rollers. All of these things come into play and all need to be considered as the paving operations continue down the road.

## Scheduling Problem

**How do you determine the speed of the paver to ensure a continuous operation with a minimal number of stops?**

NECEPT 112

Let's look at a paving production rate problem.

### Paver Production Calculation Form (An Example Scenario)

Date:____________________ Project # (ECMS)______________

Project Location_________________________________

Tons Scheduled for today: **1800** Paving Hours scheduled: **10**

Delivery Rate TONS divided by Hours **1800/10** = **180** tons per hour.

Paving Width **12** feet Paving Depth **1½** inch

NECEPT 113

**Density Calculations** Target Density **94** %

Gmm =**2.500** **2.500** X **62.4** = **156.0** lbs. per cu.ft.

**156** X **.75** = **117** lbs/sq.yd/inch at 100% compaction

**117** X **.94** % (target density) = **109.98** (**110**) lbs per inch per sq.yd

**110** X **1.5** inches thick = **165** lbs. per sq. yd @ at 94% density

NECEPT

114

**Paver Production Rate at 85 % efficiency (waiting for trucks, etc)**

**180** Tons per hour X **2000** lbs. per ton = **360,000** lbs. per hour
**360,000** divided by **165** lbs per sq. yd.= **2,181.8** (**2182**) sq.yds per hour

**2182** sq.yds X **9** = **19,638** sq ft. per hour

**19,638** divided by **12** feet (width) = **1636.5** lineal feet per hour

**1636.5** divided by **60** (min. per hour) = **27.275** (**27.28**) lineal ft. per minute

Average speed of **27.28** fpm divided by efficiency rate of **.85** = **32.09** fpm

If we increase average speed by only 1.0 fpm. We would require an additional 6.6 tons per hour or 66 tons per day, that is 3 truckloads, and is why we run out of trucks. Computations below.

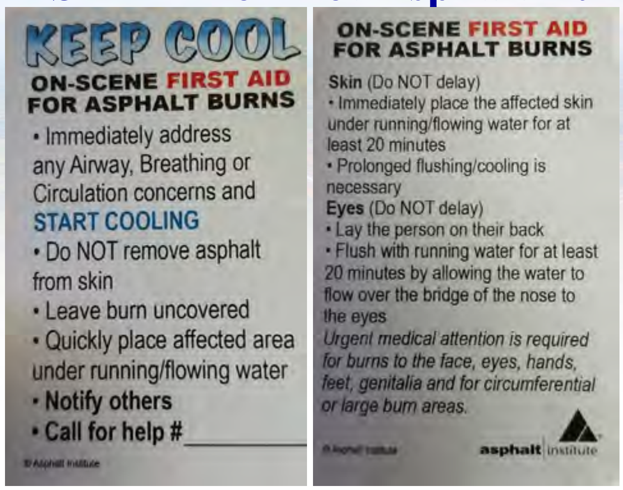
**1** fpm X **60** min/hr X **12** ft / **9** sq. ft./sq. yd. = **80** sq.yds per hour,

**80** X **165**/**2000** = **6.6** tons per hour

NECEPT

115

## FIRST AID for Hot Asphalt Burns




Source: Asphalt Institute

116

Last note: **Safety always comes first**. Here is a recommended approach in case of asphalt burns. If policies disagree with the above information, check with medical personnel, and get the policy changed.

## Module 6 – Review

- **Asphalt Paver**
  - Components and Function
    - Tractor and Screed Unit
  - Operational Principles of Screed
  - Grade and Slope Control Systems
- **Operating Techniques**
  - Initial Preparation
  - Operation
- **Paving Issues & Problems**

117

Module recap!

Do we need another yield or production rate problem?

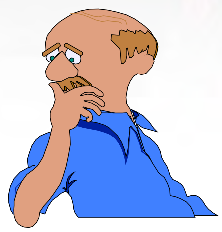

PennState
Discussion
pennsylvania
DEPARTMENT OF TRANSPORTATION
NECEPT
118

# Quiz

## Module 6

## Placement

?





**1. A paver consists of two units, a screed unit that supplies the power and a tractor unit to carry the mix.**

a. True

b. False

**Answer:**

## 2. A tractor contains the following.

a. Hopper
b. Conveyor
c. Auger
d. All of the above

**Answer:**



## 3. The goal of the material feed system is to supply a constant head of unsegregated material in front of the screed through proper position of the gates and correct conveyor and auger speed

a. True
b. False

**Answer:**

**4. The head of the material in front of the screed should be level endplate to endplate and just above the center of the auger shaft.**

a. True
b. False

**Answer:**



**5. Production of the mix by the plant, delivery of the mix by haul trucks, placement of the mix by the paver and compaction of the mix by the compaction equipment all need to be balanced in achieving the goal of a continuous operation.**

a. True
b. False

**Answer:**

**6. PENNDOT allows the use of both rigid screed extensions and hydraulic screed extensions.**

a. True
b. False

**Answer:**

NECEPT



**7. The hopper should be emptied and wings folded after each truck load of material.**

a. True
b. False

**Answer:**

NECEPT

**8. When changing the tow point or turning the thickness control crank, the paver has to move how far before the change is successful.**

a. two tow arm lengths
b. four tow arm lengths
c. five tow arm lengths
d. none of the above

**Answer:**



**9. Temporary paving needs at least the same level of attention to proper placement as mainline paving.**

a. True
b. False

**Answer:**

**10. Traffic control and safety is everyone's concern.**

a. True
b. False

**Answer:**

# Paver Production Calculation Form
# (An Example Scenario)

Date:____________________ Project # (ECMS)______________

Project Location_________________________________

Tons Scheduled for today: _____ Paving Hours scheduled: ___

Delivery Rate TONS divided by Hours _________ = ____ tons per hour.

Paving Width __ feet Paving Depth ___ inch

**Density Calculations** Target Density __ %

Gmm _____ ____ **X** ____ = _____ lbs. per cu.ft.

___ **X** ___ = ___ lbs/sq.yd/inch at 100% compaction

___ **X** ___ **%** (target density) = ______ (___) lbs per inch per sq.yd

___ **X** ___ inches thick = ___ lbs. per sq. yd @ at 94% density

**Paver Production Rate at 85 % efficiency**
**(waiting for trucks, etc)**

___ Tons per hour X ____ lbs. per ton = _______ lbs. per hour
_______ divided by ___ lbs per sq. yd.= _______ **(**____) sq.yds per hour

____ sq.yds X _ = ______ sq ft. per hour

______ divided by __ feet (width) = ______ lineal feet per hour

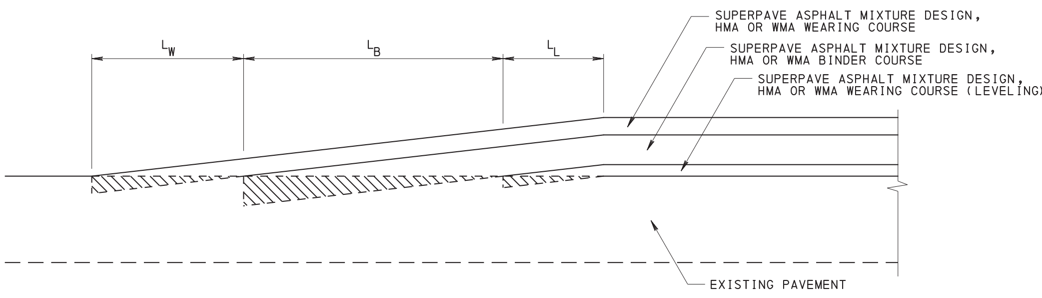
______ divided by __ (min. per hour) = ______ **(**_____**)** lineal ft. per minute

Average speed of _____ fpm divided by efficiency rate of ___ = _____ fpm

If we increase average speed by only 1.0 fpm. We would require an additional 6.6 tons per hour or 66 tons per day, that is 3 truckloads, and is why we run out of trucks. Computations below.

_ fpm **X** __ min/hr **X** __ ft **/** _ sq. ft./sq. yd. = __ sq.yds per hour,

__ **X** ___/____ = ___ tons per hour




## TYPICAL PAVING NOTCH DETAIL

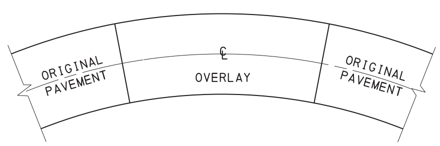
### LEGEND

 DENOTES AN AREA OF THE EXISTING PAVEMENT TO BE MILLED TO PROVIDE PROPER TRANSITION FOR THE NEW PAVEMENT COURSE. THE DEPTH SHOULD EQUAL THE NOMINAL DEPTH OF THE NEW PAVEMENT COURSE AND GRADUALLY TAPER TO NOTHING OVER A LENGTH ($L_W$, $L_B$, OR $L_L$) SHOWN IN TABLE A. THE VARIABLE DEPTH MILLING IS INCIDENTAL TO THE PAVING ITEM.

$L_W$ = THE MINIMUM LENGTH OF EXISTING PAVEMENT TO BE MILLED FOR THE WEARING COURSE.

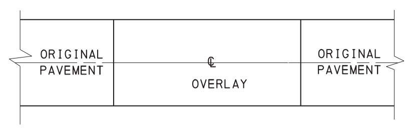
$L_B$ = THE MINIMUM LENGTH OF EXISTING PAVEMENT TO BE MILLED FOR THE BINDER COURSE.

$L_L$ = THE MINIMUM LENGTH OF EXISTING PAVEMENT TO BE MILLED FOR THE LEVELING COURSE.




PLAN VIEW

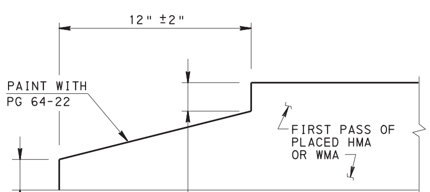
SUPERELEVATION SECTION



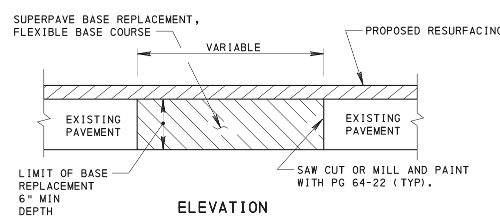

PLAN VIEW

TANGENT SECTION
TWO-LANE, TWO-WAY TRAFFIC AND
TWO-LANE DIRECTIONAL

## OVERLAY TRANSITIONS




## LONGITUDINAL NOTCHED WEDGE JOINT




ELEVATION

## SUPERPAVE BASE REPLACEMENT

SEE NOTES 3, 4, 5 AND 6.

## TABLE A

| REGULATORY POSTED SPEED LIMIT (mph) | MINIMUM LENGTH OF MILLING | | |
|---|---|---|---|
| | $L_L$ | $L_B$ | $L_W$ |
| > 65 | 35′ | 80′ | 80′ |
| ≥ 55 TO < 65 | 35′ | 80′ | 60′ |
| ≥ 45 TO < 55 | 25′ | 35′ | 30′ |
| < 45 | 15′ | 25′ | 20′ |

## TABLE B

| NOMINAL MAXIMUM AGGREGATE SIZE | |
|---|---|
| **MIX** | **ENGLISH** |
| SP9.5 | ⅜" |
| SP12.5 | ½" |
| SP19 | ¾" |

### NOTES

1. PLACE EDGE FLUSH WITH EXISTING PAVEMENT AND SEAL AS SPECIFIED IN PUBLICATION 408, SECTION 409.3(k)3.
2. CONSTRUCT FLEXIBLE BASE REPLACEMENT IN ACCORDANCE WITH THE REQUIREMENTS OF PUBLICATION 408, SECTION 316.
3. PREPARE EXPOSED VERTICAL AND HORIZONTAL SURFACES AS PER PUBLICATION 408, SECTION 409.3(k).
4. FOR NON-OVERLAY APPLICATIONS, THE TOP 1½" OF BASE REPLACEMENT WILL BE SUPERPAVE WEARING COURSE.
5. FOR RESTORATION OF RIGID PAVEMENT, REFER TO PUBLICATION 408, SECTION 516 AND RC-26M.
6. FOR SUPERPAVE BASE REPLACEMENT, SAW CUTTING, EXCAVATION, HAULING AND DISPOSAL, BITUMINOUS TACK COAT, BITUMINOUS MATERIAL, AND SEALING OF THE JOINTS ARE CONSIDERED AS INCIDENTAL.

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION
BUREAU OF PROJECT DELIVERY

# OVERLAY TRANSITIONS AND PAVING NOTCHES

| RECOMMENDED SEPT. 15, 2016 | RECOMMENDED SEPT. 15, 2016 | SHT 1 OF 2 |
|---|---|---|
| CHIEF, HWY. DELIVERY DIVISION | DIRECTOR, BUREAU OF PROJECT DELIVERY | RC-28M |

N
E
C
E
P
T

**Asphalt Pavement Construction Program**

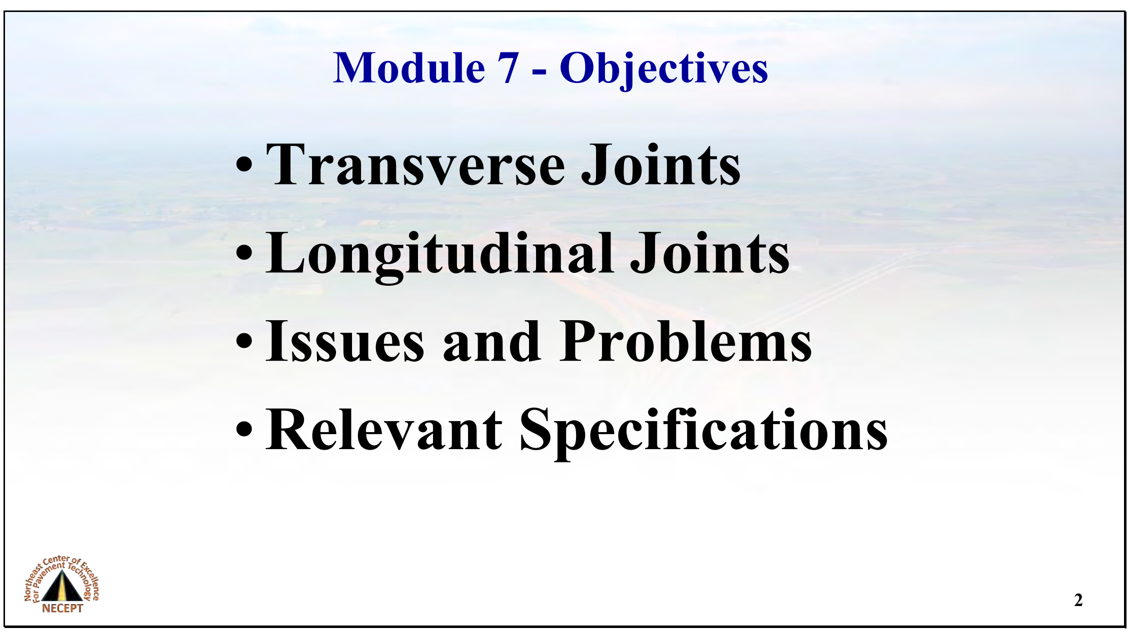
Certified Asphalt Field Technician
Course of 2025

# Module 7:

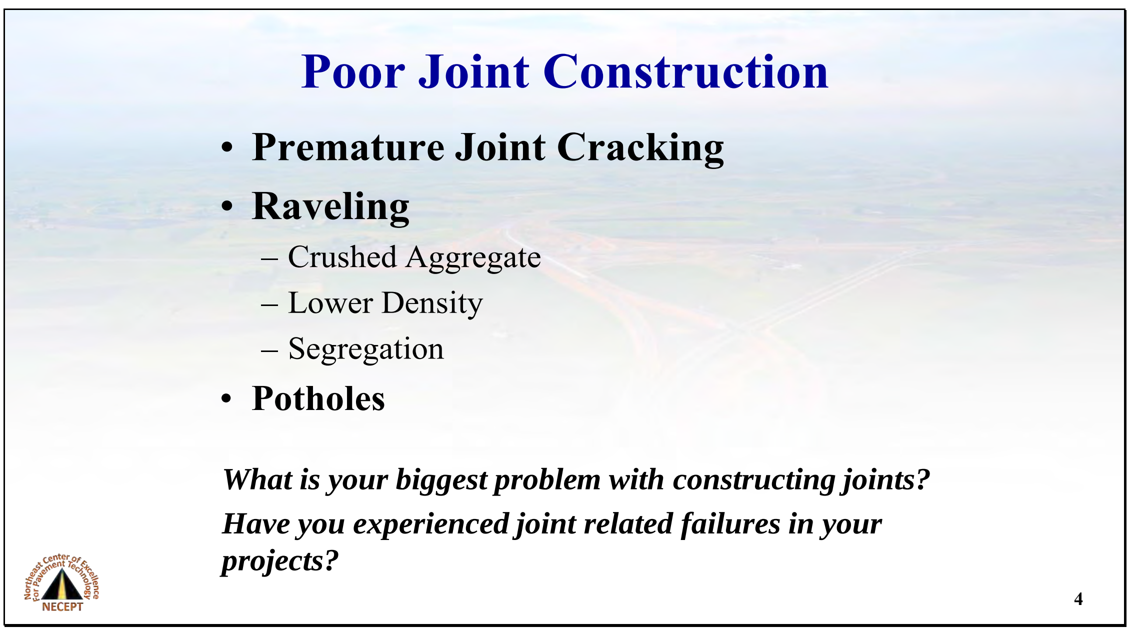
# Asphalt Paving Joint Construction

Northeast Center of Excellence for Pavement Technology
NECEPT


All pavements have one internal weakness – joints. It is difficult, however, if not impossible, to construct a pavement without any joints. Thus, the goal should be to make as few joints as possible and to construct them carefully and properly.




Longitudinal joints are between the lanes and are the weakest parts of the placed mats.




Improperly constructed joints will allow for the intrusion of water which will lead to moisture induced damage, fatigue cracking, and potholes. If not fixed, the joint failure may consequently result in total failure of the pavement.

Excessive overlap can lead to crushed aggregate which in turn will lead to loss of bond and raveling. Unnecessary luting, incorrect overlap, and improper rolling techniques can all lead to lower densities, raveling, and eventual failure.

## Transverse Joint Preparation

- Milled Notch MUST be correct (See RC 28)
- Requires skill.
- Some handwork necessary.
- "Leave the mix high" **WHY?**
- Compact immediately.

5

A transverse joint must be constructed across the pavement whenever paving starts or stops (at the beginning or end of the job) or suspended for the day. This joint must match the depth and cross slope of the existing pavement.

Tying into the existing pavement requires skill to ensure a smooth transition. There will be some handwork necessary to complete the joint, "leave the mix high" to allow for compaction. Hand-worked mix is looser than paver-laid mix and more difficult to compact. Compact this mix immediately. The longer time it takes to do hand work results in a cooler mix and difficulty in compaction.

## Transverse Joint

**Section 413.3(g)3.** Paving Notches. Mill the existing pavement surface at tie-in locations of the wearing course in accordance with the Standard Drawing RC-28M, or as otherwise indicated. Perform milling as specified in Section 491.

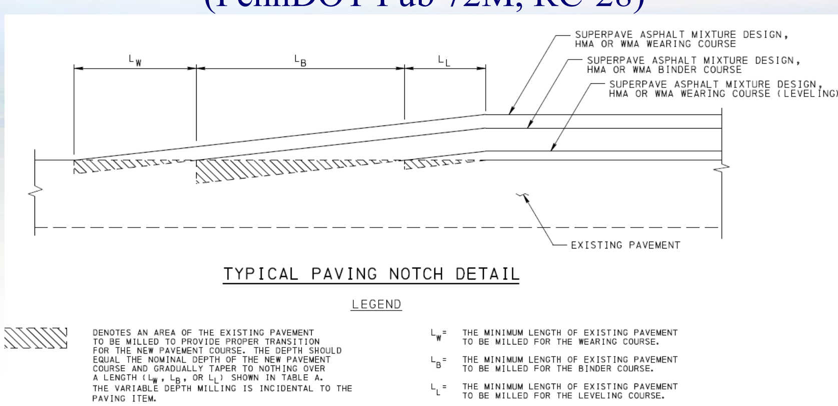
NECEPT

6

A properly milled **tie-in** will result in a smoother joint that is easier to construct and will be longer lasting.

## Paving Notches and Transitions

(PennDOT Pub 72M, RC-28)




NECEPT

7

Standards for Roadway Construction (RC) are provided in PennDOT Publication 72M. This publication must be consulted for details of any roadway related construction.

Make sure paving notches are milled and material is placed at proper depths. Ensure that the tapers (transitions) are long enough.

## Paving Notches and Transitions
(PennDOT Pub 72M, RC-28)

TABLE A

| REGULATORY POSTED SPEED LIMIT (mph) | MINIMUM LENGTH OF MILLING | | |
|---|---|---|---|
| | $L_L$ | $L_B$ | $L_W$ |
| > 65 | 35' | 80' | 80' |
| ≥ 55 TO < 65 | 35' | 80' | 60' |
| ≥ 45 TO < 55 | 25' | 35' | 30' |
| < 45 | 15' | 25' | 20' |

$L_W$ = THE MINIMUM LENGTH OF EXISTING PAVEMENT TO BE MILLED FOR THE WEARING COURSE.

$L_B$ = THE MINIMUM LENGTH OF EXISTING PAVEMENT TO BE MILLED FOR THE BINDER COURSE.

$L_L$ = THE MINIMUM LENGTH OF EXISTING PAVEMENT TO BE MILLED FOR THE LEVELING COURSE.

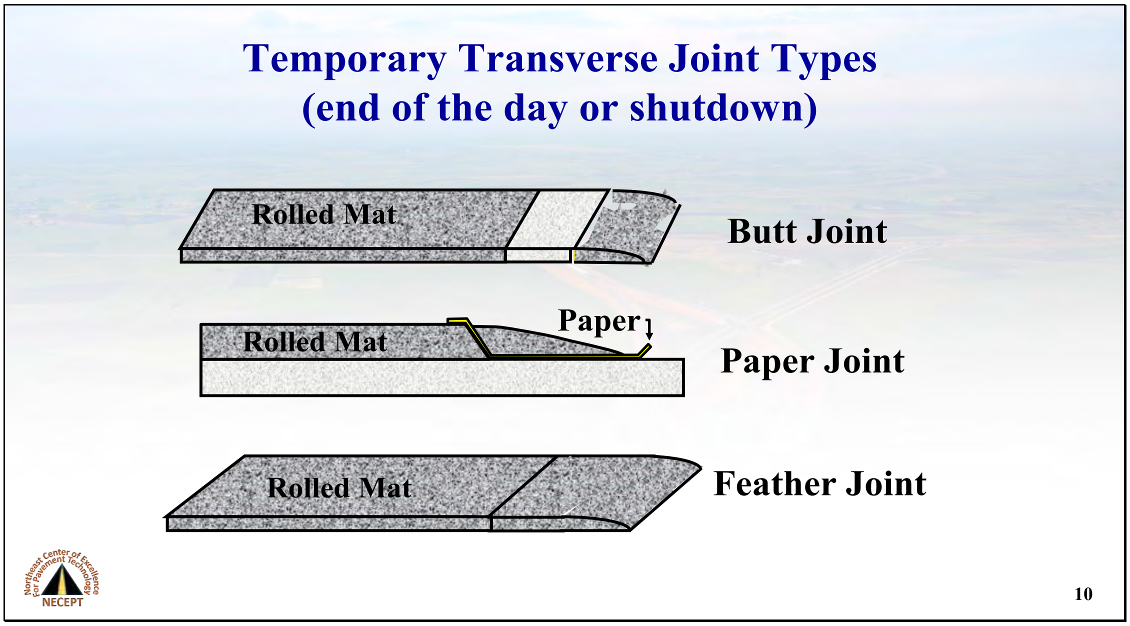
8

Note that leveling, binder, and wearing notches may be of different length. This issue must be discussed at the pre-placement meeting as this milling is incidental to the material being placed.

## Paving Notch? Third repair attempt


9

One pass of mini-mill was certainly insufficient; note depth at arrow. An attempt to improve the ride was later made by installing a longer wedge, and later still, more material was placed at the edge of the structure. Three strikes!




Temporary transverse joints are needed whenever the paving operation is interrupted. This interruption and shutdown could be because of work stoppage at the end of the day or delay for reasons such as equipment breakdown or whether impact. If traffic will be allowed, the joint could be in the form of a vertical butt joint. If traffic will be allowed, a tapered joint with ramp must be built to allow safe transition.

In the first style shown in the schematics above, a board is placed at the end of the mat and next to the joint, followed by an end ramp to allow the equipment to get off the mat. Treated paper can be used instead of boards as shown in the second sketch. At a point where the mat is still uniform in thickness, the screed is lifted, and the paver pulls off. The mix is shoveled away from the joint location, and the paper or board is placed downstream of the joint. The mix is shoveled to form a ramp and the transition is compacted. The tapered (feather) joint typically requires a milling machine for removal of the taper and is the most common type in use today.

The length of a tapered joint depends on the thickness of the mat. The thicker the mat, the longer the taper. Many agencies use a minimum ratio of 12:1 for the length of the taper. For example, a compacted thickness of 2 inches would require at least a length of 2 ft. for the taper.

## Transverse Joint Location

**Use straightedge to determine where pavement thickness begins decreasing…**

**… and mark location of joint**

11

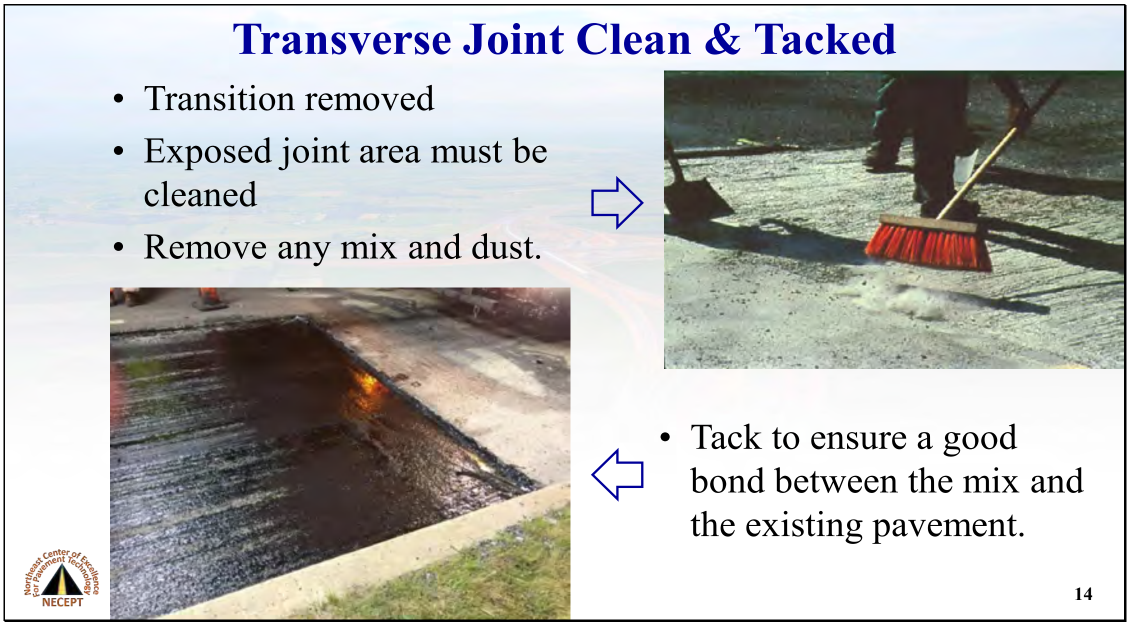
If a tapered transverse joint has been constructed, the mix in the taper must be removed and discarded before paving can be restarted. Whether using a tapered transition for a butt or papered joint, a straight-edge must be used to ensure that the joint will be in full-depth material and have the proper profile. If the straightedge indicates that the previously placed mat is not level at the pre-formed transition, the location of the transverse joint must be moved back upstream to a point where the pavement layer is of the proper thickness and smoothness. A 30 to 50-ft string line will ensure a smoother joint

Maintaining a proper head of material yesterday will result in removal of less cold hard material today.


Notice the  marks on the mat from screed and extensions. What could have caused them? How long did the paver sit with augers running while the hopper was cleaned? Where the screed vibrators still on?


Before construction of the new mat resumes, a cold milling machine can be used both to form the vertical edge of the transverse joint and to remove the unwanted mix.

This contractor is using a small milling machine to create a vertical edge where the larger milling machine left a ramp at the structure. Note the high strip left at bottom right. Care must be taken to create a clean, vertical transition, **AT THE PROPER DEPTH**, for starting the paving operation.




After the transition has been removed, the exposed joint area must be thoroughly cleaned and properly tack coated to ensure a good bond between the new mat and the existing pavement. Is the bottom photo depicting good practice?

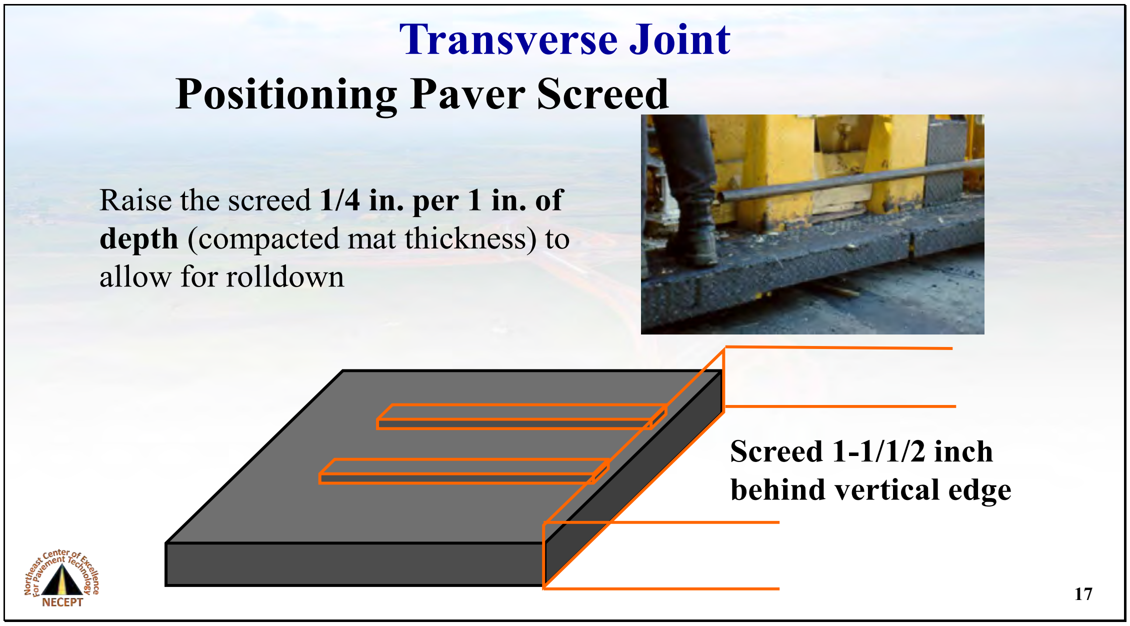
**QUESTION**: How many distributors have a working hand hose?


Backing up to a joint with a distributor or turning the bar on, and then taking off leaves excessive tack with none on the vertical edge. This is the proper place for a hand hose.

# Poor Transverse Joint Tack Application

**What is the Problem?**

**Must tack the ENTIRE surface as well as the vertical surface at the joints.**




As a rule of thumb, for every one-inch compacted thickness, the loose mix must be roughly 1 ¼" thick. In other words, once the mix is rolled and compacted, is expected to densify for roughly 20 percent (20 percent of 1 ¼" inches is 1/4" inches). Therefore, the paver screed must be placed on a set of starting blocks or strips of wood on the upstream side of the transverse joints. These blocks should be 1/4" thick for every inch of compacted mat (For example, 1/2" thickness is needed to have a compacted mat of 2 inches. Rolldown may differ for some mixes. After the screed is set on the blocks, check the initial paver settings and start-up procedures. **Pull off the blocks and bring the paver up to the laydown speed as quickly as possible**. For a screed with extensions, you will need more blocks.

The screed should be properly nulled ( twice, if necessary), and placed 1 ½ inches on the upstream side of the transverse joint, which should have been cut perpendicular to the lane being paved. The head of material should be equal across the auger centerline before pulling off from the joint. If the paver starts out on the correct blocks and the screed begins with a full head of material, the thickness of the downstream mat will be correct.

## Luting the Joint

If the paver screed is properly positioned, only the material on the old mat will need removed with no material required to be added to hot mat ………minimize luting.

NECEPT

18

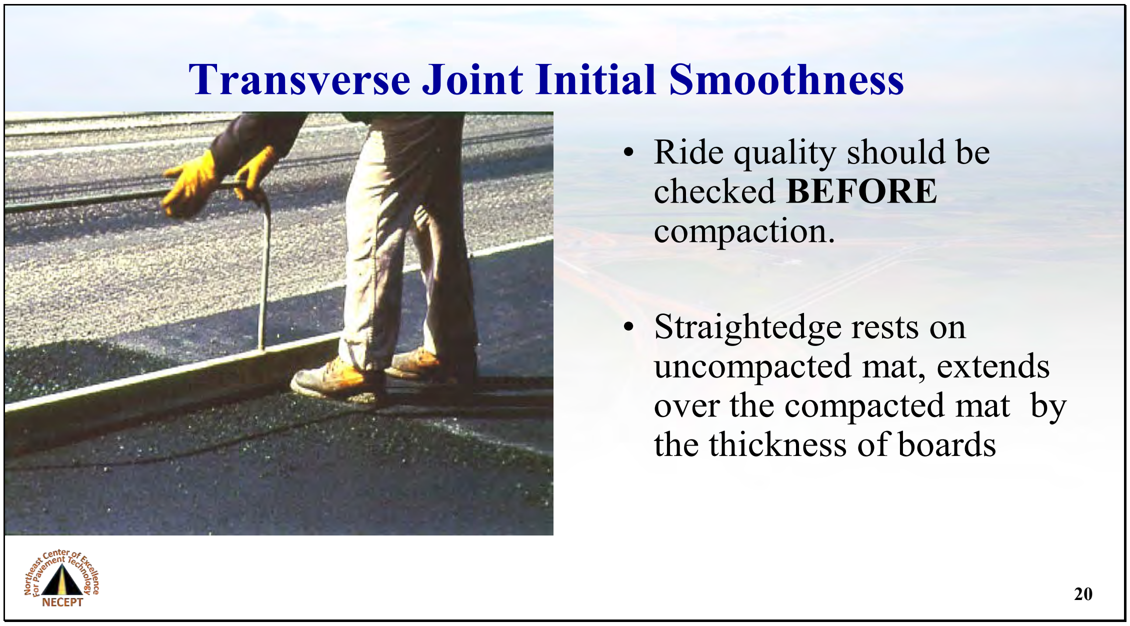
## Transverse Joint Luting

- Minimize luting
- Never a reason to lute joint excessively.
- Remove any excess coarse material
- DO NOT broadcast material back onto the mat.

**Notice material in front of lute and already on the mat.**

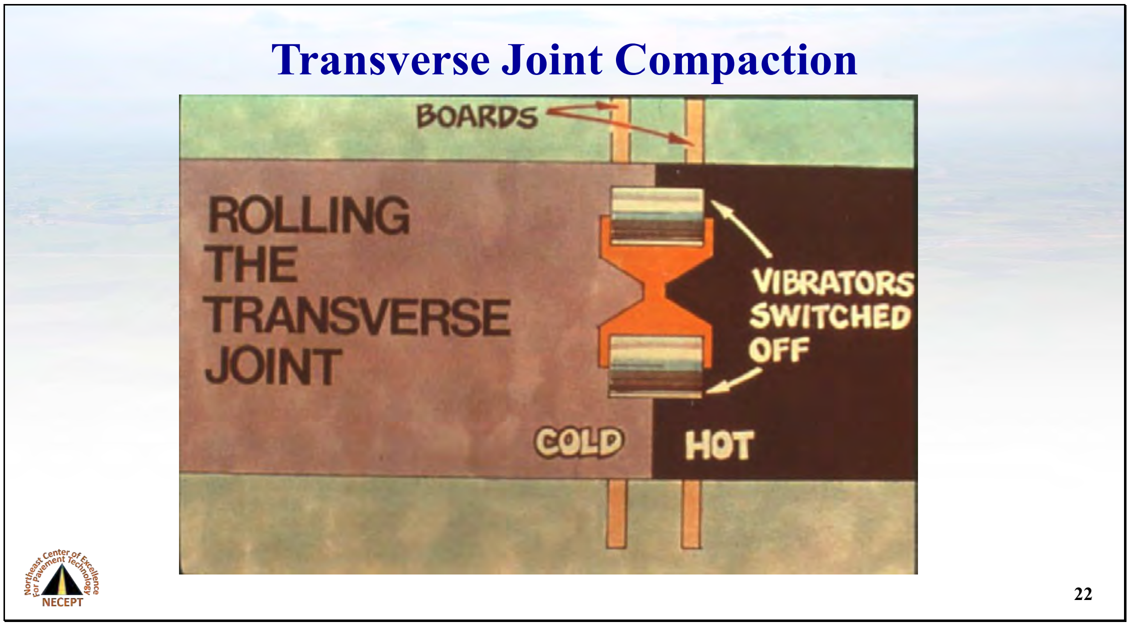
NECEPT

19




As the straightedge rests on the uncompacted mat, it should be *parallel* to the existing mat and rest completely on the starting shims or boards which should be of an equal thickness to the amount of rolldown,1/4” per one inch of depth (compacted thickness).


Poor positioning/nulling of the screed will result in a LOT of handwork, cooling of the mat, a rough riding transition and reduced pavement life at the joint.



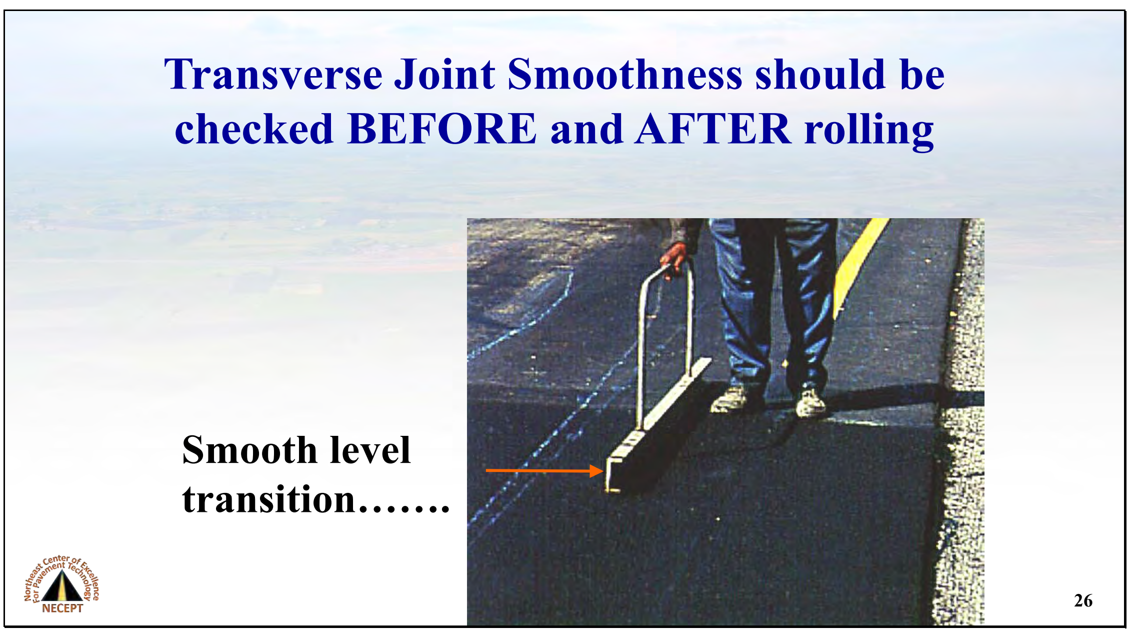

Ideally a transverse joint should be compacted in the transverse direction. If traffic and conditions allow, use runoff boards to support the roller as it moves beyond the longitudinal edge of the pavement, and to allow the roller to make the first pass in the transverse direction.

Although this may be the ideal condition, it may not be possible because of shoulders, curbs, guide rail, geometrics, and maintaining traffic.


This photo shows a roller at a transverse joint at a bridge approach rolling across the lane transversely.


If required to roll longitudinally, get the breakdown roller on the mat **as soon as possible**. Have the roller pass slowly and completely onto the mat with the driven drum leading, before reversing direction. If the joint is constructed properly, the compactive effort needed will be no different than that needed for the rest of the mat. Single drum vibratory rolling onto the mat for the first pass and NOT vibrating back into the joint will help maintain the profile as placed. At the end of the project, you may need to match wheel ruts. Transverse rolling is about the only effective method to achieve a ride.


Field conditions may prohibit transverse rolling with full sized roller, but many contractors have a small roller on site to pinch the joint and "pinch and "half-lap" roll to improve joint construction and enhance the ride.



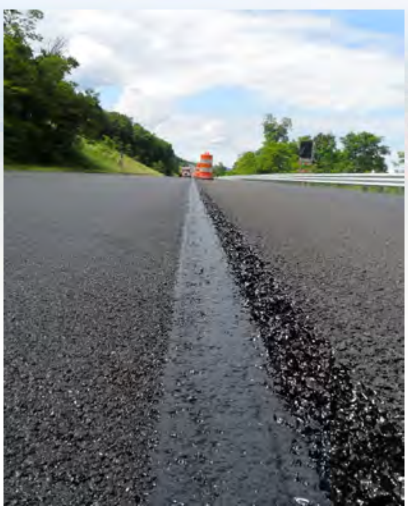

After the first compaction coverage is complete and before the mix has cooled, use a straightedge again to check the level of the joint.

## Results of Excessive Rolling of a High Transverse Joint

27

A joint that is laid to the proper depth can be ruined by vibrating back into the joint or structure. Vibrating slowly and pounding the mat into submission will NOT correct a poorly placed joint and may well ruin one that is properly placed !!!!!!!!

## Longitudinal Joint



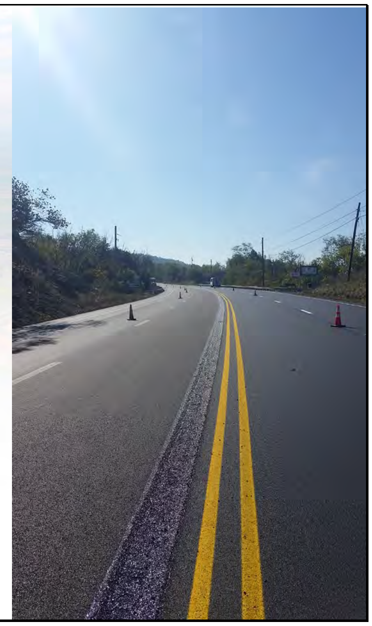
- **Various types**
  - Vertical (Butt) Joint
  - Notched Wedge Joint
  - Cut Vertical Joint (which creates a vertical butt joint)

28

A longitudinal joint is formed when a new mat is placed against an existing mat. The most common types of joints are the vertical joint, the notched wedge joint, and the cut vertical joint.

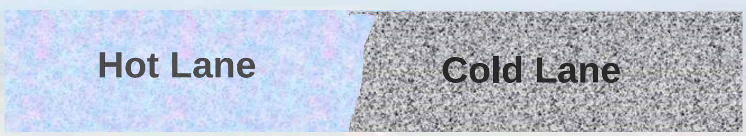
## Longitudinal Joint

- **Examples of Good Tack Coat Application Under the Mat and Extending Beyond the Joint**



NECEPT

## Vertical or Butt Joint



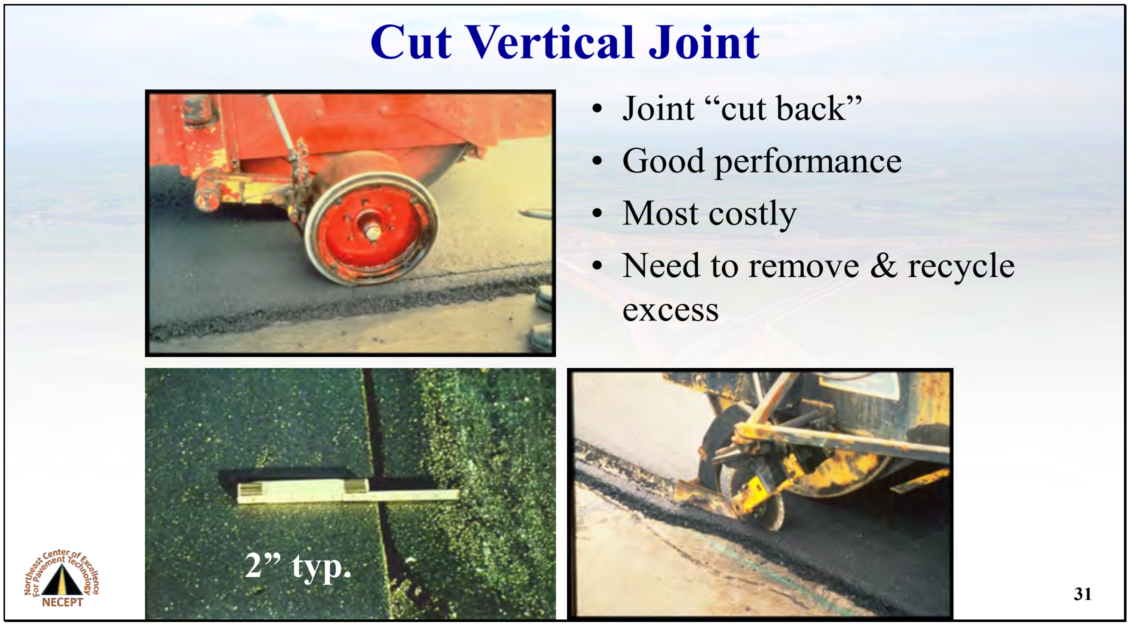

- Commonly used joint
- Good performance

**"PennDOT Approved"**

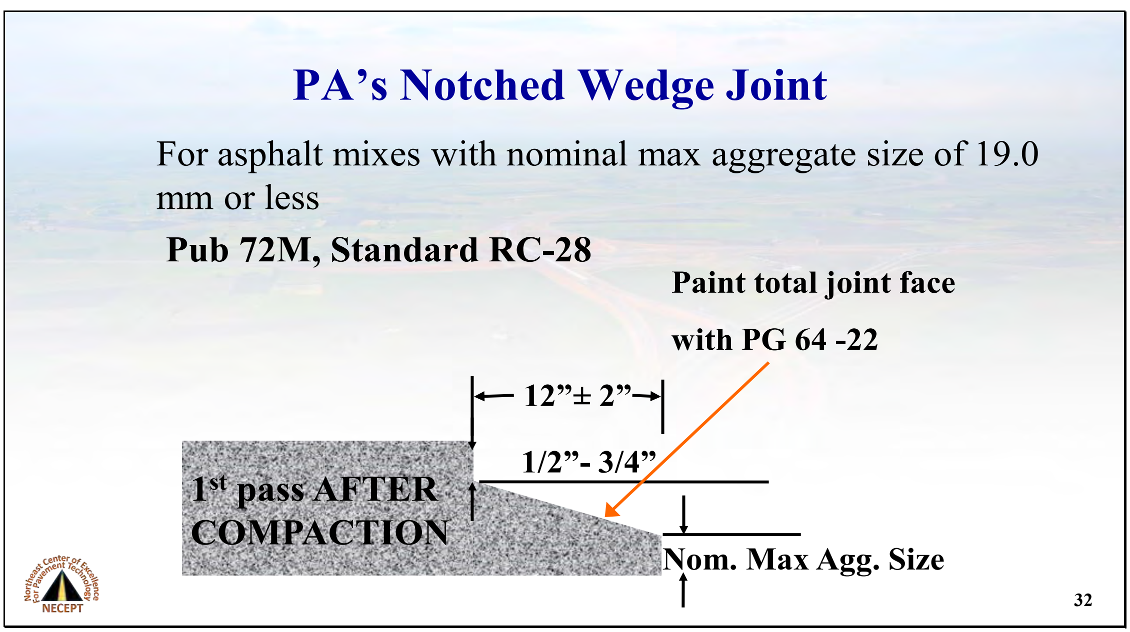
NECEPT

30

The vertical joint, or butt joint, has been used for many years and continues to perform well if care is taken during construction.




One of the better longitudinal joints is the cut vertical joint, but cut joints cost more. Over the years the best way to get the required density in an airport joint was to use the cut joint. When used on highways, safety becomes a concern in removing the material from the cut joint. Some specs require the joint to be "cut back" 1 to 2 inches before the next mat is placed. This can be done with a saw, or a cutting wheel attached to a grader, roller, or loader. The purpose of this work is to remove the part of the mat that may have less density than the rest of the mat due to lack of confinement during compaction. If traffic will not be passing over the mat, cutting back the joint while the mix is still warm requires less effort. The successful use of the cutting wheel depends upon the skill of the operator.




This profile of first pass is after rolling, not "as laid."

## Device for NWJ Compaction is both heated and vibratory

33

The joint looks good, but tack coat should be visible beyond the edge and in front of the paver.

## Does NWJ have Sufficient Depth?

Make sure the NWJ depth meet specification requirements

## Clean Placed NWJ

35

## Longitudinal Joints

**New Interlocking Joint or "Zipper Joint"**

**What happened here?**

36

One of the worst Longitudinal Joints ever constructed. " It's only base" ?????????


There is no way to construct a good joint here. How do we compact edge with 3”-6” overhang?” and How will we get consistent 1”-1½” overlap when we place the adjacent pavement?” Need to cut to get straight line. It will cost money and time.


The evidence of longitudinal joint premature failure can be found everywhere throughout our transportation system. These conditions demand our attention to improve our construction procedures for longer lasting pavements and lower maintenance costs.

## Longitudinal Joint Construction
### PennDOT/PAPA Training Video

**Watch the Video**

NECEPT

39

## Recap of Video

- Plan ahead to avoid joints whenever possible
- Offset joints **6”** from previous layer
- TACK must be **6” wider** than pavement
- First Pass MUST be **straight**
- Overhang Roller **3-6”** on **unsupported edge**

NECEPT

40

## Recap of Video –Second Pass

- Lightly coat entire surface of NWJ or vertical joint with 64S-22 or Asphalt in mix
- Paver should overlap previous lane by **1 to 1 ½ inches**
- Depth of overlap should match rolldown
- NO LUTING or RAKING

NECEPT

41

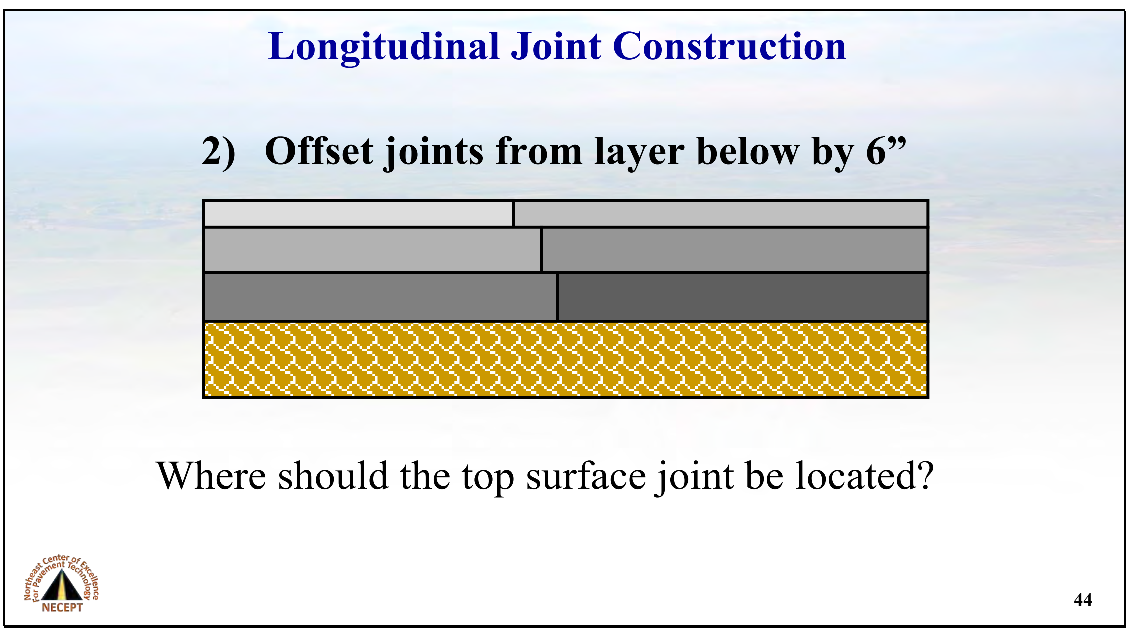
## Recap of Video –Second Pass Compaction

- Compact from edge toward joint.
- Leave about **18 inches** of uncompacted material at **NWJ**.
- Last pass of coverage overlaps Longitudinal joint by **2 to 6 inches.**
- Joint must receive as many passes as the rest of the mat.

NECEPT

42


Echelon paving is when two pavers are running next to one another. The cold joint between the two paving lanes is eliminated and tack coating the joint is not needed. Properly lapped and compacted, this longitudinal joint is difficult to see, and density in this joint will be similar to the density of the adjacent mat. Because of the need to maintain traffic and the need to minimize user delays, echelon paving is primarily confined to new highway construction and airports.




Scratch/leveling is not a layer .

## Longitudinal Joint Construction

**Offsetting joints:**

– Avoids plane of weakness down through pavement layers

– Locate surface joints near centerline but off of line striping locations

45

Offsetting joints increases the pavement strength in joint areas and prevents water penetration down through the entire pavement system if the surface joint opens.

## Longitudinal Joint Construction

**3) 1st pull of paver leaves unsupported edge**

– Needs to be clean, straight, uniform

– Will have lower density than rest of mat


46

Unsupported edges create a potential weakness in the finished pavement, and it must be handled carefully to minimize problems. It takes less effort to construct the joint properly than to repair it later!!

## What We Don't Want


NECEPT

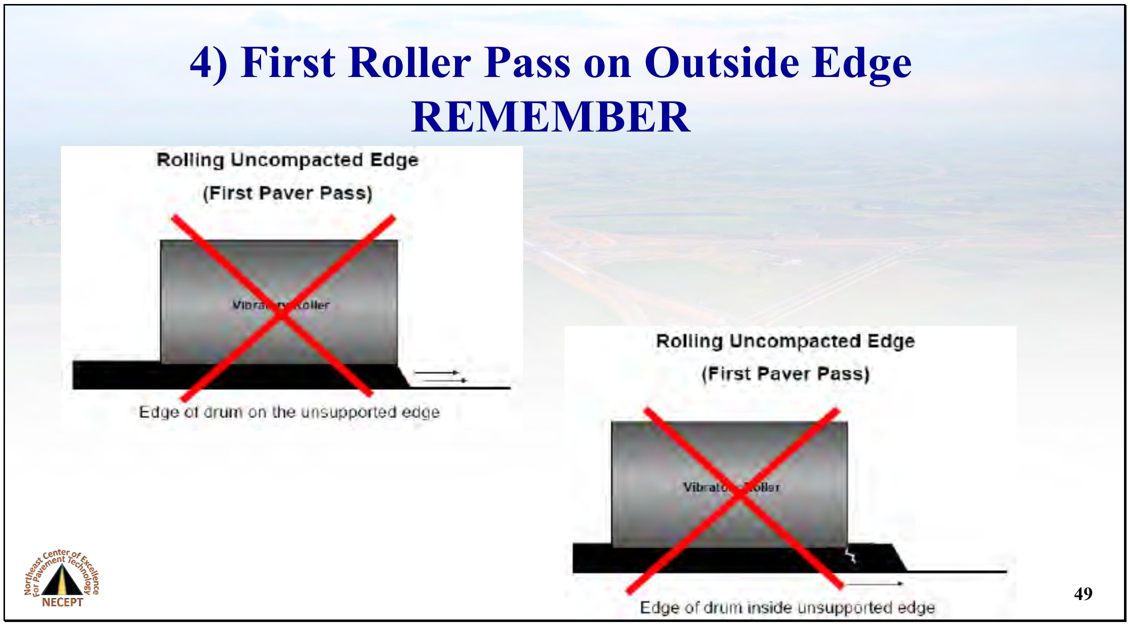
47

This is a prime example of what we do not want. Attempting to maintain a constant overlap when laying the adjacent lane will be nearly impossible, resulting in a poor performing joint. The sign on the right is certainly true!!

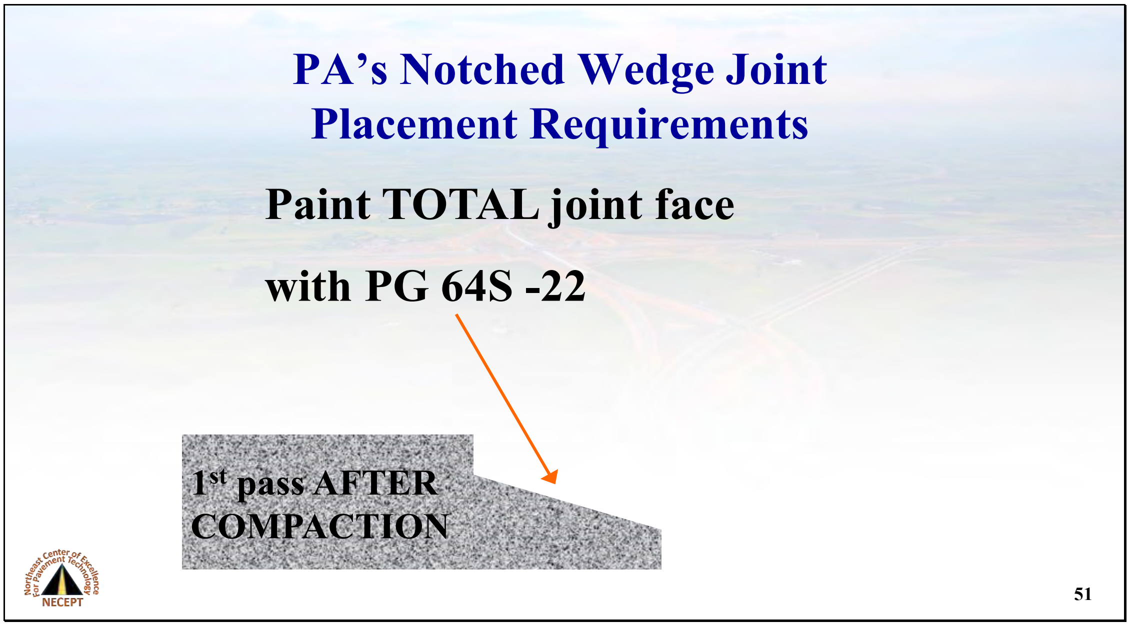
## A Well-Constructed Joint!

NECEPT

48




Although there has been extensive research investigating differences in accepted methods of rolling the joint, the methods shown above have been determined to not give consistent superior performance experienced by the overlap method.




This profile of first pass is after rolling, not "as laid."


Longitudinal joint faces shall be painted with a PG 64S-22 asphalt or the PG binder used in the mix to help fill voids and create a better bond and waterproofing. For a notched wedge joint, the entire face of the joint including the top vertical surface, the beveled wedge and the lower vertical surface should be painted.

PAINTED means THIN application of the binder.

## Applying Tack to the Shoulder Joint

53

## What we don't want

54

The entire surface of NWJ is not covered. Also note the lack of a notch at the top of the notched wedge joint.

## Longitudinal Joint Construction
## Placement of 2nd Pass Requirement

**6) Overlap 1-1½” onto cold mat coming out of paver screed**

– Paver augers should push mix up tightly against face of joint NO ROLLDOWN


55

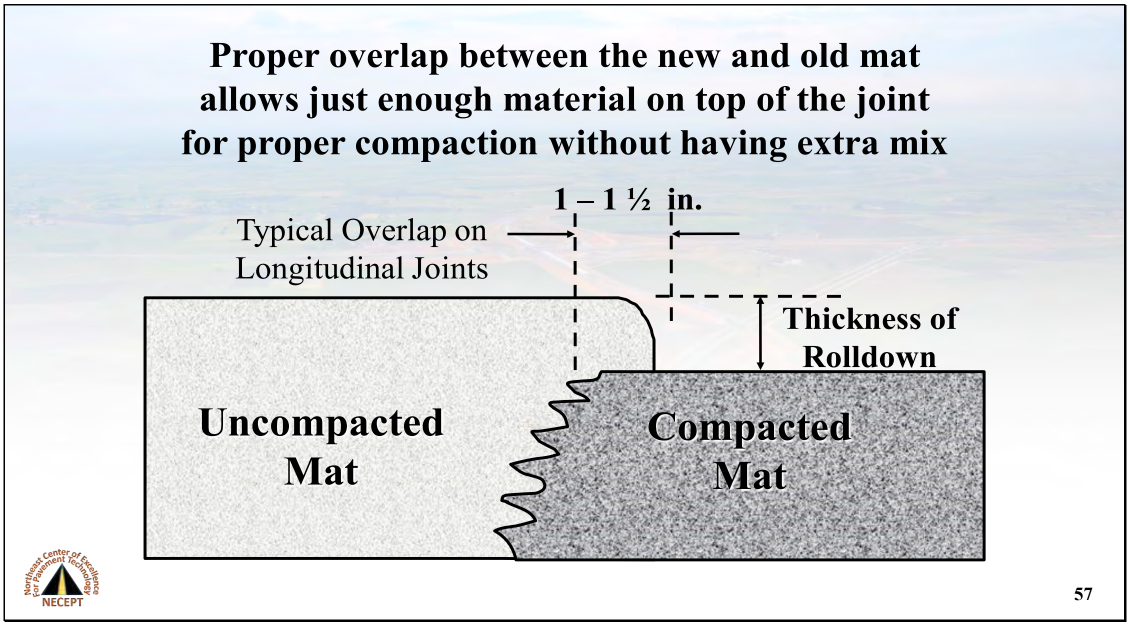
Set the screed end plate properly on the cold lane and produce a clean tight joint with an overlap of 1 to 1½ inches. The end plate should be in contact with the surface and leave a tight edge. Eliminate rolldown and segregation!!

## Proper overlap of longitudinal joint

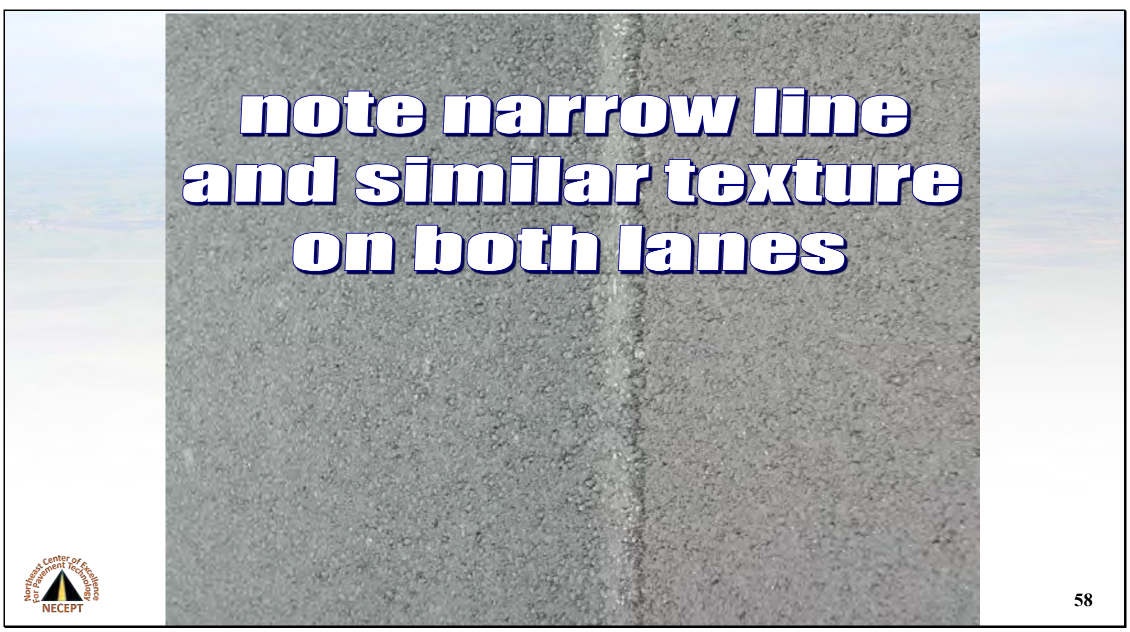
1” to 1 ½” as given in Section 413.3(k) 1(a)

56

Note the joint matcher and PG binder at the edge of the mat.




Overlap is 1-1 ½ inch whether both vertical joint and NWJ.




The white line caused by crushed aggregate should be narrow (2” or less) and some of it should be on the hot side of the joint!

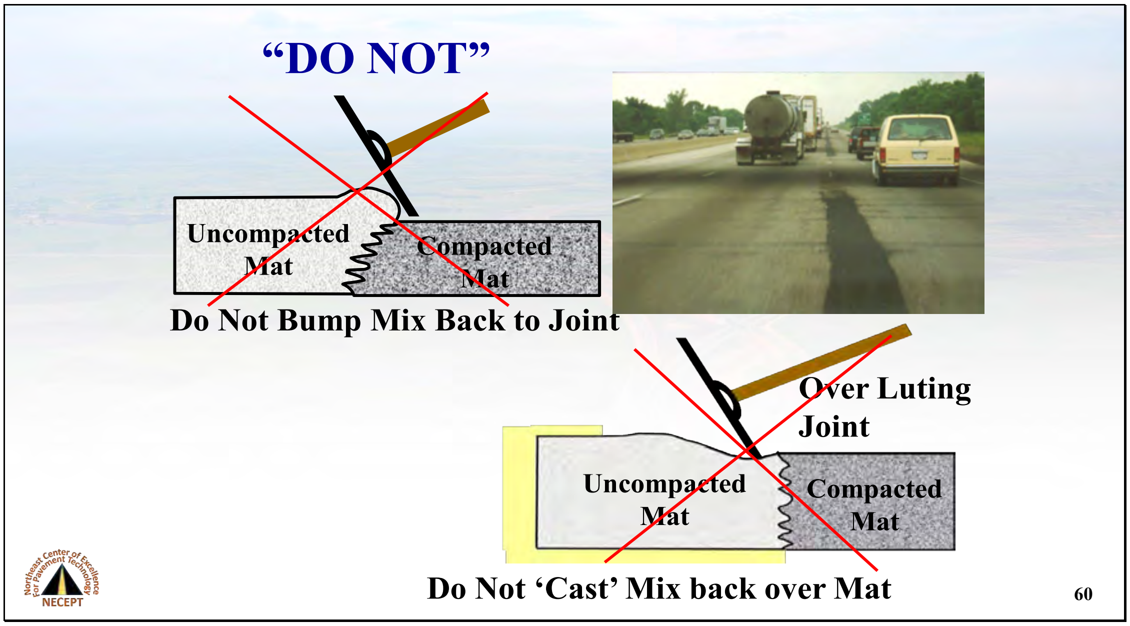
## Longitudinal Joint Construction

**Do not "bump" material, NO Luting-----**

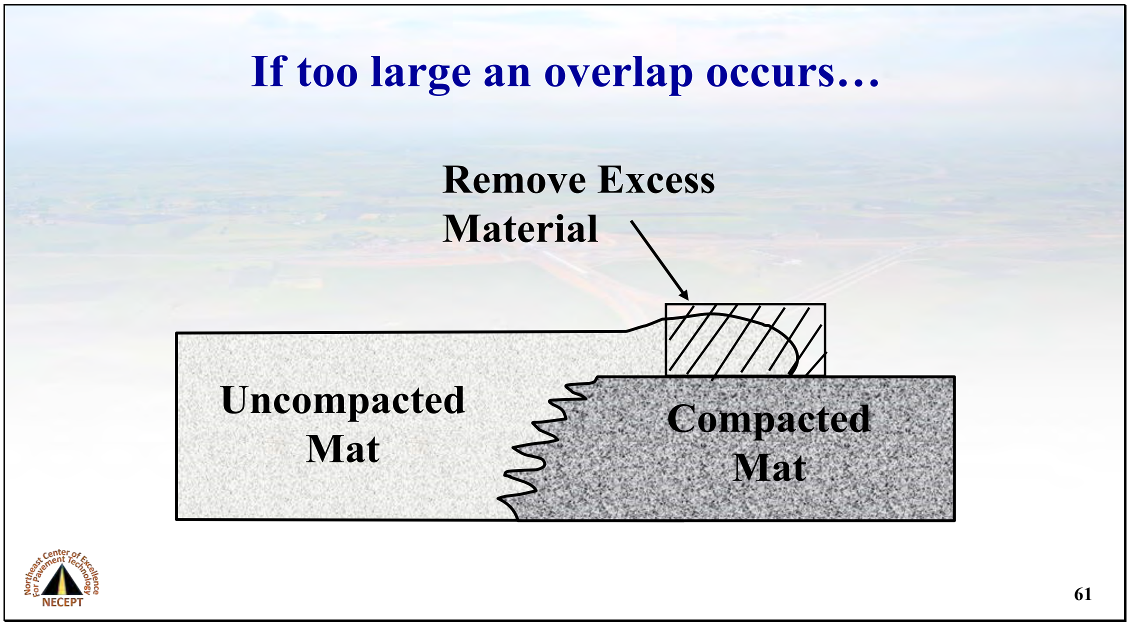
**just roll overlapped material into pavement**

59

**<u>DO NOT bump the material back to the joint with the lute.</u>** This was the standard practice in the past. The material, once laid, will simply be rolled onto the pavement. This method has been proven to provide good density.




If the amount of material is properly placed, "bumping" of the mix with the lute will not improve the joint density or performance. This action of luting flattens the joint, pushing all of the coarse aggregate away from the joint and onto the mat and will produce both a poorly performing and an unsightly joint. The first paved lane at the unsupported edge will have lower density than the remainder of the mat. When the second mat is placed and then over-luted at the joint, the material that could have been forced down into the joint to increase the density has been now removed and is no longer there. Now, both sides of the joint have low densities and will be prone to raveling. In the photo, the joint failed and the area was cut out and reconstructed.




If too large an overlap occurs, the excess material needs to be removed prior to compaction rolling. **DO NOT lute** the excess material across the mat.


Material was not placed according to the rule of 1/4" per 1" of rolldown at the joint.

## What is the White Stripe at the Joint?

Seems like excessive material and wide overlap at the joint, crushing the aggregate under the roller.

NECEPT

63

## Obvious Bridging from Excessive Overlap and/or Starved Joint

NECEPT

64

Note drum cuts on the second mat.

## Rolling Longitudinal Joint

NECEPT
Northeast Center of Excellence for Pavement Technology

65

Note width of un-compacted mat at centerline.

## Finished Joint Appearance

This method results in a crushed stone line that is mostly cosmetic and will wear off in time

NECEPT
Northeast Center of Excellence for Pavement Technology

66

On NWJ, some of the white line should be on the hot side of mat and both lanes should appear to have the same texture, if not, bridging may be an issue.

## Joint Construction Issues

<u>Filling the joint fully and getting good density is what's important for good performance</u>.

White line of crushed aggregate is excessively wide.


67

NOTE width of white line.

## Joint Construction


**Remember!**

Properly set up, the transverse and longitudinal joints will need minimal handwork.

68

Uniformity in depth and overlap depend on a true line of paving with the first pull of the paver.

## Longitudinal Joint

**Tight Joint – no luting / handwork**


NECEPT

69

Good joint construction will reduce the need for any handwork or luting.

## Minimize Number of Joints

**Shoulder joint eliminated**


NECEPT

70

Of course, the best construction will have the least number of joints. Care must be exercised when rolling joints and roadway when placed as in photo. A split or tear may be caused by roller action at the break.

## NEW “quick adjust” NWJ

71

# Issues and Problems in Joint Construction

72

All pavements have one weakness, and that is joints. Joints in asphalt pavements probably cause more problems than any other area.

## Problem

- Insufficient material to form joint or cold lumps at endplate
- Left open too long?

**notched wedge joint??**

73

## Longitudinal Joints

**Uneven irregular joint?**

**What caused this?**

Maybe tapering lane where there was inconsistent overlap at the joint?

Insufficient material at the screed ends and starving joint?

74

## First Winter Results of Poorly Constructed NWJ

NECEPT

75

Temperature segregation from the varying depth of material at the NWJ can cause problems. A consistent tack application that is wider than the paving panel INCLUDING THE NWJ is critical for success!!!

## Module 7 - Review

- **Joint Types & Construction**
  - Transverse Joints
  - Longitudinal Joints
- **Issues and Problems**

NECEPT

76

**Module recap**


PennState
Discussion
pennsylvania
DEPARTMENT OF TRANSPORTATION
NECEPT
77

# Quiz

## Module 7

## Joints



**1. Proper compaction of the joints is achieved only when density near the joint is equal to density of the mat.**

a. True

b. False

**Answer:**

**2. On rolling an unsupported edge of a newly laid mat, the roller should**

a. Roll with the edge of the drum directly in line with the edge of the mat
b. Stay back from the mat edge by 6 to 12 inches
c. Overhang the edge of the mat by 3 to 6 inches

**Answer:**



**3. When starting to pave from the transverse joint, which of the following apply to the screed?**

a. Needs to be heated
b. 1" to 1 ½" behind the vertical joint edge
c. Raised approx. ¼" per inch to account for roll down
d. All of the above

**Answer:**

**4. Which of the following is NOT a good practice for proper longitudinal joint construction?**

a. Ensure the joint receives at least as many roller passes as the mat
b. Keep the joint face free of PG binder
c. Make a straight first pass of the paver
d. Offset joints by 6” from the layer below

**Answer:**



**5. When paving in echelon the longitudinal joint remains hot enough to ensure a tight joint and does not need to be tacked.**

a. True
b. False

**Answer:**

6. PENNDOT specifications allow the use of two longitudinal joints, the vertical (butt) joint and the notched wedge joint.

a. True

b. False

Answer:



7. A transverse joint is required by the specifications to be rolled in the transverse direction.

a. True

b. False

Answer:

8. PENNDOT specifications call for the location of longitudinal joints in multiple layers be offset by

a. 2 inches
b. 3 inches
c. 6 inches
d. 12 inches

Answer:



9. A typical overlap in forming the longitudinal joint is

a. 1 inch
b. 3 inches
c. 6 inches

Answer:

**10. Luting of a longitudinal joint should be emphasized to broadcast the material back over the hot mat.**

a. True
b. False

**Answer:**

N
E
C
E
P
T

# Asphalt Pavement Construction Program

Certified Asphalt Field Technician
Course of 2025

# Module 8: Compaction

Northeast Center of Excellence for Pavement Technology
NECEPT

# Asphalt Construction Program

Certified Asphalt
Field Technician - 2025

**Module 8:**
**Compaction**

NECEPT

1

A good mix will perform poorly under traffic if it is not compacted to the proper density.

## Importance of Compaction

- **Compaction is the single most important factor that affects the performance of Asphalt Pavement***
- ***Asphalt Paving Handbook**

2

## Module 8 - Objectives

- **Terms & Definitions**
- **Importance of Compaction**
- **Factors Affecting Compaction**
- **Equipment**
  - **Types of Rollers and Maintenance**
- **Operating Techniques**

NECEPT

3

## Compaction: Related Definitions

- **Density:** A measurement of the weight of material that occupies a certain volume of space (lb./ft$^3$)
- **Compaction:** A process to reduce the volume of the mix through compression
- **Pass:** The entire roller moving over one point in the mat one time
- **Coverage:** The roller moving over the entire width of the mat one time
- **Time Available for Compaction (TAC):** The time in minutes that a particular mix is in the right temperature range for effective compaction

NECEPT

4

Knowledge of these terms is essential for successful compaction practices.

## Compaction Importance

- Improve Mechanical Stability
- Improve Resistance to Permanent Deformation (rutting)
- Reduce Moisture Penetration
- Improve Fatigue Resistance
- Reduce Low-Temperature Cracking Potential

5

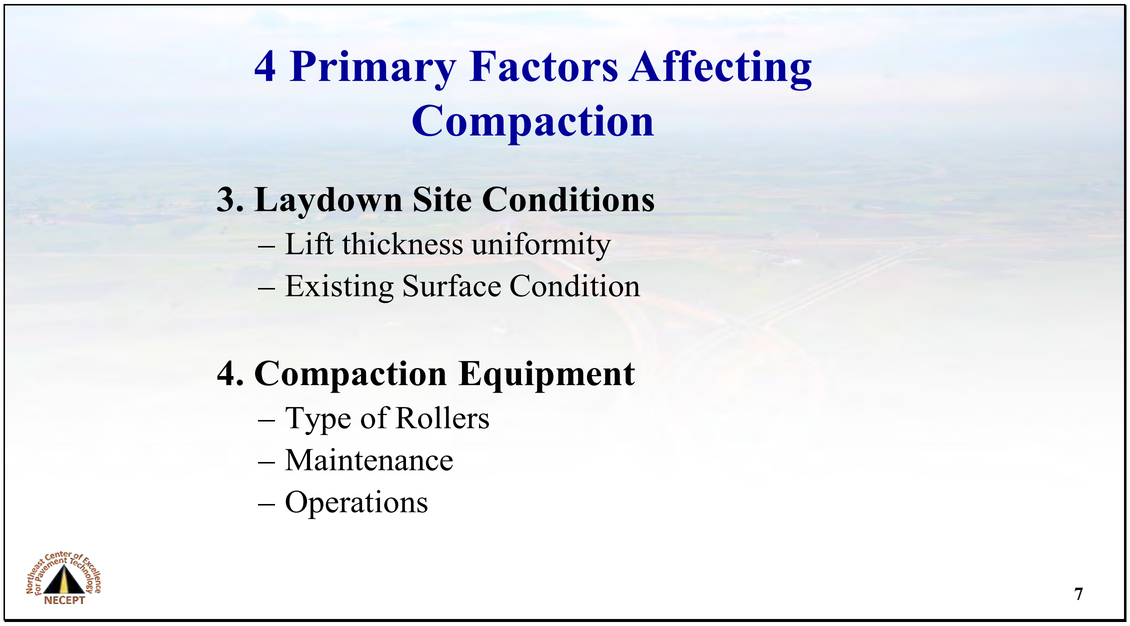
Compaction is what makes a highway out of asphalt!

## 4 Primary Factors Affecting Compaction

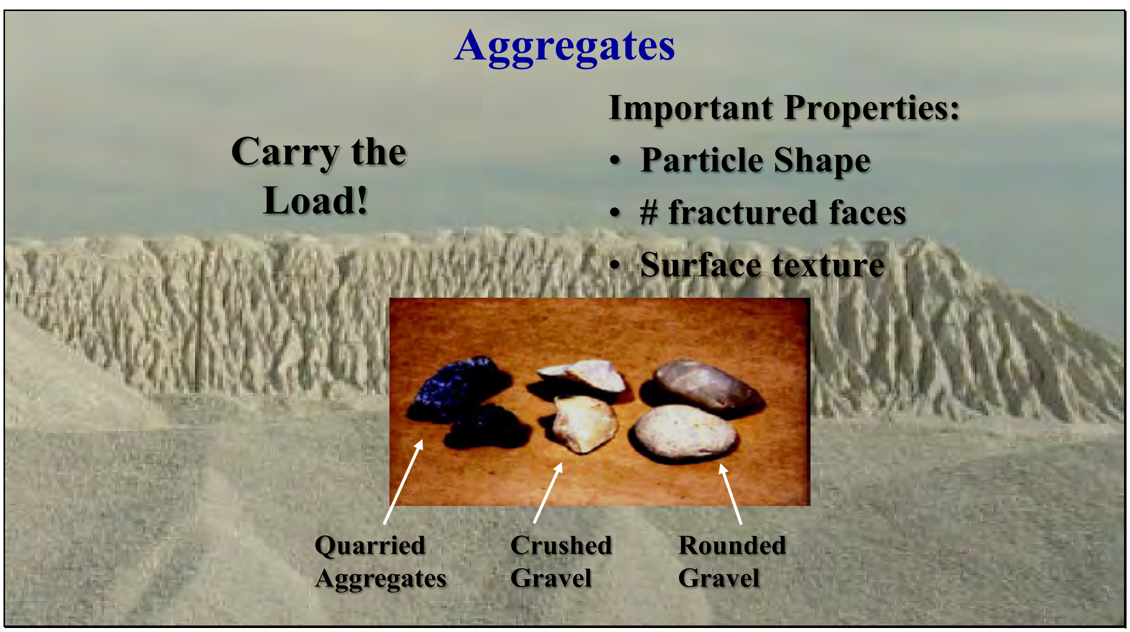
**1. Properties of the Materials**
- Aggregate size and shape
- Asphalt binder (Cement)
- Mix properties
- Lift thickness versus aggregate size

**2. Environmental Variables**
- Air and base temperature
- Mix lay-down temperature & layer thickness
- Wind velocity
- Solar flux

6




Laydown site conditions also include existing surface texture, profile and stability. Compaction equipment must be properly sized for the project and be able to effectively handle the material




**Aggregates vary greatly in properties** such as surface texture, porosity and particle shape. Aggregate may be natural (limestone, sandstone, granite, shale, dolomite, quartzite, etc.) or manufactured (steel or blast furnace slag). *Angularity of aggregate particles, crushed material content, nominal maximum size, gradation, and hardness* control the amount of compactive effort to achieve density. **Aggregate is "the rock that carries the load."**

## Aggregates


NECEPT

9

Dense graded mixtures are the most common types of asphalt mixtures used in pavements worldwide. Dense graded mixtures are comprised of coarse, medium and fine aggregate particles. However, mixtures with other aggregate gradations are also used in asphalt mixtures. For example, some Superpave mixes tend to be coarser. Stone Matrix Asphalt (SMA) is a gap-graded mixture that also tends to have a much larger proportion of coarse aggregate.

## Skid Resistance Level (SRL)

**PennDOT Pub 242, Table 5.4**

**SRL CRITERIA**

| INITIAL OR CURRENT ONE-WAY ADT | INITIAL OR CURRENT TWO-WAY ADT | SRL DESIGNATION* |
|---|---|---|
| Above 10,000 | Above 20,000 | E |
| 2,501 – 10,000 | 5,001 – 20,000 | H; Blend of E and M; Blend of E and G |
| 1,501 – 2,500 | 3,001 – 5,000 | G; Blend of H and M; Blend of E and L |
| 501 – 1,500 | 1,001 – 3,000 | M; Blend of H and L; Blend of G and L; Blend of E and L |
| 0 – 500 | 0 -1,000 | L |
| *** E = Excellent, H = High, M = Medium, G=Good, L = Low** | | |

NECEPT

10

Skid Resistance Levels (SRL) for aggregates are specified according to the ADT (Average Daily Traffic ). A higher ADT requires a harder aggregate with a higher skid resistance level. This design Table shows the required SRL Designation and blends for the aggregates for the different ADT levels.

## Asphalt Binder

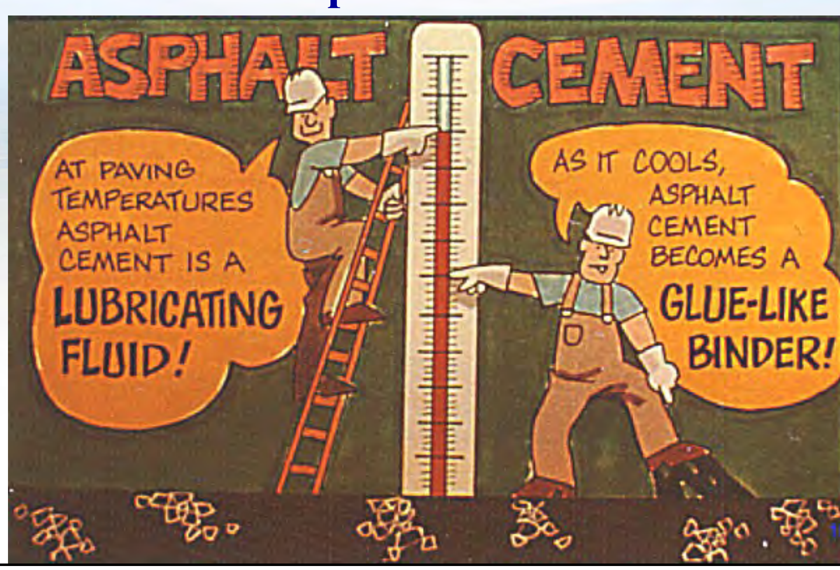
- Holds (binds) particles together
- Prevents air and water intrusion into mat
- Lubricates the mix during compaction

Can of Asphalt Binder

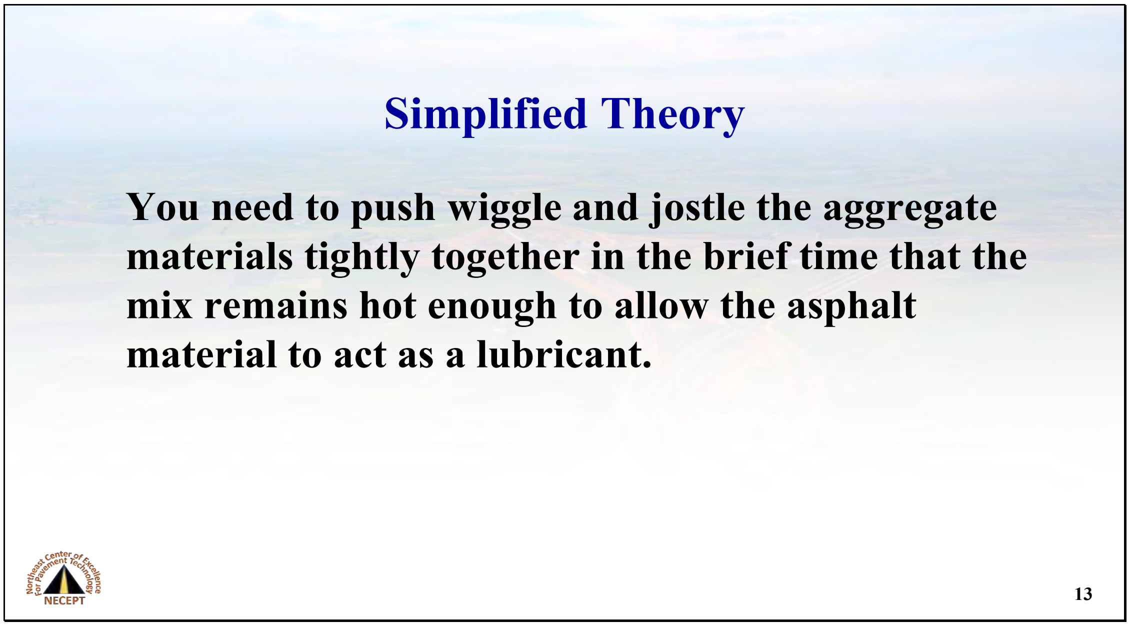
11

The grade (stiffness) and amount of *asphalt cement (*binder*)* affect our ability to densify the mix. As the binder becomes stiffer (for example, using PG 64E-22 instead of PG 64S-22), it will require higher mix temperature to assist with workability of the mix and the compaction process to achieve density. In some cases, higher grades of binder require modification of the binder with polymers, and often this modification increases the compactive effort needed to obtain density.

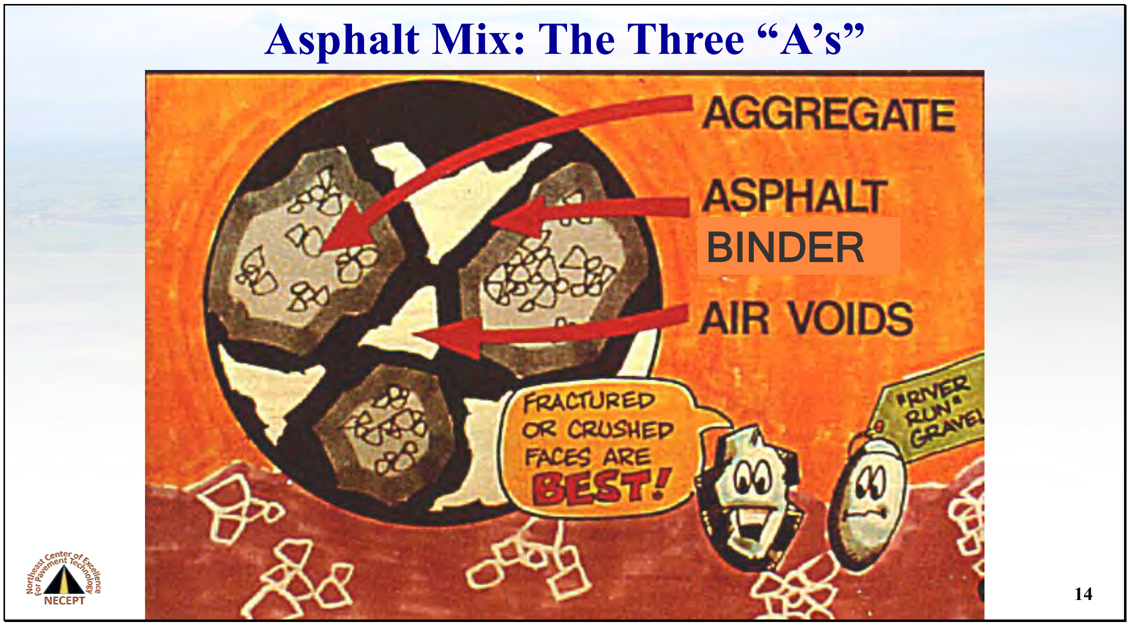
## Asphalt Binder




12




You may experience a tender zone, or “ zone of awareness” within a certain temperature range with each mix. You must learn to identify and work with this characteristic. Document parameters, techniques and results for future reference.




Asphalt paving mixture after compaction is made of three components: aggregate, asphalt, and air voids. The densification behind the rollers typically delivers between 3% and 8% air voids for a properly designed mix. A mix that is placed at a higher temperature will compact differently than a mix that is laid at a lower temperature.

Mixture properties vary based on the type of mixture specified. Type of mixture specified varies directly with traffic loading (Equivalent Single Axle Loadings, ESAL). Properly designed and compacted mixtures are a must in delivering a durable long-lasting pavement. A good asphalt pavement has an acceptable range of air void, high strength, and adequate flexibility to stand expected traffic load.

The amount of asphalt plays a significant role in the way the mix gets compacted as well as how it performs long term. In general, a mix with lower asphalt content (also referred to as dry or lean mix) will be stiffer and may require an increase in compactive effort, whereas a mix with higher binder content (also known as wet or rich mix) will be more flexible and may require a decrease in compactive effort. The amount of asphalt must be designed properly to deliver performance. Too little asphalt makes the mix brittle and susceptible to raveling and cracking. Too much asphalt makes the mix susceptible to shoving under the rollers and rutting, shoving, and bleeding later under traffic.

## Asphalt Mix – Layer Thickness

- **Uniformity**
  - Maintain uniform thickness
  - Uniform compaction helps with uniform thickness.
- **Thickness is Limited by Nominal Maximum Aggregate Size**
- **Rule of Thumb**:

  **Minimum layer thickness** = 3 to 5 times the nominal maximum size of the aggregate

NECEPT 15

Acceptable density is easier to obtain in an asphalt layer that has a constant thickness as covered in module 3.

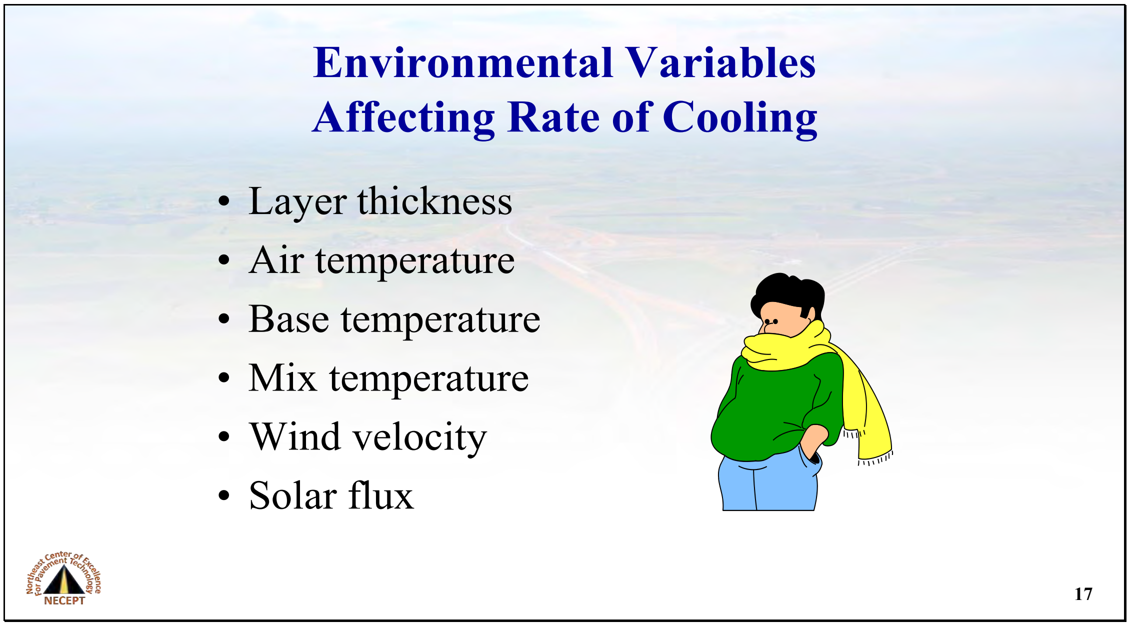
## Thickness of Superpave Mixes

| Mix | Minimum Lift (in.) | Maximum Lift (in.) |
|---|---|---|
| 6.3 mm | 0.75 | 1.25 |
| 9.5 mm FG* | 1.0 | 1.5 |
| 9.5 mm | 1.5 | 1.5 |
| 12.5 mm | 2.0 | 2.0 |
| 19.0 mm | 2.5 | 3.0 |
| 25.0 mm | 3.0 | 5.0 |
| 37.5 mm | 4.5 | 8.0 |

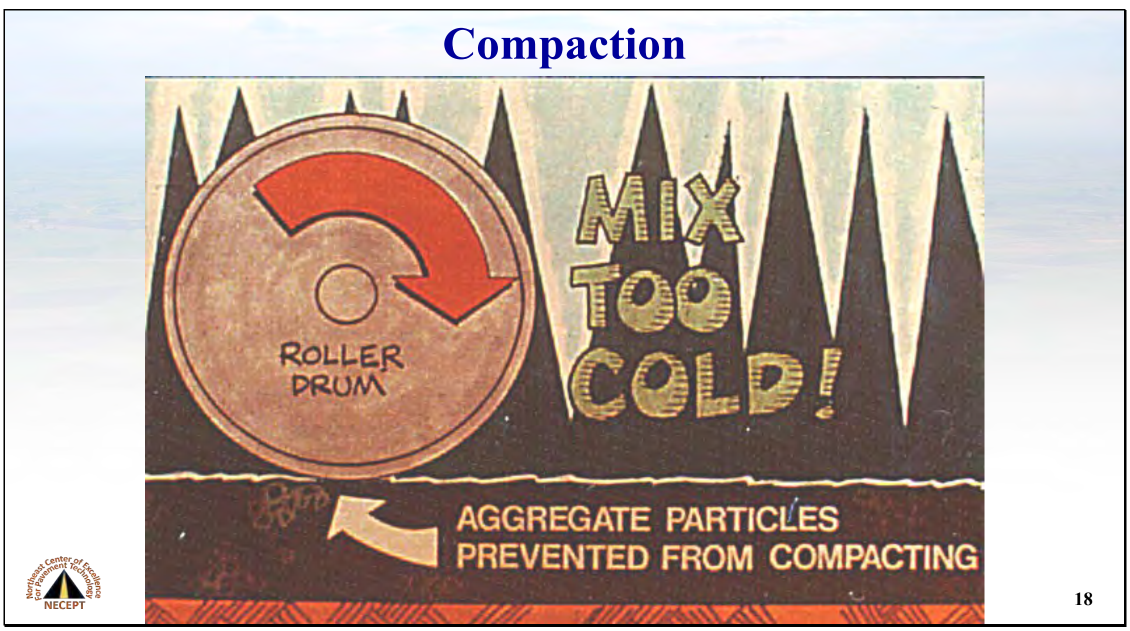
*FG= fine grade

NECEPT 16

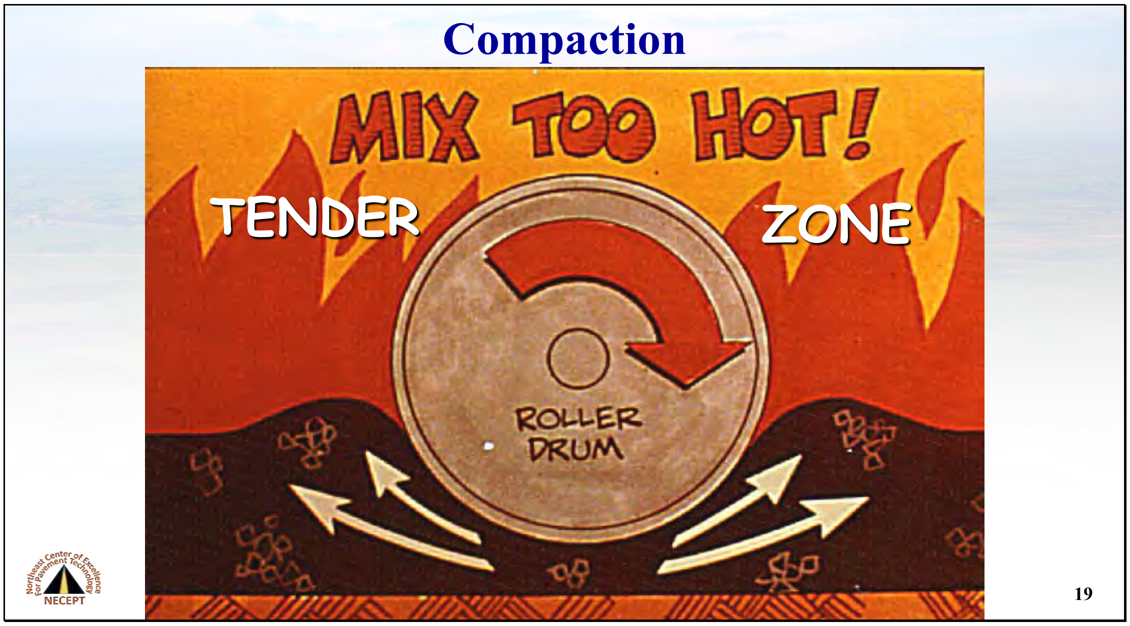
Scratch or leveling courses are routinely less than the 1.5-inch thick and suggested for placement with a 9.5-mm mix.




Research work and field experience show that once an asphalt pavement cools to a certain temperature, the internal friction and cohesion of the mix increases to the point that little density gain is achievable. With Warm Mix Asphalt (WMA), because of the viscosity reducer effect in the mix, it is possible to get to lower temperatures compared to conventional hot mix asphalt before gaining density stops.




If the mat is too cold, the asphalt binder's viscosity increases, and the binder loses its lubricating ability. The result is that the aggregate particles are prevented from compacting further. At low temperatures, the asphalt is already acting as a glue to bind the aggregate particles in place, rather than providing lubrication to the aggregates for further movement.



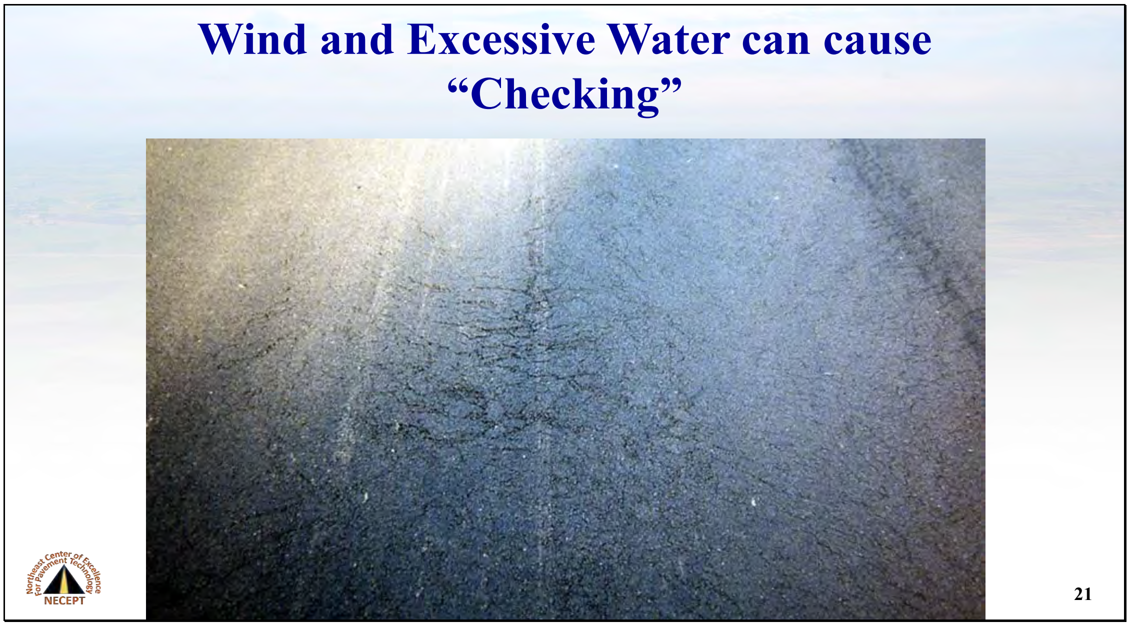

If the mat is too hot, the roller will just move the mix around and cannot compact the mix. Bow waves will appear in front of the roller drum. This can also happen during the ‘tender zone’. Tender zone, in regard to Superpave mixes, will be discussed in detail later in this module.

## Time Available for Compaction (TAC)

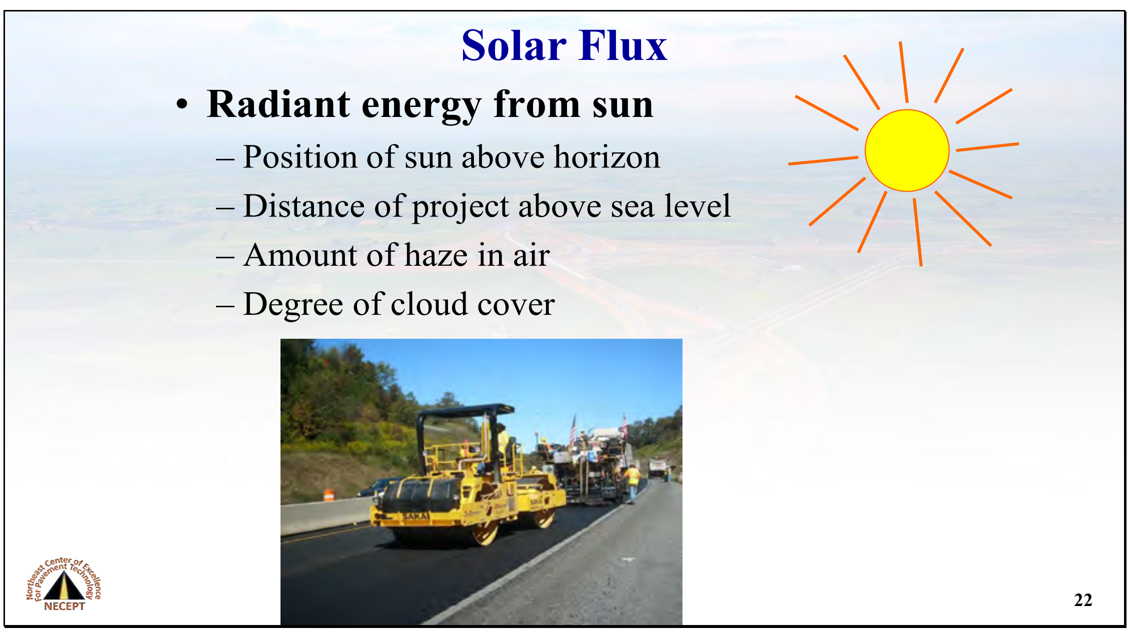
| Major Factors Affecting Rolling Time | allows MORE time | allows LESS time |
|---|---|---|
| Mat Thickness | THICK | THIN |
| Mix Temperature | HIGH | LOW |
| Base Temperature | HIGH | LOW |
| Warm Mix Additive | YES | NO |

NECEPT 20

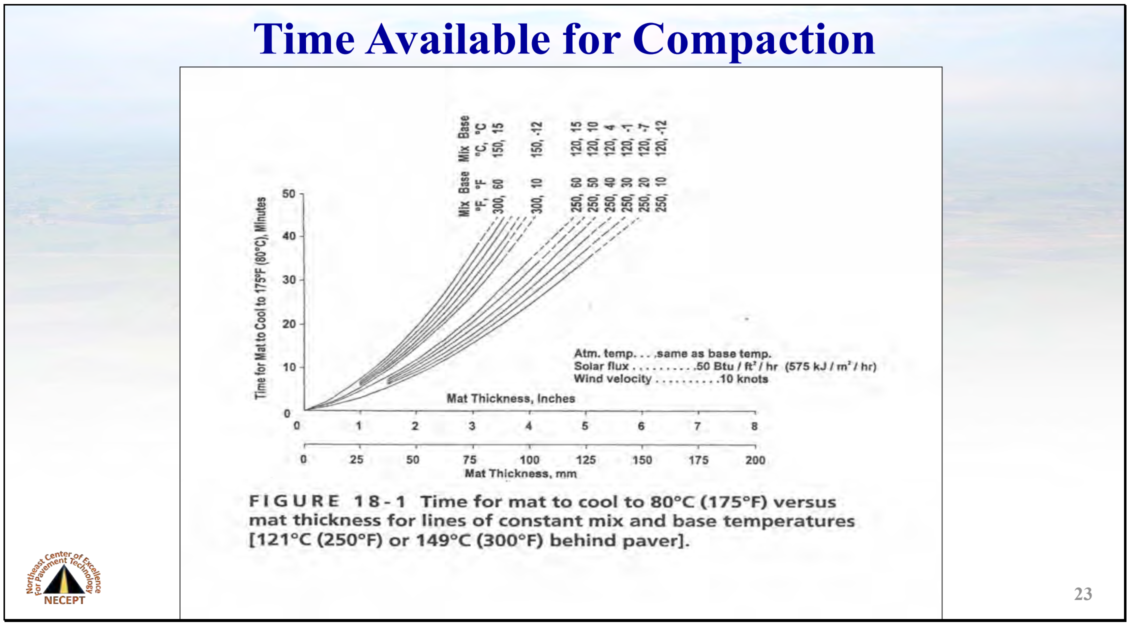
TAC is affected by mat thickness, mix and base temperatures, and WMA additives. If a thin Asphalt mat is being laid with a low mix temperature and a low base temperature, all the factors are working against you. Asphalt mixes produced between 270˚F and 325˚F can lose from 5˚F to 25˚F or more from the plant to the paver. Higher placement temperatures = more TAC. WMA additives have been demonstrated to extend time available for compaction.




A thin layer of mix will cool more quickly in a strong wind which has a greater effect on the surface of the mix than within the mix. This can cause the surface to cool so rapidly that a crust will form, and 'checking' of the asphalt may occur and may actually create a sliding condition that will separate the mix into layers as in this case. Excessive water on the roller drums will cause a more rapid cooling through evaporation and can even result in longitudinal tears in the mat. This can also occur when paving over water on the underlying surface.

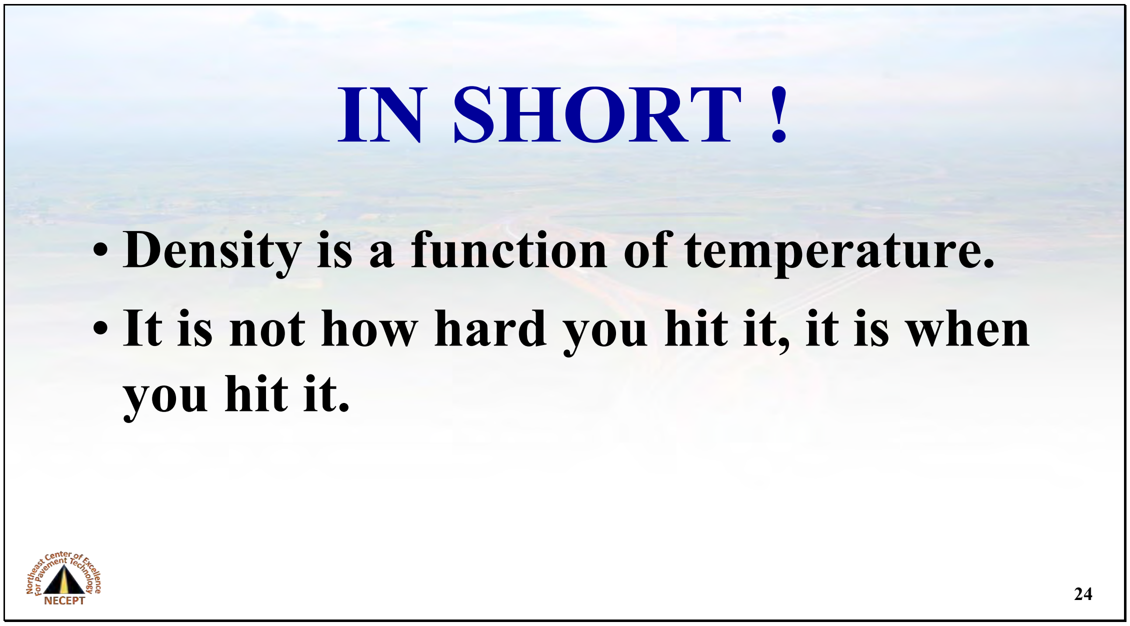



Solar flux relates to the amount of sunshine, a mix will cool more slowly on a sunny day than a cloudy day. The amount of solar flux has a greater effect on the temperature of the base surface where the mix is placed rather than the temperature of the mix being placed. However, the solar flux does affect the cooling rate of the mix.

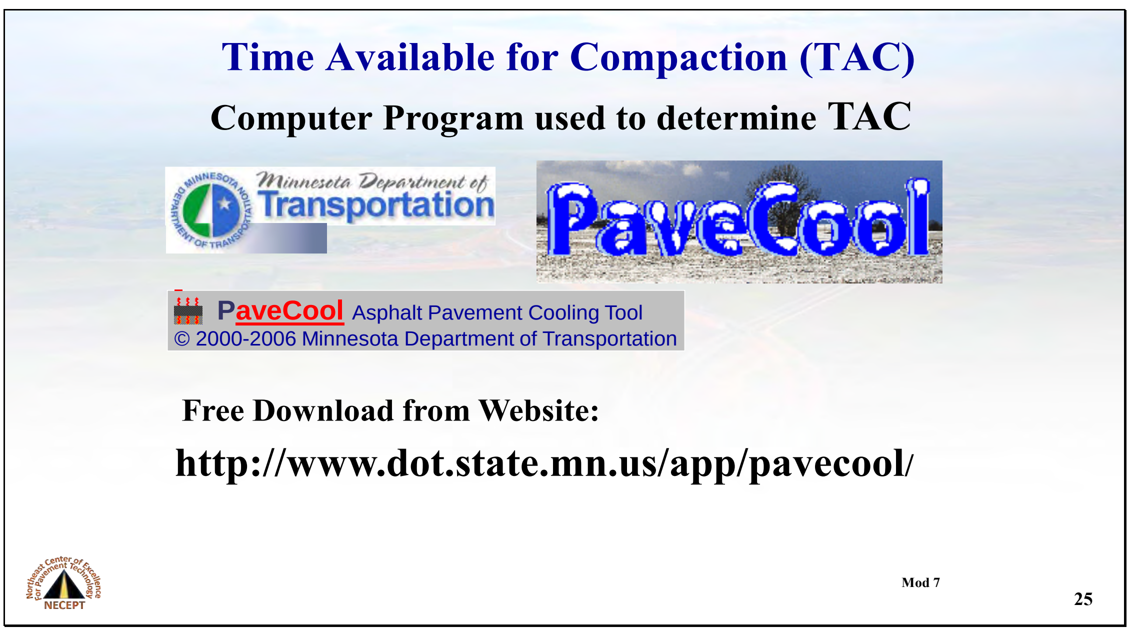



A series of "cooling curves" for asphalt mixtures illustrate the amount of time available for compaction under different combinations of the variables. The figures shown assume air temperature to be equal to the surface temperature of the base. A constant wind velocity of 10 knots and a constant degree of solar radiation is also used to generate the graphs. The curves then provide the time in minutes, for the mix to cool from the laydown temperature to a minimum compaction temperature for different compacted layer thicknesses. This chart is for laydown temperatures of 250ºF and 300ºF. There is also a chart for laydown temperatures of 225ºF and 275ºF. (Reference: Hot-Mix Asphalt Paving Handbook 2000). A full-sized chart is in the handout and will be used later in this module.

For a thickness of 2 inches and a base/air temperature of 40ºF, the time to cool to 175ºF increases from 9 min to 16 min as the placement temperature increases from 250ºF to 300ºF. For a 3-inch course and a base/air temperature of 60ºF, a change in laydown temperature from 300ºF to 250ºF reduces the time available for compaction from 36 min to 21 min. The effect of mat laydown temperature is more significant at lesser mat thicknesses and lower base temperatures.




Learning and recording the temperature related characteristics for each mix and roller train combination is the most fickle and demanding part of your job.




Pave Cool computer software has been developed by the Minnesota DOT to assist contractors, inspectors and engineers to make rapid decisions regarding cool-weather paving. The user enters the time of day, date and latitude of the paving job, along with the type of mix and type of surface being paved. The surface temperature, air temperature, wind speed, lift thickness, and mixture delivery temperature are then entered, and finally the amount of cloud cover. A heat flow model is used to compute the temperature drop in the mat and the time it takes for the mix to cool from its delivery temperature to 175°F.

website: http://www.dot.state.mn.us/app/pavecool/index.html


If surface preparation does not provide the uniform level platform on which to pave, density will be much harder to achieve. Asphalt leveling courses that, by their very nature and purpose, are non-uniform in thickness, are often difficult to densify uniformly, when placed over a rutted or wavy road. In Superpave mixes there will be some larger material and the rule of thumb is 3x NMAS for lift thickness except for scratch/ leveling courses.


The type of equipment used to compact the asphalt mix obviously has a significant effect on the degree of density that can be obtained. Four types of compaction equipment are currently being used: static steel wheel rollers, pneumatic tire rollers, vibratory rollers, and oscillatory rollers.

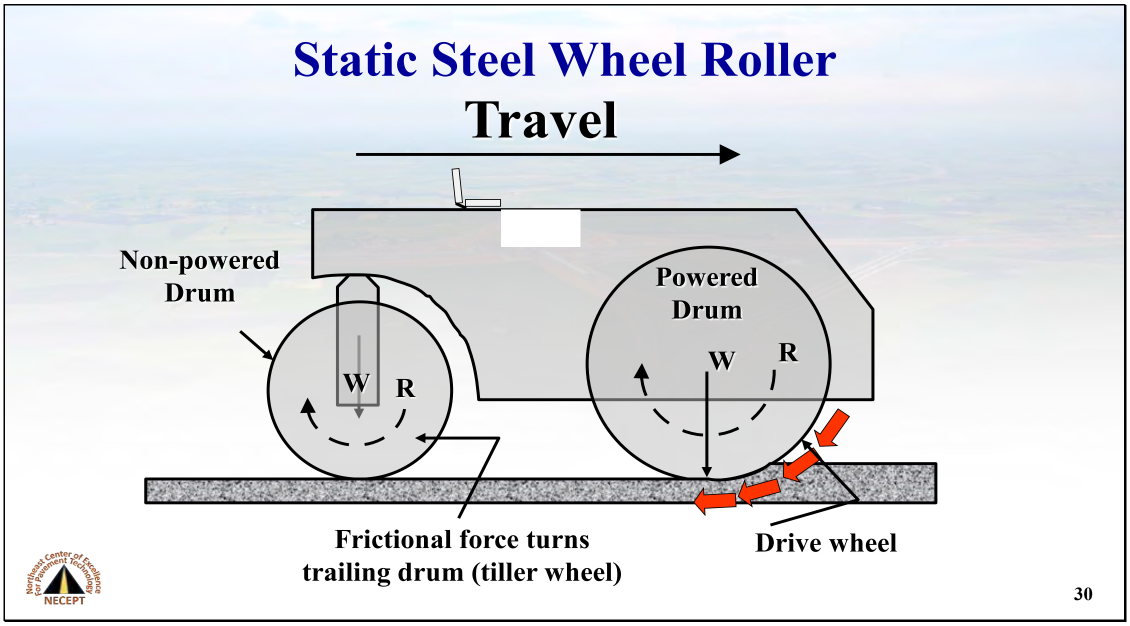

Contact pressure moves the aggregate particles together and removes air voids. Each roller type applies contact pressure slightly differently, but the concept is the same. In practice, compacting is not so simple because of the many variables involved. We know *densification* increases stability by recalling that if we walk across a freshly laid mat, without any roller passes, that we sink in the mat; yet after even one pass of the roller we make few marks.

## Steel Wheel Roller


29

Static steel wheel rollers normally range in weight from 3 to 14 tons and have drums that vary in diameter from approximately 40 inches to more than 60 inches. The gross weight of the roller can usually be altered by adding ballast to the roller, but this adjustment cannot be made while the roller is operating and is not normally changed during the term of a project.

Drawbar pull is defined as the horizontal force required to move the roller forward. Rollers with large-diameter drums have lower drawbar pull (rolling resistance) because they do not tend to penetrate as far into the mix as does a roller with smaller-diameter drums.




Always run with the powered drum toward the paver. The red arrows represent the rotational force on the wheel which is transmitted to the mix and tends to move the mix under the wheel. This transition results in nearly direct vertical force. The tiller wheel has a tendency to push the mix causing a wave in front. Analysis reveals two forces, one a vertical force downward (weight), and a horizontal force forward. Densification occurs as a result of the downward force and not as a result of the horizontal movement within the mix (shoving) which can and often results in a reduction in density.

Once the size and weight of a static steel wheel roller is selected, the variables under the control of the roller operator are the speed, position of the roller on the mat in relation to the paver, the number of passes and **temperature of the mat**.


## Roller Contact Pressure Is *GREATER* as the mat cools

Below is an example of contact pressure for a 12-ton static roller as depth of roller penetration into the mat decreases.

| Penetration Depth (inches) | 3/4 | 1/2 | 1/4 | 3/16 | 1/8 | 1/16 |
|---|---|---|---|---|---|---|
| **Contact Pressure (PSI)** | **36** | **46** | **63** | **74** | **88** | **132** |

**PSI is pounds per square inch.**

NECEPT 31

Effective weight or contact pressure, in terms of pounds per square inch of contact area (PSI), is the key variable for this type of equipment and is dependent on the depth of the penetration into the mix. The greater the depth of penetration, the greater the contact area and the less the contact pressure. On the first pass, when the indentation of the drums into the mix is the greatest, the contact area between the roller and the mat is the largest, and therefore, the roller exerts less contact pressure on the mix. On subsequent passes, as the mix becomes denser, the drums penetrate less and the contact pressure increases. As the pressure increases, at some point, the roller "walks out of the mat" as the roller cannot cause further indentation and cannot increase density. At this point, the internal strength of the mix increases to a level that does not allow further movement under the roller pressure. As shown in the chart, during the first passes of a typical 12-ton static roller, the contact pressure may range from 36 to 46 psi as the drum sinks in ¾ to ½ of an inch, depending on the initial stiffness of the mix. With additional passes, the mix becomes stiffer as the aggregate is packed together and air voids are reduced. The drum eventually "walks out" of the mix and the contact pressure becomes extremely high. Roller contact pressure increases as the mix's internal strength increases during compaction. At 1/16-inch penetration, the contact pressure is 132 in. lbs./in$^2$, a 366% increase over the original pressure!

## Pneumatic (Rubber Tire) Roller

**Factors affecting Ground Contact Pressure**

- Wheel load
- Tire inflation pressure
- Tire design (ply rating)

All tires should be the same size, same ply, and same air pressure resulting in uniform ground contact pressure.


32

Most pneumatic or rubber tire rollers are operated in the intermediate roller position, behind a vibratory or static steel wheel breakdown roller and in front of a static steel wheel finish roller. These rollers are sometimes used for initial rolling of the mix as well as occasionally for finish rolling. Pneumatic tires tend to pick up fines from the mix, and mixes with higher binder contents are especially susceptible to pick up by pneumatic tires. Pneumatic tired rollers are therefore not used on those mixes (such as SMA).

For a pneumatic roller, the compactive effort applied to the mix is a function of the wheel load of the machine, the tire pressure, tire design, and depth of penetration of the tires into the mix. Changing any of these parameters from tire to tire will change the ground contact pressure and result in uneven compaction across the width of the roller. The greater the contact pressure between the tire and the mix (higher air pressure in the tires), the greater the compactive effort applied by the roller.

## Pneumatic (Rubber Tire) Roller


Photo: Courtesy of Caterpillar

33

Once the size of the pneumatic roller and the tire pressure are selected, the variables that can be controlled by the operator are the rolling speed, location of the roller with respect to the paver, and the number of roller passes. If the compactive effort applied by the pneumatic roller is not adequate, the operator should alter the wheel load on the tires (ballast) and/or change the inflation pressure in the tires. Pneumatic rollers are ideal for uneven courses such as scratch and leveling.

NOTE: Pneumatic tired rollers should always be operated in a specific temperature zone, and NEVER back into the water on mat left by the trailing rollers. You can help to avoid picking up of fines by driving the pneumatic tire roller back and forth numerous times before going onto the hot mat as this will help to warm the tires.

## Pneumatic Tire Rollers

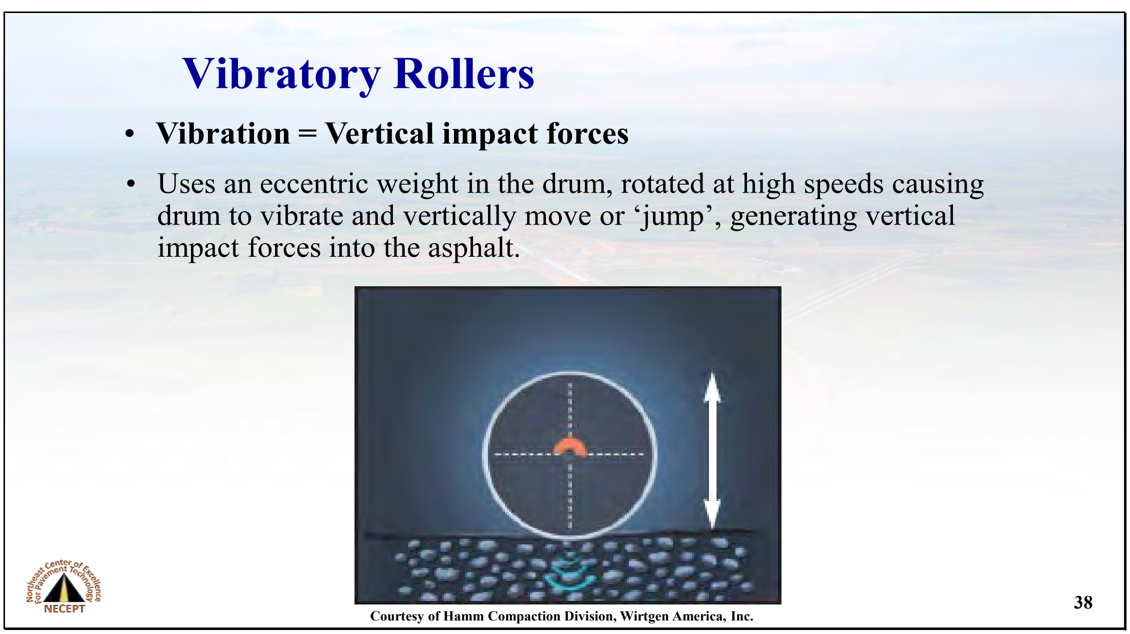
- Indentation tracks from pneumatic tire roller should be evident after finish roller on scratch/leveling courses due to differing depths of material (wheel ruts, etc.)
- If not, was the roller used at an effective temperature range?

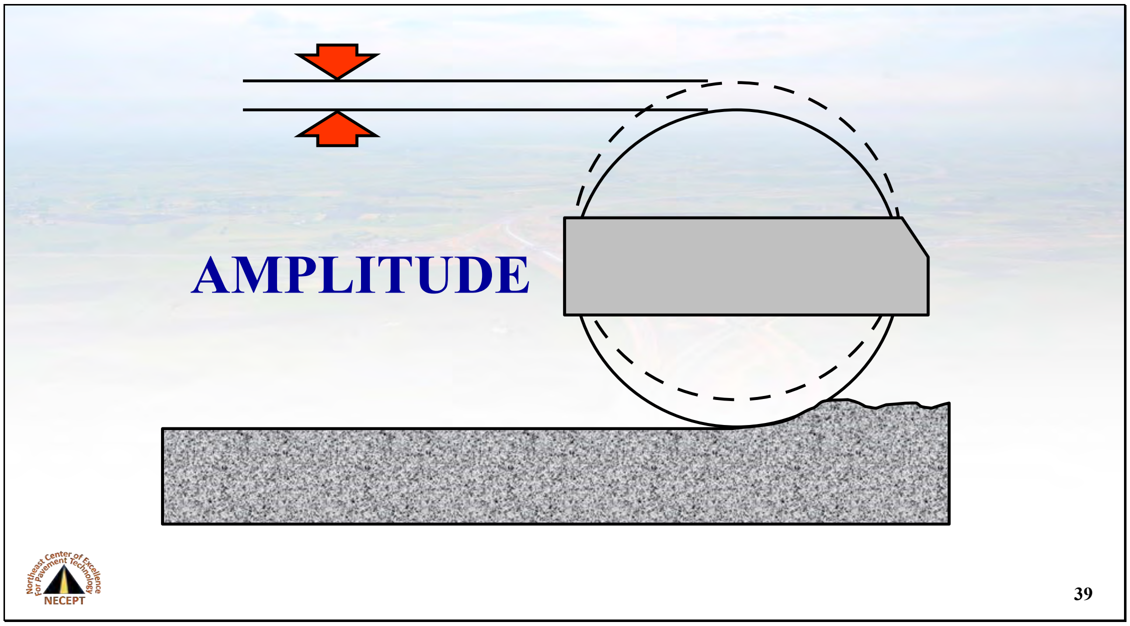
34


Pneumatic tire rollers should operate in a specific heat range to maintain uniformity of tire temperature. Providing a Non-contact thermometer is just good sense.

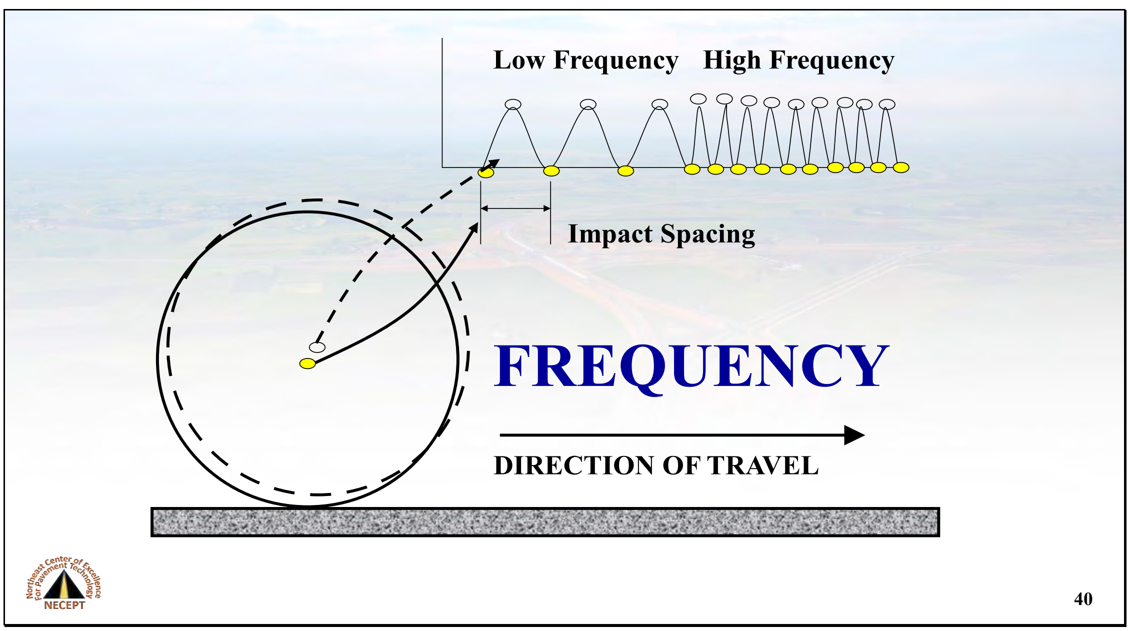

This photo illustrates the need for a pneumatic tire roller when paving on surfaces with raised areas or depressions. Note the bridging of the steel drum roller on this scratch course. The very left edge is well compacted, where the material is thinner, then the next several feet across the mat received very little compaction due to roller bridging.


Vibratory rollers come in a variety of configurations. Roller speed, temperature of the layer being compacted, number of passes , amplitude, and *IPF* can all be varied. Vibratory rollers come in rigid-frame, single-articulated-frame, and double-articulated-frame models. Vibratory rollers can be operated in any one of three modes: static (vibrators off); one drum vibrating, one static; and both drums vibrating. Vibratory rollers have two types of compactive forces: static weight which is the weight of the drums and frame, and dynamic (impact) force produced by a rotating eccentric weight located inside the drum(s).



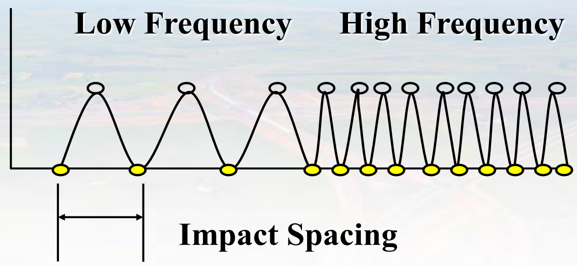



Amplitude is simply the vertical distance the drum vibrates. Normal values of amplitude range from 0.01 to 0.04 in. Some rollers can operate at only one fixed amplitude, others have "high" and "low" amplitude positions, and others are variable. As the layer thickness increases, it is often advantageous to increase the amplitude. Unless 'high' amplitude is needed to achieve a density, the vibratory roller is usually operated in 'low' amplitude.




The frequency of vibration is the number of complete cycles that the eccentrics rotate per minute (vibrations per minute or VPM). The faster the rotation of the eccentrics, the greater the frequency of vibration. Vibratory rollers may operate at only one frequency, while other vibratory rollers can alter the frequency of the applied load between 1600 and 3600 vibrations per minute. Frequencies <2000 VPM are not normally used to compact asphalt mixtures.

## Impact Spacing




**Target: 10 to 12 impacts per foot**

NECEPT 41

The spacing of the applied force is a function of the frequency of vibration and the travel speed. Impacts per foot (IPF) should be in the range of 10 to 12. That translates into 1.0 to 1.2 inches between impacts, to ensure the highest efficiency of the vibratory rollers and reduce the possibility of leaving ripples in the finished pavement. Proper impact spacing and amplitude at the correct temperature are the keys to successful compaction.

## Typical Data for Vibratory Tandem Rollers

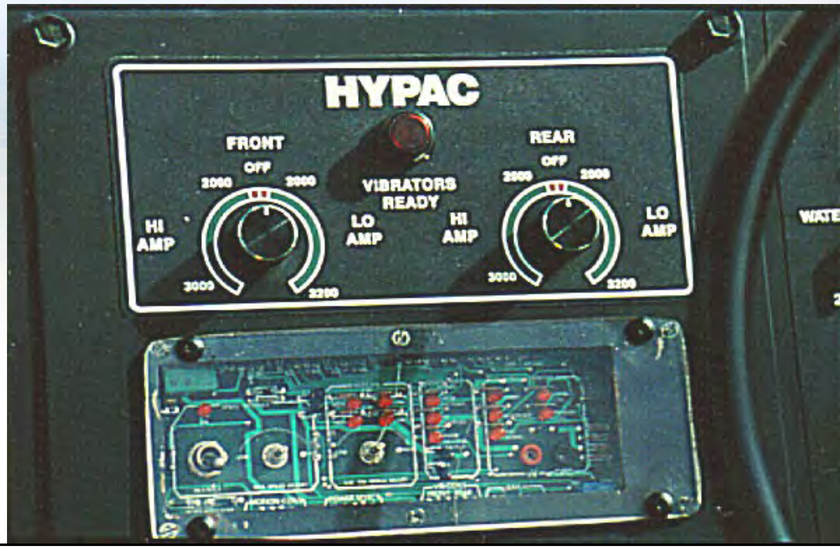
| *Vibratory Steel Tandem tons* | *Oper. Wt. lbs.* | *Drum Diam. ins.* | *Drum Width ins.* | *Static Drum p.l.i.* | *Dynamic Drum p.l.i.* | *VPM* | *Nom. Amp. in.* |
|---|---|---|---|---|---|---|---|
| *6-8* | 14700 | 41.5 | 56.5 | 130 | 260 | 2,900 | 0.025 |
| *91/2-11* | 20500 | 48 | 66 | 155 | 380 | 2,600 | 0.030 |
| *> 12* | 30000 | 59 | 84 | 185 | 420 | 2,400 | 0.030 |

p.l.i. = pounds per linear inch

NECEPT 42

A review of the chart gives us an opportunity to familiarize ourselves with the values used for analyzing vibratory rollers. Notice the comparison of capabilities with the vibrators on versus off. Drum rollers are often specified to have a certain p.l.i. (pounds per linear inch) of roller width at a drum contact arc of 1 inch. However, this may differ on each drum of a double drum roller since the weight is not equally distributed on both drums.

## Vibratory Roller Control Panel




NECEPT

43

Vibration frequency, vibration amplitude, and direction and speed of travel are under control of the operator who should be well trained in the selection and interaction of these variables. All of these factors have an effect on the density achieved under the compactive effort applied to the mix. On many rollers amplitude is still manually controlled by rotating a drum mounted wheel.

## Vibratory Rollers

- **Caution! Vibratory rollers can cause damage to:**
  - Underground utilities
  - Box culverts or other structures
  - Bridge and bridge decks


NECEPT

44

## Oscillation Rollers

- Rocking motion – not a vertical pounding
- Maintains constant pavement contact
- Faster compaction
- Less concern for damage to underground facilities or bridges




**Photos Courtesy of Hamm Compaction Division, Wirtgen America, Inc.**

45

Oscillation technology is a completely different type of Asphalt compaction. Oscillation compaction is non-aggressive because it compacts with a gentle rocking motion, not a vertical pounding. Oscillation compaction creates compactive effort through generation of horizontal shear forces, as opposed to vertical amplitude, and with no damage to adjacent structures, including bridges and underground facilities.


The oscillatory system uses dual, opposed, eccentric weights rotating in the same direction around the drum axis causing the drum to move in a rocking motion instead of a vertical or jumping motion. This rocking motion creates horizontal and downward sheer forces that achieve compaction without the 'bounce' of a conventional vibratory drum. The surface of the mat is smooth and flat. Oscillation movement helps to ensure that the asphalt will be compacted without damage to the aggregate.

## Roller Maintenance

- Water Systems
- Hydraulic Systems
- Mechanical Systems
- Vibratory Systems
- Drums, Tires, Pads, Scrapers



NECEPT

47

The technician and the operator should know what needs to be done to ensure that the roller is working properly and does not pick up the asphalt mix or damage the mat. A roller maintenance diagram depicting where to find key parts of the roller as well as showing an owner's recommended frequency to lubricate, change and check parts on the roller. The Reed Tachometer is a valuable tool for verifying vibratory performance or diagnosing problems when involved with a sensitive or difficult mix.

## Computing Impacts per Foot (IPF) ) Target 10-12

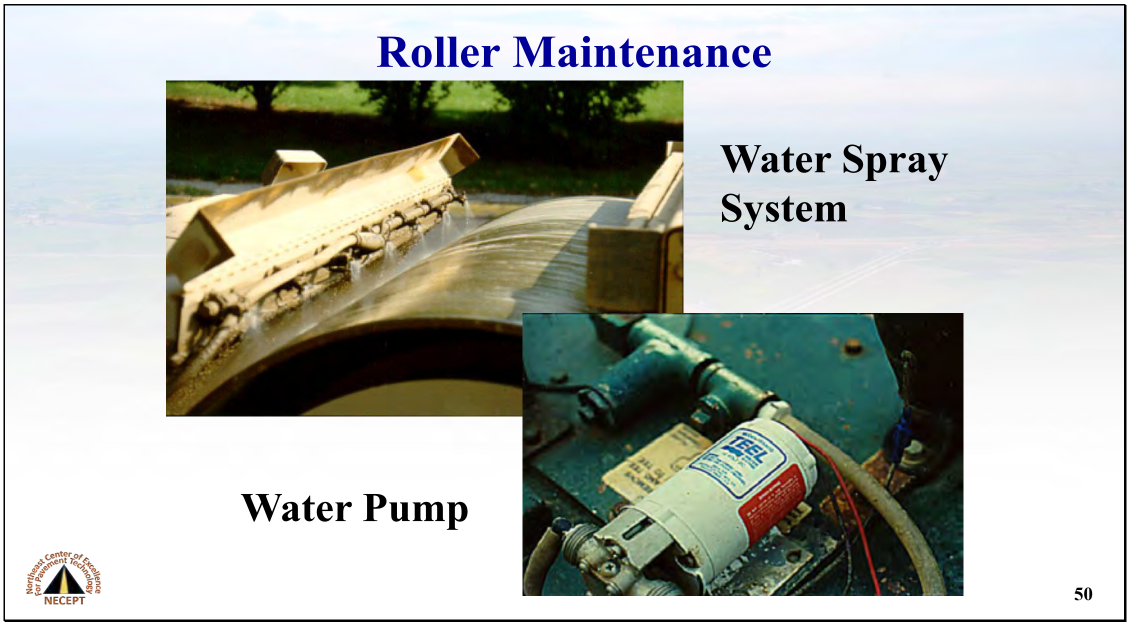
- Divide the frequency of the roller (Vibrations per Minute: **VPM**) by the desired Impacts per Foot (**IPF**) to obtain the correct speed in Feet per Minute (**FPM**)
- Example: 2,700 VPM divided by 12 IPF =225 FPM
- 3,000 VPM divided by 10 IPF =300 FPM

NECEPT

48

Establishing the maximum speed (FPM) at which a roller can operate while producing the desired impact spacing is critical to obtaining acceptable densities and balancing paver speed. Vibrations per minute (VPM or *frequency*) are constant on some machines, others have high and low, and some are infinitely variable within certain limits.


In this photo, the roadway shows evidence of roller impacts and the impact spacing is approximately 4 impacts per foot, and the material has a slight washboard effect. This was likely done on a cold mat. This photo was taken in spring following the fall paving.




The water system is designed to keep the mix from sticking to the drums or tires and is typically the highest maintenance item on a roller. The top left photo shows uniform spray ensuring uniform wetting and uniform pavement cooling. Spray systems that clog will cause asphalt to adhere to the steel or rubber-tired rollers. Use the minimum amount of water, just enough to prevent pick up. Excessive water is wasteful and requires more frequent refills and too much roller downtime. A stream of water running off the edge of the drum can create cold streaks and lead to rips or tears in the mat. For pressure fed systems without a gravity flow backup, keeping an additional water pump and spare nozzles available is a good idea.

## Roller Maintenance

**Scrapers and Pads**

51

Spare pads and the means for attaching them should be readily available. Scrapers also wear down and need replacing and should be made of material that will not gouge the drum surface. Scrapers on rubber tired rollers are as important as those on steel rollers. Rollers are the last equipment on and off the pavement and should be checked for maintenance needs at the end of each day. The last pavement placed must receive the same attention to detail and compactive effort as the first section.

## Roller Operating Techniques

**Topics we discuss as related to roller operating techniques:**

- Proper Equipment
- Compaction Variables
- Control Strip Construction
- Establishing Roller Patterns
- Breakdown Rolling
  - Joints
- Intermediate Rolling
- Finish Rolling
- Re-watering
- Opening to traffic

52


Different mixes may require considerably different levels of compactive effort and thus different compaction equipment and rolling procedures. An asphalt mix containing large aggregate, for example, may need different types of rollers to achieve a required level of density than an asphalt mix made with smaller size coarse aggregate.


The selection of rollers that were utilized on a previous project for a present job may not be the most cost-efficient or effective due to the variables involved in the present job. Although vibratory rollers are usually used for breakdown rolling and pneumatic tire rollers for intermediate rolling, a greater degree of density with fewer roller passes might be obtainable with a different combination. Determination of the “optimum” combination of rollers is key, along with a control strip to determine the proper pattern.

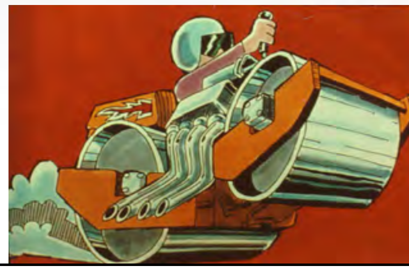

Each of these factors influences the level of density achieved under the compactive effort applied to the mix. **The most important variable is the knowledge and experience of the roller's operator.**

**NOTE:** Excellent communication with the Density Gauge Operator is required.

## Roller Speed

### Typical Range of Roller Speeds (mph)

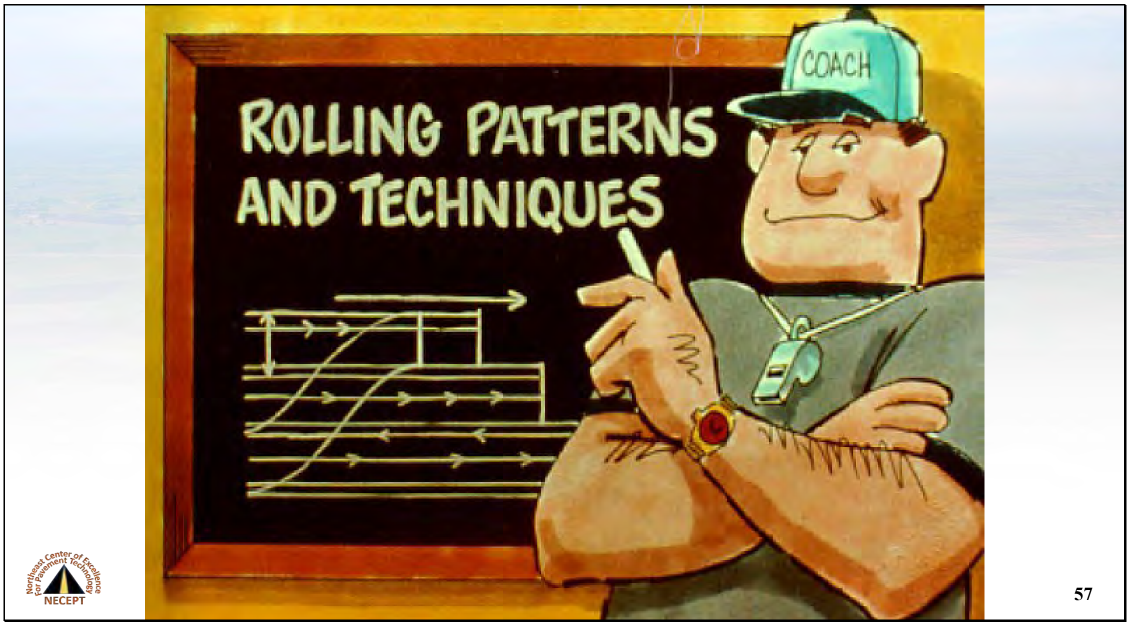
| ***Type of Roller*** | ***Breakdown*** | ***Intermediate*** | ***Finish*** |
|---|---|---|---|
| Static Steel Wheel | 2 to 3.5 | 2.5 to 4 | 3 to 5 |
| Pneumatic | 2 to 3.5 | 2.5 to 4 | 4 to 7 |
| Vibratory | 2 to 3 | 2.5 to 3.5 | ------- |



NECEPT

56

The faster a roller passes over a particular point in the new asphalt surface, the less time the weight of the roller "dwells" on that point, meaning that less compactive effort is applied. As the roller speed increases, the density achieved with each roller pass decreases. Speed selected is dependent on a combination of factors: productivity, layer thickness, and the position of the equipment in the roller "train." If the mixture moves excessively under the rollers, the speed of the compaction equipment should be reduced as long as it does not affect the impact spacing. Mat temperature is critical when deciding roller speeds and paver speed. **Speeds may change substantially with an increase in thickness of loose mixture being placed.**




Rollers are "busy" most of the time on a paving project. The question is whether they operate correctly and effectively. Numerous compaction studies have shown that the middle of the width of the paver pass typically receives more compactive effort than the edges of the pavement. This is unfortunate, because traffic uses the wheelpath areas and travels near the edge of the pavement more often than in the center of a lane.

Use of an 84" drum on a 12 ft. pass will cause the center of the lane to receive at least twice as many "hits" and twice as much cooling as the wheel path area. This can and often does create inconsistent density across the mat.

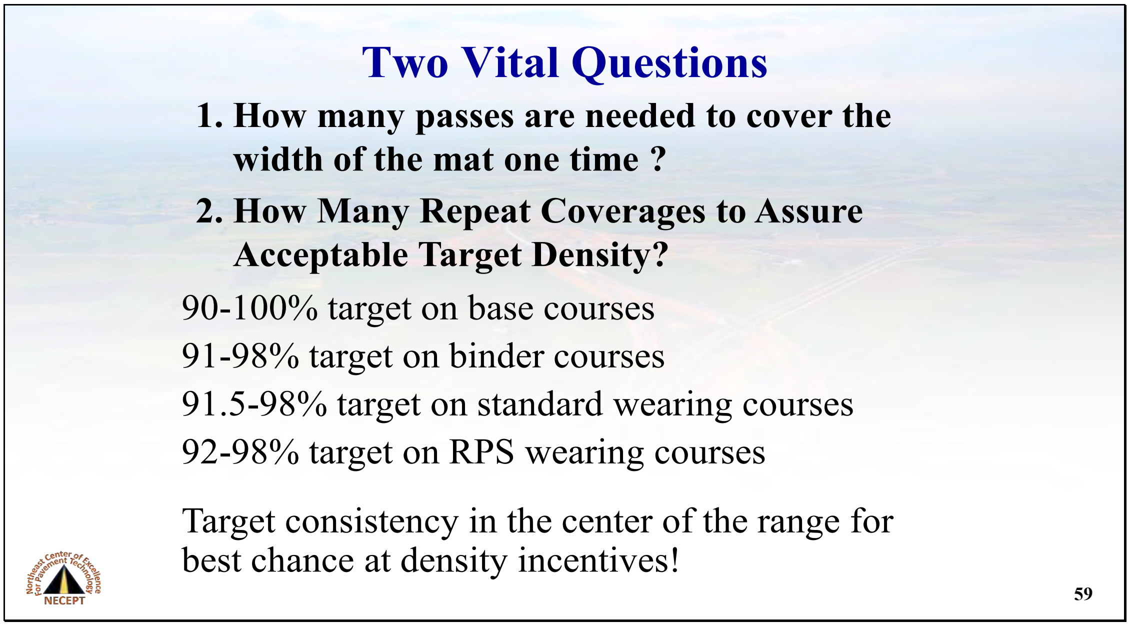
## Control Strip Construction

- Simulating Actual Conditions
- Establishing Roller Patterns
- Calculating Effective Roller Speed

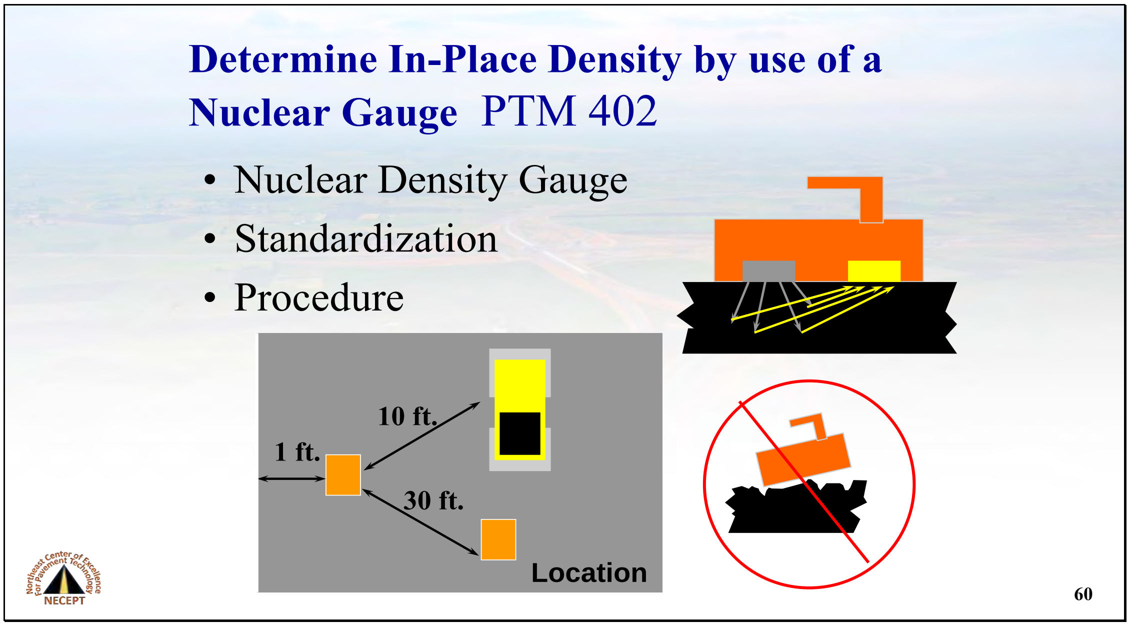

NECEPT

58

The actual rolling pattern to be used to compact the mix on a paving project can be determined at the start of the project through the construction of a roller control strip which will remain as part of the final pavement structure. The mix should be the same material to be produced for the project and the thickness of the layer should be the same as that used for the rest of the project. Length may vary but should be long enough to ensure that the results are representative of a full-day production. A control strip determines the most effective sequence of rollers to achieve the required compaction, smoothness of the mat, and economical production.

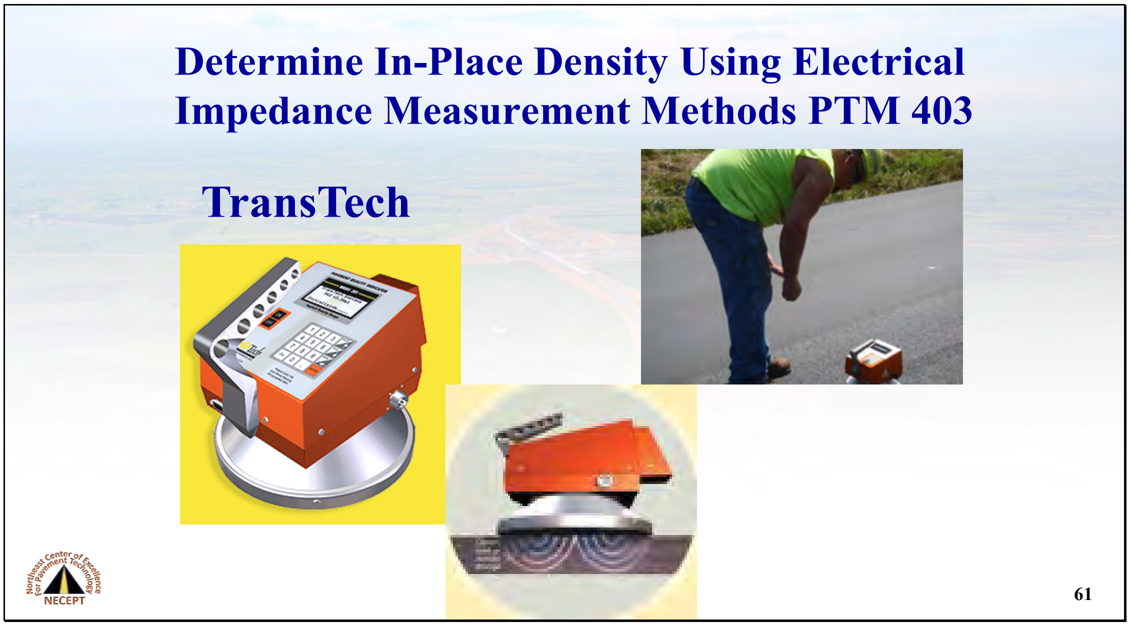



To obtain the target air void content and uniform density in an asphalt mixture, it is necessary to roll over each point in the pavement mat a certain number of times. Thus, the two vital questions become: 1) how many passes of the roller are needed for each coverage and 2) how many coverages are needed to obtain required density of the mix?
What is Maximum Density allowed and why?????????

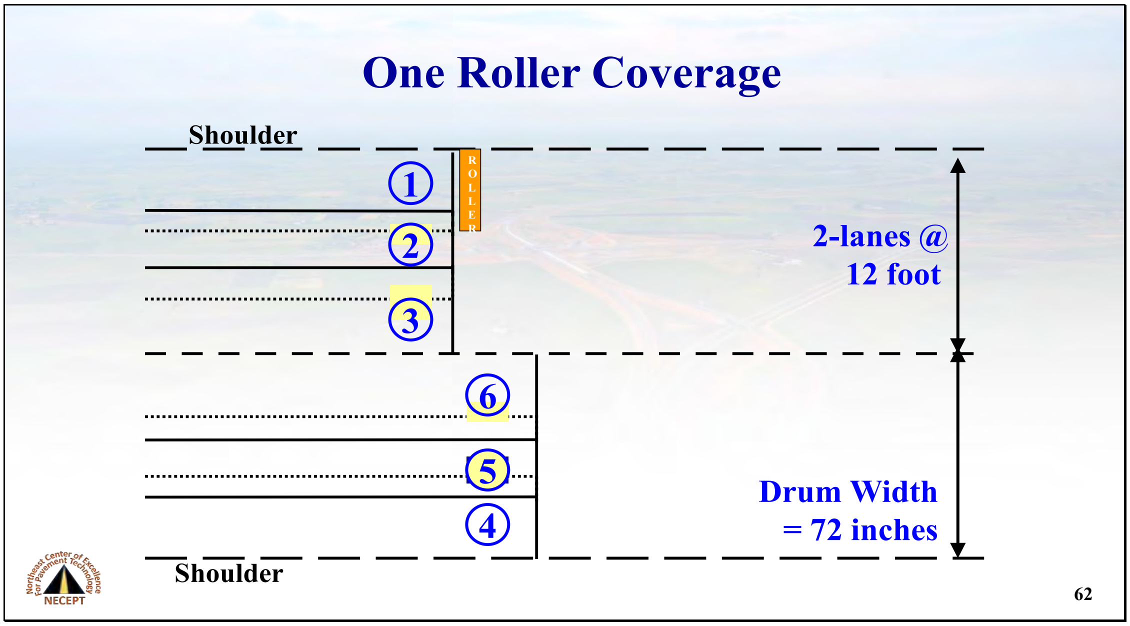



A common method for monitoring changes in density with roller passes is through the use of a nuclear density gauge, which transmits gamma rays into the mix and measures the amount of radiation reflected back to the device in a given time. The gauge must be calibrated to the mixture and must be standardized every day. PENNDOT specs call for the back scatter method. Direct transmission is to be used only when approved for the project. Some gauges give counts, which are converted to density, while others read density directly.

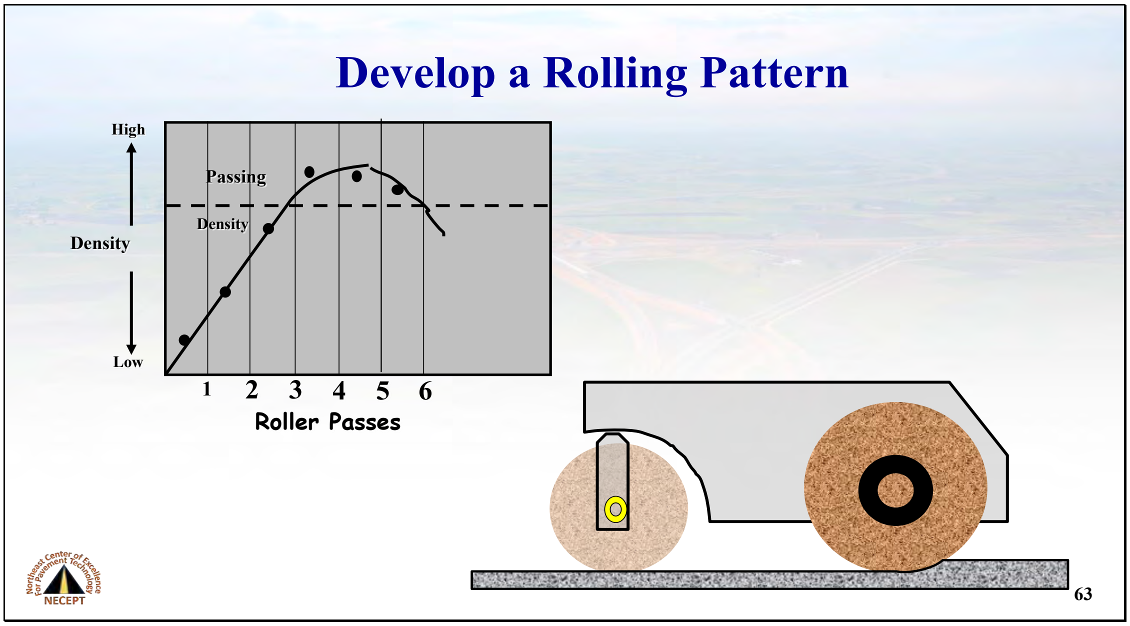
Gauge must be *standardized* every day. Follow guidelines as given by manufacturer or PTM 402 and record on TR-4276B




Using an electrical impedance device to determine density is a nondestructive technique as is the use of nuclear density gauge. **Density reading are relative** and require calibration with a known density sample. The density gauge, referred to as the Pavement Quality Indicator, uses low voltage with an impedance sensing head. Reflected, or back-scattered alternating frequency is measured by a sensor. The density is calculated from the amount of electrical resistance and reactance to flow of alternating current. The PQI is designed and built to provide quick readings of density, temperature and moisture content on asphalt pavements. The PQI unit takes readings in about three seconds, allowing the test technician plenty of time to run a series of tests quickly and get out of the way of the roller. The PQI is in use by contractors, QC/QA facilities and highway officials. Its electromagnetic field is safer than devices based on nuclear sources.




Standard paving widths of 10, 12, 14, and sometimes 16 feet can affect the efficiency of certain rollers. Ideally, the roller that can cover the width of paving with the fewest number of passes will be the most efficient. Smaller width rollers are routinely used, but the number of total passes will increase. For each roller employed on a project, the mat width can be divided by the width of the compaction drums to determine the number of passes needed to cover each transverse point in the surface. If the width of the roller drum is 84 inches, only two passes of the roller are needed to cover the 12-foot-wide lane, including a 6 in overhang at each edge of pavement. Three passes of the 72 in wide roller would be necessary to properly compact the lane. If the roller had drums that were 60 inches wide, three passes of the roller would also be required, similar to the roller with the 72 in wide drums. A 54 in drum needs four passes for one coverage.




Density readings should be taken after each *pass* of each roller, and the rate of increase in density after each pass determined. For acceptance by *Optimum Roller Pattern* , when no appreciable increase in density (>3 lbs./cu. ft.) is obtained with 3 consecutive passes, the maximum relative density for that mix has been obtained, **at that temperature range and with that machine only**. The density value determined with the nuclear or electrical Impedance gauge is relative and is generally not the same as the density value obtained from cores cut from the pavement. Compaction efforts with less than a noted continual improvement of 3 lbs./cu. ft. or less with 3 passes are wasting time and generally lead to crushed aggregate and shortened pavement life.

## Developing a Correlation

Nuclear Gauge versus Lab Tests

NECEPT

64

A correlation must be developed between the density reading and the actual unit weight of the pavement. That unit weight must be compared to the theoretical maximum unit weight of the mix in order to calculate the actual in-place air void content of the layer. This correlation has to be updated constantly, so that in the end the project meets the void criteria.

## Establishing Roller Pattern

- Width of paving
- Width of roller
- Impact Spacing
- Number of coverages needed
- Density testing
- Paving upgrade or down grade

NECEPT

65

All of these items come into play in establishing an optimum rolling pattern. Target value of impact spacing is 10 -12 impacts per foot (IPF).

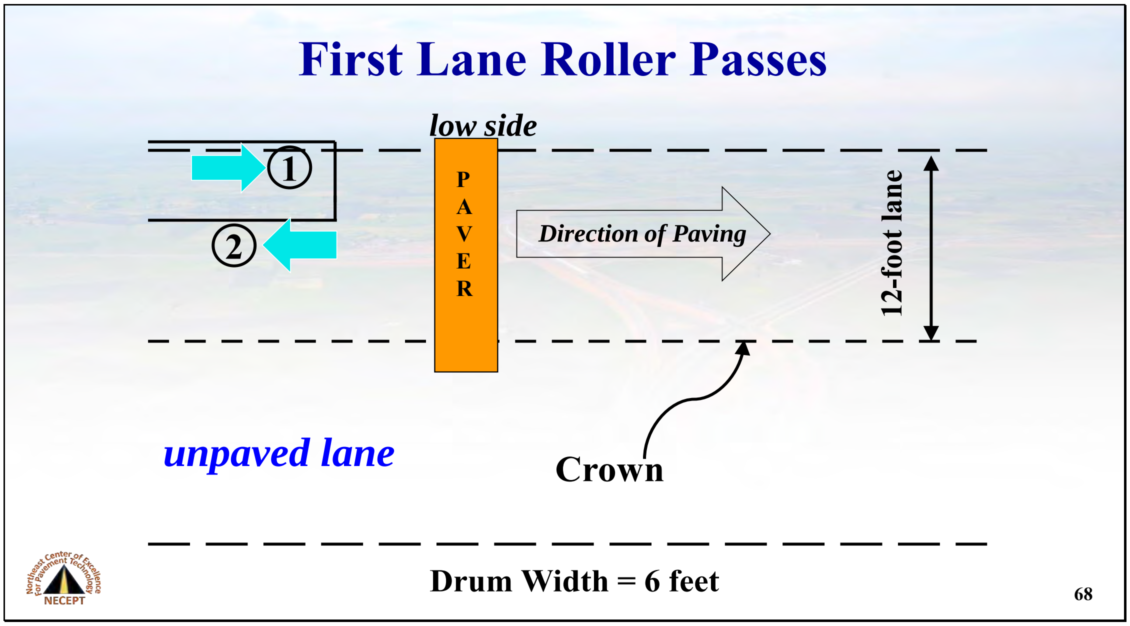
66

## Optimum Roller Pattern

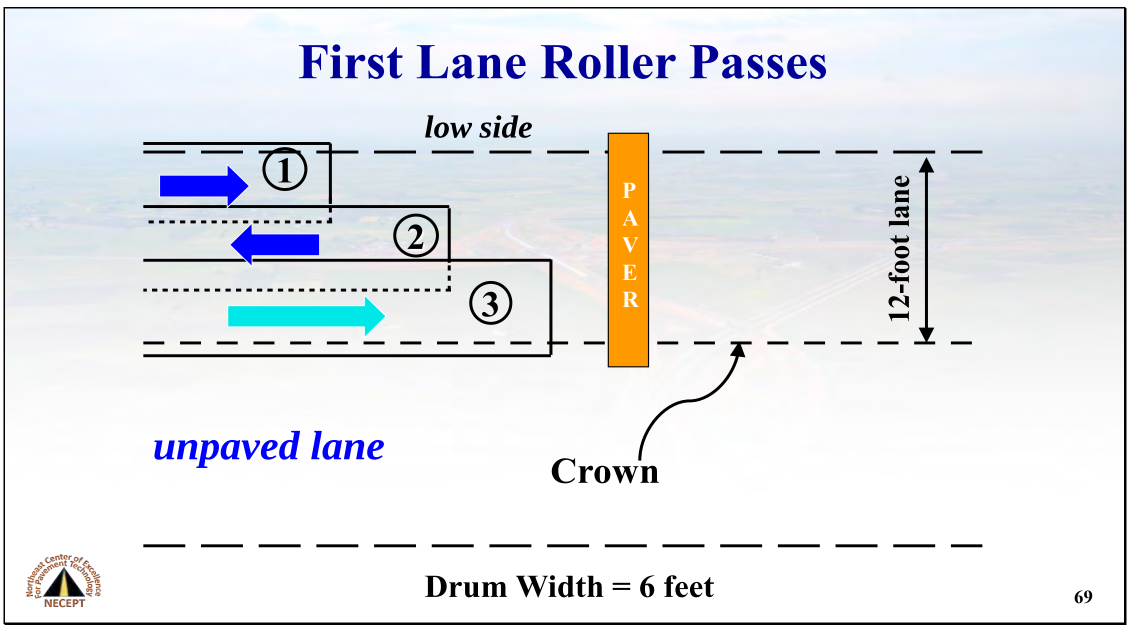
- Optimum—greatest degree attained under implied or specified conditions
- Pavement life concerns
- Mat quality
- Time constraints

67

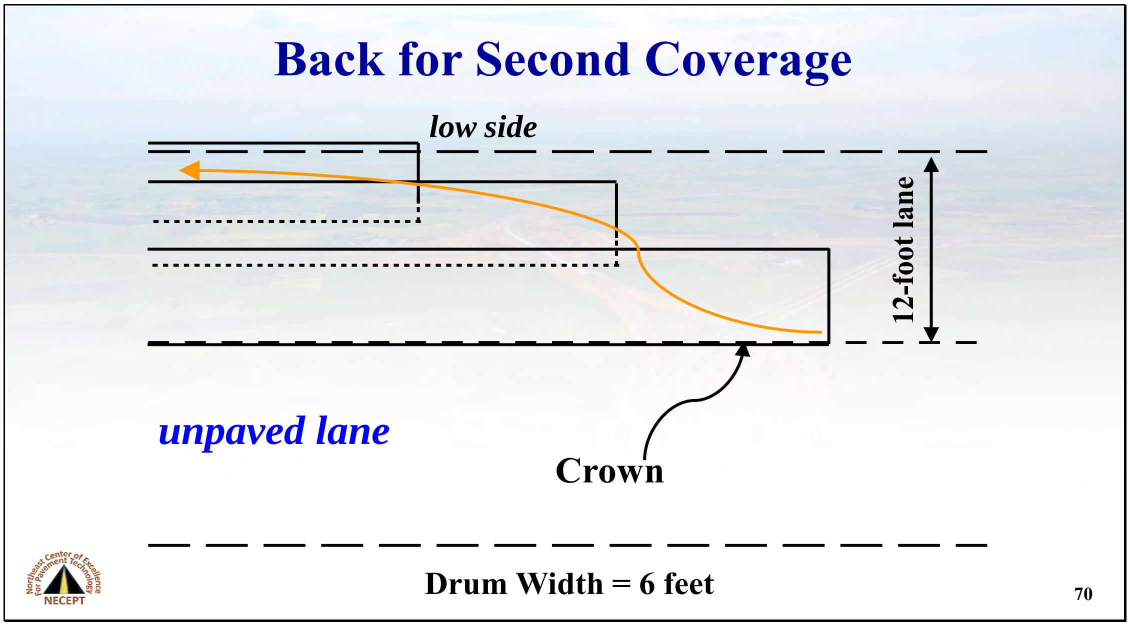
Pavement life: acceptable density while avoiding crushed aggregate.
Mat Quality:  absence of ripples , waves, severe polishing, roller marks.
Time constraints:  establishing number of coverages required and ability to keep up with paver.



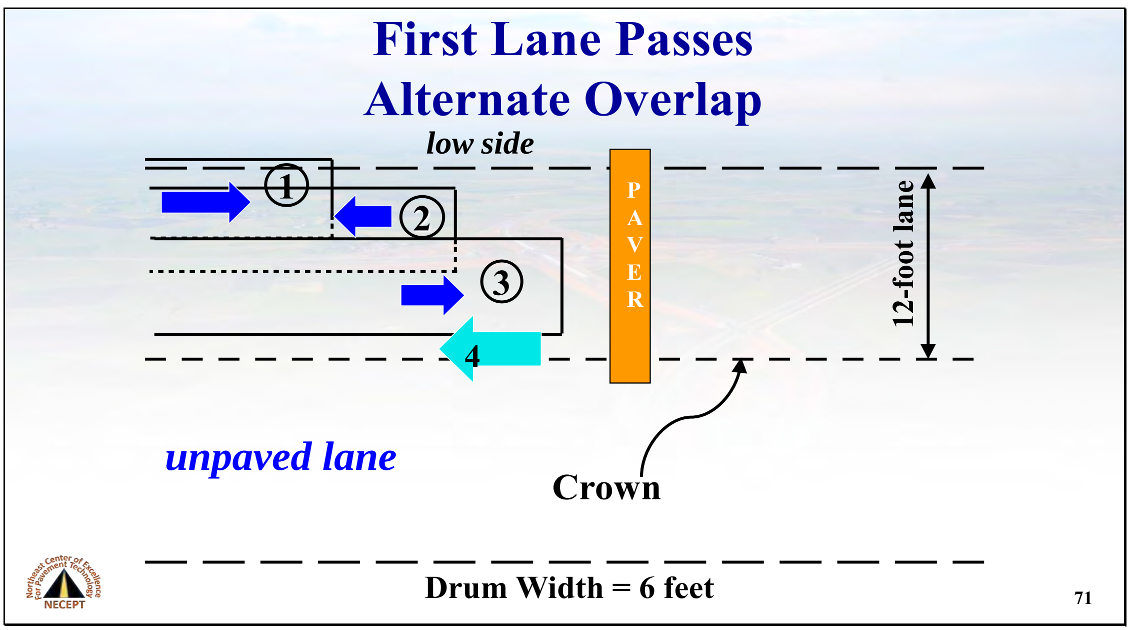

To the paver and back is two passes, utilize the overlap to determine density increase from two "hits"



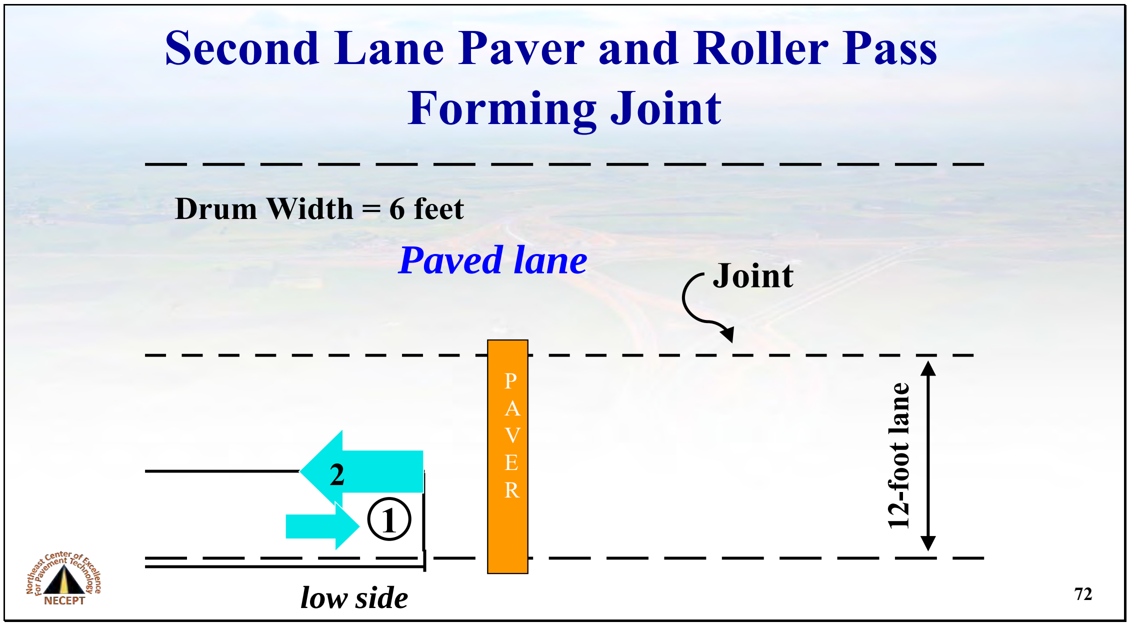

Note that the roller is overhanging each edge and should be changing directions at different locations with a slight turn, and avoiding going back in the same path. We now have two overlapped areas that have received two passes. The width of the roller drum will also help to determine the number of passes required for a ***coverage***.



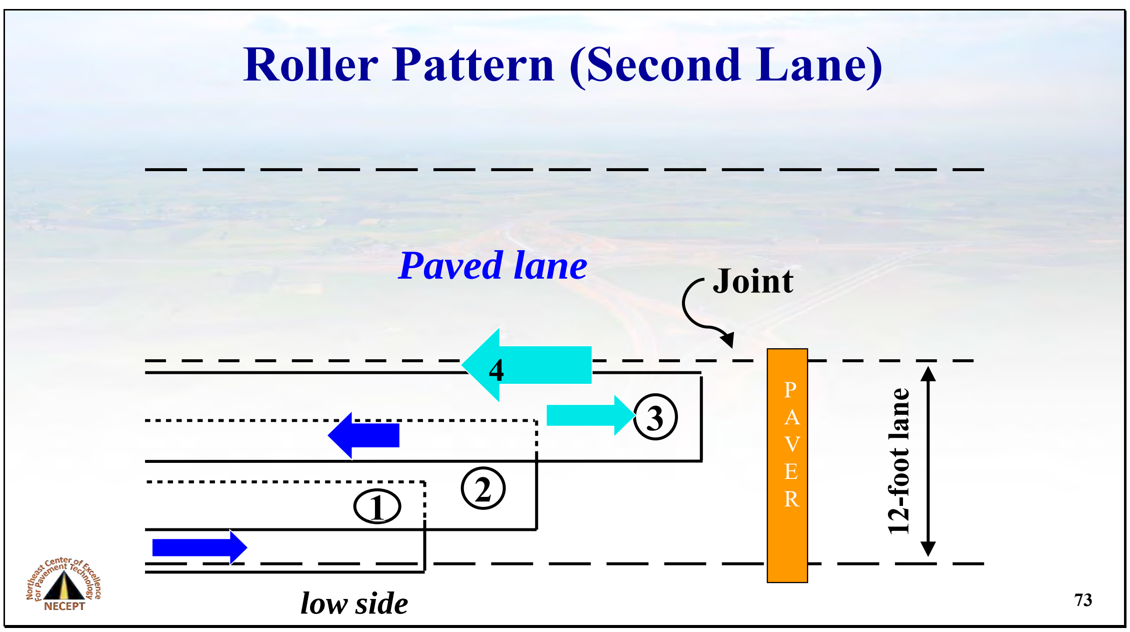

Second pass on low side will have occurred as the roller returns to beginning of the pattern. Vibrating (preferred) or static operation during the transition from high to low side and passing back through the change of direction areas will result in a smoother ride. Avoid traveling in the same pass as much as possible.



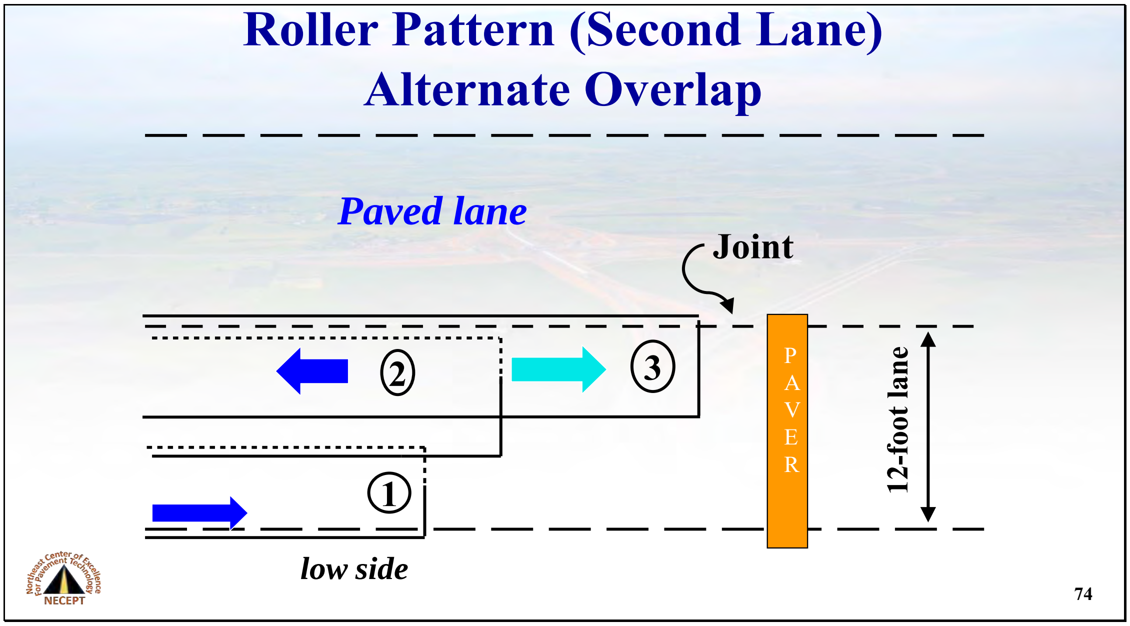

This alternate method results in wider overlaps and does not allow the roller to vibrate back through the change of direction locations. Some contractors use the previous pattern and this one in combination to help ensure uniform density across (transverse) the mat by varying the location of the overlaps.



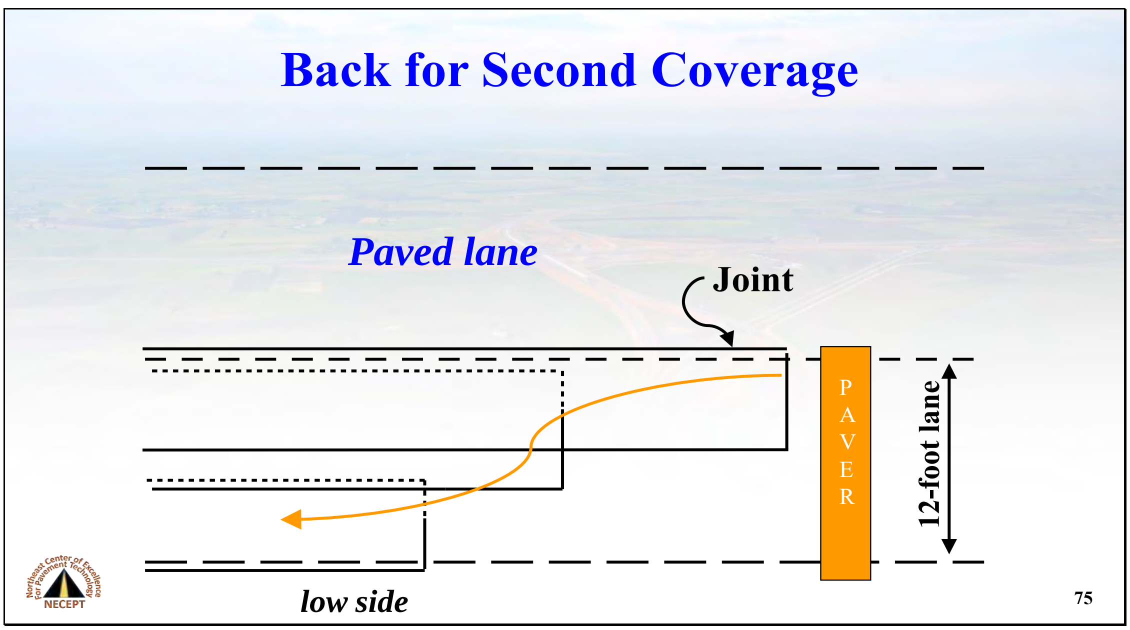

When compacting the second lane, rolling should again begin at the low side and overlap the unsupported edge 3 to 6 inches.




The next to the last past (3rd) will be made 6 to 12 inches away from the joint, following the longitudinal joint construction procedures. The 4th pass will position the roller at the beginning of the temperature related pattern.




The next to the last past (2nd in this scenario) will be made 6 to 12 inches away from the joint, following the longitudinal joint construction procedures.




This method allows the roller to vibrate back through the change of direction bumps. Gradual, shallow turns are required at any time while compacting asphalt and are especially necessary when operating near the edge of pavement. The roller will be at the back of the pattern following the 3rd pass of second coverage in this scenario and will create an extra pass on a portion of the roadway and differing densities will be noted in that area.

## Overlaps and Hits in Rolling

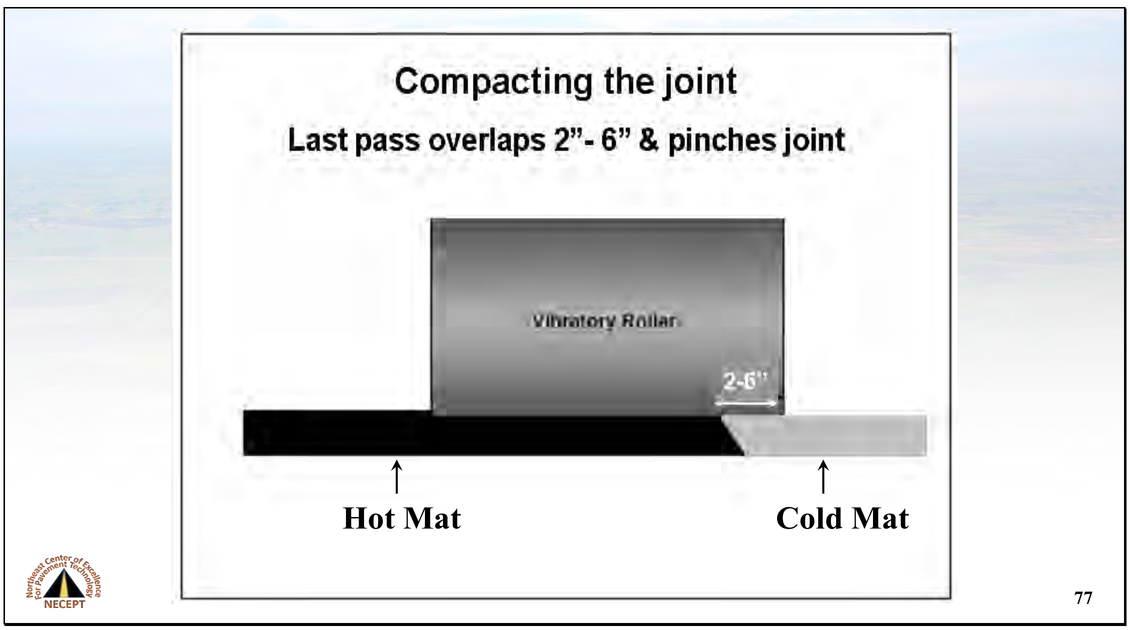
All roller patterns will create some additional “hits” and varying overlaps.

Density at change of direction areas for break-down roller will not be indicative of overall compaction—difference should be less after 2$^{nd}$ pass.

Use overlap streaks to check density increases created by additional “hits.”

NECEPT

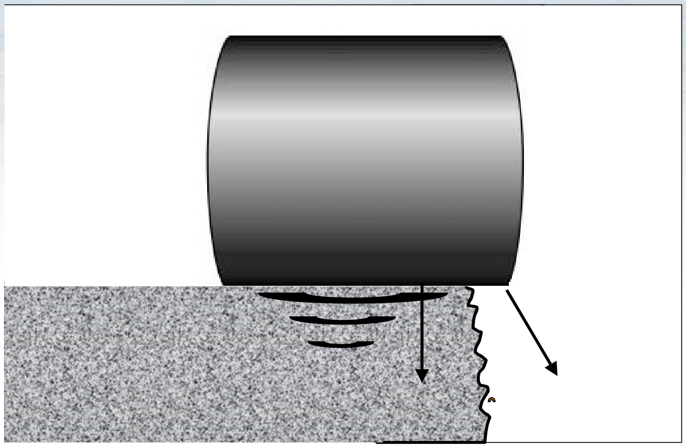
76




Remember, next to last pass across mat leaves 6 to 12”” uncompacted at the joint. The last pass then pinches the longitudinal joint by overlapping onto the cold mat by 2 to 6 inches.

## Rolling unconfined edge

### Remember!



78

Remember, rolling the first pass along the unconfined edge, overlap the edge 3 to 6 inches to get the optimum vertical compaction force.

## Breakdown Rolling

- Majority of compaction is obtained with breakdown rolling
- Check density now!
- The first vibratory pass at the proper temperature will usually obtain 60 % of that rollers results

**Be alert for loss of density (de-compaction) during last pass of breakdown roller---*TENDER ZONE Awareness***

79

The majority of the compaction is obtained during breakdown rolling, so it is important to keep this roller moving as much as possible. When the roller does stop, it should be parked diagonally on a cold mat. Otherwise, you may leave marks. Density testing should be done periodically right behind the roller during breakdown rolling. If enough density is not obtained at this point, proper density will not be able to be achieved.

**Density readings of less than 89 % behind the breakdown roller require immediate adjustments!!!!!!!!!**

## Intermediate Rolling

- Follow roller pattern
- May or may not be required to achieve density
- “Tender Zone” may develop in Asphalt Superpave mixes between 190°-240° F.
- WMA mixes have also shown tender zone characteristics


NECEPT

80

If adequate density cannot be achieved with the breakdown roller, an intermediate roller may be needed. Intermediate rollers should follow a roller pattern and not concentrate on running down the middle of the mat. Some projects will require use of a pneumatic tire roller for surface texture and kneading action.

A “tender zone” may develop in Superpave mixes between 190-240°F. Mix will shove and possibly crack under a steel wheel roller, and you can either let the mat cool or use a pneumatic roller. This tendency for tender zones to develop is prevalent in Superpave and other coarse aggregate mixes. (A recommendation is to make a pass with the roller after each 5 or 10°F drop in temperature and monitor density readings, when the density starts to increase continue to roll.)

## Finish Rolling

- Static steel wheel or vibratory roller in static mode
- “Irons” out any roller marks for smooth surface
- Do not count on obtaining additional density

NECEPT

81

Finish rolling is the last step of the operation and is a cosmetic process. “**NEVER FINISH ROLL IN THE VIBRATORY MODE**.” Finish rolling is not the place to count on obtaining additional density.

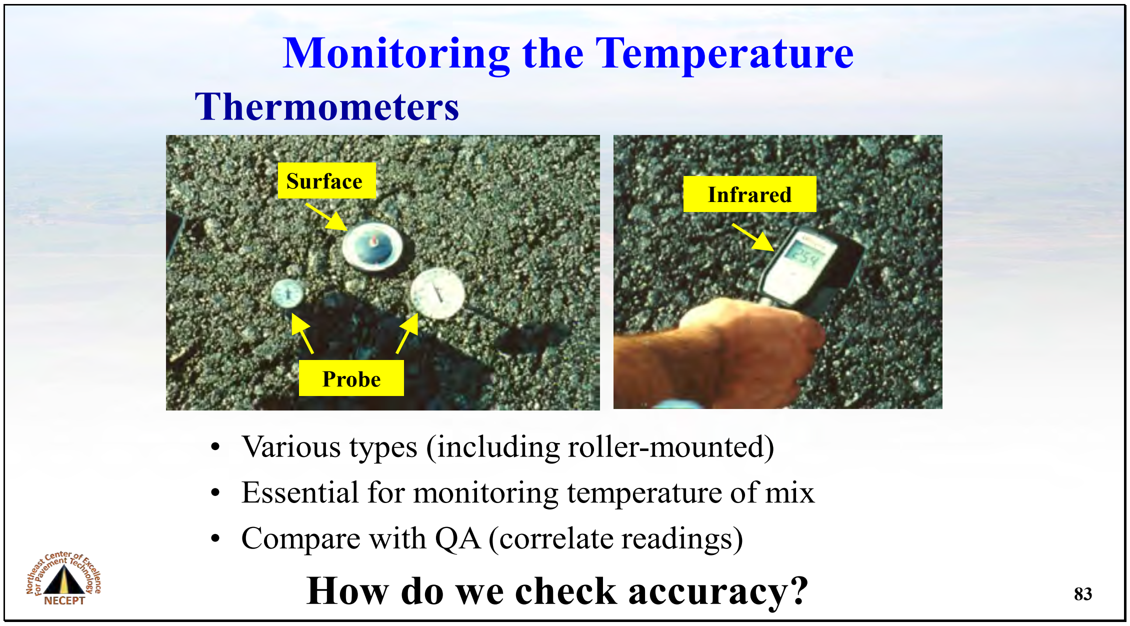
## Remember!

- Placement of cooler Asphalt mixes creates pavement areas near cessation temperature
- No significant compaction occurs below cessation temperature
- WMA cessation temperatures vary as to method of production.

NECEPT

82

Some contractors equip all roller operators with an infrared thermometer so that rolling can occur within a range of temperatures. Some newer equipment has an infrared thermometer mounted directly on the roller. The finish roller is normally well behind the paving operation and operating alone. Traffic safety devices must remain until finish rolling is complete. The operator and any additional personnel, performing a coring operation or monitoring density for example, must be careful of stray traffic entering the site. The traveling public may not see a lone roller or technician bent over a density gauge until it is too late.




From the moment of delivery until the rolling operation is completed the temperature has to be monitored. Several types of thermometers are available, but all do the same thing…they measure temperature. The more expensive ones tend to do it faster and more accurately.

When monitoring the mix, take enough readings to develop a comfort index with the specific conditions you are working in. Occasionally compare your temperature value with the quality assurance department on the job. Achieving density in a consistent and quick way is directly proportional to the temperature of the mat.

The photo shows four different temperature measuring devices and if we could see the readings, they would all be showing a different temperature. Never completely trust a single thermometer; run a couple of checks. For a precision check, insert several probe thermometers into the center of a hot mix pile and wait a minute – they should all read the same temperature. If you are using an infrared unit, aim it at the same pile and compare the probe measurements to the infrared. This will allow you to develop a simple correlation between surface and depth temperatures.

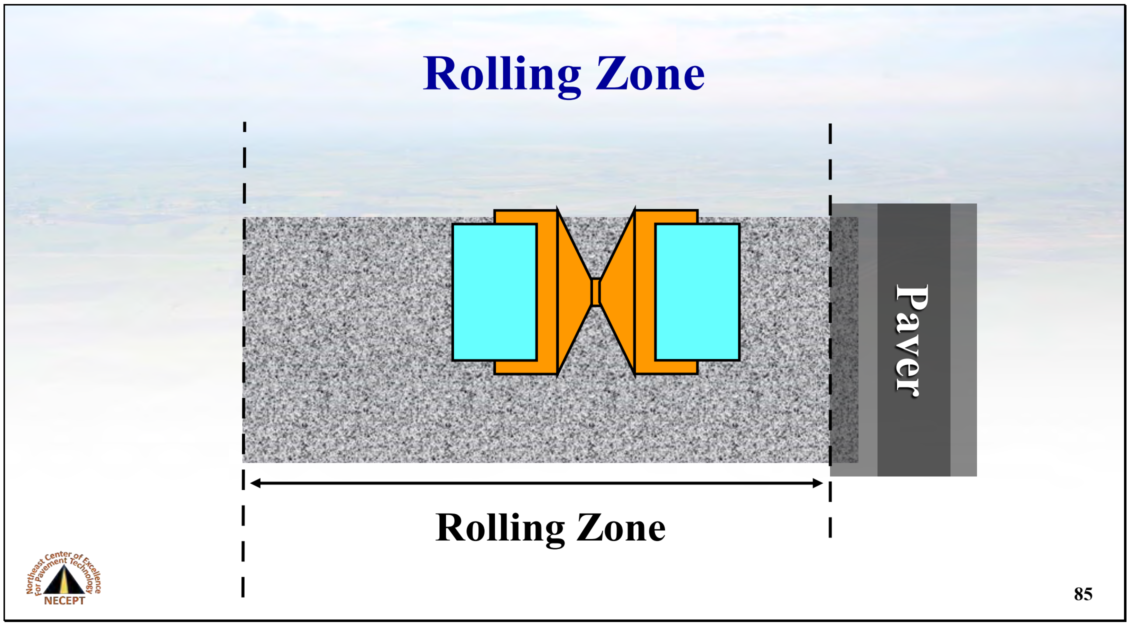
For a quick accuracy check, place probe thermometers in a pan of boiling water, you should get 212 °F at sea level. Thermometers need to be calibrated at least weekly.

## Compaction Rolling

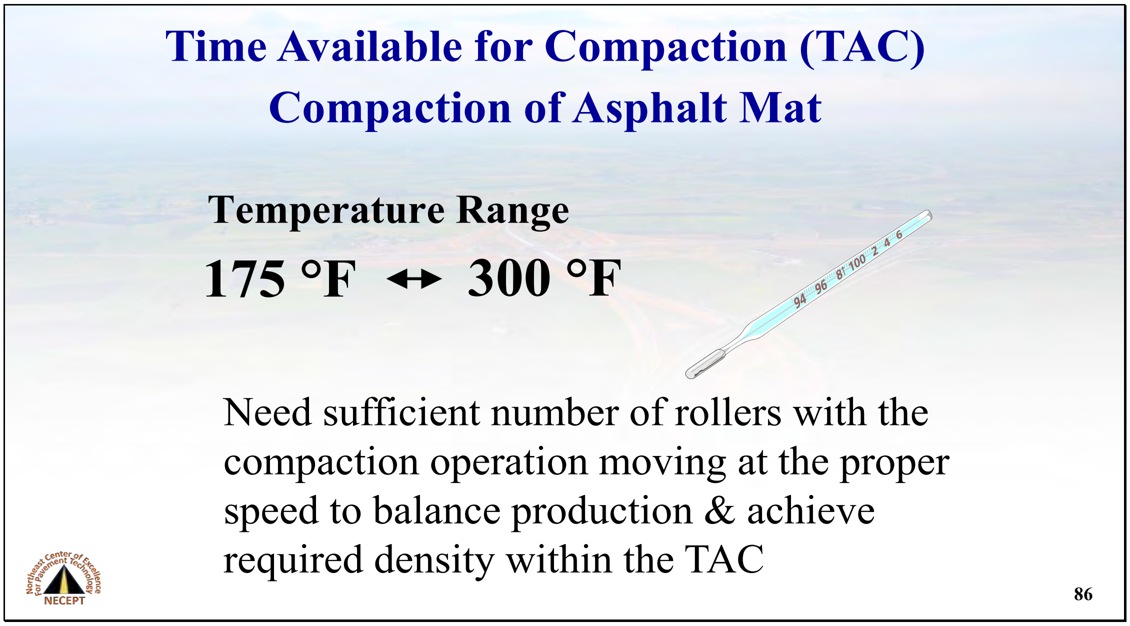
- **Develop roller pattern**
- **Determine the rolling zone by:**
  - Experience
  - Estimating
  - Density

84

Breakdown rolling is the first interaction between the roller and the asphalt mat and can be a friendly or a troublesome meeting. Most contractors use steel drums. Some use a pneumatic tired to breakdown the mix, increase the mat density, and establish the mat smoothness. Rollers should stop and start slowly on uncompacted mix and angle the drum when stopping to reverse.
All compaction should be accomplished by the breakdown and intermediate rolling. Establishing a rolling pattern within a temperature zone is the most efficient and effective means of achieving desired density.




All compaction must be achieved while the viscosity of the asphalt cement in the mix and the stiffness of the mix is low enough to allow reorientation of the aggregate particles under the action of the rollers. As the proper level of air void should be obtained before the mix cools to 175 °F, the rolling zone is the area in which the available compaction equipment can provide the required coverages to achieve desired density within the proper temperature range. Initial compaction should occur directly behind the paver while the temperature is still very hot, if the stability of the mixture is acceptable at high temperature. Superpave with polymer modified binder has shrunk the distance between the roller and the paver to as little as 3 to 15 feet.




Remembering the Time Available for Compaction is the time (in minutes) that a particular mix is at the right temperature range for efficient compaction, and all compaction must be accomplished before the asphalt mat cools to a temperature below 175-185°F. It is good practice to complete rolling on WMA by 175°F as well, although some additional compaction may be achievable depending on the particular WMA technology. Rolling at cool temperature will lead to over rolling, crushed aggregate, and loss of density.

## Time Available for Compaction

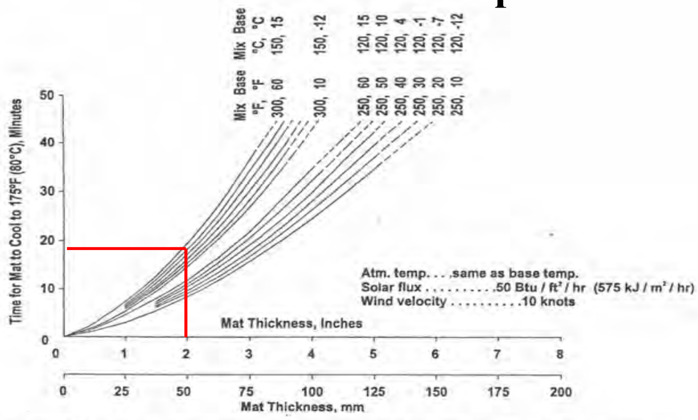



**FIGURE 18-1** Time for mat to cool to 80°C (175°F) versus mat thickness for lines of constant mix and base temperatures [121°C (250°F) or 149°C (300°F) behind paver].

87

Going back to our chart on "cooling curves" for asphalt mixtures, we now can use the information obtained from the compaction production problem to determine the rolling zone. If we are laying down a two-inch mat with a mix temperature of 300°F and a base/air temperature of 50ºF, we can plot these parameters and find that we have 18 minutes as the time available for compaction.

## Rolling Zone

- 28 fpm x 18 min. (TAC) = 504 feet
- ~ 500 foot rolling zone

88

Since our compaction production rate is 28 feet per minute and we have 18 minutes, our rolling zone calculates to 504 feet. Thus, we have an approximate rolling zone of 500 feet behind the paver where efficient compaction is possible.

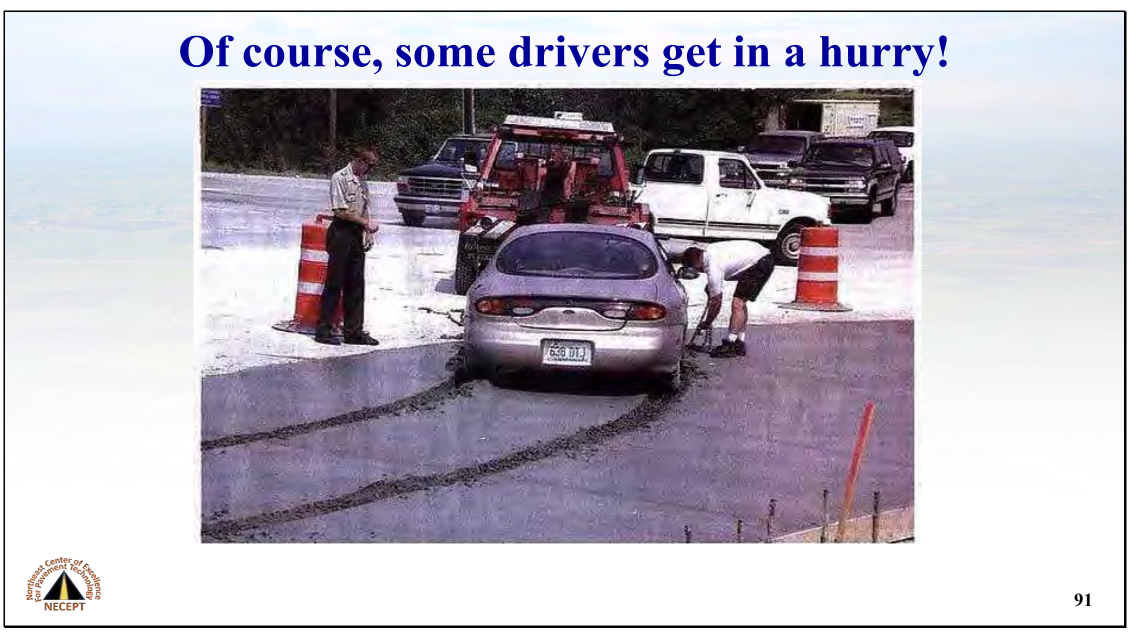
## Re-Watering During Paving

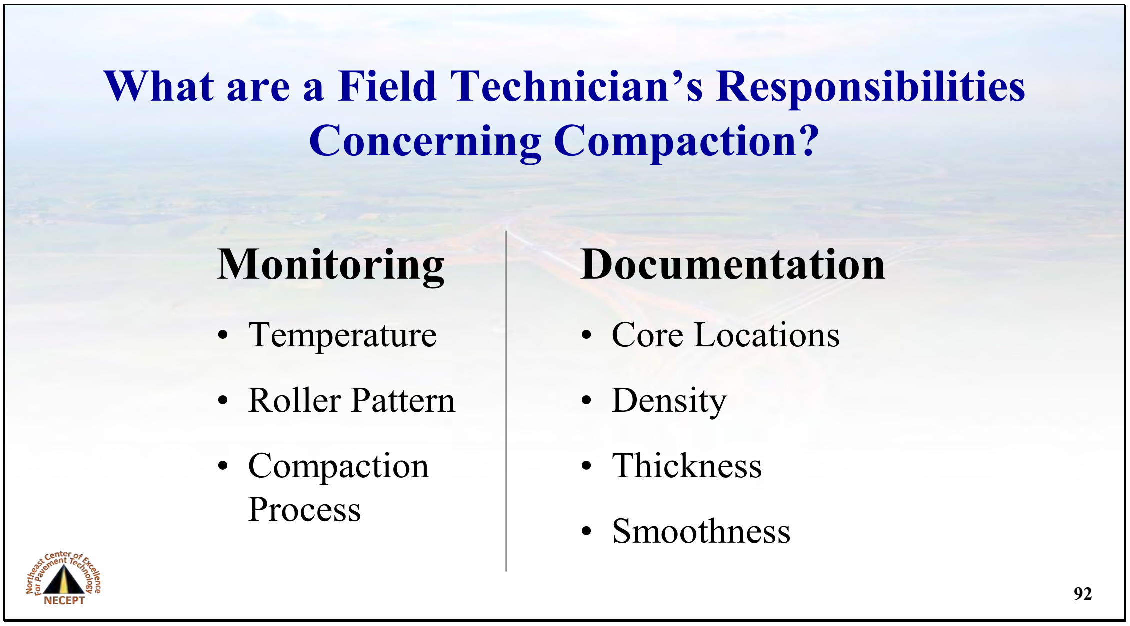
- Close available source
- Rewater during any lull in paving (refill half empty tank)

89

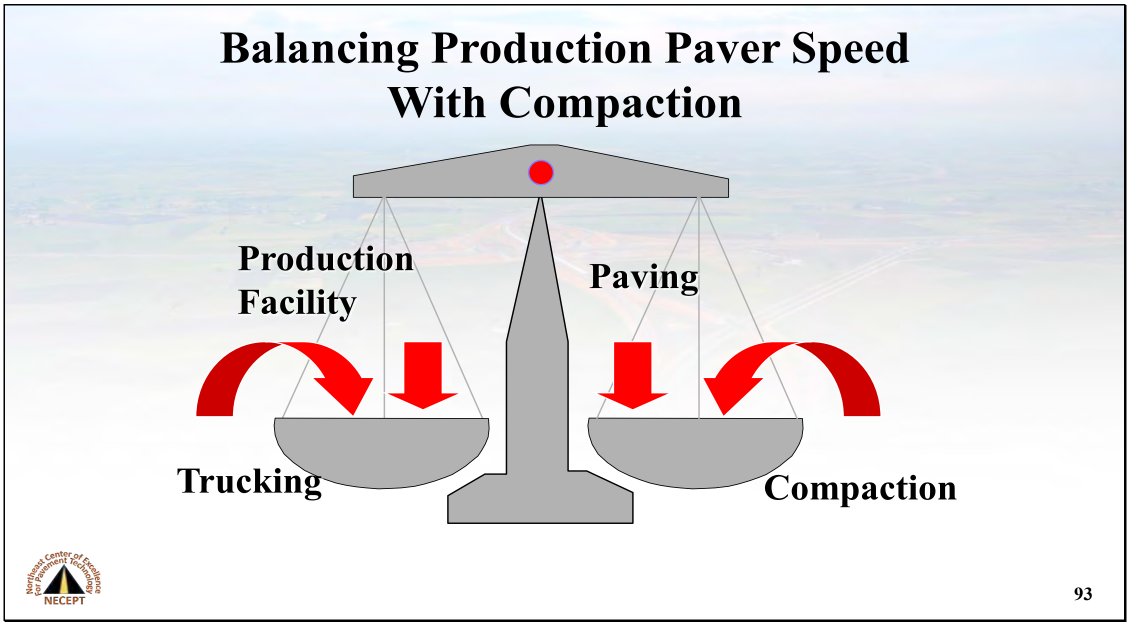
Maintaining a spray system that uses the minimum amount of water will reduce these re-watering stops, but not eliminate them. It is best to re-water during a temporary lull in paving, and refill a half empty tank, then to wait until production is peaking and run out of water. If this cannot be avoided, and the mix is cooling too rapidly to wait, the intermediate or finish roller should be moved to the breakdown position until the original breakdown roller is available. Ensuring access to local fire hydrants should be taken care of prior to the start of the project with the appropriate owner of the water facilities. Usually, water companies or municipalities assign contractors portable meters for payment as shown here.


If the mix has not cooled below a mix-specific temperature before opening to traffic, additional densification can occur in the mix with traffic creating wheel path ruts. The temperature of asphalt mixes (surface or internal?) should be down to at least 140ºF before the pavement is opened to traffic. Intersections, night paving, and ramps plus driveway entrances are key areas. Artificial watering is not allowed. WHY?






Although the duties of the Certified Field Technician will vary depending on the employer, they should be aware and able to perform any of the above activities. Although responsibilities will vary, we will treat each technician as if they were responsible for each function.




As was discussed in the previous modules, the entire paving operation is a balancing act. It starts at the asphalt facility with how much the producer can supply to the project and how many trucks will be available to transport the asphalt to the paver. Now we have to determine the speed of the paver to ensure a constant flow of material with a minimal number of stops. Schedule ahead of time to balance all of these rates. Understanding the variables that can affect each rate is the key to adjusting the others when changes occur–and be assured, changes will occur. Keeping the rates in balance will lead to a better pavement, and more production. If you have a number of trucks waiting, should you speed up the paver to empty them? Not necessarily -- the roller operator may not be able to achieve compaction if the paver speeds ahead. Also, if you change the speed of the paver, you may need to change the amount of mix delivered to the augers to compensate for the change. Automatic material flow control will adjust for these changes. Speeding up the paver will change the *pre-compactive* effort by the screed, requiring more compactive effort from the rollers. All of these things come into play and all need to be considered as the paving operations continue down the road.

## Roller Production Scenario Calculations

### Balancing breakdown roller production with paver speed

Paver Speed is 27.3 feet per minute (FPM) at 12 feet wide.

78 inch drum (6.5 feet) with 6 inch overlap = **72 inch (6 ft.)** effective width

Minimum of three passes required to construct longitudinal joint as per method spec.: Section 409.3 (k) 1.a or PTM 402 or 403

2 coverages required to obtain specified density, but 2 X 3 = 6 (an even number), so roller will be at back of pattern, which then requires a "catch-up" pass. SO: **7** X **27.3** = **191** FPM

Plus, add 10% for reversal factor: **191** + **19** = **210** FPM *minimum required average speed*

NECEPT

94

If a 4-foot shoulder is being placed simultaneously, 4 passes per coverage will be required:

4 passes X 2 coverages = **8** passes, but 8 is an even number, so a "catch-up" pass is required. Therefore, **9** passes are required.

9 X 27.3 = **245.7** FPM. Plus 10% for reversal factor = 245.7 + **24.57** (**24.6**) = **270.3**

270.3 FPM *minimum required average speed* required to keep up with paving operation IF the paver does not stop.

NECEPT

95

Desired impact spacing 10-12 impacts per foot (IPF). Roller speed is computed by dividing machine frequency (vibrations per minutes – VPM) by the desired impact spacing.

**2700 VPM Roller Computations**

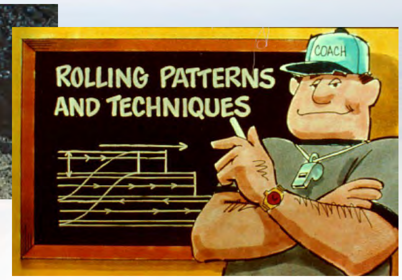
| | |
|---|---|
| 2700 VPM / 10 IPF = 270 FPM | 270 FPM / 88 = 3.068 (3.1) MPH |
| 2700 VPM / 12 IPF = 225 FPM | 225 FPM / 88 = 2.556 (2.6) MPH |
| **If 3000 VPM machine:** | ***Divide FPM by 88 to obtain Miles per Hour (MPH)*** |
| 3000 VPM / 10 IPF = 300 FPM | 300 FPM / 88 = 3.40 (3.4) MPH |
| 3000 VPM / 12 IPF = 250 FPM | 250 FPM / 88 = 2.84 (2.8) MPH |

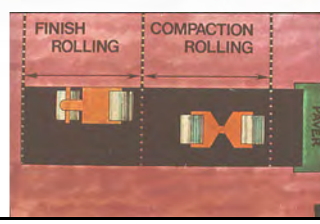
Rollers need to be refilled with water throughout the day and this creates a need to increase the operating speed to maintain the *minimum required average speed*. If the proper impact spacing (IPF) cannot be produced at the higher speed, density reading will suffer and substituting a breakdown roller with a higher frequency, or reducing the paver speed is suggested. Time Available for Compaction (TAC) will be computed for entire operation.

96

# Activities To Be Monitored

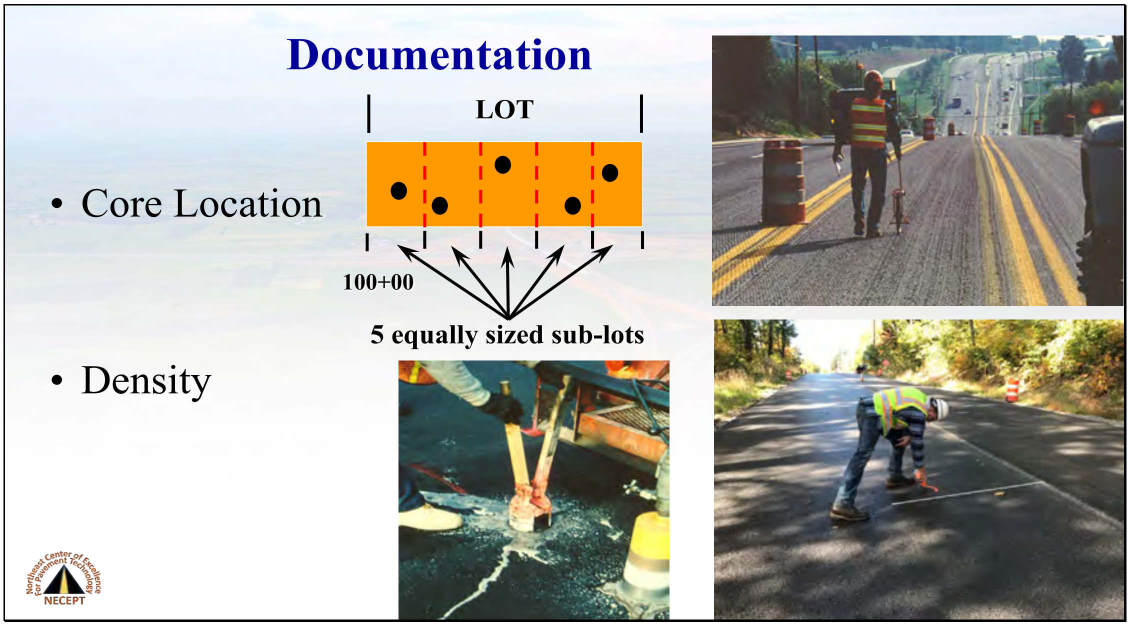
- Temperature
- Roller Pattern
- Compaction Process



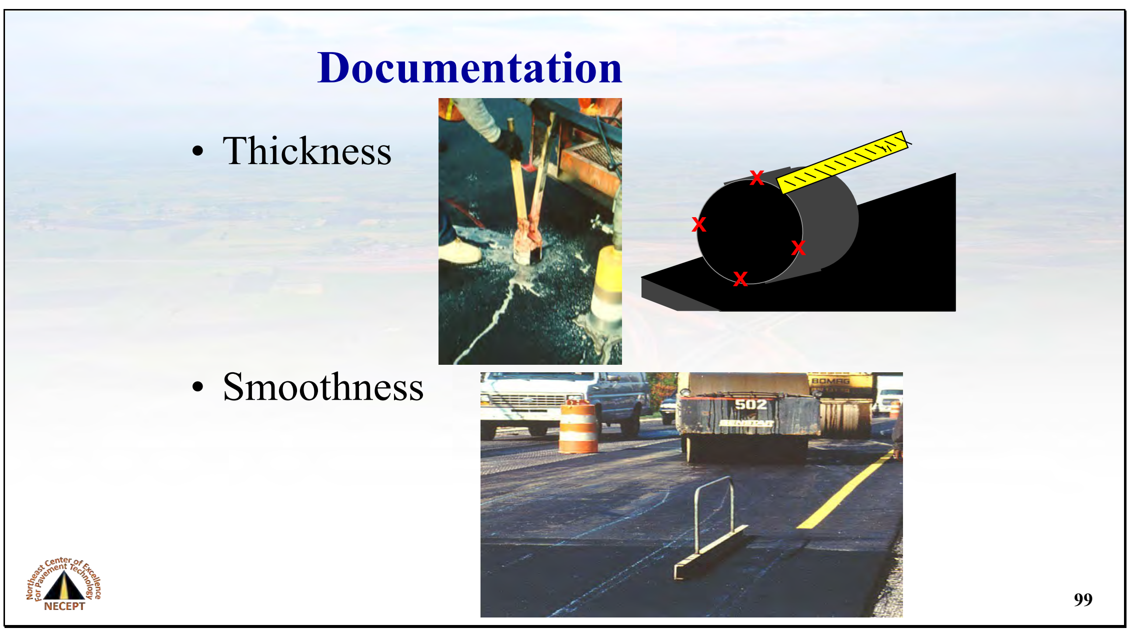




97

Activities that need to be monitored are temperature, roller pattern and the compaction process.




Documentation that will be required are core location and density monitoring.




Additional documentation will be required to check the pavement thickness and smoothness.

## You Should Know!

- How to control density?
- What to do if density is not achieved?
- What the specifications requires (line of action)?
- What are the density requirements- acceptance/rejections?
- What is the role of thermometer and correlation
- Who will be running the density tests?

NECEPT

100

## Problem Identification

**Problem:** Too little compaction or too much (crushed aggregate)

**Result:**

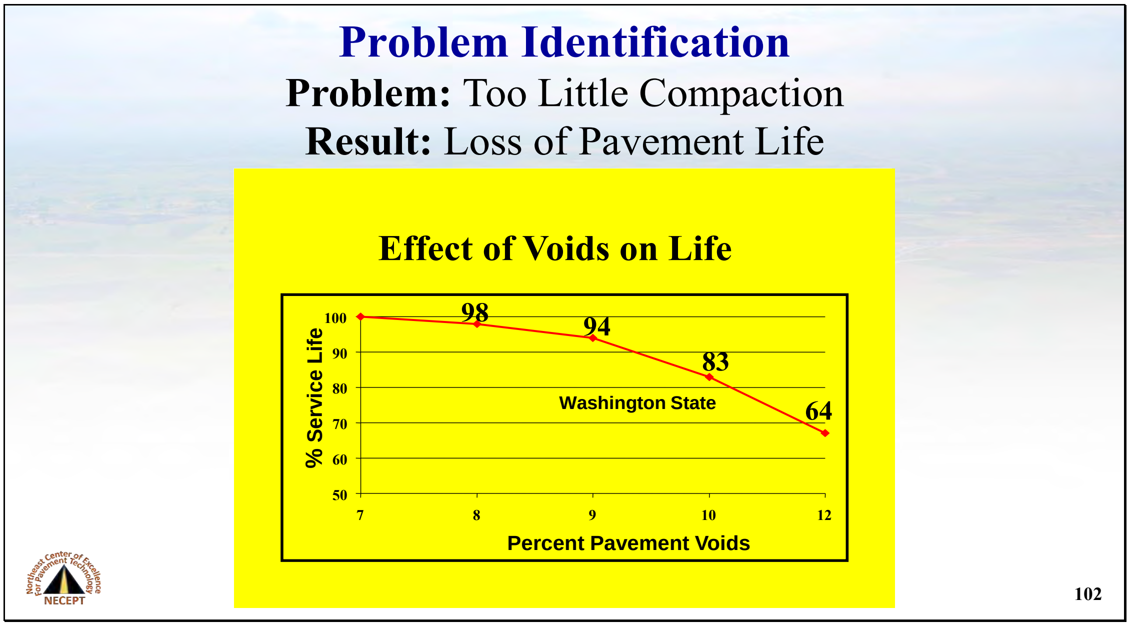
Raveling

NECEPT

101

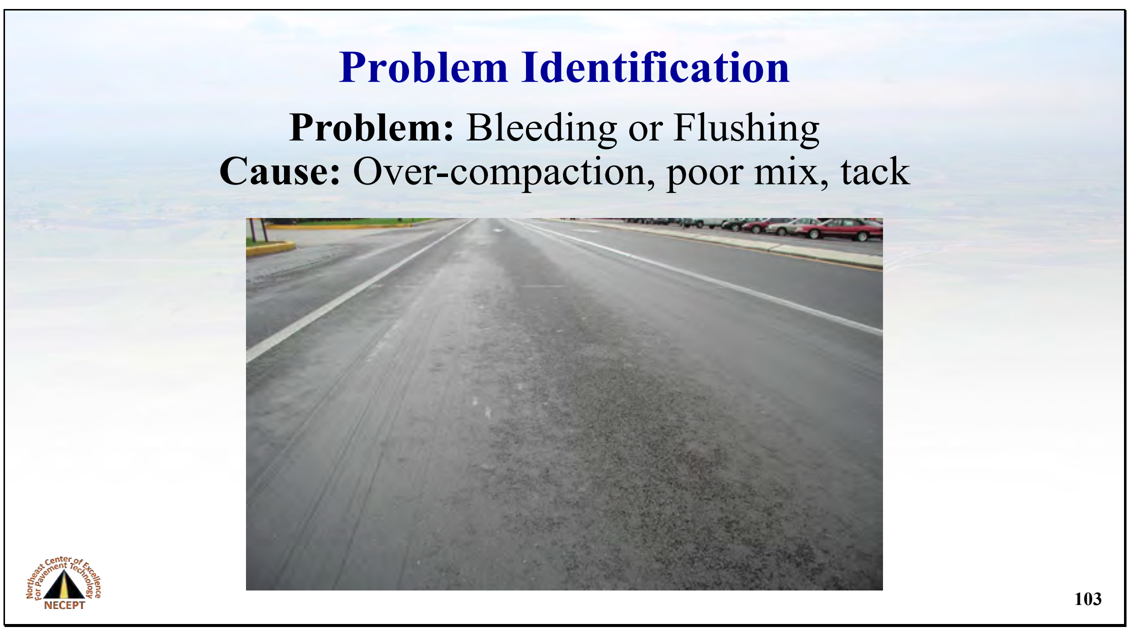
Too little compaction can be a cause of raveling. Crushed aggregate from rolling at low mat temperatures is also a common cause.

This will only appear after the roadway is under traffic for a period of time.




It has been shown that for every increase in 1 % voids above 7% there is a 10% decrease in the life of the pavement.

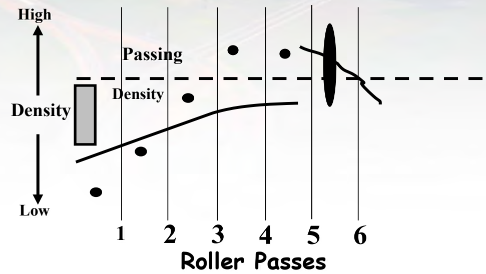
The above chart shows research results from Washington State, depicting the loss of pavement life. In other words, dropping 93% density to 92% decreases pavement life by 10%.




The opposite problem is too much compaction which can be a cause of bleeding or flushing. Typically, this is a result of a poor mix or extremely excessive tack.

## Solution

Develop a Rolling Pattern
PTM 402 or 403




NECEPT

104

The development of a good rolling pattern should ensure acceptable densities.

NOTE: If densities above 96% are routinely achieved, there is probably a problem within the material...**NOTIFY THE PLANT**

- **Establish Action Points**
- **What are Action Points?**

NECEPT

105

And the establishment of action points! Also, **a plan of action** with the knowledge of who to notify and what procedures are to be followed in case of undesirable results or an out of your control condition.

## Conditions Requiring Action

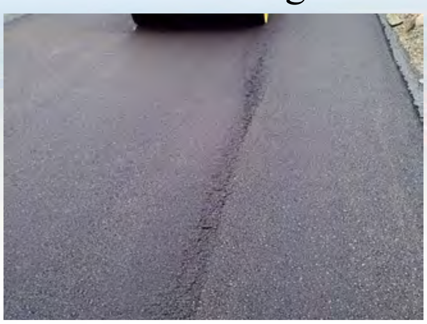
- Low/high delivery temperatures
- Low densities behind breakdown roller
- Transverse Cracks (checking)
- Longitudinal Cracking/tears/splits
- Bumps, Waves or Ripples
- Repeated density readings greater than 96%
- Density reading less than minimum requirements

NECEPT 106

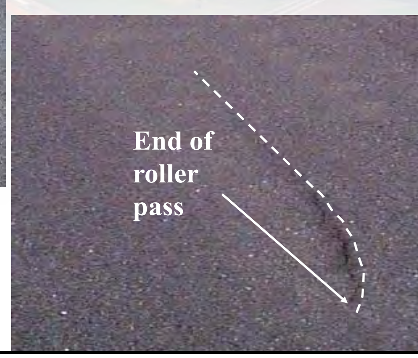
These action points are only for the compaction operation, MANY more exist!!!!!

## Problem Identification

**Problem:** Longitudinal Tears/Splits



Vibratory or Violent Turn




Excessive water?

NECEPT 107

Another problem may be cracking due to a tender mat. This may occur during rolling or sometime in the future.

We previously discussed that a "tender zone" may develop in Superpave mixes between 190-240°F.

If you do start to experience this, here are a few recommendations.

## Temperature Related Checking

108

Too much rolling at the wrong temperature, or possible deep area? Did the breakdown roller operator miscount passes?

## Temperature Related Checking

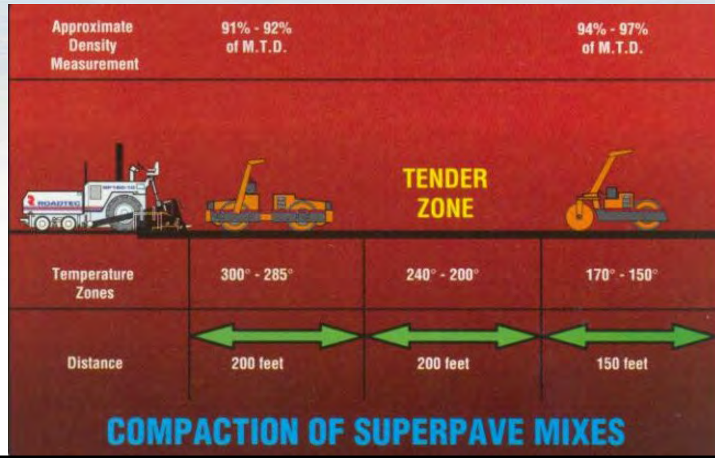
109

Rolling in the tender zone caused this. High roller speeds can make the condition worse. When you see a "bow wave" in front of the roller, stay out of that temperature area on the mat. If you experience excessively tender mix, notify the plant as mix design changes may be needed.

# Problem Solution

## When Cracking Occurs due to tender Zone:

Lay off the rolling,




or..

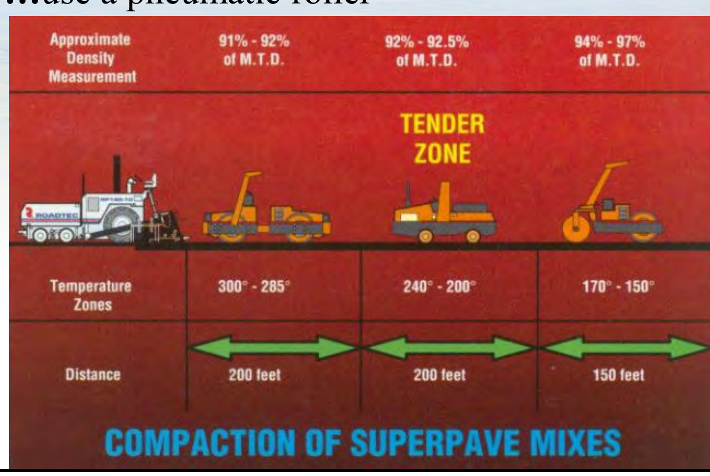
110

When encountering a tender zone, it has been found that by holding back on the rolling until it cools sufficiently to allow further densification is one way to eliminate the cracking.
To ensure proper density can still be achieved, you may want to double your break-down rolling with two rollers to achieve greater density sooner and before the tender zone appears.

# Problem Solution

## When Cracking Occurs due to tender Zone:

…use a pneumatic roller

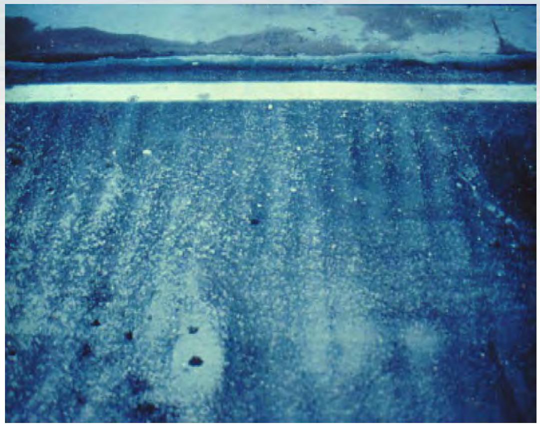



111

Another method to try would be using a pneumatic roller on the tender mat. This roller will also seal the surface, slow the cooling rate and enhance the void structure thus reducing oxidation.

## Problem Identification

**Problem:** Ripples/corrugations due to improper impact spacing and cold mat



NECEPT 112

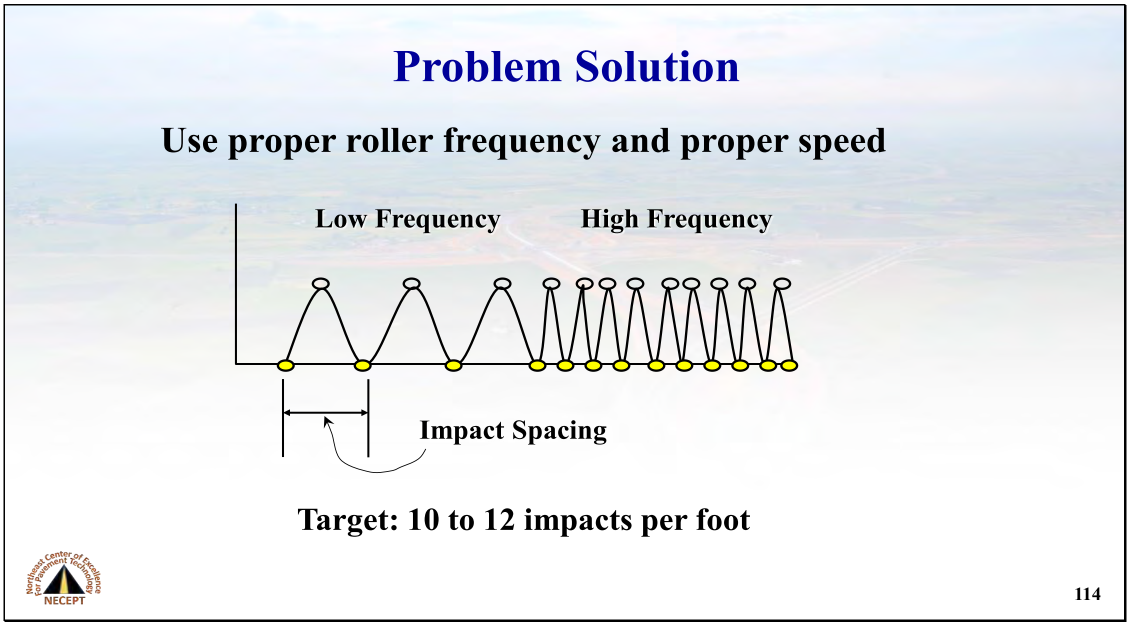
The spacing of the impacts of a roller is a function of the frequency of the vibration and the travel speed of the roller. Proper impact spacing and amplitude are the keys to successful pavement compaction and smoothness.

NO IMPACT SPACING (static rolling) was the correct operation here!!!!!!!!

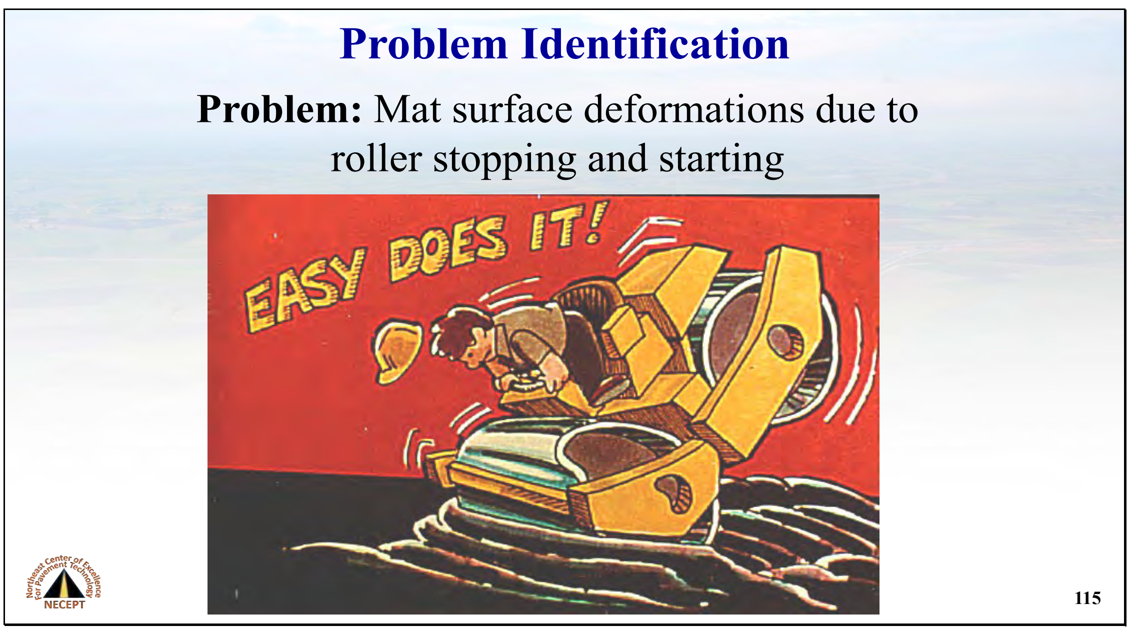
## Poor Impact Spacing and Material Too Cold!!!

NECEPT 113

This makes a very noisy ride.




To eliminate the washboard effect, the operator should check and verify mat temperature, that the frequency is set properly, and that he is not rolling too fast. The impact spacing should be in the range of 10 to 12 impacts per foot to ensure the highest efficiency of the vibratory rollers and reduce the possibility of leaving ripples in the finished pavement.




The roller operator needs patience when stopping and starting, to move in different directions, and to achieve acceptable compaction. Gradual slow movements will diminish deformations in the mat.


Starts and stops should be done gradually. At the end of each pass as you bring the roller to a stop, roll so that you form a small arc. Roll completely through that a portion of that arc with your next pass and you will take out any small ridge you may have formed when bringing the roller to a stop.

The operator needs patience in staying with their rolling pattern for the entire day to ensure proper compaction of the pavement. And if there is a break in delivery, park the roller on the cold mat.

## Problem Identification

**Problem:** Scuff marks made by the cold tires of a pneumatic roller or by rapid change of direction.

The fines picked up here will be re-deposited on the mat.

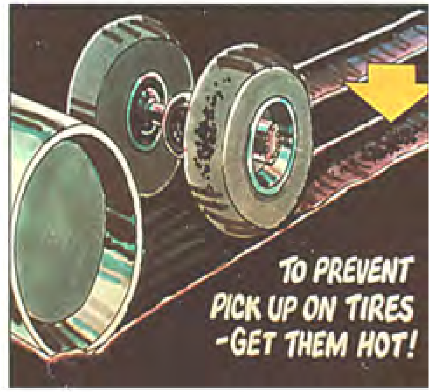
117

Damage like this needs to be avoided. Although the density of the pavement is probably being achieved, the finished surface is mottled and will most likely have surface blemishes which may hold water.

**NOTE:** on a scratch or leveling course due to differing depths of material, some tracks of the pneumatic roller should be evident behind the finish roller.

## Problem Solution

Some contractors do not use water or release agent!!!


118

The key is to get the tires hot and keep them hot by keeping the roller moving. The tires on a pneumatic roller will often pick up certain mixes, especially if the mix being compacted contains particular additives. Most often, attempts are made to eliminate this pickup problem by spraying water or a release agent on the tires during the rolling process. Another solution is to allow the tires on the roller to reach the same temperature as the mix being compacted without adding water or release agent to the tires. Get the tires hot by running the pneumatic roller on existing pavement first and then by slowly getting them hot on the new pavement. The use of 'skirts' not only helps in getting the tires hot but also ensures that they will stay hot all day by limiting the wind's cooling effects. Pneumatic rollers may not be suited for mixes that contain polymer modified binders. They tend to be very sticky and will pick up.

## Module 8 - Review

- Terms & Definitions
- Importance of Compaction
- Factors Affecting Compaction
- Equipment
  - Types of Rollers and Maintenance
- Operating Techniques


NECEPT

119

**Module recap**

PennState

# Discussion

pennsylvania
DEPARTMENT OF TRANSPORTATION

NECEPT

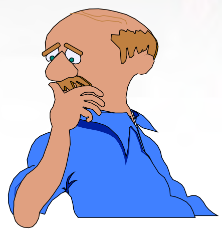
120

# Quiz

## Module 8

## Compaction

?





**1. A coverage is defined as the roller moving over the entire width of the mat one time.**

a. True

b. False

**Answer:**

a. True

2. Under the percent within tolerance specification, the best way to maximize incentive payments for density is to…

a. Stop rolling at minimum density
b. Consistently achieve densities in the center of the density range
c. Keep roller impact spacing < 8 impacts/ft.
d. Use only oscillatory rollers

Answer:

b. Consistently achieve densities in the center of the density range



3. A pass is defined as the entire roller moving over one point of the mat two times (up and back).

a. True
b. False

Answer:

b. False

**4. TAC (time available for compaction) is considered the time that the mix is within the temperature range of**

a. 140°F to 300°F
b. 175°F to 300°F
c. 240°F to 320°F

**Answer:**

b. 175°F to 300°F

NECEPT



**5. Compaction will reduce air voids, thereby increasing mat density and increasing pavement life.**

a. True
b. False

**Answer:**

a. True

NECEPT

**6. The rollers compact by applying their weight over the area of the drum/tire that touches the mat (contact pressure).**

a. True

b. False

**Answer:**

a. True



**7. When making the first pass with the roller, the contact pressure will be the highest.**

a. True

b. False

**Answer:**

b. False, the drum will penetrate the mat more at higher temperatures and at early stages of compaction when the mat is less dense, thus more of the drum is in contact with mat, reducing the contact pressure

**8. The dynamic (impact) force of a vibratory roller is determined by the amplitude and frequency with the target impact spacing being**

a. 6 to 8 impacts per foot
b. 8 to 10 impacts per foot
c. 10 to 12 impacts per foot
d. 12 to 15 impacts per foot

**Answer:**

c. 10 to 12 impacts per foot



**9. The faster a roller passes over a particular point in the new surface; the more compactive effort is applied.**

a. True
b. False

**Answer:**

b. False

**10. Suitable minimum layer thickness for a mix with nominal maximum aggregate size of 9.5 mm (3/8”) is**

a. 3/4”
b. 1.25”
c. 1.75”
d. 2”

**Answer:**

NECEPT

## Roller Production Scenario Calculations

### Balancing breakdown roller production with paver speed

Paver Speed is ____ feet per minute (FPM) at __ feet wide (from paver production form).

__ inch drum ( ___ feet) with 6 inch overlap = _______________ effective width

Minimum of three passes required to construct longitudinal joint as per method spec.: Section 409.3 (k) 1.a or PTM 402 or 403

2 coverages required to obtain specified density, but 2 X 3 = 6 (an even number), so roller will be at back of pattern, which then requires a "catch-up" pass. SO: __ X ____ = ____ Roller FPM

Plus, add 10% for reversal factor: ______ + ___ = ____ FPM *<u>minimum required average speed</u>*

If a 4-foot shoulder is being placed simultaneously, 4 passes per coverage will be required:

4 passes X 2 coverages = __ passes, but __ is an even number, so a "catch-up" pass is required. Therefore, __ passes are required.

__ X ____ = _____ FPM. Plus 10% for reversal factor = _____ + _____ (____) = _____

_____ FPM *<u>minimum required average speed</u>* required to keep up with paving operation IF the paver does not stop.

Desired impact spacing 10-12 impacts per foot (IPF). Roller speed is computed by dividing machine frequency (vibrations per minutes – VPM) by the desired impact spacing.

**2700 VPM Roller Computations**

| | |
|---|---|
| 2700 VPM / 10 IPF = ____ FPM | 270 FPM / 88 = _____ (___) MPH |
| 2700 VPM / 12 IPF = ____ FPM | 225 FPM / 88 = _____ (___) MPH |
| **If 3000 VPM machine:** | ***Divide FPM by 88 to obtain Miles per Hour (MPH)*** |
| 3000 VPM / 10 IPF = ____ FPM | 300 FPM / 88 = ____ (___) MPH |
| 3000 VPM / 12 IPF = ____ FPM | 250 FPM / 88 = ____ (___) MPH |

Rollers need to be refilled with water throughout the day and this creates a need to increase the operating speed to maintain the *minimum required average speed*. If the proper impact spacing (IPF) cannot be produced at the higher speed, density reading will suffer and substituting a breakdown roller with a higher frequency, or reducing the paver speed is suggested. Time Available for Compaction (TAC) will be computed for entire operation.

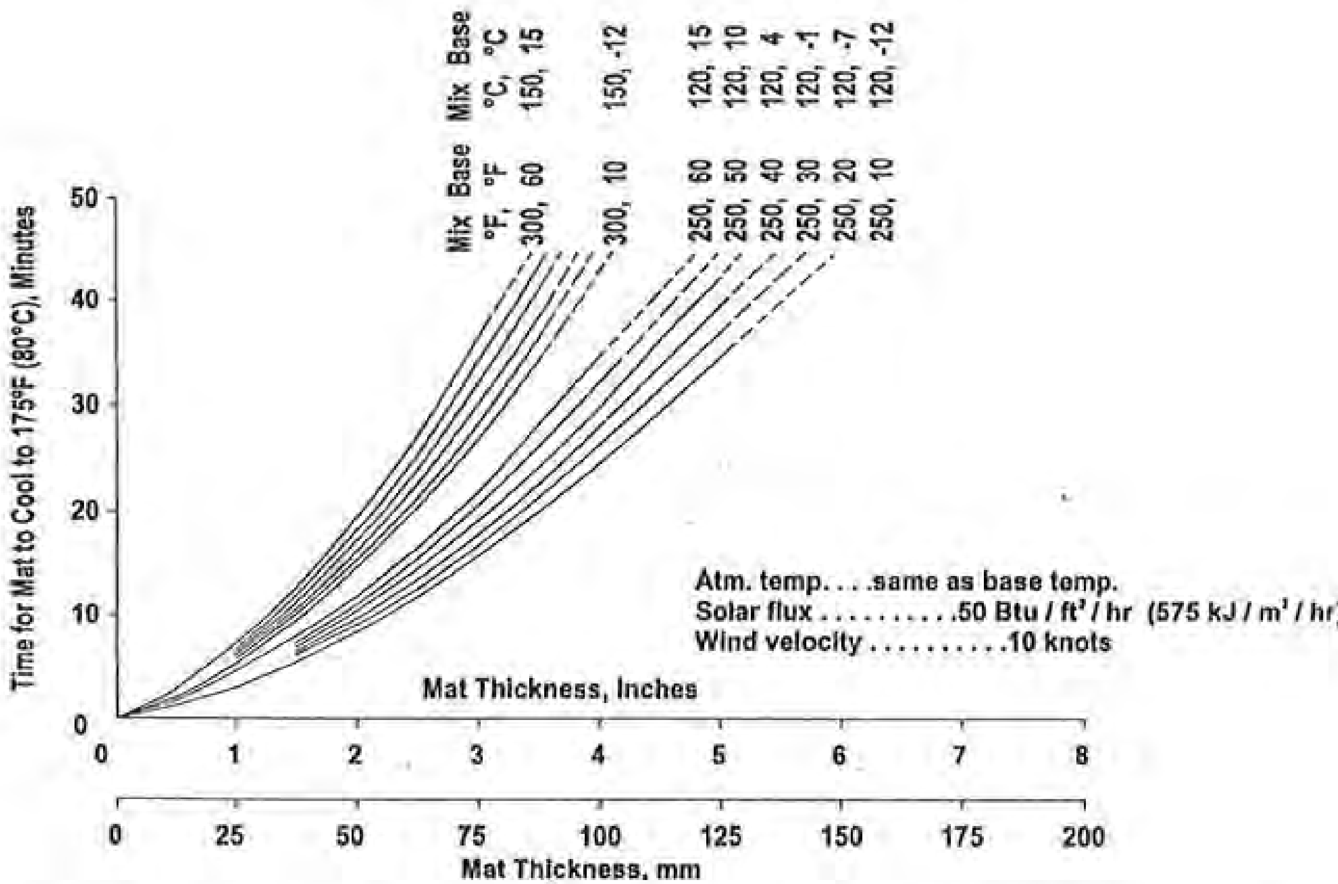



**FIGURE 18-1** **Time for mat to cool to 80°C (175°F) versus mat thickness for lines of constant mix and base temperatures [121°C (250°F) or 149°C (300°F) behind paver].**

# Asphalt Pavement Construction Program

## Certified Asphalt Field Technician
## Course of 2025

# Module 9:
# Asphalt Mixture Segregation

## Asphalt Construction Program

**Certified Asphalt**
**Field Technician - 2025**

**Module 9:**
**Asphalt Mixture Segregation**

NECEPT

1

Segregation is a major problem in the construction of asphalt pavements. Segregation has been mentioned throughout the previous modules. This module will zoom in on segregation with more detailed discussions.

## Module 9 - Objectives

- **What Is Segregation?**
- **How Does It Affect Pavement life?**
- **How Does It Happen?**
- **How Can It Be Prevented?**
- **How Do I Identify Segregated Pavements?**
- **What Action Needs To Be Taken?**

2

## What Is Segregation?


3

What is segregation? Would you consider this mat segregated?
Webster defines *Segregation* as: "to set apart or separate from others of the same kind"
**Applied to Asphalt mixes** "Segregation is the separation of the coarse and fine aggregate in the mix, collecting and distributing these fractions so that the Asphalt Mix is no longer uniformly textured."

## What Is The Effect Of Segregation On Pavement?

- **Premature Distress**
  - Raveling
  - Frost Damage
  - Potholes

4

When segregation occurs in a pavement it will lead to premature distress. This distress may be in the form of raveling, frost damage, potholes, etc. which will lead to other more severe distresses.

## Why Do Premature Failures Occur Due To Segregation?

- Weaker Aggregate Structure and Gradation
- Weaker Mix
- Higher Voids
- More Water Intrusion

NECEPT

Segregated mixtures are weak. They have weaker aggregate structures and gradations that tend to produce higher void structures than are recommended for sound long lasting pavements.

## Sources of Segregation

- Stockpiling
- Cold Feed Bins
- Hot Bins
- Truck Loading

**Plant Technicians Responsibility**

- Truck Hauling
- Truck Unloading
- Paver – Hopper, Slat Conveyers, Hopper gates, Auger, Screed
- Paving Operation Continuity (Balance)

**Field Technicians Responsibility**

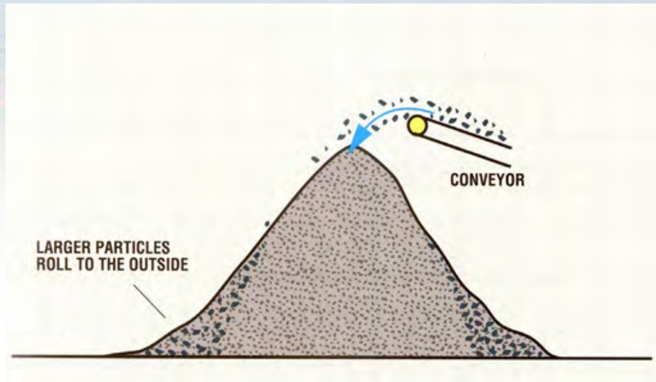
NECEPT

6

Segregation results from mishandling of the mix at any of several points during the mix production, hauling, and placing operations.

**Stockpile Segregation**
**How does it happen?**

- Large Stockpiles
- Single Aggregate Blends




NECEPT 7

Although plant segregation is not the responsibility of the Certified Field Technicians, they should be aware of how it could occur at the plant. **Large stockpiles are very sensitive for single aggregate blends.** Larger particles have a tendency to roll to the outside of the pile thereby segregating the material.

**Stockpile Segregation**
**How is it prevented?**

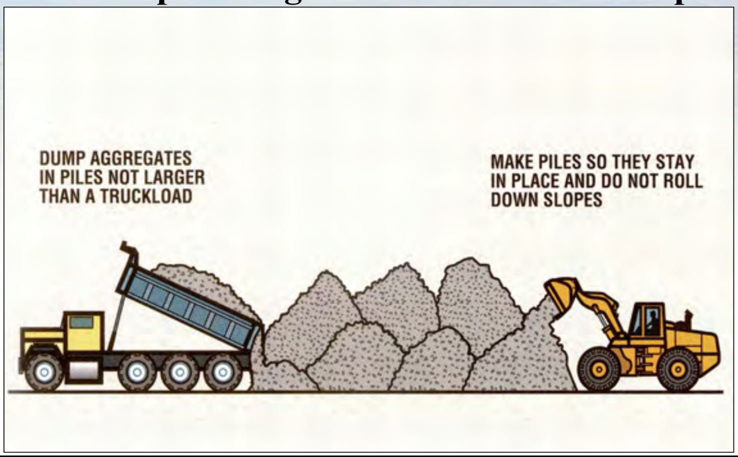
**•Well-trained Operators**

NECEPT 8

A good front-end operator can take a segregated pile and by working the pile minimize the problem. By the same token, he can take a good pile and mess it up.

## Stockpile Segregation
## How is it prevented?

**Do smaller piles. It generates milder side slopes**

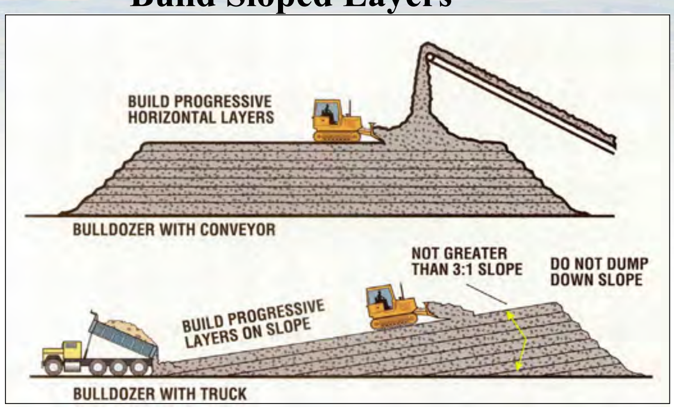



9

Generally, different-sized materials are stockpiled separately for feeding to an asphalt plant. To minimize segregation in forming a stockpile use numerous small piles.

## Stockpile Segregation
## How is it prevented?

- **Build Horizontal Layers**
- **Build Sloped Layers**

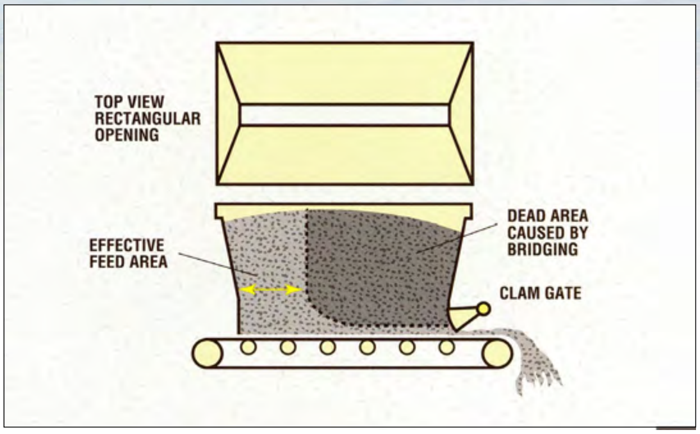



10

Other methods are to build stockpiles in layers, either horizontal layers or sloped layers. Dozer operation should be monitored to assure degradation is not occurring.

## Cold Feed Bin Segregation
## How does it happen?

### Bridging



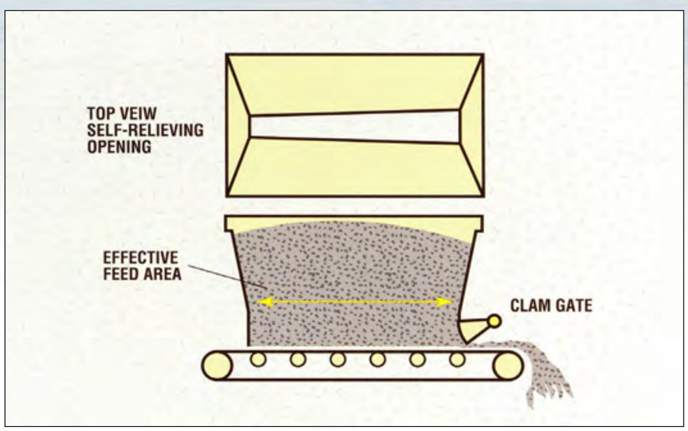

NECEPT

11

Segregation in cold feed bins is usually not a problem unless the aggregate material consists of several sizes. If material bridging takes place non-uniform feeding takes place, resulting in a segregated mix**.**

## Cold Feed Bin Segregation
## How is it prevented?

### Reconfigure Opening



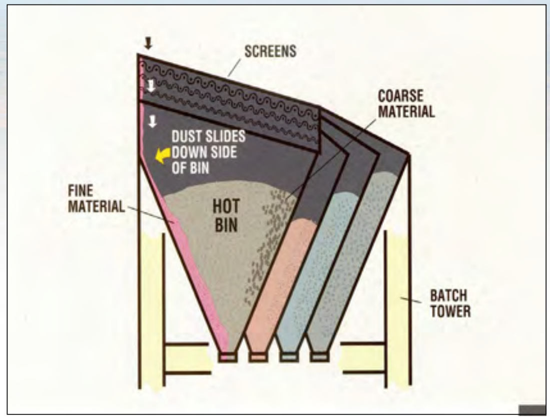

NECEPT

12

By utilizing a self-relieving bottom, uniform feeding will occur all along the opening of the cold feed bin, eliminating bridging as a source of segregation.

## Hot Bin Segregation
## How does it happen?

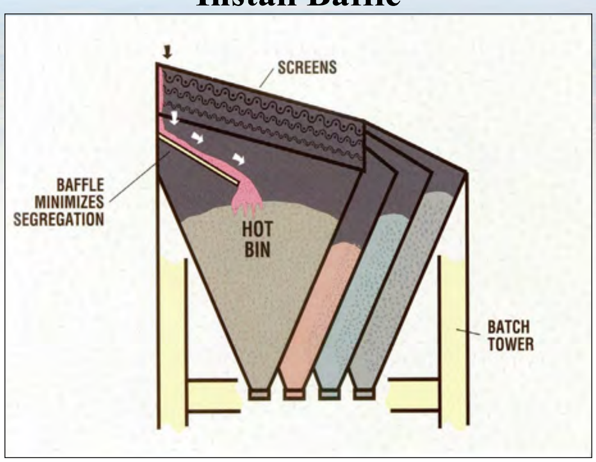
- Range of Materials
- Size of Bin
- Shape of Bin
- No. 1 Bin




13

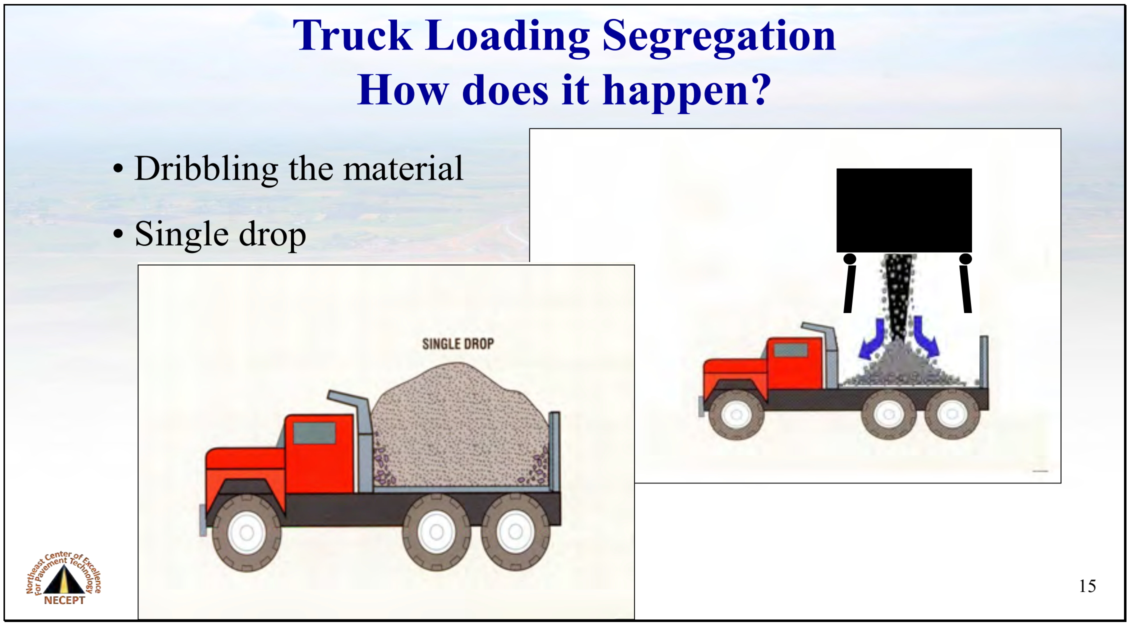
Segregation often occurs in the No.1 hot bin due to the size and shape of the large bin and the wide size range of materials in that bin. The ultra-fine dust may lay on the sloping bin wall and then break loose in large slugs, producing an ultra-fine mix that is segregated and uncoated.

## Hot Bin Segregation
## How is it Prevented?
**Install Baffle**

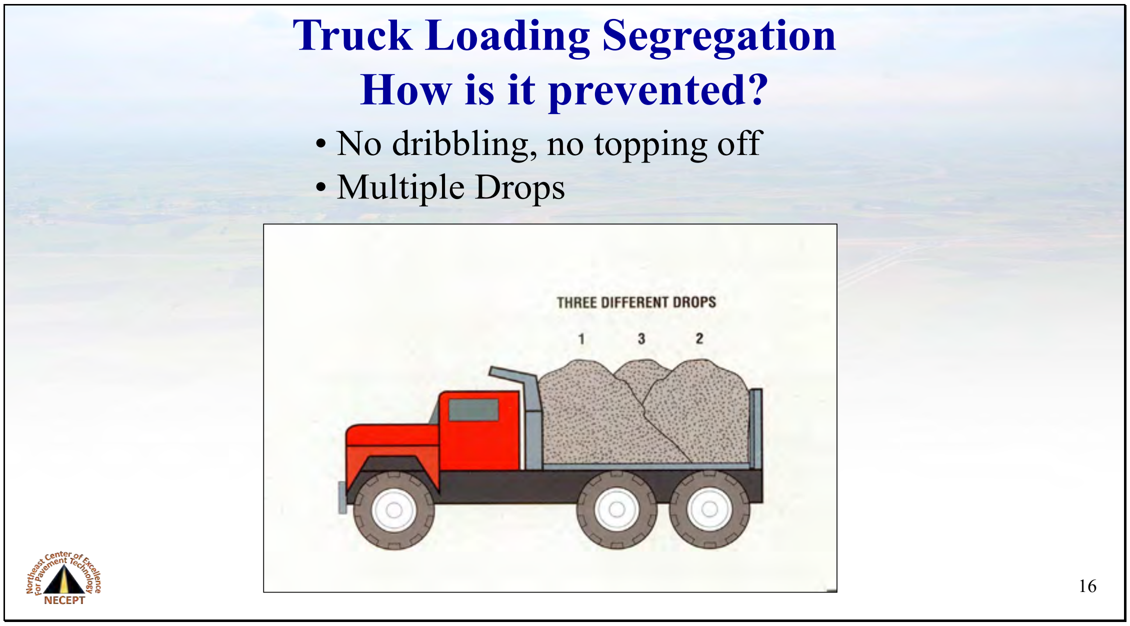



14

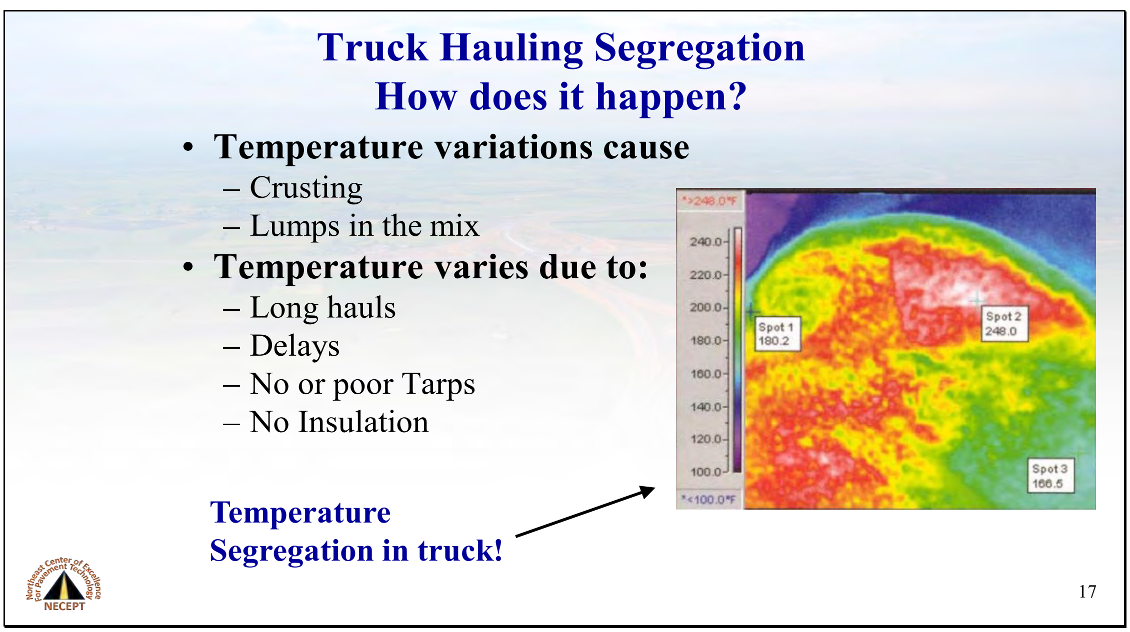
The installation of a baffle causes the dust to slide to the center of the bin where it is mixed with the coarse material.




Segregation can be caused by not loading the truck in mass, but rather loading it by trickling or dribbling the material into the truck. This will cause the larger aggregate to separate and fall into the truck first. Also, a single drop of the materials will cause the larger aggregate to roll to the front and rear of the truck, resulting in coarse material being the first and last material to be discharged from the truck bed.




The gates of the bins should be opened and closed as quickly as possible with the mix being dumped in mass into the truck bed, with no dribbling. There should be no topping off, opening the gates slightly to allow a little more mix to bring the truck weight to maximum. In addition, by loading the truck in three different drops, with the first drop being very near the front of the truck, the second drop extremely close to the tail gate and the third drop in the center, segregation caused by incorrect truck loading is eliminated.




In hauling mix in trucks, temperature variations can occur causing excessive crusting and lumps in the mix. Extra-long hauls and delays at the plant or on the road due to traffic with no tarps or insulation as required can all cause temperature variation in the mix.

## Truck Hauling Segregation
## How is it prevented?

- Proper planning
- Proper tarp
- Proper insulation
- Truck loading sequence

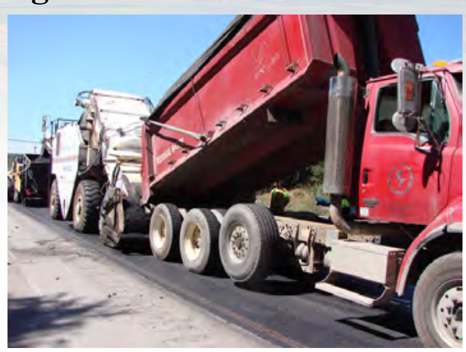
18

The solution is proper planning for the right number and size of trucks, proper scheduling with the plant, and making sure trucks are properly tarped and insulated as needed.

## Truck Hauling Segregation
## How is it prevented?

**"Strive for Continuous Paving"**

- **Proper Planning /Scheduling**
  - Proper Coordination with Plant
  - Proper Number of Trucks
  - Coordination with Paver Speed
  - Avoid Bunching of Trucks at Paver or Clean-out Area
  - Use Material Transfer Vehicle

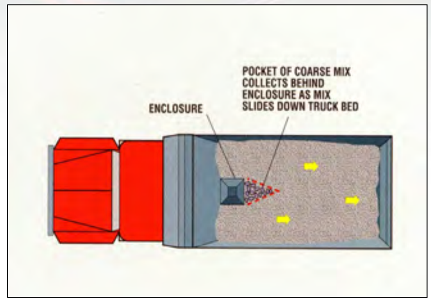


19

Another way to help minimize segregation is to ensure a constant flow of material to the paver. This will minimize the number of stops, thus eliminating some of the sources of segregation. Two ways to foster continuous paving are to have sufficient trucks and/ or a materials transfer vehicle (MTV). The materials transfer vehicle is so designed to ensure continuous movement of the material and is constantly remixing the material as it moves from the truck to the paver. This constant remixing helps minimize not only aggregate segregation but also temperature segregation.

## Truck Unloading Segregation
## How does it happen?

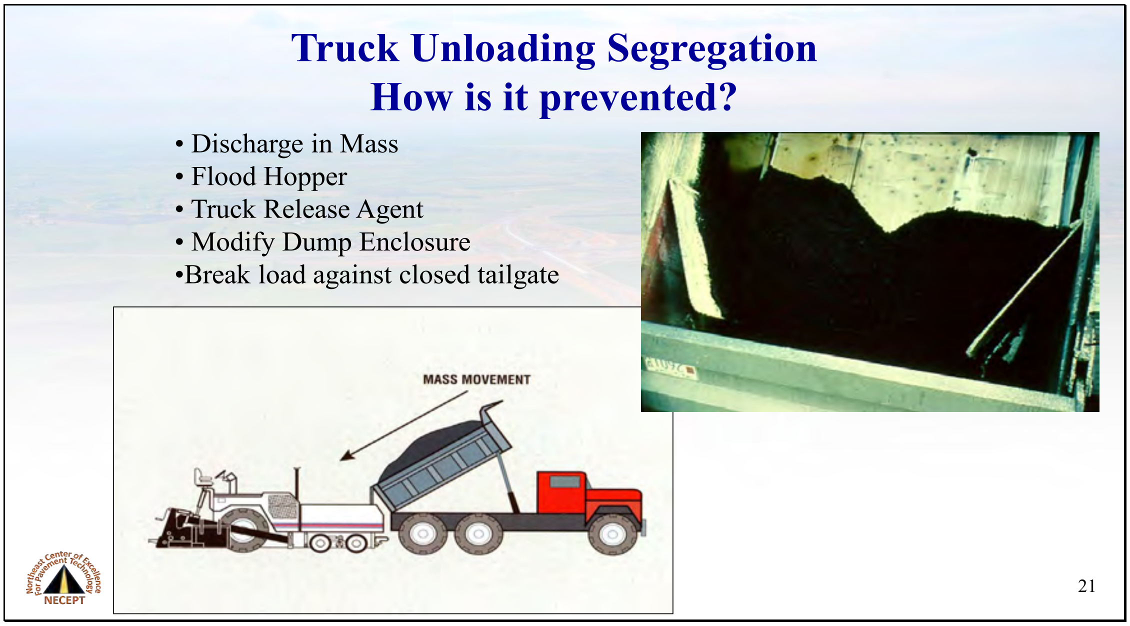
- Dribbling material/improper angle
- Poor Bed Condition
- No Release Agent



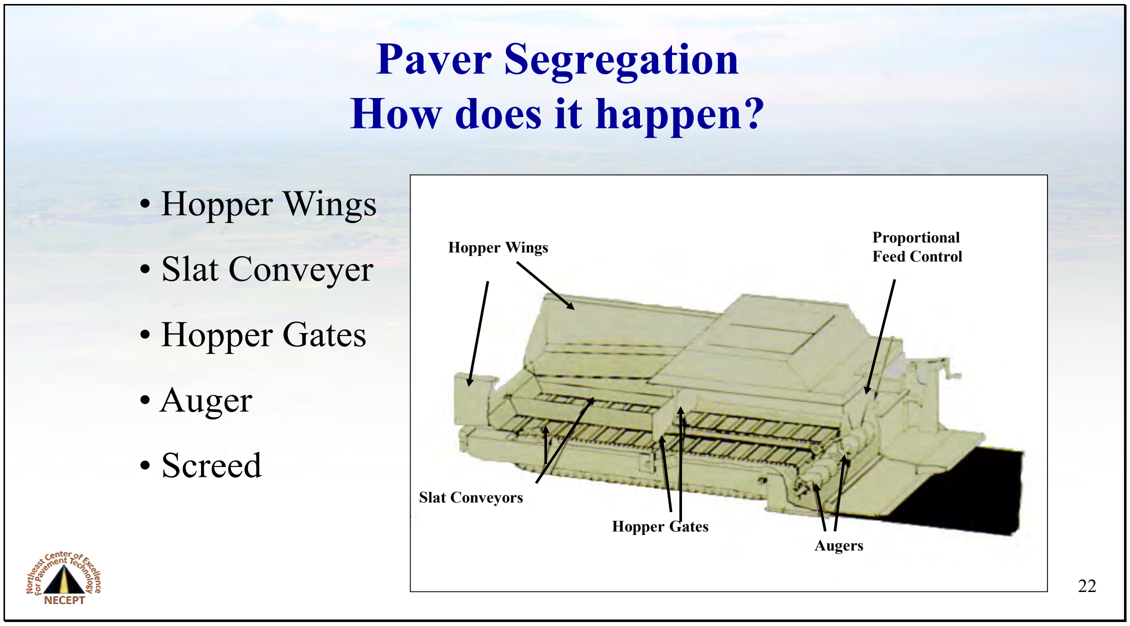

NECEPT

20

When unloading a truck into a paver hopper, it is important not to dribble the material into the hopper. If the bottom of the truck bed is in poor condition the truck release agent will pond and cause material to stick to other areas.  With sensitive mixes, pockets of coarse aggregates may accumulate in the center of the bed behind the hydraulic cylinder enclosure. As the load moves forward, it caves in, forcing large stones to accumulate behind the enclosure.

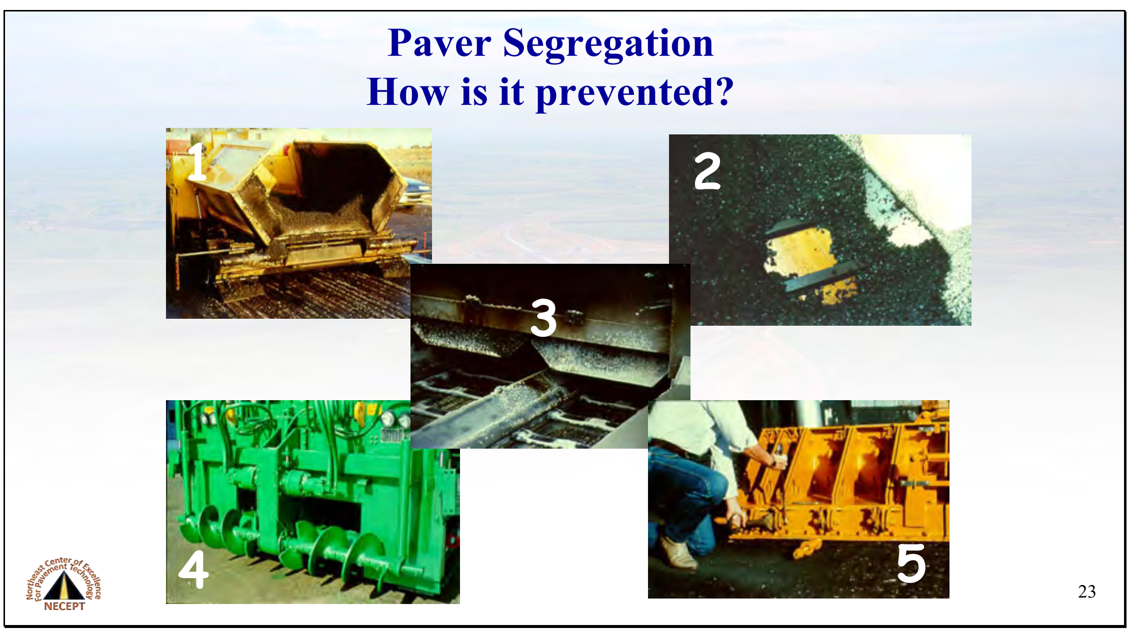



When unloading a truck into a paver hopper, it is important to discharge the material as a mass. To do this, the bottom of the truck bed needs to be in good condition and lubricated so that the entire load will slide rearward. Elevate the truck bed just enough to "break" the load before the tailgate is opened, while remaining at a safe angle. A mass discharge prevents an accumulation of coarse material at the outside portion of the paver hopper. The hydraulic cylinder enclosure may have to be modified for sensitive mixes.



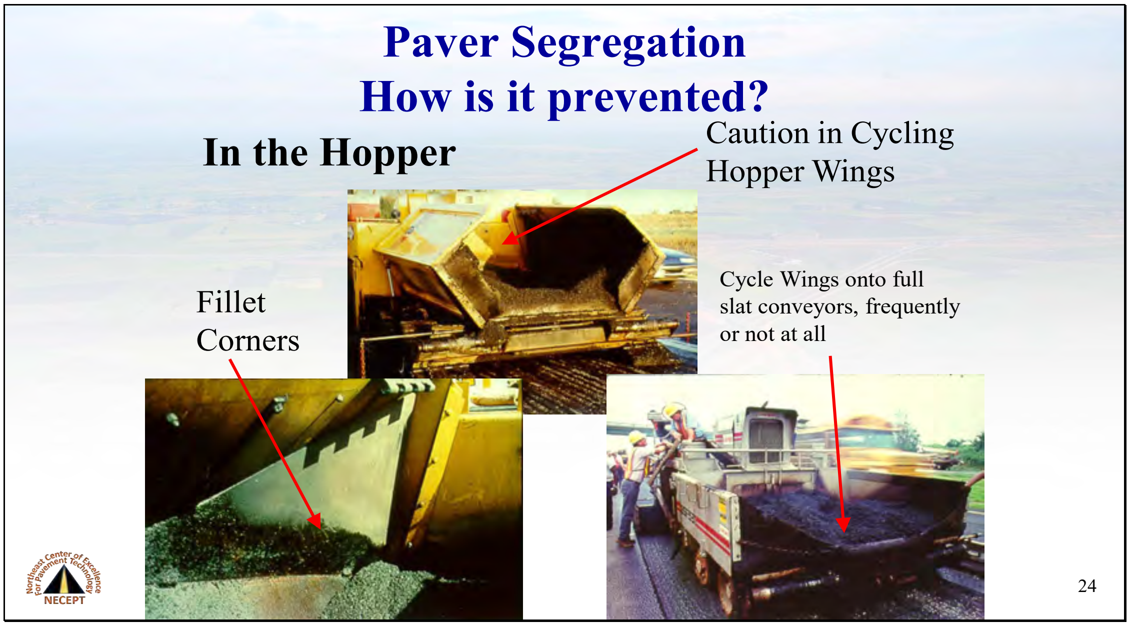

In order to understand how segregation can occur in the paver we have to look at the entire Material Feed System from the hopper to the screed.

**<u>The importance of fully understanding and controlling the head of material</u> cannot be overemphasized**, as most mat problems and paver induced segregation is caused by not maintaining a <u>uniform constant level</u> of material in front of the screed. The feed system should be set up and adjusted so the material is moved from the hopper, to the auger chamber, across the augers and under the screed **in an uninterrupted uniform manner**. Segregation may occur whenever this flow of material is interrupted or changed.

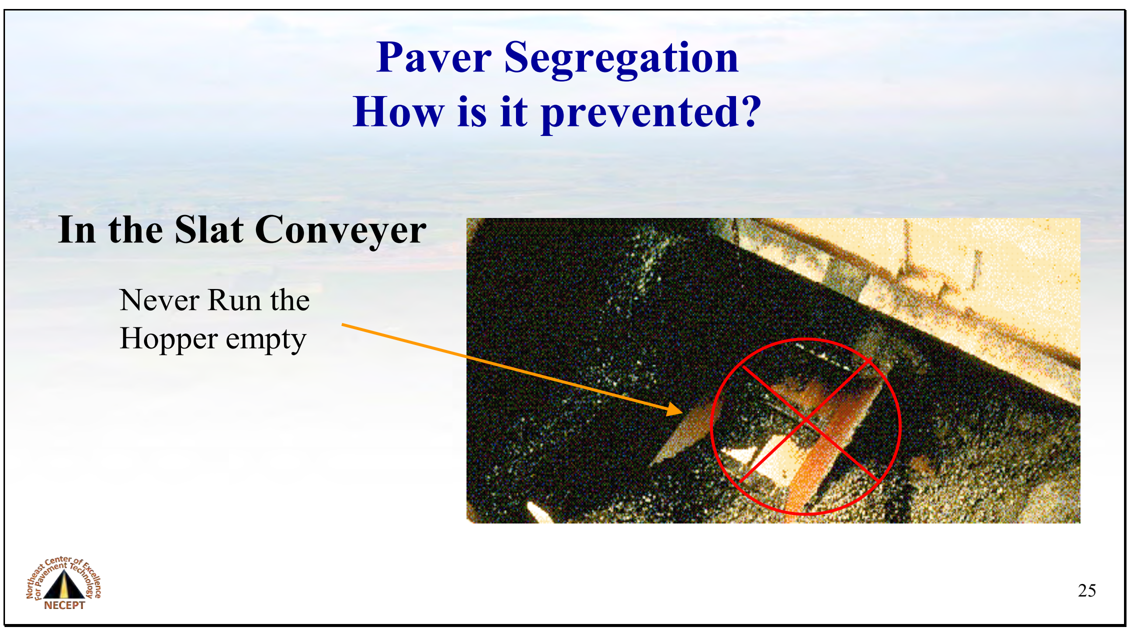



So how can segregation be prevented by the operation of the following?

**1. Hopper, 2. Slat Conveyor, 3. Flow Gates, 4. Auger, and 5. Screed.**




Some companies fashion metal plates into the corners of the hopper to prevent coarse aggregate from forming pockets of segregated material during the unloading operation. Caution should be used in cycling hopper wings because cycling hopper wings when the hopper is less than 25 percent full causes patch type segregation. Make sure that the area of the slat conveyor is filled when the wings are cycled.




Running the hopper dry before recharging causes random segregation, which is difficult to distinguish from spotty segregation caused by loading improperly from the silos. The potential consequence will be end-of load segregation, appearing as inverted 'V"

## Segregation at Slats
## How is it Prevented?

- Truck operator must communicate with paver operator
- MTV operator is responsible to not let hopper insert run "dry"
- Smooth and effective truck exchange when working without an MTV

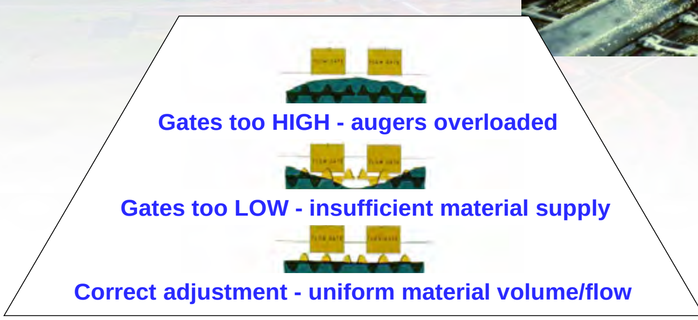
NECEPT
Northeast Center of Excellence for Pavement Technology

26

Some pavers are equipped with infra-red sensors which stop the slat conveyor when empty– this STILL allows segregation!

## Paver Segregation
## How is it prevented?

**In setting the Hopper Gates**




NECEPT
Northeast Center of Excellence for Pavement Technology

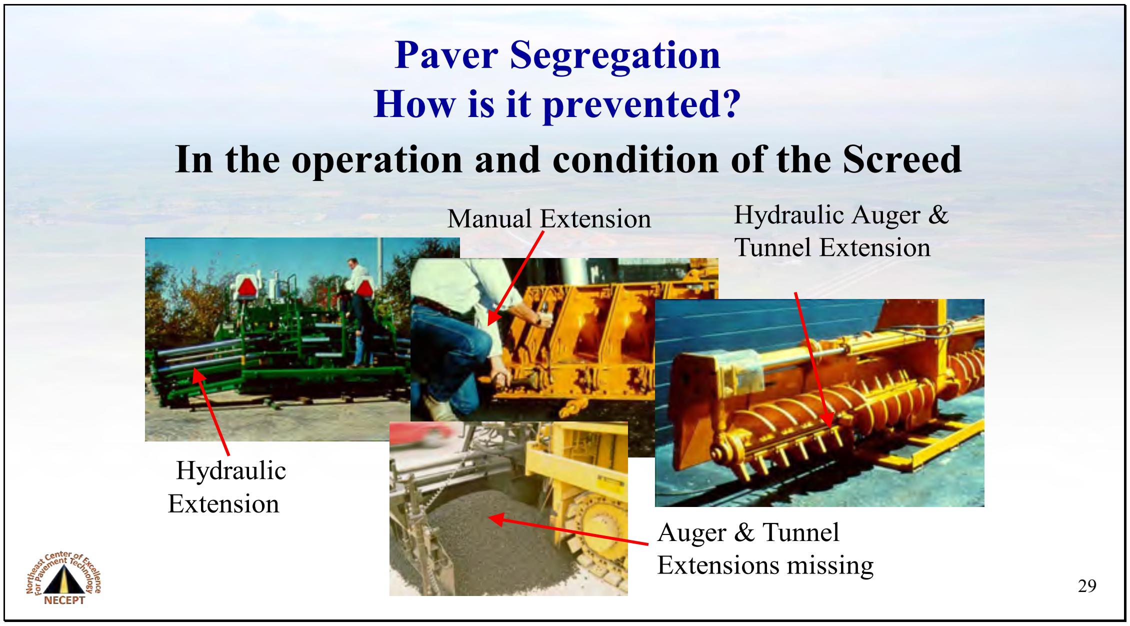
27

The settings on the hopper gates and the speed of the slat feeder should be adjusted so that the level of material across the main screed just covers the auger shafts and the speed of the auger maintained at a constant speed. High or low levels of material in this area may cause segregation to occur. When paving with extension only on one side, that gate should be raised to keep auger speeds equal.


A gear box is located in the center of the auger. Kick back paddles are used to "tuck" mix under the gear box. Make sure the paddles are positioned to push the material toward the gear box. If the paddles were not there, the proper amount of mix would not get under the gear box and can cause segregation.

The correct head of material is just covering the auger shaft. **The auger should be running 100% of the time** while the paver is moving and the **speed of the auger approximately 20 to 40 RPM**. An off/on or erratic feeder system may cause segregation patches to occur. Excessive high or low auger RPM as well as high or low levels of material may cause segregation stripes to occur. Auger height should be set so the bottom of the flight is at least 2" above the surface of the mat being placed. If the auger is too close to the surface of the mat being placed segregation can occur. Heavy or large rock designs may require the height to be increased.

The feed sensors control the level of material at the outboard ends of the augers. They should be positioned and adjusted so the correct auger material level is constantly maintained at the outer ends of the screed.




Most paver screeds can be extended either hydraulically or with fixed extensions. Extend the augers to **within 12 to 18 inches of the end gate to ensure a continuous supply of fresh material** is carried to either end of the paving width. When paving a level surface, it is important that the extendable portion of the screed is set at the same angle of attack as the main screed. If the extensions are not properly aligned with the main screed, a longitudinal line or ridge will appear in the mat. Also, a difference in surface texture between the main screed and extension may occur. Excessive amounts of material that is not contained properly may cause segregation stripes to occur.


Maintaining a consistent paver speed is important in the operation of the paver, as the material feed system is set and affected by paver speed. Paver should be moving at a consistent paving speed, with a minimum goal of 85 percent of the time; spending 15 percent or less of the time stopped waiting on trucks. Paving speed is determined by the delivery rate of material from the hot plant to the paving site.

**When stopping is necessary, you should stop the paver as quickly as possible, without being erratic in nature; and, when starting again, accelerate as quickly as possible to the previous paving speed, again without being erratic in nature.**

The goal is to have "**Non-Stop Paving**." The purpose of non-stop paving is to eliminate the problems that occur at each stop and to establish a constant paving speed. The feeder system can be set up and adjusted to where the materials are moved from the hopper to the screed in a uniform constant manner that prevents segregation.

## Goal: Non-Stop Paving

**Industry's Approach to Non-Stop Paving** ➡

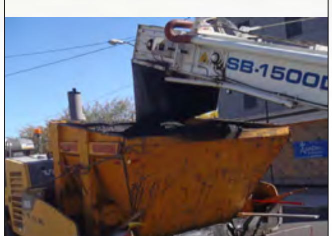
- Mobile Conveyors
- Material Transfer Vehicle


NECEPT

31

When using a material transfer vehicle (MTV), the material is dumped into a receiving hopper, then conveyed to a storage bin. From the storage bin, it is moved to the discharge conveyor. There are other machines that can be used to develop the non-stop paving procedure. The use of these pieces of equipment will not guarantee the elimination of segregation.

## Segregation can still occur!



**Problem:**

- Dropping Materials

**Solution:**

- Limit drop
- Keep hopper insert full

NECEPT

32

In the case of Mobile Conveyors and the Materials Transfer Vehicles, extreme care must be used to prevent severe segregation. To decrease drop-caused segregation, limit the drop and keep the hopper insert full.


A field technician has responsibilities concerning segregation. The specifications do address the issue and can aid the technician in their responsibilities.


Is this pavement segregated? It is very difficult to teach an individual how to identify segregated areas. However, there are tools available to assist in the development of this talent. We will review ways of identifying segregation in the next section.

## If Pattern Segregation Is Suspected

PennDOT Specs
Section 413.3(h)3

- Notify Department and contractor
- Contractor continues work at his own risk
- The Department will initiate an investigation
- Surface texture depth (PTM 751) can be used to determine if segregation is present

35

A field technician, representing the contractor or the agency, observes an area that looks to be pattern segregation. The Contractor may elect to continue work at his own risk and immediately and continually adjust the operation until the pattern segregation is eliminated from the finished mat. The Department technician will immediately begin an evaluation to determine the severity of the pattern segregation.

## How Do You Troubleshoot A Suspected Segregated Pavement ?

36

Up to this point we have reviewed the paving operations and determined those deficiencies that could lead to segregation. We have reviewed the specifications and the tests that are used to determine if pattern segregation is present. How does the technician troubleshoot a suspected segregated pavement? How does she/he go about determining where changes have to be made in the paving operations to improve the surface texture?

## Segregation
## Trouble Shooting

**Segregation caused by**

- poor truck loading
- empty conveyor slats
- folding wings on empty hopper

**and**

- auger hanger segregation

37

This pictures illustrates beginning and end of load segregation.

## Centerline Segregation Stripe


38

Centerline segregation must be corrected ASAP.

## Centerline Segregation Stripe

39

If not corrected, it will not just roll out when being compacted. It will lead to long term issues, which are just beginning to show up in this photo on a limited access highway.

## Centerline Segregation Causes

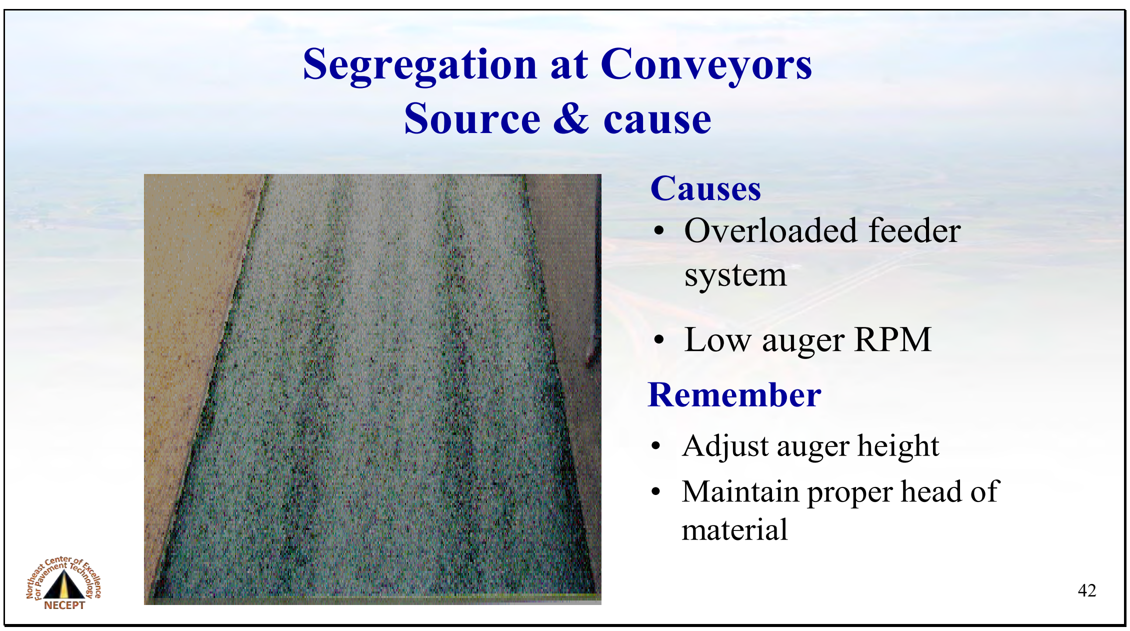
- **Missing or damaged baffle plates**
- **Overloaded material feed system**
- **Worn or non-existent reversing auger paddles**
- **Low auger RPM**
- **Warped or improperly set screed**

40

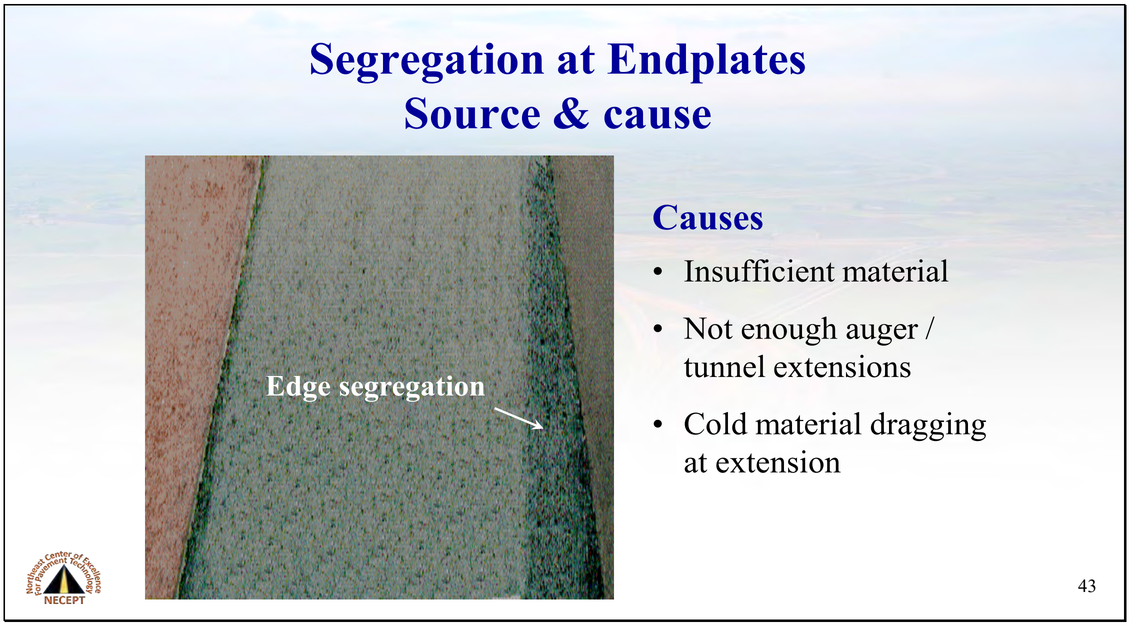
The source could be attributed to missing or damaged baffle plate in the plant, overloaded material feed system in the paver, worn or missing reverse auger paddles, low auger RPM, or a warped or improperly set screed.

**NOTE:** Raising (or lowering) pre- strike off plate may hide this, but it WILL show up again as the pavement ages. Extension height setting may also cause this centerline stripe.


The mix segregation is shown in the form of a single stripe in line with the outer auger bearing support.




Once again, the form of segregation can be caused by low auger RPM or an overloaded feeder system. The head of material should be at the centerline of the augers or just covering the center shaft.




This form of edge segregation is usually caused by insufficient material or failure to use auger extensions and tunnels. Failure to add auger extensions when you extend the screed will lead to the material not being carried to the endplate. This material will spill out into the void at the end of the auger causing the material to segregate. If the auger speed is too low, it can also cause this type of segregation as the coarse material tends to roll to the outside of the mat.

## All That's Left is the Line Painting – What Can Go Wrong with That?


45

## Identifying Problems & Causes for Asphalt Pavements

**4 Trouble Shooting Charts**

**(See handout)**

46

## Module 9 - Review

- What Is Segregation?
- How Does It Affect Pavement life?
- How Does It Happen?
- How Can It Be Prevented?
- How To Identify Segregated Pavements?
- What Action Needs To Be Taken?

NECEPT

47

**Module recap**

PennState

# Discussion

pennsylvania
DEPARTMENT OF TRANSPORTATION

NECEPT

48


PennState
Final Questions?
pennsylvania
DEPARTMENT OF TRANSPORTATION
NECEPT
49


PennState
Evaluation Forms
pennsylvania
DEPARTMENT OF TRANSPORTATION
NECEPT
50


PennState
Good Luck!
pennsylvania
DEPARTMENT OF TRANSPORTATION
Northeast Center of Excellence for Pavement Technology
NECEPT
51

# Quiz

## Module 9

## Segregation



**1. Segregation is the separation of the course and fine aggregate in the mix, so that the Asphalt mix is no longer uniformly textured.**

a. True

b. False

**Answer:**

**2. Beginning and end of load segregation results primarily from**

a. Too many adjustments of the screed thickness screws
b. Not using a hopper insert with an MTV
c. Improper loading/dumping of the haul trucks
d. Excessive low auger RPM

**Answer:**



**3. Preventing asphalt pavement segregation is both the Plant Technician's and the Field Technician's responsibility.**

a. True
b. False

**Answer:**

**4. Segregation can occur in the paver in the following locations.**

a. The hopper
b. The slat conveyer
c. The control gates
d. The auger
e. The screed
f. All of the above

**Answer:**



**5. In preventing segregation, a major goal is to have a continuously moving paving operation.**

a. True
b. False

**Answer:**

**6. P.T.M. 751 is used to assist in the identification of surface pattern segregation.**

a. True
b. False

**Answer:**



**7. When loading a truck, each drop should be in one mass and not dribbled into the bed. How many of these drops are needed for proper loading of one truck?**

a. 1
b. 2
c. 3
d. 4

**Answer:**

**8. Using a material transfer vehicle will eliminate segregation.**

a. True
b. False

**Answer:**

(but it can help eliminate end of load segregation issues)



**9. If unacceptable pattern segregation is evident through Department testing, the full lane width of the segregated area plus 5 feet minimum beyond each end needs to be removed and replaced.**

a. True
b. False

**Answer:**

**10. When segregation occurs, Field and Plant Technicians should be in constant communications reviewing and discussing sources of segregation.**

a. True
b. False

**Answer:**

| Insufficient or Non-Uniform Tack Coat | Improperly Cured Prime or Tack Coat | Mixture Too Coarse | Excess Fines in Mixture | Insufficient Asphalt | Excess Asphalt | Improperly Proportioned Mixture | Unsatisfactory Batches in Load | Excess Moisture in Mixture | Mixture Too Hot or Burned | Mixture Too Cold | Poor Spreader Operation | Spreader in Poor Condition | Excessive Moisture in Subsoil | Excessive Prime Coat or Tack Coat | Excessive Hand Raking | Labor Careless or Unskilled | Excessive Segregation in Laying | Operating Finishing Machine Too Fast | *Types of Pavement Imperfections That May Be Encountered In Laying Plant Mix Paving Mixtures.* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | X | X | X | | | | | | | X | | | | | Bleeding |
| | | | | X | | | | X | X | | | | | | | | | | Brown, Dead Appearance |
| | | | | | X | X | X | | | | | | | X | | | X | | Rich or Fat Spots |
| | | X | X | | | X | X | | | X | X | X | | | X | X | X | X | Poor Surface Texture |
| X | X | X | | | | X | X | | | X | X | X | | | X | X | X | X | Rough Uneven Surface |
| | | X | | X | | X | X | | | X | X | X | | | X | X | X | | Honeycomb or Raveling |
| | | X | | | | | | | | X | X | X | | | X | X | X | | Uneven Joints |
| | | | X | | X | X | | | | X | | | | | | X | | | Roller Marks |
| X | X | | X | | X | X | X | X | | | X | X | | | X | | | | Pushing or Waves |
| | | | X | X | | X | | | | | | | X | | | | | | Cracking (Many Fine Cracks) |
| | | | | | | | | | | | | | X | | | | | | Cracking (Large Long Cracks) |
| | | X | | | | X | | | | X | X | X | | | | | | | Rocks Broken by Roller |
| | | X | | X | | X | | | X | X | X | X | | | | | X | X | Tearing of Surface During Laying |
| X | X | | X | | X | X | | X | | X | | | X | X | | | | | Surface Slipping on Base |

FIGURE 5.20—Typical Mat Problems and Their Probable Causes.

| ITEM | EFFECT | CORRECTIONS* |
|---|---|---|
| *Aggregate* | | |
| • Smooth Surfaced | Low interparticle friction | Use light rollers<br>Lower mix temperature |
| • Rough Surfaced | High interparticle friction | Use heavy rollers |
| • Unsound | Breaks under steel-wheeled rollers | Use sound aggregate<br>Use pneumatic rollers |
| • Absorptive | Dries mix—difficult to compact | Increase asphalt in mix |
| *Asphalt* | | |
| • Viscosity | | |
| — High | Particle movement restricted | Use heavy rollers<br>Increase temperature |
| — Low | Particles move easily during compaction | Use light rollers<br>Decrease temperature |
| • Quantity | | |
| — High | Unstable & plastic under roller | Decrease asphalt in mix |
| — Low | Reduced lubrication—difficult compaction | Increase asphalt in mix<br>Use heavy rollers |
| *Mix* | | |
| • Excess Coarse Aggregate | Harsh mix—difficult to compact | Reduce coarse aggregate<br>Use heavy rollers |
| • Oversanded | Too workable—difficult to compact | Reduce sand in mix<br>Use light rollers |
| • Too Much Filler | Stiffens mix—difficult to compact | Reduce filler in mix<br>Use heavy rollers |
| • Too Little Filler | Low cohesion—mix may come apart | Increase filler in mix |
| *Mix temperature* | | |
| • High | Difficult to compact—mix lacks cohesion | Decrease mixing temperature |
| • Low | Difficult to compact—mix too stiff | Increase mixing temperature |
| *Course Thickness* | | |
| • Thick Lifts | Hold heat—more time to compact | Roll normally |
| • Thin Lifts | Lose heat—less time to compact | Roll before mix cools<br>Increase mix temperature |
| *Weather Conditions* | | |
| • Low Air Temperature | Cools mix rapidly | Roll before mix cools |
| • Low Surface Temperature | Cools mix rapidly | Increase mix temperature |
| • Wind | Cools mix—crusts surface | increase lift thickness |

* Corrections may be made on a trial basis at the plant or job site. Additional remedies may be derived from changes in mix design.

FIGURE 6.23—Summary Table of Influences of Compaction.

| PROBLEM / CAUSES | Fluctuating Head of Material | Feeder Screws Overloaded | Finisher Speed Too Fast | Too Much Lead Crown in Screed | Too Little Lead Crown in Screed | Overcorrecting Thickness Control Screws | Excessive Play in Screed Mechanical Connection | Screed Riding on Lift Cylinders | Screed Plates Worn Out or Warped | Screed Plates Not Tight | Cold Screed | Moldboard on Strikeoff Too Low | Running Hopper Empty Between Loads | Feeder Gates Set Incorrectly | Kicker Screws Worn Out or Mounted Incorrectly | Incorrect Nulling of Screed | Screed Starting Blocks Too Short | Screed Extensions Installed Incorrectly | Vibrators Running Too Slow | Grade Control Mounted Incorrectly | Grade Control Hunting (Sensitivity Too High) | Grade Control Wand Bouncing on Reference | Grade Reference Inadequate | Sitting Long Period Between Loads | Improper Joint Overlap | Improper Mat Thickness for Max. Agg. Size | Trucks Bumping Finisher | Truck Holding Brakes | Improper Base Preparation | Improper Rolling Operation | Reversing or Turning Too Fast of Rollers | Parking Roller on Hot Mat | Improper Mix Design (Aggregate) | Improper Mix Design (Asphalt) | Mix Segregation | Moisture in Mix | Variation of Mix Temperature | Cold Mix Temperature |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Wavy Surface — Short Waves (Ripples) | ✓ | ✓ | ✓ | | | | ✓ | ✓ | | ✓ | | | | | | | | | | ✓ | ✓ | ✓ | ✓ | | | | | | X | X | | | X | X | X | | X | |
| Wavy Surface — Long Waves | ✓ | ✓ | | | | ✓ | ✓ | ✓ | | | | | ✓ | ✓ | | | | | | ✓ | | | ✓ | ✓ | | | X | X | X | | X | X | | | X | | X | |
| Tearing of Mat — Full Width | | | ✓ | | | | | | ✓ | | ✓ | | | | | | | | | | | | | | | X | | | | | | | X | X | X | X | X | X |
| Tearing of Mat — Center Streak | | | | | ✓ | | | | ✓ | | ✓ | | | ✓ | ✓ | | | | | | | | | | | | | | | | | | | | | | | X |
| Tearing of Mat — Outside Streaks | | | | ✓ | | | | | ✓ | | ✓ | ✓ | | ✓ | | | | ✓ | | | | | | | | | | | | | | | | | | | | X |
| Mat Texture — Nonuniform | ✓ | ✓ | ✓ | | | | | ✓ | ✓ | ✓ | ✓ | | ✓ | | | | | ✓ | ✓ | | | | | ✓ | | X | | | X | | | | X | X | X | | X | X |
| Screed Marks | | | | | | | ✓ | | | | | | | | | | | | | | | | | | | | X | X | | | | | | | | | | |
| Screed Not Responding to Correction | | | ✓ | | | | ✓ | ✓ | | ✓ | | | | | | | | | | ✓ | | | | | | X | | | | | | | | | | | X | X |
| Auger Shadows | | ✓ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | X | X | | | |
| Poor Precompaction | | | ✓ | | | | | ✓ | | | | | | | | | | | ✓ | | | | | | | X | | | X | | | | | | | | | X |
| Poor Longitudinal Joint | ✓ | ✓ | | | | ✓ | | ✓ | | | | | | | | | | | | ✓ | ✓ | ✓ | | | ✓ | | | | | X | | | | | | | | X |
| Poor Transverse Joint | | ✓ | | | | | ✓ | ✓ | | ✓ | | | | | | ✓ | ✓ | | | | | | | | | | | | | X | | | | | | | | X |
| Transverse Cracking (Checking) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | X | | | X | X | | X | X | |
| Mat Shoving Under Roller | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | X | X | | X | X | | X | X | |
| Bleeding or Fat Spots in Mat | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | X | | X | X | |
| Roller Marks | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | X | X | X | | | | | X | |
| Poor Mix Compaction | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | X | X | X | X | X | | X | X | X |

1. Find problem above.
2. Checks indicate causes related to the paver. X's indicate other problems to be investigated.

NOTE: Many times a problem can be caused by more than one item, therefore, it is important that each cause listed is eliminated to assure solving the problem.

Figure 101. Mat problem troubleshooting guide *(Barber-Greene)*.

| Aggregates Too Wet | Inadequate Bunker Separation | Aggregate Feed Gates Not Properly Set | Over-Rated Dryer Capacity | Dryer Set Too Steep | Improper Dryer Operation | Temp. Indicator Out of Adjustment | Aggregate Temperature Too High | Worn Out Screens | Faulty Screen Operation | Bin Overflows Not Functioning | Leaky Bins | Segregation of Aggregates in Bins | Carryover in Bins Due to Overloading Screens | Aggregate Scales Out of Adjustment | Improper Weighing | Feed of Mineral Filler Not Uniform | Insufficient Aggregates in Hot Bins | Improper Weighing Sequence | Insufficient Asphalt | Too Much Asphalt | Faulty Distribution of Asphalt to Aggregates | Asphalt Scales Out of Adjustment | Asphalt Meter Out of Adjustment | Undersize or Oversize Batch | Mixing Time Not Proper | Improperly Set or Worn Paddles | Faulty Dump Gate | Asphalt and Aggregate Feed Not Synchronized | Occasional Dust Shakedown in Bins | Irregular Plant Operation | Faulty Sampling | *Types of Deficiencies That May Be Encountered In Producing Plant-Mix Paving Mixtures.* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | A | | | | | | | | | | | | B | B | | | | A | A | A | B | C | B | B | B | | C | | | A | Asphalt Content Does Not Check Job Mix Formula |
| | A | A | | | | | | B | B | B | B | A | A | B | B | B | A | | | | | | | B | | B | B | C | B | | A | Aggregate Gradation Does Not Check Job Mix Formula |
| | A | A | | | | | | | B | B | B | A | A | B | B | B | A | | | | | | | B | B | | | C | B | | A | Excessive Fines in Mix |
| A | | | A | A | A | A | A | | | | | | | | | | | | | | | | | | | | | | | A | | Uniform Temperatures Difficult to Maintain |
| | | | | | | | | | | | B | | | B | B | | | | | | | | | B | | | | | | | | Truck Weights Do Not Check Batch Weights |
| | | | | | | | | | | | | | | B | B | | | | | A | A | B | C | B | | B | | C | | | | Free Asphalt on Mix in Truck |
| | | | | | | | | | | | | | | | | | | B | | | | | | | | | B | | | | | Free Dust on Mix in Truck |
| A | | | A | A | A | A | | | | | | | | | | | | | A | | A | B | C | B | B | B | | C | | A | | Large Aggregate Uncoated |
| | | | | | | | | | B | B | A | A | A | B | B | B | A | B | | | A | B | C | | B | B | B | C | B | A | | Mixture in Truck Not Uniform |
| | | | | | | | | | | | | | | | | | | B | | | A | | | B | B | B | | | | A | | Mixture in Truck Fat on One Side |
| | | | | | A | | | | | | | | | | | | | | | A | A | B | C | B | | | | C | | A | | Mixture Flattens in Truck |
| | | A | | | A | A | A | | | | | | | | | | | | | | | | | | | | | | | A | | Mixture Burned |
| A | | | A | A | A | A | | | B | | | | | | | | | | A | | | B | C | B | | | | C | | A | | Mixture Too Brown or Gray |
| | | | | | | | | | | | | | | B | B | B | A | | | A | A | B | C | B | | | | C | | A | | Mixture Too Fat |
| | | | | | A | A | A | | | | | | | | | | | | | | | | | | | | | | | A | | Mixture Smokes in Truck |
| A | | | A | A | A | A | | | | | | | | | | | | | | | | | | | | | | | | A | | Mixture Steams in Truck |
| | | | | | A | A | A | | | | | | | | | | | | A | | | | | | | | | | A | A | | Mixture Appears Dull in Truck |

FIGURE 4.23—Possible Causes of Deficiencies in Hot Plant-Mix Paving Mixtures. A—Applies to Batch and Drum Mix Plants; B—Applies to Batch Plants; C—Applies to Drum Mix Plants.

**Pennsylvania Construction Specifications – Publication 408**

This document contains the most relevant PennDOT Specifications for Certified Asphalt Technicians.

The specification sections included are from **Change No. 7 of Spec 408**, with effective date of Oct 6, 2023.


**PENNDOT PUBLICATION 408**

**CONSTRUCTION SPECIFICATION**

**2020 Edition**

| Version | Effective Date |
|---|---|
| Initial Edition | April 10, 2020 |
| Change No. 1 | October 2, 2020 |
| Change No. 2 | April 9, 2021 |
| Change No. 3 | October 8, 2021 |
| Change No. 4 | April 1, 2022 |
| Change No. 5 | October 7, 2022 |
| Change No. 6 | April 14, 2023 |
| **Change No. 7** | **October 6, 2023** |

Section 106. Control of Materials

Section 313. Superpave Asphalt Mixture Design, Standard Construction, Base Course

Section 314. Superpave Asphalt Mixture Design, Standard Construction, Asphalt Rich Base Course

Section 316. Flexible Base Replacement

Section 344. Full Depth Replacement

Section 360. Asphalt Treated Permeable Base

Section 404. Evaluation of Asphalt Pavement Ride Quality and Payment of Incentive

Section 405. Evaluation of Asphalt Pavement Longitudinal Joint Density and Payment of Incentive/Disincentive

Section 410. Superpave Mixture Design, Standard and RPS Construction of Plant- Mixed Asphalt Fine-Graded Courses

Section 412. Superpave Mixture Design, Construction of Plant=mixed 6.3 mm Thin Asphalt Overlay Courses

Section 413. Superpave Mixture Design, Standard and RPS Construction of Plant- Mixes Asphalt Courses with Percent Within Limits and LTS Testing (PWL-LTS)

Section 419. Stone Matrix Asphalt Mixture Design, RPS Construction of Plant-Mixed Wearing Courses

Section 420. Pervious Asphalt Pavement System

Section 460. Asphalt Tack Coat

Section 483. Polymer-Modified Emulsified Asphalt Paving System (Micro Surfacing)

Section 489. Ultra-Thin Bonded Wearing Course

Section 491. Milling of Asphalt Pavement Surface

Section 496. Asphalt Concrete Pavement, 60-month Warranty

# SECTION 106—CONTROL OF MATERIAL

**106.01 GENERAL**—Use material complying with the requirements of these specifications. At the pre-construction conference, submit a list of material to be sampled and tested by the Contractor and a list of material to be sampled and tested by the Department.

Comply with the provisions of the Pennsylvania Trade Practices Act, 71 P.S. Section 773.101, et seq., concerning the purchase of aluminum and steel products produced in a foreign country. On Federal-Aid projects, also comply with the provisions specified in Section 106.10.

Comply with the provisions of the Steel Products Procurement Act, 73 P.S. Section 1881, et seq. in the performance of the contract or any subcontract.

Following contract execution, furnish to the Department a complete statement of the project construction material's origin, composition, and manufacture.

For Fabricated Structural Steel materials, as identified in Section 1105.01(a) and inspected in accordance with Section 1105.01(e), and any other fabricated aluminum, precast or prestressed concrete products inspected during manufacturing, stamped and approved for shipment by the Department's Representative, furnish Form CS-4171 to the Inspector-in-Charge. Certified mill test reports for any steel included will be reviewed by the Department's Inspector and retained by the fabricator.

For all other steel products or products containing steel that will be permanently incorporated in the project, provide the Inspector-in-Charge the following when the product is delivered to the project site:

- For any "identifiable" steel products, certification that Section 4 of the Steel Products Procurement Act, 73 P.S. Section 1884, has been complied with. Identifiable steel products are steel products which contain permanent markings which indicate the material was both melted and manufactured in the United States.
- For all other "unidentifiable" steel products, documentation such as invoices, bills of lading, and mill certification that positively identify that the steel was melted and manufactured in the United States.

The provisions of the Steel Products Procurement Act will not be waived unless the Secretary has determined, under authority granted in Section 4(b) of the act, that a certain steel product or products is not produced in the United States in sufficient quantities to meet contract requirements. Such a determination will be set forth in a proposal for the Department's review and response. Include with the proposal a comprehensive list of sources, including names and contact information, for verification. The Secretary does not have the authority to waive the provisions specified in Section 106.10.

Steel products are defined as products rolled, formed, shaped, drawn, extruded, forged, cast, fabricated, otherwise similarly processed, or processed by a combination of two or more of these operations from steel made in the United States by the open hearth, basic oxygen, electric furnace, Bessemer, or any other steel-producing process. Included are cast iron products and machinery and equipment as listed in United States Department of Commerce Standard Industrial Classification 25, 35, and 37 and made of, fabricated from, or containing steel components. If a product, as delivered to the project, contains both foreign and United States steel, such product is considered to be a United States steel product only if at least 75% of the cost of the articles, materials, and supplies have been mined, produced, or manufactured, as the case may be, in the United States. On Federal-Aid projects, comply with the provisions specified in Section 106.10.

No payment will be made on the contract if unidentified steel products are supplied, until the hereinbefore requirements are met.

Any payments made that should not have been made may be recoverable from a manufacturer or supplier as well as from a contractor or subcontractor.

Any person who willfully violates the Steel Products Procurement Act will be prohibited from submitting bids for any contract for a period of 5 years from the date of determination that a violation has occurred. If a subcontractor, manufacturer or supplier, violates the Steel Products Procurement Act, such person will be prohibited from performing any work or supplying any materials to the Department for a period of 5 years from the date of determination that a violation has occurred.

If steel products are used as a construction tool or appurtenance and will not serve a permanent functional use in the project, compliance with the Steel Products Procurement Act is not required.

When standard manufactured items are specified and these items are identified by unit mass (unit weight), section dimensions, or similar characteristics, their identification will be considered to be nominal masses (weights) or dimensions. Unless more stringently controlled by specified tolerances, industry established manufacturing tolerances will be accepted.

**106.02 MATERIAL—**

**(a) Preliminary Acceptance and Approval.** Have each material and material source of supply listed on Form CS-200 (Source of Supply – Materials) or Form CS-201 (Source of Supply – Traffic Control Devices) and approved before delivery to project. Department Bulletin listed material and material sources are available for use by the Contractor. If non-Bulletin material or material sources are proposed for use, the requirements specified in 106.02(a)2 must be met before these materials are delivered to the project. The Department reserves the right to obtain samples of any material provided by the Contractor for laboratory testing to verify compliance with specifications.

**1. Bulletin Material, Material Application, and Material Source.** Defined as any of the following:

- Any material and material source listed in Bulletin 14 and used in the material application as specified in the Bulletin, Publication 408, or a Special Provision.
- Any material and material source listed in Bulletin 15 and used in the material application as specified in the Bulletin, Publication 408, or a Special Provision.
- Any asphalt material and material application specified in Publication 408 and produced at a source listed in Bulletin 41.
- Any cement concrete material and material application specified in Publication 408 and produced at a source listed in Bulletin 42.

Submit a CS-200 or CS-201 to the Representative with the following information: contract item number, item description, material description/type/class, product name, manufacturer/producer plant location, applicable Bulletin supplier code, Bulletin number, and Publication 408 or Bulletin Section.

If a previously submitted Bulletin material source no longer provides the specified material, submit a change in material to the Representative as outlined on Form CS-200 or CS-201. Once written acceptance is received, furnish material from another Bulletin material source listed in Bulletin 14, 15, 41, or 42.

**2. Non-Bulletin Material, Material Application, or Material Source.** Defined as any of the following:

- Any material, product, or material source not listed in Bulletin 14 or Bulletin 15.
- Any material, product, or material source listed in Bulletin 14 or Bulletin 15 being used in an application not intended or specified in the Bulletin, Publication 408, or a Special Provision.
- Any asphalt material or product not produced at a source listed in Bulletin 41.
- Any asphalt material or product not specified in Publication 408 or a Special Provision.
- Any ready-mixed, cement concrete material or product not produced at a source listed in Bulletin 42.
- Any ready-mixed, cement concrete material or product not specified in Publication 408 or a Special Provision.

**2.a. Construction-Aid Material.** A necessary, temporary, or ancillary material that is not specified for use as part of a contract item or extra work item, but used by the Contractor only to aid in the completion of the work. The material is typically not a permanent part of the specified work (example: wood and nails for temporary formwork). The material need not be listed on Form CS-200 and does not require any Department approval for delivery to or use on the project. The Representative reserves the right to determine whether a material is a construction-aid material. Note temporary traffic control items are not construction-aid materials and do need listed on Form CS-201 since these items must be from Bulletin 15 listed sources and are specified for use as part of contract items or extra work items.

**2.b. Project-Specific, LTS Approved Material.** Non-Bulletin material proposed for use on a particular project as part of a contract item or extra work item, which requires approval by the LTS. Use of material is not meant to circumvent the use of available material sources listed in Bulletin 14, 15, 41, or 42. Have each material and material source listed on Form CS-200 or Form CS-201. The material is defined as any material, product, or material source that meets one or more of the following criteria:

- Meets specified requirements in Publication 408 or Special Provision, for the material and material application.
- Meets specified requirements in AASHTO or ASTM Standard for the material and material application.
- Meets specified requirements in project Special Provision for the material and material application.

Submit material to the LTS for evaluation and testing a minimum of 90 days before planned delivery to the project. Submit the following information to the LTS, with a copy to the Representative: source, description, specified use, QC Plan, independent lab test data showing material meets all specified requirements as determined on a single lot of material, and material samples of the kind and quality specified. Do not deliver material to the project until written acceptance is received from the Representative.

**2.c. Project-Specific, Locally Approved Material.** Non-Bulletin material proposed for use on a particular project as part of a contract item or extra work item, which does not require LTS approval because of the low risk to constructed Project performance, but does require local approval by the Representative (i.e. at the District or project level). This category of material is not meant to circumvent the use of available material sources listed in the Bulletins, or the requirements of Project-Specific, LTS Approved Materials. These materials must meet specification requirements and will be clearly identified in the specification as only needing local approval by the Representative. Have each material and material source listed on Form CS-200 or Form CS-201. Submit for local approval by the Representative all required information for the material, as indicated in the specification.

Examples of locally approved materials are project specific items, such as Section 860 (inlet filter bags), Section 867 (compost filter socks), and Section 868 (compost blanket and compost filter berms) where the specification indicates that these materials are to be locally approved. Bulletin 15 will reference specific Publication 408 Sections that apply to Locally Approved Materials. Bulletin 15 will not list actual materials or material sources for this category of materials as they will be accepted for use on a project-specific basis by local approval.

**(b) Inspection.** Inspect material delivered to the project and stockpile the material passing inspection for use. Do not incorporate questionable material, until material is tested by LTS and accepted in writing by the Representative. The Department reserves the right to reject questionable material delivered to the project when the LTS test results are not according to the specifications. Furnish assistance to the Inspector, as required to obtain samples.

Allow designated Department representatives to inspect material being used, or intended to be used, at any time before, during, or after material preparation, while being used during the progress of the work, or after the work has been completed. Furnish or arrange with producers or manufacturers to provide necessary material, labor, tools, and equipment for such inspection.

Inspections and tests, if made at any point other than the point of incorporation in the work, will not guarantee acceptance of the material. Inspection and testing performed by the Department will not relieve the Contractor's responsibility for QC.

## 106.03 TESTS AND ACCEPTANCE OF MATERIAL—

### (a) Restricted Performance Specifications.

**1. Responsibility.** The Department will be responsible for determining the acceptability of the material and construction. Material will be reviewed for acceptance through the Department's specified acceptance procedures. Sample locations for acceptance testing will be determined by the Department.

Perform sampling and testing for acceptance in the presence of the Inspector, unless otherwise specified. Lot size will be specified. In the event that operational conditions cause work to be interrupted before the specified lot size has been achieved, the lot may be redefined by the Inspector. It is the intent of these specifications that each lot be evaluated based on the same number of samples. Transport acceptance samples from sampling point to testing site or other designated location in the presence of the Inspector.

The Contractor is responsible for the control and quality of the material and construction.

Prepare a QC Plan as specified in Section 106.03(a)2.a and submit it to the Inspector-In-Charge for review at the start of the project. Include QC sampling and testing frequencies and action points to initiate corrective measures. Notify the Inspector before performing QC sampling and testing. Perform QC sampling and testing and report results to the Inspector.

Obtain and test samples according to the Department's PTMs. If the required test method is not specified, use methods described in the AASHTO Standard Specifications for Transportation Materials and Methods of Sampling and Testing, and Supplements, Standards and/or Tentatives of ASTM, or other testing procedures adopted by the Department.

Verification sampling and testing will be performed by the District, unless otherwise specified.

QA sampling and testing will be performed or witnessed by the BOPD.

Independent Assurance sampling and testing will be administered by the CQAS.

**2. QC.**

**2.a** Maintain a QC system that provides reasonable assurance that materials, products, and completed construction, submitted for acceptance, conform to contract requirements whether self-manufactured, processed, or procured from subcontractors or vendors. When specified, submit for review, a plan of the QC system to be used. Have performed or perform the inspections and tests required to substantiate product conformance to contract requirements. Make the inspection and test results available for review throughout the contract life. Procedures will be subject to the review of the Department before the work is started. Charts and records documenting QC inspections and tests are the property of the Department. Submit a QC Plan for use in compliance with the following guidelines, as a minimum:

**2.a.1 Raw Materials.** List the source of material along with methods of documentation and testing performed to assure the material quality.

**2.a.2 Production Control.** List lot size and samples required; include sample selection, labeling and test procedure; also include manufacturing phase.

**2.a.3 Product Testing.** List type and frequency of tests to be performed, along with method of documenting and reporting test results. List test equipment and calibration procedure (frequency) required. List procedure for retesting or rejecting items failing the tests. List the disposal methods and location for test samples and rejected lots.

**2.a.4 Personnel.** List the personnel in charge of QC and define their areas of responsibility.

**2.a.5 Packaging and Shipping.** List method of identifying, storing, loading, transporting, and unloading to assure safe delivery of acceptable material and products.

**2.a.6 Documentation.** List the procedures used for documentation and certification.

The QC Plan and process are subject to periodic review and inspection by the Department.

**2.b** Promptly record conforming and non-conforming inspection and test results on acceptable forms or charts. Keep these records complete and keep them available for inspection at all times during the performance of the work.

**2.c** Promptly correct any errors, equipment malfunctions, process changes, or other assignable causes which have resulted or could result in the submission of material, products, and completed construction not conforming to specification requirements.

**2.d** When required, provide or have provided and maintain measuring and testing devices necessary to ensure that material and products conform to contract requirements. In order to ensure continued accuracy, calibrate these devices at established intervals against Department standards.

**2.e** When required, make the measuring and testing equipment available to the Representative for use in determining conformance of material, products, or completed construction with contract requirements. In addition, make personnel available for the operation of such devices and for verification of the accuracy and condition of the devices. Have calibration results available at all times. The Department reserves the right to conduct periodic inspections of the measuring and testing devices to confirm both calibration and condition of operation.

**2.f** Failure to comply with the QC Plan may result in suspension of approval to provide material for Department use and/or removal from the approved list of material suppliers in the applicable bulletins.

**3. Acceptance Plans.**

**3.a Percent Within Limits.** The percentage of each lot within the specified limits will be determined by the following procedures:

**3.a.1** The "n" sampling positions on the lot will be located by use of the table of random numbers found in PTM No. 1.

**3.a.2** A measurement will be made at each location, or a test portion taken and the measurement made on the test portion.

**3.a.3** The lot ( X ) measurements are averaged to find $\overline{X}$.

$$\overline{X} = \sum_{i=1}^{n} \frac{X_i}{n}$$

**3.a.4** The Standard Deviation, "s," of the lot measurements will be determined as follows:

$$s = \sqrt{\sum_{i=1}^{n} \frac{(X_i - \overline{X})^2}{n - 1}}$$

**3.a.5** The Quality Index ($Q_U$) is found by subtracting the average (X) of the measurements from the upper specification limit (U) and dividing the result by "s."

$$Q_u = \frac{(u - \overline{X})}{s}$$

**3.a.6** The Quality Index ($Q_L$) is found by subtracting the lower specification limit (L) from the average and dividing the result by "s."

$$Q_L = \frac{(\overline{X} - L)}{s}$$

**3.a.7** The percentage of material that will fall within the upper limit (U) is estimated by entering Table A or Table B with $Q_U$, using the column appropriate to the total number of measurements (n). Use Table A if $Q_U$ has a negative value, or use Table B if $Q_U$ has a positive value.

**3.a.8** The percentage of material that will fall within the lower limit (L) is estimated by entering Table A or Table B with $Q_L$, using the column appropriate to the total number of measurements (n). Use Table A if $Q_L$ has a negative value, or use Table B if $Q_L$ has a positive value.

**3.a.9** In cases where both upper (U) and lower (L) limits are concerned, the percentage of material that will fall within limits is found by adding the percent ($P_U$) within the upper limit (U) to the percent ($P_L$) within the lower limit (L) and subtracting 100 from the sum.

Total percent within limits = ($P_U$ + $P_L$ ) - 100

**3.a.10** When determining the percentage within limits when the calculated Quality Index (Q.I.) value is between two tabular values in Table A or Table B, the following procedure is used:

- The difference between the tabular Q.I. values on either side of the calculated value Q.I. value will be determined.

- The difference will be divided by 2 and the quotient added to the lower tabular Q.I. value, resulting in the interpolated Q.I. value.

- If the calculated Q.I. is equal to or greater than the interpolated value, the higher listed percent within limits will be used.

- If the calculated Q.I. is less than interpolated value, the lower listed percent within the limits will be used.

**TABLE A**
**Estimating Percent of Lot Within Limits**
**(Standard Deviation Method)**
**Negative Values of $Q_U$ or $Q_L$**

| Percent Within Limits | n=3 | n=4 | n=5 | n=6 | n=7 |
|---|---|---|---|---|---|
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 49 | 0.0361 | 0.0300 | 0.0281 | 0.0272 | 0.0267 |
| 48 | 0.0722 | 0.0600 | 0.0562 | 0.0545 | 0.0535 |
| 47 | 0.1083 | 0.0900 | 0.0843 | 0.0818 | 0.0802 |
| 46 | 0.1444 | 0.1200 | 0.1124 | 0.1091 | 0.1070 |
| 45 | 0.1806 | 0.1500 | 0.1406 | 0.1364 | 0.1338 |
| 44 | 0.2158 | 0.1800 | 0.1689 | 0.1639 | 0.1608 |
| 43 | 0.2510 | 0.2100 | 0.1972 | 0.1914 | 0.1878 |
| 42 | 0.2863 | 0.2400 | 0.2256 | 0.2189 | 0.2148 |
| 41 | 0.3215 | 0.2700 | 0.2539 | 0.2464 | 0.2418 |
| 40 | 0.3568 | 0.3000 | 0.2823 | 0.2740 | 0.2689 |
| 39 | 0.3912 | 0.3300 | 0.3106 | 0.3018 | 0.2966 |
| 38 | 0.4252 | 0.3600 | 0.3392 | 0.3295 | 0.3238 |
| 37 | 0.4587 | 0.3900 | 0.3678 | 0.3577 | 0.3515 |
| 36 | 0.4917 | 0.4200 | 0.3968 | 0.3859 | 0.3791 |
| 35 | 0.5242 | 0.4500 | 0.4254 | 0.4140 | 0.4073 |
| 34 | 0.5564 | 0.4800 | 0.4544 | 0.4426 | 0.4354 |
| 33 | 0.5878 | 0.5101 | 0.4837 | 0.4712 | 0.4639 |
| 32 | 0.6187 | 0.5401 | 0.5131 | 0.5002 | 0.4925 |
| 31 | 0.6490 | 0.5701 | 0.5424 | 0.5292 | 0.5211 |
| 30 | 0.6788 | 0.6001 | 0.5717 | 0.5586 | 0.5506 |
| 29 | 0.7076 | 0.6301 | 0.6018 | 0.5880 | 0.5846 |
| 28 | 0.7360 | 0.6601 | 0.6315 | 0.6178 | 0.6095 |
| 27 | 0.7635 | 0.6901 | 0.6619 | 0.6480 | 0.6395 |
| 26 | 0.7905 | 0.7201 | 0.6919 | 0.6782 | 0.6703 |
| 25 | 0.8164 | 0.7501 | 0.7227 | 0.7093 | 0.7011 |
| 24 | 0.8416 | 0.7801 | 0.7535 | 0.7403 | 0.7320 |
| 23 | 0.8661 | 0.8101 | 0.7846 | 0.7717 | 0.7642 |
| 22 | 0.8896 | 0.8401 | 0.8161 | 0.8040 | 0.7964 |
| 21 | 0.9122 | 0.8701 | 0.8479 | 0.8363 | 0.8290 |
| 20 | 0.9342 | 0.9001 | 0.8798 | 0.8693 | 0.8626 |
| 19 | 0.9555 | 0.9301 | 0.9123 | 0.9028 | 0.8966 |
| 18 | 0.9748 | 0.9601 | 0.9453 | 0.9367 | 0.9315 |
| 17 | 0.9940 | 0.9901 | 0.9782 | 0.9718 | 0.9673 |
| 16 | 1.0118 | 1.0201 | 1.0125 | 1.0073 | 1.0032 |

**TABLE A (continued)**
**Estimating Percent of Lot Within Limits**
**(Standard Deviation Method)**
**Negative Values of $Q_U$ or $Q_L$**

| Percent Within Limits | n=3 | n=4 | n=5 | n=6 | n=7 |
|---|---|---|---|---|---|
| 15 | 1.0286 | 1.0501 | 1.0469 | 1.0437 | 1.0413 |
| 14 | 1.0446 | 1.0801 | 1.0819 | 1.0813 | 1.0798 |
| 13 | 1.0597 | 1.1101 | 1.1174 | 1.1196 | 1.1202 |
| 12 | 1.0732 | 1.1401 | 1.1538 | 1.1592 | 1.1615 |
| 11 | 1.0864 | 1.1701 | 1.1911 | 1.2001 | 1.2045 |
| 10 | 1.0977 | 1.2001 | 1.2293 | 1.2421 | 1.2494 |
| 9 | 1.1087 | 1.2301 | 1.2683 | 1.2866 | 1.2966 |
| 8 | 1.1170 | 1.2601 | 1.3091 | 1.3328 | 1.3465 |
| 7 | 1.1263 | 1.2901 | 1.3510 | 1.3813 | 1.3990 |
| 6 | 1.1330 | 1.3201 | 1.3946 | 1.4332 | 1.4562 |
| 5 | 1.1367 | 1.3501 | 1.4408 | 1.4892 | 1.5184 |
| 4 | 1.1402 | 1.3801 | 1.4898 | 1.5500 | 1.5868 |
| 3 | 1.1439 | 1.4101 | 1.5428 | 1.6190 | 1.6662 |
| 2 | 1.1476 | 1.4401 | 1.6018 | 1.6990 | 1.7615 |
| 1 | 1.1510 | 1.4701 | 1.6719 | 1.8016 | 1.8893 |

**TABLE B**
**Estimating Percent of Lot Within Limits**
**(Standard Deviation Method)**
**Positive Values of $Q_U$ or $Q_L$**

| Percent Within Limits | n=3 | n=4 | n=5 | n=6 | n=7 |
|---|---|---|---|---|---|
| 99 | 1.1510 | 1.4701 | 1.6719 | 1.8016 | 1.8893 |
| 98 | 1.1476 | 1.4401 | 1.6018 | 1.6990 | 1.7615 |
| 97 | 1.1439 | 1.4101 | 1.5428 | 1.6190 | 1.6662 |
| 96 | 1.1402 | 1.3801 | 1.4898 | 1.5500 | 1.5868 |
| 95 | 1.1367 | 1.3501 | 1.4408 | 1.4892 | 1.5184 |
| 94 | 1.1330 | 1.3201 | 1.3946 | 1.4332 | 1.4562 |
| 93 | 1.1263 | 1.2901 | 1.3510 | 1.3813 | 1.3990 |
| 92 | 1.1170 | 1.2601 | 1.3091 | 1.3328 | 1.3465 |
| 91 | 1.1087 | 1.2301 | 1.2683 | 1.2866 | 1.2966 |
| 90 | 1.0977 | 1.2001 | 1.2293 | 1.2421 | 1.2494 |
| 89 | 1.0864 | 1.1701 | 1.1911 | 1.2001 | 1.2045 |
| 88 | 1.0732 | 1.1401 | 1.1538 | 1.1592 | 1.1615 |
| 87 | 1.0596 | 1.1101 | 1.1174 | 1.1196 | 1.1202 |
| 86 | 1.0446 | 1.0801 | 1.0819 | 1.0813 | 1.0798 |
| 85 | 1.0286 | 1.0501 | 1.0469 | 1.0437 | 1.0413 |
| 84 | 1.0118 | 1.0201 | 1.0125 | 1.0073 | 1.0032 |
| 83 | 0.9940 | 0.9901 | 0.9782 | 0.9718 | 0.9673 |
| 82 | 0.9748 | 0.9601 | 0.9453 | 0.9367 | 0.9315 |
| 81 | 0.9550 | 0.9301 | 0.9123 | 0.9028 | 0.8966 |
| 80 | 0.9342 | 0.9001 | 0.8798 | 0.8693 | 0.8626 |
| 79 | 0.9122 | 0.8701 | 0.8479 | 0.8363 | 0.8290 |
| 78 | 0.8896 | 0.8401 | 0.8161 | 0.8040 | 0.7964 |
| 77 | 0.8661 | 0.8101 | 0.7846 | 0.7717 | 0.7642 |
| 76 | 0.8416 | 0.7801 | 0.7535 | 0.7403 | 0.7320 |
| 75 | 0.8164 | 0.7501 | 0.7227 | 0.7093 | 0.7011 |
| 74 | 0.7905 | 0.7201 | 0.6919 | 0.6782 | 0.6703 |
| 73 | 0.7635 | 0.6901 | 0.6619 | 0.6480 | 0.6395 |
| 72 | 0.7360 | 0.6601 | 0.6315 | 0.6178 | 0.6095 |
| 71 | 0.7076 | 0.6301 | 0.6018 | 0.5880 | 0.5846 |
| 70 | 0.6788 | 0.6001 | 0.5717 | 0.5586 | 0.5506 |
| 69 | 0.6490 | 0.5701 | 0.5424 | 0.5292 | 0.5211 |
| 68 | 0.6187 | 0.5401 | 0.5131 | 0.5002 | 0.4925 |
| 67 | 0.5878 | 0.5101 | 0.4837 | 0.4712 | 0.4639 |
| 66 | 0.5564 | 0.4800 | 0.4544 | 0.4426 | 0.4354 |
| 65 | 0.5242 | 0.4500 | 0.4254 | 0.4140 | 0.4073 |

**TABLE B (continued)**
**Estimating Percent of Lot Within Limits**
**(Standard Deviation Method)**
**Positive Values of $Q_U$ or $Q_L$**

| Percent Within Limits | n=3 | n=4 | n=5 | n=6 | n=7 |
|---|---|---|---|---|---|
| 64 | 0.4917 | 0.4200 | 0.3968 | 0.3859 | 0.3791 |
| 63 | 0.4587 | 0.3900 | 0.3678 | 0.3577 | 0.3515 |
| 62 | 0.4252 | 0.3600 | 0.3392 | 0.3295 | 0.3238 |
| 61 | 0.3912 | 0.3300 | 0.3106 | 0.3018 | 0.2966 |
| 60 | 0.3568 | 0.3000 | 0.2823 | 0.2740 | 0.2689 |
| 59 | 0.3215 | 0.2700 | 0.2539 | 0.2464 | 0.2418 |
| 58 | 0.2863 | 0.2400 | 0.2256 | 0.2189 | 0.2148 |
| 57 | 0.2510 | 0.2100 | 0.1972 | 0.1914 | 0.1878 |
| 56 | 0.2158 | 0.1800 | 0.1689 | 0.1639 | 0.1608 |
| 55 | 0.1806 | 0.1500 | 0.1406 | 0.1364 | 0.1338 |
| 54 | 0.1444 | 0.1200 | 0.1124 | 0.1091 | 0.1070 |
| 53 | 0.1083 | 0.0900 | 0.0843 | 0.0818 | 0.0802 |
| 52 | 0.0722 | 0.0600 | 0.0562 | 0.0545 | 0.0535 |
| 51 | 0.0361 | 0.0300 | 0.0281 | 0.0272 | 0.0267 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

**3.b Resampling of Lot.** It is the intent of these specifications that lots will meet specification requirements at the time of submission. If permitted, nonconforming lots that can be corrected may be reworked and sampled.

**3.c General Basis of Adjusted Payment.** The related adjusted percentage of contract price will be determined by the method designated in the appropriate specification section.

**(b) Specifications, Other than Restricted Performance.**

**1. Responsibility.** The Department will be responsible for determining the acceptability of the material and construction. Material will be reviewed for acceptance through the Department's specified acceptance procedures. Sample locations for acceptance testing will be determined by the Department.

Perform sampling and testing for acceptance in the presence of the Inspector, unless otherwise specified. Transport acceptance samples from sampling point to testing site or other designated location in the presence of the Inspector.

The Contractor is responsible for the control and quality of the material and construction.

Prepare a QC Plan as specified in Section 106.03(a)2.a and submit it to the Inspector-In-Charge for review at the start of the project. Include QC sampling and testing frequencies and action points to initiate corrective measures. Notify the Inspector before performing QC sampling and testing. Perform QC sampling and testing and report results to the Inspector.

Do not incorporate any material into the work that is determined to be outside the specification limits.

Obtain and test samples according to the Department's PTMs. If the required test method is not specified, use methods described in the AASHTO Standard Specifications for Transportation Materials and Methods of Sampling and Testing, and Supplements, Standards and/or Tentatives of ASTM, or other testing procedures adopted by the Department.

Verification sampling and testing will be performed by the District, unless otherwise specified.

QA sampling and testing will be performed or witnessed by the BOPD.

Independent Assurance sampling and testing will be administered by the CQAS.

**2. QC.** Section 106.03(a)2. and as follows:

Provide a plan of the QC system to be used for all construction work requiring acceptance testing by the Department, including QC test frequencies and action points to initiate corrective measures. Submit a copy of the QC Plan to the Project Engineer, to be maintained at the Department's project field office, before the start of work. A QC Plan is not required for items specified in Section 901.

**3. Compliance Certification of Bulletin Materials.** The Contractor is responsible for the control and quality of all materials, both Bulletin and non-Bulletin materials, arriving at the project. Each Bulletin material must be certified to be from a Bulletin source and to be in compliance with the specification requirements for the material. A properly completed and submitted Form CS-4171, Certificate of Compliance, is the means for certification of Bulletin materials. Bulletin materials are defined in Section 106.02(a)1.

The Department reserves the right to sample and test any material for verification that specification requirements are met. Materials of questionable quality delivered to the project will be sampled, tested, and approved by LTS before incorporation in any work. Materials on a reduced certification level may be required to be sampled, tested, and approved by LTS before incorporation in any work. Random field verification samples of the material may be taken by the Representative at the material source, from delivered project material, or at the place of the last manufacturer, fabricator, or producer before delivery. Random QA samples may also be taken by the Representative from delivered project material, at the place of supply, or at the place of the last manufacturer, fabricator, or producer before delivery. The random samples will be sent to the LTS for testing.

**3.a Form CS-4171 Completion.** Form CS-4171 is completed by the manufacturer, fabricator, or producer (Producer) of Bulletin material provided to the project. The Producer maintains the original Form CS-4171 and provides a copy of Form CS-4171 with each direct shipment to the project.

When a Producer sells a Bulletin 15 material to a distributor/supplier (shipper), the Producer provides a copy of Form CS-4171 with each delivery to the shipper. When a shipper provides Bulletin 15 material directly to the project, the shipper completes and signs a new Form CS-4171 and provides a copy with each direct shipment to the project. The shipper will maintain the copy of the Producer's Form CS-4171that they have received.

Form CS-4171 must be properly signed by a legally responsible company official.

**3.b Form CS-4171 Submission for Project Shipments.** Ensure that Form CS-4171 is received for each project shipment of Bulletin material. Submit to the Representative a properly completed and signed copy of Form CS-4171 for each project shipment. Do not incorporate any Bulletin material in the work until certification arrives on the project, unless otherwise approved by the Representative. Payment for material will be withheld until proper certification documentation is received.

Form CS-4171 may be submitted to the Department either in hard copy format or electronically. Contractors who wish to submit certification documentation to a project electronically, e.g. via e-mail, facsimile or through a PennDOT Project Collaboration Site, must notify the Department at the preconstruction meeting.

**3.c Supplemental or Alternate Certification.** Certain Bulletin materials require the submission of supplemental CS-4171 certification in addition to Form CS-4171, to provide traceability of materials in multi-step manufacturing processes.

- Epoxy coated or galvanized reinforcement steel requires the submission of supplemental certification Form CS-4171C (Epoxy Coating or Galvanizing Facility) and/or Form CS-4171F (Fabrication Facility).
- Structural steel, aluminum, or precast/prestressed concrete products, produced in a Bulletin 15 approved facility with an on-site Inspector or a Representative, must be stamped with an approved inspection stamp at the plant and certified with a Form CS-4171.
- Steel products containing foreign steel require the submission of supplemental Form CS-4171S.

Certain Bulletin materials require a form of certification other than the Form CS-4171, as identified in the particular material specification.

- Section 701 and Section 702 materials require a properly completed vendor bill of lading.
- Certification of daily asphalt mixtures by submission of Form CS-4171B.

- Certification of locally approved non-Bulletin materials by submission of Form CS-4171LA.

Organize and submit only Forms CS-4171 and supplemental or alternate certifications for material supplied to the project. Submissions containing irrelevant forms or documentation for materials not incorporated into the project will not be accepted.

**3.d CS-4171 Record Retention.** Retain Form CS-4171 and supplemental and alternate certifications as defined in Section 106.03(b)3.c, for a period of not less than 3 years from the date of the last project shipment. Make files available for inspection and verification by the Department.

Notify shippers that a certification file must be maintained for purchased Bulletin materials to provide an audit trail to the Producer. Certifications for purchased Bulletin materials must be maintained at their place of business for a period of not less than 3 years from the date of the last shipment to the project and must be available for inspection by the Department.

Notify Producers that all component certifications for purchased Bulletin materials must be maintained at their place of business for a period of not less than 3 years from the date of the last shipment to the project and must be available for inspection by the Department.

**3.e Levels of Certification for Bulletin 15 Producers**. The BOPD determines the Level of Certification for each Producer based on the Producer's ability to comply with the material specifications. The Levels of Certification are defined in Table C. Bulletin 15 will indicate if a Producer is at a certification level other than Level 1. Material provided by Producers listed in Bulletin 15 is approved for use only in its intended application(s).

**TABLE C**

<table>
<tr><th colspan="2">Levels of Certification for Bulletin 15 Producers</th><th>Producer Material Shipment Procedure</th><th>Producer Additional Requirements</th></tr>
<tr><td>Level 1</td><td>Standard Certification</td><td>Ship on Certification with Form CS-4171*</td><td>None</td></tr>
<tr><td>Level 2</td><td>Standard Certification - Reduced</td><td>Ship on Certification with Form CS-4171*</td><td>See Section 106.03(b)3.e.2</td></tr>
<tr><td>Level 3</td><td>Lot Approval Certification</td><td>Ship only after Material Lot Approval using Modified Certification, with Form CS-4171*</td><td>See Section 106.03(b)3.e.3</td></tr>
<tr><td>Suspension or Removal</td><td colspan="3">According to the State's Contractor Responsibility Program:<br>• Producer may be suspended or removed from Bulletin 15 for any of the reasons stated in the Bulletin 15 Preface, regardless of Producer certification level.<br>• Failure of Producer to advance above Certification Level 3 will result in PennDOT's initiating action for suspension or removal from Bulletin 15.</td></tr>
</table>

* Certain Bulletin materials require supplemental or alternate forms of certification, as specified in Section 106.03(b)3.c.

**3.e.1 LEVEL 1 (Standard Certification).**

- Initial Level of Certification typically issued to Bulletin 15 listed Producers.
- Material is produced and tested in accordance with the Producer's approved QC Plan.
- No known material performance or quality issues exist that warrant a reduced level of certification.
- Material is shipped on certification using Form CS-4171.

**3.e.2 LEVEL 2 (Standard Certification - Reduced).**

- Reduced Level of Certification issued to Bulletin 15 listed Producers who have exhibited minor/moderate material performance or quality issues.

- Producer is required to work with PennDOT on submission of an improvement plan that may include, but is not limited to, any or all of the following items: a revised QC Plan, a failure analysis/action plan to assess why failures are occurring and how to prevent these failures from occurring in the future, correlation testing between in-house and independent lab testing to assist with validating results.
- Material is produced and tested in accordance with the improvement plan approved by PennDOT.
- Material is shipped on certification using Form CS-4171.

**3.e.3 LEVEL 3 (Lot Approval Certification).**

- This Level of Certification is issued to Bulletin 15 listed Producers who have exhibited major material performance or quality issues.
- Producer is required to work with PennDOT on an improvement plan as defined in Level 2.
- Material cannot be shipped to projects using the standard CS-4171 certification process.
- Producer must arrange for independent, in-plant acceptance testing (IPAT) that will be conducted side-by-side with "in-house" Producer testing at the designated frequencies in the revised QC plan. IPAT will be at the Producer's expense. PennDOT's LTS must approve the Producer's proposed IPAT provider, before it begins.
- Any material lot to be used on a project must be tested and approved by the IPAT as meeting the required PennDOT specification prior to shipment to the project.
- Each material lot meeting the specification may be shipped to a project using a modified certification process as follows: submit, to both the Project Representative and LTS, Form CS-4171 along with a signed letter from the IPAT (on their official letterhead) indicating that the material lot meets testing and specification requirements.
- Correlate results from parallel "in-house" Producer testing and IPAT testing, and submit to the LTS on a monthly basis.

**106.04 USE OF MATERIALS FROM WITHIN THE PROJECT**—With written permission, material found in the excavation areas and meeting the Department's specifications may be used in the project construction. Material used will be paid for, as specified in Section 110.01. However, replace any portion removed with suitable material, if required to complete the embankments. The replaced quantity will be 110% of the volume of stone or gravel removed and 100% of the volume of sand and other material removed. Do not use reserved material, as specified in Section 104.06, or as indicated in the proposal.

**106.05 STORAGE OF MATERIAL**—

**(a) General.** Store material to assure preservation of specified quality and fitness for the work.

Stored material, even though accepted before storage, may again be inspected before use in the work. Locate stored material to facilitate prompt inspection and control.

Adhere to the restrictions below for the storage of construction materials with known physical hazards (explosive, flammable, or combustible) or storage of any motorized equipment under any structure with vertical clearance measured:

- Less than 16 feet – No storage is allowed.
- Between 16 feet and 24 feet – Short term operational storage will be allowed provided the materials are stored in an enclosure which meets all ANSI and OSHA requirements for said material(s) and a fire prevention plan has been submitted for the short term operational storage. Short term operational storage is limited to the amount of material and/or equipment required for a 24-hour period.
- Greater than 24 feet – No restriction.

Vertical clearance is measured from the lowest structure member to the ground level below that member.

Do not use private property for storage purposes without written permission of the owner or lessee. Make copies of this permission available to the Department. Restore storage sites to conditions acceptable to property owners and the Department.

**(b) Storage of Aggregates.** Provide a separate stockpile for each aggregate size and type at cement concrete plants. Do not use aggregates that become segregated or mixed with earth or foreign material.

If divided aggregate bins are used for storage or for proportioning, take measures to prevent mixing of aggregates.

Provide an area for storage of aggregates for use in Portland cement concrete and asphalt concrete. Store aggregates on one of the following constructed according to standard practice:

- Asphalt concrete base course, 4 inches minimum depth.
- Class C concrete, or better, 4 inches minimum depth.

**(c) Control of Aggregates.** Have aggregates available for use in cement concrete at the proportioning plant in enough time before batching to allow inspection and testing. Handle the aggregates so they may be field tested and accepted, before storing them with previously accepted aggregates. Batch fine and coarse aggregates separately. Properly control uniformity of moisture and uniformity of gradation. Provide a system of water sprays, then use when required, to maintain coarse aggregate moisture control.

During cool and cold weather concrete production, maintain aggregates required for individual concrete placements, whether stored in proportioning bins or stockpiles, at a temperature of not less than 40F before and during batching operations, for a sufficient length of time to eliminate the presence of frost in or around the aggregate particles.

**(d) Storage of Reinforcement.** Satisfactorily store reinforcement above ground, in a clean and dry condition on a platform, in an orderly manner, plainly marked to facilitate inspection.

## 106.06 HANDLING AND TRANSPORTATION OF MATERIAL—

**(a) General.** Carefully handle material to preserve quality and fitness for the work and to prevent loss, segregation, or inconsistency in quantities after weighing or measuring for incorporation in the work.

**(b) Aggregates.** In dry batching operations, measure aggregates or weigh before placing in the compartments of the vehicle, unless otherwise specified or permitted. Clean the vehicles and provide tight batch partitions at least 4 inches higher than the batched aggregate level being hauled, to prevent any spillage from one compartment to another.

**(c) Bulk Cement.** Bulk cement may be used, as specified in Section 701.

If bulk cement is used, transport to the mixer in acceptable metal, rubber, or plastic, watertight containers or compartments.

**(d) Bag Cement.** If bag cement is used, dump the contents of the correct number of bags required for each batch into the mixer skip. If permitted, bag cement may be transported from storage to the mixer by placing the correct number of bags per batch on the batched aggregate in the aggregate compartments. When transported, the bag cement may be dumped on the aggregate after having been checked by the inspector, and if done not more than 100 feet from the mixer. Bag cement that is allowed to lie on the batched aggregates longer than 2 hours, or cement dumped on the batched aggregate longer than 1 hour, will be rejected.

## 106.07 UNACCEPTABLE MATERIAL—

**(a) Restricted Performance Specifications.**

**1. Acceptance or Rejection.** Following the application of the appropriate acceptance plan, the Representative's decision will be final as to the acceptance, rejection, or acceptance at an adjusted price of sampled lots.

**2. Disposition of Lots.** If permitted, lots not conforming to specifications may be reworked and resubmitted for acceptance sampling. For nonconforming lots that are not adaptable to correction by reworking, remove and replace them, have them accepted without payment, or have them accepted at an adjusted price as stated in the specifications or, if not stated, as directed.

**(b) Specifications, Other than Restricted Performance.** Material not conforming to the requirements of the specifications, whether in place or not, will be rejected. Remove such material promptly from the site of the work, unless otherwise directed. Do not return rejected material to the work site until defects have been corrected and the material has been accepted for use.

**(c) Serviceable Precast or Prestressed Concrete, Fabricated Structural Steel and Aluminum Products.** Plant produced fabricated materials or products having materials substitutions, dimensional deviations, specifications deficiencies, or damage which result in materials or products which may be serviceable but, do not meet all contract requirements will be addressed as follows:

**1. Minor Deficiency or Defect.** For materials or products with one or more minor deficiencies or defects, resolution of the deficiencies or defects will be made directly by the precaster or fabricator with the BDTD's Structural Materials Section. Minor defects and deficiencies are generally defined as those which will not require:

- engineering design review
- revisions to approved installation or erection plans or methods
- anticipated premature maintenance or rehabilitation

The Structural Materials Section may determine that one or more of the minor deficiencies or defects are actually significant deficiencies or non-conformances and require the precaster or fabricator to resolve the deficiency or defect as a significant deficiency or non-conformance as specified in Section 106.07(c)2.

**2. Significant Deficiency or Non-Conformance.** For materials or products having one or more significant deficiencies or non-conformances, which cannot be corrected to meet the contract specifications and which the Department determines may require one or more of the bulleted items listed in Section 106.07(c)1., submit documentation to support acceptance of the material or product (provided by the precaster or fabricator) and a request for Department evaluation and final disposition of the materials or products.

Where visible defects are present, or when otherwise requested, include detailed sketches, drawings, or photographs along with the supporting documentation form the precaster or fabricator to support acceptance of the material or product. Include a detailed repair procedure to correct the deficiency, if applicable.

For requests submitted for acceptance of the material or product "as is", provide supporting justification to demonstrate that the significant deficiency or non-conformance will not result in additional constructability issues during erection or construction or unanticipated premature maintenance work. Obtain approval of any revisions required to the shop drawings to reflect as built conditions prior to shipment.

Submit engineering calculations, when required or requested, to support the acceptability of the significant deficiency or non-conformance, sealed by a registered Professional Engineer that is licensed in the State. Submittals must include a statement by the Engineer that the defect will not compromise either the structural capacity or service life of the original design.

Submit the above to the District Assistant Construction Engineer with copies to the following:

- Chief Structural Materials Engineer, Bridge Design and Technology Division, Bureau of Project Delivery
- District Structural Control Engineer
- District Bridge Engineer
- Chief Bridge Engineer, Bridge Design and Technology Division, Bureau of Project Delivery (when calculations are required or requested).

Include the following minimum information on a cover page, attached to the submission:

- ECMS or other contract identification including State Route, Section and County
- Structure Number, if applicable
- Specific identification of the affected unit(s), i.e. girder-beam-culvert number, etc.
- Anticipated shipping date
- Detailed sketches, drawings or photographs of the defect, if visible or when requested.

After evaluation, the disposition of the material or product, including any conditions of acceptance, will be provided by the Chief Structural Materials Engineer from information provided by the Engineering District. Replace materials or products which are rejected via this policy with those complying with the contract specifications and requirements.

**106.08 DEPARTMENT FURNISHED MATERIAL**—The Department will furnish material, if specified in the proposal, in the quantities required. Material will be delivered or made available at the point specified.

The cost of handling and placing material after delivery will be included in the contract price for the item.

After delivery and acceptance by the Contractor, the cost of replacing material due to shortages, deficiencies, or damage, including demurrage charges, will be deducted from money due or to become due.

**106.09 PENNSYLVANIA TRADE PRACTICES ACT**—This section does not apply to projects which are partially or totally financed with Federal funds.

**(a) General.** Pursuant to the PA Trade Practices Act, Act 226-1968, the Department will not specify, purchase, or permit to be furnished or used in any contract aluminum or steel products as set forth below made in the countries set forth below.

The Department may utilize the discretionary waiver provision of Act 3-1978 as to steel products. As to aluminum products, if the sole source is from a banned country relief may be permitted under the Statutory Construction Act, 1 PA C.S. 1901 et seq.

**1. Brazil.** Welded carbon steel pipes and tubes; carbon steel wire rod; tool steel; certain stainless steel products including hot-rolled stainless steel bar; stainless steel wire rod and cold-formed stainless steel bar; pre-stressed concrete steel wire strand; hot-rolled carbon steel plate in coil; hot-rolled carbon steel sheet; and cold-rolled carbon steel sheet.

**2. Spain.** Certain stainless steel products, including stainless steel wire rod, hot-rolled stainless steel bars, and cold-formed stainless steel bars; pre-stressed concrete steel wire strand; certain steel products, including hot-rolled steel plate, cold-rolled carbon steel plate, carbon steel structural shapes, galvanized carbon steel sheet, hot-rolled carbon steel bars; and cold-formed carbon steel bars.

**3. South Korea.** Welded carbon steel pipes and tubes; hot-rolled carbon steel plate; hot-rolled carbon steel sheet; and galvanized steel sheet.

**4. Argentina.** Carbon steel wire rod and cold-rolled carbon steel sheet.

**106.10 BUY AMERICA PROVISIONS AND CONVICT PRODUCED MATERIALS**—This section only applies to projects partially or totally financed with Federal funds.

**(a) Buy America Provisions.** Furnish steel or iron materials, including coating for permanently incorporated work according to 23 CFR 635.410 and as follows:

- Pig iron and processed, pelletized, and reduced iron ore manufactured outside of the United States is acceptable for use in domestic manufacturing process for steel and/or iron materials.

- All manufacturing processes of steel or iron materials in a product, including coating; and any subsequent process that alters the steel or iron material's physical form or shape, or changes its chemical composition; are to occur within the United States. This includes rolling, extruding, machining, bending, grinding, drilling, and coating. Coating includes all processes that protect or enhance the value of the material, such as epoxy coatings, galvanizing or painting.

- Provide certification to the Inspector-in-Charge, that all manufacturing processes for steel and iron materials in a product, including coating, have occurred in the United States; certify as specified in Section 106.01.

Products manufactured of foreign steel or iron materials may be used, provided the cost of such products as they are delivered to the project does not exceed 0.1% of the total contract amount, or $2,500, whichever is greater.

**(b) Convict Produced Materials.** Pursuant to 23 CFR 635.417, materials produced by convict labor after July 1, 1991 may not be used for Federal-aid highway construction projects, unless produced at a prison facility which had been producing convict-made materials for Federal-Aid construction projects before July 1, 1987.

Material produced by convicts who are on parole, supervised release, or probation from a prison may be incorporated in a Federal-Aid highway construction project.

# SECTION 313—SUPERPAVE ASPHALT MIXTURE DESIGN, STANDARD CONSTRUCTION, BASE COURSE

**313.1 DESCRIPTION—**This work is the standard construction of a plant-mixed asphalt base course on a prepared surface using a volumetric mixture design developed with the Superpave Gyratory Compactor (SGC) using prescribed manufactured additives, or plant process modifications or both.

**313.2 MATERIAL—**Section 413.2

**313.3 CONSTRUCTION—**Section 413.3 as specified for standard construction and with additions and modifications as follows:

**(b) Weather Limitations.** Section 413.3(b). Replace with the following:
Do not place base course on prepared surfaces that are wet or if the temperature of the air or the prepared surface is 35F or lower. If work is halted because of weather conditions, the Representative may allow the Contractor to place limited quantities of base course that are en route to the project.

**(h) Spreading and Finishing.** Revise as follows:

**1.b Spreading and Finishing.** Add the following:
If the indicated compacted depth of a Superpave 25.0 mm asphalt base course is more than 6 inches, place the asphalt base course in two or more layers of approximately equal compacted depth, with no layer less than 3 inches or more than 6 inches. If the indicated compacted depth of a Superpave 37.5 mm asphalt base course is more than 8 inches, place the asphalt base course in two or more layers of approximately equal compacted depth, with no layer less than 4 inches or more than 8 inches.

**(l) Surface Tolerance.** Replace the requirement for defective pavement with the following:
The pavement is defective if irregularities are more than 1/4-inch.

**(m) Tests for Depth.** Replace with the following:
Control the loose depth of each layer to construct the base course to the compacted depth indicated and within the specified tolerance. On the top lift and in the presence of the Inspector, drill full-depth cores at one random location selected by the Inspector according to PTM No. 1 in each 3,000 square yards of completed base course and at other locations the Inspector suspects are deficient.

The Inspector will measure the depth of the full-depth cores according to PTM No. 737. Pavement deficient in depth by 1/2 inch or more and that cannot be satisfactorily corrected is defective. After the Inspector completes depth measurements, backfill, compact, and seal core holes with the mixture used to construct the course. Immediately start correcting courses or pavement that are deficient in depth at the core location and proceed longitudinally and transversely until the depth is less than ½ inch deficient of the design depth.

**313.4 MEASUREMENT AND PAYMENT—**Section 413.4(a), with modifications as follows:

**(a) Asphalt Mixtures (Standard).** Revise as follows:

**1. Asphalt Courses.** Add the following:

**1.f Superpave Asphalt Mixture Design, Base Course.** Square Yard or Ton

# SECTION 314—SUPERPAVE ASPHALT MIXTURE DESIGN, STANDARD CONSTRUCTION, ASPHALT RICH BASE COURSE

**314.1 DESCRIPTION—**This work is the standard construction of a plant-mixed asphalt rich base course (ARBC) on a prepared surface using a volumetric mixture design developed with the Superpave Gyratory Compactor (SGC) using prescribed manufactured additives, or plant process modifications or both.

**314.2 MATERIAL—**Section 413.2 with the following modifications:

**(c) Recycled Asphalt Material.** Section 413.2(c) with the following modifications and additions:

1. **RAP.** Add the following: Do not exceed 20 percent by weight RAP content in ARBC mixtures.

2. **Manufacturer Waste Recycled Asphalt Shingles (RAS).** Add the following: Do not use RAS material in ARBC mixtures.

**(e) Mixture Composition for Standard and RPS Construction.** Section 413.2(e) with the following modifications and additions:

1. **Virgin Material Mixtures.** Size, uniformly grade, and combine aggregate fractions, asphalt binder, and either WMA Technology additive(s) or modifier(s) in proportions to produce a JMF that conforms to the material, gradation, and volumetric Superpave Asphalt Mixture Design requirements according to Bulletin 27, except as modified in Table A1. Produce an asphalt mixture for the indicated nominal maximum aggregate size (NMAS) and design ESALs except as procedurally modified by the WMA Technology Manufacturer Technical Representative to address laboratory procedures when preparing, compacting and testing asphalt mixtures to achieve a uniform blend. Special additive(s) or modifier(s) need not be used if mixture temperature, workability, and compaction can be achieved solely through plant mechanical modification to produce foamed asphalt. Do not incorporate the WMA Technology additive, modifier or process during the volumetric asphalt mixture design process, so that the JMF volumetrics and material percentages are based on a mixture with no WMA Technology. Only use the WMA Technology additive, modifier or process to evaluate results from moisture susceptibility testing during the mix design process. Develop an asphalt mixture JMF, then incorporate the WMA Technology additive, modifier, or process into that JMF during production. Create an asphalt JMF cover sheet (Form TR-448A) for approval containing the WMA Technology used, additive dosage rate or percent water added for foaming, material code, and the TSR data from the moisture susceptibility testing.

   Submit a copy of each completed JMF, signed by a certified Asphalt Level 2 plant technician, to the DME/DMM at least 3 weeks before the planned start of mixture production. Include a list of all material sources and the asphalt mixture producer in the JMF. Provide the calibration factors ($C_f$ and 200 $C_f$) according to PTM No. 757 with the JMF. Do not start mixture production until after the DME/DMM reviews the JMF.

**TABLE 1**
**Mix Design Requirements for Asphalt Rich Base Courses**

| Volumetric Mix Design Property | 25 mm NMAS |
|---|---|
| Design Gyrations ($N_{design}$) for All Ranges of Design ESALs | 50 |
| Design Air Voids ($V_a$) for All Specified Ranges of Design ESALs (Percent) | 2.5 |
| Voids in Mineral Aggregate (VMA) Minimum for All Specified Design ESALs and Production QC Samples (Percent) | 13.0 |

| | |
|---|---|
| Voids Filled with Asphalt (VFA) for All Ranges of Design ESALs (Percent) | 80 – 85 |

**314.3 CONSTRUCTION—**Section 413.3 as specified for standard construction and with additions and modifications as follows:

**(b) Weather Limitations.** Section 413.3(b). Replace with the following:
Do not place ARBC on prepared surfaces that are wet or if the temperature of the air or the prepared surface is 35F or lower. If work is halted because of weather conditions, the Representative may allow the Contractor to place limited quantities of ARBC that are en route to the project.

**(h) Spreading and Finishing.** Revise as follows:

**1.b Spreading and Finishing.** Add the following:
Place the indicated compacted depth of ARBC in one layer not less than 3 inches or more than 6 inches.

**(j) Mat Density acceptance.** Add the following:
Accept ARBC by Optimum-Rolling Pattern as specified in Section 413.3(j)3.

**(l) Surface Tolerance.** Replace the requirement for defective pavement with the following:
The pavement is defective if irregularities are more than 1/4-inch.

**(m) Tests for Depth.** Replace with the following:
Control the loose depth of each layer to construct the ARBC to the compacted depth indicated and within the specified tolerance. In the presence of the Inspector, drill full-depth cores at one random location selected by the Inspector according to PTM No. 1 in each 3,000 square yards of completed ARBC and at other locations the Inspector suspects are deficient.
The Inspector will measure the depth of the full-depth cores according to PTM No. 737. Pavement deficient in depth by 1/2 inch or more and that cannot be satisfactorily corrected is defective. After the Inspector completes depth measurements, backfill, compact, and seal core holes with the mixture used to construct the course. Immediately start correcting courses or pavement that are deficient in depth at the core location and proceed longitudinally and transversely until the depth is less than ½ inch deficient of the design depth.

**314.4 MEASUREMENT AND PAYMENT—**Section 413.4(a), with modifications as follows:

**(a) Asphalt Mixtures (Standard).** Revise as follows:

**1. Asphalt Courses.** Add the following:

**1.f Superpave Asphalt Mixture Design, Asphalt Rich Base Course.** Square Yard or Ton

# SECTION 316—FLEXIBLE BASE REPLACEMENT

**316.1 DESCRIPTION**—This work is replacing the existing pavement with Superpave Asphalt Mixture Design, Base Course.

**316.2 MATERIAL**—

**(a) Subbase.** Section 350.2

**(b) Superpave Asphalt Mixture Design.**

- **Base Course, 25.0 mm Mix.** Section 313.2

**(c) Asphalt Cement, PG 64S-22.** Section 702

**316.3 CONSTRUCTION** As shown on the Standard Drawings, as specified in Section 313 and as follows:
Mark the perimeter of the area to be replaced. Saw cut or mill the perimeter. Remove all material within the saw cut or milled area to the depth indicated. Compact the existing subgrade or subbase before placing the base course material. Clean all vertical surfaces of the area to be patched and coat the vertical faces with a uniform application of PG 64S-22. Place the asphalt base course in a manner that does not cause segregation and to the lift thickness indicated. Compact to the density specified by use of approved compaction equipment as specified in Section 108.05(c).

**316.4 MEASUREMENT AND PAYMENT**—Square Yard or Ton
Saw cutting, excavation, hauling and disposal, asphalt tack coat, asphalt material, and sealing of the joints are considered as incidental.

# SECTION 344—FULL DEPTH RECLAMATION

**344.1 DESCRIPTION—**This work consists of in-place pulverizing and mixing a combination of existing roadway material layers, stabilizing additives, and imported aggregate or RAP material, as required, to specified depths and grading, and compacting the mixed materials to form a new pavement base layer upon which an asphalt overlay, or a surface treatment is applied. This work is defined as full-depth reclamation (FDR), and often includes the incorporation of additional materials based on an approved FDR mix design.

**344.2 MATERIAL—**

**(a) Reclaimed Material from Existing Roadway.** Pulverize and mix existing roadway material layers, which may include bound pavement layers, aggregate subbase material, and subgrade material, such that 95% of the material passes the 2-inch sieve.

**(b) Aggregate.**

**1. General.** Provide fine or coarse aggregate from approved aggregate producers listed in Bulletin 14 or provide reclaimed aggregate material (RAM) meeting the specified size (e.g., AASHTO No. 57) as required by the approved mix design.

**2. Fine Aggregate.** Section 703.1, Type A or B.

**3. Coarse Aggregate.** Section 703.2, Type A, B, or C.

**(c) Reclaimed Asphalt Pavement (RAP) Material from Other Roadways or Projects.** Provide processed RAP material with 95% passing the 2-inch sieve.

**(d) Stabilizing Additives.** Provide one or more of the stabilizing additive materials listed below as included in the approved mix design. Potential additives are not limited to the materials listed below. Those listed below include references to sections with additional information.

**1. Emulsified Asphalt Material.**

**1.a Emulsified Asphalt Material**. Section 702, Class CMS-2, SS-1h, CSS-1h, SS-1hP, HFMS-2 or CSS-1hP.

**2. Chemical.**

**2.a Portland Cement.** Section 701

**2.a.1 Portland Cement Slurry**, Section 701 Portland Cement Slurry must be produced at a concrete plant listed in Bulletin 42 and supplied in Ready Mix Concrete Trucks approved by the DME/DMM. Other slurries must be provided in distributor and tanker trucks equipped with a recirculating pump and/or agitation system to prevent settling of the materials before application.

**2.a.1.a Admixtures**—Section 711.3

**2.b Hydrated Lime.** Section 723

**2.c Supplementary Cementitious Material.** Section 724

**2.d. Lime Pozzolan.** Section 725

**3. Calcium Chloride.** Section 721

**4. Magnesium Chloride**. Use only as permissible on a project approval basis.

**(e) Water.** Section 720.2

**(f) FDR Mix Design.** Select one or more stabilizing additives based on the composition of the existing roadway materials according to Publication 242 Pavement Policy Manual. A formal design protocol should be followed to optimize the performance of the pavement section. After selecting the appropriate stabilizing additive(s), develop a mix design following the appropriate mix design procedures for the stabilizing additive(s) as follows:

**TABLE A**
**Mix Design Procedure for Primary Stabilizing Additive Type**

| **Primary Stabilizing Additive** | **Mix Design Procedure** |
|---|---|
| Asphalt | Pub. 27 (Bulletin 27) |
| Chemical (Portland Cement, Hydrated Lime, Supplementary Cementitious Material**& Portland Cement Slurry) | Pub. 242 Appendix J.3 |
| Calcium Chloride | PTM No. 106 *, Pub. 242 Appendix J.3 |

*When used as the primary stabilizing material, calcium chloride should be applied as a minimum 35% solution at a rate between 0.10 to 0.15 gallons per square yard for each inch of depth reclaimed.
**Calcium oxide is used to activate the cementitious performance of Supplementary Cementitious Material.

Submit the mix design for the FDR work as specified in Section 108.03.

**(g) Emulsified Asphalt Material.** Section 702, Emulsified Asphalt Material, Class AEP, E-1 Prime, or EDP.

**(h) Asphalt Tack Coat.** Section 460.

**(i) Asphalt Fog Seal.** CSS-1h or SS-1h diluted as specified in 472.2, Table A.

**(j) Calcium Chloride.** Section 721.

**344.3 CONSTRUCTION—**Comply with applicable environmental standards. Appropriate equipment and techniques should be used to protect adjacent properties from fugitive dust or other material components of the FDR process. Dry additive will not be applied when the wind conditions are such that blowing additives become objectionable to traffic or adjacent property owners. Manual and/or gravity (tail gate) spreading of the additives is unacceptable.

Stabilization may be accomplished using asphalt material, Portland cement or other chemical stabilization materials, or calcium chloride according to the recommendations of the FDR Best Practices found in Publication 242 and approved in the project mix design.

**(a) Equipment.** Provide the necessary equipment to pulverize reclaimed material to a maximum particle size of 2 inches in the greatest dimension, blend, shape, and compact the FDR materials.

**1. Reclaimer.** Provide a self-propelled, traveling rotary reclaimer or equivalent machine capable of cutting through existing roadway to depths of up to 16 inches, or as required by the design, with one pass. The equipment must also be capable of pulverizing "in-place" the existing pavement, subbase, and subgrade materials, at a minimum width of 8 feet, and mixing any added materials to the specified depth. The cutting drum must have the ability to operate at various speeds (rpm), independent of the machine's forward speed, to control oversized material and gradation.

Use a machine equipped with a computerized integral liquid proportioning system capable of regulating and monitoring the water application rate relative to depth of cut, width of cut, and speed. Connect the water pump on the machine to the water supply tanker or distributor by a hose, and mechanically or electronically interlock the flow of water with the forward ground speed of the machine. Mount the spray bar to allow the water to be injected directly into the cutting drum/mixing chamber. Provide equipment capable of mixing water, dry or liquid stabilizing additives, emulsion, and the pulverized pavement into a homogenous mixture. Keep the cutting drum fully maintained and in good condition at all times throughout the project. Equipment such as road planers or cold-milling machines designed to mill or shred the existing roadway rather than crush or fracture them is not allowed.

**1.a** Use equipment capable of automatically metering liquids in the mixture and ensure thorough mixing of the reclaimed materials. Use equipment that is also able to record the volumes metered.

**1.b** Maintain equipment as specified in Section 108.05(c).

**2. Placement Equipment.** Use a motor grader or another method approved by the Representative.

**3. Compaction Equipment.** Provide suitable compaction equipment as follows. Use a 25-ton (or greater) pneumatic tire roller for breakdown and intermediate rolling if the FDR is emulsion or foamed asphalt based and is less than 8 inches in depth. Use a 25-ton vibratory padfoot roller for initial breakdown if FDR is 8 inches or deeper. Perform finish rolling using a single or tandem steel drum static roller of 12 to 14 tons.

**(b) Weather Limitations.** Do not place FDR materials when air temperature falls, or is anticipated to fall, below 40F within the subsequent required 7-day cure period. Do not perform reclamation in rain, or if rain is anticipated within 2 hours of completion of the work. Cement slurry with accelerating admixtures may be used in periods of cooler temperatures with the written approval of the DME/DMM. Do not place cement slurry mixtures with accelerating admixtures when the air temperature is anticipated to fall below 35F within the first 24 hours following placement.

**(c) Quality Control.** Provide a QC Plan for the FDR work a minimum of 2 weeks before the start of work. Identify the equipment, personnel, and processes to be used during the work. Ensure that all equipment is operational and functional before deployment to the job site. All equipment must be properly calibrated before application. This calibration should be verified through the test strip. Operators of water and additive applicators must keep proper records of the amount of material applied and the times of application. Describe means of establishing and controlling centerline, proposed crown and any existing or proposed superelevations.

**(d) Test Strip.** Before starting full production work, construct a 300-foot test strip demonstrating the FDR process including final compaction and shaping. Verify application rates for materials incorporated into the FDR process including stabilization materials and water. Identify and correct aspects of the work not conforming to the contract requirements before proceeding with full production work. If aspects of the work are not found to be adequately controlled to produce the desired mixed and refinished reclaimed roadway, construct additional test strips until the necessary control is established. After completing the test strip and demonstrating that the minimum density can be achieved as specified in 344.3(e)3.a, determine n=1 density of the FDR according to PTM No. 402 for each 3,000 square yard lot.

**(e) Reclamation.**

**1. Pulverization.** Before the application of stabilizing additives, pulverize the roadway to the size and depth specified. Shape the pulverized material to the approximate line and grade. Adding Calcium Chloride during pulverization is acceptable.

**2. Mixing.** Combine the FDR material, aggregates (if necessary), RAP (if necessary), stabilizing additive(s), and water according to the mix design and at the mix design recommended moisture content. Maintain adequate liquids in the mixture to ensure thorough mixing of the reclaimed material, aggregates, RAP, and stabilizing additives. If conditions change, make field adjustments to obtain a satisfactory FDR material.

If slurries are used, use Ready Mix Concrete Trucks or equip the distributor and tanker trucks with a re-circulating pump and/or agitation system to prevent settling of the materials before application.

If using slurry delivered in Ready Mix Concrete Trucks, verify “cement” application rate by calculating the weight of cement contained in the mixer truck and the area covered by the slurry after discharge by the Ready Mix Concrete Truck. The cement slurry producer shall supply a written record of the amount of cement, water, and admixture with each load of cement slurry. Evenly and uniformly distribute the cement slurry, over the area of the prepared subgrade, calculated to provide the required application rate. Accelerating or retarding admixtures maybe added to the cement slurry with the written approval of the DME/DMM.

**3. Compaction.** Compact the FDR material to a minimum density of at least 95% of the laboratory compacted maximum density at optimum moisture content according to PTM No. 106. Demonstrate that the minimum specified density can be achieved during paving of the compaction control strip. After completing the compaction control strip, and establish the roller pattern as specified in Section 344.3(e)3.a , determine n=1 density according to PTM No. 402 for each 3,000-square yard lot.

Commence rolling at the low side of the course. Leave 3 to 6 inches from any unsupported edge(s) unrolled initially to prevent distortion. Compact the entire reclaimed area using the number of uniform passes of compaction equipment determined from the control strip, ensuring that uniform density is achieved throughout.

Complete compaction of chemically stabilized reclaimed material within 4 hours of the water/additive mixing operation.

**3.a Compaction Control Strip**. Establish a roller pattern that achieves at a minimum the density specified in Section 344.3(e)3 by the construction of at least one 300-foot long control strip during initial reclamation. The compaction control strip may be contained within the project startup test strip. Take nuclear density reading tests according to PTM No. 402 after each pass of the compaction equipment. The properly calibrated nuclear gauge must be operated in direct transmission mode. Continue compaction with each piece of equipment until no appreciable increase in density is obtained by additional passes. Upon completion of compaction, make a minimum of ten tests at random locations according to PTM No. 1 to determine the average in-place density of the compaction control strip. Provide density results to the Representative for verification to the minimum density requirements as specified in Section 344.3(e)3.

If the density of the compaction control strip is less than the minimum density specified in Section 344.3(e)3, but the base course is uniform in texture, stable, and otherwise acceptable, provide additional compaction. If additional compaction does not achieve the minimum density, construct another compaction control strip to verify that the minimum density is achievable with the FDR process and mix design in use. Take a minimum of ten tests at random locations according to PTM No. 1 to determine the average in place density of the new compaction control strip. The minimum density for the new control strip is 98% of the control strip density.

**3.b Moisture Content.** Verify the original moisture content of the road material to be reclaimed before starting work. The moisture content can be determined according to ASTM D 2216, ASTM D 44643, or AASHTO T 265. Make appropriate adjustment between the moisture content determined at the time of mix design sampling and current moisture content by adjusting the design recommended water application rate.

The moisture content for compaction must achieve the optimum moisture content as determined from the project mix design but cannot exceed optimum by more than 3%.

**4. Finishing.** Shape the FDR material surface not to exceed 1 1/2-inch irregularity of the existing centerline, grades and/or cross-slope of the proposed roadway. Avoid excessively working the chemically stabilized FDR material, which may detrimentally affect the ultimate strength of the stabilized layer.

**5. Cure.** Cure the FDR material until the 7-day strength requirement is met. Do not allow heavy traffic on the reclaimed material during the 7-day cure period. Appropriate traffic signs must be posted to prevent heavy traffic on the constructed base until completion of base curing and application of the overlay.

For chemical stabilization, maintain the reclaimed layer in a damp condition by the daily application of water to the surface, or the application of an emulsified asphalt prime material followed by an asphalt fog seal at a residual asphalt rate between 0.02 and 0.10 gallons per square yard, or Tack Coat as specified in Section 460. Apply while FDR material is at optimum moisture content, but not exceeding more than 3%.

The rate of curing depends on many factors. In favorable weather conditions (no rain, sunshine, low humidity, high temperature), curing can take place at a considerably faster rate. Sufficient curing and strength gain could take from 2 or 3 days to at least 2 weeks depending on the type and amount of materials used and the climatic conditions.

FDR should be proof rolled with a vehicle similar to the heaviest vehicle expected in traffic, or base opening on a strength measurement of the FDR, before opening to traffic. Same day return to car traffic at posted safe speeds is possible. In general, the constructed base could be opened to light traffic (vehicles under 5 tons) 2 hours after completion of the base construction, with proof rolling. For emulsified asphalt stabilized roadways, the moisture content should be at 50% of the design optimum moisture content or 3% total moisture content, whichever is reached first, before overlay. No damage should be apparent at slow speed, less than 10 miles per hour. Immediately correct the damage. Otherwise verify strength by testing as covered under 344.3(g).

**6. Surface Tolerance.** Test the completed stabilized base for smoothness and accuracy of grade, both transversely and longitudinally. Satisfactorily correct any 3,000-square yard lot where the average surface irregularity exceeds 1/2 inch under a 10-foot template or straightedge, based on a minimum of at least three measurements within the lot.

Provide a minimum final surface cross slope of 1/4-inch per foot, or as otherwise required by the project design.

**(f) Maintenance and Protection of Traffic (MPT).** Relocate traffic using approved traffic control devices and procedures as specified in Section 901. Provide MPT until the road can be opened to traffic as specified in Section 344.3(h).

**(g) Acceptance.** Acceptance will be based on each 3,000-square yard lot complying with requirements for surface tolerance as specified in Section 344.3(e)6, for density as specified in Section 344.3(e)3, and strength as follows.

Any lot failing to meet the acceptance criteria will be identified for rework. Cores may be taken to determine the extent of the failing area. Once a failed area has been identified, develop and obtain approval of a new mix design. Failed areas must be reclaimed again with the additional stabilizing material, as necessary, to achieve the required acceptance criteria. Fill core holes remaining outside the reworked area with an approved repair material listed in Bulletin 15.

Make a minimum of three standard Proctor samples according to ASTM D1633 for strength testing for each lot size of 3,000 square yards. Wrap the specimens in plastic wrap, seal in an airtight, moisture proof bag and cure the test specimens for a period of 7 days. Follow PTM No. 1 for selecting sample locations from the reclaimed material after addition of the stabilizing additive. For emulsion based mixes or mixes stabilized with foamed asphalt, an accepted alternative approach will be compaction of specimens with the Superpave Gyratory Compactor (SGC) to a thickness between 2 and 3 inches using 50 gyrations.

**1. Asphalt Stabilized FDR.** Achieve a minimum indirect tensile strength of 50 pounds per square inch when tested according to Bulletin 27. This requirement is for specimens compacted in the SGC to a thickness between 2 and 3 inches.

**2. Chemical Stabilized FDR.** Achieve an unconfined compressive strength of 300 to 500 pounds per square inch in 7 days when tested according to ASTM D1633 for the roads to be surfaced with less than a 3-inch overlay or asphalt surface treatment. Achieve an unconfined compressive strength value of 280 to 500 pounds per square inch in 7 days for roads to be surfaced with an asphalt overlay of 3 inches or greater. For emulsion based mixes as well as mixes stabilized with foamed asphalt, the minimum compressive strength requirement will be 280 pounds per square inch. If the average of the specimens does not meet the minimum required strength listed above, rework will be required. Chemically stabilized material tested to strengths greater than 900 pounds per square inch may result in shrinkage cracking, and rework will be required.

**(h) Opening to Traffic**. Do not open the road to unlimited traffic until the specified 7-day strength has been achieved. Limited local light vehicular traffic may be allowed once the reclaimed material has obtained a stable condition. Repair damage resulting from local traffic. Do not allow trucks to use the road until the above referenced 7-day strength has been achieved.

## 344.4 MEASUREMENT AND PAYMENT—

**(a) Full Depth Reclamation, Excluding Additive.** Square Yard.

**1. Additional pay items depending on stabilization method.**

**1.a Chemical Additive.** Gallon or Ton.

**1.b Emulsified Asphalt Material.** Gallon.

**1.c Calcium Chloride Additive.** Gallon.

**1.d Magnesium Chloride Additive.** Gallon.

**(b) Asphalt Tack Coat.** Section 460.4.

**(c) Asphalt Fog Seal.** Section 472.4.

# SECTION 360—ASPHALT TREATED PERMEABLE BASE COURSE

**360.1 DESCRIPTION**—This work is the construction of an asphalt treated permeable base course (ATPBC) on a prepared surface. When placed on subgrade, it includes the preparation of subgrade as specified in Section 210.

**360.2 MATERIAL**—

**(a) Asphalt Material.** Asphalt Cement, Class PG 64S-22, as specified in Section 702.

**(b) Coarse Aggregate.** Type A, Section 703.2. When using crushed gravel, provide a minimum of 75% crushed particles with at least three faces resulting from fracture.

**(c) Fine Aggregate.** Type A or Type B, Section 703.1.

**(d) Additives.**

**1. Hydrated Lime.** Before adding the asphalt cement, add hydrated lime to the aggregate to reduce stripping potential.

Furnish hydrated lime conforming to ASTM C 1097 and add the lime as follows:

- Add at least 1% hydrated lime by weight of the total dry aggregate.
- Provide a separate bin or tank and feeder system to store and accurately proportion the lime, in dry form, into the aggregate.
- Provide a convenient and accurate means of calibrating the proportioning device.
- Interlock the proportioning device with the aggregate feed or weight system.
- Mix the lime and aggregate to uniformly coat the aggregate with lime.
- Furnish aggregate containing at least 3% free moisture.
- Do not stockpile lime treated aggregate.
- Control the feeder system by a proportioning device accurate to within 10% of the specified amount.
- Provide a flow indicator or sensor and interlock with the plant controls such that production is interrupted if there is a stoppage of the lime feed.
- Before production, obtain approval of the method to introduce and mix the lime and aggregate.

**2. Heat-Stable, Anti-Stripping Additive.** The Contractor may use an anti-stripping additive other than hydrated lime. Blend the additive with the asphalt cement before adding the additive and asphalt cement to the mixture. Use the manufacturer's recommended dosage of the additive, but not less than 0.25% by weight of the asphalt. Select an additive that does not harm the completed asphalt concrete mixture and that is compatible with the aggregate and asphalt supplied for the project.

**(e) Mixture Design and Production.**

**1. Design.** Size, uniformly grade, and combine aggregate fractions according to Table A below. Marshall test requirements do not apply. Design a JMF with an initial target asphalt content of 2.5% by weight. If necessary, adjust the asphalt content within the range specified in Table A below to uniformly coat the aggregate and ensure the aggregate has no observable runoff of excess asphalt.

Test materials, proportions, and the mixture at the asphalt concrete plant laboratory. Verify conformance with the uniformity requirements specified in this Section. When required, the Department will perform the tests at the LTS. Provide a JMF that conforms to all Department requirements. Submit a copy of the JMF to the DME/DMM at least 3 weeks before the scheduled start of producing the mixture for the project. If the Department has not used the JMF on previous projects, provide test results from previous mixture production that show the mixture conformed to all JMF production tolerances.

**2. QC Plan.** Prepare and submit a QC Plan, as specified in Section 106, at the start of the project and at least annually thereafter. Do not start ATPBC production until after the Representative reviews the QC Plan.

**3. Production.** During the first day of production, take at least three asphalt content and gradation tests to verify the mixture conforms to the JMF. After the first day, perform tests for asphalt content and aggregate gradation according to the QC Plan and PTM No. 1. Produce ATPBC conforming to the gradation requirements in Table A and with a asphalt content within 0.8% of the JMF (n=1). Ensure the aggregate is uniformly coated with asphalt and no runoff of excess asphalt is observed.

**4. Acceptance of the Mixture.** Obtain material certification from the material producer using the results of QC tests for asphalt content and gradation. Provide the certification to the Inspector-in-Charge within 1 working day after taking QC tests.

**TABLE A**
**Composition of Mixture**
**(Total Percent by Mass (Weight) Passing Square Openings Based on Laboratory Sieve Tests)**

| Sieve Size | Percent Passing |
|---|---|
| 37.5 mm (1 1/2-inch) | 100 |
| 25.0 mm (1-inch) | 95 – 100 |
| 12.5 mm (1/2-inch) | 35 - 65 |
| 4.75 mm (No. 4) | 12 – 24 |
| 1.18 mm (No. 16) | 6 - 16 |
| 75 µm (No. 200) | 0 – 5 |
| | |
| Asphalt Content | 2.0% - 3.0%* |

* For approved gravel and slag mixtures, the Representative may allow the Contractor to exceed the upper limit.

**360.3 CONSTRUCTION**— Section 413.3, with modifications as follows:

**(b) Weather Limitations.** Replace with the following:
Do not place ATPBC on surfaces that are unstable, frozen, or below a temperature of 35F. Do not place ATPBC when the air temperature is below 35F or during rain. If work is halted because of weather conditions, the Representative may allow the Contractor to place limited quantities of ATPBC that are en-route to the project.

**(c) Asphalt Mixing Plant.** Add the following:

**3. Plant Requirements.** The Contractor is not required to provide equipment for developing the design and control test.

**4. Preparation of Mixture.** Before mixing, dry the aggregate as necessary. Heat the asphalt material so that combining with aggregate produces a completed mixture. Coat the aggregate with the asphalt material to form a film of adequate thickness to provide the required binding properties. Produce ATPBC at a temperature below 320F that also provides suitable viscosity for adequate coating of aggregate particles, and that does not cause segregation of asphalt and aggregate during transportation.

Do not stockpile ATPBC. The ATPBC must be placed within 8 hours from when it is made.

**(f) Rollers.** Replace with the following:
Use steel-wheel power rollers with a manufacturer's certified metal weight of 8 tons to 10 tons.

**(h) Spreading and Finishing.** Replace with the following:
Use a slip form paver, as specified in Section 413.3(e), or a mechanical spreader. Spread and strike off the mixture for the entire lane width or as much lane as practical. Place the mixture in maximum 4-inch compacted lifts. Adjust screed assemblies to provide the cross section and depth indicated. Construct the profile to the design grade line. Use fully automated sensors to control profile and transverse grade. Allow the mixture to cool to 100F before placing subsequent layers or pavement courses. Perform handwork at locations directed by the Representative.

**(i) Compaction.** Replace with the following:
Perform rolling as soon as the mat has cooled sufficiently to avoid shoving or lateral movement of the ATPBC. Seat ATPBC using an 8 ton to 10 ton, steel-wheeled roller, or vibratory roller operated in the static mode only. Compact ATPBC by applying four roller passes. One roller pass is defined as one trip of the roller in one direction over any one spot. Additional passes are allowed only to eliminate any surface irregularities, or creases. Do not compact the material to the point that it is not free draining or the aggregate is crushed.

**(j) Mat Density Acceptance.** Delete this section.

**(k) Joints.** Replace with the following

**1. Longitudinal Joints.** Spread the ATPBC to overlap the edge of the lane previously placed by 1 inch to 2 inches. Maintain the uniform uncompacted depth adjacent to a compacted lane necessary to provide a smooth joint after compaction.

**2. Transverse Joints.** At the end of each day's work and when more than a 30 minute interruption occurs in ATPBC paving operations, install a temporary vertical bulkhead to form a straight transverse construction joint. The joint shall be the full depth and width of the ATPBC. Instead of a temporary bulkhead, the Contractor may saw construction joints.

**(l) Surface Tolerance.** Replace the requirements for correcting irregularities with the following:
Test the finished surface at locations the Representative suspects are irregular and at transverse joints and paving notches. Test the surface in stages using a 10-foot straightedge. At each stage, hold the straightedge in contact with the surface and parallel to the road centerline and, in successive positions, test the pavement surface from one side to the other. Advance the test location to the next stage by moving the straightedge along the pavement centerline by not more than 5 feet.

Correct irregularities of more than 1/2 inch by loosening surface mixture and removing or adding ATPBC. For irregularities that develop after compaction is completed, correct the irregularity by a method that does not produce contaminating fines or damage the base. Do not grind or mill the ATPBC. The area is defective if irregularities or defects remain after final compaction.

**(m) Tests for Depth: Binder and Wearing Courses.** Replace with the following:
Carefully dig or drill one 6-inch diameter test hole to the full depth of the ATPBC for each 3,000 square yards, or less, of completed base course. The Representative may require additional test holes in areas the Representative suspects are deficient in depth. The Representative will measure the depth of the base course. Using material acceptable to the Representative, backfill the test holes and compact the material to fill the test hole flush with the completed base course.

Remove and replace sections deficient in depth by 1/2 inch or more. Start correction at the point of determined deficiency and continue correction longitudinally and transversely until the depth is within 1/2 inch of the indicated depth.

**(n) Protection of Courses.** Replace with the following:

Section 105.13 and as follows: Traffic is not permitted on the asphalt treated permeable base material, except for trucks and equipment required to place the next layer. Replace areas damaged or contaminated, as directed and at no cost to the Department. If necessary, re-compact the ATPBC before starting subsequent paving.

Protect the surface from damage before and during the concrete paving process.

**(o) Defective Work.** Replace with the following:

Unless otherwise directed in writing by the District Executive, remove and replace ATPBC deficient in surface tolerance, deficient in depth, defective in asphalt content, or excessive in percent passing the 75 µm (No. 200 sieve). The ATPBC is defective in asphalt content if production tolerances are exceeded, percent of coated aggregate particles is less than 95%, or the mixture contains observable runoff of excess asphalt.

With written permission from the District Executive, the Contractor may fill low areas during construction of the next pavement course.

Acceptance testing and QA testing does not relieve the Contractor of responsibility for defective material or work.

**360.4 MEASUREMENT AND PAYMENT—**Square Yard or Ton

# SECTION 400
# FLEXIBLE PAVEMENTS

## SECTION 404—EVALUATION OF ASPHALT PAVEMENT RIDE QUALITY AND PAYMENT OF INCENTIVE

**404.1 DESCRIPTION—**This work evaluates an asphalt pavement surface profile and determines the ride-quality incentive associated with the pavement surface profile.

**(a) General Requirements**. Determine the ride quality of finished pavement surfaces, including overlaid bridge approach slabs and overlaid bridge decks. At least two of the following construction operations must be indicated in areas included in ride-quality lot measurements:

- Profile milling as specified in Section 492.
- Asphalt Base course.
- Asphalt Scratch course.
- Asphalt Leveling course.
- Asphalt Binder course.
- Asphalt Wearing course.

In the presence of the Inspector, measure the pavement surface profile according to PTM No. 428. Provide daily calibration results to the Representative before taking any measurements. Provide the raw unfiltered data files and a summary printout of the resultant International Roughness Index (IRI) data and Mean Roughness Index (MRI) values to the Representative within 24 hours of taking measurements. The Representative will determine payment for each ride-quality lot based on the MRI.

Measure the pavement surface of the following excluded areas separate from the pavement surface profile of ride-quality lots. The Representative will not include measurements from excluded areas to determine lot incentive payment;

- Pavement surfaces not constructed as a full-depth overlay, as indicated, such as the vertical transition areas at the limits of paving and at the approaches to bridges.
- Bridge decks unless overlaid.
- Ramps less than 1,500 feet in length.
- Tapered pavements.
- Shoulders, medians, and other pavement surfaces indicated.
- Pavement from 5 feet before and up to 5 feet after any appurtenances such as water boxes, manholes, railroad tracks, and inlets extending out into the pavement.
- Partial lots less than 100 feet
- Roadways with a posted speed limit of 40 miles per hour or lower.

**(b) Lot Size.** A full lot is 528 feet of a single pavement lane. The Representative will designate lots starting at the beginning limit of paving and continuing to the ending limit of paving for each pavement lane and ramp that is 12 feet or wider. Do not include the length of excluded areas in the 528 feet.

The Representative will designate a partial lot at the ending limit of paving and at an excluded area, when the lot length is less than 528 feet. The Representative will evaluate a partial lot as a percentage of a full lot.

**404.3 CONSTRUCTION—**

**(a) Equipment and Operator.** Provide pavement surface profile measuring equipment that has been verified by the Department according to PTM No. 428. In the presence of the Inspector, calibrate the distance sensor and check the profile system calibration before each day's testing.

Provide an operator that is Department certified according to PTM No. 428. The operator must carry a valid PennDOT certification card during pavement surface profiling.

**(b) Testing.**

**1. Lots.** Provide the traffic control and station marking necessary to accommodate testing. Remove objects and equipment from the surface and sweep the surface as necessary to remove debris. For projects identified for verification as specified in Section 404.3(f), identify and delineate the profiling limits and excluded areas on the day of the verification. The Representative will verify the profiling limits are correct. Use traffic cones with reflective tape and reflective tape on the pavement at the beginning and end of each lane and excluded areas for triggering the start and stop locations of the profiler. In the presence of the Inspector, determine the pavement surface profile for each lot according to PTM No. 428. At the completion of testing, immediately submit the lot IRI data and MRI values, according to PTM No. 428, to the Representative.

**2. Excluded Areas.** Provide the traffic control necessary to accommodate testing. Test the entire surface of each excluded area in stages using a 12-foot straightedge. At each stage, hold the straightedge in contact with the surface and parallel to the roadway centerline and, in successive positions, test the pavement surface profile from one side of the excluded area to the other. Advance the test location to the next stage by moving the straightedge along the roadway centerline not more than 5 feet.

**(c) Acceptance.**

**1. Lots.** The Representative will compare the lot MRI to Table A in Section 404.4 to determine if the lot requires corrective action. Additionally, perform corrective action on any individual bump that requires grinding and where the irregularity is more than 3/16 inch when tested with a 12-foot straightedge.

**2. Excluded Areas.** Perform corrective action where irregularities are more than 3/16 inch when tested with a 12-foot straightedge. To improve the ride quality and at the Department's expense, the Representative may require grinding of excluded areas that conform to the acceptable straightedge surface tolerances specified in Section 404.3(c).

**(d) Corrective Action.** Do not produce a deviation, such as a ridge or valley with the adjacent pavement, of more than 3 mm (1/8 inch) when measured on the transverse profile. Correct a sufficient length of pavement to correct the pavement surface profile without producing additional high or low points. Retest the lots and excluded areas after completing corrective action. Perform additional measurements of the pavement surface profile, as necessary, for the Representative to determine which lots do not require additional corrective action. Correct surfaces to provide a uniform texture and positive cross slope so the pavement drains.

Perform all corrective action before testing for pavement depth. Use one or more of the following methods:

**1. Carbide Grinding.** Use carbide grinding for correcting areas 15 feet in length or less. Use grinders of the walk-behind type that have cutting heads of carbide tipped shackles, stars, or blades and have a locking depth control to produce a uniform pavement surface texture.

Provide a pavement surface texture consisting of parallel grooves between 3/32 inch and 1/4 inch wide with a "land area" between grooves of 1/16 inch and 3/16 inch. Operate the grinder by making multiple passes, if necessary, with a maximum depth of any single pass of 1/8 inch. Grind longitudinally or transversely across the pavement surface.

**2. Diamond Grinding.** Section 514.3 and modified as follows:

**(d) Tolerance.** Delete this section.

Unless otherwise approved, grind the entire lane width.

**3. Removal and Replacement.** Remove the surface course of the entire pavement lane width by milling and replace at least the minimum layer depth of the specified surface course. Place more than the minimum layer depth if necessary to correct the pavement surface profile.

**(e) Defective Work.** A ride-quality pavement lot is defective if:

- The MRI of the lot exceeds the maximum acceptable MRI as specified in Table A of Section 404.4.
- Any individual bump (must grind) exists in the lot where the irregularity is more than 3/16 inch when tested with a 12-foot straightedge.
- The surface adjacent to another ride-quality lot contains a ridge or valley of more than 1/8 inch.
- The specifications for pavement construction require removal and replacement of pavement within the ride-quality lot.

Unless the Department and Contractor agree to leave a defective lot in place as specified in Section 404.4, remove and replace defective areas and retest the ride-quality lot.

**(f) Verification.** For Federally funded projects, the Department will perform smoothness verification testing at a minimum of one day and on at least 10% of the project's lane miles being evaluated using the Department's inertial lightweight profiler concurrent with smoothness acceptance testing. The Department may require smoothness verification testing for any smoothness acceptance testing.

Coordinate with the Representative at least 14 days in advance to arrange for Department profiler testing and to schedule a virtual meeting with the Department's Roadway Inventory and Testing Unit (RITU) to verify the smoothness verification testing procedures.

Ensure the Department's smoothness verification testing occurs concurrently with smoothness acceptance testing. The smoothness acceptance test results will be compared to the Department's smoothness verification test results. The smoothness acceptance test results will be used for incentive payment when the following tolerances are met:

- The verification MRI does not exceed the acceptance MRI by more than 6.1 inches/mile on at least 90 percent of the 528 feet lots for each lane.
- The average verification MRI does not exceed the average acceptance MRI by more than 6.1 inches/mile for all lots tested in each lane.
- The difference in the length for all lots tested in each lane is less than 0.2 percent.

If the tolerances above are not met during smoothness verification testing, the Department will immediately review the testing procedures, equipment, and personnel used in the smoothness acceptance testing to determine if the test results are acceptable. When the Contractor's smoothness acceptance test results are not considered acceptable, the Department's smoothness verification test results will be used for incentive payment, and the Contractor's profiler certification will be suspended and must be recertified pursuant to PTM No. 428. Contact the RITU within 10 business days to schedule the profiler for recertification. Recertify the profiler before use on all Department projects.

**404.4 MEASUREMENT AND PAYMENT—**Dollar

The proposal will include an item and a predetermined amount of money for Evaluation of Asphalt Pavement Ride Quality and Payment of Incentive. The contract item will have a unit of measure of DOLLAR, a unit price of $1.00, and a quantity equal to the predetermined amount.

Due to the incentive or bonus status of the payment being made, the provisions of Section 110.02(d) are not applicable to this item.

Measured and paid for, under the Evaluation of Asphalt Pavement Ride Quality and Payment of Incentive item as follows:

- If the lot is not defective, Table A and the MRI for each lot will be used to determine the incentive payment for ride quality.
- The incentive payment for a lot subjected to corrective action will be determined according to Table A and the MRI for the lot after the Contractor completes corrective action.
- The incentive payment for a partial lot will be determined as a percentage of a full lot.
- After corrective action, the Contractor may leave a defective lot in place if the District Executive provides written approval and the Contractor accepts a $4,000 downward adjustment (rebate) of the amount paid for the lot.
- Costs associated with evaluating pavement ride quality will not be paid for separately.

TABLE A
Payment Schedule for Ride Quality Incentive

| **SCHEDULE A** | |
|---|---|
| **For Expressway Work Using Three Operations** | |
| **MRI inches/mile/lot** | **Amount** |
| ≤ 35 | $600 |
| ≤ 50 | $300 |
| ≤ 60 | $150 |
| ≤ 70 * | $0 |
| > 70 | Corrective action required |
| * Maximum acceptable MRI | |

| **SCHEDULE B** | |
|---|---|
| **For Expressway Work Using Two Operations and Non-Expressway Work Using Two or More Operations** | |
| **MRI inches/mile/lot** | **Amount** |
| ≤ 45 | $600 |
| ≤ 55 | $300 |
| ≤ 70 | $150 |
| ≤ 90 * | $0 |
| > 90 | Corrective action required |
| * Maximum acceptable MRI | |

# SECTION 405—EVALUATION OF ASPHALT PAVEMENT LONGITUDINAL JOINT DENSITY AND PAYMENT OF INCENTIVE/DISINCENTIVE

**405.1 DESCRIPTION—**This work is evaluating asphalt pavement longitudinal joint samples on the surface wearing course for determining densities and the incentive/disincentive.

**405.3 CONSTRUCTION—**

**(a) General Requirements**. Longitudinal joint density lots will be established as specified in Section 405.3(b). These incentive/disincentive lots are completely independent from lots defined in other sections of these Specifications for pavement acceptance. The Representative will determine the payment addition or deduction.

**(b) Lot Size.** A full lot is 12,500 feet of longitudinal joint and will consist of five sublots of 2,500 feet. The Representative will designate lots as the longitudinal joints on the project are constructed, beginning on the first day wearing course paving abuts a previously placed wearing course, forming a longitudinal joint. Joints constructed with tandem pavers will be included, unless otherwise indicated. As paving progresses and longitudinal joints are constructed, drill one core per sublot until a full lot is obtained as specified in Section 405.3(e). Do not include the length of excluded joints in the 12,500 feet lot. A single lot need not be contiguous and may include multiple joints throughout the project limits.

Partial lots with less than three sublots will be combined with the previous lot. Partial lots with three or more sublots will stand as a separate lot.

**(c) Quality Control Strip.** On the first day paving abuts a previously placed mat, forming a longitudinal joint eligible for evaluation, determine the effectiveness of the material placement and compaction operations as well as the mixture design on longitudinal joint density. In addition to any incentive/disincentive payment sublot cores, obtain five 6-inch diameter core samples located randomly on the longitudinal joint for QC density testing. Test the cores according to PTM No. 715 or PTM No. 716 and provide the results of the tests to the Representative within 24 hours. The Contractor may elect to make adjustments to the mixture design or placement and compaction operations to ensure adequate in place density is being achieved. If proposing changes that impact the field quality control plan or job mix formula, submit any modifications or revisions to the Department for review.

**(d) Excluded Areas.** The following joint areas are to be excluded from the longitudinal joint lots. The Representative will not obtain samples from excluded areas to determine lot incentive/disincentive payment.

- Joints where one or both sides of the pavements forming the joint were accepted for density by means other than pavement cores
- Joints where one side of the joint is formed by existing pavement not constructed under this contract
- Areas within 1 foot longitudinally of an obstruction during construction of the wearing course (manholes, inlet grates, utilities, bridge structures, pavement notches, etc.)
- Small areas, such as intersections, gore areas or transitions, or anywhere the Representative determines paving and phasing methods do not allow for consistent longitudinal joint construction. Prior to paving, submit requests in writing to the Representative for consideration of any areas to be excluded on this basis. The Representative will make the final determination.

**(e) Sampling.** The Representative will select one location in each sublot according to PTM No. 1 and PTM No. 729. The Contractor may take one companion core per sublot for quality control purposes. For vertical joints center joint cores on the line where the joint between the two adjacent lifts abut at the surface. For notched wedge joints, center joint cores 6-inches or one half the joint taper width away from the joint line in the direction of the wedge. With the Representative present, drill 6-inch diameter cores as soon as possible, but no later than the day following the construction of the longitudinal joint at each sublot location. Do not compress, bend, or distort samples during cutting, handling, transporting, and storing. If samples are damaged, immediately obtain replacement samples, as directed by the Representative, from within 12 inches of the original sample location. Within 24 hours after coring, backfill the hole(s) with mixture of the same JMF or with mixture used for subsequent courses and compact and seal the mixture.

Identify the samples by longitudinal joint lot and sublot number, location, dates of placement, mixture type, and as acceptance samples (Sample Class AS). Provide the daily theoretical maximum specific gravity value as specified in Section 413.2(e)1.d.4 for the mix on each side of the longitudinal joint. The average of the two values will be used for the density calculation of each sublot according to PTM No. 729. Immediately package and deliver the samples to the Representative according to the QC Plan. Use sample containers of sufficient strength to prevent samples from being damaged during transport.

Each joint core will be comprised of portions of two lanes, with the potential for two different JMFs within each core. The Representative will submit separate samples and Forms TR-447 for sublots after work stoppages of more than 5 days.

The LTS will test the density samples according to PTM No. 715, and if necessary PTM No. 716, to determine the percent compaction.

**(f) Percent Within Limits (PWL).** Once all test results for a lot have been received, the Representative will compute the PWL and average in place density for each lot as specified in Section 106.03(a)3.a and as follows. The lower specification limit (L) will be 91.0 %. No upper specification limit (U) for density will be factored into the PWL determination.

## 405.4 MEASUREMENT AND PAYMENT—Dollar

The proposal will include an item and a predetermined amount of money for Evaluation of Asphalt Pavement Longitudinal Joint Density and Payment of Incentive/Disincentive. The Contract item will have a unit of measure of DOLLAR, a unit price of $1.00, and a quantity equal to the predetermined amount. When asphalt pavement longitudinal joint density evaluation indicates that a disincentive adjustment is applicable, the appropriate amount will be deducted from money due or to become due to the Contractor through the processing of a contract adjustment.

Due to the incentive or bonus status of the payment being made the provisions of Section 110.02(d) are not applicable to this item.

Measured and paid for, under the Evaluation of Asphalt Pavement Longitudinal Joints and Payment of Incentive item as follows:

For each lot Table A will be used to determine the incentive/disincentive payment for longitudinal joint density.

The incentive/disincentive payment for a lot containing other than 5 sublots will be determined as a percentage of a full 12,500 feet lot, by the following:

N=3 (60% of the Table A amount)
N=4 (80% of the Table A amount)
N=6 (120% of the Table A amount)
N=7 (140% of the Table A amount)

For a full lot with a PWL $\geq$ 81, the Contractor will receive a prorated positive incentive payment up to a maximum of $7,500 calculated according to Table A.

For a full lot with a PWL $\leq$ 49, the Contractor will receive a prorated negative adjustment (disincentive) up to a maximum of $12,500 for the longitudinal joint lot calculated according to Table A. Lots with PWL $\leq$ 49 and average density $\geq$ 90.0 % will be assessed a disincentive up to a maximum of $1,000 per sublot regardless of PWL.

Costs associated with providing joint pavement cores will not be paid for separately and will be considered incidental to the construction items for the wearing courses eligible for the longitudinal joint evaluation.

**TABLE A**

| Lot by Lot Payment Schedule for Longitudinal Joint Incentive/Disincentive | |
|---|---|
| **Lot PWL** | **Amount** |
| PWL $\geq$ 81 | (PWL -80)/20 x $7,500<br>(Incentive) |
| PWL = 50 to 80 | $0 |
| PWL $\leq$ 49 | (50-PWL)/50 x -$12,500<br>(Disincentive) |

# SECTION 410 – SUPERPAVE MIXTURE DESIGN, STANDARD AND RPS CONSTRUCTION OF PLANT-MIXED ASPHALT FINE-GRADED COURSES

**410.1 DESCRIPTION—**This work is the standard and RPS construction of a plant-mixed asphalt wearing course on a prepared surface using a volumetric mixture design developed with the Superpave Gyratory Compactor and modified to be a fine-graded (FG) mixture.

**410.2 MATERIALS—**Section 413.2 using the procedure and volumetric tolerances for the 9.5 mm nominal maximum aggregate size mixture and modified as follows:

**(e) Mixture Composition for Standard and RPS Construction.**

**1. Virgin Material Mixtures.** Submit a JMF meeting all of Bulletin 27 requirements for a 9.5 mm nominal maximum aggregate size mixture, except the JMF must have a minimum percent passing the No. 8 sieve of 47% and a maximum percent passing the No. 8 sieve of 67%.

**410.3 CONSTRUCTION**—Section 413.3 using the test procedures, limits and tolerances for a 9.5 mm nominal maximum aggregate size mixture except where procedures, limits and tolerances are specifically indicated for a 9.5 mm fine-graded nominal maximum aggregate size mixture and as modified as follows:

Revise Table G to include 9.5 mm Fine Grade Wearing Course as follows:

**TABLE G**
**Mixture Minimum Compacted Depths**

| Mixture | Minimum Depth |
|---|---|
| 9.5 mm Fine Grade Wearing Course | 1 in. |

**410.4 MEASUREMENT AND PAYMENT**—Square Yard or Ton

Paid as specified in Section 413.4 for a 9.5 mm Wearing Course.

# SECTION 412—SUPERPAVE MIXTURE DESIGN, CONSTRUCTION OF PLANT-MIXED 6.3 MM THIN ASPHALT OVERLAY COURSES

**412.1 DESCRIPTION—**This work is the construction of a thin lift wearing course of plant-mixed, dense-graded asphalt concrete with 6.3 mm Nominal Maximum Aggregate Size (NMAS), placed on a prepared surface.

**412.2 MATERIALS—**Section 413.2 with additions and modifications as follows:

**(a) Asphalt Material.**

**1. Virgin Mix.** Furnish PG 64E-22, conforming to the requirements of Standard Specifications for Performance-Graded Asphalt Binder Using Multiple Stress Creep Recovery (MSCR) Test, AASHTO M 332, except as revised in Bulletin 25. Obtain material from a source listed in Bulletin 15 for the specified performance grade. Provide QC testing and certification as specified in Sections 106.03(b) and 702.1(b)1. Provide the Representative a copy of a signed Bill of Lading for asphalt binder material on the first day of paving and when the batch number changes.

**1.a. WMA Technology Additives or Modifiers Blended at the Asphalt Material Supplier's Refinery or Terminal.** Provide refinery or terminal blended asphalt material blended with an approved WMA Technology additive or modifier from an approved manufacturer and source listed in Bulletin 15. Include in the asphalt material Producer QC Plan, the WMA Technology additive or modifier manufacturer name, WMA Technology name, and source, dosage rates, blending method, QC testing, corrective action points, disposition of failed material, storage, handling shipping, and bill of lading information following the applicable requirements in Section 702. Include the WMA Technology additive or modifier and dosage rate on the bill of lading. Provide certification that the refinery or terminally blended asphalt binder, that when modified with the WMA Technology additive or modifier, meets the requirements for the specified performance grade.

**1.b. WMA Technology Additives or Modifiers Blended at the Asphalt Mixture Producer's Plant**. Provide a blended asphalt binder consisting of an approved WMA Technology additive or modifier from an approved manufacturer and source listed in Bulletin 15 that is blended with a base asphalt binder of the specified performance grade conforming to the requirements of Standard Specifications for Performance-Graded Asphalt Binder Using Multiple Stress Creep Recovery (MSCR) Test, AASHTO M 332, except as revised in Bulletin 25 and from an approved source listed in Bulletin 15, Section 702. Prepare a Producer QC Plan as specified in Section 106 and conforming to the Producer QC Plan requirements in Section 413.2(e)1.a and the additional Producer QC Plan requirements within this specification.

**(b) Aggregate**

**1. General Requirements.** Provide aggregate from approved producers and sources listed in Bulletin 14. Furnish aggregate that conforms to the quality requirements for Superpave Asphalt Mixture Design as specified in Bulletin 27 with modifications as specified in Section 412.2. Provide aggregate with at least the SRL designation specified. To achieve the specified SRL, the Contractor may provide a blend of two aggregates if the blend has an SRL designation equal to or better than that specified. Blends for SRL are 50% by mass (weight) of each aggregate. Blend the aggregates using an approved method.

**2. Fine Aggregate.** Section 703.1, except Table A gradation does not apply and as follows:

- Determine the uncompacted void content according to AASHTO T 304, Method A, or use the value listed in Bulletin 14, and ensure the uncompacted void content conforms to AASHTO M 323, Table 6.
- Determine the sand equivalent value according to AASHTO T 176 and ensure the sand equivalent value conforms to AASHTO M 323, Table 6.

All manufactured sand fine aggregates used in NMAS 6.3 mm mixtures must be from a source that has a coarse aggregate SRL rating listed in Bulletin 14 as specified. Manufactured sand fine aggregate must be manufactured from the same parent material(s) as the Bulletin 14 listed coarse aggregate and will have the same SRL rating as the listed coarse aggregate.

All natural sand fine aggregates, and manufactured sand fine aggregates without a coarse aggregate from the same source with an SRL rating listed in the Bulletin 14 used in NMAS 6.3 mm mixture must be submitted to the LTS for SRL determination.

**3. Coarse Aggregate.** Type A, Section 703.2, except Table C gradation does not apply and revise the following requirements of Table B:

- Abrasion, Maximum Percent Loss as specified in Bulletin 27, Chapter 2A, Table 5A
- Flat and Elongated Particles in Coarse Aggregate maximum percent as specified in ASTM D4791using material retained on the No. 4 sieve, Maximum 10 percent for 1:5 ratio, and Maximum 20 percent for 1:3 ratio.
- Crushed Fragments, Minimum Percent, as specified in AASHTO M 323, Table 6, for Fractured Faces, Course Aggregate using the material retained on the No. 4 sieve.

The coarse aggregate must satisfy specified SRL requirements. Do not use coarse aggregate or anti-skid aggregate in the mixture until the quality, type, and SRL, are determined.

**(c) Recycled Asphalt Material.** Do not use Reclaimed Asphalt Pavement (RAP) or Recycled Asphalt Shingles (RAS) in the 6.3 mm Wearing Course.

**(d) Filler.** Follow Section 703.1(c)1. Do not use fly ash if the design traffic is greater than or equal to 3 million Equivalent Single Axle Loads (ESALs). Hydrated lime is allowed as a filler and may constitute up to 2 % of the weight of total dry aggregate unless otherwise shown on the plans. Provide hydrated lime that conforms to the requirements of ASTM C977.

**(e) Mixture Composition.**

**1. Virgin Material Mixtures.** Design 6.3 mm NMAS mix that meets all Department requirements. Size, uniformly grade, and combine aggregate fractions, asphalt binder, and an approved WMA Technology in proportions to develop a JMF that conforms to the material, gradation, and volumetric Superpave Asphalt Mixture Design requirements as specified in Bulletin 27, Chapter 2A, except as modified in Table A.

The WMA Technology Manufacturer Technical Representative (Technical Representative) will address laboratory procedure modifications necessary to prepare, compact, and test WMA mixtures and to achieve a uniform blend. Develop a JMF and incorporate the WMA Technology additive, modifier, or process into that JMF during production. Do not develop a volumetric JMF based on incorporating the WMA Technology additive, modifier or process during the volumetric asphalt mixture design process. For all JMFs, perform moisture susceptibility analysis according to Bulletin 27 and ensure the asphalt mixture used for the analysis includes the WMA Technology. Ensure the WMA Technology additive, modifier, or process is not detrimental to the moisture resistance of the mixture.

Submit a complete copy of the JMF, including a Form TR-448A signed by a certified Asphalt Level 2 Plant Technician, to the DME/DMM at least 3 weeks before the planned start of mixture production. Include a list of all material sources and the asphalt mixture producer on the TR-448A. Provide the calibration factors ($C_f$ for both asphalt content and 75 µm (No. 200) sieve) required by PTM No. 757 with the JMF on the TR-448A. Do not start mixture production until after the DME/DMM reviews the JMF.

Submit a completely new JMF, including a new Form TR-448A, with a change in material sources or if a new JMF is necessary to produce a mixture conforming to this specification.

**TABLE A**
**Mix Design Requirements for Thin Lift 6.3 mm Asphalt Wearing Course**

| **AGGREGATE GRADATION REQUIREMENTS, PERCENT PASSING** | |
|---|---|
| **Sieve Size** | **Min. – Max.** |
| 9.5 mm (3/8 inch) | 100 Min. |
| 6.3 mm (1/4 inch) | 90-100 |
| 4.75 mm (No. 4) | 0-85 |
| 2.36 mm (No. 8) | 37-55 |
| 300 µm (No. 50) | 8-25 |
| 75 µm (No. 200) | 3-10 |
| **VOLUMETRIC DESIGN REQUIREMENTS** | |
| **Design Gyrations ($N_{design}$) for All Specified Ranges of Design ESALs** | 75 |
| **Voids in Mineral Aggregate (VMA), Min. %, for All Specified Ranges of Design ESALs** | 16.5 |
| **Design Air Voids ($V_a$), %, for All Specified Ranges of Design ESALs** | 3.5-4.0 |
| **Binder Draindown (AASHTO T 305), % Maximum, for mixture with greater than 7.0% Asphalt Content** | 0.3% |
| **Binder Grade for All Specified Ranges of Design AASHTO M 332** | PG 64E-22 |

**1.a Producer QC Plan.** Section 413.2(e)1.a

**1.b Plant Technicians.** Section 413.2(e)1.b

**1.c Annual JMF Verification.** Section 413.2(e)1.c except conform to the single and multiple sample tolerances in Section 412.2(e)1.d Tables B and C.

**1.d Production.** Section 413.2(e)1.d except as follows:

**1.d.1 Apparent Moisture Content.** Section 413.2(e)1.d.1

**1.d.2 Asphalt Content.** Include in the producer QC Plan a frequency of obtaining mixture samples according to PTM No. 1 and performing asphalt content tests to verify that the mixture conforms to the tolerances of Table B. Test the samples according to either PTM No. 757, PTM No. 702, or PTM No. 742. After obtaining a minimum of three test results, determine compliance with the multiple sample tolerances in Table B. After obtaining five or more test results, determine compliance with the multiple sample tolerances in Table B using the running average of the last five consecutive test results.

Printed ticket results may be used in place of laboratory test results for QC of asphalt content of the mixture if the producer is currently approved to use printed tickets according to Bulletin 27. During mixture production, maintain 90% of printed ticket results for each day of production within 0.2 percentage points of the JMF.

**1.d.3 Gradation.** Sample the completed mixture, the combined aggregate from the hot bins of a batch plant, or the combined aggregate belt of a drum plant, according to PTM No. 1 and at the frequency in the producer QC Plan. If mineral filler is used in the mixture, determine gradation by testing samples of the completed mixture.

- Test the completed mixture according to PTM No. 757 or according to PTM No. 702 and PTM No. 739.
- Test combined aggregate samples according to PTM No. 743.

Produce a mixture within the tolerances of Table B. Determine compliance with the multiple-sample tolerance after obtaining a minimum of three test results for the mixture. After obtaining five or more test results for the mixture, determine compliance with the multiple-sample tolerances using the running average of the last five consecutive test results.

**1.d.4 Theoretical Maximum Specific Gravity.** Section 413.2(e)1.d.4

**1.d.5 Volumetric Analysis of Compacted Specimens.** Sample the completed mixture according to PTM No. 1 and at the frequency in the producer QC Plan. Prepare a minimum of two specimens from each sample according to AASHTO T 312.

Produce a mixture with volumetric properties conforming to the tolerances of Table C. Determine the bulk specific gravity of the specimens as specified in AASHTO T 312 and calculate air voids ($V_a$) and Voids in Mineral Aggregate (VMA) at $N_{design}$ according to AASHTO R 35 and as specified in Bulletin 27.

**TABLE B**
**Composition Tolerance Requirements of the Completed Plant Mix**

| | | **Single Sample (n = 1)** | **Multiple Samples (n ≥ 3)** |
|---|---|---|---|
| **Gradation** | | | |
| Passing 6.3 mm (1/4 inch) to 300 µm (No. 50) Sieves (Inclusive) | | ±6% | ±4% |
| Passing 75 µm (No. 200) Sieve | | ±3.0% | ±2.0% |
| **Asphalt Content** | | | |
| 6.3 mm | | ±0.6% | ±0.4% |
| **Temperature of Mixture (F)** | | | |
| **Class of Material** | **Type of Material** | **Minimum** | **Maximum** |
| PG 64E-22 | Asphalt Cement | 285 | 330 |
| **Job-Mix Tolerance Requirements for Combined Hot Bin Gradations** | | | |
| **Gradation** | | **Single Sample (n = 1)** | |
| Passing 6.3 mm (1/4 inch) to 300 µm (No. 50) Sieves (Inclusive) | | ±4% | |
| Passing 75 µm (No. 200) Sieve | | ±3.0% | |

**TABLE C**
**Volumetric Tolerance Requirements of the Plant Mixed, Laboratory Compacted Mixture**

| | **Single Specimen (n = 1)** | **Multiple Specimens (n ≥ 2)** |
|---|---|---|
| Air Voids at $N_{design}$ ($V_a$) from Target | ±2.0% | ±1.5% |
| Minimum VMA % | 16.0 | - |

**1.e Corrective Actions.** Immediately take corrective actions if one or more of the following occurs:

- QC test results on a single sample (n=1) for percent passing the 6.3 mm (1/4 inch) sieve, 2.36 mm (No. 8) sieve, 300 µm (No. 50) sieve, 75 µm (No. 200) sieve, or asphalt content are not within the tolerances in Table B.
- The average of multiple samples (n≥3) for percent passing any sieve or asphalt content, as determined according to Section 412.2(e)1.d, are not within the tolerances in Table B.
- QC test results on a single specimen (n=1) or on multiple specimens (n≥2) are not within the tolerances in Table C.
- Independent assurance (IA) or QA sample results tested at the producer's plant are not within the tolerances of Tables B or C.

After taking corrective actions, sample the completed mixture within 150 tons of production. After sampling, test the mixture and provide test results to the Representative. If less than three samples are tested for mixture composition, determine conformance with Table B by comparing each result to the multiple sample tolerances. If the mixture does not conform to the single and multiple sample tolerances in Table B and the single and multiple specimen tolerances in Table B, suspend production and shipping to the project and determine the cause of the problem. Provide a written explanation of the problem and a proposed solution to the Department. After the Representative reviews the proposed solution and authorizes production to continue, resume production and perform JMF verification according to the QC Plan. During corrective actions and JMF verification, mixture acceptance is according to the approved acceptance level of Section 413.2(f) Table C.

**2. Draindown Sensitivity.** For mixtures with greater than 7 percent total asphalt content determine the draindown sensitivity of the mixture using AASHTO T 305 at the maximum mixture temperature listed in Table B minus 5F. Use Fibers to reduce binder draindown if draindown exceeds the requirements of Table A. Use stabilizer types specified in Section 419.2(d) as needed to address draindown.

**(f) Mixture Acceptance.** Section 413.2(f) except as follows:

**1. General.** The Department will accept the mixture according to the certification acceptance in Section 412.2(f)2 or lot acceptance in Section 412.3(h)2.

**2. Certification Acceptance.** Acceptance by certification is appropriate for the following applications:

- Scratch Courses, Leveling courses and driveway adjustments.
- Mixtures used by Department maintenance forces.
- Mixtures purchased by local municipal governments.
- Mixture placed in quantities less than 350 tons in a continuous placement operation unless otherwise directed by the Representative.
- Other conditions, or applications as approved by the Representative.

**2.b Certification of Mixture.** Certify each mixture daily if QC test results conform to the single sample and multiple sample JMF production tolerances of Table B. The acceptance values will be:

- Asphalt Content
- Percent Passing the 75 µm (No. 200) sieve

If using printed ticket results in place of laboratory test results for asphalt content, certify that at least 90% of each day's printed ticket results for asphalt content are within 0.2 percentage points of the JMF.

If the mixture does not conform to the above requirements, do not certify the mixture. Instead, provide all QC test results to the Inspector-in-Charge. If using printed ticket results for asphalt content, provide the percentage of daily printed ticket results within 0.2 percentage points of the JMF to the Inspector-in-Charge. Payment will be determined according to Table D based on the QC test results.

If a day's production is interrupted by corrective action, material produced after the corrective action may be certified if QC test results conform to production tolerances.

**(g) WMA Technologies (Additive(s), Modifier(s), or Processes) and WMA Manufacturers.** Section 413.2(f)

**(h) Anti-Strip Additives**. Section 413.2(g)

**(i) WMA Technology Manufacturer Technical Representative (Technical Representative)**. Section 413.2(h)

**(j) 6.3 mm Mixture use with Membrane Systems Specified in Section 467 or Section 680**. Do not use 6.3 mm wearing course paving mixture for material placed directly on top of membrane systems.

## 412.3 CONSTRUCTION—Section 413.3 with additions and modifications as follows:

**(a) Preplacement Requirements.** Provide asphalt courses as indicated for the entire project.

**1. Paving Operation QC Plan.** Prepare a paving operation QC Plan, as outlined on Form CS-413, for field control and evaluation of asphalt concrete paving operations. Submit the QC Plan to the Representative before or at the pre-construction conference. The QC Plan shall describe the construction equipment and methods necessary to construct and test the asphalt concrete courses as specified in Section 412.3. The WMA Technical Representative will provide all recommendations and direction specific to the WMA technology in the paving operation QC Plan. Do not start paving until after the Representative reviews the QC Plan.

**2. Preplacement Meeting.** At least 2 weeks before placing asphalt paving mixtures, schedule an asphalt preplacement meeting with the Representative to review at a minimum the specification, paving operation QC Plan, sequence of paving operations, mixture acceptance, density acceptance and the care and custody of asphalt acceptance samples.

**(b) Weather Limitations.** Do not place 6.3 mm wearing course paving mixtures from October 1 to March 31 in Districts 1-0, 2-0 (except Juniata and Mifflin Counties), 3-0, 4-0, 5-0 (Monroe and Carbon Counties only), 9-0 (Cambria and Somerset Counties only), and 10-0; and from October 16 to March 31 in Districts 2-0 (Juniata and Mifflin Counties only), 5-0 (except Monroe and Carbon Counties), 6-0, 8-0, 9-0 (except Cambria and Somerset Counties), 11-0 and 12-0. No exceptions to paving weather limitations will be allowed unless approved in writing by the District Executive. Do not place asphalt paving mixtures when surfaces are wet, when the air or surface temperature is 50F or lower. If work is halted because of weather conditions, the Representative may allow the Contractor to place limited quantities of mixture that are en route to the project.

**1. Paving Season Extensions.** Section 413.3(b)1. With the following addition:

If an exception to the Weather Limitation dates is approved by the District Executive for 6.3 mm wearing course, the minimum surface temperature of 50F, and an air temperature of 40F will be strictly enforced and compaction of the asphalt mixture completed as quickly as possible.

**(c) Asphalt Mixing Plant.** Section 413.3(c).

**1. Batch Plant**. Section 413.3(c)1.

**2. Drum Mixer Plant**. Section 413.3(c)2.

**(d) Hauling Equipment.** Section 413.3(d)

**(e) Paving Equipment.** Section 413.3(e)

**(f) Rollers.** Use an adequate number of steel-wheeled rollers, each weighing a minimum of 10 tons and as specified in Section 108.05(c)3 to keep up with the paving operation. Operate rollers according to manufacturer's recommendations. Use rollers equipped with a watering or soapy watering system that prevents material from sticking to the rollers. Do not use pneumatic wheeled rollers.

Do not use rollers in vibratory mode unless it can be demonstrated to the satisfaction of the Representative that no breaking of aggregate or flushing of asphalt binder results from the vibration. Monitor pavement cores for aggregate breakage on every lot. Discontinue vibration if aggregate breakage or flushing of asphalt binder occurs.

**(g) Preparation of Existing Surface.** Section 413.3(g) with the following modification:

**1. Conditioning of Existing Surface.** Before delivering asphalt mixtures, remove and dispose of loose and foreign material and excess joint sealer and crack filler from the surface of existing pavement or previously placed pavement courses. If necessary, use a power broom. Remove all thermoplastic pavement markings. If practical, do not allow traffic on the existing surface after cleaning, to prevent contamination.

Before placing a wearing course, correct irregularities in the binder course. Repair potholes and gouges greater than 1 inch in depth. Fill and seal all pavement cracks or joints that exceed 1/8 inches in width. Use fillers and sealants conforming to PennDOT specifications.

Paint all existing vertical surfaces of curbs, structures, gutters, and pavements that will be in contact with asphalt mixtures with a uniform coating of either emulsified asphalt, consisting of PennDOT Material Class TACK, or NTT/CNTT, applied in two or more applications or hot asphalt binder of the class and type designated for the asphalt course.

Before overlaying existing surfaces, apply a tack coat to the clean surface according to Section 460. Allow adequate time for tack to break completely prior to placing any material.

**(h) Spreading and Finishing.** Section 413.3(h) with the following modification:

**1. General Requirements.**

**1.a Placing.** Unless otherwise allowed, deliver, place, and compact 6.3 mm paving mixtures during daylight hours. Ensure the mixture does not contain lumps of cold material. Deliver and place 6.3 mm paving mixtures at the laying temperatures specified in Table B.

Utilize a Material Transfer Vehicle (MTV) as specified in Section 108.05(c)5 for 6.3mm paving mixtures unless otherwise approved by the Representative.

**1.b Spreading and Finishing.** Section 413.3(h)1.b with the following addition:

Plan and schedule operations to minimize hand work of 6.3 mm paving mixtures.

**1.c Field Technician.** Section 413.3(h)1.c

**2. Mixture Lot Acceptance.** Section 413.3(h)2 with the following modification:

**2.a Lots and Sublots.** 413.3(h)2.a.

**2.a.1 Partially Completed Lots (n=2 or less).** When process conditions change to an extent that a partially completed lot cannot be combined with the most recently completed lot, samples will be independently evaluated on the partially completed lot. For asphalt content and percent passing the 75 µm (No. 200) sieve, mixture acceptance samples will be evaluated individually as specified in Table B (n=1) criteria. For density, mat density acceptance samples will be evaluated individually using the criteria in Table E.

If samples tested for asphalt content and percent passing the 75 µm (No. 200) sieve meet the n=1 criteria of Table B, and samples tested for density meet the criteria in Section 413.3(h), Table E, payment will be 100% of the contract unit price. If samples tested for asphalt content and percent passing the 75 µm (No. 200) sieve do not meet the n=1 criteria of Table B, the material will be considered defective work.

Unless otherwise directed in writing by the District Executive, remove and replace defective work.

**2.b Mixture Acceptance Samples**. Section 413.3(h)2.b and add the following to the end of the first paragraph:

If a representative mixture acceptance sample cannot be obtained directly behind the paver, the loose mixture acceptance sample for each sublot may be taken from the paver hopper or from the paver screed representing the sample sublot location. Determine the approved mixture acceptance sample collection method for loose mixture acceptance samples at the preconstruction or prepaving meeting.

**2.c Mixture Acceptance Sample Testing.** LTS Testing will be utilized unless otherwise indicated in the proposal.

**2.c.1 LTS Testing.** The LTS will test the mixture acceptance samples according to PTM No. 757 or PTM No. 702, Modified Method D, if previously identified problematic aggregates are used in the mixture, to determine asphalt content and the percent passing the 75 µm (No. 200) sieve. The LTS will use the calibration factors ($C_f$ and 200 $C_f$) provided with the JMF for PTM No. 757. The minimum sample size for PTM No. 757 is 1000 grams when 6.3 mm mix is used. For individual increment test results outside of the single sample (n=1) tolerances in Table B, the LTS will analyze the test results for extreme values according to PTM No. 4 at the 5% significance level. If discarding an extreme value reduces a lot to less than three remaining test results, the Department will accept the lot as specified in Section 412.3(h)2.a.1. The Department will accept lots with three or more test results as specified in Section 412.4(a)2.

If the asphalt content or the percent passing the 75 µm (No. 200) sieve is not within the single sample (n=1) or multiple sample ($n \geq 3$) tolerances in Table B for two consecutive lots or a total of three lots, stop all production of the JMF. Determine the cause of the problem and provide a proposed solution to the Department.

Do not resume production of the JMF until the Representative reviews the proposed solution and authorizes production to continue.

**3. Pattern Segregation.** Section 413.3(h)3.

**4. Flushing.** Section 413.3(h)4.

**(i) Compaction.** Begin rolling immediately after placement of mixture. Compact the 6.33 mm paving mixture to achieve the optimum rolling pattern requirements and to eliminate all roller marks. Compact the mixture while it is in proper condition and adjust roller speed, pattern, and roller size (and/or amplitude and frequency if vibratory rolling is approved by the Representative) to eliminate displacement, shoving, cracking, and aggregate breakage as specified in Section 412.3(f). Satisfactorily correct displacement resulting from reversing roller directions and other causes. Do not use pneumatic-tire rollers.

Without using excess water, maintain wheels of steel wheel rollers moist and clean to prevent the mixture from adhering to the wheels.

For areas inaccessible to rollers, compact with mechanical vibrating hand tampers.

Remove areas that are loose, broken, mixed with dirt, or show an excess or deficiency of asphalt material. Replace removed mixture with fresh, hot 6.3 mm paving mixture and compact the mixture even with the surrounding pavement surface.

**(j) Mat Density Acceptance.** The Department will accept the mat density based on non-movement and optimum rolling pattern.

**1. Non-Movement.** The Department will accept the density when the mixture does not move under the compaction equipment.

**2. Optimum-Rolling Pattern.** With the Representative and the Contractor's certified asphalt field technician present, determine density with an approved nuclear gauge according to PTM 402, or determine density with an approved electrical impedance gauge according to PTM No. 403. Nuclear gauges must be operated by a licensed nuclear gauge operator. In the presence of the Representative, follow the control strip technique specified in PTM No. 402 to construct at least one control strip to establish the optimum rolling pattern for each course. Document readings using the forms provided in PTM No. 402 and provide the completed forms to the Representative. Compact the course according to the optimum rolling pattern. During paving, the Representative may require the Contractor to construct a new control strip to verify the optimum rolling pattern.

Use one of the following gauges or approved equal:

- Troxler Electronics, Model 3411B or Model 4640B
- Campbell Pacific Nuclear, Model MC-2
- Seaman Nuclear, Model MC-2
- TransTech Systems, Inc., PQI™, Model 300 or Model 301
- Troxler Electronic Laboratories, PaveTracker™

Submit a copy of the certificate of nuclear gauge annual calibration according to ASTM D2950 and documentation of training of the nuclear gauge operator. Recalibrate any nuclear gauge that is damaged or repaired.

**(k) Joints.** Section 413.3(k)

**(l) Surface Tolerance.** Section 413.3(l)

**(m) Tests for Depth: Wearing Courses.** Section 413.3(m)

**(n) Protection of Courses.** Section 413.3(n)

**(o) Defective Work.** Section 413.3(o)

## 412.4 MEASUREMENT AND PAYMENT -

**(a) Standard 6.3mm Asphalt Construction.**

**1. Asphalt Courses.**

**1.a Thin Lift 6.3 mm Asphalt Wearing Course.** Square Yard or Ton

**1.b Thin Lift 6.3 mm Asphalt Wearing Course (Scratch).** Ton

**2. Asphalt Tack Coat.** Section 460.4

**3. Mixture Acceptance by Certification and Density Acceptance by Non-Movement, Optimum-Rolling Pattern.** The Representative will pay at the contract unit price, adjusted according to Table D. The total payment factor percentage is the sum of adjustments for each test criterion subtracted from 100%. The adjustment for an individual test criterion is the payment factor percentage subtracted from 100%. The pavement will be considered defective if the payment factor for asphalt content and percent passing the 75 µm (No. 200) sieve are both 85%.

**TABLE D**
**Contract Unit Price Adjustments - Mixture Acceptance by Certification**

<table>
<tr><th>Mixture NMAS</th><th>Test Criteria</th><th colspan="2">Test Value</th><th>Payment Factor Percentage</th></tr>
<tr><td colspan="5">Asphalt Content</td></tr>
<tr><td rowspan="2">6.3 mm</td><td rowspan="2">Printed Tickets</td><td colspan="2">At least 90% of Daily Printed Tickets Within 0.2% of JMF</td><td>100</td></tr>
<tr><td colspan="2">Less than 90% of Daily Printed Tickets Within 0.2% of JMF</td><td>85</td></tr>
<tr><td rowspan="4">6.3 mm</td><td rowspan="4">QC Sample Testing**</td><td>Single Sample (n=1)</td><td>Multiple Samples (n≥2)</td><td></td></tr>
<tr><td>±0.7%</td><td>±0.5%</td><td>100</td></tr>
<tr><td>±0.8% to 1.0%</td><td>±0.6%</td><td>85</td></tr>
<tr><td>> ±1.0%</td><td>≥ ±0.7%</td><td>*</td></tr>
<tr><td colspan="5">Gradation</td></tr>
<tr><td></td><td></td><td>Single Sample (n=1)</td><td>Multiple Samples (n≥2)</td><td></td></tr>
<tr><td rowspan="3">6.3 mm</td><td rowspan="3">QC Sample Testing for % Passing 75 µm (No. 200) Sieve**</td><td>±3.0%</td><td>±2.1%</td><td>100</td></tr>
<tr><td>±3.1% to ±4.0%</td><td>±2.2% to ±2.7%</td><td>85</td></tr>
<tr><td>> ±4.0%</td><td>≥ ±2.8%</td><td>*</td></tr>
<tr><td colspan="5">Mat Density</td></tr>
<tr><td rowspan="2">6.3 mm</td><td>Non-Movement</td><td colspan="2">Section 412.3(j)1.</td><td>100</td></tr>
<tr><td>Optimum-Rolling Pattern</td><td colspan="2">Section 412.3(j)2.</td><td>100</td></tr>
<tr><td colspan="5">* Defective pavement. Remove and replace or, when permitted by the District Executive in writing, leave in place and the Department will pay 70% of the contract unit price.<br><br>** For these test criteria, the daily Payment Factor Percentage will be determined by the single sample test result from the daily QC sample. If more than one QC sample test result is available for a day, the Payment Factor Percentage will be determined based on the average of the results using multiple sample tolerances. If corrective action is taken, Payment Factor Percentages will be separately determined for material placed before and after the corrective action.</td></tr>
</table>

**4. Mixture Acceptance by Lot and Density Acceptance by Optimum Rolling Pattern.** The Department will pay on a lot-by-lot basis at the contract price, adjusted for Payment Factor Percentages as specified in Table E. For the payment factor percentages based on percent within tolerance, the Department will determine the percent within tolerance according to Section 106.03(a)3, using the upper and lower specification limits in Table F.

**TABLE E**
**Contract Unit Price Adjustments - Mixture Acceptance by Lots**

| Mixture NMAS | Test Criteria | Test Value | Payment Factor Percentage |
|---|---|---|---|
| **Asphalt Content** | | | |
| 6.3 mm | Acceptance Sample Testing | All individual sublot acceptance sample test results for the lot (n=1) are within ± 0.6% and the lot average (n≥3) is within ± 0.4%* | 100 |
| | | Percent Within Tolerance if any individual sublot acceptance sample test result for the lot is not within the n=1 tolerances or the lot average is not within the n≥3 tolerances listed above. | Table G |
| **Gradation** | | | |
| 6.3 mm | Acceptance Sample Testing for % Passing 75µm (No. 200) Sieve | All individual sublot acceptance sample test results for the lot (n=1) are within ± 3.0% and the lot average (n≥3) is within ± 2.0%* | 100 |
| | | Percent Within Tolerance if any individual sublot acceptance sample test result for the lot is not within the n=1 tolerances or the lot average is not within the n≥3 tolerances listed above. | , Table G |
| **Mat Density** | | | |
| 6.3 mm | Optimum-Rolling Pattern | Section 412.3(j)2 | 100 |
| * The Department may elect to randomly select and test only one sublot acceptance sample from each lot to determine conformance to the specifications. If only one sublot acceptance sample is tested, tighter tolerances will be used to determine conformance to the specifications for the entire lot. If the one sublot is within ±0.2% of the JMF for asphalt content and within ±1.0% of the JMF for percent passing the 75 µm (No. 200) sieve, the lot will be considered to conform with the specifications and the lot's payment factor percentage will be determined according to this table. If the one sublot fails to meet the tighter tolerances, all acceptance samples from the lot will be tested to determine the payment factor percentage according to this table. | | | |

**TABLE F**
**Upper and Lower Specification Limits for Calculating Percent Within Tolerance**

| | **Testing Criteria** | |
|---|---|---|
| **Mixture NMAS** | **Lower Specification Limit (L)** | **Upper Specification Limit (U)** |
| | **Asphalt Content from JMF Value, %** | |
| 6.3 mm | -0.4 | +0.4 |
| | **Percent Passing the 75 µm (No. 200) sieve from JMF Value, %** | |
| 6.3 mm | -2.0 | +2.0 |

**TABLE G**
**Payment Factor Based on Percent Within Tolerance**

| Percent Within Tolerance | Payment Factor Percentage |
|---|---|
| 99 | 97 |
| 98 | 97 |
| 97 | 97 |
| 96 | 96 |
| 95 | 96 |
| 94 | 96 |
| 93 | 95 |
| 92 | 95 |
| 91 | 95 |
| 90 | 95 |
| 89 | 93 |
| 88 | 91 |
| 87 | 90 |
| 86 | 88 |
| 85 | 86 |
| 84 | 84 |
| 83 | 83 |
| 82 | 81 |
| 81 | 79 |
| 80 | 78 |
| 79 | 76 |
| 78 | 74 |
| 77 | 72 |
| 76 | 71 |
| 75 | 69 |
| 74 | 67 |
| 73 | 66 |
| 72 | 64 |
| 71 | 62 |
| 70 | 60 |
| 69 | 59 |
| 68 | 57 |
| 67 | 55 |
| 66 | 54 |
| 65 | 52 |
| 64 | 50 |
| Less than 64 | Defective Lot** |

**Remove and replace the lot. If only one lot characteristic has a percent within tolerance less than 64, the District Executive may allow the Contractor to leave the defective lot in place. The Department will pay for the defective lot at 70% of the contract unit price.

**4.a Payment.** The Representative will compute the percent of the contract unit price paid as follows:

$$\text{Lot Payment} = C_P(2P_D + P_B + P_A)/400$$

$C_P$ = Contract unit price per lot (unit price times lot quantity)

$P_D$ = Payment Factor Percentage for density

$P_B$ = Payment Factor Percentage for asphalt content.

$P_A$ = Payment Factor Percentage for percent passing the 75 µm (No. 200) sieve

**4.b Dispute Resolution.** For mixture acceptance testing performed by the LTS, the Contractor may request in writing that the Department retest a lot if the initial test results indicated a defective lot (remove and replace). Provide written retest requests to the District Executive within 3 weeks of the date the LTS test results are released. Retests will not be allowed if a written retest request is not received within 3 weeks of the date the LTS test results are released. Provide quality control test results and control charts, companion sample test results (if available), test data trend evaluation, and any other pertinent information to justify the retest request. The Department will evaluate the information and may allow retesting if the information submitted provides a reasonable basis to conclude that the failing test results may not represent the in-place material. The LTS will perform the retest with the Contractor present, unless otherwise agreed to in writing with the Contractor.

For retesting of materials failing for asphalt content or percent passing the 75 µm (No. 200) sieve, the Inspector will identify the locations where the original box samples were collected. The Inspector will select retest sample locations 24 inches from the original sample locations longitudinally in the direction of traffic. If the 24 inch offset causes the retest sample location to fall outside of the sublot, the Inspector will select the retest sample location 24 inches from the original sample locations longitudinally in the opposite direction from traffic.

With the Inspector present, provide appropriate traffic control and drill two 6-inch diameter cores at each retest sample location for retesting purposes. Rinse all retest cores thoroughly with water immediately after drilling to remove all loose material on the core from the drilling operation. Within 24 hours after coring, backfill the holes with asphalt mixture of the same JMF or with asphalt mixture used for subsequent courses and compact and seal the asphalt mixture. Provide traffic control, core, and backfill the core holes at no cost to the Department. The test method used for asphalt determination during the original acceptance testing (PTM No. 757 or PTM No. 702) will be used for the retest, unless the (DME/DMM) grants written approval for a change in test method. The results of the retest cores will be used to calculate payment for both asphalt content and percent passing the 75 µm (No. 200) sieve for the lot.

The Department will deduct from the payment the cost per lot associated with conducting a retest as follows in Table H:

**TABLE H**
**Dispute Resolution Retest Cost Table**

| Test Method | Mixture Acceptance Retest Cost if Retest Results Indicate<br><br>100% Pay Factor(s)* | Mixture Acceptance Retest Cost if Retest Results Indicate<br><br><100% Pay Factor(s) |
|---|---|---|
| PTM No. 702/739 | $900 | $3,500 |
| PTM No. 757 | $500 | $2,000 |

# SECTION 413—SUPERPAVE MIXTURE DESIGN, STANDARD AND RPS CONSTRUCTION OF PLANT-MIXED ASPHALT COURSES WITH PERCENT WITHIN LIMITS AND LTS TESTING (PWL-LTS)

**413.1 DESCRIPTION—**This work is the Standard and RPS construction of a plant-mixed, dense-graded, asphalt pavement course on a prepared surface using a volumetric asphalt mixture design developed with the Superpave Gyratory Compactor (SGC), using prescribed manufactured additives or modifiers, or plant process modifications or both. Acceptance of the work is based on testing of field samples by the LTS and statistical evaluation of sample test results by Percent Within Limits (PWL) procedures.

**413.2 MATERIALS—**Do not incorporate any materials into the asphalt mixture that are not specified including additives, rejuvenators, or other materials.

**(a) Asphalt Material**

**1. Virgin Mix, Mix Containing 5% to 15% RAP, or Mix Containing 5% Recycled Asphalt Shingles (RAS).** Furnish material conforming to the requirements of Standard Specifications for Performance-Graded Asphalt Binder using Multiple Stress Creep Recovery (MSCR) Test, AASHTO M 332, except as revised in Bulletin 25. Obtain material from a source listed in Bulletin 15 for the specified grade. Provide QC testing and certification as specified in Sections 106.03(b) and 702.1(b)1. Provide the Representative a copy of a signed Bill of Lading for asphalt binder on the first day of paving and when the batch number changes.

**2. Mix Containing More than 15% RAP or Mix Containing Both 5% RAS and 5% or More RAP.** The LTS will evaluate the asphalt binder in the RAP and, if applicable, the RAS source material. The LTS will determine the class (grade) of asphalt binder that the Contractor is required to use in the mixture.

Furnish material conforming to the requirements of Standard Specifications for Performance-Graded Asphalt Binder using Multiple Stress Creep Recovery (MSCR) Test, AASHTO M 332, except as revised in Bulletin 25. Obtain material from a source listed in Bulletin 15 for the specified grade. Provide QC testing and certification as specified in Sections 106.03(b) and 702.1(b)1. Provide the Representative a copy of a signed Bill of Lading for asphalt binder on the first day of paving and when the batch number changes.

**3. WMA Technology Additives or Modifiers Blended at the Asphalt Binder Supplier's Refinery or Terminal.** Provide refinery or terminal blended asphalt binder blended with a WMA Technology additive or modifier from an approved manufacturer and source listed in Bulletin 15. Include in the asphalt binder Producer QC Plan, the WMA Technology additive or modifier manufacturer name, WMA Technology name, and source, dosage rates, blending method, QC testing, corrective action points, disposition of failed material, storage, handling shipping, and bill of lading information as specified in Section 702. Include the WMA Technology additive or modifier and dosage rate on the bill of lading. Provide refinery or terminally blended asphalt binder modified with the WMA Technology additive or modifier as specified in Section 413.2(a)1 or Section 413.2(a)2 for the specified grade.

**4. WMA Technology Additives or Modifiers Blended at the Asphalt Mixture Producer's Plant**. Provide a blended asphalt binder consisting of an approved WMA Technology additive or modifier from an approved manufacturer and source listed in Bulletin 15 that is blended with a base asphalt binder of the specified grade conforming to the requirements of Standard Specifications for Performance-Graded Asphalt Binder using Multiple Stress Creep Recovery (MSCR) Test, AASHTO M 332, except as revised in Bulletin 25 and from an approved source listed in Bulletin 15, Section 702. Prepare a Producer QC Plan as specified in Section 106 and conforming to the Producer QC Plan requirements as specified in Section 413.2(e)1.a . Provide asphalt binder blended with the WMA Technology additive or modifier at the asphalt mixture production plant as specified Section 413.2(a)1 or Section 413.2(a)2 for the specified grade.

**(b) Aggregate and RAM.**

**1. General Requirements.** Provide aggregate from sources listed in Bulletin 14. Aggregate and RAM shall conform to the quality requirements for Superpave Asphalt Mixture Design according to Bulletin 27. For wearing courses, provide aggregate with at least the SRL designation specified. To achieve the specified SRL, the Contractor may provide a blend of two aggregates if the blend has an SRL designation equal to or better than that specified. Blends are 50% by mass (weight) of each aggregate. Blend the aggregates using an approved method. Do not use 4.75 mm asphalt mixtures in applications that require an SRL designation higher than L.

**2. Fine Aggregate.** Section 703.1, except Table A gradation does not apply and as follows:

Determine the uncompacted void content according to AASHTO T 304, Method A, or use the value listed in Bulletin 14, and ensure the uncompacted void content conforms to AASHTO M 323, Table 6. Determine the sand equivalent value according to AASHTO T 176 and ensure the sand equivalent value conforms to AASHTO M 323, Table 6.

**3. Coarse Aggregate.** Section 703.2, Type A, except Table C gradation does not apply and revise the following quality requirements of Table B:

- Abrasion, Maximum Percent according to Bulletin 27, Chapter 2A, Table 5A
- Thin and Elongated Pieces, Maximum Percent according to AASHTO M 323, Table 6, for Flat and Elongated
- Crushed Fragments, Minimum Percent, according to AASHTO M 323, Table 6, for Fractured Faces, Coarse Aggregate

**(c) Recycled Asphalt Material**

**1. RAP.** If RAP material is proposed for use in the mixture, use at least 5% RAP consisting of cold milled or crushed asphalt mixture. Include a plan to control RAP and the procedures to handle RAP of significantly different composition in the producer QC Plan. Maintain all processed material free of foreign materials and minimize segregation. Process the RAP so that the final mixture meets requirements as specified in Section 413.2(e).

**2. Manufacturer Waste Recycled Asphalt Shingles (RAS).** If RAS material is proposed for use in the mixture, use 5% RAS by mass (weight) of the total mixture consisting of manufacturer waste shingles that are rejected asphalt shingles or shingle tabs that are discarded in the manufacturing process of new asphalt roofing shingles. Do not use post-consumer asphalt roofing shingles that are removed from the roofs of existing structures. Due to significant composition differences, keep rejected asphalt shingles manufactured with fiberglass felt or paper or organic felt separate. Do not use both fiberglass felt, and paper or organic felt asphalt roofing shingles in the same mixture. Obtain certification, as specified in Section 106.03(b)3, from the manufacturer of the waste shingles certifying that the waste shingles were discarded during the manufacturing process of new asphalt roofing shingles and certifying the type of felt used during manufacturing of the waste shingles. Maintain and provide the Representative access to all certification records for manufacturer waste shingles.

Process RAS material by shredding, screening or other methods so that 100 percent passes the 9.5 mm ( 3/8 inch) sieve. RAS may be uniformly blended with fine aggregate as a method of preventing the agglomeration of RAS material. If RAS and fine aggregate are blended, blend at 50% by mass (weight) of each material.

Include a plan to stockpile and control RAS and the procedures to handle RAS of significantly different composition in the producer QC Plan. Maintain all processed material free of foreign materials and minimize segregation. Process the RAS so that the final mixture conforms to Section 413.2(e).

**(d) Filler.** Section 703.1(c)1. Do not use fly ash if the design traffic is greater than or equal to 3 million Equivalent Single Axle Loads (ESALs).

**(e) Mixture Composition for Standard and RPS Construction.**

**1. Virgin Material Mixtures.** Size, uniformly grade, and combine aggregate fractions, asphalt binder, and either WMA Technology additive(s) or modifier(s) in proportions to produce a JMF that conforms to the material, gradation, and volumetric Superpave Asphalt Mixture Design requirements according to Bulletin 27, Chapter 2A. Produce an asphalt mixture for the specified nominal maximum aggregate size and design ESALs except as procedurally modified by the WMA Technology Manufacturer Technical Representative (Technical Representative) to address laboratory procedures when preparing, compacting and testing asphalt mixtures to achieve a uniform blend.

Special additive(s) or modifier(s) need not be used if mixture temperature, workability, and compaction can be achieved solely through plant mechanical modification to produce foamed asphalt. Do not incorporate the WMA Technology additive, modifier or process during the volumetric asphalt mixture design process, so that the JMF volumetrics and material percentages are based on a mixture with no WMA Technology. Only use the WMA Technology additive, modifier or process to evaluate results from moisture susceptibility testing during the mix design process. Develop an asphalt mixture JMF, then incorporate the WMA Technology additive, modifier, or process into that JMF during production. Create an asphalt JMF cover sheet (Form TR-448A) for approval containing the WMA Technology used, additive dosage rate or percent water added for foaming, material code, and the TSR data from the moisture susceptibility testing.

Submit a copy of each completed JMF, signed by a certified Asphalt Level 2 plant technician, to the DME/DMM at least 3 weeks before the planned start of mixture production. Include a list of all material sources and the asphalt mixture producer in the JMF. Provide the calibration factors ($C_f$ and 200 $C_f$) according to PTM No. 757 with the JMF. Do not start mixture production until after the DME/DMM reviews the JMF.

Submit a new JMF with a change in material sources or if a new JMF is necessary to produce a mixture conforming to this specification.

**1.a Producer QC Plan.** Each producer must prepare a QC Plan as specified in Section 106 and conforming to the additional QC requirements of this specification. Submit the QC Plan to the DME/DMM annually at least 3 weeks before the planned start of mixture production and do not start production until the DME/DMM reviews the QC Plan.

**1.a.1 QC Organization Chart.**

- Names of personnel responsible for QC.
- Area of responsibility of each individual.
- List outside agencies, (e.g., testing laboratories) and a description of services provided.

**1.a.2 Testing Plan with Action Points.**

- List of all tests to be performed.
- Frequency of testing.
- List action points to initiate corrective procedures.
- Recording method to document corrective procedures.
- Procedures for conducting JMF verification testing.

**1.a.3 Materials Storage and Handling.**

- Aggregate/RAP/RAM/RAS stockpiles.
- Cold-feed systems for aggregates/RAP/RAM/RAS.
- Additives or modifiers for mixture
- Modified asphalt/liquid additive storage tanks.
- Surge/storage silos for mixture. Do not store more than one JMF in a surge/storage silo at any given time.

- All measuring and conveying devices, including calibration procedures.
- Haul vehicle loading procedures.
- WMA Technology additive or modifier manufacturer name, WMA Technology name, and source as listed in Bulletin 15.
- WMA Technology additive or modifier storage and handling before blending.
- All measuring, conveying and blending devices for the WMA Technology and anti-strip additive (if required), including calibration procedures.
- WMA Technology additive or modifier and anti-strip additive (if required) method of introduction, dosage rates, blending with the asphalt binder and method of automation, recordation and print outs.
- Storage and handling of the blended asphalt binder with the WMA Technology additive or modifier.
- Asphalt production temperature range for normal paving and any specific temperature ranges for special conditions or situations.
- Asphalt laboratory compaction temperature for QC volumetric analysis. Determine the SGC compaction temperature for the production QC which yields the same target air voids as the designed JMF.

**1.b Plant Technicians.** During mixture production, provide a certified Asphalt Level 1 plant technician at the plant and an on-call certified Asphalt Level 2 plant technician, both meeting the requirements according to Publication 351. Instruct and train the certified technicians to perform all tests and to control plant operation. The Department may use its own certified Asphalt plant technicians to verify tests and to work in coordination with the producer’s technicians. All technicians must carry a valid certification card during mixture production.

**1.c Annual JMF Verification.** During initial production of each JMF, verify, according to the QC Plan, that the mixture conforms to this specification. If the mixture does not conform to the single and multiple sample tolerances in Tables A and B within 2 days of production, suspend shipping the mixture to the project. Do not ship the mixture to the project until after the Representative reviews and verifies that results conform to the single and multiple sample tolerances in Tables A and B. During JMF verification, mixture acceptance is according to the approved acceptance level of Table C.

**1.d Production.** After JMF verification, sample and test the mixture according to the QC Plan. For daily production of each JMF greater than 50 tons, determine asphalt content, gradation, and theoretical maximum specific gravity from the same sample at least once each day. For daily production of each JMF greater than 150 tons, determine asphalt content, gradation, theoretical maximum specific gravity and perform volumetric analysis of compacted specimens from the same sample at least once each day. Perform additional sampling and testing as directed. Produce a mixture within the following production limits:

**1.d.1 Apparent Moisture Content.** If the water absorption of a coarse aggregate, determined according to AASHTO T 85, exceeds 2.0%, sample the mixture according to PTM No. 1 and at the frequency in the producer QC Plan. Determine the apparent moisture content in the mixture according to PTM No. 749. Produce a mixture with the apparent moisture content not to exceed 0.5%.

**1.d.2 Asphalt Content.** Include in the producer QC Plan a frequency of obtaining mixture samples according to PTM No. 1 and performing asphalt content tests to verify that the mixture conforms to the tolerances of Table A. Test the samples according to either PTM No. 757, PTM No. 702, or PTM No. 742. After obtaining a minimum of three test results, determine compliance with the multiple sample tolerances in Table A. After obtaining five or more test results, determine compliance with the multiple sample tolerances in Table A using the running average of the last five consecutive test results.

Printed ticket results may be used in place of laboratory test results for QC of asphalt content of the mixture if the producer is currently approved to use printed tickets according to Bulletin 27. During mixture production, maintain 90% of printed ticket results for each day of production within 0.2 percentage points of the JMF. If RAP or RAS is used in the mixture, determine asphalt content by testing samples of the completed mixture.

**1.d.3 Gradation.** Sample the completed mixture or sample the combined aggregate from the hot bins of a batch plant or the combined aggregate belt of a drum plant, according to PTM No. 1 and at the frequency in the producer QC Plan. If mineral filler, RAP, or RAS are used in the mixture, determine gradation by testing samples of the completed mixture.

- Test the completed mixture according to PTM No. 757 or according to PTM No. 702 and PTM No. 739.
- Test combined aggregate samples according to PTM No. 743.

Produce a mixture within the tolerances of Table A. Determine compliance with the multiple-sample tolerance after obtaining a minimum of three test results for the mixture. After obtaining five or more test results for the mixture, determine compliance with the multiple-sample tolerances using the running average of the last five consecutive test results.

**1.d.4 Theoretical Maximum Specific Gravity.** Sample the mixture according to PTM No. 1 at the frequency required in Bulletin 27. Condition and test the samples according to Bulletin 27.

Calculate the percentage of unfilled voids and the theoretical maximum density of the mixture using the most recently determined theoretical maximum specific gravity value or average value according to Bulletin 27. Certify the theoretical maximum specific gravity value to the Inspector daily using Form CS-4171B. If the theoretical maximum specific gravity value varies 0.030 or more from the previous test or from the JMF value, immediately notify the DME/DMM.

**1.d.5 Volumetric Analysis of Compacted Specimens.** Sample the completed mixture according to PTM No. 1 and at the frequency in the producer QC Plan. Prepare a minimum of two specimens from each sample according to AASHTO T 312.

Produce a mixture with volumetric properties conforming to the tolerances of Table B. Determine the bulk specific gravity of the specimens according to AASHTO T 312 and calculate air voids ($V_a$) and Voids in Mineral Aggregate (VMA) at $N_{design}$ according to AASHTO R 35 and according to Bulletin 27. Determine compliance with the multiple specimen tolerances using the average of the results for all specimens prepared from the sample.

**TABLE A**
**Job-Mix Formula**
**Composition Tolerance Requirements of the Completed Mix**

| | **Single Sample (n = 1)** | **Multiple Samples (n $\geq$ 3)** |
|---|---|---|
| **Gradation** | | |
| Passing 12.5 mm (1/2 inch) and Larger Sieves | ±8% | ±6% |
| Passing 9.5 mm (3/8 inch) to 150 µm (No. 100) Sieves (Inclusive) | ±6% | ±4% |
| Passing 75 µm (No. 200) Sieve | ±3.0% | ±2.0% |
| **Asphalt Content** | | |
| 19.0 mm Asphalt mixtures and smaller | ±0.7% | ±0.4% |
| 25.0 mm Asphalt mixtures and larger | ±0.8% | ±0.5% |

| Temperature of Mixture (F) | | | | |
|---|---|---|---|---|
| Class of Material | Type of Material | Chemical, Organic, Foaming Additives Minimum* | Mechanical Foaming Equipment/Process Minimum* | Maximum* |
| PG 58S-28 | Asphalt Binder | 215 | 230 | 310 |
| PG 64S-22 | Asphalt Binder | 220 | 240 | 320 |
| PG 64E-22 | Asphalt Binder | 240 | 260 | 330 |
| All other Binders | Asphalt Binder | The higher of 215 or the minimum temp. specified in Bulletin 25 minus 45F | The higher of 230 or the minimum temp. specified in Bulletin 25 minus 30F | As specified in Bulletin 25 |
| * Outline in the Producer QC Plan and follow more restrictive temperature requirements provided by the WMA technology manufacturer or Technical Representative(s) for production and placement of the mixture. Determine the SGC compaction temperature for the production QC which yields the same target air voids as the designed JMF . Include the SGC compaction temperature in the Producer QC Plan. Compact the completed mixture in the SGC for QC volumetric analysis at the SGC compaction temperature according to the guidelines provided by the Technical Representative. | | | | |

**TABLE B**
**Job-Mix Formula**
**Volumetric Tolerance Requirements of the Laboratory Compacted Mix**

| Property | Each Specimen | Multiple Specimens |
|---|---|---|
| Air Voids at $N_{design}$ ($V_a$) | (±2%) | (±1.5%) |
| Minimum VMA % for 4.75 mm | 16.0 | - |
| Minimum VMA % for 9.5 mm | 15.5 | - |
| Minimum VMA % for 12.5 mm | 14.5 | - |
| Minimum VMA % for 19.0 mm | 13.5 | - |
| Minimum VMA % for 25.0 mm | 12.5 | - |
| Minimum VMA % for 37.5 mm | 11.5 | - |

**1.e Corrective Actions.** Immediately take corrective actions if one or more of the following occurs:

- QC test results on a single sample (n=1) for percent passing the 2.36 mm (No. 8) sieve, the 75 µm (No. 200) sieve, or asphalt content are not within the tolerances in Table A.
- The average of multiple samples (n≥3) for percent passing any sieve or asphalt content, as specified in Section 413.2(e)1.d, are not within the tolerances in Table A.
- QC test results on each specimen or on multiple specimens are not within the tolerances in Table B.
- Independent assurance (IA) or QA sample results tested at the producer's plant are not within the tolerances of Tables A or B.

After taking corrective actions, sample the completed mixture within 150 tons of production. After sampling, test the mixture and provide test results to the Representative within 500 tons of production. If less than three samples are tested for mixture composition, determine conformance with Table A by comparing each result to the multiple sample tolerances. If the mixture does not conform to the single and multiple sample tolerances in Table A and the single and multiple specimen tolerances in Table B, suspend production and shipping to the project and determine the cause of the problem. Provide a written explanation of the problem and a proposed solution to the Department. After the Representative reviews the proposed solution and authorizes production to continue, resume production and perform JMF verification according to the QC Plan. During corrective actions and JMF verification, mixture acceptance is according to the approved acceptance level of Table C.

**2. Mixtures with RAM, 5% or More RAP, and/or 5% RAS.** Section 413.2(e)1 and as follows:

**2.a RAM and RAP SRL.** For asphalt wearing courses, limit the total combination of RAM and RAP to a maximum of 15% of the mixture by mass (weight) unless documentation of the SRL designation of the coarse aggregate in the RAM and RAP materials is provided to the DME/DMM and the RAM and RAP meet the specified SRL or can be blended for SRL as specified in Section 413.2(b)1.

**2.b RAP and/or RAS Asphalt Content and Gradation.** Determine the average asphalt content and gradation of the RAP and/or RAS stockpile(s) according to Bulletin 27. Determine the proportions of RAP, RAM, RAS, and virgin materials necessary to conform to the JMF requirements. Maintain and provide the Representative access to records of all sampling, testing, and calculations.

**(f) WMA Technologies (Additive(s), Modifier(s), or Processes)** Produce the asphalt mixture using approved or provisionally approved WMA Technologies, including additives, modifiers or processes from manufacturers listed in Bulletin 15. If blending WMA additives or modifiers with asphalt material, provide asphalt material blended with the WMA additive or modifier as specified in Section 413.2(a)3 or Section 413.2(a)4. For WMA Technology additives or modifiers blended with the asphalt mixture at the asphalt mixture production plant, prepare a QC Plan as specified in Section 106 and also conforming to the additional Producer QC Plan requirements within this specification. Submit the QC Plan to the DME/DMM annually and at least 3 weeks before the planned start of the blending of WMA Technologies with asphalt material. Do not start blending until the DME/DMM reviews the QC Plan.

**(g) Anti-Strip Additives**. Use either a compatible, heat stable, amine-based liquid anti-strip or a compatible alternate anti-strip additive. If the WMA Technology includes an anti-strip additive as part of its WMA Technology, perform moisture susceptibility analysis as specified in Section 413.2(e)1 and add additional anti-strip additive or make other adjustments to the JMF if needed to meet the specified moisture susceptibility requirements.

**(h) WMA Technology Manufacturer Technical Representative (Technical Representative)**. If the Asphalt Producer is using a provisionally or conditionally approved WMA Technology listed in Bulletin 15 or is using a fully approved WMA Technology for the very first time, identify one or more Technical Representative(s) that are knowledgeable in how the WMA Technology will affect the storage, handling, blending, mixture production, mixture QC testing, placement and compaction requirements of the mix. Have one or more Technical Representative(s) on-call and capable of being in direct, verbal contact with the Producer, Contractor, and/or Department within 2 hours after initial contact. Have one or more Technical Representative(s) review the Producer's QC Plan to ensure that all of the data as specified in Sections 413.2(e) 1.a.2 and 413.2(e) 1.a.3 are supported according to current manufacturer's recommendations. Include the Technical Representative's office and mobile telephone numbers in the Producer's QC Plan.

**(i) Mixture Acceptance.**

**1. General.** For standard construction, the Department will accept the mixture according to the appropriate level in Table C. For RPS construction, the Department will accept the mixtures by lot acceptance as specified in Section 413.3(h)2.

**TABLE C**
**Mixture Acceptance**

| Acceptance Level | Acceptance Method |
|---|---|
| Certification Acceptance | Producer Certification of Mixture (Section 413.2(i)2) |
| Lot Acceptance | Mixture Acceptance Sample Testing (Section 413.3(h)2) |

**2. Certification Acceptance.** Acceptance by certification is appropriate for the following mixtures, conditions, or applications:

- Scratch courses, leveling courses less than 2 inch depth and driveway adjustments.

- Mixtures used by Department maintenance forces.
- Mixtures purchased by local or municipal governments.
- Mixtures placed in quantities not exceeding 500 tons in a continuous placement operation unless otherwise directed by the Representative (See Section 101.01).
- Mixtures used for parking lots.
- All 4.75 mm NMAS asphalt mixtures.
- Other mixtures, conditions, or applications as approved by the Representative (See Section 101.01).

**2.a General.** Obtain certification from the mixture producer. Use all QC tests during mixture production as acceptance tests. Certify mixtures using Form CS-4171B. Include, or attach, the QC test results on the form. Provide the form to the Inspector-in-Charge within 1 working day after completing the QC tests. Certify mixtures as specified in Section 106.03(b)3 and the requirements below.

**2.b Certification of Mixture.** Certify each mixture daily if QC test results conform to the single sample and multiple sample JMF production tolerances of Table A. The acceptance values will be:

- Asphalt Content
- Percent Passing the 2.36 mm (No. 8) sieve (not applicable for 4.75 mm NMAS asphalt mixtures)
- Percent Passing the 75 µm (No. 200) sieve

If using printed ticket results in place of laboratory test results for asphalt content, certify that at least 90% of each day's printed ticket results for asphalt content are within 0.2 percentage points of the JMF.

If the mixture does not conform to the above requirements, do not certify the mixture. Instead, provide all QC test results to the Inspector-in-Charge. If using printed ticket results for asphalt content, provide the percentage of daily printed ticket results within 0.2 percentage points of the JMF to the Inspector-in-Charge. Payment will be determined according to Table H based on the QC test results.

If a day's production is interrupted by corrective action, material produced after the corrective action may be certified if QC test results conform to production tolerances.

**2.c Maintaining Approval to Certify Mixtures.** The Department may suspend a plant's approval to certify mixtures if QC is not performed according to the producer QC Plan, mixtures are not produced according to Bulletin 27, a mixture cannot be certified on 2 consecutive production days, or as described below.

The Department may take IA samples of the completed mixture at the plant. In the presence of the Department, test the IA samples for asphalt content and gradation according to the test methods indicated in the producer QC Plan. Take immediate corrective actions if the mixture does not conform to Table A.

The Department may take QA samples of the completed mixture at the plant or on the roadway directly from the uncompacted mixture placed by the paving equipment specified in Section 413.3(e). The Department will test QA samples according to PTM No. 757 or PTM No. 702, Modified Method D, if previously identified problematic aggregates are used in the mixture, for conformance to Table A. If the results of the QA samples do not comply with Table A, review the producer QC Plan and the QC test results that followed the QA samples for conformance to Table A. If QC results do not conform to Table A, perform the corrective actions necessary to provide a mixture conforming to Table A.

After completing corrective actions or the sample review, the Department will perform an on-site evaluation of the producer's plant operation and QC and then take a sample of the completed mixture at the plant. In the presence of the Representative, test the sample. If the sample does not comply with Table A, the Department will suspend certification. Immediately suspend shipping mixtures accepted by certification to the project.

After testing verifies that the produced mixture conforms to Tables A and B and with the Representative present, conduct JMF verification according to the producer QC Plan. After successfully completing JMF verification, resume both certification and shipping mixtures accepted by certification to the project.

## 413.3 CONSTRUCTION—

### (a) Preplacement Requirements.

**1. Paving Operation QC Plan.** Prepare a paving operation QC Plan, as outlined on Form CS-413, for field control and evaluation of asphalt concrete paving operations that addresses all recommendations and direction from the Technical Representative(s) associated with any WMA Technology being used. Submit the QC Plan to the Representative before or at the pre-construction conference. The QC Plan shall describe the construction equipment and methods necessary to construct and test the asphalt concrete courses as specified in Section 413.3. Do not start paving until after the Representative reviews the QC Plan.

**2. Preplacement Meeting.** At least 2 weeks before placing asphalt paving mixtures, schedule an asphalt preplacement meeting with the Representative to review at a minimum the specification, paving operation QC Plan, sequence of paving operations, mixture acceptance, density acceptance and the care and custody of asphalt acceptance samples.

**(b) Weather and Seasonal Limitations.** Do not place any asphalt paving mixtures outside of the following dates, unless an extension of the paving season, as specified in Section 413.3(b)1, is granted in writing by the District Executive.

- For all PG 64E-22 wearing courses, >10 million ESALs wearing courses, 4.75 mm wearing courses, or other wearing courses placed at compacted depths less than 1.5 inches, paving may occur April 1 to October 15.
- For all other courses, paving may occur April 1 to October 31.

Do not place asphalt paving mixtures when surfaces are wet or when the air or surface temperature is 40F or lower. If work is halted because of weather conditions, the Representative may allow the Contractor to place limited quantities of mixture that are enroute to the project.

**1. Paving Season Extensions.** Submit requests in writing for paving outside of the dates listed in Section 413.3(b) at least 14 calendar days before performing any extended season paving operations. With the written request, submit an Extended-Season Paving Plan on Form CS-413ES that addresses quality control operations in detail. The plan must address steps at the plant and in the field to ensure that a quality product will be delivered and constructed. Do not commence paving during the extended-season until the Representative reviews the Extended-Season Paving Plan.

An extension of the paving season will be granted in writing by the District Executive with the following additional requirements:

- For all PG 64E-22 wearing and binder courses, >10 million ESALs wearing courses, 4.75 mm wearing courses, or other wearing courses placed at compacted depths less than 1.5 inches, paving may occur April 1 to November 15.
- For all other courses, paving may occur March 1 to December 15.
- Density acceptance will be by pavement cores, regardless of quantity, for mixtures placed at the minimum compacted depths in Table G. For pavements not meeting the requirements for pavement cores, density acceptance will be by optimum-rolling pattern. For non-RPS pavements, the Representative may waive the pavement core requirement at their sole discretion provided the contractor’s quality control efforts give confidence that optimum density has been achieved throughout the course.
- Utilize a Material Transfer Vehicle (MTV) as specified in Section 108.05(c)5 on any day when the paving length will exceed 1,500 linear feet, unless the Representative determines the MTV to be infeasible for the location.
- Use an approved asphalt JMF, according to the temperature restrictions specified in Section 413, Table A
- Do not ship material to the project until the Representative on the project releases the shipment.
- At least five days before extended-season paving, schedule an extended-season preplacement meeting with the Representative to review, at a minimum, the details of the Extended-Season Paving Plan.

- If the Representative determines that the Extended-Season Paving Plan is not being followed, stop paving operations, modify processes to comply with the Extended-Season Paving Plan, and communicate process modifications to the Representative. Do not resume paving operations until the Representative authorizes paving operations to continue.
- Within 24 hours of paving completion, provide Form CS-413EQC to the Representative with all documentation and measurements associated with the extended-season paving operations outlined in the Extended-Season Paving Plan. Payment will not be made until the documentation is received.
- Paving work completed during the fall portion of the Extended-Season will be subject to a spring evaluation and manual survey by the Department to be conducted by May 1. Manual surveys will be conducted according to Publication 336. The Department will evaluate the material and workmanship looking at characteristics of fatigue cracking, transverse and miscellaneous cracking, raveling/weathering, rutting, flushing, potholing, joint and edge deterioration, and loss of bond/delamination to determine acceptance or remedial action as outlined below:

**Extended Season Paving Performance Requirements and Remedial Actions**

| Performance Criterion | Threshold Level | Remedial Action |
|---|---|---|
| Fatigue Cracking** | All low, medium or high severity* | Remove and replace as specified in Section 496, Table A |
| Transverse and Miscellaneous Cracking | All low to medium severity* | Crack seal as specified in Section 469 |
| | All high severity* | Remove and replace as specified in Section 496, Table A |
| Raveling/Weathering | All medium or greater severity* | Remove and replace as specified in Section 496, Table A |
| Rutting | > ¼ inch | Remove and replace as specified in Section 496, Table A |
| Flushing | All | Remove and replace as specified in Section 496, Table A |
| Potholes, Loss of Bond, Delamination | All | Remove and replace as specified in Section 496, Table A for Potholes |
| Longitudinal Joint or Edge Joint Deterioration | All low severity* | Crack seal as specified in Section 469 |
| | All medium or greater severity* | Remove and replace distressed layer full lane width on both sides transversely of the distressed area and a minimum of 24 inches beyond the distressed area in all longitudinal directions. |

* The Threshold Level according to Publication 336.
** Fatigue cracking will only be considered in those portions of the pavement under which the contractor has performed base course placement operations

The Department will solely make the determination and notify the Contractor whether the work is accepted, or remedial action is required. The contractor may witness the manual performance survey. As specified in 413.3(o), the BOPD, CMD will review representative determinations of defective material or workmanship. Remove and replace or repair defective work as directed at no additional cost to the Department. Should the distance between repair areas be less than 100 feet, make one continuous repair. All repairs must meet the surface tolerance requirements as specified in Section 413.3(l).

- A Final Acceptance Certificate will not be issued for paving completed during the extended season until the spring evaluation and any repair work is completed.
- Any necessary changes to means, methods, or materials are at no additional cost to the Department. Complete all work by the Required Completion Date or Construction Engineering Liquidated Damages, as specified in Section 108.07(a), will apply. If repairs are required following the spring evaluation, liquidated damages will not be applied during the winter shutdown period on the project and will be applied during the repair and associated work period.

**(c) Asphalt Mixing Plant.** Obtain asphalt mixtures from a plant fully automated and recordated and currently listed in Bulletin 41. Make any plant modifications, if needed, to introduce the WMA Technology additives, modifiers, or processes according to specific recommendations and direction from the WMA Technology Technical Representative(s) or process manufacturer to achieve a uniform blend of the WMA Technology additive, modifier or foaming process. The necessary facilities for inspection include a plant office as specified in Section 714.5(a), except the minimum floor space is 120 square feet. For recycled mixtures, add the following requirements:

**1. Batch Plant.** Modify the batch plant to measure the mass (weight) of the RAP and/or RAS before adding it into the pug mill. Design the cold-feed bin(s), conveyor system(s), charging chute(s), and all special bins to prevent RAP and/or RAS from segregating and sticking. Dry the virgin aggregate and RAM and then heat the virgin aggregate and RAM to a temperature that, after adding RAP and/or RAS, produces a completed mixture within the temperatures specified in Table A for the class and type of material used. Dry the aggregate according to the specific recommendations and direction from the WMA Technology Technical Representative(s) and heat to a temperature so the resulting completed mixture temperature is within the mixture temperature recommended by the WMA Technology Technical Representative(s) or manufacturer and Table A. Ensure that the aggregate is free of unburned fuel oil and excess moisture as specified in Section 413.2(e) 1.d.1 when delivered to the pug mill.

**2. Drum Mixer Plant.** Modify the drum mixer plant to prevent RAP and/or RAS from directly contacting the burner flame and prevent RAP and/or RAS from overheating. Design the cold-feed bin(s), conveyor system(s), charging chute(s), and all special bins to prevent RAP and/or RAS from segregating and sticking. Produce a completed mixture that is within the mixture temperature range recommended by the WMA Technology Technical Representative(s) or manufacturer and Table A. Ensure that the aggregate and completed mixture is free of unburned fuel oil and excess moisture as specified in Section 413.2(e) 1.d.1.

**(d) Hauling Equipment.** Haul the mixtures in tightly sealed vehicles that do not contain petroleum oils, solvents, or other materials that adversely affect asphalt mixture. Provide covers of sufficient size and quality to protect the entire load under all conditions. Maintain the proper and uniform placement temperature as specified in Section 413.3(h)1. Provide insulation on all sides of the truck body, a double-walled truck body, or a heated truck body when the air temperature is below 50F from October 1 to April 30. Provide a 3/8 inch diameter hole near the center and approximately two-thirds the distance down from the top of the vehicular box, on both sides, to allow for asphalt mixture temperature checks.

**(e) Paving Equipment**

**1. Asphalt Pavers.** Provide self-contained, power-propelled units with activated screeds or activated strike-off assemblies and with automatic screed controls, capable of producing a finished surface of specified evenness and texture. Provide heated units capable of spreading and finishing the mixture to the widths and depths indicated. Provide units capable of being operated at forward speeds consistent with satisfactory placement of the mixture, equipped with receiving hoppers having sufficient capacity for uniform spreading, and equipped with distribution systems that place the mixture uniformly in front of the screeds.

Use hydraulic or other extension types against abutting lanes or longitudinal joints only if the unit feeds and activates the extension by the same method as the main screed. For fixed width paving operations on pavers where the screed is fed by augers, provide auger extensions to within 18 inches or less of the end gate. At the outside edge of pavement widths that cannot be uniformly placed, the Contractor may use a non-activated extension when approved by the Inspector-in-Charge.

Do not use equipment that tears, shoves, or gouges the mixture, or that causes tracks, indented areas, flushing, segregation, or other permanent blemishes. Do not use blade graders or drags.

**2. Asphalt Wideners.** Provide self-contained, power-propelled units with strike-off assemblies capable of producing a finished surface of specified evenness and texture. Provide units capable of spreading and finishing the mixture to the widths and depths indicated. Provide units capable of being operated at forward speeds consistent with satisfactory placement of the mixture, equipped with receiving hoppers having sufficient capacity for uniform spreading, and equipped with distribution systems that place the mixture uniformly in front of the strike-off assemblies.

Do not use equipment that tears, shoves, or gouges the mixture, or that causes tracks, indented areas, flushing, segregation, or other permanent blemishes.

**(f) Rollers.** Use steel-wheel, pneumatic-tire, vibratory, or oscillating rollers as specified in Section 108.05(c)3a, 3b, 3c, 3e, 3f, 3h, or 4. Operate rollers according to manufacturer's recommendations. Use vibratory and oscillating rollers with separate controls for frequency and amplitude.

**(g) Preparation of Existing Surface.**

**1. Conditioning of Existing Surface.** Before delivering asphalt mixtures, remove and dispose of loose and foreign material and excess joint sealer and crack filler from the surface of existing pavement or previously placed pavement courses. If necessary, use a broom.

Before placing a wearing course, correct irregularities in the binder course. If practical, do not allow traffic on the binder course to prevent contamination. Remove and replace binder course that cannot be cleaned to the Representative’s satisfaction.

Paint existing vertical surfaces of curbs, structures, gutters, and pavements that will be in contact with asphalt mixtures with a uniform coating of either emulsified asphalt, consisting of PennDOT Material Class TACK or NTT/CNTT and applied in two or more applications, or hot asphalt binder of the class and type designated for the asphalt course.

Before overlaying existing surfaces and previously placed courses, apply a tack coat as specified in Section 460 unless otherwise indicated.

**2. Scratch and Leveling Courses.** Where indicated, place a separate scratch or leveling course ahead of resurfacing operations. Use a scratch course to fill wheel ruts and other local small depressions even with the surrounding pavement. Use a leveling course to provide a relatively uniform working platform for placing binder or wearing courses.

**3. Paving Notches.** Mill the existing pavement surface at tie-in locations as shown on the Standard Drawings, or as otherwise indicated. Perform milling with equipment as specified in Section 491.3(a).

**(h) Spreading and Finishing.**

**1. General Requirements.**

**1.a Placing.** Unless otherwise allowed or indicated, deliver, place, and compact asphalt paving mixtures during daylight hours. Ensure the mixture does not contain lumps of cold material. Deliver and place mixtures at the laying temperatures specified in Table A for the type and class of material used. Do not incorporate any material delivered outside the temperature limits as specified in Table A

Utilize a Material Transfer Vehicle (MTV) as specified in Section 108.05(c)5 for RPS pavements unless otherwise approved by the Representative (See Section 101.01).

**1.b Spreading and Finishing.** Spread and strike off the mixture for the entire lane width or as much lane width as practical. Adjust screed assemblies to provide the required cross section and depth. After spreading, do not add mixture to the pavement mat that is segregated, below the minimum temperature, contains either a deficiency or an excess of asphalt content, or is otherwise unsuitable to add to the pavement mat.

If the course is more than 6 inches in compacted depth, construct it in two or more layers of approximately equal depth, with no layer less than 3 inches or more than 6 inches in compacted depth. For binder or leveling courses that have isolated areas exceeding 6-inch compacted depth, use a scratch or leveling course to eliminate the isolated areas before full-depth paving.

Immediately after placing the asphalt mixture, work the exposed outer edges to eliminate sharp, ragged, and open edges, to eliminate an unfinished appearance, and to reduce edge breakdown. Immediately repair edge breakdowns.

In areas where mechanical spreaders cannot be used, place and screed the mixture with suitable hand tools. Do not use rakes.

Adjacent to flush curbs, gutters, and other abutting structures, place the wearing course mixture uniformly higher so that after compaction the finished surface is slightly above the edge of the abutting structure. Remove harmful material, clean, and seal the surface of wearing courses adjacent to curbs to form an asphalt gutter. Seal the mixture surface with a hot asphalt material of the class and type listed in Table A. Evenly apply the asphalt material a minimum width of 12 inches from the curb. The Contractor may use emulsified asphalt, consisting of PennDOT

Material Class TACK or NTT/CNTT, instead of hot asphalt binder material if allowed by the Inspector-in-Charge. Control the application rate so residual asphalt completely fills surface voids and provides a watertight joint along the curb. If necessary, apply emulsified asphalt in two or more applications. After sealing, remove excess sealant material.

**1.c Mixture Production, Delivery and Placing Temperatures When Placing Over Membrane Systems as Specified in Section 467 or Section 680.** If a project includes an item or items of work for membrane systems, as specified in Section 467 or Section 680, produce and place asphalt mixture on top of the membrane at elevated mixture temperatures as per the membrane manufacturer's recommendation and within the Table A temperature requirements. Ensure proper adhesion between the asphalt pavement overlay and the underlying membrane.

**1.d Field Technician.** Provide a certified asphalt field technician, with the qualifications according to Publication 351, to control the placement of asphalt mixtures. Instruct and train the certified asphalt field technician to control the paving operation so that the completed paving work complies with the specified requirements. A certified asphalt field technician must be onsite and carry a valid certification card during placement of all asphalt mixtures.

**1e. Safety Edge**. Construct the Safety Edge as the standard edge treatment on the outside edge of asphalt pavements and shoulders. Use the Safety Edge for both wearing and binder courses with a depth of 1.5 inches or greater. Do not place the Safety Edge at total depths greater than 5 inches. The Safety Edge is not required where curb or sidewalk are encountered or where the face of guiderail is directly over the edge of pavements. Do not place the Safety Edge for base, leveling, or scratch courses.

Construct the Safety Edge with the same material used to construct the roadway course being placed or, if specified, the paved shoulders. Attach a device to the paver to confine material at the end gate and extrude the asphalt material in a wedge shape. Use an adjustable device that allows the operator to vary the slope extruded at the paver to account for the angle becoming steeper during compaction (roll up). Before construction, the Safety Edge device must be approved by the Representative(s) (See Section 101.01).

Compact the roadway or paved shoulder as required by the specifications. Do not delay rolling of the mat adjacent to the Safety Edge. After compaction of the mat is complete, provide a Safety Edge meeting the final shape requirements as shown on the Standard Drawings. The completed angle of the Safety Edge must be 26 to 40 degrees measured from the pavement cross slope extended. At the beginning of each days paving, measure the angle of the Safety Edge from the pavement cross slope extended. Perform measurements after final compaction is complete. If the angle of the Safety Edge does not meet the slope requirements, stop paving and provide corrective action. Do not resume production paving until final shape requirements of Safety Edge are achieved.

Allow automatic transition to intersections, driveways, guiderail sections, and obstructions.

Use the device to constrain the asphalt head, reducing the area and increasing the density of the extruded profile. A single plate strike-off method is not allowed. Do not place the Safety Edge on organic material.

**2. Mixture Lot Acceptance (Standard and RPS Construction).** Lot acceptance is appropriate for standard construction placed in quantities that allow consistent operation of the plant and is appropriate for RPS construction.

**2.a Lots and Sublots.** Material will be accepted in the field on a lot by lot basis. Lots will be established cumulatively and will be specific for each JMF. Once the sublot size for each specific JMF has been established based on the project's plan quantity, the sublot size will remain unchanged throughout project completion. A completed sublot has a mixture acceptance box sample as specified in Section 413.3(h)2.b and either a core collected according to PTM No. 1 and PTM No. 729, or other density acceptance as specified in Section 413.3(j).

For JMFs placed in quantities of 2,500 tons or greater, a normal lot size is 2,500 tons with five, 500 ton sublot s (n=5), unless operational conditions or project size dictate otherwise. If operational conditions or project size dictate, readjustment of the lot will be made as specified in Table D. Breakdowns or stoppages of short periods due to such causes as weather or equipment failure will not be considered as reasons to adjust the lot size. The original lot will be continued when work resumes after short stoppages of less than 5 calendar days. If a lot is ended due to a stoppage of 5 calendar days or more, adjust the lot size and number of sublots as specified in Table D. If the work stoppage is 5 calendar days or more, a new lot will be established.

To terminate a lot without a work stoppage of 5 calendar days or more, stop paving operations and notify the Inspector-in-Charge in writing of the lot termination and include the reason for termination. Do not begin paving again until the Inspector-in-Charge authorizes paving activities to resume. If a lot is terminated when quantities exceed a normal size lot of 2,500 tons, the work will be considered two separate lots, a normal size lot and a terminated lot.

The terminated lot will be only that portion of the work which exceeds the 2,500 ton normal sized lot up to the point the paving operations were stopped.

A terminated lot will be evaluated based on the samples obtained before the lot was terminated. For terminated lots with three or more sublots, acceptance will be determined using PWL pay factor adjustments. Terminated lots with two or fewer sublots will be evaluated as specified in Section 413.3(h) 2.a.1. For terminated lots where density acceptance is by pavement cores, if the first randomly selected coring location was not yet reached at the time the lot was terminated, the Inspector will recalculate one new sample location according to PTM No. 1, PTM No. 729, and PTM No. 746 from the pavement placed.

The payment for any terminated lot the Contractor elects to terminate will be 95% of the contract unit price or the payment value determined by evaluating the samples tested, whichever is less. Remove and replace terminated lot pavements when test results indicate defective work. The District Executive will not consider requests for reduced payment on terminated lots when test results indicate defective work.

**TABLE D**
**Re-adjustment of Lot Size and Associated Number of Sublots**

| Remaining Quantity* Following Last Full Lot | Action |
|---|---|
| Less than 500 tons without a combination of one mixture acceptance sample and one core** | Quantity combined with the previous lot, (n=5) |
| Less than 500 tons with a combination of one mixture acceptance sample and one core** | One new sublot defined and quantity combined with the previous lot, (n=6) |
| 500 tons to less than 1,000 tons without a combination of two mixture acceptance samples and two cores** | One new sublot defined and quantity combined with the previous lot, (n=6) |
| 500 tons to less than 1,000 tons with a combination of two mixture acceptance samples and two cores** | Two new sublots defined and quantity combined with the previous lot, (n=7) |
| 1,000 tons to less than 1,500 tons without a combination of three mixture acceptance samples and three cores** | Two new sublots defined and quantity combined with the previous lot, (n=7) |
| 1,000 tons to less than 1,500 tons with a combination of three mixture acceptance samples and three cores** | New lot defined, (n=3) |
| 1,500 tons to less than 2,000 tons without a combination of four mixture acceptance samples and four cores** | New lot defined, (n=3) |
| 1,500 tons to less than 2,000 tons with a combination of four mixture acceptance samples and four cores** | New lot defined, (n=4) |
| 2,000 tons to less than 2,500 tons without a combination of five mixture acceptance samples and five cores** | New lot defined, (n=4) |
| 2,000 tons to less than 2,500 tons with a combination of five mixture acceptance samples and five cores** | New lot defined, (n=5) |
| *For contract items bid on an area basis, compute equivalent tons based on design depth of paving course and design density as specified in Section 110.04(b)4.b.<br><br>** If mat density is accepted using pavement cores and mixture acceptance is by lots. | |

**2.a.1 Partially Completed Lots (n=2 or less).** When process conditions change to an extent that a partially completed lot cannot be combined with the most recently completed lot, samples will be independently evaluated on the partially completed lot. For asphalt content and percent passing the 75 µm (No. 200) sieve, mixture acceptance samples will be evaluated individually as specified in Section 413.2(e), Table A (n=1) criteria. For density, mat density acceptance samples will be evaluated individually using the criteria in Table E.

If samples tested for asphalt content and percent passing the 75 µm (No. 200) sieve meet the n=1 criteria of Table A, and samples tested for density meet the criteria in Table E, payment will be 100% of the contract unit price. If samples tested for asphalt content and percent passing the 75 µm (No. 200) sieve do not meet the n=1 criteria of Table A, the material will be considered defective work. If samples tested for density are no more than 2.0% below the minimum or no more than 2.0% above the maximum limits of Table E, payment will be 90% of the contract unit price. If samples for density are more than 2.0% below the minimum or more than 2.0% above the maximum limits of Table E, the pavement will be considered defective work.

Unless otherwise directed in writing by the District Executive, remove and replace defective work.

**TABLE E**
**Density Limits for Partially Completed Lots**

| MIXTURE NMAS | DENSITY LIMITS |
|---|---|
| All RPS 9.5 mm, 12.5 mm, 19 mm, and 25 mm Wearing or Binder Courses | ≥ 92.0% and ≤ 98.0% |
| All Standard 9.5 mm, 12.5 mm, 19 mm, and 25 mm Wearing or Binder Courses | ≥ 91.0% and ≤ 98.0% |
| All 25 mm and 37.5 mm Base Courses | ≥ 90.0% and < 100.0% |

**2.a.2 For JMF's placed in quantities less than 2,500 tons.** For JMFs placed in quantities of greater than 500 tons and less than 2,500 tons, the tonnage will be considered a lot. The lot will be divided into five equal sublots.

For JMFs placed in quantities of 500 tons or less, mixture acceptance will not be applicable for PWL pay factor adjustments and will be accepted by certification. If density acceptance is by pavement cores, the tonnage will be considered a lot and the lot will be divided into three equal sublots. Density acceptance will be determined using PWL pay factor adjustments.

**2.b Mixture Acceptance Samples.** The Representative will select different sample locations in each sublot according to PTM No. 1 and PTM No. 746. In the presence of the Inspector, obtain one loose mixture sample for each sublot directly from the uncompacted mixture placed by the paving equipment specified in Section 413.3(e) and immediately package. For 19 mm and smaller NMAS mixtures, package individual samples in cardboard boxes dimensioned approximately 3 3/4 inches x 4 3/4 inches x 9 1/2 inches. For 25 mm and larger NMAS mixtures, package individual samples in cardboard boxes dimensioned approximately 5 inches x 5 1/2 inches x 9 inches. Do not package samples in cardboard boxes with any one dimension greater than 10 1/4 inches or any one dimension smaller than 3 1/2 inches.

Immediately after packaging and in the presence of the Representative, identify the samples by ECMS project number, lot and sublot number, location (station and offset), date of placement, mixture type, and as acceptance samples (Sample Class AS). Leave at least one side of the cardboard sample box free of any writing or marking for LTS use in testing the samples.

Immediately after identifying, submit the samples to the Representative.

For quality control purposes, a maximum of one loose sample per sublot may be obtained. No loose mixture or core samples may be taken by the Contractor for mixture composition testing after the mixture acceptance samples are obtained. Do not obtain any other pavement samples, except those which are directed by and surrendered to the Department, unless allowed in writing from the District Executive.

The Contractor may elect to expedite delivery of the acceptance samples to the LTS at no additional cost to the Department. If the delivery is expedited, the Inspector will secure all containers with Department issued, uniquely numbered security tape. The Inspector will record the information from the security tape onto Form TR-447 which will be packaged inside the secured container and return the secured containers to the Contractor for transport to the LTS.

The Contractor may transport the secured samples to the LTS or utilize a third-party shipping service. If the Contractor elects to utilize a third-party shipping service, the service must provide the ability to track package delivery.

Provide all expedited delivery details in the QC Plan and discuss expedited delivery details at the preconstruction and pre-paving meetings. For expedited delivery, provide all containers, cushioning material, and packaging supplies to the Inspector. The Inspector will package all samples in the provided containers and secure the samples prior to surrendering the secured containers to the Contractor.

Upon arrival at the LTS, the secured containers will be visually examined for evidence that the tape has not been compromised and the unique numbers will be compared between the security tape and the value recorded on Form TR-447 inside the container. If sample security has not been compromised, samples received under expedited delivery will be tested on a priority basis. If the containers show any signs of compromised security, the following conditions apply:

- Obtain replacement samples as directed within 12 inches longitudinally of the original samples.
- Immediately stop expedited delivery and all samples will be delivered to the Inspector for transport.
- Conduct an investigation to determine the cause of the compromised security and provide a written explanation to the Representative.

- Do not resume expedited delivery until the Representative has reviewed the written explanation and is satisfied that proper steps have been taken to address the issue. The Department reserves the right to terminate expedited delivery after the first occurrence of compromised sample security.

**2.b.1 Theoretical Maximum Specific Gravity (Gmm) Verification Samples.** For federally funded projects or projects on the National Highway System, when density acceptance is by pavement cores, obtain a second loose mixture sample as specified in Section 413.3(h)2.b in each sublot at the same location as the mixture acceptance sample and immediately package in cardboard boxes sized as specified in Section 413.3(h)2.b. The second loose mixture sample at each location will be used to determine the theoretical maximum specific gravity (Gmm) and corresponding theoretical maximum density (lbs/ft$^3$) values for each sublot.

Immediately after packaging and in the presence of the Inspector, identify the sample by ECMS project number, lot and sublot number, location (station and offset), date of placement, mixture type, and as Gmm verification samples (Sample Class FV). Leave at least one side of the cardboard sample box free of any writing or marking for LTS use in testing the samples.

**2.c Mixture Acceptance and Gmm Verification Sample Testing.** Utilize LTS Testing unless otherwise indicated in the proposal. These procedures apply to standard and RPS construction.

**2.c.1 LTS Testing.** The LTS will test the mixture acceptance samples according to PTM No. 757 or PTM No. 702, Modified Method D and PTM No. 739, if previously identified problematic aggregates are used in the mixture, to determine asphalt content and the percent passing the 75 μm (No. 200) sieve. The LTS will use the calibration factors ($C_f$ and 200 $C_f$) provided with the JMF for PTM No. 757. For individual increment test results outside of the single sample (n=1) tolerances in Table A, the LTS will analyze the test results for extreme values according to PTM No. 4 at the 5% significance level. If discarding an extreme value reduces a lot to less than three remaining test results, the Department will accept the lot as specified in Section 413.3(h)2.a.1. The Department will accept lots with three or more test results as specified in Section 413.4(a)4 or Section 413.4(b).

If the asphalt content or the percent passing the 75 μm (No. 200) sieve is not within the single sample (n=1) or multiple sample (n≥3) tolerances in Table A for two consecutive lots or a total of three lots, stop all production of the JMF. Determine the cause of the problem and provide a proposed solution to the Department.

Do not resume production of the JMF until the Representative reviews the proposed solution and authorizes production to continue.

The LTS will test Gmm verification samples as specified in Section 413.3(j)4.d

**3. Pattern Segregation.** Pattern segregation is continuous or repeated areas of non-uniform distribution of coarse and fine aggregate particles in the finished mat. The Department will address pattern segregation as follows:

**3.a Evaluating Pattern Segregation.** If the Representative observes pattern segregation that may result in defective pavement, then:

- The Inspector will notify the Contractor of the observed pattern segregation.

- The Contractor may continue to work at their own risk while immediately and continually adjusting the operation to eliminate the pattern segregation from future work.

- As a minimum and in the presence of the Representative, determine the average depth of pavement surface macrotexture according to PTM No. 751 in areas with the pattern segregation and in areas with non-segregated pavement. The pattern segregation is unacceptable if the difference in average pavement texture depth between the non-segregated and segregated areas exceeds 0.024 inch. The Representative will determine if the pavement is defective as specified in Section 413.3(h)3.c.

**3.b Test Section.** If the macrotexture tests identify unacceptable pattern segregation, then:

- Immediately suspend placing the asphalt course. Evaluate the cause of pattern segregation according to the Paving Operation QC Plan and as directed. Provide proposed corrective actions to the Representative and do not resume placing the asphalt course until after the Representative reviews the proposed corrective actions and authorizes paving to continue.

- Determine if the pattern segregation resulted in defective pavement as specified in Section 413.3(h)3.c.

- After the Representative allows paving to resume, place a test section not to exceed 200 tons. If the corrective actions do not eliminate observed pattern segregation, the Department will suspend paving, even if it is before the Contractor places the entire test section. Propose additional corrective actions and construct another test section. Resume normal paving operations after constructing an entire test section without pattern segregation as determined by the Representative.

**3.c Defective Pavement.** At locations selected by the Inspector and with the Inspector present, drill a minimum of three 6-inch diameter cores from the area of pattern segregation and a minimum of three cores from the pavement representing a non-segregated area. Do not compress, bend, or distort samples during cutting and handling and immediately provide the cores to the Inspector. The Inspector will transport cores to the producer's laboratory. With the Inspector present, test the cores at the plant for density, asphalt content, and gradation. The Department may request additional tests as part of its evaluation of pattern segregation. Determine the maximum theoretical density according to Bulletin 27, the core density according to PTM No. 715, and asphalt content according to PTM No. 757 if previously identified problematic aggregates are used in the mixture, PTM No. 702 modified Method D, and PTM No. 739 or other test method identified in the producer QC Plan.

An area of pattern segregation contains defective pavement if the summation of absolute deviations from any two sieves is 20% or more from the JMF, the core density is defective, the mixture is defective in asphalt content, or the mixture is defective for percent passing the 75 μm (No. 200) sieve. Remove and replace the full width of the affected lane and a minimum of 5 feet beyond each end of the area with unacceptable pattern segregation. Construct replacement pavement conforming to the appropriate surface tolerances as specified in Section 313.3(l) or Section 413.3(l).

**4. Flushing.** Provide a mix that will not flush. Flushing is continuous or repeated areas of excessive asphalt on the pavement surface. The Department may recognize flushing until the Department approves the project through final inspection. The Department will address flushing as follows:

**4.a Evaluating Flushing.** When the Representative observes flushing, then:

- The Representative will immediately notify the Contractor of the observed flushing.

- The Contractor may continue work at their own risk while immediately and continually adjusting the operation to eliminate flushing from future work.

- In the presence of the Representative, determine the average depth of pavement surface macrotexture according to PTM No. 751 in areas of suspected flushing. If the average texture depth is less than or equal to 0.006 inches, then the pavement will be considered to be flushed and is defective.

**4.b Test Section.** If the macrotexture tests identify flushing, then:

- Immediately suspend placing the paving course. Evaluate the cause of flushing according to the Paving Operation QC Plan and as directed. Provide proposed corrective actions to the Representative and do not resume placing the paving course until after the Representative reviews the proposed corrective actions and authorizes paving to continue.

- Remove and replace the defective wearing course at no additional cost to the Department for the full width of the affected lane and a minimum of 5 feet beyond each end of the area of defective wearing course. Construct replacement wearing course conforming to the appropriate surface tolerances as specified in Section 413.3(l).

- After the Representative allows paving to resume, place a test section not to exceed 200 tons. If the corrective actions do not eliminate observed flushing, the Department will suspend paving even if it is before the Contractor places the entire test section. Propose additional corrective actions and construct another test section. Resume normal paving operations after constructing an entire test section without flushing as determined by the Representative.

**(i) Compaction.** Compact the mixture to achieve the density acceptance requirements and to eliminate all roller marks. Compact the mixture while it is in proper condition and adjust roller speed, amplitude, frequency, pattern, and roller size to eliminate displacement, shoving, cracking, and aggregate breakage. Satisfactorily correct displacement resulting from reversing roller directions and other causes.

Without using excess water, maintain wheels of steel-wheel rollers moist and clean to prevent the mixture from adhering to the wheels. Use suitable methods to clean wheels of pneumatic-tire rollers.

Use pneumatic-tire rollers for compacting scratch courses.

For areas inaccessible to rollers, compact with mechanical vibrating hand tampers.

Remove areas that are loose, broken, mixed with dirt, or show an excess or deficiency of asphalt material. Replace removed mixture with fresh hot mixture and compact the mixture even with the surrounding pavement surface.

**(j) Mat Density Acceptance.**

**1. General.** The Department will accept the mat density of standard construction according to one of the levels in Table F. Areas may be accepted by non-movement or optimum-rolling pattern based on the criteria in Sections 413.3(j)2 and 413.3(j)3. Do not place mixtures for non-movement or optimum-rolling pattern acceptance until the Department has approved the density-acceptance level.

The Department will accept the mat density of RPS construction by lots and pavement cores as specified in Section 413.3(j)4. The Department will accept mat density of all 4.75 mm NMAS asphalt mixtures by non-movement or optimum-rolling pattern.

**TABLE F**
**Density Acceptance**

| Density Acceptance Level | Acceptance Criteria |
|---|---|
| Non-Movement | Table H |
| Optimum-Rolling Pattern | Table H |
| Pavement Cores | Table I |

**2. Non-Movement.** The Inspector-in-Charge will approve density acceptance by non-movement for the following materials, conditions, or applications:

- Scratch courses or leveling courses less than 1-inch in depth or equal to or less than 110 pounds per square yard.
- Areas of paving or patching less than 4 feet in width or narrow enough to cause bridging of the area by approved compaction equipment.

The Inspector-in-Charge will accept density by non-movement for the following materials, conditions, or applications if they are determined by the Representative to be non-critical for density:

- Materials placed in small quantities not exceeding 500 tons in a continuous placement.
- Mixtures placed on unstable or non-uniform bases.
- Mixtures used for patching, road widening, shoulders, driveway adjustments, parking lots, and other miscellaneous applications determined by the Representative. Shoulders where density is critical will be accepted by pavement cores as specified in Section 413.3(j)4.a.

The Department will accept the density when the mixture does not move under the compaction equipment.

**3. Optimum-Rolling Pattern.** The Inspector-in-Charge may accept density using an optimum-rolling pattern for the following materials, conditions, or applications:

- Materials placed in small quantities not exceeding 500 tons in a continuous placement.

- Mixtures placed on unstable or non-uniform bases.

- Leveling courses or other courses that are greater than or equal to 1-inch in depth or greater than or equal to 110 pounds per square yard.

- Mixtures used for patching, road widening, driveway adjustments, parking lots, shoulders where density is not critical, and other miscellaneous applications determined by the Representative. Shoulders where density is critical will be accepted by pavement cores as specified in Section 413.3(j)4.a.

- Mixtures placed at less than the minimum compacted depths in Table G.

With the Representative and the Contractor's certified asphalt field technician present, determine density with an approved nuclear gauge according to PTM No. 402, or determine density with an approved electrical impedance gauge according to PTM No. 403. Nuclear gauges must be operated by a licensed nuclear gauge operator. In the presence of the Representative, establish the optimum-rolling pattern for each course according to PTM No. 402 or PTM No. 403. Document optimum-rolling patterns using the appropriate Form TR-4276B or Form TR-4276C and provide the completed forms to the Representative. Compact the course according to the optimum-rolling pattern. During paving, the Representative may require the Contractor to verify the target density established by the optimum-rolling pattern. If the target density is not achieved, establish a new optimum-rolling pattern as directed. The Representative will suspend paving when the optimum-rolling pattern is not being followed.

Use one of the following gauges or approved equal:

- Troxler Electronics, Model 3411B or Model 4640B
- Campbell Pacific Nuclear, Model MC-2
- Seaman Nuclear, Model MC-2
- TransTech Systems, Inc., PQI™, Model 300 or Model 301
- Troxler Electronic Laboratories, PaveTracker™

Submit a copy of the certificate of nuclear gauge annual calibration according to ASTM D2950 and documentation of training of the nuclear gauge operator. Recalibrate any nuclear gauge that is damaged or repaired.

**4. Pavement Cores (Standard and RPS Construction).**

**4.a General.** Pavement cores are required for accepting the density of RPS construction. Pavement cores are required for standard construction of extended-season paving, unless waived by the Representative as specified in Section 413.3(b)1. Pavement cores are appropriate for accepting the density of standard construction if all of the following materials, conditions, or applications exist:

- Materials placed at compacted depths greater than or equal to the minimum depths specified in Table G.

- Materials placed on stable and uniform bases.

**TABLE G**
**Mixture Minimum Compacted Depths**

| Mixture | Minimum Depth |
|---|---|
| 9.5 mm Wearing Course | 1 1/2 in. |
| 12.5 mm Wearing Course | 2 in. |
| 19 mm Binder Course | 2 1/2 in. |
| 25 mm Binder Course | 3 in. |

**4.b Lots and Sublots.** Section 413.3(h)2.a.

**4.c Density Acceptance Samples.** The Inspector will select different sample locations in each sublot according to PTM No. 1, PTM No. 729, and PTM No. 746. With the Inspector present, drill 6-inch diameter cores as soon as possible but no later than the day following placement. The core at each location will be used to determine the bulk specific gravity (Gmb) and density (lbs/ft$^3$) of the compacted mix. Do not compress, bend, or distort samples during cutting, handling, transporting, and storing. If samples are damaged, immediately obtain replacement samples, as directed by the Inspector, from within 12 inches of the original sample location. Within 24 hours after coring, backfill the hole with mixture of the same JMF or with mixture used for subsequent courses and compact and seal the mixture.

In the presence of the Inspector, identify the samples by ECMS project number, lot and sublot number, location (station and offset), date of placement, mixture type, and as acceptance samples (Sample Class AS). Provide the daily theoretical maximum specific gravity value as specified in Section 413.2(e) 1.d.4 for the density calculation of each sublot in the lot. If density samples from the lot are taken from more than 1 day's placement, the daily theoretical maximum specific gravity values from each production day will be used to calculate the percent of theoretical density for each individual density acceptance core placed on that production day upon Gmm verification as specified in Section 413.3(j)4.d.1. Immediately deliver the samples to the Inspector and provide sample containers of sufficient strength to prevent samples from being damaged during transport. The Representative will submit samples for one lot in one container.

For quality control purposes, a maximum of one pavement core per sublot may be obtained unless the Representative allows additional cores. No cores may be taken by the Contractor after the acceptance cores are obtained. Do not obtain any other pavement cores, except those which are directed by and surrendered to the Department, unless allowed in writing by the District Executive.

The Contractor may expedite delivery of the acceptance samples to the LTS at no additional cost to the Department. If the delivery is expedited, the Inspector will secure all containers with Department issued, uniquely numbered security tape. The Inspector will record the information from the security tape onto Form TR-447 which will be packaged inside the secured container and return the secured containers to the Contractor for transport to the LTS.

The Contactor may transport the secured samples to the LTS or utilize a third-party shipping service. If the Contractor elects to utilize a third-party shipping service, the service must provide the ability to track package delivery.

Provide all expedited delivery details in the Paving Operation QC Plan and discuss expedited delivery details at the preconstruction and pre-paving meetings. For expedited delivery, provide all containers, cushioning material, and packaging supplies to the Inspector. The Inspector will package all samples in the provided containers and secure the samples prior to surrendering the secured containers to the Contractor.

Upon arrival at the LTS, the secured containers will be visually examined for evidence that the security tape has not been compromised and the unique numbers will be compared between the security tape and the value recorded on Form TR-447 inside the container. If sample security has not been compromised, samples received under expedited delivery will be tested on a priority basis. If the containers show any signs of compromised security, the following conditions apply:

- Obtain replacement samples as directed within 12 inches longitudinally of the original samples.
- Immediately stop expedited delivery and all samples will be delivered to the Inspector for transport.
- Conduct an investigation to determine the cause of the compromised security and provide a written explanation to the Representative.
- Do not resume expedited delivery until the Representative has reviewed the written explanation and is satisfied that proper steps have been taken to address the issue. The Department reserves the right to terminate expedited delivery after the first occurrence of compromised sample security.

**4.d Acceptance and Gmm Verification Sample Testing.** These procedures apply to standard and RPS construction.

**4.d.1 LTS Acceptance and Gmm Verification Testing.** The LTS will test each density acceptance sample according to PTM No. 715, and if necessary PTM No. 716, to determine the bulk specific gravity (Gmb) and bulk density (lbs/ft$^3$) of the compacted mixture. For individual increment test results outside of the lower and upper specification limits in Table I, the LTS will analyze the bulk density test results for extreme values according to PTM No. 4 at the 5% significance level. If discarding an extreme value reduces a lot to less than three remaining test results, the Department will accept the lot as specified in Section 413.3(h)2.a.1. The Department will accept lots with three or more test results as specified in Section 413.4(a)4 or Section 413.4(b)

For lots with no required Gmm verification loose mixture samples, the Contractor's daily theoretical maximum specific gravity values from each production day will be used for acceptance.

For lots with required Gmm verification loose mixture samples, the LTS will randomly select one of the Gmm verification loose mixture samples obtained as specified in Section 413.3(h)2.b.1 from the lot according to PTM No. 1. The LTS will test the randomly selected Gmm verification loose mixture sample to determine the theoretical maximum specific gravity (Gmm) of the compacted mixture according to AASHTO T 209 as modified in Bulletin 27, with the following exception:

- The samples will be obtained as specified in Section 413.3(h) 2.b.1.

The LTS will compare the randomly selected Gmm verification sample test result with the Contractor's daily Gmm value for that same production or placement date. If the LTS and Contractor Gmm values do not differ by more than ± 0.030, the Contractor's daily Gmm values in the whole lot will be considered verified and the Contractor's daily Gmm values will be used to determine the percent of theoretical maximum density for each density acceptance sample placed on that date. If the initial randomly selected LTS Gmm verification sample test result differs from the Contractor's daily Gmm value for that same production or placement date by more than ± 0.030, the LTS Gmm test result value will be used as the acceptance Gmm value to determine the percent of theoretical maximum density for the individual density acceptance cores produced or placed on that same date. The Department reserves the right to select more than one Gmm verification sample from the lot representing the same production or placement date and to select other Gmm verification samples from the lot representing different production or placement dates to verify the Contractor's daily Gmm values. When more than one Gmm verification sample is selected from the lot representing the same production or placement date, the LTS Gmm test results will be averaged and the average will be used to verify the Contractor's daily Gmm value for that same production or placement date.

Individual sublot density values will be calculated and then rounded to the nearest tenth of a percent of theoretical maximum density according to ASTM E 29. Lot average density will subsequently be calculated from the individual sublot values and then rounded to the nearest tenth of a percent theoretical maximum density according to ASTM E 29. The Department will determine acceptance, with respect to density, as specified in Section 413.4(a)4 or Section 413.4(b).

If cores are not taken within 1 day after placing the mixture, or if the density for two consecutive lots or for a total of three lots does not meet the density payment factor percentage of ≥100, stop paving operations for the project as directed. Review and evaluate the operation and determine the cause of the problem. Do not resume paving until after the Representative reviews the proposed solution and authorizes paving to continue.

**(k) Joints.**

**1. Longitudinal Joints.**

**1.a General.** Offset joints in a layer from the joint in the layer immediately below by approximately 6 inches. Plan joint locations to ensure that the joint in the top layer is at the approximate pavement centerline for two-lane roadways and within 12 inches of the lane lines for roadways with more than two lanes. Avoid joint locations directly beneath planned pavement marking applications where possible.

Before placing abutting lanes, paint the entire area of the joint with a uniform coating of asphalt material, the PG-Binder used in the pavement course or PG 64S-22. Painting of the joint face is not required for scratch courses.

Place and compact the mixture at the joint according to the Paving Operation QC Plan. Ensure the surface across the joint and along the joint is within the surface tolerances specified in Section 413.3(l).

Adhere to the following additional requirements for the construction of longitudinal joints that will not be evaluated as specified in Section 405:

- Assure a true line when paving. Place and closely follow lines or markings for this purpose. When compacting loose mixture at an unsupported edge, make the first roller pass with the edge of the roller drum extending beyond and overhanging the unsupported edge by 3 to 6 inches. Do not allow pneumatic-tire rollers to cause lateral movement at any unsupported edge.
- When placing uncompacted mixture adjacent to a previously compacted lane, operate the paver so that the material overlaps the edge of the previously placed lane by 1 to 1 1/2 inches. Ensure that mixture behind the screed is tightly pushed against the free face of the existing lane. Maintain the uncompacted mixture uniformly higher than the existing lane by at least 1/4 inch per inch of material being placed to assure full compaction. When possible, use automated joint matchers when constructing joints between traveled lanes. Do not bump back or lute the overlapped material unless overlap inadvertently exceeds the specified tolerances. When compacting the loose mix at the longitudinal joint, keep the roller drum approximately 18 inches from the joint for the first pass forward, avoiding the roller edge of the drum operating directly above the bottom edge of any underlying notched wedge joint. On the backward and subsequent passes, overlap the joint 2 to 6 inches. Ensure that the joint receives at least as many roller passes as the rest of the mat.
- If traffic or other cause distorts the lane edge, restore the lane edge to its original shape, using acceptable procedures.

Seal all longitudinal joint(s) for surface courses with hot PG 64S-22 asphalt binder at no additional cost to the Department. Heat and maintain asphalt binder sealant between 265F and 320F. Do not place sealant when the air temperature is below 40F, unless permitted by the Representative. Apply the sealant only to joints in pavement surfaces that are clean, dry and free of any loose material and debris. Clean with a power broom as required. Utilize a pressure applicator with a wand or nozzle capable of applying hot asphalt sealant in a straight and consistent width band of 4 inches +/-1 inch and thickness of 1/16 inch +/- 1/32 inch. Center the sealant band within 1 inch of the joint. Remove and dispose of excess sealant at no additional cost to the Department. Reseal areas of the joint that are inconsistently or not completely covered at no additional cost to the Department. Replace pavement markings that are marred by sealing operations at no additional cost to the Department.

**1.b Vertical Joints.**

- The Contractor may use vertical joints for base, binder, and wearing courses.
- If traffic or other cause distorts the lane edge, carefully saw a vertical lane edge before painting.
- Place the abutting lane on the same day, and if necessary, leave only short lane sections, normally less than 25 feet in length, where the abutting lane is not placed the same day.

**1.c Notched Wedge Joints.**

- The Contractor may use notched wedge joints for wearing and binder courses with NMAS mixtures of 19.0 mm or smaller.
- Remove and dispose of all loose and foreign material before opening the lane to traffic.
- Construct the joint as shown on the Standard Drawing.
- If the joint is next to opposing traffic, place the abutting asphalt mixture within 1 working day after placing the mixture. If the joint is next to traffic in the same direction, place the abutting asphalt mixture within 2 working days after placing the mixture.
- If both lanes that make the joint are not placed on the same day, amend the Maintenance and Protection of Traffic Plan and install additional signing for uneven lane at no additional cost to the Department. Install "Uneven Lane" signs according to Publication 212, Publication 213, and

MUTCD and 1/2-mile before the notched wedge joint area and every 1/2-mile within the uneven pavement area.

**2. Transverse Joints.** Construct joints perpendicular to the pavement centerline. The Contractor may saw transverse joints. If used, install bulkheads straight and perpendicular to the surface. If a bulkhead is not used and the roller moves over the rounded edge of new mixture, locate the joint a sufficient distance from the rounded edge to provide a true surface and cross section. Paint the joint face with a thin coating of asphalt material, the PG-Binder used in the pavement course or PG 64S-22, before placing fresh mixture against the joint face. Painting of the joint face is not required for scratch courses.

**3. Other Joints.** Where placing a wearing course abutting to existing pavement at locations such as paving notches, lane additions, or utility openings, seal the joint with hot asphalt material of the class and type designated for the wearing course. Evenly apply the sealant a minimum of 6 inches on both sides of the joint. The Contractor may use emulsified asphalt, consisting of PennDOT Material Class TACK or NTT/CNTT, instead of hot asphalt material. Before sealing, clean and remove harmful material from the area to be sealed. Control the application rate so residual asphalt completely fills surface voids and provides a watertight joint. If necessary, use two or more applications of emulsified asphalt. Remove excess asphalt material and immediately cover the sealed area with a light application of dry sand that is acceptable to the Representative.

**(l) Surface Tolerance.** Test the finished surface with a 12-foot straightedge at areas the Representative determines may be deficient or irregular, and at transverse joints (including bridge decks and pavement transition) and paving notches. Hold the straightedge in contact with the surface and in successive positions parallel to the road centerline to check the entire width of the pavement. Advance along the pavement in stages of not more than one-half the length of the straightedge until the entire area is tested. The pavement is defective if irregularities are more than 3/16 inch.

**(m) Tests for Depth: Binder and Wearing Courses.** Construct the pavement to the depth indicated and within the specified tolerances.

For courses with density acceptance by lots, the Inspector will measure the depth of each sublot according to PTM No. 737 using the density acceptance samples.

For courses with a designed course depth and density acceptance by non-movement or optimum rolling pattern, the Inspector will calculate the mass per square meter (weight per square yard) for verification of yield. If yield results indicate insufficient course depth, drill one 6 inch diameter core for each 500 tons of material placed to determine the extent of the deficient depth. Core locations will be determined according to PTM No. 1. For courses with density acceptance by lots, the inspector will measure the depth of each sublot according to PTM No. 737 using density acceptance samples.

Pavement deficient in depth by more than 1/4 inch is defective work. Pavement deficient in depth by more than 1/8 inch in three or more adjacent core locations is defective work. The extent of the defective work is the entirety of all sublots represented by the adjacent deficient core samples. After the Inspector completes depth measurements, backfill, compact, and seal core holes with the mixture used to construct the course. Immediately start correcting courses or pavement that are deficient in depth at the core location and proceed longitudinally and transversely until the depth is within 1/4 inch of the design depth.

**(n) Protection of Courses.** Do not allow vehicular traffic or loads on newly compacted courses for 24 hours or until the course uniformly cools to a temperature of 140F or less. Provide alternate routes as indicated or as directed. If both lanes that form a longitudinal joint are placed on the same day and public safety is not restricted, do not allow vehicular traffic or loads on the lanes until adequate stability and adhesion is obtained and the material has uniformly cooled to 140F or less. Maintain the course, as specified in Sections 105.13, 107.15, and 901.

**(o) Defective Work.** As specified in Section 105.12 and as follows:

Department acceptance and QA testing shall not relieve the Contractor of responsibility for material or workmanship that the Representative determines is defective before the Department issues the acceptance certificate. Remove and replace or repair defective work as directed. The BOPD, CMD will review Representative determinations of defective material or workmanship.

Remove and replace pavement defective for pattern segregation as specified in Section 413.3(h)3, for flushing as specified in Section 413.3(h)4, surface tolerance as specified in Section 413.3(l) or Section 313.3(l) and depth as specified in Section 413.3(m), or Section 313.3(m). Remove and replace pavement defective for percent within limits or Payment Factor Percentages as specified in Tables H and I.

## 413.4 MEASUREMENT AND PAYMENT—

### (a) Standard Asphalt Construction.

**1. Asphalt Courses.**

**1.a Superpave Asphalt Mixture Design, Asphalt Wearing Course.** Square Yard or Ton

**1.b Superpave Asphalt Mixture Design, Asphalt Wearing Course (Scratch).** Ton

**1.c Superpave Asphalt Mixture Design, Asphalt Wearing Course (Leveling).** Ton

**1.d Superpave Asphalt Mixture Design, Asphalt Binder Course.** Square Yard or Ton

**1.e Superpave Asphalt Mixture Design, Asphalt Binder Course (Leveling).** Ton

**2. Asphalt Tack Coat.** Section 460.4.

**3. Mixture Acceptance by Certification and Density Acceptance by Non-Movement, Optimum-Rolling Pattern, or Pavement Cores.** The Representative will pay at the contract unit price, adjusted according to Table H. The total payment factor percentage for pavements with density acceptance other than by pavement cores is the sum of adjustments for each test criterion subtracted from 100%. The adjustment for an individual test criterion is the payment factor percentage subtracted from 100%. The pavement will be considered defective if the payment factor for asphalt content, percent passing the 75 µm (No. 200) sieve, and percent passing the 2.36 mm (No. 8) sieve are all 85%.

For pavements with density acceptance by cores, the payment will be as specified in Section 413.4(a)4 with pay factors from Table H being applied. The pavement will be considered defective if the pavement density cores result in a percent within limits less than 50.

**TABLE H**
**Contract Unit Price Adjustments - Mixture Acceptance by Certification**

| Mixture NMAS | Test Criteria | Test Value | | Payment Factor Percentage |
|---|---|---|---|---|
| **Asphalt Content** | | | | |
| All sizes | Printed Tickets | At least 90% of Daily Printed Tickets Within 0.2% of JMF | | 100 |
| | | Less than 90% of Daily Printed Tickets Within 0.2% of JMF | | 85 |
| 19.0 mm and smaller | QC Sample Testing** | Single Sample (n=1) | Multiple Samples (n≥2) | |
| | | ±0.7% | ±0.5% | 100 |
| | | ±0.8% to 1.0% | ±0.6% | 85 |
| | | > ±1.0% | ≥ ±0.7% | * |
| 25.0 mm and larger | QC Sample Testing** | ±0.8% | ±0.6% | 100 |
| | | ±0.9% to ±1.2% | ±0.7% | 85 |
| | | > ±1.2% | ≥ ±0.8% | * |
| **Gradation** | | | | |
| | | Single Sample (n=1) | Multiple Samples (n≥2) | |
| All sizes | QC Sample Testing for % Passing 75 µm (No. 200) Sieve** | ±3.0% | ±2.1% | 100 |
| | | ±3.1% to ±4.0% | ±2.2% to ±2.7% | 85 |
| | | > ±4.0% | ≥ ±2.8% | * |
| All sizes | QC Sample Testing for % Passing 2.36 mm (No. 8) Sieve** | ±6% | ±4% | 100 |
| | | ±7% to ±8% | ±5% | 85 |
| | | > ±8% | ≥ ±6% | * |
| **Mat Density** | | | | |
| All sizes | Non-Movement | Section 413.3(j)2. | | 100 |
| | Optimum-Rolling Pattern | Section 413.3(j)3. | | 100 |
| Sizes from Table I | Acceptance Sample Testing of Pavement Cores | Table I | | Section 413.4(a)4.a |

* Defective pavement. Remove and replace or, when permitted by the District Executive in writing, leave in place and the Department will pay 70% of the contract unit price.

** For these test criteria, the daily Pay Factor will be determined by the single sample test result from the daily QC sample. If more than one QC sample test result is available for a day, the Payment Factor Percentage will be determined based on the average of the results using multiple sample tolerances. If corrective action is taken, Pay Factors will be independently determined for material placed before and after the corrective action.

**4. Mixture Acceptance by Lot and Density Acceptance by Non-Movement, Optimum-Rolling Pattern, or Pavement Cores.** The Department will pay on a lot-by-lot basis at the contract unit price, adjusted for Pay Factors (PF) as specified. For the PF based on Percent Within Limits (PWL), the Department will determine the individual PWL values for in-place pavement density ($PWL_D$), asphalt content ($PWL_{AC}$), percent passing the 75 µm (No. 200) sieve ($PWL_{200}$), and for percent passing the primary control sieve ($PWL_{PCS}$) as specified in Section 106.03(a)3, using the upper and lower specification limits in Table I. The Department will determine each PF for in-place pavement density, asphalt content, percent passing the 75 µm (No. 200) sieve, and for percent passing the primary control sieve as specified in Section 413.4(a)4.a. The Department will determine the Overall Lot Pay Factor (OLPF) as specified in Section 413.4(a)4.a.2.

**4.a Pay Factors**

**4.a.1 Pay Factors for In-Place Pavement Density ($PF_D$), Asphalt Content ($PF_{AC}$), Percent Passing 75 µm (No. 200) Sieve ($PF_{200}$), and Percent Passing the Primary Control Sieve ($PF_{PCS}$).** For lots with density acceptance by non-movement or optimum-rolling pattern, $PF_D$ = 100.00.

The Department will determine $PF_D$, for lots with density acceptance by pavement cores and $PF_{AC}$, $PF_{200}$, and $PF_{PCS}$ for all lots, according to the following:

**4.a.1.a All PWL Parameters Greater Than or Equal to 50.** When $PWL_D$, $PWL_{AC}$, $PWL_{200}$, and $PWL_{PCS}$ are each greater than or equal to 50, the Department will determine the pay factor for each PWL as specified in one of the following equations as appropriate.

When PWL is ≥ 90, determine the pay factor for the specific pay parameter as specified in the following Equation:

$$PF_X = 100 + 0.4(PWL_X - 90)^*$$

Where,

$PF_X$ = Pay Factor of the individual pay parameter ($PF_D$, $PF_{AC}$, $PF_{200}$ or $PF_{PCS}$)

$PWL_X$ = Percent within Limits of the individual pay parameter ($PWL_D$, $PWL_{AC}$, $PWL_{200}$ or $PWL_{PCS}$)

* For 9.5 mm and 12.5 mm courses with average density < 93.0, the maximum $PF_D$ = 100

When PWL is < 90 and ≥ 50, or when $PWL_{200}$ is less than 50 and the average percent passing the 75 µm (No. 200) sieve is within ± 2.0% from the JMF, determine the pay factor for the specific pay parameter as specified in the following Equation:

$$PF_X = 70 + 0.75(PWL_X - 50)$$

Where,

$PF_X$ = Pay Factor of the individual pay parameter ($PF_D$, $PF_{AC}$, $PF_{200}$ or $PF_{PCS}$)

$PWL_X$ = Percent within Limits of the individual pay parameter ($PWL_D$, $PWL_{AC}$, $PWL_{200}$ or $PWL_{PCS}$)

**4.a.1.b One PWL Parameter Less Than 50.** When either one of $PWL_D$ or $PWL_{AC}$ is less than 50, the lot is defective. When $PWL_{200}$ is less than 50, the lot is defective when the average percent passing the 75 µm (No. 200) sieve is greater than ± 2.0% from the JMF. When $PWL_{PCS}$ is less than 50, the $PF_{PCS}$ = 60.00. For defective lots, the DE will direct one of the following:

- Leave the lot in place. The DE will apply an OLPF of 70.
- Remove and replace the entire lot. The District Executive will direct removal and replacement of the entire lot at no additional cost to the Department with new lot acceptance sampling and testing.

**4.a.1.c Two PWL Parameters Less Than 50.** When two or more of $PWL_D$, $PWL_{AC}$, or $PWL_{200}$, with the average percent passing the 75 µm (No. 200) sieve greater than ± 2.0% from the JMF, are less than 50, the lot will be considered defective and the DE will direct removal and replacement of the entire lot with new acceptance sampling and testing.

**4.a.2 Overall Lot Pay Factor (OLPF).** The Department will determine the OLPF as specified in the following equation and then will round the resulting OLPF to the nearest whole number according to ASTM E29:

$$OLPF = (0.50 \times PF_D) + (0.30 \times PF_{AC}) + (0.10 \times PF_{200}) + (0.10 \times PF_{PCS})$$

Where,

$PF_D$ = Pay Factor for In-Place Density

$PF_{AC}$= Pay Factor for Asphalt Content

$PF_{200}$= Pay Factor for Percent Passing the 75 µm (No. 200) Sieve

$PF_{PCS}$= Pay Factor for Percent Passing the Primary Control Sieve (PCS)

**TABLE I**
**Upper and Lower Specification Limits for Calculating Percent Within Limits**

| | **Testing Criteria** | |
|---|---|---|
| **Mixture NMAS** | **Lower Specification Limit (L)** | **Upper Specification Limit (U)** |
| | **Asphalt Content from JMF Value, %** | |
| 9.5 mm, 12.5 mm | -0.4 | +0.4 |
| 19 mm | -0.5 | +0.5 |
| 25 mm and 37.5 mm | -0.6 | +0.6 |
| | **Percent Passing the 75 µm (No. 200) sieve from JMF Value, %** | |
| All sizes | -1.5 | +1.5 |
| | **Percent Passing the Primary Control Sieve from JMF Value, %** | |
| 9.5 mm (PCS = 2.36 mm (No. 8) sieve) | -5 | +5 |
| 12.5 mm (PCS = 2.36 mm (No. 8) sieve) | -5 | +5 |
| 19 mm (PCS = 4.75 mm (No. 4) sieve) | -8 | +8 |
| 25 mm (PCS = 4.75 mm (No. 4) sieve) | -9 | +9 |
| 37.5 mm (PCS = 4.75 mm (No. 4) sieve) | -9 | +9 |
| | **Mat Density *** | |
| All 9.5 mm, 12.5 mm | 92.0 | 98.5 |
| All 19 mm Courses, 25 mm Binder Courses | 91.0 | 98.0 |
| 25 mm and 37.5 mm Base Courses | 90.0 | No Upper Limit |
| * Where Limits = Percent of Theoretical Maximum Density | | |

**4.a.3 Lot Payment.** The Representative will compute the percent of the contract unit price paid as follows:

Lot Payment = $C_P$ (OLPF)/100

Where,

$C_P$ = Contract unit price per lot (unit price times lot quantity)

OLPF = Overall Lot Pay Factor

**4.a.4 Evaluation of Overall Lot Pay Factor and Payment of Incentive / Disincentive**. Dollar.

The proposal will include a contract item and a predetermined amount of money for Evaluation of Overall Lot Pay Factor and Payment of Incentive. The contract item will have a unit of measure of DOLLAR, a unit price of $1.00, and a quantity equal to the predetermined amount.

Due to the incentive status of the payment being made, the provisions of Section 110.02(d) are not applicable to this item.

The Evaluation of Overall Lot Pay Factor and Payment of Incentive contract item will be measured and paid as follows:

- **Incentive**. When asphalt pavement evaluation indicates that an incentive adjustment is applicable, the appropriate amount will be paid under this contract item.

- **Disincentive**. When asphalt pavement evaluation indicates that a disincentive adjustment is applicable, the appropriate amount will be deducted from money due or to become due to the Contractor through the processing of a Contract Adjustment.

**4.b Dispute Resolution.** For mixture acceptance testing or density acceptance testing performed by the LTS, the Contractor may request, in writing, that the Department retest a lot if the initial test results indicated a defective lot (remove and replace), a lot with an OLPF < 90.00, the asphalt content pay factor for the lot is < 80.00, or the density pay factor for the lot is < 80.00, except for density when one or more density acceptance cores in the lot were coated with paraffin wax as a result of PTM No. 716 during the original density acceptance testing. Provide written retest requests to the District Executive within 3 weeks of the date the LTS test results are released. Provide in the written request the preferred test method for asphalt content determination (PTM No. 757 or PTM No. 702, Modified Method D). Retests will not be allowed if a written retest request is not received within 3 weeks of the date the LTS test results are released. Provide quality control test results and control charts, companion sample test results (if available), test data trend evaluation, and any other pertinent information to justify the retest request. The Department will evaluate the information and may allow retesting if the information submitted provides a reasonable basis to conclude that the failing test results may not represent the in-place material. The LTS will perform the retest with the Contractor present, unless otherwise agreed to in writing with the Contractor.

For retesting of materials failing for asphalt content, percent passing 75 µm (No. 200) sieve, or percent passing the PCS, the Inspector will identify the locations where the original box samples were collected. The Inspector will select retest sample locations 24 inches from the original sample locations longitudinally in the direction of traffic. If the 24 inch offset causes the retest sample location to fall outside of the sublot, the Inspector will select the retest sample location 24 inches from the original sample locations longitudinally in the opposite direction from traffic.

With the Inspector present, provide appropriate traffic control and drill 6-inch diameter cores for retesting purposes according to the procedure for drilling in PTM No. 729. Ensure drilling procedures include washing off and towel drying the core samples immediately after drilling. Within 24 hours after coring, backfill the hole with mixture of the same JMF or with mixture used for subsequent courses and compact and seal the mixture. Provide traffic control, core, and backfill the core holes at no additional cost to the Department. The test method used for asphalt determination during the original acceptance testing (PTM No. 757 or PTM No. 702, Modified Method D, and PTM No. 739) will be used for the retest, unless the DME/DMM grants written approval for a change in test method. If required to separate the applicable pavement course lift from other pavement courses, the cores will be saw cut at the course lift line(s) as determined by the LTS. The results of the retest cores will be used to calculate payment for asphalt content, percent passing the 75 µm (No. 200) sieve, and percent passing the PCS for the lot.

For retesting of density acceptance, the original density acceptance cores will be utilized. The LTS will not retest a lot for density acceptance when one or more density acceptance cores in the lot were coated with paraffin wax as a result of PTM No. 716 during the original density acceptance testing. The LTS will retest each original density acceptance core according to PTM No. 715 and PTM No. 716, as necessary, to determine the Gmb and bulk density values. The LTS will not perform Gmm testing for lots where the Contractor's Gmm value was previously considered verified as specified in Section 413.3(j) 4.d.1. After Gmb testing is completed, for lots where the Contractor's Gmm was not verified, the LTS will select one original density acceptance pavement core from each production or placement date represented by the density acceptance cores in the lot. Each core selected will be the core with the highest bulk density for that production or placement date from the retest results (e.g., if a lot was placed over 3 production days, and the lot density acceptance cores include at least one core from each production or placement day, the original density cores selected during a density retest to perform Gmm testing will be 3; one from each production or placement date). The LTS will perform Gmm testing on the selected cores according to AASHTO T 209 as modified in Bulletin 27, with the following exceptions:

- The samples will be obtained as specified in Section 413.3(j)4.c
- No conditioning, only drying, will be performed on the sample
- The minimum sample size will be waived, as necessary, to use the 6-inch diameter pavement core sample, and
- The supplemental procedure for mixtures containing porous aggregate will only be performed when either the coarse aggregate or fine aggregate in the mixture has a water absorption of ≥ 1.5% as indicated on the JMF and then only when the calculated percent of theoretical maximum density indicates any one individual failing sublot which results in a density pay factor less than 100.00.

The LTS Gmm value(s) determined will be the Gmm values used to determine the percent of theoretical maximum density for the cores represented by the applicable production or placement dates in the lot. Either the previously verified Contractor's Gmm values(s) or the newly tested LTS Gmm value(s) will be used for acceptance to determine the percent theoretical maximum density for each sublot core in the lot.

Upon completing the retesting of the original density acceptance cores, the LTS will evaluate testing repeatability for the bulk density results determined according to PTM No. 715 and PTM No. 716, if necessary, using both the bulk original density test values and the bulk density retest values according to PTM No. 5. After evaluating the testing repeatability, the density test values used to determine the final payment factor percentage for density will be as follows:

- If repeatable, the original test values will be used.
- If lack of repeatability (i.e., non-repeatable), the retest values will be used.

The Department will deduct from the payment the cost per lot associated with conducting a retest as follows in Table J:

**TABLE J**
**Dispute Resolution Retest Cost Table**

| **Test Method** | **Mixture Acceptance Retest Cost if Retest Results Indicate ≥ 100% Pay Factor(s)*** | **Mixture Acceptance Retest Cost if Retest Results Indicate <100% Pay Factor(s)** |
|---|---|---|
| PTM No. 702/739 | $900 | $3,500 |
| PTM No. 757 | $500 | $2,000 |
| | **Density Acceptance Retest Cost if Retest Results Indicate a Lack of Repeatability** | **Density Acceptance Retest Cost if Retest Results are Repeatable** |
| PTM No. 715, or PTM No. 716 only | $200 | $750 |
| PTM No. 715, or PTM No. 716, and AASHTO T 209 as specified in Section 413.3(j)4.d.1 | $1,100 | $4,000 |

* For lots where the original test results indicated a defective lot, only the pay factor(s) where original test results indicated a PWL < 50 for asphalt content, percent passing the 75 µm (No. 200) sieve, or density will be utilized to determine the retest cost. If no original test results indicated PWL < 50 for lots where OLPF < 90, then all pay factors will be utilized to determine the retest cost.

**(b) Asphalt RPS Construction.** Square Yard or Ton

**1. Mixture Acceptance by Lot and Density Acceptance by Pavement Cores.** Section 413.4(a)4, except for RPS, the Department will determine mat density by pavement cores only.

# SECTION 419—STONE MATRIX ASPHALT MIXTURE DESIGN, RPS CONSTRUCTION OF PLANT-MIXED WEARING COURSES

**419.1 DESCRIPTION—**This work is the RPS construction of plant-mixed Stone Matrix Asphalt (SMA), on a prepared surface using a volumetric mixture design developed with the Superpave Gyratory Compactor. The SMA is to be produced as WMA using an approved WMA technology and accepted by either the Hands On Local Acceptance (HOLA) process or the LTS acceptance process.

**419.2 MATERIALS—**Do not incorporate material into the asphalt mixture that are not specified in Section 419.2 including additives, rejuvenators, or other materials.

**(a) Asphalt Material**

**1. Virgin Mix or Mix Containing up to 10% RAP (If indicated).** Furnish material conforming to the requirements of Standard Specifications for Performance-Graded Asphalt Binder using Multiple Stress Creep Recovery (MSCR) Test, AASHTO M 332, except as revised in Bulletin 25. Obtain material from a source listed in Bulletin 15 for the specified grade. Provide QC testing and certification as specified in Sections 106.03(b) and 702.1(b) 1. Provide the Representative a copy of a Bill of Lading for asphalt material on the first day of paving and when the batch number changes.

When producing a mixture with a WMA technology, adhere to the following requirements:

**1.a WMA Technology Additives or Modifiers Blended at the Asphalt Material Supplier's Refinery or Terminal.** Provide refinery or terminal blended asphalt material blended with an approved WMA Technology additive or modifier from an approved manufacturer and source listed in Bulletin 15. Include in the asphalt material Producer QC Plan, the WMA Technology additive or modifier manufacturer name, WMA Technology name, and source, dosage rates, blending method, QC testing, corrective action points, disposition of failed material, storage, handling shipping, and bill of lading information following the applicable requirements as specified in Section 702. Include the WMA Technology additive or modifier and dosage rate on the bill of lading. Provide refinery or terminally blended asphalt material, that when blended with the WMA Technology additive or modifier, the final blend meets the requirements for the specified performance grade of the asphalt binder.

**1.b WMA Technology Additives or Modifiers Blended at the Asphalt Mixture Producer's Plant.** Provide a blended asphalt material consisting of an approved WMA Technology additive or modifier from an approved manufacturer and source listed in Bulletin 15 that is blended with a base asphalt material of the specified performance grade conforming to the requirements of Standard Specifications for Performance-Graded Asphalt Binder using Multiple Stress Creep Recovery (MSCR) Test, AASHTO M 332, except as revised in Bulletin 25 and from an approved source listed in Bulletin 15, Section 702. Prepare a Producer QC Plan as specified in Section 106 and conforming to the Producer QC Plan requirements in Section 413.2(e)1.a and the additional Producer QC Plan requirements within this specification.

**(b) Aggregate.**

**1. General Requirements.** Provide aggregate from sources listed in Bulletin 14. Provide aggregate with at least the SRL designation specified. To achieve the specified SRL, the Contractor may provide a blend of two aggregates if the blend has an SRL designation equal to or better than that specified. Blends for SRL are 50% by weight of each aggregate. Blend the aggregates using an approved method.

**2. Fine Aggregate.** Section 703.1, except as follows: Determine Sand Equivalent Value according to AASHTO T 176 and meet requirements of 45% minimum sand equivalent. Do not exceed 15% sodium sulfate soundness loss in five cycles. Determine the uncompacted void content according to AASHTO T 304, Method A, or use the value listed in Bulletin 14. Provide a fine aggregate that meets 45% minimum uncompacted void content.

**3. Coarse Aggregate.** Type A, Section 703.2, except as follows: Meet the aggregate quality requirements of Table A.

**TABLE A**
**Coarse Aggregate Quality Requirements**

| Characteristic | Test Method | Required Values |
|---|---|---|
| Abrasion Loss, % | AASHTO T 96 | ≤ 35 |
| Flat and Elongated Particles, %<br>3:1 Ratio<br>5:1 Ratio | ASTM D4791, Method B<br>(measured by mass, on material retained on and above the 4.75 mm (No.4) sieve) | <br>≤ 20<br>≤ 5 |
| Absorption, % | AASHTO T 85 | ≤ 2.0 |
| Crushed Fragments, %<br>One Fractured Face<br>Two or More Fractured Faces | ASTM D5821 | <br>100<br>≥ 90 |

**(c) Mineral Filler.** Furnish mineral filler consisting of finely divided mineral matter such as rock or crushed limestone dust free of organic impurities. Furnish material with a maximum plasticity index of 4 and conforming to the grading requirements of AASHTO M 17. Submit a hydrometer analysis performed according to AASHTO T 88 for mineral filler.

**(d) Stabilizer.** Provide mineral fiber, cellulose fiber, crumb rubber (CR), or an approved WMA Technology additive stabilizer conforming to the requirements below and added at a rate specified in Table B. Use the dosage rate prescribed in the JMF.

**1. Requirements for All Fiber Types.** Fibers must prevent draindown in the mixture according to the tolerances in Table B. Use a fiber of the type and properties appropriate to the plant's metering and delivery system.

**2. Cellulose Fibers.** Fibers must be of sufficient quality to prevent mixture draindown.

**3. Cellulose Pellets.** Use cellulose fiber stabilizing additive in pellet form that disperses sufficiently at mixing temperature to blend uniformly into the asphalt mixture. Use pellets that do not exceed 0.25 inch average diameter. Pellets may contain binder ingredients such as asphalt binder, wax, or polymer. Do not use pellets if the binder ingredient exceeds 20.0% of the total weight of the pellets. Use binder that produces no measurable effect on the properties of the asphalt binder. Do not use fiber pellets which soften or clump together when stored at temperatures up to 122F.

**Note:** If the binder material constitutes more than 3% of the pellet weight, base the dosage rate on the net fiber content.

**4. Mineral Fibers.** Use mineral fibers made from virgin basalt, diabase, slag, or other silicate rock. Use an approved mineral fiber meeting the following requirements for shot content, as tested according to ASTM C612.

| Sieve | Percent Passing |
|---|---|
| 250 µm (No. 60) | 85 - 95 |
| 63µm (No. 230) | 60 - 80 |

**5. Crumb Rubber (CR).** Use CR derived from the processing of recycled tires. Rubber tire buffings produced by the retreading process qualify as a source of CR. Furnish processed, free flowing CR from a manufacturer listed in Bulletin 15, certified as specified in Section 106.03(b)3.

**5.a Gradation.** Meet the following gradation as determined according to ASTM D5461 using 200 mm diameter sized sieves and maintaining a maximum allowable loss after sieve analysis of 7.65%. As an alternative dry sieve analysis test method, perform the sieve analysis of the CR according to Florida Test Method, FM 5-559.

**CR Gradation**

| Sieve Size | Percent Passing |
|---|---|
| 4.75 mm (No. 4) | 100 |
| 2.36 mm (No. 8) | 98-100 |
| 75 µm (No. 200) | 0-3 |

**5.b Contaminants.** Provide CR relatively free from fabric, wire, cord, and other contaminating materials to a maximum total contaminant content of 2.5% (maximum of 1.0% iron, 1.0% fiber, and 0.5% other contaminants by weight of total CR sample components).

Remove rubber particles from the fiber balls before weighing. Determine the metal content by thoroughly passing a magnet through a 50.0 ± 0.1 g (1.76 ± 0.004 ounces) sample. Determine fiber content by weighing fiber balls, which are formed during the gradation test procedure.

**6. WMA Technology Additive.** Use only a Bulletin 15 approved commercially available WMA Technology additive as specified in Section 419.2(a), and according to manufacturer's recommendations for controlling draindown.

**(e) RAP.** If the use of RAP material is indicated, use up to 10% RAP consisting of cold milled or crushed asphalt in the mixture. Include a plan to control RAP and the procedures to handle RAP of different composition in the asphalt producer QC Plan. Follow POM B.7.22 for all SMA mixtures incorporating any RAP. Maintain all processed material free of foreign materials and minimize segregation. Process the RAP so that the final mixture meets requirements as specified in Section 419.2(f).

**(f) Mixture Composition.**

**1. Material Mixtures.** Design and control SMA according to Bulletin 27, Chapter 2B. Size, uniformly grade, and combine aggregate fractions, asphalt material, and an approved WMA Technology in such proportions that the total aggregate and asphalt in the JMF conform to the material, gradation, and volumetric requirements for the SMA mixture according to Tables B and C.

For asphalt mixtures, the WMA Technology Manufacturer Technical Representative (Technical Representative) will address laboratory procedure modifications necessary to prepare, compact, and test asphalt mixtures and to achieve a uniform blend. Incorporate the WMA Technology additive, modifier, or process into that JMF during production. Do not develop a volumetric asphalt JMF based on incorporating the WMA Technology additive, modifier, or process during the volumetric asphalt mixture design process. For all asphalt JMFs, perform moisture susceptibility analysis according to Bulletin 27. Ensure the WMA Technology additive, modifier, or process is not detrimental to the moisture resistance of the mixture.

**TABLE B**
**Mix Design Requirements for SMA Mixtures**

| AGGREGATE GRADATION REQUIREMENTS, PERCENT PASSING | | |
|---|---|---|
| **Sieve Size** | **9.5-mm Mixture** | **12.5-mm Mixture** |
| 19.0 mm (3/4 inch) | - | 100 |
| 12.5 mm (1/2 inch) | 100 | 90 – 99 |
| 9.5 mm (3/8 inch) | 75 – 95 | 70 – 85 |
| 4.75 mm (No. 4) | 30 – 50 | 28 – 40 |
| 2.36 mm (No. 8) | 20 – 30 | 18 – 30 |
| 1.18 mm (No. 16) | - | - |
| 600 μm (No. 30) | - | - |
| 300 μm (No. 50) | - | - |
| 150 μm (No. 100) | - | - |
| 75 μm (No. 200) | 8 – 13 | 8 – 11 |
| **VOLUMETRIC DESIGN REQUIREMENTS** | | |
| **Design Gyrations ($N_{design}$)** | 100 | |
| **Voids in Mineral Aggregate** | 18.0 % minimum(1) | |
| **Voids in Coarse Aggregate (VCA)** | $VCA_{mix} < VCA_{dry\ rodded}$ | |
| **Design air voids** | 3.5 - 4.0 % | |
| **Minimum asphalt binder content** | Table C | |
| **Binder grade** | PG 64E-22 | |

| | |
|---|---|
| **Stabilizer content** | Cellulose: 0.2 to 0.4 % by total mix weight<br>Mineral: 0.3 to 0.4 % by total mix weight<br>CR: 0.3 to 1 % by total mix weight |
| **Draindown** | 0.3 % maximum(2) |

(1) When a WMA Technology additive is used as the stabilizing agent, the DME/DMM may allow the minimum VMA to be lowered to a minimum of 17.5%.
(2) When a WMA Technology additive is used as the stabilizing agent, perform this test at 5F above the desired high production temperature limit in the QC plan, but no higher than 305F.

**TABLE C**
**Minimum Asphalt Binder Requirements for SMA Mixtures**

| Combined Aggregate Bulk Specific Gravity | Minimum Asphalt Content, % by Total Mix Weight(1) |
|---|---|
| 2.400 - 2.449 | 7.4 |
| 2.450 - 2.499 | 7.2 |
| 2.500 - 2.549 | 7.1 |
| 2.550 - 2.599 | 7.0 |
| 2.600 - 2.649 | 6.8 |
| 2.650 - 2.699 | 6.7 |
| 2.700 - 2.749 | 6.6 |
| 2.750 - 2.799 | 6.5 |
| 2.800 - 2.849 | 6.4 |
| 2.850 - 2.899 | 6.3 |
| 2.900 - 2.949 | 6.2 |
| 2.950 - 2.999 | 6.1 |
| 3.000 - 3.049 | 6.0 |

(1) When a WMA Technology additive is used as the stabilizing agent, the DME/DMM may allow the Minimum Asphalt Content to be 0.30 lower than the values in Table C.

Perform draindown testing according to AASHTO T 305 using a 1 hour reading. Design a mix meeting the tolerances specified in Table B.

Design each SMA mix within the job-mix tolerances according to Tables B and C. Test the materials, proportions, and the mixture at the asphalt plant laboratory.

Submit a copy of each completed JMF, signed by a certified Asphalt Level 2 plant technician, to the DME/DMM at least 3 weeks before the planned start of mixture production. Include a list of all material sources and the asphalt producer in the JMF. Provide the calibration factors ($C_f$ and 200 $C_f$) according to PTM No. 757 with the JMF. Do not start mixture production until after the DME/DMM reviews the JMF.

Submit a new JMF with a change in material sources or if a new JMF is necessary to produce an SMA mixture conforming to this specification.

**1.a Producer QC Plan.** Section 413.2(e)1.a, except RAS/RAM is not allowed in the mixture.

**1.b Plant Technicians.** Section 413.2(e)1.b with the following additions: All HOLA mixture and density acceptance testing will be performed by Department Representatives certified as Asphalt Level 1 or Level 2 Plant Technicians.

**1.c Annual JMF Verification.** During initial production of each JMF, verify, according to the QC Plan, that the mixture conforms to this specification. If the mixture does not conform to the single and multiple sample tolerances according to Tables D and E within 2 days of production, suspend shipping the mixture to the project. Do not ship the mixture to the project until after the Representative reviews and verifies that results conform to the single and multiple sample tolerances in Tables D and E. Perform annual verification of the asphalt mixture JMF.

**1.d Production.** Section 413.2(e)1.d, except as follows:

Produce and test mixtures, including Superpave Gyratory Compactor (SGC) specimens for quality control , except as modified by the Producer QC Plan. Maintain records of the testing of the asphalt mixture and make available for review by the Representative when requested.

**1.d.3 Gradation.** Section 413.2(e)1.d.3, except RAS is not allowed. Produce the mix within the tolerances of Table D.

**1.d.5 Volumetric Analysis of Compacted Specimens.** Sample the completed mixture according to PTM No. 1 and at the frequency in the producer QC Plan. Prepare a minimum of two specimens from each sample according to AASHTO T 312.

Produce a mixture with volumetric properties conforming to the tolerances according to Table E. Determine the bulk specific gravity of the specimens as specified in AASHTO T 312 and calculate air voids ($V_a$) and Voids in Mineral Aggregate (VMA) at $N_{design}$ according to AASHTO R 35 and as specified in Bulletin 27. Determine compliance with the multiple specimen tolerances using the average of the results for all specimens prepared from the sample.

**1.d.6 Mixture Draindown.** Sample the completed mixture according to PTM No. 1 a minimum of once daily. Perform draindown testing according to AASHTO T 305 along with the first mixture samples for each day's production. Produce a mixture that meets the tolerances of Table D.

**1.d.7 Degree of Particle Coating.** For all asphalt mixtures, sample the mixture according to PTM No. 1 and at the frequency in the Producer QC Plan. Determine the degree of particle coating of the completed asphalt mixture according to AASHTO T 195. Produce an asphalt mixture with percent coated particles ≥ 95.0%. Increase the plant mixing time or make other plant adjustments if the required percent of coated particles is not met. Produce an asphalt mixture capable of being handled, placed, and compacted without stripping the asphalt material from the aggregate.

**TABLE D**
**Composition Tolerance Requirements of the Completed Mix**

| | | **Single Sample (n=1)** | **Multiple Samples (n ≥ 3)** |
|---|---|---|---|
| **Gradation** | | | |
| Passing 9.5 mm (3/8 inch) and Larger Sieves | | ±5% | ±4% |
| Passing 4.75 mm (No. 4) to 150 µm (No. 100) Sieves (Inclusive) | | ±4% | ±3% |
| Passing 75 µm (No. 200) Sieve | | ±3.0% | ±2.0% |
| **Asphalt Content** | | | |
| % Asphalt by Weight | | ±0.7% | ±0.4% |
| **Draindown** | | | |
| % by Weight | | 0.3 % maximum(2) | |
| **Temperature of Mixture (F)** | | | |
| **Class of Material** | **Type of Material** | **Minimum** | **Maximum** |
| | | | |
| PG 64E-22 | Asphalt Binder | 260 | 330 |

(1) 300F maximum temperature when a WMA Technology additive is used for the stabilizer.
(2) When a WMA Technology additive is used as the stabilizing agent, perform this test at 5F above the desired high production temperature limit in the QC plan, but no higher than 305F.

**TABLE E**
**Volumetric Tolerance Requirements of the Laboratory Compacted Mix**

| | **Single Specimen (n=1)** | **Multiple Specimens (n ≥ 2)** |
|---|---|---|
| Air Voids at $N_{design}$ ($V_a$) | ±2.0% from JMF | ±1.5% from JMF |
| Minimum VMA | 17.0(1) | _ |

(1) When a WMA Technology additive is used as the stabilizing agent, the DME/DMM may allow the minimum VMA to be lowered to a minimum of 16.5%.

**1.e Corrective Actions.** Immediately take corrective actions if one or more of the following occurs:

- QC test results on a single sample (n=1) for percent passing the 4.75 mm (No. 4) sieve, the 2.36 mm (No. 8) sieve, the 75 µm (No. 200) sieve, or asphalt content are not within the tolerances in Table D.
- The average of multiple samples (n ≥ 3) for percent passing any sieve or asphalt content, as determined according to Section 419.2(f)1.d, are not within the tolerances according to Table D.
- QC test results on a single specimen (n=1) or on multiple specimens (n ≥ 2) are not within the tolerances according to Table E.
- Draindown test result(s) are not within the tolerances according to Table D.
- Independent Assurance (IA) or QA sample results from testing at the producer's plant are not within the tolerances of Tables D or E.

After taking corrective actions, sample the completed mixture within 150 tons of production. After sampling, test the mixture and provide test results to the Representative within 500 tons of production. If less than three samples are tested for mixture composition, determine conformance with Table D by comparing each result to the multiple sample tolerances. If the mixture does not conform to the single and multiple sample tolerances in Table D and the single and multiple specimen tolerances in Table E, suspend production and shipping to the project and determine the cause of the problem. Provide a written explanation of the problem and a proposed solution to the Department. After the Representative reviews the proposed solution and authorizes production to continue, resume production and perform JMF verification according to the QC Plan.

**(g) Mixture Acceptance.**

**1. General.** The Department will accept the mixtures by lot acceptance as specified in Section 419.3(i)2 by either LTS or HOLA acceptance methods as indicated.
The Department or the Contractor may for any reason stop HOLA acceptance and switch to LTS acceptance for lots with samples not yet tested. To change the acceptance method from LTS acceptance to HOLA acceptance, the Contractor and the District Executive must agree to the change in writing. The acceptance method for a lot cannot be changed after acceptance testing for that lot starts.

**2. Certification.** SMA mixtures will not be accepted by certification. The only exception for SMA accepted by certification is small quantities of SMA mixture used for patches and miscellaneous placements equal to or less than 150 tons as specified in Section 419.3(i)2.a.

**(h) WMA Technologies (Additive(s), Modifier(s), or Processes) and WMA Manufacturers.** For WMA mixtures, Section 413.2(f)

**(i) Anti-Strip Additives**. For asphalt mixtures, Section 413.2(g)

**(j) WMA Technology Manufacturer Technical Representative (Technical Representative)**. For asphalt mixtures, Section 413.2(h)

## 419.3 CONSTRUCTION—

**(a) Preplacement Requirements.** Provide asphalt mixtures as indicated for the entire project.

**1. Paving Operation QC Plan.** Prepare a paving operation QC Plan, as outlined on Form CS-413, for field control and evaluation of asphalt concrete paving operations. Submit the QC Plan to the Representative before or at the pre-construction conference. Include in the QC Plan a description of the construction equipment and methods necessary to construct and test the asphalt concrete courses as specified in Section 419.3. For asphalt mixtures, have the Technical Representative provide all recommendations and direction specific to the WMA technology in the paving operation QC Plan. Do not start paving until after the Representative reviews the QC Plan.

**2. Preplacement Meeting.** At least 2 weeks before placing asphalt paving mixtures, schedule an asphalt preplacement meeting with the Representative to review at a minimum the specification, paving operation QC Plan, sequence of paving operations, mixture acceptance, density acceptance, and the care and custody of asphalt acceptance samples.

**(b) Weather Limitations.** Do not place SMA paving mixtures from October 1 to March 31 in Districts 1-0, 2-0 (except Juniata and Mifflin Counties), 3-0, 4-0, 5-0 (Monroe and Carbon Counties only), 9-0 (Cambria and Somerset Counties only), and 10-0; and from October 16 to March 31 in Districts 2-0 (Juniata and Mifflin Counties only), 5-0 (except Monroe and Carbon Counties), 6-0, 8-0, 9-0 (except Cambria and Somerset Counties), 11-0 and 12-0. Exceptions require the written permission of the District Executive, as specified in Section 413.3(b)1. Do not place asphalt paving mixtures when surfaces are wet or when the air or surface temperature is 50F or lower. If work is halted because of weather conditions, the Representative may allow the Contractor to place limited quantities of mixture that are enroute to the project.

**(c) Asphalt Mixing Plant.** Section 413.3(c), except the following requirements are for SMA mixes.

Obtain asphalt mixtures from a plant fully automated and recordated and currently listed in Bulletin 41. The necessary facilities for inspection include a plant office as specified in Section 714.5(a), except the minimum floor space is 120 square feet.

Ensure that both the aggregates and the completed mixture are free of unburned fuel oil and excess moisture as specified in Section 413.2(e)1.d.1.

For asphalt mixtures, make any plant modifications needed to introduce the WMA Technology additives, modifiers, or processes according to specific recommendations and direction from the Technical Representative or process manufacturer to achieve a uniform blend of the WMA Technology additive, modifier or foaming process and produce an asphalt mixture meeting these specifications. For batch plants, dry the aggregate according to the specific recommendations and direction from the Technical Representative.

**1. Mineral Filler System**. Follow the requirements listed in Chapter 1, Section 2.5 of Bulletin 27.

**2. Stabilizer Supply System**. When utilized, add stabilizer through specialized equipment that can accurately proportion and meter, by weight, the proper amount per batch for batch plants, or continuously and in a steady uniform manner for drum plants. Do not feed fiber, pelletized or loose, through the cold feed bins or through the RAP bins.

Provide proportioning devices that are interlocked with the plant system and controlled to ±10% of the weight of the fibers required. During the trial demonstration specified in Section 419.3(g), perform an equipment calibration to the satisfaction of the Representative to show that the fiber is being accurately metered and uniformly distributed into the mix.

Include the following on the stabilizer supply system:

- low level indicators
- no-flow indicators
- a printout of feed rate status in pounds/minute
- a section of transparent pipe in the stabilizer supply line for observing consistency of flow or feed.

Have the Representative approve all stabilizer addition systems.

When a batch plant is used, add the stabilizer to the aggregate in the weigh hopper and increase both dry and wet mixing times. Ensure that the stabilizer is uniformly distributed before the injection of asphalt binder into the mixture. When a drum plant is used, do not allow the fibers to become removed by the exhaust system. If there is any evidence of fiber in the bag-house or wet washer fines, relocate the liquid asphalt binder line and/or the fiber line so that the fiber is captured by liquid asphalt spray and incorporated into the mix. If there is any evidence of clumps of fibers or pellets at the discharge chute, increase the mixing time and/or intensity.

Store stabilizer in a dry environment.

**3. Hot-Mixture Storage.** Ship material within 2 hours of plant mixing. Stored SMA material that does not consistently meet the same quality as material discharged directly into hauling vehicles will be rejected.

**4. HOLA Laboratory Testing Facility.** For testing of HOLA samples by the Department, identify a laboratory testing facility where the local acceptance testing is to be performed. Identify either the laboratory located at the asphalt mixture production plant, the laboratory where the plant production mixture is being tested for QC, or another agreed upon laboratory location meeting the requirements of Bulletin 27. Identify a laboratory testing facility that has demonstrated testing proficiency through an AASHTO re:source On-Site Laboratory Assessment performed within the last 2 years before the HOLA sample testing. The AASHTO re:source On-Site Laboratory Assessment must have been completed on the equipment proposed for utilization by the Department.

At the project preconstruction meeting, submit the identified laboratory testing facility location, AASHTO re:source On-Site Laboratory Assessment report, and any necessary corrective action documentation to correct any deficiencies on the Laboratory Assessment report for review by the Representative. The Representative will review the laboratory testing facility location and AASHTO re:source assessment documentation and, if acceptable, designate the laboratory testing facility for the project. Use the designated laboratory for testing all HOLA samples.

If a change in the designated laboratory testing facility is necessary, submit the new laboratory testing facility location. Include the AASHTO re:source On-Site Laboratory Assessment report for the new laboratory testing facility and corrective action documentation for deficiencies noted by the AASHTO re:source On-Site Laboratory Assessment report. The Representative will review the new laboratory testing facility and AASHTO re:source assessment documentation and, if acceptable, designate the new laboratory testing facility for the project. If an acceptable laboratory facility cannot be identified and agreed to, acceptance testing will be performed by LTS.

The Representative will specifically review the testing facility equipment to ensure it meets the required test method requirements, manufacturer installation requirements, standardization or calibration requirements and frequency, manufacturer maintenance requirements and frequency, maintenance log record requirements, and the facility QC plan includes an action plan for removing equipment from service if it fails to meet any requirements, requires standardization or calibration, becomes inoperable or requires repair/maintenance.

Provide dedicated laboratory testing equipment for Department use at the designated laboratory testing facility as required in the specified test methods and as modified in Bulletin 27 for testing mixture and density HOLA samples. The Representative may reject the proposed laboratory facility if it is determined that sufficient equipment is not available to ensure priority of the local acceptance testing. Additional equipment other than the minimum required equipment listed in Bulletin 27 may be required to properly run some of the referenced procedures.

**(d) Hauling Equipment.** Section 413.3(d).

**(e) Asphalt Pavers.** Section 413.3(e)1.

**(f) Rollers.** Use a minimum of three steel-wheeled rollers, each weighing a minimum of 10 tons and as specified in Section 108.05(c)3. Operate rollers according to manufacturer's recommendations. Use rollers equipped with a watering or soapy watering system that prevents material from sticking to the rollers. Do not use pneumatic wheeled rollers.

Do not use rollers in vibratory mode unless it can be demonstrated during the trial demonstration specified in Section 419.3(g) and to the satisfaction of the Representative that no breaking of aggregate or flushing of asphalt binder results from the vibration. Monitor pavement cores for aggregate breakage on every lot. Discontinue vibration if aggregate breakage or flushing of asphalt binder occurs.

**(g) Demonstration.** Before proceeding with the actual work, demonstrate to the Representative that the proposed SMA mix can be produced, placed, and compacted to meet the requirements of this specification. Place a minimum of 100 tons at a location identified on the approved paving operation QC Plan for each trial demonstration. Simulate the hauling time for the demonstration. Obtain and test three loose mixture samples at the plant for asphalt content, gradation, and draindown and three pavement cores from the demonstration pavement for density. Test one set of volumetric specimens for Air Voids at $N_{design}$ ($V_a$) and test for one maximum specific gravity of the mixture value. If test results do not meet specification limits for both single and multiple sample tolerances for any parameter, perform another demonstration.

If vibratory rolling is proposed, demonstrate to the satisfaction of the Representative that no breaking of aggregate or flushing of asphalt binder results from the vibration. If the contractor requests to waive the requirement for a demonstration strip, and is approved by the Representative, obtain three cores from the first 100 tons of the first day's production placement as soon as temperature allows extraction. Cores will be used to demonstrate to the satisfaction of the Representative that no breaking of aggregate or flushing of asphalt binder results from the vibration. No payment will be made for the demonstration placement, when waived by the Representative.

**(h) Preparation of Existing Surface.** Section 413.3(g).

**(i) Spreading and Finishing.**

**1. General Requirements.**

**1.a Placing.** Unless otherwise allowed or indicated, deliver, place, and compact SMA paving mixtures during daylight hours. Ensure the mixture does not contain lumps of cold material. Deliver and place SMA mixtures at the temperatures specified in Table D.

Use a material transfer vehicle (MTV) as specified in Section 108.05(c)5 to apply the final surface course. Have the MTV perform additional mixing of the SMA material and then deposit the mixture into the paver at a uniform temperature and consistency.

**1.b Spreading and Finishing.** Section 413.3(h)1.b and as follows: Plan and schedule operations to minimize hand work of SMA. Do not allow the finished pavement surface to flush. Flushing is continuous or repeated areas of excessive asphalt on the pavement surface. Areas that are determined to be flushed will be considered defective work.

**1.c Field Technician.** Section 413.3(h)1.d.

**1.d Safety Edge**. Construct the Safety Edge as the standard edge treatment on the outside edge of asphalt pavements and shoulders. Use the Safety Edge for SMA courses with a depth of 1.5 inches or greater. The Safety Edge is not required where curb or sidewalk are encountered or where the face of guiderail is directly over the edge of pavements.

Construct the Safety Edge with the same material used to construct the roadway course being placed or, if specified, the paved shoulders. Attach a device to the paver to confine material at the end gate and extrude the asphalt material in a wedge shape. Use an adjustable device that allows the operator to vary the slope extruded at the paver to account for the angle becoming steeper during compaction (roll up). Before construction, the Safety Edge device must be approved.

Compact the roadway or paved shoulder as required by the specifications. Do not delay rolling of the mat adjacent to the Safety Edge. After compaction of the mat is complete, provide a Safety Edge meeting the final shape requirements as shown on the Standard Drawings. The completed angle of the Safety Edge must be 26 to 40 degrees measured from the pavement cross slope extended. At the beginning of each days paving, measure the angle of the Safety Edge from the pavement cross slope extended. Perform measurements after final compaction is complete. If the angle of the Safety Edge does not meet the slope requirements, stop paving and provide corrective action. Do not resume production paving until final shape requirements of Safety Edge are achieved.

Allow automatic transition to intersections, driveways, guiderail sections, and obstructions.

Use the device to constrain the asphalt head, reducing the area and increasing the density of the extruded profile. A single plate strike-off method is not allowed. Do not place the Safety Edge on organic material.

**2. Mixture and Density Lot Acceptance (RPS Construction).** Lot acceptance is required for RPS construction.

**2.a Lots and Sublots.** Material will be accepted in the field on a lot by lot basis. Lots will be established cumulatively and will be specific for each JMF. Each lot consists of five equal sublots (n=5). A completed sublot has a mixture acceptance box sample as specified in Section 413.3(h)2.b and a pavement core sample collected according to PTM No. 1 and PTM No. 729 as specified in Section 413.3(j)4.c.

A normal lot size is 2,500 tons with five, 500 ton sublots (n=5), unless operational conditions or project size dictate otherwise. If operational conditions or project size dictate, readjustment of the lot will be made as specified in section 413.3(h)2 Table D. Breakdowns or stoppages of short periods due to such causes as weather or equipment failure will not be considered as reasons to adjust the lot size. The original lot will be continued when work resumes after short stoppages of less than 5 calendar days. If a lot is ended due to a stoppage of 5 calendar days or more, adjust the lot size and number of sublots as specified in Section 413.3(h)2 Table D. If the work stoppage is 5 calendar days or more, a new lot will be established.

For small quantities of SMA placements equal to or less than 150 tons, mixture acceptance will be based on certification as specified in Sections 413.2(i)2.b and 419.2(g)2 and density acceptance will be accepted on optimum rolling pattern or non-movement as specified in Section 413.3(j).

**2.a.1 Partially Completed Lots (n=2 or less).** When process conditions change to an extent that a partially completed lot cannot be combined with the most recently completed lot, samples will be independently evaluated on the partially completed lot. For asphalt content and percent passing the 75 µm (No. 200) sieve, mixture acceptance samples will be evaluated individually as specified in Section 419.4(a), Table I (n=1) criteria. For density, mat density acceptance samples will be evaluated individually using the criteria in Table F.

If samples tested for asphalt content and percent passing the 75 µm (No. 200) sieve meet the n=1 criteria of Table I, and samples tested for density meet the criteria in Table F, payment will be 100% of the contract unit price. If samples tested for asphalt content and percent passing the 75 µm (No. 200) sieve do not meet the n=1 criteria according to Table I, the material will be considered defective work. If samples tested for density are no more than 2.0% below the minimum or no more than 2.0% above the maximum limits according to Table F, payment will be 90% of the contract unit price. If samples for density are more than 2.0% below the minimum or more than 2.0% above the maximum limits of Table F, the pavement will be considered defective work.

Unless otherwise directed in writing by the District Executive, remove and replace defective work.

**TABLE F**
**Density Limits for Partially Completed Lots**

| MIXTURE NMAS | DENSITY LIMITS |
|---|---|
| All RPS 9.5 mm, 12.5 mm Wearing Courses | ≥ 93.0 and ≤ 98.0 |

**2.a.2 For JMF’s placed in quantities less than 2,500 tons.** For JMFs placed in quantities of greater than 500 tons and less than 2,500 tons the tonnage will be considered a lot. The lot will be divided into five equal sublots.

For JMF’s placed in quantities of 500 tons or less, the tonnage will be divided into three equal sublots and sampled as specified in Section 419.3(i)2.a.

**2.b Mixture Acceptance and Theoretical Maximum Specific Gravity (Gmm) Verification Samples.** The Representative will select different sample locations in each sublot according to PTM No. 1 and PTM No. 746. In the presence of the Representative, obtain two loose mixture samples (One for acceptance and one for Gmm verification) for each sublot at each sample location and immediately package. Obtain the sample from uncompacted placed mixture or from the paver screed. One loose mixture sample at each location will be used to determine the mixture acceptance and the second loose mixture sample at each location will be used to determine the theoretical maximum specific gravity (Gmm) value. Both sets of mixture samples will be submitted to the testing laboratory on separate Form TR-447 sample identification forms.

Package individual loose mixture samples using interior lined cardboard boxes dimensioned approximately 3 3/4 inches x 4 3/4 inches x 9 1/2 inches. Do not package samples in cardboard boxes with any one dimension greater than 10 1/4 inches or any one dimension smaller than 3 1/2 inches. The lining is homogenously constructed within the interior portion of the cardboard box to prevent asphalt binder absorption/adhesion of the loose mixture sample.

Immediately after packaging and in the presence of the Representative, identify the samples by ECMS project number, lot and sublot number, location (station and offset), date of placement, mixture type, and as either mixture acceptance samples (Sample Class AS) or as Gmm verification samples (Sample Class FV). Leave at least one side of the cardboard sample box free of any writing or marking for LTS use in testing the samples.

For LTS samples, immediately after identifying, submit the samples to the Representative.

For HOLA samples, provide locking containers of adequate size to accommodate at least seven loose mixture samples. Identify each sample by sublot and as either an acceptance or Independent Assurance (IA) sample. The Representative will not package samples from more than one lot in the same container. The Department will inspect the containers provided. Repair, modify or replace all containers determined to be inadequate or not secure. Provide new and sealed locks with two keys, or other acceptable device that will ensure the security of the samples, to the Representative. The containers will be secured by the Representative before being turned over to the contractor for transport to the testing location. Samples received at the testing location will only be opened by the District Materials Representative.

For QC purposes, a maximum of one loose sample per sublot may be obtained. No loose mixture or core samples may be taken by the Contractor for mixture composition testing after the mixture acceptance samples and Gmm verification samples are obtained. Do not obtain any other pavement samples, except those which are directed by and surrendered to the Department, unless allowed in writing from the District Executive.

**2.b.1 IA Sampling for HOLA mixture acceptance.** The Department will perform IA testing of HOLA mixture samples on the initial lot and a minimum of one lot for every 10 lots thereafter. For the IA lots selected by the Representative, obtain one additional loose mixture sample at each sublot location identified in Section 419.3(i)2b.

Immediately after packaging and in the presence of the Representative, identify each sample by ECMS project number, lot and sublot number, location (station and offset), date of placement, mixture type, and as an IA sample. Leave at least one side of the cardboard sample box free of any writing or marking for LTS use in testing the sample.

The Representative will submit the IA sample from each sublot within the lot to LTS for testing by delivering them to the shipping point within 3 days of receipt.

**2.b.1.a Mixture IA Sample HOLA Test Result Analysis.** LTS IA sample test results will be compared to the HOLA Acceptance Sample test results on the same lot. If the difference in the average HOLA and IA test results meet the Independent Assurance tolerances in Table G, the Department will continue with IA testing at a minimum of one out of every ten lots thereafter.

**Table G**
**Independent Assurance Tolerances on Lot Averages**

| Testing Criteria | Max. Difference Between Average Test Results (n≥3) |
|---|---|
| Asphalt Content for 9.5 mm and 12.5 mm NMAS Mixtures | ±0.3% |
| Percent Passing the No. 8 sieve for 9.5 mm and 12.5 mm NMAS mixtures | ±4% |
| Percent Passing the No. 200 sieve for all mixtures | ±1.2% |

If the difference between the lot averages of IA sample test results and HOLA sample test results exceeds the maximum IA tolerances in Table G, specific calibration factors (C*f* and 200 C*f*) will be determined for each ignition furnace used for testing the IA samples and HOLA samples according to PTM No. 757 and additional IA samples will be collected as specified in Section 419.3(i)2.b.1 from the project directly behind the paving equipment for IA comparison. If the IA tolerances in Table G are still exceeded, the Representative will perform an investigation of the cause of the non-comparison of the test results.

Provide information to the Representative, as requested, on the integrity of samples and the testing equipment used in the sample testing. The Representative will also review personnel and test methods used in the HOLA testing. Implement corrective measures for any noted deficiencies to ensure the tests are performed according to the prescribed procedures. The Representative will record the HOLA sample test results, the IA sample test results and any applicable corrective measures. The Representative will select the next lot on the project for IA and will submit the IA samples to LTS for testing. If the difference between subsequent IA sample test results and HOLA sample test results exceeds the IA tolerances in Table G, the Department may discontinue testing of HOLA samples and begin LTS testing of the mixture acceptance samples for the remainder of the project. If the difference between subsequent IA sample test results and HOLA sample test results meets the IA tolerances in Table G, the Department may continue testing of HOLA samples with IA testing at a minimum of one out of every ten lots.

**2.c Mixture and Density Acceptance Sample Testing.** LTS Testing will be utilized unless otherwise indicated in the contract. The Contractor may elect to expedite delivery of the acceptance samples as specified in section 413.3(h) 2.b.

**2.c.1 LTS and HOLA Acceptance Testing.** Density acceptance samples will be tested according to PTM No. 715, and if necessary PTM No. 716, to determine the percent compaction. For individual increment test results outside of the individual mat density tolerances in Table I, the LTS or the District HOLA Representative will analyze the bulk density test results for extreme values according to PTM No. 4 at the 5% significance level. If discarding an extreme value reduces a lot to less than three remaining test results, the Department will accept the lot as specified in Section 419.3(i)2.a.1.

The Department will then randomly select one of the Gmm verification loose mixture samples obtained as specified in Section 419.3(i)2.b for either LTS or HOLA from the lot according to PTM No. 1. The LTS or the District HOLA Testing Representative will test the randomly selected Gmm verification loose mixture sample to determine the theoretical maximum specific gravity (Gmm) of the compacted mixture according to AASHTO T 209 as modified in Bulletin 27, with the following exception:

- The samples will be obtained as specified in Section 419.3(i)2.b.

Randomly selected Gmm verification sample test result will be compared with the Contractor's daily Gmm value for that same production or placement date. If the Department and Contractor Gmm values do not differ by more than ±0.030, the Contractor's daily Gmm values in the whole lot will be considered verified and the Contractor's daily Gmm values will be used to determine the percent of theoretical maximum density for each density acceptance sample placed on that date. If the initial randomly selected Gmm verification sample test result differs from the Contractor's daily Gmm value for that same production or placement date by more than ±0.030, the Department Gmm test result value will be used as the acceptance Gmm value to determine the percent of theoretical maximum density for the individual density acceptance cores produced or placed on that same date. The Department reserves the right to select more than one Gmm verification sample from the lot representing the same production or placement date and to select other Gmm verification samples from the lot representing different production or placement dates to verify the Contractor's daily Gmm values. When more than one Gmm verification sample is selected from the lot representing the same production or placement date, the Department Gmm test results will be averaged and then rounded to the nearest 0.001 according to the rounding method of ASTM E29 and the average value used to verify to the Contractor's daily Gmm value for that same production and placement date.

The Department will accept density lots with three or more test results as specified in Section 419.4(a)3.

The Department will test the mixture acceptance samples according to PTM No. 757 or PTM No. 702, Modified Method D, if previously identified problematic aggregates are used in the mixture, to determine asphalt content and the percent passing the 75 µm (No. 200) sieve. For PTM No. 757, the LTS will use the calibration factors ($C_f$ and 200 $C_f$) provided with the JMF. For individual increment test results outside of the single sample (n=1) tolerances in Table D, the Department will analyze the test results for extreme values according to PTM No. 4 at the 5% significance level. If discarding an extreme value reduces a lot to less than three remaining test results, the Department will accept the lot as specified in Section 419.3(i)2.a.1. The Department will accept lots as specified in Section 419.4(a).

Stop all paving operations if any of the following conditions exist:

- cores are not taken within 1 day after placing the mixture
- the density for two consecutive lots or a total of three lots does not meet the density payment factor percentage of 100
- asphalt content is not within the single sample (n=1) or multiple sample (n≥3) tolerances in Table D for two consecutive lots or a total of three lots
- the percent passing the 75 µm (No. 200) sieve is not within the single sample (n=1) or multiple sample (n≥3) tolerances in Table F for two consecutive lots or a total of three lots
- the pavement exhibits flushing as outlined in 419.3(i)1.b.

Determine the cause of the problem and provide a proposed solution to the Department. Do not resume paving until the Representative reviews the proposed solution and authorizes production to continue.

**(j) Compaction.** Begin rolling material immediately after placement. Compact the SMA mixture to achieve the density acceptance requirements and to eliminate all roller marks while not producing flushing of the asphalt binder. Compact the mixture while it is in proper condition and adjust roller speed, pattern, and roller size (and/or amplitude and frequency if vibratory rolling is approved by the Representative) to eliminate displacement, shoving, cracking, and aggregate breakage as specified in Section 419.3(f). Satisfactorily correct displacement resulting from reversing roller directions and other causes.

Without using excess water, maintain wheels of steel-wheel rollers moist and clean to prevent the mixture from adhering to the wheels.

For areas inaccessible to rollers, compact with mechanical vibrating hand tampers.

**(k) Mat Density Acceptance.**

**1. General Requirements.** The Department will accept the mixtures by lot acceptance as specified in Section 419.3(i)2. The acceptance criteria will be as shown in Table F. The Department will determine acceptance with respect to density, as specified in Section 419.4(a)3.

**1.a. Density Acceptance Samples.** The Representative will select different sample locations in each sublot according to PTM No. 1 and PTM No. 729. With the Representative present, drill 6-inch diameter cores as soon as possible but no later than the day following placement. The core at each location will be used to determine the bulk specific gravity (Gmb) and density (pounds per cubic foot) of the compacted mix. Do not compress, bend, or distort samples during cutting, handling, transporting, and storing. If samples are damaged, immediately obtain replacement samples, as directed by the Representative, from within 12 inches of the original sample location. Within 24 hours after coring, backfill the hole with mixture of the same JMF or with mixture used for subsequent courses and compact and seal the mixture.

In the presence of the Representative, identify the samples by ECMS project number, lot and sublot number, location (station and offset), date of placement, mixture type, and as acceptance samples (Sample Class AS). Provide the daily theoretical maximum specific gravity value as specified in Section 419.2(f)1.d.4 for the density calculation of the lot. If density samples from the lot are taken from more than 1 day's placement, the daily theoretical maximum specific gravity values from each production day will be used to calculate the percent of theoretical density for each individual density acceptance core placed on that production day upon Gmm verification as specified in Section 419.3(i)2.c.1.

For LTS samples, immediately deliver the samples to the Representative and provide sample containers of sufficient strength to prevent samples from being damaged during transport and sufficient size to accommodate the density samples from one lot. The Representative will submit samples for one lot in one container.

For HOLA samples, provide locking containers of adequate size to accommodate seven core samples. Identify each sample by sublot and as either acceptance or IA sample. The Representative will not package samples from more than one lot in the same container. The Department will inspect the containers provided. Repair, modify or replace all containers determined to be inadequate or that are not secure. Provide new and sealed locks with two keys, or other acceptable device that will ensure the security of the samples to the Representative. The containers will be secured by the Representative before being turned over to the contractor for transport to the testing location. Samples received at the testing location will only be opened by the District Materials Representative.

For quality control purposes, a maximum of one pavement core per sublot may be obtained unless the Representative allows additional cores. No cores may be taken by the Contractor after the acceptance cores are obtained. Do not obtain any other pavement cores, except those that are directed by and surrendered to the Department, unless allowed in writing by the District Executive.

**1.b. IA Density Samples.** The Department will perform IA testing of HOLA density samples on the initial lot and a minimum of one out of every ten lots thereafter. The Representative will identify one HOLA sample as specified in Section 419.3(k)1.a to also serve as an IA sample. Cores coated with paraffin wax according to PTM No. 716 are omitted from IA testing.

With the Representative present, identify the samples by ECMS project number, lot and sublot number, location (station and offset), date of placement, mixture type, and as AS/IA samples. Provide the daily theoretical maximum specific gravity value as specified in Section 419.3(i)2.b for the density calculation of the lot. Immediately after identifying, submit the density samples to the Representative as specified in Section 419.3(k)1.a. Upon testing of the sample for HOLA density as specified in Section 419.3(i)2.c.1, the Representative will package the density IA samples in the containers and submit the IA samples to LTS for testing.

**1.b.1. LTS Testing of IA HOLA Density Samples.** The LTS will test the density samples for IA according to PTM No. 715, and if necessary PTM No. 716, to determine the percent compaction.

**1.b.1.a Density IA Sample Test Result Analysis.** LTS IA density sample test results will be compared to the HOLA density sample test results on the same lot. If the difference in the average test results of the HOLA and IA meet the IA tolerances in Table H, the Department will continue with IA testing at a minimum of one out of every ten lots thereafter.

**Table H**
**Independent Assurance Tolerances on Lot Averages**

| Testing Criteria | Max. Difference Between Test Results (n≥3) |
|---|---|
| PTM No. 715 or PTM No. 716, Gmb | 0.020 |
| AASHTO T 209 as modified in Bulletin 27 | 0.030 |

If the difference between the lot averages of IA sample test results and HOLA sample test results exceeds the maximum IA tolerances in Table H, the Representative will perform an investigation as to the cause for the non-comparison of the test results. Provide information to the Representative, as requested, on the integrity of samples and on the equipment used in the sample testing. The Representative will also review personnel and test methods used in the HOLA testing. Implement corrective measures for any noted deficiencies to ensure the tests are performed according to the prescribed procedures. The Representative will record the HOLA Sample test results, the IA sample test results and any applicable corrective measures in the Field Inspector's Diary. The Representative will select the next lot on the project for IA and will submit the IA companion density samples to LTS for testing. If the difference between subsequent IA sample test results and HOLA sample test results exceeds the IA tolerances in Table H, the Department may discontinue testing of HOLA samples and begin LTS testing of the acceptance samples for the remainder of the project and revert to Section IV for measurement and payment. If the difference between subsequent IA sample test results and HOLA sample test results meets the IA tolerances in Table H, the Department may continue testing of HOLA samples with IA testing at a minimum of one out of every ten lots.

**(l) Joints.** Section 413.3(k).

**(m) Surface Tolerance.** Section 413.3(l).

**(n) Tests for Depth.** Section 413.3(m).

**(o) Protection of Courses.** Section 413.3(n).

**(p) Defective Work.** As specified in Section 105.12 and as follows:
Department acceptance and QA testing does not relieve the Contractor of responsibility for material or workmanship that the Representative determines is defective before the Department issues the acceptance certificate. Remove and replace or repair defective work as directed. The CMD will review Representative determinations of defective material or workmanship.

Unless otherwise directed in writing by the District Executive, remove and replace pavement defective for flushing as specified in Section 419.3(i)1.b, surface tolerance as specified in Section 413.3(l) and depth as specified in Section 413.3(m). Remove and replace pavement defective for percent within limits or Payment Factor Percentage according to Table I.

## 419.4 MEASUREMENT AND PAYMENT—

**(a) SMA RPS Construction.**

**1. SMA Wearing Course RPS.** Square Yard or Ton.

**2. Asphalt Tack Coat.** Section 460.4.

**3. Mixture and Density Acceptance by Lot using Pavement Cores.** The Department will pay on a lot-by-lot basis at the contract unit price, adjusted for Payment Factor Percentages as specified in Table I. For the payment factor percentages based on percent within limits, the Department will determine the percent within limits as specified in Section 106.03(a)3, using the upper and lower specification limits in Table J.

**3.a Payment.**

The Representative will compute the percent of the contract unit price paid as follows:

Lot Payment = $C_P(2P_D + P_B + P_A)/400$

$C_P$ = Contract unit price per lot (unit price times lot quantity)

$P_D$ = Payment Factor Percentage for density

$P_B$ = Payment Factor Percentage for asphalt content.

$P_A$ = Payment Factor Percentage for percent passing the 75 µm (No. 200) sieve

**TABLE I**
**Contract Price Adjustments**

| Test Criteria | Test Value | Payment Factor Percentage |
|---|---|---|
| **Asphalt Content** | | |
| Acceptance Sample testing of % Asphalt | All acceptance sample test results are within ±0.7% for n=1 and ±0.4% for n≥ 3 of the JMF | 100 |
| | Percent Within Limits if all acceptance sample test results are not within ±0.7% for n=1 and ±0.4% for n≥ 3 of the JMF | Table K |
| **Gradation** | | |
| Acceptance Sample Testing of % Passing 75 µm (No. 200) Sieve | All acceptance sample test results are within +3.0% and -3.0% for n=1, and + 2.0% and -2.0% for n≥ 3 of the JMF | 100 |
| | Percent Within Limits if all acceptance sample test results are not within +3.0% and -3.0% for n=1, and + 2.0% and - 2.0% for n≥ 3 of the JMF | Table K |
| **Mat Density** | | |
| Acceptance Sample Testing of Pavement Cores | All individual results for the lot are ≥ 93.0 % and ≤ 98.0 % of the maximum theoretical density | 100 |
| | Percent Within Limits if any individual sublot test result for the lot is not ≥ 93.0 % and ≤ 98.0 % of the maximum theoretical density. | Table K |

**TABLE J**
**Upper and Lower Specification Limits for Calculating Percent Within Limits**

| Testing Criteria | |
|---|---|
| **Lower Specification Limit (L)** | **Upper Specification Limit (U)** |
| **Asphalt Content from JMF Value, %** | |
| -0.4 | +0.4 |

| Percent Passing the 75 µm (No. 200) sieve from JMF Value, % | |
|---|---|
| -2.0 | +2.0 |
| **Mat Density*** | |
| 92.0 | 98.0 |
| * The Percent of Theoretical Maximum Density | |

**TABLE K**
**Payment Factor Based on Percent Within Limits**

| Percent Within Limits | Payment Factor Percentage |
|---|---|
| 99 | 97 |
| 98 | 97 |
| 97 | 97 |
| 96 | 96 |
| 95 | 96 |
| 94 | 96 |
| 93 | 95 |
| 92 | 95 |
| 91 | 95 |
| 90 | 95 |
| 89 | 93 |
| 88 | 91 |
| 87 | 90 |
| 86 | 88 |
| 85 | 86 |
| 84 | 84 |
| 83 | 83 |
| 82 | 81 |
| 81 | 79 |
| 80 | 78 |
| 79 | 76 |
| 78 | 74 |
| 77 | 72 |
| 76 | 71 |
| 75 | 69 |
| 74 | 67 |
| 73 | 66 |
| 72 | 64 |
| 71 | 62 |
| 70 | 60 |
| 69 | 59 |
| 68 | 57 |
| 67 | 55 |
| 66 | 54 |
| 65 | 52 |
| 64 | 50 |
| Less than 64 | Defective Lot** |

**Remove and replace the lot. If only one lot characteristic has a percent within limits less than 64, the District Executive may allow the Contractor to leave the defective lot in place. The Department will pay for the defective lot at 50% of the contract unit price.

**3.b Dispute Resolution.** For mixture acceptance testing or density acceptance testing performed by the LTS, the Contractor may request in writing that the Department retest a lot if the initial test results indicated a defective lot (remove and replace) except for density when one or more density acceptance cores in the lot were coated with paraffin wax as a result of PTM No. 716 during the original density acceptance testing. For HOLA acceptance, the Contractor may only request in writing that the Department retest a mixture acceptance lot if the initial test results indicate a remove and replace defective lot. All retesting for HOLA and LTS will be performed by the LTS lab. Provide written retest requests to the District Executive within 3 weeks of the date the LTS test results are released. Retests will not be allowed if a written retest request is not received within 3 weeks of the date the LTS test results are released. Provide quality control test results and control charts, companion sample test results (if available), test data trend evaluation, and any other pertinent information to justify the retest request. The Department will evaluate the information and may allow retesting if the information submitted provides a reasonable basis to conclude that the failing test results may not represent the in-place material. The LTS will perform the retest with the Contractor present, unless otherwise agreed to in writing with the Contractor.

For retesting of materials failing for asphalt content or percent passing 75 µm (No. 200) sieve, the Representative will identify the locations where the original mixture acceptance samples were collected. The Representative will select retest sample locations 24 inches from the original sample locations longitudinally in the direction of traffic. If the 24-inch offset causes the retest sample location to fall outside of the sublot, the Representative will select the retest sample location 24 inches from the original sample locations longitudinally in the opposite direction from traffic.

With the Representative present, provide appropriate traffic control and drill 6-inch diameter cores for retesting purposes according to the procedure for drilling in PTM No. 729. Ensure drilling procedures include washing off and towel drying the core samples immediately after drilling. Within 24 hours after coring, backfill the hole with SMA or Superpave mixture of the same NMAS and PG asphalt grade as the material sampled or with mixture used for subsequent courses and compact and seal the mixture. Provide traffic control, core, and backfill the core holes at no cost to the Department. The test method used for asphalt determination during the original acceptance testing (PTM No. 757 or PTM No. 702) will be used for the retest, unless the DME/DMM grants written approval for a change in test method. The results of the retest cores will be used to calculate payment for both asphalt content and percent passing the 75 µm (No. 200) sieve for the lot.

When a request is received for retesting of density acceptance, the original density acceptance cores will be utilized. The LTS will not retest a lot for density acceptance when one or more density acceptance cores in the lot were coated with paraffin wax as a result of PTM No. 716 during the original density acceptance testing. The LTS will retest each original density acceptance core according to PTM No. 715 and PTM No. 716, as necessary, to determine the Gmb and bulk density values. The LTS will not perform Gmm testing for lots where the Contractor's Gmm value was previously considered verified as specified in Section 413.3(j)4.d.1. After Gmb testing is completed, for lots where the Contractor's Gmm value was not verified, the LTS will select one original density acceptance pavement core from each production or placement date represented by the density acceptance cores in the lot. Each core selected will be the core with the highest bulk density for that production or placement date from the retest results (e.g., if a lot was placed over three production days, and the lot density acceptance cores include at least one core from each production or placement day, the original density cores selected during a density retest to perform Gmm testing will be 3; one from each production or placement date). The LTS will perform Gmm testing on the selected cores according to AASHTO T 209 as modified in Bulletin 27, with the following exceptions:

- the samples will be obtained as specified in Section 413.3(j)4.c,
- no conditioning, only drying, will be performed on the sample,
- the minimum sample size will be waived, as necessary, to use the 6-inch diameter pavement core sample, and
- the supplemental procedure for mixtures containing porous aggregate will only be performed when either the coarse aggregate or fine aggregate in the mixture has a water absorption value ≥ 1.5% as indicated on the JMF and then only when the calculated percent of theoretical maximum density indicates any one individual failing sublot which results in a density pay factor less than 100.00.

The LTS Gmm value(s) determined will be the Gmm values used to determine the percent of theoretical maximum density for the cores represented by the applicable production or placement dates in the lot. Either the previously verified Contractor's Gmm value(s) or the newly tested LTS Gmm value(s) will be used for acceptance to

# SECTION 420—PERVIOUS ASPHALT PAVEMENT SYSTEM

**420.1 DESCRIPTION—**This work is the construction of plant-mixed asphalt concrete pervious pavement on a prepared surface designed to allow the infiltration of storm water into the subsoil. The pervious asphalt surface layer is a horizontal plane that is permeable to water and air. The second layer of the storm water system is an open graded, angular stone layer that is used for temporary storm water detention.

**420.2 MATERIAL—**

**(a) Aggregate.** Section 703

**1. Coarse Aggregate.**

**1.a For use in Asphalt JMF.** Course Aggregate, Type A, Section 703.2, except Table C gradation does not apply and revise the following quality requirements of Table B.

- Abrasion, Maximum Percent as specified in Bulletin 27, Chapter 2A, Table 5A
- Thin and Elongated Pieces, Maximum Percent as specified in AASHTO M 323, Table 5, for Flat and Elongated
- Crushed Fragments, Minimum Percent, as specified in AASHTO M 323, Table 5, for Fractured Faces, Coarse Aggregate

**1.b For use in Detention Basin.** Either AASHTO No. 3 as the primary detention coarse aggregate topped with AASHTO No. 57 as a choker and leveling coarse; or AASHTO No. 57 only, as designed and specified.

**2. Fine Aggregate.**

**2.a For use in Asphalt JMF.** Section 703.1, except Table A gradation does not apply and as follows: Determine the un-compacted void content according to AASHTO T 304, Method A, or use the value listed in Bulletin 14, and conform to AASHTO M 323, Table 5. Determine the sand-equivalent value according to AASHTO T 176 and conform to AASHTO M 323, Table 5.

**2.b For use in Detention Basin.** Fine Aggregate, Type A or Type B.

**(b) Fibers.** Section 711.3(g)

**(c) Geotextile, Class 4, Type A.** Section 212

**(d) Edge Restraints**. Provide asphalt edge restraints (as a locally approved material as specified in Section 106.02(a)2.c) when specified and of sufficient strength to resist lateral roller forces where the pervious asphalt adjoins landscaped areas to provide a clean, durable edge for the pavement. Other edge restraints may be utilized with the approval of the Representative. For manufactured edge restraints, install in accordance with the manufacturer's guidelines. Provide black edge restraints when permanently incorporated into the project.

**(e) Asphalt Binder Material**.

**1. Pervious 9.5 mm Wearing Course.** Asphalt Cement, Class PG 64H-22 or PG 64E-22 as specified in Section 702. Approved polymer additives or ground tire rubber may be used to meet the PG grade.

**2. Pervious 19.0 mm Binder Course.** Asphalt Cement, Class PG 64S-22 as specified in Section 702.

**(f) Recycled Asphalt Pavement.** Limit RAP to a maximum of 10% of the mixture.

**(g) Additives.** Incorporate an anti-strip additive or hydrated lime for pervious mixes utilizing the same aggregates as approved 9.5 mm or 19.0 mm dense graded mixtures and with the same PG grade binder where an anti-strip additive was required. If no history exists for an approved dense graded mixture, perform testing in accordance with ASTM D 3625 on the finished mix with a minimum of 90% coating to determine moisture susceptibility and an anti-strip additive is required.

**1. Heat-Stable, Anti-Stripping Additive.** Blend the additive with the asphalt cement before adding the additive and asphalt cement to the mixture. Use the manufacturer's recommended dosage of the additive, but not less than 0.25% by weight of the asphalt. Select an additive that does not harm the completed asphalt concrete mixture and that is compatible with the aggregate and asphalt supplied for the project.

**2. Pervious Asphalt Stabilizer.** Perform testing in accordance with AASHTO T 305 to determine whether a stabilizer is required. When required, provide cellulose fibers in the mixture according to the tolerances in Table B. Stabilizer dosage rate must be within 0.2% to 0.4% by weight of the total mix.

**(h) Mixture Design and Production.**

**1. Design.** Size, uniformly grade, and combine aggregate fractions according to Table A. Determine air voids using any method from Table B for bulk specific gravity. Determine the maximum theoretical specific gravity in accordance with AASHTO T 209. Gyrate two specimens in accordance with AASHTO T 312 and determine bulk specific gravity by averaging them, employing one of the methods in Table B to calculate air voids.

Test materials, proportions, and the mixture at the asphalt concrete plant laboratory. Verify conformance with the uniformity requirements of this specification. Verification testing may be performed by the LTS at the Department's discretion. Provide a JMF that conforms to all Department requirements. Submit a copy of the JMF to the DME/DMM at least 3 weeks before the scheduled start of producing the mixture for the project. If the Department has not used the JMF on a previous project, provide test results from previous mixture production that indicate the mixture conformed to all JMF production tolerances when submitting the design for initial review.

**TABLE A**
**Composition of Mixture**
**(Total Percent by Mass (Weight) Passing Square Openings Based on Laboratory Sieve Tests)**

| | **Pervious 9.5 mm Wearing** | **Pervious 19.0 mm Binder** |
|---|---|---|
| **Sieve Size** | **Percent Passing** | **Percent passing** |
| 25.0 mm (1-inch) | | 100 |
| 19.0 mm (3/4-inch) | 100 | 85 - 100 |
| 12.5 mm (1/2-inch) | 95 - 100 | 35 - 68 |
| 9.5 mm (3/8-inch) | 70 - 100 | |
| 4.75 mm (No. 4) | 20 - 40 | 10 - 25 |
| 2.36 mm (No. 8) | 10 - 20 | 5 - 15 |
| 75 µm (No. 200) | 0 - 4 | 0 - 4 |
| | | |
| Asphalt Content | 5.5% - 7.0% | 3.0% - 5.0% |

**TABLE B**
**Mixture Composition**

| | | |
|---|---|---|
| Gyrations | $N_{initial}$ | N/A |
| | $N_{design}$ | 50 |
| | $N_{maximum}$ | N/A |
| Air Voids | ASTM D 6752 | 16.0% - 20.0% |
| | AASHTO T 275 | 18.0% - 22.0% |
| | AASHTO T 269* | 18.0% - 22.0% |
| Draindown | AASHTO T 305 | $\leq$ 0.3% |

*When using AASHTO T 269 the height of the specimen will be determined by the gyratory compactor reading at $N_{design}$.

**2. QC Plan.** Prepare and submit a QC Plan, as specified in Section 106. Provide the QC plan to the Representative at the start of the project. Do not begin production until receiving approval of the QC Plan from the Representative.

**3. Production.** Perform QC Tests in accordance with Table C.

**TABLE C**
**Production Testing**

| Property | Frequency | Range |
|---|---|---|
| Asphalt content | Daily | ± 0.7% |
| Gradation | Daily | Table A |
| Air Voids | Daily | Table B |
| Draindown | Daily | ≤ 0.3% at design compaction temperature |

**4. Acceptance of the Mixture.** Obtain material certifications from the material producer using the results of QC tests for asphalt content, gradation, and air voids. Provide copies of the certifications to the Inspector-in-Charge within 1 working day after performing QC tests.

## 420.3 CONSTRUCTION—

**(a) Test Sections.** Produce two test sections using the approved JMF and placement and finishing operations to be used in production and construct at the project site on a prepared subgrade and base, using the material and construction requirements used in production. Each section must have an area of at least 225 square feet. Perform infiltration on both test sections in accordance with ASTM C 1701. The average of both infiltration values must exceed 200 inches per hour. Compacted thickness cannot be more than 1/4-inch less than the design thickness.

**(b) Subgrade Preparation.** Excavate subgrade to undisturbed soil without compaction, allowing the subgrade to be left as permeable as possible. Where erosion of subgrade has caused accumulation of fine materials and/or surface ponding, remove the accumulated material using light equipment and scarify the underlying soil to a minimum depth of 6 inches using a spring tooth rake or equivalent and a light tractor. Avoid driving haul trucks or other heavy equipment through the installation area. Repair damaged areas to the satisfaction of the Representative. Do not compact or otherwise subject the existing subgrade under pavement areas to excessive construction equipment traffic before geotextile and stone bed placement. Satisfactorily correct and repair any damaged or compacted areas to the satisfaction of the Representative. Notify the Representative upon completion of subgrade work for final inspection and acceptance before proceeding with basin and choker course installation.

**(c) Detention Basin.** Prevent sediment from washing into beds during site development. Cover the bottom of the detention base with a minimum of 2 inches of fine aggregate to prevent soils from migrating into the storm water storage area. Wrap basin sides with a non-woven geotextile fabric. Install detention basin coarse aggregate in 8 inch maximum lifts. Compact the course in as specified in Section 360.3. Install aggregates to grades indicated on drawings. Place the specified depth(s) of coarse aggregate on top of the fine aggregate and roll as specified in Section 420.3(f). Remove temporary sediment control materials when the site is fully stabilized.

**(d) Asphalt Treated Permeable Base Course.** Section 360.3, where required for buses or light trucks.

**(e) Weather Limitations.** Do not place pervious pavement mixtures when the air or surface temperature is lower than 50F.

**(f) Rollers.** Use smooth steel-wheeled rollers in the static mode and seat with one to four passes. Do not use pneumatic tire rollers.

**(g) Conditioning of Existing Surface.** Before placing a wearing course, correct irregularities in the binder course. If practical, do not allow traffic on the binder course to prevent contamination. Remove and replace binder course that cannot be cleaned to the Representative's satisfaction.

Coat existing vertical surfaces of curbs, structures, gutters, and pavements that will be in contact with asphalt mixtures with a thin, uniform coating of emulsified asphalt (AASHTO SS-1, CSS-1, SS-1h, CSS-1h, or TACK) applied in two or more applications, or of the class and type designated for the asphalt course.

Do not use a tack coat between lifts of any pervious asphalt. Place the wearing course as soon as practical after the placement of the binder course.

**(h) Spreading and Finishing.** Use a track paver, as specified in Section 413.3(e), or a mechanical spreader. Spread or strike off the entire for the entire lane width or as much lane as practical. Place the mixture in maximum 4-inch compacted lifts. Adjust screed assemblies to provide the cross section and depth indicated. Construct the profile to the design grade line. Use fully automatic sensors to control profile and transverse grade. Allow the mixture to cool to 100F before placing subsequent layers or pavement courses. Perform handwork at locations directed by the Representative. For multiple lift construction, second lift may be placed and rolled perpendicular to the direction of placement and rolling of the first lift.

Do not use pervious pavement beds for storage of equipment, materials, or soils during construction.

**(i) Compaction.** Compact the pervious asphalt pavement when the surface is cool enough to resist a 10-ton steel-wheeled static roller or vibratory roller operated in the static mode. Limit compaction to not more than four passes to preclude a reduction in the surface porosity. One roller pass is defined as one trip of the roller in one direction over any one spot. Do not over compact the material to the point that it is not free draining or the aggregate is crushed.

**(j) Joints.**

**1. Longitudinal Joints.** Spread the pervious paving course to overlap the edge of the lane previously placed by 1 inch to 2 inches. Maintain the uniform un-compacted depth adjacent to a compacted lane necessary to provide a smooth joint after compaction.

**2. Transverse Joints.** At the end of each day's work and when more than a 30 minute interruption occurs in pervious paving operations, install a temporary vertical bulkhead to form a straight transverse construction joint. The joint must be the full depth and width of the pervious paving course. In lieu of a temporary bulkhead, a full depth transverse joint may be sawed before resuming paving.

**(k) Surface Tolerance.** Test the finished surface at locations the Representative suspects are irregular and at transverse joints and paving notches. Test the surface in stages using a 12-foot straightedge. At each stage, hold the straightedge in contact with the surface and parallel to the road centerline and, in successive positions, test the pavement surface from one side to the other. Advance the test location to the next stage by moving the straightedge along the pavement centerline by not more than 5 feet.

Immediately correct irregularities of more than 3/8-inch by loosening surface mixture and removing or adding pervious paving course. For irregularities exceeding 3/8-inch that develop after compaction is completed, correct the irregularity by a method that does not produce contaminating fines or damage the base. Do not grind or mill the pervious paving course. The area is defective if irregularities or defects remain after final compaction. Remove and replace defective areas. If allowed, submit a corrective action plan to the representative for approval.

**(l) Tests for Depth: Binder and Wearing Courses.** Carefully dig or drill one 6-inch diameter test hole to the full depth of the pervious course for each 3,000 square yards or less of completed base course. The Representative may require additional test holes in areas the Representative suspects are deficient in depth. The Representative will measure the depth of the pervious course. Using material acceptable to the Representative, backfill the test holes and compact the material to fill the test hole flush with the completed course.

Remove and replace sections deficient in depth by 1/2-inch or more. Start correction at the point of determined deficiency and continue correction longitudinally and transversely until the depth is within 1/2-inch of the indicated depth.

**(m) Infiltration Testing**. Perform infiltration testing on three areas selected in accordance with PTM No. 1 for every 10,000 square feet of pervious asphalt pavement placed in accordance with ASTM C 1701. Remove and replace pervious asphalt pavement not meeting or exceeding a minimum average infiltration rate of 200 inches per hour. Document the average infiltration value from testing for use in future maintenance activities.

**(n) Defective Work.** Unless otherwise directed in writing by the District Executive, remove and replace pervious asphalt that is deficient in surface tolerance, depth, asphalt content, percent of coated aggregate particles is less than 95%, or when percent passing the 4% maximum for the No. 200 sieve for the composite mixture is exceeded.

Pervious courses are also considered defective if the ASTM C 1701 infiltration rate is less than 200 inches per hour.

With written permission from the District Executive, low areas may be filled during construction of the next pavement course.

## 420.4 MEASUREMENT AND PAYMENT—

**(a) Pervious Asphalt Pavement System.** Square Yard or Ton

**1. Pervious Wearing Course.** Square Yard or Ton

**2. Pervious Binder Course.** Square Yard or Ton

**(b) Asphalt Treated Permeable Base Course.** Section 360.4

# SECTION 460—ASPHALT TACK COAT

**460.1 DESCRIPTION**—This work is the conditioning and treating of an existing surface with an application of emulsified asphalt bonding material.

**460.2 MATERIAL**

**(a) Emulsified Asphalt Material.** One of the following as specified in Section 702. Submit a Certificate of Compliance as specified in Section 106.03(b)3 and a Bill of Lading as specified in Section 702.1(c) to the Representative indicating the asphalt residue content (ARC) of the material being used. If the emulsified asphalt material is stored for 30 days or longer after certification, resample and retest the emulsified asphalt material at no additional cost to the Department to determine if it meets Bulletin 25 specification requirements.

**TABLE A**
**Emulsified Asphalt Materials**

| Class of Material | Type of Material | Application Temperature F | |
|---|---|---|---|
| | | Minimum | Maximum |
| TACK | Anionic or Cationic Emulsified Asphalt | 90 | 150 |
| NTT/CNTT | Anionic or Cationic Emulsified Asphalt | 140 | 180 |

**(b) Fine Aggregate (For Blotting).** Section 703.1

**460.3 CONSTRUCTION**—

**(a) Conditioning Existing Surface.** Section 413.3(g).

**(b) Application of Emulsified Asphalt Material.** Use a distributor designed, equipped, calibrated, maintained, and operated to apply material uniformly on surfaces with varying widths and up to 15 feet wide. Provide a distributor capable of maintaining a uniform distributing pressure and controlling the application rate (AR) within a tolerance of 0.02 gallon per square yard. Provide a distributor equipped with a tachometer, pressure gauges, accurate volume-measuring devices or a calibrated tank, a thermometer for measuring temperatures of tank contents, a power-operated pump, and full circulation spray bars with lateral and vertical adjustments. Provide nozzles sized according to the manufacturer's recommendations for the material selected for application. In the field, determine the distributor's application rate according to PTM No. 747.

The Contractor may use hand-spraying equipment in areas inaccessible to the distributor.

Apply tack coat at an application rate, approved by the Representative, to leave a uniform asphalt residual rate within the ranges per surface type according to Table B~~.~~ Identify the application rates and the residual rates on the Paving Operation QC Plan and review the QC plan application rates and residual rates with the Representative at the Preplacement Meeting.

**TABLE B**
**Uniform Asphalt Residual Rates by Surface Type**

| Surface Type | Uniform Asphalt Residual Rates (RR) (gallons per square yard) |
|---|---|
| New Asphalt Paving | 0.03 to 0.05 |
| Existing Asphalt Paving | 0.04 to 0.07 |
| Milled Surface (Asphalt & Portland Cement Concrete) | 0.04 to 0.08 |
| Portland Cement Concrete | 0.04 to 0.07 |

The application rate to achieve a uniform asphalt residual rate can be determined using the following equation:

*AR = (RR / ARC)*

AR = Application Rate, (gallons per square yard); the amount of emulsified asphalt sprayed by the distributor truck.

RR = Residual Rate; (gallons per square yard); the amount of emulsified asphalt remaining on the surface after it has broken and set.

ARC = Asphalt Residue Content; (% divided by 100); the percentage amount of asphalt in the emulsified asphalt. Provided on the Bill of Lading and expressed as a decimal.

When paving operations begin, apply tack coat on a 100-linear foot minimum test section on the project for each paving course. Apply tack coat at the distributor's application rate to achieve the proposed residual rate within the ranges listed in Table B. Adjust distributor application rate and spray bar height to obtain a uniform surface coverage. Review adequacy of the tack coat coverage with the Representative before continuing with the tack coat application.

Apply the tack coat only when the air temperature is 40F and rising and when the existing surface is dry. Before each paving course, apply the tack coat at an application rate to be within ranges of the uniform asphalt residual rate for the surface type according to Table B. Uniformly distribute the tack coat over the entire surface. Extend the tack coat a minimum of 6 inches beyond the longitudinal joint of the paving course being placed.

Correct all uncoated or lightly coated areas as directed to the Representative's satisfaction. At designated locations, correct areas with an excess of emulsified asphalt material by covering the area with sufficient dry fine aggregate to blot up or remove excess tack coat.

Allow the tack coat to break and set, without being disturbed. Do not begin paving until the Representative determines the tack coat has cured to the point that tracking is minimized.

**(c) Protection of Treated Surface.** Maintain and protect the treated surface against damage. Repair damaged areas to the Representative's satisfaction before placing the next pavement course.

## 460.4 MEASUREMENT AND PAYMENT—

**(a) Area Basis.** Square Yard

**(b) Material Used Basis.** Gallon

# SECTION 483—POLYMER-MODIFIED EMULSIFIED ASPHALT PAVING SYSTEM (MICRO SURFACING)

**483.1 DESCRIPTION**—This work is the construction of a polymer-modified emulsified asphalt paving system, commonly known as micro-surfacing, to fill ruts and/or resurface existing pavements.

Micro-surfacing material is classified into three mix types as follows:

**(a) Type A.** Used to seal cracks, fill voids and shallow (less than 1/2 inch) ruts, and provide a scratch course or surface seal. Use a double application, when specified, to meet total design pounds per square yard for surface courses.

**(b) Type B.** Used to fill moderate (1/2 inch to 1 1/4 inch) ruts; and provide a scratch course, a leveling course, a seal coat, or a surface treatment. Use a double application, when specified, to meet total design pounds per square yard for surface courses.

**(c) Type Rut Fill (RF)**. Used to fill deep (2 inch) ruts in a single pass.

**483.2 MATERIAL**—

**(a) Emulsified Asphalt Material.** Class CQS-1hPM as specified in Bulletin 25. Obtain material from an approved producer and source listed in Bulletin 15 and provide quality control testing and certification as specified in Sections 106.03(b) and 702.1(b)1.

**1. Polymer Modifier.** Provide a latex based modifier capable of making a micro-surfacing mix which cures fast enough to allow traffic to be placed on the pavement within 1 hour, without damaging the surface.

**(b) Aggregate.** Provide coarse or fine aggregates from sources listed in Bulletin 14. Provide fine aggregate Type B or better meeting the quality requirements of Table A, Section 703.1(c) and coarse aggregates meeting the quality requirements of Table B, Section 703.2(a). The final gradation must meet the final gradation specified in Table A of this specification. For wearing courses, provide aggregate with at least the SRL designation specified. To achieve the specified SRL, the Contractor may provide a blend of two aggregates if the blend has an SRL designation equal to or better than that specified. Blends are 50% by weight of each aggregate. Blend the aggregates using an approved method.

**(c) Filler.** Supply filler, when required to maintain the percent by weight passing the 75 µm (No. 200) sieve, as specified in Section 703.1(c)1 consisting of any approved, non-air entrained, Type 1, Portland cement free of lumps or hydrated lime as specified in Section 723.1.

**(d) Water.** Section 720.2 and free of harmful soluble salts.

**(e) Other Additives.** Supplied by the manufacturer to control mix set time in the field due to varying ambient environmental conditions.

**(f) Mixture Composition.** Size, uniformly grade, and combine aggregate fractions in such proportions that the total aggregate and filler in the JMF conform to the composition by weight percentages specified in Table A. Perform the tests identified in Table B for each mix design and provide the test results to document each mix design's characteristics.

Submit a certified mix design(s) using a Micro-Surfacing Mix Design and Materials Analysis Form TR-483 to the DME/DMM at least 2 weeks before its use in the work. Clearly show for each mix design the proportions of aggregate, filler, percent polymer-modified emulsified asphalt and asphalt residue, based on the dry weight of the aggregate, and the design cure time. Ensure all the materials used in the mix design represent the materials proposed for use on the project. If minor adjustments are required during construction, based on field conditions, provide the changes in writing to the Representative.

**1. QC Plan and JMF.** Prepare a QC Plan, as specified in Section 106, and submit it for review at the start of the project and at least annually thereafter. Include the number of applications and the mix design used with each application in the QC Plan. Do not start work until the QC Plan has been reviewed and the JMF has been submitted.

When unsatisfactory results or other conditions make it necessary, a new JMF may be required. If a change in sources of materials is made, submit a revised JMF to the DME/DMM before using any new material.

**2. Uniformity.** Produce each mix type within the ranges specified in Table C.

**TABLE A**

| SIEVE SIZE | COMPOSITION, TOTAL PERCENT BY MASS (WEIGHT PASSING) | | |
|---|---|---|---|
| | TYPE A | TYPE B | TYPE RF |
| 12.5 mm (1/2 inch) | 100 | 100 | 100 |
| 9.5 mm (3/8 inch) | 100 | 95 - 100 | 90 - 100 |
| 4.75 mm (No. 4) | 85 - 100 | 65 - 85 | 55 - 75 |
| 2.36 mm (No. 8) | 50 - 75 | 46 - 65 | 40 - 55 |
| 1.18 mm (No. 16) | 40 - 65 | 28 - 45 | 24 - 40 |
| 600 µm (No. 30) | 25 - 45 | 19 - 34 | 19 - 34 |
| 300 µm (No. 50) | 13 - 25 | 10 - 23 | 10 - 20 |
| 75 µm (No. 200) | 5 - 15 | 5 - 15 | 5 - 15 |
| Note: Material finer than the 75 µm (No. 200) sieve will be determined as per PTM No. 100. | | | |

**TABLE B**

| MICRO-SURFACING MIX DESIGN PROPERTIES | | |
|---|---|---|
| **Property** | **Test Method** | **Test Requirements** |
| Wet Cohesion: | ISSA TB 139 30 Minutes<br>ISSA TB 139 60 Minutes | 12 kg-cm min<br>20 kg-cm min or near spin |
| Wet Track Abrasion Loss: | ISSA TB 100 1 Hour Soak<br>ISSA TB 100 6 Day Soak | 50 g/ft$^2$ max<br>75 g/ft$^2$ max |
| Mix Time: | ISSA TB 113 | 120 seconds min |
| Classification of Compatibility: | ISSA TB 144 | 11 grade points min |
| Wet Stripping: | ISSA TB 114 | Pass (90% min) |
| Loaded Wheel Test: | ISSA TB 147 | Vertical 10% max, Lateral 5% max |
| Note: Provide aggregate with a minimum sand equivalency of 65 as determined by AASHTO T 176. If the sand equivalency is < 65, the aggregate may be approved as long as the Plasticity Index (PI) is zero. Test the PI as per AASHTO T 89 and AASHTO T 90 and meets the methyl blue test. | | |

**TABLE C**

| MIX TYPE | MINIMUM SURFACING APPLICATION THICKNESS (inch) | ASPHALT RESIDUE (% by Weight of Aggregate) | SINGLE APPLICATION RATE (Pounds per Square Yard) | DOUBLE APPLICATION RATE (Pounds per Square Yard) |
|---|---|---|---|---|
| A | 1/4 | 6.0 - 8.5 | 25-30 | 35-40 |
| B | 3/8 | 5.5 - 7.5 | 35- 40 | 40- 55 |
| RF | N/A | 5.5-7.5 | 22-38 | |
| Note A: Provide mix set additive for each mix type as required.<br>Note B: Filler for each mix type to be from 1% to 2%± 0.5% by weight of dry aggregate depending on weather conditions.<br>Note C: It is permissible to increase asphalt content for slag and other absorptive aggregates at the discretion of the DME/DMM. | | | | |

**(g) Mixture Acceptance.** Provide a certified calibration sheet for the mixing equipment for each mix design to be used within 60 days before its use on the project. Record mixing equipment meter readings of material control devices on a Run Sheet, daily, for each mix design. Calculate the percent cement or hydrated lime, total emulsion, asphalt residue based on the dry weight of the aggregate, and the yield square yard.

Certify the mixture composition and application rate based on quality control tests and Run Sheet calculations. Send certifications to the Inspector-In-Charge within 1 working day following any quality control testing. Certify mixtures and each shipment of material delivered to the job site as specified in Section 106.03(b)3.

**(h) Asphalt Tack Coat.** Section 460.2

**(i) Certification.** Section 106.03(b)3.
Certify each shipment of material delivered to the job site.

**483.3 CONSTRUCTION—**

**(a) Preplacement Meeting.** Hold a preplacement meeting on site or at a location that is acceptable to the Representative with both Contractor and PennDOT personnel present before placing any material on the project. Identify any areas of concern in the pavement that may show any signs of fatigue or excessive rutting at the pre-placement meeting. Also review the Specification, QC Plan, source of supply list, and the Aggregate Delivery Plan. It may be necessary to hold more than one preplacement meeting on larger projects with multiple State Routes.

**(b) Weather Limitations.** Apply when entire surface is in a condition to allow satisfactory penetration and adhesion and the atmospheric temperature is 50F minimum during the entire placement. Under no circumstances will the 50F minimum temperature requirement to be waived even for night work. Do not apply mixture if rain is imminent or if freezing temperatures are expected within 24 hours after application. Remove and replace rained on mixture before it sets. Do not apply from September 16 to April 30 in Districts 1-0, 2-0, 3-0, 4-0, 10-0, and 5-0 (Monroe, Carbon, and Schuylkill Counties only) and from October 1 to April 30 in Districts 6-0, 8-0, 9-0, 11-0, 12-0, and 5-0 (Berks, Lehigh, and Northampton Counties only). No exceptions to weather limitations will be allowed, unless directed in writing by the District Executive.

**(c) Aggregate Delivery Plan.** Before the start of work, submit an Aggregate Delivery Plan to the DME/DMM for approval. Include in the plan the number of trucks that will be used to haul aggregates to the micro-surfacing machine in order to keep it moving continuously to limit starting and stopping.

All aggregates being delivered to the micro-surfacing machine must be screened directly into the truck.

All screening plants must be equipped with a scalping screen with a 3/8 inch maximum square opening for Type A and with a 1/2 inch maximum square opening for Type B and Type RF.

**(d) Mixing Equipment.** Produce mixture in a self-propelled, front feed, continuous-loading mixing machine equipped with a chain-dragged conveyor belt aggregate delivery system interconnected with a positive displacement, water-jacketed gear pump to accurately proportion ingredients. Truck mounted units may be allowed on projects less than 20,000 square yards except for limited access highways and for all municipal projects. Locate filler feed so that the proper amount of cement is coating the aggregate before charging into the mixer. Provide a spray bar to completely wet the aggregate dropping down into the pug mill with additive and water.

Provide a continuous-flow, twin shafted, multi-bladed pug mill at least 50 inches long. Introduce polymer-modified emulsified asphalt beyond the first quarter point of the mixer to ensure thorough mixing of aggregate, cement, additive, and water before polymer-modified emulsified asphalt is added. Meet manufacturer's recommendations for blade size and side clearance. Provide readily accessible material control devices, placed so that the Inspector is able to determine the amount of each material being used at any time. Calibrate each material control device before production of each mix type. Equip the machine with a water pressure system and nozzle spray bar to provide a water spray ahead of and outside the spreader box, when required.

**(e) Spreading Equipment.** Spread the mixture uniformly by means of a mechanical type squeegee box attached to the mixer and equipped with paddles mounted on adjustable shafts to continually agitate and distribute the material throughout the box. Provide sufficient turbulence to prevent the mix from setting up in the box, forming excessive side build-up, or forming lumps. Attach flexible front and rear seals, in contact with the road, to prevent loss of mixture from the box. Furnish rut filling equipment with movable steel strike-off bar. Operate spreading equipment to prevent loss of the mixture on super elevated curves and to leave a uniform, skid-resistant application of aggregate and asphalt on the surface. Operate spreading equipment to achieve a uniform consistency without skips, lumps, or tears in the finished surface.

**(f) Conditioning of Existing Surface.** Section 413.3(g)1 and as follows:

Immediately before placing mixture, clean the surface of vegetation, loose materials, dirt, mud, and other objectionable items. Ensure all pavement markings and legends are completely removed before placing any mixture. Before placing mixture on existing concrete surfaces, apply tack coat over the entire area as specified in Section 460. Do not apply tack coat on existing asphalt surfaces. Apply water to dampen entire surface immediately before placing mixture.

**(g) Spreading and Finishing.** Section 413.3(h) and as follows:

Spread the mixture to seal cracks, fill voids, and to leave a uniform surface. When filling ruts, take care to restore the designed profile of the pavement cross section. Avoid excess crowning (over filling) of rutted areas. Use squeegees and lutes in areas inaccessible to the spreader box.

Carry a sufficient amount of material at all times, in all parts of the spreader box, to obtain complete coverage. Water may be sprayed into the spreader box, to facilitate spreading, without harming the mix. Lumps, balls, or unmixed aggregate in the finished surface is not allowed.

Adjustments to the additive may be required to slow mixture set time where hand spreading is needed. When hand spreading, pour mixture in a small windrow along one edge of the surface to be covered and spread uniformly by hand squeegee or lute.

Make a neat seam where two passes join. Immediately remove excess material from the ends of each run.

**1. General Requirements.** Ensure mixture properly sets within one hour of placement. If mixture takes longer than one hour to properly set, the Representative will give the Contractor a warning and an opportunity to immediately correct mixture application and set time. If the mixture takes longer than one hour and twenty minutes to properly set, stop placement operations immediately.

**2. Mixture Set Time.** Remove and replace mixture if mixture set time takes longer than one hour and twenty minutes.

**(h) Compaction.** Before opening to traffic, compact using a pneumatic-tire roller as specified in Section 108.05(c)3.f, except having tire pressures of 40 pounds per square inch to 60 pounds per square inch. Roll the entire surface area of the placed mixture. On a double application, roll the entire surface area of the placed mixture for each application.

**(i) Sampling and Testing.** At least 2 weeks before the start of work, under the direction and supervision of the Representative, obtain samples of the aggregates from stockpiles designated and constructed for each mixture type and each project. Obtain a minimum sample size of 3 pounds using guidelines for stockpile sampling specified in PTM No. 607. Immediately deliver the samples to the Representative for testing. Passing aggregate acceptance test results are required before placement of the mixture. All acceptance samples will be obtained and all acceptance tests will be performed by the Representative according to PTM No. 616 and PTM No. 100 using the following frequency:

- **When the projected quantity of aggregate for the specified mixture type is less than 500 tons.** The entire quantity will be designated as one lot and divided into three equal sublots for sampling. Under the direction and supervision of the Representative obtain a sample from each sublot and immediately deliver the samples to the Representative for testing. One of the three sublot samples will be randomly selected and tested according to PTM No. 1 by the Representative and tested for compliance with Table A. If the sample tested meets the specification, the entire lot will be considered acceptable for delivery to the designed project. If the sample fails, the remaining two samples will be tested and the Representative will determine the percent within limits (PWL) according to Section 106.03(a)3. If results indicate a PWL for the material less than 90, the Representative will reject the stockpile. After the entire rejected lot has been blended, screened, or replaced, retesting for acceptance of the aggregate will be performed. If retesting is performed, all sublot samples will be tested as specified in Section 703.5(b)2. All acceptance testing will be performed by the Representative. All test results will be recorded on a TR-4126A aggregate report form.

- **When the projected quantity of aggregate for the specified mixture type is 500 tons or greater.** The aggregates will be divided into equal lots at the discretion of the aggregate supplier, but in no case will the lot exceed 1000 tons. Each lot will be divided into three equal sublots. Under the direction and supervision of the Representative obtain a sample for each sublot. All three samples for each lot will be tested and the Representative will determine the percent within limits (PWL) according to Section 106.03(a)3. If results indicate a PWL for the material less than 90, the Representative will reject the stockpile. If the test results for each lot meets the specification and are in compliance with Table A, the entire lot is acceptable for shipment to the project. If the test results fail to meet the specifications, the lot will be rejected. Retesting for lot acceptance will be performed as described above. All acceptance testing will be performed by the Representative. All test results will be recorded on a TR-4126A aggregate report form.

**(j) Blending Aggregates on the Project.** Requests to blend aggregates on the project to meet gradation requirements from Table A and the method of blending must be approved in writing by the DME/DMM before the start of work. Include on the QC Plan a detailed description of equipment used to blend aggregates, a list of supplier codes for aggregates being blended, and the percentages of each aggregate being blended. Set up a portable laboratory at the blending site equipped to perform PTM No. 616 and PTM No. 100 tests for acceptance of aggregates on the project. The Contractor's aggregate technician must be a PennDOT certified aggregate technician before performing any aggregate testing at the staging area in the presence and direction of the Representative. Aggregates will be accepted as specified in Section 483.3(i). Provide aggregate for use in all mixture Types including each application of a double application of a mixture Type having the SRL designation indicated in the bid proposal. An aggregate designation or blends, equal to or better than that specified, may be supplied.

**(k) Test Strip.** On the first day of work the Representative will identify a location to perform the test strip. The test strip will be prohibited on a limited access highway. Construct a test strip to demonstrate the mixture's ability to be laid in multiple stone thicknesses and to be opened to traffic within one hour after placement. Construct the test strip in the same manner and condition as required on the project. Construct the test strip over one-full lane width and between 100 feet and 550 feet long. Apply the mixture at an application rate representative of the application rate for the project. Test the mixture according to ISSA Test Method TB 102 in the presence of the Representative. The Representative will evaluate and approve the test strip based on its ability to be opened to traffic within one hour and on its ability to have a set time of 10 minutes, maximum, as determined by ISSA Test Method TB 102.

Do not continue with work until the Representative has approved the test strip. The Representative does not have the authority to waive or eliminate the test strip requirement. If this work is to be performed a test strip is mandatory. The test strip will be payable as specified in Section 483.4.

**(l) Defective Work.** As specified in Section 105.12 and as follows:

Unless otherwise directed in writing by the District Executive, satisfactorily correct pavement not meeting the following criteria:

**1. Application Rate.** Calculate yield at the end of each day's application. Areas where application rates deviate from the acceptable ranges in Table C will be considered defective work. Failure to meet the acceptable ranges in Table C will require an additional minimum 15 pounds per square yard application or the District Executive, with the concurrence of the Director of the Bureau of Project Delivery, may allow the Contractor to leave the defective lot in place. The Department will pay for the defective lot at 50% of the contract unit price.

**2. Finished Surface.** Provide a finished, uniform surface texture meeting the following requirements**:**

- No areas of excess emulsified asphalt (flushing) greater than 5% of the finished surface area. Areas of excess emulsified asphalt are characterized by a smooth, shiny surface that may be tacky to the touch. Bleeding at joints is not allowed.

- No tear and/or drag marks greater than 1 inch wide and 3 inches long.

- No more than 12 tear and/or drag marks greater than 1/2 inch wide and 4 inches long per 10 feet of a lane.

- No clumps and/or other foreign objects greater than 1 1/2 inch in diameter.

- No completed sections of micro-surfacing which exhibit washboard or ripple patterns exceeding 100 linear feet. If these areas exist they will be considered defective work, as determined by the Representative, and will require surface correction.

- No longitudinal streaks with greater than a 1/4 inch ridge, bump or depression, as measured with a 10 foot long straightedge.

**3. Longitudinal Joints.** Make a neat seam where two longitudinal passes join with no greater than a 1/4 inch bump, ridge, or depression as measured with a 12 foot straightedge. Do not overlap longitudinal joints more than 4 inches, except on irregular roadway widths when approved by the Representative.

**4. Longitudinal Edges.** Place material to the final widths specified. Make a neat longitudinal edge along the roadway lane, shoulder, and/or curb lines. Place edges flush with curbs. Place edges with no more than ±3 inches horizontal variance in any 100 feet of roadway.

**5. Transverse Profile.** Fill ruts to have no depressions as measured with a 12 foot long straightedge.

**(m) Opening to Traffic.** Do not allow traffic on newly completed surface course until mix has set sufficiently to prevent pick-up and until directed by the Representative.

## 483.4 MEASUREMENT AND PAYMENT—

**(a) Micro-Surfacing.**

**1. Area Basis.** Square Yard

**2. Weight Basis.** Ton
Under the direction and supervision of the Representative complete measurements based on the combined tonnages of aggregate, filler, and polymer-modified emulsified asphalt actually used; computed as follows:

- **Aggregate.** Measure aggregate quantity using the calibrated, dry weight from the aggregate control device. Make a deduction for moisture naturally occurring in the aggregate by using PTM No. 513.

- **Filler.** Compute filler quantity from the fines feeder control device.

- **Polymer-modified emulsified asphalt.** Compute polymer-modified emulsified asphalt quantity by weight used.

**(b) Asphalt Tack Coat**. Section 460.4

# SECTION 489—ULTRA-THIN BONDED WEARING COURSE

**489.1 DESCRIPTION—**This work is the construction of a polymer-modified emulsified asphalt membrane ( UTFCEM – Ultra-Thin Friction Course Emulsified Asphalt) immediately overlaid with an ultra-thin bonded wearing course of hot-mix asphalt concrete (UTWC – Ultra-Thin Wearing Course) in one pass of a single paving machine.

**489.2 MATERIAL—**

**(a) Asphalt Material.**

**1. Asphalt Binder.** Provide material as specified meeting the requirements of the Standard Specification for Performance-Graded Asphalt Binder, AASHTO M 332, except as revised in Bulletin 25. Obtain material from an approved producer and source listed in Bulletin 15 for the specified grade and provide quality control testing and certification as specified in Sections 106.03(b) and 702.1(b)1.

**2. Emulsified Asphalt.** Class UTFCEM as specified in Bulletin 25. Obtain material from an approved producer and source listed in Bulletin 15 and provide quality control testing and certification as specified in Sections 106.03(b) and 702.1(b)1.

**(b) Aggregate.**

**1. Fine Aggregate.** Manufactured sand from an approved source, listed in Bulletin 14 and meeting the requirements in Table A.

**TABLE A**

| FINE AGGREGATE PROPERTIES | | | |
|---|---|---|---|
| **TEST** | **TEST METHOD** | **MINIMUM** | **MAXIMUM** |
| Sand Equivalent | AASHTO T 176 | 45 | - |
| Methylene Blue | AASHTO T 330 | - | 10 |
| Uncompacted Void Content | AASHTO T 304 | 40 | - |

**2. Coarse Aggregate.** Coarse aggregate from an approved source, listed in Bulletin 14 and meeting the requirements in Table B.

**TABLE B**

| COARSE AGGREGATE PROPERTIES | | | | |
|---|---|---|---|---|
| **TEST** | **TEST METHOD** | **AVERAGE DAILY TRAFFIC (ADT)** | | |
| | | **< 5,000** | **5,000 < 20,000** | **> 20,000** |
| Abrasion Max. % | AASHTO T 96 | 35 | 30 | 30 |
| Micro-Deval (MD)* Max. % | AASHTO T 327 | 18 | 18 | 18 |
| Skid Resistance Level (SRL) . | Bulletin 14 | G or higher | H or higher | E |
| Absorption Max. % | AASHTO T 85 | 2 | 2 | 2 |
| Thin and Elongated Pieces Max. % | ASTM D4791 | 10 | 10 | 10 |
| Soundness Max. % | PTM No. 510 | 10 | 10 | 10 |
| Min % Crushed, 1 Face | ASTM D5821 | 95 | 95 | 100 |
| Min % Crushed, 2 Face | ASTM D5821 | 85 | 85 | 85 |
| *MD > 18, requires approval of DME/DMM. | | | | |

**(c) Filler.** Do not use fly ash if the design traffic is greater than or equal to 3 million Equivalent Single Axle Loads (ESALs).

**(d) Mixture Composition.** Provide a wearing course of plant mixed asphalt concrete consisting of fine aggregate, coarse aggregate, filler, and asphalt binder. Size, uniformly grade, and combine aggregate fractions in such proportions that the total aggregate and the asphalt in the JMF conform to the composition specified in Table C, and meet the mixture characteristics of Table D.

**TABLE C**

| COMPOSITION, TOTAL PERCENT BY MASS (WEIGHT) PASSING | | | |
|---|---|---|---|
| **SIEVE SIZE** | **TYPE A** | **TYPE B** | **TYPE C** |
| 19.0 mm (3/4 inch) | 100 | 100 | 100 |
| 12.5 mm (1/2 inch) | 100 | 100 | 85 - 100 |
| 9.5 mm (3/8 inch) | 100 | 75 - 100 | 65 - 85 |
| 6.3 mm (1/4 inch) | 75 - 100 | 28 - 45 | 28 - 45 |
| 4.75 mm (No. 4) | 40 - 60 | 23 - 37 | 23 - 37 |
| 2.36 mm (No. 8) | 15 - 30 | 21 - 31 | 21 - 31 |
| 1.18 mm (No. 16) | 12 - 20 | 15 - 23 | 15 - 23 |
| 600 µm (No. 30) | 8 - 15 | 10 - 18 | 10 - 18 |
| 300 µm (No. 50) | 6 - 12 | 8 - 14 | 8 - 14 |
| 150 µm (No. 100) | 5 - 10 | 5 - 10 | 6 - 10 |
| 75 µm (No. 200) | 4.0 – 6.5 | 4.0 – 6.5 | 4.0 – 6.5 |
| Asphalt % by mass (weight) | 4.5 - 5.8 | 4.5 - 5.7 | 4.5 - 5.7 |
| Note: Material finer than the 75 µm (No. 200) sieve will be determined as per PTM No. 100. | | | |

**TABLE D**

| MIXTURE CHARACTERISTICS | | | |
|---|---|---|---|
| **MIXTURE CHARACTERISTIC** | **TEST METHOD** | **MINIMUM** | **MAXIMUM** |
| Moisture sensitivity, % TSR | AASHTO T 283* | 80 | - |
| Average % Draindown | AASHTO T 305 | - | 0.1 |
| Apparent Asphalt Film Thickness, microns | Bul. 27, Sec 12.4.1 | 10.0 | - |

*Prepare specimens according to Department's modified procedures for Superpave Mix Design, detailed in Bulletin 27, Chapter 2A referencing AASHTO R 35 Section 11, with the following exceptions:

1. Condition the mixture according to Bulletin 27.
2. Compact to 100 gyrations.
3. Extrude as soon as possible without damage to the sample.
4. Use AASHTO T 269 to determine void content.
5. Record the void content of the specimens. (Maintain the range from the lowest to the highest air void content of all specimens at a maximum difference of 1.0%)
6. Condition specimens, compute the Tensile Strength Ratio, and evaluate the specimens according to Bulletin 27.
7. Visual stripping will require modification or readjustments or both as directed by the Representative.

**1. Producer QC Plan and JMF.** Prepare a QC Plan, as specified in Section 106, and submit it for review at the start of the project and at least annually thereafter. Do not start work until the QC Plan has been reviewed and the JMF has been submitted.

When unsatisfactory results or other conditions make it necessary, a new JMF may be required. If a change in sources of materials is made, submit a revised JMF to the DME/DMM before using any new material.

**2. Uniformity.** Produce the asphalt mixture to meet the requirements as specified in Table C. Produce the mixture within the JMF tolerances specified in Table E.

**TABLE E**

| JMF TOLERANCE REQUIREMENTS OF COMPLETED MIX (n≥1) | | | |
|---|---|---|---|
| Percent Passing 9.5 mm (3/8 inch) and larger sieves | | ±5% | |
| Percent Passing 6.3 mm (1/4 inch) to 2.36 mm (No. 8) sieves | | ±4% | |
| Percent Passing 1.18 mm (No. 16) to 0.3 mm (No. 50) sieves | | ±3% | |
| Percent Passing 150 µm (No. 100) sieve | | ±2% | |
| Percent Passing 75µm (No. 200) sieve | | ±1.5% | |
| Asphalt % by mass | | ±0.5% | |
| **TEMPERATURE OF MIXTURE (F)** | | | |
| **CLASS OF MATERIAL** | **TYPE OF MATERIAL** | **MINIMUM** | **MAXIMUM** |
| PG 64S-22 | Asphalt Binder | 285 | 330 |
| PG 64E-22 | Asphalt Binder | 295 | 340 |

**(e) Mixture Acceptance.** Obtain material certification from the material producer. Send certification to the Inspector-In-Charge within 1 working day following any QC tests for asphalt determination and sieve analysis of the mixture.

The mixture will be accepted by certification at the plant when quality control tests conform to the JMF within the tolerances specified in Table E. Acceptance by certification may be suspended if QC tests or QA samples obtained by QA Teams from the BOPD deviate from the tolerances in Table E for acceptance values. The acceptance values are:

- Asphalt Content by mass (weight),
- Percent passing the 75µm (No. 200) sieve,
- Percent passing the 2.36 mm (No. 8) sieve, and
- Percent passing the 6.3 mm (1/4 inch) sieve.

If at any time during the course of the work any acceptance values deviate from the tolerances in Table E in consecutive tests, immediately make necessary changes to comply with the JMF. If the material cannot be brought into compliance within 150 tons of production, suspend operations and notify the Inspector-In-Charge. Do not resume production for the project until the Representative has reviewed any corrective action.

If the asphalt content or the percent passing the 75µm (No. 200) sieve deviates from the tolerances specified in Table E, the material represented will be considered defective and acceptance will be determined as specified in Section 413.3(o).

**(f) Certification.** Section 106.03(b)3.

Certify each day's shipment of material delivered to the job site.

**489.3 CONSTRUCTION—**Section 413.3 with additions and modifications as follows:

**(a)** Preplacement Requirements. Add the following

Address in the QC plan material delivered to the paver as it relates to paver speed. Provide calculations to support material production, haul units used for delivery and paver speed to eliminate placement stoppages during laydown.

**(b) Weather Limitations.** Replace with the following:

Do not place asphalt paving mixtures containing PG 64S-22 from November 1 to March 31 and asphalt paving mixtures containing PG 64E-22 from October 15 to March 31, unless allowed in writing by the District Executive. Do not place asphalt paving mixtures when the surfaces are wet or when the air or surface temperature is below 50F. If work is halted because of weather conditions, the Representative may allow the Contractor to place limited quantities of mixture that are en route to the project.

**(e) Paving Equipment.**

**1. Asphalt Pavers.** Add the following:

Use pavers that include a built-in spray bar placed in front of the variable-width heated screed unit, so that the operations of spreading UTFCEM and the UTWC are performed in succession, within a period of less than 5 seconds.

**(g) Preparation of Existing Surface.**

**1. Conditioning of Existing Surface.** Replace with the following:

At least 24 hours before paving operations, seal longitudinal and transverse joints and cracks 1/4-inch and wider as specified in Section 469. Use rubberized sealant as specified in Section 469 and minimize the sealant over-band thickness and width. Do not exceed Section 469 over-band tolerances. Remove thermoplastic and tape traffic markings greater than 0.2 inches thick. Thoroughly clean pavements impregnated with grease, oil, or fuel. Immediately prior to applying the UTFCEM and the UTWC, clean the surface by sweeping or other means necessary to remove all loose particles and unsuitable material.

**(h) Spreading and Finishing.**

**1.b Spreading and Finishing.** Replace with the following:

Apply UTFCEM with a metered mechanical pressure sprayer, at a temperature of 120F to 180F. Continuously monitor the rate of spray, ensuring a uniform application rate over the entire width to be overlaid. Determine the spray rate given the existing pavement porosity, and apply between 0.15 and 0.25 gallons per square yard. Do not allow wheels or other parts of the paving machine to come in contact with the UTFCEM before the UTWC is applied. Within 5 seconds of applying the UTFCEM, lay the UTWC within the temperature range specified in Section 489.2 Table E for the class and type of material used, and at the placement rate specified in Section 489.3 Table F.

Continuously adjust operations to obtain a quality surface free from drags marks, open areas or suspect quality. If adjustments do not obtain a quality surface free from visual surface segregation the Representative may direct work to stop. Areas identified by the Representative to have visual surface segregation are to be removed and replaced at no additional cost to the Department. Do not begin spreading and finishing until the Representative is satisfied with proposed corrective actions to provide a satisfactory surface.

**TABLE F**

| TYPE | NMAS | PLACEMENT RATES FOR UTWC |
|---|---|---|
| A | 6.3 mm (1/4 inch) | 45 to 65 pounds per square yard |
| B | 9.5 mm (3/8 inch) | 55 to 80 pounds per square yard |
| C | 12.5 mm (1/2 inch) | 60 to 85 pounds per square yard |
| Note: Placement rates are intended as a guide and additional material may be required to obtain a quality surface. In no case should material yield be below the lower limits of the placement rate range. | | |

**(i) Compaction.** Replace with the following:
Roll the UTWC immediately after placement and before the material temperature has fallen below 185F. Roll using a minimum of two passes with a steel double-drum asphalt roller having a mass of not less than 8 tons. Do not allow roller(s) to remain stationary on the freshly placed UTWC. Maintain roller(s) in reliable operating condition and equipped with functioning water system and scrapers to prevent adhesion of the fresh mix onto the roller drums. A release agent (added to the water system) may be required. Compact in the static mode, with the exception of joints where vibration may be necessary. A pneumatic-tire roller may be used to prevent the "bridging" effect of the steel drum roller.

**(j) Mat Density Acceptance.** Density testing is not required.

**(k) Joints.** Replace with the following:

**1. Longitudinal Joints.** Form butt joints only and compact with rollers. Seal the longitudinal joint(s) for surface courses with hot PG 64S-22 asphalt cement at no additional cost to the Department. Heat and maintain asphalt cement sealant between 265F and 320F. Do not place sealant when the air temperature is below 40F, unless otherwise allowed by the Representative. Apply the sealant only to joints in pavement surfaces that are clean, dry and free of any loose material and debris. Clean with a power broom as required. Utilize a pressure applicator with a wand or nozzle capable of applying hot asphalt sealant in a straight and consistent width band of 4 inches +/-1 inch and thickness of 1/16 inch +/- 1/32 inch. Center the sealant band within 1 inch of the joint. Remove and dispose of excess sealant at no additional cost to the Department. Re-seal areas of the joint that are inconsistently or not completely covered at no additional cost to the Department. Replace pavement markings that are marred by sealing operations at no additional cost to the Department.

**2. Transverse Joints.** Minimize the number of transverse joints. Maintain continuous forward paving wherever possible. Construct joints perpendicular to the direction of traffic and compact. If the QC plan proves ineffective for minimizing the number of transverse joints, stop paving and submit a plan for corrective action to the Representative. Do not begin paving until the Representative has reviewed the plan and authorizes paving to resume.

**(m) Tests for Depth.** Loose depth or compacted depth tests are not required. However, control the depth of courses by the weight per square yard.

## 489.4 MEASUREMENT AND PAYMENT—

**(a) Ultra-thin Bonded Wearing Course.** Square Yard.
For the type indicated.

**(b) Crack Filling and Sealing.** Section 469.4

# SECTION 491—MILLING OF ASPHALT PAVEMENT SURFACE

**491.1 DESCRIPTION**—This work is the milling of an existing asphalt pavement surface.

**491.3 CONSTRUCTION**—

**(a) Equipment.** Provide a milling machine designed and built for milling existing asphalt pavements with an automatic grade and slope control system and be capable of milling concrete.

**(b) Milling Operation.** Mill to provide a finished surface that is free from gouges, grooves, and ridges and that conforms to the surface tolerance requirements of Section 413.3(l). Immediately after milling, remove milled material. Carefully remove the existing asphalt material around utility facilities within work areas. Repair or replace utility facilities that are damaged by the milling operation to the satisfaction of the utility owner. Control the rate of milling to avoid tearing of the mat, which causes chunky and non-uniformly milled material. If directed, separate oversized and chunky milled material. Maintain the milled pavement surface free of all loose materials and dust.

Do not allow traffic to drive on any milled surface for more than 6 calendar days. Place the first overlaying asphalt course within 7 calendar days from the start of the milling operation. Failure to overlay a milled section of roadway within 7 calendar days after it has been milled will constitute a failure to comply with a contract traffic control requirement for which work zone liquidated damages, as specified in section 108.07(c), will be assessed. Work stoppages caused by the Department, Utilities, and documented weather delays will not count towards the 7 calendar days for calculating Work Zone Liquidated Damages. Maintain all milled surfaces and repair or replace any areas damaged due to the asphalt overlay not being placed within 7 calendar days of the milling operation methods accepted by the Representative at no additional cost to the Department.

If the first course of the asphalt overlay is not placed on the same day of the milling operation, install ROUGH ROAD (W8-8) signs according to Publication 212, Publication 213, and MUTCD 1/2- mile in advance of the project and at a minimum of 1/2- mile intervals throughout the project before the end of the day. Eliminate vertical edges around utilities and inlets within all open travel lanes at the end of each day. If this is not feasible, install a BUMP (W8-1) sign in advance of the appurtenance, and consider a reduced regulatory speed limit sign. Install these signs at no additional cost to Department.

**(c) Disposition of Milled Material.** The proposal/contract will indicate which one of the following conditions will apply with regard to the disposition of milled material.

**1. Milled Material Retained by Contractor.** When indicated that milled material is to be retained by the Contractor, satisfactorily dispose of milled material immediately after milling.

**2. Milled Material Retained by Department (Delivered to Stockpile).** When indicated that milled material will be retained by the Department, deliver milled material to the designated stockpiling location immediately after milling. The proposal/contract will include a special provision that identifies where milled material is to be stockpiled, as well as the approximate distance (miles) from the project site to the designated stockpiling location. Advance notification of a scheduled delivery of milled material to the designated stockpile is to be provided to the individual whose name and telephone number are listed in the special provision.

**491.4 MEASUREMENT AND PAYMENT**—

**(a) Milling of Asphalt Pavement Surface, Milled Material Retained by Contractor.** Square Yard

**(b) Milling of Asphalt Pavement Surface, Milled Material Retained by Department (Delivered to Stockpile).** Square Yard

The cost of delivering milled material to the designated stockpiling location is incidental to this item of work.

# SECTION 496—ASPHALT CONCRETE PAVEMENT, 60-MONTH WARRANTY

**496.1. DESCRIPTION—**This work is construction of a plant-mixed, asphalt concrete pavement on a prepared surface with a 60 month warranty and includes the furnishing of a warranty bond. Acceptability of this work will be determined by construction end-result and the warranty performance criteria.

**496.2. MATERIAL—**Provide material which ensures that the asphalt concrete pavement meets the warranty performance criteria. Select the type and class of asphalt material, type of aggregate, and, when necessary, type of filler to be used in the constructed pavement. For wearing courses, use aggregate, having the specified SRL designation, from a source listed in Bulletin 14. An aggregate designation or blends, equal to or better than that specified, may be supplied. Blends are 50% by weight.

**(a) Composition of Mixtures**. Establish the JMF(s) using a volumetric mix design procedure with the Superpave Gyratory Compactor (SGC).

Submit mix design(s) on the most current version of the TR-448A form, signed by a Certified Asphalt Level 2 Plant Technician, to the DME/DMM at least 7 calendar days before its use in the work. The submitted mix design(s) will be used for information only and will become part of the as-built project files. Submission of the mix design(s) will not relieve the Contractor from responsibility for meeting the specified construction end-result or warranty performance criteria. Stone Matrix Asphalt (SMA) wearing course mixes may be submitted for consideration. For each mix design, provide the following information:

- Date of Submission
- Project S.R., Section, and County
- Project Contract No.
- Asphalt Concrete Producer: Name and Location
- Asphalt Plant Type
- Aggregate Producer: Supplier Code, Material Code/Class, Percent in Mix, Bulk Specific Gravity and Percent Absorption
- Asphalt Cement Producer: Supplier Code, Material Code/Class, Percent in Mix and Bulk Specific Gravity
- Volumetric Mix Design Method
- Other JMF Materials: Source, Material Code/Class, Percent in Mix, Bulk Specific Gravity and % Absorption (if applicable)
- JMF: Design and Upper and Lower Tolerances for production control
- SGC Gyrations at Nini, Ndes, and Nmax
- Combined Aggregate Bulk Specific Gravity (Gsb)
- Theoretical Maximum Specific Gravity (Gmm) or Density
- Laboratory Specific Gravity at Ndes (Gmb) or Density
- Voids in Mineral Aggregate (VMA), percent by volume
- Voids in Total Mixture (VTM), percent by volume
- Voids Filled with Asphalt (VFA), percent by volume
- Ignition Furnace Correction Factors for Asphalt Binder and 0.75 µm (No. 200) Sieve
- Moisture Sensitivity Data (Tensile Strengths, Tensile Strength Ratio, Date Performed) or (Hamburg Wheel Tracking Results)
- Combined Aggregate Consensus Properties (Sand Equivalency, Fine Aggregate Angularity, Coarse Aggregate Angularity, Flat & Elongated Pieces)
- Gradation Chart (FHWA 0.45 Power Type) with JMF plotted
- Types and results of additional mixture testing, if performed
- Designer's signature

Ensure all component materials shown in the mix design are representative of the materials that will be used on the project. If, for any reason, a change in material source or other adjustments are necessary during construction, before using any new material notify the DME/DMM in writing, explaining the need for the change. Submit a copy of the revised JMF with the written notification.

**1. QC Plan**. Prepare a QC plan, as specified in Section 106, and submit it at the start of the project. Do not start work until the QC plan and the JMF have been submitted. The submitted QC plan will be used for information only and will become part of the as-built project files.

Provide certified results of QC testing to the Representative within 48 hours of material sampling. The submitted test results will be used for information only and will become part of the as-built project files.

**(b) Warranty Bond and Liability Insurance**. When awarded the contract, in addition to the required bonds specified in Section 103.04, furnish a Warranty Bond, with sufficient surety or sureties, in an amount equal to 50% of the total contract amount for all pavements to be constructed under the pavement warranty item(s). Have the bond specify that remediation work will be completed in a manner satisfactory to the Secretary. Have the bond state that the State is to be saved harmless from any expense or damage incurred through the failure of the Contractor to complete remediation work, as specified, or from any damages growing out of the carelessness of the Contractor, the Contractor's employees, or subcontractors in performing remediation work.

Have a corporate surety, legally authorized to transact business in the State and satisfactory to the Secretary, execute the bond. If the Secretary decides the bond surety is unsatisfactory, promptly furnish any additional required security to protect the State's interests and the interests of all persons, firms, or corporations who/which have furnished material, provided equipment on rental, or supplied/performed labor services on, or in connection with, the performance of the remediation work for this contract.

The Warranty Bond is to be effective beginning on the date of physical work completion, established by the Representative for the whole project or any substantial project section, as specified in Section 110.08(a). The Warranty bond is to remain in effect for a period of 60 months from the effective date or until completion of all remediation work identified in the final annual performance surveys, whichever is later. If a substantial section of the project is completed in advance of the whole, the Contractor may request that a final inspection of that section be conducted. If the Department accepts the work on the section of the project, in writing, and the section is opened to normal traffic, the warranty period for that section will start in advance of the date of physical work completion for the entire project. The Warranty Bond, however, must remain in effect until all criteria established in Section 496.3(c)6 are satisfied, and the Warranty Acceptance Notification has been issued. The amount of the warranty bond will be reduced proportionately if the warranty period for a portion of the work expires in advance of the warranty period for the remainder of the work.

Maintain insurance to indemnify and save harmless the Commonwealth, the Department, and all of its officers and employees from all suits, actions, or claims of any character, name, and description, brought for or on account of any injuries or damages received or sustained by any person, persons, or property related to the performance of any work by the Contractor, these pavement items, or to remedial actions taken throughout the warranty period, whether the same is due to the use of defective material, defective work, neglect in safeguarding the work or public interests, or by or on account of any act, omission, neglect or misconduct of the Contractor.

**496.3. CONSTRUCTION—**Provide an asphalt concrete pavement meeting the requirements specified herein and capable of meeting the warranty performance based criteria specified herein.

Construct the pavement as a combination of two or more different asphalt concrete pavement courses to achieve the total depth indicated.

**(a) Tests for Depth of Binder and Wearing Courses.** Within 24 hours after final compaction, in the presence of the Inspector, drill one, 4-inch diameter or larger core through all lifts and courses placed under this item of work to the top of the existing pavement or base, for each 2,000 linear feet of pavement lane. The Inspector will determine core locations using PTM No. 1, excluding any transitional areas indicated.

The Inspector will measure the depth of each core according to PTM No. 737. When any one core depth measurement indicates the pavement is deficient in depth by more than 1/4 inch, which cannot be satisfactorily corrected, the affected pavement area will be considered defective work. When core depth measurements indicate that the pavement is uniformly deficient in depth by more than 1/8 inch in any three consecutive core locations and the deficiency cannot be satisfactorily corrected, the affected pavement area will be considered defective work. After the Inspector completes depth measurements, backfill, compact, and seal core holes with mixture used to construct the wearing course. After depth measurement, the cores may be used for QC testing.

Immediately correct pavement that is deficient in depth starting at the point of the determined deficiency, and proceed longitudinally and transversely until the depth within the limits of the entire repair area is within 1/4 inch of the required depth. Drill additional cores as needed, both forward and back of the cores determined to have deficient depth, to determine the actual starting and ending point of the deficiency. Coring operations will not exclude pavement from the warranty performance criteria.

**(b) Information Samples for the Department.** The Department reserves the right to direct the Contractor to obtain loose mixture box samples and/or pavement core samples at random locations selected by the Inspector according to PTM No. 1 for testing at the LTS for informational purposes only.

If directed and in the presence of the Inspector, obtain n=1 loose mixture box samples from directly behind the paver before the material is compacted. Immediately package loose mixture samples in individual cardboard boxes sized no larger than 240 cubic inches and identify each sample by number, location (lane, direction, and station), date of placement, mixture type, and as Information Samples (Sample Class IF). Immediately deliver the packaged loose mixture box samples to the Inspector.

If directed and in the presence of the Inspector, drill and obtain n=1 6-inch diameter pavement core samples for each 1,000 tons of material placed. Do not bend, compress, or distort samples during cutting, handling, transporting, and storing. If core samples are damaged, immediately obtain replacement samples, as directed by the Inspector, from within 12 inches of the original sample location. Obtain samples no later than 24 hours after placement. Identify the samples by number, location (lane, direction, and station), date of placement, mixture type, and as Information Samples (Sample Class IF). Immediately package and deliver the samples to the Inspector. Within 24 hours after coring, backfill the hole with mixture of the same JMF or with mixture used for subsequent courses and compact and seal the mixture.

**(c) Warranty.**

**1. Performance Criteria**. Performance results will be determined by automated surveys. These distresses will be identified, measured, and reported using the survey techniques, rating procedures, and extent estimation procedures in accordance with Publication 336. Surveys will be performed by the Department or a designee. Manual surveys, when necessary, will be performed according to Publication 336. Performance results for flushing and potholes will be determined by manual surveys.

For each Segment, or partial Segment, performance criteria limits for distresses are indicated in Table A. A segment is defined as a division of the State Route approximately one-half mile in length with termini designated by the Department typically beginning and ending at physical features. The segment beginning points will be designated on the plans.

If the last performance survey (year 5) determines that 30% of segment area has two or more distresses with low severity, then remedial action is required by microsurfacing, or other treatment approved by the Department.

**TABLE A**
**Performance Criteria Distress Limits**

| PERFORMANCE CRITERION | THRESHOLD LEVEL | REMEDIAL ACTION |
|---|---|---|
| FATIGUE CRACKING | All medium or greater severity* | Remove and replace distressed layers full lane width to a depth necessary to correct observed distress but not to exceed warranted pavement and length not less than 10 feet beyond the distressed area. |
| CRACKING | All low to medium severity* | Crack seal as specified in Section 469. |
| (Transverse Cracking & Miscellaneous Cracking) | All high severity* | Remove and replace distressed layers full lane width to a depth necessary to correct observed distress but not to exceed warranted pavement and length not less than 10 feet beyond the distressed area. |
| RAVELING / WEATHERING | All medium or greater severity* | Remove and replace distressed layers full lane width to a depth necessary to correct observed distress but not to exceed warranted pavement and length not less than 10 feet beyond the distressed area. |
| RUTTING | > 3/8 inch | Remove and replace distressed layers full lane width to a depth necessary to correct observed distress but not to exceed warranted pavement and length not less than 10 feet beyond the distressed area. |
| FLUSHING | ALL | Remove and replace distressed layer full depth and full or half lane width (longitudinal joint at center of lane for half lane width) and a minimum of 24 inches beyond distressed pavement in all longitudinal directions. |
| POTHOLES (INCLUDING SLIPPAGE AREAS) | ALL | Remove and replace distressed layers full lane width to a depth necessary to correct observed distress but not to exceed warranted pavement and length not less than 10 feet beyond the distressed area. |
| LONGITUDINAL JOINT DETERIORATION | All medium severity* | Crack seal as specified in Section 469. |
| EDGE DETERIORATION (shoulder joint) | All high severity* | Remove and replace distressed layer one foot either side of the joint transversely and a minimum of 24 inches beyond distressed pavement in all longitudinal directions. |
| LONGITUDINAL JOINT DETERIORATION | All medium severity* | Crack seal as specified in Section 469. |
| LEFT EDGE JOINT (lane joints) | All high severity* | Remove and replace distressed layer one foot either side of the joint transversely and a minimum of 24 inches beyond distressed pavement in all longitudinal directions. |

*The Threshold Level as defined in Publication 336.

**NOTE:** Should deviations beyond the threshold levels indicated in Table A in combination total a remedial action area greater than 20% of the surface area of any segment of pavement as defined herein, (except that, for this determination, a medium severity crack referenced above will be considered to be a deviation affecting 6 inches on either side of the crack for the entire length of the crack) remove and replace the entire segment.

Should the distance between repair areas be less than 100 feet, make one continuous repair.

All repairs must meet the surface tolerance as specified in Section 413.3 (l).

**2. Remediation Work under the Pavement Warranty**.

**2.a Department's Responsibility**. To determine compliance with specified performance criteria the Department will be responsible for conducting an annual performance analysis, the basis of which will be the distress criteria established in Table A.

The Department will schedule and perform annual surveys, and additional surveys if needed, of the warranted pavement for flushing and potholes. When needed, Rut Depth measurements will be verified using a 12 foot straight edge, across the lane width, to determine the severity and extent. Surveys will be conducted annually throughout the warranty period. The Contractor will be notified at least 14 calendar days in advance of all scheduled manual surveys. In addition, the Department will routinely schedule and perform traffic classification counts to confirm that Equivalent Single Axle Load (ESAL) estimates remain within the projected values included in the contract documents.

The Department reserves the right to schedule and perform additional or more frequent performance surveys if, at any time during the warranty period, evidence exists that performance criteria are not being met. The Department will provide the Contractor with access to the results of all performance surveys and traffic counts. Performance survey results will be reported for each individual State Route Segment as established under the Department's Location Reference System (LRS) or partial Segment within the limits of the warranty project. Within 14 calendar days after completion, the Department will notify the Contractor, in writing, of the results of performance surveys, identifying the Segment (location) and the performance criterion, and indicating whether specified distress limits have been met or exceeded. After performance surveys are completed, if the Department determines remedial action is necessary, the Contractor will be notified within 5 calendar days, from the date of that determination, that remediation work is required.

During the warranty period, the Department will not perform routine pavement maintenance, such as crack sealing and base repairs, on the warranted pavement. If the Department determines emergency repair work is necessary, the Contractor will be notified immediately of the emergency repair work that is required. The Contractor will be given 24 hours to review the emergency repair work that is needed and notify the Department if they will perform the required repairs. When the Contractor notifies the Department agreeing to make the required emergency repairs, they must begin repair work within 48 hours of the Department’s initial notification. If the Contractor does not notify the Department within 24 hours or begin the repair work within 48 hours of the Department’s initial notification, the Department reserves the right to make emergency repairs to the warranted pavement during the warranty period. If the pavement condition is determined to be potentially harmful or unsafe, the Department reserves the right to make immediate emergency repairs to the warranted pavement during the warranty period. The Department will then notify the Contractor of the location of all emergency repairs performed. The costs expended by the Department for any emergency repair work needed to correct deficiencies covered under the terms of this warranty specification will be the responsibility of the Contractor.

**2.b Contractor's Responsibility**. The Contractor’s obligation to perform required remediation work shall survive acceptance of the work and final settlement of the Contract.

The Contractor may witness all manual performance surveys. Where survey results for a given Segment indicate that performance criteria distress limits for one or more distress types have been exceeded, perform the remediation work described in Table A. If proposing to utilize a method of testing, measurement, or remedial action other than that prescribed, submit a plan that includes a detailed description of the proposed testing, measurement, or remedial action to the Representative for review and approval. The Department will review and approve or disapprove the submitted testing, measurement, or remedial action plan within 5 calendar days of receipt of the submission.

Complete remediation work required as part of the pavement warranty, at the location(s) indicated, within 60 calendar days after receipt of the Department's written notification that remediation work is required. Perform remediation work to meet the material and performance criteria requirements contained herein. Notify the District Executive of the tentative start date for remediation work and submit a schedule for remedial repairs within 5 calendar days of that notification. If remediation work does not begin by the start of the 61st calendar day after the date of the Department’s written notification, the Contractor will be responsible to pay an amount equivalent to the Construction Engineering Liquidated Damages as specified in Section 108.07. This cost will accrue until the required remedial work ends. In addition to the continuing cost equivalent to the Construction Engineering Liquidated Damages, costs equivalent to Road Users Liquidated Damages as specified in Section 108.07 will be assessed no sooner than the 61st calendar day after the date of the Department’s written notification, for each calendar day that the roadway is not open to unrestricted traffic. If inclement weather prohibits quality repairs, the Contractor will be responsible for placing and maintaining temporary repairs until permanent remediation work can be properly completed. Charges equivalent to Road Users Liquidated Damages will not be assessed following temporary repair work, provided the temporary repairs are properly maintained. Permanent repairs are to be constructed as soon as weather permits. The Department will notify the Contractor in writing when weather conditions permit permanent repairs. Charges equivalent to Construction Engineering Liquidated Damages and Road Users Liquidated Damages will resume beginning 5 calendar days beyond this notification until permanent repairs are completed. In the final year of the warranty period, segments with distresses that cannot be repaired due to inclement weather will have the warranty period extended for these segments only until permanent repairs are satisfactorily completed. The warranty bond can be reduced proportionately to cover only the distressed segments. All charges equivalent to Liquidated Damages as referenced herein will be determined from original contract documents.

Furnish all materials, equipment, and labor needed to perform remediation work required as part of the pavement warranty, including traffic control, at no cost to the Department. When the remedial action specified in Table A calls for removal and replacement, use only plant-mixed, asphalt concrete unless other materials are accepted, in writing, by the District Executive. Under adverse weather conditions**,** temporary repair methods and materials may be used in remediation work, provided traffic safety and normal traffic patterns are maintained**.** Remove temporary repairs and perform permanent remediation work as soon as weather conditions permit.

The Department's notice to perform required remediation work, or the Department's approval of the Contractor's written proposal to perform elective or preventative maintenance work, shall serve as a right-of-entry that authorizes the work to be done, subject to time and location limitations contained in that notification, or those agreed to by the Contractor and the Department. Perform remediation work, including replacements, to meet the specified performance criteria indicated in Table A. Restore, according to Department specifications, all features removed and/or damaged during remediation work.

Except for allowable crack sealing, as indicated in Table A, repair distress areas to the limits specified with square or rectangular patches using materials meeting the requirements of this specification and constructed to meet the construction end-result and performance criteria of this specification.

Provide and maintain traffic control for operations involved in remediation work performed as part of the pavement warranty. Use the traffic control plan (TCP) provided in the original contract for remediation work, or submit an alternate TCP to the District Executive for approval. Submit alternate TCPs at least 14 calendar days before the start of remediation work. Alternate TCPs are to comply with the provisions of Publications 212 and 213, the MUTCD, and the contract special provisions.

If the Department's written notification indicates that remedial action is required as part of the pavement warranty and the Department's performance survey results are disputed, notify the Department, in writing, within 30 calendar days from the date of the Department's written notification. Base disputes on appraisals of the performance survey results supplied by the Department. The Contractor may base a dispute on a third party appraisal of the performance results. If the Department and Contractor cannot resolve a dispute over remediation work within 14 calendar days from the date of the Contractor's written notification, the dispute will be submitted to the Conflict Resolution Team identified in Section 496.3(c)3.

Remove material placed by the Department, during emergency repair work within warranted pavement areas and perform required remediation work if it is determined that the emergency repair was required due to faulty work or construction.

The Contractor may monitor or test warranted pavement course(s), using nondestructive methods, at any time during the warranty period. Notify the District Executive at least 7 calendar days in advance of any nondestructive testing. Provide all nondestructive test results to the Department for information. Obtain written authorization from the Department before conducting nondestructive Testing.

Do not perform any remediation work without prior written notification from the Department. Submit a written proposal, to the District Executive, setting forth the reason(s) for performing elective or preventative remediation work not directed by the Department. The Department will review and approve or disapprove elective or preventative remediation work initiated by the Contractor within 5 calendar days from receipt of the written proposal.

**3. Conflict Resolution Team**. The Conflict Resolution Team (Team) will consist of two representatives selected by the Contractor, two representatives selected by the Department (District and Bureau of Project Delivery), and a fifth person mutually agreed upon by both the Department and the Contractor. Any costs incurred for the fifth Team member will be shared equally by the Department and the Contractor. The Team members, who will be identified at the pre-construction meeting, must be knowledgeable in the terms and conditions of the warranty specification and the methods used in the measurement and calculation of pavement distress. Each Team member will have an equal vote and the decision of the majority will be final. If a change in the team is required the same selection procedure will be used as stated above.

The Team will resolve disputes concerning defective work, warranted pavement performance, survey results, required remediation work, proposed alternate repair methods and material selection, and disputes over probable causes.

The Team will meet and resolve disputes within 30 calendar days from the date of submission.

**4. Probable Cause**. The Department will furnish the Contractor with the results of performance surveys and traffic counts, noting those distresses considered to be caused by factors beyond the control of the Contractor. The Contractor will not be held responsible for meeting specified performance criteria or performing remediation work within these distress areas, which will be calculated by multiplying the maximum transverse width of the distress by the maximum longitudinal length. The area of non-responsibility will be defined as a square or rectangular area centered over and equal to 150% of the distress area, but extending no more than 10 feet on either side of the distress area.

The Department may repair distresses determined to be caused by factors beyond the control of the Contractor using routine repair techniques.

Factors beyond the control of the Contractor include the following:

**4.a Base Condition**. If performance surveys detect fatigue cracking or other distresses which might indicate an unacceptable base condition, a series of 6-inch diameter cores will be drilled within the distress area, as necessary, at locations directed by the Department. The Inspector will measure the depth of each core. The cores will be tested according to PTM No. 715 and AASHTO T-209 to determine the percent of unfilled voids, PTM No. 702 or other approved test methods to determine the percent asphalt, and PTM No. 739 to determine gradation. Have a Representative witness the testing. Test results will be provided to the DME/DMM. If the warranted pavement meets the specified minimum thickness, the density is $\geq$ 92% of theoretical maximum density and test results for percent asphalt and gradation are within the tolerances indicated in the Contractor's mix design(s), or if field evaluation clearly indicates base failure beyond the Contractor's control, the Contractor will not be held responsible for repair of the distress and will be reimbursed, by the Department, the total cost of the testing. Should these criteria not be achieved, further investigation may be necessary to determine the cause of the distress.

**4.b Traffic Loadings**. If, during the warranty period, the Department's traffic counts indicate that estimated cumulative ESALs have exceeded 100% of the estimated 20-year design life ESALs or if the ESAL's increase enough to warrant a change in the mix design in the number of gyrations, the Contractor will not be held responsible for repair of rutting or base condition distresses for the remainder of the warranty period.

**4.c Routine Maintenance by the Department**. During the warranty period, the Department will perform routine maintenance such as snow removal, application of anti-skid material and/or de-icing chemicals, repairs to safety appurtenances, application and maintenance of pavement markings, mowing, and sign maintenance. Routine pavement maintenance activities, such as crack sealing, pothole patching, or milling, will not be performed by the Department during the warranty period.

**4.d Destructive Procedures by the Department**. The Contractor will not be held responsible for repair of distresses caused by coring, milling or other destructive procedures performed by the Department.

**4.e Uncontrolled Forces of Nature**. The Contractor will not be held responsible for repair of distresses caused by floods, earthquakes, tornadoes, brush or forest fires, landslides, sinkholes, or other natural disasters.

**4.f Traffic Accidents**. The Contractor will not be held responsible for repair of distresses caused by traffic accident-related fuel or chemical spills, vehicle fires, and/or gouging or goring of the pavement surface unless the Contractor or its representative is the cause of the distress.

**5. Final Warranty Inspection**. At the end of the warranty period, and when any remediation work, if required, is substantially complete (at least 90%), make arrangements for a mutual final warranty inspection. At the time of final warranty inspection, the Representative, along with the Contractor, will establish the following:

- The list of all physical work items requiring completion and/or correction; and
- A list of all documents requiring submission, completion, and/or correction.

As established during the final warranty inspection, perform work as necessary for required correction or completion of all physical work items, and complete, correct, and submit all outstanding documents.

6. **Release from Warranty**. To be released from warranty responsibility, satisfy all of the following:

- Meet minimum requirements for each of the specified performance criteria through the end of the warranty period,
- Complete all required remediation work identified during the warranty period at no additional cost to and to the satisfaction of the Department, and
- Submit all required warranty documents.

When the warranty period has expired, all physical remediation work has been satisfactorily completed, and all required warranty release criteria have been met, the Representative will establish the date of physical warranty work completion; the date on which the Contractor will be relieved of responsibility for further physical remediation work and maintenance on the project or any substantial project section.

Upon receipt and verification, the Representative will establish the date that all required warranty documents are satisfactorily furnished.

When all physical remediation work has been satisfactorily completed and all contractually required warranty documents have been properly furnished, the date of warranty project acceptance will be established.

If the warranty period for a substantial project section expires in advance of the whole, a final warranty inspection will be made of that section, as specified for the entire project, and the Contractor notified, in writing, that the warranty terms for the specific section of the project have been satisfied. No further remediation work will be required on the section as specified in Section 108.04(b). The Contractor will then be allowed to reduce their warranty bond proportionately.

7. **Warranty Acceptance Notification**. Upon completion of the requirements of Section 496.3(c)6, a Warranty Acceptance Notification will be issued indicating that the project warranty has been satisfactorily completed and certifying that the project is accepted as of that date.

8. **Warranty Default and Termination of Contract**. As specified in Section 108.08 and as follows:

- Failure of the Contractor to perform remediation work within the time specified.

## 496.4. MEASUREMENT AND PAYMENT—

**(a) Asphalt Concrete Pavement, 60-Month Warranty.** Square Yard

Payment will be made, as specified in Section 110.05, as work progresses, based on the quantity of each separate pavement course placed meeting specified construction criteria.

The Inspector will measure the quantity of each pavement course placed, on a daily basis, and compute the payable quantity by multiplying the measured area by a factor equal to the depth of the pavement course being placed divided by the total, indicated pavement depth. The placement depth will be determined as indicated in Section 496.3(a). No additional payment will be made for pavement depths in excess of the total, indicated depth.

**(b) Asphalt Concrete Pavement, 60-Month Warranty, Warranty Bond and Liability Insurance.** Lump Sum

# Pennsylvania Test Methods – Publication 19

This document contains the most relevant Pennsylvania Test Methods for Certified Asphalt Technicians. See PennDOT Publication 19 for a complete list of test methods. The test methods included are from **Change No. 13 of Pub 19**, with effective date of September 29, 2023.

## PENNDOT PUBLICATION 19

## Test Method

## 2013 Edition (Change 12)

Commonwealth of Pennsylvania
Department of Transportation

**Publication 19**

| Change | Effective Date |
|---|---|
| 2013 Edition | October 31, 2013 |
| Change No. 1 | March 14, 2014 |
| Change No. 2 | January 29, 2016 |
| Change No. 3 | March 25, 2016 |
| Change No. 4 | July 22, 2016 |
| Change No. 5 | January 13, 2017 |
| Change No. 6 | September 28, 2017 |
| Change No. 7 | May 31, 2018 |
| Change No. 8 | November 30, 2018 |
| Change No. 9 | March 29, 2019 |
| Change No. 10 | December 6, 2019 |
| Change No. 11 | October 23, 2020 |
| Change No. 12 | May 27, 2022 |
| Change No. 13 | September 29, 2023 |

## PTMS in THIS DOCUMENT

LABORATORY TESTING SECTION

Method of Test for

# PROBABILITY SAMPLING

## 1. SCOPE

1.1 This method of test outlines the procedures for selecting sampling sites in accordance with accepted probability sampling techniques. It is intended that all Department samples, regardless of size, type or purpose shall be selected in an unbiased manner, based entirely on chance.

## 2. SECURING SAMPLES

2.1 Department samples shall be taken as directed by the engineer or their authorized representative.

2.2 Sample location and sampling procedure are as important as testing. It is essential that the sample location be chosen in an unbiased manner and the sample taken precisely as directed by the appropriate PTM.

## 3. RANDOM NUMBER TABLE

3.1 For test results or measurements to be meaningful, it is necessary that the SUBLOTS to be sampled or measured be selected at random, which means using a table of random numbers. The following table of random numbers has been devised for this purpose. To use the table in selecting sample locations, proceed as follows.

3.2 Determine the LOT size and the number of SUBLOTS Per LOT by referring to the PTM for the material being sampled.

3.3 For each LOT containing SUBLOTS, use consecutive random numbers from Table I for each SUBLOT. For example, if the specification or PTM for a particular material specifies five sublots per LOT and the number 15 is randomly selected as the starting point for the first LOT, numbers 15-19 would be the five consecutive random numbers. For the second LOT, you may continue using consecutive random numbers from Table I, numbers 20-24, or another random starting point can be selected. If number 91 is selected, for example, then the numbers 91-95 are used for the five consecutive random numbers. The same procedure is used for additional LOTS.

3.4 For samples taken from the roadway, use the decimal values in Column X and Column Y to determine the coordinates of the sample locations as specified in the appropriate PTM.

3.5 In situations where coordinate locations do not apply (i.e., plant samples, stockpile samples, etc.), use only those decimal values from Column X as specified in the appropriate PTM.

## 4. SAMPLING PROCEDURE

4.1 After the appropriate number of random locations has been determined, refer to the proper PTM for special sampling procedure instructions and examples.

## 5. DEFINITION OF TERMS

5.1 LOT - an isolated quantity of a specified material from a single source or a measured amount of specified construction assumed to be produced by the same process. The LOT size is specified in the specification or PTM for the material being sampled.

5.2 SUBLOT - a portion of a LOT; the actual location from which a sample is taken. The size of the sublot and the number of sublots per LOT are specified in the specification or PTM for the material being sampled.

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION
TABLE I
RANDOM POSITIONS IN DECIMAL FRACTIONS (2 PLACES)

| | X | | Y | | X | | Y | | X | | Y |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | 0.29 | R | 0.66 | 34. | 0.61 | L | 0.87 | 67. | 0.93 | R | 0.17 |
| 2. | 0.74 | R | 0.49 | 35. | 0.76 | R | 0.16 | 68. | 0.40 | R | 0.50 |
| 3. | 0.89 | L | 0.79 | 36. | 0.87 | L | 0.10 | 69. | 0.44 | R | 0.15 |
| 4. | 0.60 | R | 0.39 | 37. | 0.41 | L | 0.10 | 70. | 0.03 | L | 0.60 |
| 5. | 0.88 | R | 0.31 | 38. | 0.28 | R | 0.23 | 71. | 0.19 | L | 0.37 |
| 6. | 0.72 | L | 0.54 | 39. | 0.22 | L | 0.18 | 72. | 0.92 | L | 0.45 |
| 7. | 0.12 | R | 0.08 | 40. | 0.21 | L | 0.94 | 73. | 0.20 | L | 0.85 |
| 8. | 0.09 | L | 0.94 | 41. | 0.27 | L | 0.52 | 74. | 0.05 | R | 0.56 |
| 9. | 0.62 | L | 0.11 | 42. | 0.39 | R | 0.91 | 75. | 0.46 | R | 0.58 |
| 10. | 0.71 | R | 0.59 | 43. | 0.57 | L | 0.10 | 76. | 0.43 | R | 0.91 |
| 11. | 0.36 | L | 0.38 | 44. | 0.82 | L | 0.12 | 77. | 0.97 | L | 0.55 |
| 12. | 0.57 | R | 0.49 | 45. | 0.14 | L | 0.94 | 78. | 0.06 | R | 0.51 |
| 13. | 0.35 | R | 0.90 | 46. | 0.50 | R | 0.58 | 79. | 0.72 | L | 0.78 |
| 14. | 0.69 | L | 0.63 | 47. | 0.93 | L | 0.03 | 80. | 0.95 | L | 0.36 |
| 15. | 0.59 | R | 0.68 | 48. | 0.43 | L | 0.29 | 81. | 0.16 | L | 0.61 |
| 16. | 0.06 | L | 0.03 | 49. | 0.99 | L | 0.36 | 82. | 0.29 | R | 0.47 |
| 17. | 0.08 | L | 0.70 | 50. | 0.61 | R | 0.25 | 83. | 0.48 | R | 0.15 |
| 18. | 0.67 | L | 0.68 | 51. | 0.87 | L | 0.36 | 84. | 0.73 | R | 0.64 |
| 19. | 0.83 | R | 0.97 | 52. | 0.34 | L | 0.19 | 85. | 0.05 | L | 0.94 |
| 20. | 0.54 | R | 0.58 | 53. | 0.37 | R | 0.33 | 86. | 0.43 | L | 0.05 |
| 21. | 0.82 | R | 0.50 | 54. | 0.97 | L | 0.79 | 87. | 0.87 | R | 0.98 |
| 22. | 0.66 | R | 0.73 | 55. | 0.13 | R | 0.56 | 88. | 0.37 | L | 0.71 |
| 23. | 0.06 | L | 0.27 | 56. | 0.85 | R | 0.64 | 89. | 0.94 | L | 0.26 |
| 24. | 0.03 | L | 0.13 | 57. | 0.14 | L | 0.04 | 90. | 0.57 | L | 0.63 |
| 25. | 0.55 | L | 0.29 | 58. | 0.99 | R | 0.74 | 91. | 0.26 | R | 0.80 |
| 26. | 0.64 | L | 0.77 | 59. | 0.40 | L | 0.76 | 92. | 0.01 | L | 0.79 |
| 27. | 0.30 | R | 0.57 | 60. | 0.37 | L | 0.09 | 93. | 0.83 | R | 0.59 |
| 28. | 0.51 | R | 0.67 | 61. | 0.90 | R | 0.74 | 94. | 0.71 | L | 0.21 |
| 29. | 0.29 | R | 0.09 | 62. | 0.09 | L | 0.70 | 95. | 0.65 | L | 0.63 |
| 30. | 0.63 | R | 0.82 | 63. | 0.66 | L | 0.97 | 96. | 0.65 | L | 0.87 |
| 31. | 0.53 | L | 0.86 | 64. | 0.89 | L | 0.55 | 97. | 0.72 | R | 0.92 |
| 32. | 0.99 | R | 0.22 | 65. | 0.67 | L | 0.44 | 98. | 0.85 | L | 0.78 |
| 33. | 0.02 | R | 0.89 | 66. | 0.02 | R | 0.65 | 99. | 0.04 | L | 0.46 |
| | | | | | | | | 100. | 0.29 | L | 0.95 |

X = Decimal fraction of the total length measured along the road from the starting point.
Y = Decimal fraction measured across the road from either outside edge towards the centerline of the paved lane.
R = Indicates measurement from the right edge of the paved lane.
L = Indicates measurement from the left edge of the paved lane.

This page left intentionally blank

Commonwealth of Pennsylvania
Department of Transportation

PA Test Method No. 402
October 2017
6 Pages

LABORATORY TESTING SECTION

Method of Test for

# DETERMINING IN-PLACE DENSITY AND MOISTURE CONTENT OF CONSTRUCTION MATERIALS BY USE OF NUCLEAR GAUGES

**This PTM is a modification of ASTM D2950 (for Bituminous Concrete) and AASHTO T 310 (for Soils and Granular Material, Type 1). The full standards are available, respectively, from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428 (www.astm.org) and the American Association of State Highway and Transportation Officials, 444 N. Capitol Street, N.W., Suite 249, Washington, D.C. 20001 (www.transportation.org).**

**The modifications to ASTM D2950 are as follows:**

8. STANDARDIZATION AND REFERENCE CHECK (FOR BITUMINOUS CONCRETE)

8.2 The gauge standardization procedure shall be conducted and documented on Form TR-4276B before establishing an optimum-rolling pattern.

9. PROCEDURE- OPTIMUM-ROLLING PATTERN (FOR BITMINOUS CONCRETE)

9.1 Purpose- The objective of the optimum-rolling pattern is to obtain the maximum density attainable under existing field conditions and to employ this value as a target or standard for measurement of compaction compliance for the specified work.

9.2 Establishment of Optimum-Rolling Pattern

9.2.1 Enter into the gauge the theoretical maximum density (pcf) from the job mix formula for the bituminous material being placed.

9.2.2 The thickness of the course shall be the same as specified in the contract. Select a location that would be a convenient test site between roller passes. During compaction, the nuclear gauge operator shall take a surface density reading and surface temperature at the selected location after each pass of the roller. A pass is defined as one coverage of the entire roller. The counting period for each reading shall be one (1) minute, unless the area is too small to effectively compact without significant delay. In such cases, the readings may be reduced to 1/2 or 1/4 minute. Each roller shall make at least three (3) passes, and compaction with each roller shall continue until the increase of three (3) successive readings is $\leq$ 3.0 pcf. The optimum number of passes for each roller will be either the 2$^{nd}$ or 3$^{rd}$ pass from the three (3) successive readings with the greatest increase in compaction. If a decompaction reading is obtained, the previous pass will be the optimum number of passes for that roller. Then, proceed to the next roller or temperature range. Record all density values and all surface temperatures and plot the optimum-rolling pattern growth curve for each roller.

NOTE 8- When a pneumatic-tire roller is used, nuclear density readings shall not be taken until after the second pass with this piece of equipment.

9.3 Summary of Optimum-Rolling Pattern Density

9.3.1 Compact the entire course according to the optimum-rolling pattern. After compaction is complete, select an area of at least 400 square yards, when practical, containing ten (10) random locations selected according to PTM No. 1 within this area. At each location, at least one (1) surface density (backscatter) reading shall be taken and documented. The counting period must be one (1) minute for each of these readings. Determine the average of the ten (10) readings and document this value as the target density.

11. REPORT

11.1 Complete Form TR-4276B to document an optimum-rolling pattern for bituminous density acceptance by nuclear method.

TR-4276B (3-15)

pennsylvania
DEPARTMENT OF TRANSPORTATION
www.dot.state.pa.us

# OPTIMUM-ROLLING PATTERN FOR BITUMINOUS DENSITY ACCEPTANCE BY NUCLEAR METHOD

(REFERENCE: PTM NO. 402)

ECMS # ______________ S.R. ________ Sec. _______ County ____________________ District _____ Date __________

Material Type _______________________ JMF # ______________ Theoretical Max Density _________ pcf Thickness ___________

## NUCLEAR GAUGE STANDARDIZATION PROCEDURE

| DENSITY Standard Counts | MOISTURE Standard Counts | OPERATING LIMITS Density | OPERATING LIMITS Moisture |
|---|---|---|---|
| | | ________ to ________ | ________ to ________ |

Tested By ________________________

Gauge Manufacturer ________________________

Gauge Model No. ________________________

Calibration Date ________________________

Remarks:

## ESTABLISHMENT OF OPTIMUM-ROLLING PATTERN

**Roller No. 1**

Type ______________________

| | Density, pcf | % Density | Temp, °F |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| 9. | | | |
| 10. | | | |

Optimum No. Passes ___________

Surface Temp Range ___________

**Roller No. 2**

Type ______________________

| | Density, pcf | % Density | Temp, °F |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| 9. | | | |
| 10. | | | |

Optimum No. Passes ___________

Surface Temp Range ___________

**Roller No. 3**

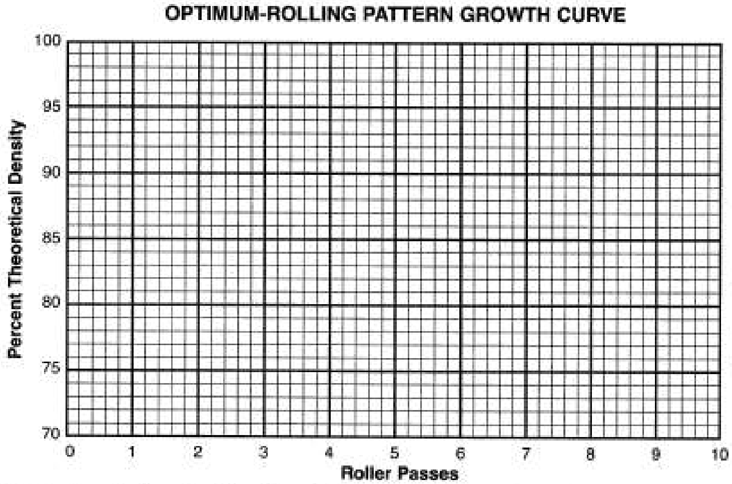
Type ______________________

| | Density, pcf | % Density | Temp, °F |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| 9. | | | |
| 10. | | | |

Optimum No. Passes ___________

Surface Temp Range ___________

## OPTIMUM-ROLLING PATTERN GROWTH CURVE




## SUMMARY OF OPTIMUM-ROLLING PATTERN DENSITY

| | Location | Offset | Density |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| 9. | | | |
| 10. | | | |

**TARGET DENSITY** ________

Each roller should make at least three (3) passes, and compaction with each roller shall continue until the increase of three (3) successive readings is ≤ 3.0 pcf. The optimum number of passes will be either the 2nd or 3rd pass from the three (3) successive readings with the greatest increase in compaction. If a decompaction reading is obtained, the previous pass will be the optimum number of passes for that roller. Then, proceed to the next roller or temperature range.

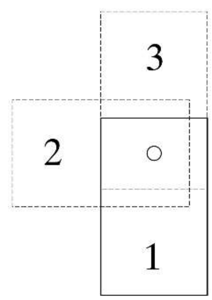
**The modifications to AASHTO T 310 are as follows:**

8. STANDARDIZATION (FOR SOILS AND GRANULAR MATERIAL, TYPE 1)

8.2.4 The gauge standardization results shall be documented on Form TR-4276A. Standardization for Troxler manufactured gauges can be performed using PTM No. 418 or AASHTO T 310. All other gauges should be standardized using AASHTO T 310

9. PROCEDURE

9.5.9 Secure and record three (3) one (1) minute readings. Rotate the gauge about the axis of the probe 90° in the same direction between readings. Average the three (3) readings to obtain an average density value for the test location.




11. REPORT

11.1 Complete Form TR-4276A to document all compaction density tests by nuclear method.

TR-4276A (3-15)

pennsylvania
DEPARTMENT OF TRANSPORTATION
www.dot.state.pa.us

# REPORT ON COMPACTION DENSITY BY NUCLEAR METHOD

(Reference: PTM No. 402)

**Fill Out Completely. Original to be retained with project records. Remit copy to District Office**

ECMS # ______________ S.R. ________ Sec. _______ County ____________________ District _____ Date ___________

TYPE OF CONSTRUCTION: ☐ Embarkment ☐ Subgrade ☐ Pipe Backfill ☐ Other ____________________
*(check one type only)*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1. Test No. | | | | | | | |
| 2. Time of Test | | | | | | | |
| 3. Type of Material | | | | | | | |
| 4. Source of Material | | | | | | | |
| 5. Specific Gravity of Material (SG) | | | | | | | |
| 6. Station | | | | | | | |
| 7. Offset | | | | | | | |
| 8. Subgrade Elevation, ft. | | | | | | | |
| 9. Test Elevation, ft. | | | | | | | |
| 10. Lift Height, in. | | | | | | | |
| 11. Source Rod Position | | | | | | | |
| 12. Target Density (Proctor), pcf | | | | | | | |
| 13. Optimum Moisture, % | | | | | | | |
| 14. % Passing 3/8" Sieve | | | | | | | |
| 15. % Passing No. 200 Sieve | | | | | | | |
| 16. Minimum % Compaction Required | | | | | | | |
| 17. % of Compaction of Test | | | | | | | |
| 18. Dry Density, pcf (DD) | | | | | | | |
| 19. Wet Density, pcf (WD) | | | | | | | |
| 20. Moisture, pcf (M) | | | | | | | |
| 21. % Moisture (M%) | | | | | | | |
| 22. Density Count (Shift + Counts) | | | | | | | |
| 23. Moisture Count (Shift + Counts) | | | | | | | |
| 24. Zero Air Voids Formula Check (Y/N) | | | | | | | |
| 25. (P)ASS or (F)AIL | | | | | | | |

| DENSITY Standard Counts | MOISTURE Standard Counts |
|---|---|
| | |

| OPERATING LIMITS | |
|---|---|
| Density | Moisture |
| ________ to ________ | ________ to ________ |

Tested By ____________________
Gauge Manufacturer ____________________
Gauge Model No. ____________________
Calibration Date ____________________
Remarks:

**Zero Air Voids Formula**

$$\frac{62.4}{DD} - \frac{1}{SG} \geq M\%$$

This page left intentionally blank

LABORATORY TESTING SECTION

Method of Test for

# DETERMINING IN-PLACE DENSITY OF BITUMINOUS CONCRETE USING ELECTRICAL IMPEDANCE MEASUREMENT METHODS

**This PTM is a modification of AASHTO T-343. The full standard is available from the American Association of State Highway and Transportation Officials, 444 N. Capitol Street, N.W., Suite 249, Washington, D.C. 20001 (www.transportation.org).**

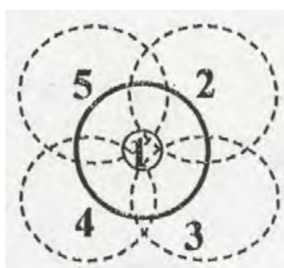
**The modifications to AASHTO T-343 are as follows:**

## 3. SIGNIFICANCE

3.2 The density results obtained by this test method are relative and require a screed calibration method according to Section 7.4.

## 4. INTERFERENCES

4.2 This test method exhibits spatial bias in that the instrument is most sensitive to the density of the material in closest proximity to the center of the instrument sensor. Oversized aggregate particles in the center of the sensor path may cause variations in density readings. The average of at least 5 measurements at each test location is required.




## 5. APPARATUS

5.4 The device shall include the internal circuitry suitable for automatically averaging a number of individual measurements to obtain a mean value.

7. CALIBRATION PROCEDURE

7.2 The device shall be calibrated on the bituminous mat at compaction temperature ranges allowing subsequent readings to be taken as paving progresses at this temperature range.

7.4 All data used for calibration shall be documented on Form TR-4276C before establishing an optimum-rolling pattern. Calibrate the device following the screed calibration method outlined below:

7.4.1 This screed calibration method utilizes the percent compaction obtained by the screed to calculate a starting density. This method requires the operator to estimate the percent compaction obtained by the screed; routinely this number is 75 to 85 percent of the theoretical maximum density (pcf). Operator experience will contribute to the accuracy of the compaction estimate and the success of this method.

7.4.2 Enter into the device the theoretical maximum density (pcf) from the job mix formula for the bituminous material being placed.

7.4.3 Estimate the percent compaction obtained by the screed.

7.4.4 Multiply the estimated percent compaction obtained by the screed, in decimal form by the theoretical maximum density of the material. Example: The estimated screed compaction is 81%, 0.81; the theoretical maximum density is 154 pcf. The gauge should read 124.7 pcf behind the screed ($0.81 \times 154$ pcf = 124.7 pcf).

7.4.5 Compute the average of five (5) density readings of the mixture exiting the screed and offset the device to obtain the reading calculated in Section 7.4.4. Follow the manufacturer's specific recommendations to input the offset.

8. PROCEDURE OF OPERATION

8.4 The objective of the optimum-rolling pattern is to obtain the maximum density attainable under existing field conditions and to employ this value as a target or standard for measurement of compaction compliance for the specified work.

8.5 Establishment of Optimum-Rolling Pattern

8.5.1 The thickness of the course shall be the same as specified in the contract. Select a location that would be a convenient test site between roller passes. During compaction, the operator shall take a surface density reading and surface temperature at the selected location after each pass of the roller. A pass is defined as one coverage of the entire roller. Each roller shall make at least three (3) passes, and compaction with each roller shall continue until the increase of three (3) successive readings is $\leq 3.0$ pcf. The optimum number of passes for each roller will be either the 2$^{nd}$ or 3$^{rd}$ pass from the three (3) successive readings with the greatest increase in compaction. If a decompaction reading is obtained, the previous pass will be the optimum number of passes for that roller. Then, proceed to the next roller or temperature range. Record all density values, all surface temperatures, and plot the optimum-rolling pattern growth curve for each roller.

NOTE 1- When a pneumatic-tire roller is used, density readings shall not be taken until after the second pass with this piece of equipment.

8.6 Summary of Optimum-Rolling Pattern Density

8.6.1 Compact the entire course according to the optimum-rolling pattern. After compaction is complete, select an area of at least 400 square yards, when practical, with ten (10) random locations being selected according to PTM No. 1 within this area. At each location, at least one (1) surface density reading shall be taken and documented. Determine the average of the ten (10) readings and document this value as the target density.

9. RECORDING RESULTS

9.1 Complete Form TR-4276C to document an optimum-rolling pattern for bituminous density acceptance by the electrical impedance measurement method.

TR-4276C (3-15)

pennsylvania
DEPARTMENT OF TRANSPORTATION
www.dot.state.pa.us

# OPTIMUM-ROLLING PATTERN FOR BITUMINOUS DENSITY ACCEPTANCE BY ELECTRICAL IMPEDANCE MEASUREMENT METHOD

(Reference: PTM No. 403)

ECMS # ____________ S.R. ______ Sec. ______ County ______________ District ________ Date __________

Material Type ________________ JMF # __________ Theoretical Max Density ________ pcf Thickness ________

## ELECTRICAL IMPEDANCE GAUGE CALIBRATION PROCEDURE

Gauge Operator ________________ Manufacturer ________________ Model No. ____________

Screed Density = Estimated Screed Density (As Decimal) ______ × Theoretical Max Density ________ = ________ pcf

| | Reading 1 | | Reading 2 | | Reading 3 | | Reading 4 | | Reading 5 | | Total | | Average | | Screed Density | | Offset Value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Screed | ______ | + | ______ | + | ______ | + | ______ | + | ______ | = | ______ | ÷ 5 = | ______ | - | ______ | = | ______ |

## ESTABLISHMENT OF OPTIMUM-ROLLING PATTERN

**Roller No. 1**

Type ________________

| | Density, pcf | % Density | Temp, °F |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| 9. | | | |
| 10. | | | |

Optimum No. Passes ________

Surface Temp Range ________

**Roller No. 2**

Type ________________

| | Density, pcf | % Density | Temp, °F |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| 9. | | | |
| 10. | | | |

Optimum No. Passes ________

Surface Temp Range ________

**Roller No. 3**

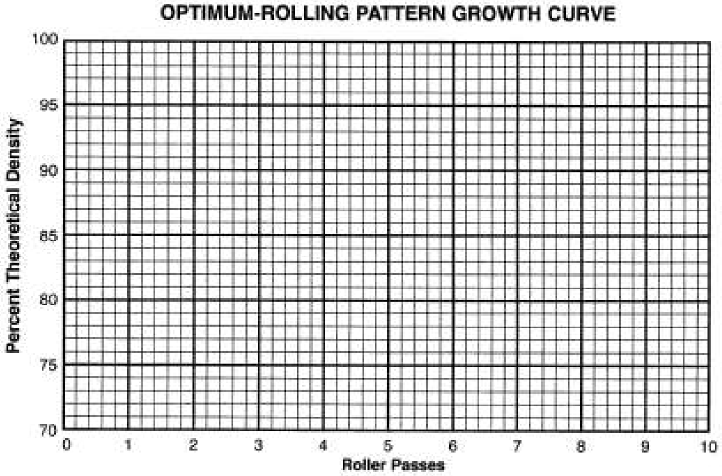
Type ________________

| | Density, pcf | % Density | Temp, °F |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| 9. | | | |
| 10. | | | |

Optimum No. Passes ________

Surface Temp Range ________

## OPTIMUM-ROLLING PATTERN GROWTH CURVE




## SUMMARY OF OPTIMUM-ROLLING PATTERN DENSITY

| | Location | Offset | Density |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| 9. | | | |
| 10. | | | |

**TARGET DENSITY** ________

Each roller should make at least three (3) passes, and compaction with each roller shall continue until the increase of three (3) successive readings is ≤ 3.0 pcf. The optimum number of passes will be either the 2nd or 3rd pass from the three (3) successive readings with the greatest increase in compaction. If a decompaction reading is obtained, the previous pass will be the optimum number of passes for that roller. Then, proceed to the next roller or temperature range.

This page left intentionally blank

Commonwealth of Pennsylvania
Department of Transportation

PA Test Method No. 428
September 2023
14 Pages

ASSET MANAGEMENT DIVISION

Method of Test for

# MEASURING PAVEMENT PROFILE USING A LIGHT WEIGHT PROFILER

## 1. SCOPE

1.1 This test method covers the measurement of pavement profile and roughness using a Light Weight Profiler by driving the profiler longitudinally over the pavement.

1.2 This test method covers the determination of the pavement ride quality from the longitudinal profile, in the form of the International Roughness Index (IRI), for acceptance and payment.

1.3 This test method covers the calibration verification procedures and it outlines the procedures for collecting Light Weight Profiler data on paving projects.

1.4 This test method covers the submission requirements for projects with a ride quality specification.

## 2. REFERENCED DOCUMENTS

2.1 NCHRP Report 228, Calibration of Response-Type Road Roughness Measuring Systems

2.2 ASTM Standards

2.2.1 E950/E950M, Standard Test Method for Measuring the Longitudinal Profile of Traveled Surfaces with an Accelerometer-Established Inertial Profiling Reference

2.2.2 E1926, Standard Practice for Computing International Roughness Index of Roads from Longitudinal Profile Measurements

2.2.3 E2560, Standard Specification for Data Format for Pavement Profile

2.3 AASHTO Standards

2.3.1 R 56, Standard Practice for Certification of Inertial Profiling Systems

2.3.2 R 57, Standard Practice for Operating Inertial Profiling Systems

2.4 PennDOT Publications and Forms

2.4.1 Publication 408, Specifications

2.4.2 Publication 589, Light Weight Profiling System Calibration Verification and Operator Certification Program Manual

2.4.3 Publication 2, Project Office Manual, Section B.6.23, Verification Process for Ride Quality of Newly Constructed Pavements

2.4.4 Form M-7, Daily IRI Data Collection Form

3. TERMINOLOGY - DESCRIPTION OF TERMS SPECIFIC TO THIS PTM

3.1 International Roughness Index (IRI) - A scale for roughness based on the response of a generic motor vehicle to roughness of the road surface. IRI was developed as a reference measure by The World Bank and is based on a quarter-car simulation as described in NCHRP Report 228. IRI is determined by obtaining a suitably accurate measurement of the profile of the road, processing it through an algorithm that simulates the way a reference vehicle would respond to the roughness inputs, and accumulating the suspension travel.

3.2 Mean Roughness Index (MRI) – A derivative of the IRI. The MRI is the average of the left and right wheel path IRI values for a given segment or lot.

3.3 Excluded Area - An area that is not included in the measurement, used to determine lot payment.

3.4 Light Weight Profiler System (LWP) - An inertial profiler that is relatively lightweight (golf cart, ATV, etc.) compared with high-speed profilers. The device is often operated much more slowly than the prevailing traffic speed.

3.5 Raw Unfiltered Data – Inertial profiler output files that are not filtered and are saved in binary, encrypted form. Profiler manufacturers use various file extensions to save the profile, speed and elevation data which are required for the data to be reprocessed as the user needs. Refer to your profiler's manufacturer for questions regarding your equipment's raw binary output files.

3.5.1 Engineering Research Division (ERD) – A file format developed within the Engineering Research Division of the University of Michigan Transportation Research Institute (UMTRI). ERD is the standard file format used by ProVAL, an engineering software application that allows users to view and analyze longitudinal pavement profiles.

3.5.2 Pavement Profile Standard File Format (PPF) – A binary based file format created for ProVAL, an engineering software application that allows users to view and analyze longitudinal pavement profiles. The ASTM International profile data file specification, E2560, is based on this format.

4. APPARATUS

4.1 The Light Weight Profiling System must be an all-terrain or golf-cart type vehicle equipped with various hardware and software that together allow the measurement and recording of the longitudinal profile of a traveled wheel path and the reference distance traveled along the traveled wheel path.

4.2 The equipment and software will produce an IRI in English units (inches/mile) for 0.10 mile intervals conforming to ASTM E1926 and meet the requirements of Appendix A, Generic Specification for Light Weight Profiling System.

4.3 Must be certified for use on PennDOT projects described in Section 6.

5. REPAIR AND ADJUSTMENT OF LIGHT WEIGHT PROFILER

5.1 Major component repairs or replacement that would require recertification of the inertial profiler include, but are not limited to, the following:

5.1.1 the accelerometer and its associated hardware,

5.1.2 the non-contact height sensor and its associated hardware,

5.1.3 the distance measuring instrument, or

5.1.4 any printed circuit board necessary for collecting and processing of raw sensor data of the LWP and IRI.

6. ACCEPTANCE

6.1 This section provides minimum certification requirements for LWP devices and operators.

6.1.1 Prior to testing, the LWP device will be checked to verify that it has been calibrated and is operating properly.

6.1.1.1 Verification/certification will be done in accordance with Publication 589.

6.1.1.2 Accepted profilers are designated with a decal that is valid until June 30 of the following calendar year provided no changes are made to the equipment or software. The decal must adhere to the outside of the LWP in clear view.

6.1.1.3 Additional reverification/recertification of profilers or operators may be required, due to repairs, replacements, and/or upgrades to the profiler's hardware or software, or questionable results and/or practices on a construction project.

6.1.2 The LWP operator must be certified. Certified operators will receive individual certification cards that are valid for up to three calendar years. Certified operators must carry their PennDOT certification card during pavement surface profiling on Department projects.

6.1.3 The operator of a certified LWP must use the same software version and settings on PennDOT projects that were used during the profiler certification. A copy of these settings may be obtained by contacting the Roadway Inventory and Testing Unit or by viewing the Roadway Inventory and Testing Unit's website at http://www.penndot.gov/ProjectAndPrograms/ResearchandTesting/RoadwayManagementandTesting/Pages/Light-Weight-Profiler-Certifications.aspx#.VmsrSqMo670.

6.1.4 Changes to the software version may result in the need for reverification or recertification of the profiler.

7. PROJECT SITE VERIFICATION

7.1 The Department shall certify all Light Weight Profilers and Operators prior to testing.

7.2 The Project Engineer (or designee) will approve the operator and equipment for project level testing by verifying the equipment and software information on the PennDOT issued decal and by verifying the operator has a current PennDOT issued certification card. The operator and equipment information shall be documented daily by the Project Engineer (or designee) on the Form M-7. A list of approved contractor operators and approved equipment is posted on the Bureau of Operations, Asset Management Division, Pavement Testing and Asset Management Section, Roadway Inventory and Testing Unit's webpage.

7.3 The following daily verification procedure is required for all testing. Although the specific steps to complete the verifications will vary in accordance with the manufacturer's recommendations, the basic procedures will not change. The results of the verification checks shall be documented in a log. The Project Engineer (or designee) shall verify the profiler meets the following requirements:

7.3.1 Longitudinal Verification (Distance)

7.3.1.1 The longitudinal verification will be a straight roadway test section at least 528 feet in length. This distance shall be measured accurately within ± 0.1% using a steel measurement tape or electronic measuring device.

7.3.1.2 Verify the tire air pressure on the wheels of the apparatus daily and maintain per the vehicle manufacturer's recommendations.

7.3.1.3 Warm up the LWP's tires and electronic systems in accordance with the manufacturer's recommendations.

7.3.1.4 If the LWP's distance measuring subsystem measures the length of the test section to within 0.1% of its actual length, no additional verification is necessary.

7.3.1.5 If the LWP's distance measuring subsystem fails to measure the length of the test section to within 0.1% of its actual length, the calibration shall be adjusted according to the manufacturer's guidelines and the longitudinal verification repeated.

7.3.1.6 No more than one single certified operator is to occupy the profiler during verification/calibration.

7.3.1.7 If the LWP fails to meet these requirements, the LWP will be deemed to be not certified and prohibited from use on PennDOT projects until it is recertified.

7.3.1.8 A printed copy of the distance verification must be submitted to the PennDOT representative each day prior to taking any measurements.

7.3.2 Laser Height Verification (Block Test)

7.3.2.1 Laser height verification must be performed in accordance with AASHTO R 57-14 or the manufacturer's recommended procedures each day the LWP device is in use.

7.3.2.2 The block sensor tests are run after the profiler has reached operational stability as defined and specified by the manufacturer. This test should be performed on a flat level area. Its purpose is to check the height measurements, in inches, from the height sensor(s) of the LWP using blocks of known heights. During the test, do not lean on the LWP or cause it to move in any way. At a minimum, two base plate and three varying measurement plate (typically 0.25, 0.5 and 1 inch) readings will be needed. The absolute difference should be less than or equal to 0.01 inch for each gauge block.

7.3.2.2.1. Center the base plate under the height sensor of the LWP and allow the system to take height measurements.

7.3.2.2.2. Center a 0.25-inch block underneath the height sensor on top of the base plate and record the height measurement.

7.3.2.2.3. Replace the 0.25-inch block from the base plate with a 0.50-inch block and record the height measurement.

7.3.2.2.4. Replace the 0.50-inch block from the base plate with a 1.0-inch block and record the height measurement.

7.3.2.2.5. Remove the 1.0-inch block leaving only the base plate and record the height measurement. The profiler's height measurement subsystem returns to zero.

7.3.2.2.6. If the tests fail to meet these requirements, the LWP will be deemed to be not certified and prohibited from use on PennDOT projects until it is recertified.

7.3.2.2.7. A printed copy of the laser height verification results must be submitted to the PennDOT representative each day prior to taking any measurements.

7.3.3 Vertical Verification (Bounce Test)

7.3.3.1 A bounce test in accordance with AASHTO R 57-14 or manufacturer's equivalent must be performed each day the LWP device is in use, prior to taking any measurements.

7.3.3.2 With the base plates in position simultaneously under both wheel path sensors, place the LWP in an operating mode that simulates longitudinal movement and initiate profile data collection. Allow the profiler to collect a minimum of 828 feet (includes a 300-foot lead-in) of static profile with the LWP as motionless as possible.

7.3.3.3 Sensor(s) should be moved vertically for a total displacement of approximately 1 to 2 inches keeping the sensors as close to perpendicular to the surface as possible during this movement. The bouncing must continue until a minimum of 528 feet of simulated distance has been traveled.

7.3.3.4 After a minimum of 528 feet of bounce profile is collected, allow the profiler to collect an additional minimum of 828 feet (includes a 300-foot lead-out) of static profile with the LWP as motionless as possible.

7.3.3.5 When reviewing the analysis results, the first and last (static) 528-foot segments shall not exceed 3 inches per mile, while the IRI for the middle (bouncing) segment shall not exceed 8 inches per mile for the bounce test. If the computed IRI values exceed 3 inches per mile for the static test and/or exceed 8 inches per mile for the bounce test, then the manufacturer's recommendations for performing sensor operational checks shall be followed. The static bounce test shall be repeated.

7.3.3.6 If the tests fail to meet these requirements, the LWP will be deemed to be not certified and prohibited from use on PennDOT projects until it is recertified.

7.3.3.7 A printed copy of the bounce test results must be submitted to the PennDOT representative each day prior to taking any measurements.

7.3.4 Accelerometer Verification

7.3.4.1 Accelerometer verification must be performed in accordance with the manufacturer's recommended procedures each day the LWP device is in use, prior to taking any measurements. The tolerance for the accelerometer verification must meet the manufacturer's requirements.

7.4 The operator will check that all sensor positions are displaying correctly and verify that sensor collection rates are properly set. All such constants or factors must be automatically set and stored during calibration/verification procedures.

7.5 A calibration verification log, in accordance with AASHTO R 56, is to be kept with the inertial profiler to provide a verification of calibration history. The results of the routine bounce tests, block checks, accelerometer and distance verification runs shall also be included in this log. If the log is electronic, a backup copy shall be kept in a secure location.

8. PROCEDURE

8.1 Startup and initialization.

8.1.1 Clean the roadway path of all debris and other loose material before measuring.

8.1.2 Perform all necessary start up procedures.

8.1.3 Verify that distance measurement, sensors, and accelerometers are properly calibrated. Perform all necessary calibration procedures, as specified in Section 7, and as per equipment manufacturer procedures. Save all values.

8.1.4 Check that all sensor positions are displaying correctly and verify that sensor collection rates are properly set.

8.1.5 Enter the location identification information (all data collected must have this information printed on all output files) and define the direction of traffic for the pavement to be tested.

8.1.6 Collect measurements in the direction of traffic. When using a LWP that collects a single wheel path per pass, take care to ensure that the measurements from each wheel path in a travel lane start and stop at the same longitudinal locations.

8.2 Sampling

8.2.1 Pavement profiles must be taken in the wheel paths of each lane. The first profile must be approximately 3 feet from and parallel to the outside edge of pavement, and the second profile must be approximately 5.75 feet from the first profile, or as directed by the Project Engineer.

8.2.2 Measure profiles to the limits of the pavement areas, as specified. As per Publication 408, sampling areas must be designated as lots, and excluded areas must be defined and measured separately (measure profiles of the excluded areas to their limits).

8.2.3 Only a single certified operator is to occupy the profiler during sampling. The weight of additional passengers, including Department personnel, may adversely affect results and is not permissible.

8.3 Data collection

8.3.1 Position the LWP to a point where the testing speed can be reached before testing begins. A 100-foot lead-in section of roadway is required to eliminate all error through filtering in the program that processes the data. This lead-in section should be located immediately before the section of pavement being tested. When this is not possible, then crop the beginning of the run until the LWP has reached testing speed and the systems have had a chance to stabilize or add a minimum of 100-foot lead-in and/or lead-out through the report program to account for speed adjustments and system stabilization.

8.3.2 Verify that all software and hardware is ready to collect data. Start the data collection system.

8.3.3 The LWP shall remain stationary for approximately 1 minute for the system filters to stabilize.

8.3.4 Start the LWP moving and initiate testing when the LWP reaches testing speed.

8.3.5 If targeting is used, allow the target to reset the system at test start and finish.

8.3.6 Continue testing at a consistent speed until the test end point is passed. A lead-out may be used in accordance with the profiler manufacturer's operating requirements.

8.3.7 Terminate the test after the test end point is passed or allow targeting to terminate the test.

8.3.8 End data collection and save the file. It is recommended to save all data, and then delete unwanted data later, rather than abort the file save mode.

8.3.9 If applicable, mark where the total file may be broken into smaller files for analysis.

8.3.10 Upon completion of a sampling path, make ending notations and review the test for reasonableness. Repeat the procedure, driving the LWP in the same direction for successive sampling paths for a given section of pavement. Test each sampling path only once. Additional profiles may be taken to define the limits of an out-of-tolerance surface variation.

8.3.11 Measure IRI for excluded areas separately.

9. WEATHER LIMITATIONS

9.1 Collect data only when the temperature and weather conditions are within the operating range recommended by the manufacturer of the light weight profiler.

9.2 Data collection is not permitted during precipitation.

9.3 Data collection is not permitted when standing water is present on the pavement.

10. SUBMITTALS

10.1 All test results shall be reported in English units (inches/mile).

10.2 Test values shall be reported to one digit to the right of the decimal in accordance with conventional rounding procedures.

10.3 Provide a summary printout of the IRI and MRI values calculated for each pass as generated by the equipment performing the test, within 24 hours of the conclusion of each test. IRI shall be calculated using a quarter-car simulation as outlined in NCHRP Report 228.

10.4 As a minimum, the following information must be printed from the inertial profiler for the interpreted output:

10.4.1 Date and time of day

10.4.2 Operator and equipment identification

10.4.3 Weather conditions: temperature, cloud cover, and wind

10.4.4 Surface description: type of pavement and condition

10.4.5 Location and description of section: Job ID, lot, lane, wheel path, beginning and ending stationing, and direction measured

10.4.6 Lot length

10.4.7 Software version: both the LWP and the reporting software

10.4.8 Data filter settings

10.4.9 High-pass filter setting = 100 feet

10.4.10 Lot IRI value for profilers with one laser sensor or IRI and MRI values for profilers with two laser sensors

10.4.11 IRI values for excluded areas

10.5 Within 24 hours of conclusion of each test, supply the necessary raw unfiltered data files and a copy of the operator's certification card for all projects. Provide a USB flash drive or another media acceptable to the PennDOT representative that contains the raw unfiltered data for each wheel path, so that PennDOT may perform verification analysis. Each pass shall be clearly labeled to include county, state route, project number, lot number, and wheel path. The raw unfiltered data files must be in ERD or PPF format.

# APPENDIX A

## GENERIC SPECIFICATION FOR LIGHT WEIGHT PROFILING SYSTEM

The purpose of this specification is to define the requirements for a Light Weight Profiling (LWP) System that can be used to collect roadway surface data for determining the roughness and profile of roads. The following items are required:

1. The computer-based system, with its profile sensing system described must be capable of the following:

    (1) interfacing with the operator

    (2) controlling the tests

    (3) measuring the necessary resultant test signal data

    (4) recording the resultant test data on USB flash memory drive or another media acceptable to the PennDOT representative

    (5) calculating and storing profile, roughness, and distance values

    (6) displaying the stored data

    (7) printing the stored data upon operator request

2. The LWP operational system must be an all-terrain or golf-cart type vehicle equipped with various hardware and software that together allows the measurement and recording of the longitudinal profile of a traveled wheel path and the reference distance traveled along the traveled wheel path. The longitudinal profile must be measured using a concept where three transducers are used. These transducers include:

    (1) non-contact height measurement (sensor) subsystems, capable of measuring the height from the mounted sensor face to the surface of the pavement under test.

    (2) an inertial reference (accelerometer) subsystem, capable of measuring the movement of the LWP vehicle as it traverses the pavement under test.

    (3) a distance measuring subsystem which provides a reference measurement of the vehicle as it traverses the pavement, verified accurate to within 1 foot per 0.20 mile of actual distance traveled.

3. The data must be saved and recorded so that road profiles obtained with this system must be independent of the measuring speed and the type of vehicle used. The LWP must:

    (1) include hardware and software capable of producing and storing inertial profiles by combining the data from the inertial referencing subsystem, the distance subsystem, and the height measurement subsystem.

(2) be capable of measuring and storing profile elevations at 1-inch intervals or less and outputting in ERD or PPF format.

(3) have the capability of summarizing the profile elevation data into summary roughness statistics over a section length equal to 0.1 mile (the summary roughness statistic is the International Roughness Index (IRI) for each longitudinal path profiled). In addition, profile plots must be capable of being displayed and printed during post processing.

(4) have design to allow field calibration and verification of calibration for the distance measurement (horizontal) subsystem and the height measurement (vertical) subsystem as required by agency standards.

4. The roughness value must be calculated using the standardized International Roughness Index (IRI). In addition to the normal IRI unit value the system must also provide an "inches/mile" statistic. The IRI was developed as a reference measure by The World Bank and is based on a quarter-car simulation as described in NCHRP Report 228. This value must conform to the requirements of ASTM E950/E950M. IRI measures obtained from this system must match those obtained from other valid profilometers, and also IRI measures obtained using agency approved ground truth devices. A plot of roughness using any base length for averaging must also be reproducible. The above roughness results must be displayable on the system screen, printed on a printer or written into an electronic file format for processing.

5. The profile system hardware and software for collecting and processing the data obtained in real time in conjunction with the post processing software must have as a minimum the following capabilities:

    (1) profile computation

    (2) IRI computation

    (3) high-pass filtering

    (4) low-pass filtering (smoothing)

    (5) height sensor error checking

6. The system must be capable of calculating, displaying, and storing the average roughness value obtained from the stored data. Additionally, the system must be capable of putting the accumulated roughness test results through mathematical equations and printing results when enabled by the operator. These options must be done in real time or in post processing. The system must be capable of performing all required post processing operations.

7. The test software must activate the testing using the timing and control parameters stored by the test control setup software.

    (1) The operational system through the Distance/Data Acquisition Subsystem (DAS) must provide all interfaces to collect data to derive distance, speed, and profile from the transducers mounted on the vehicle; activate the tests; derive distance and location information from the transmission mounted distance transducer; process operator inputs from the keyboard signaling that the test vehicle has encountered a significant

feature; and pass information on about the feature and its location to the processing unit for display and logging.

(2) The software must monitor the signals to verify that the testing is being performed properly and indicate detectable errors.

(3) The test software must receive, display, and store raw data received from the vehicle mounted transducers at corresponding distances and test speeds.

8. An optical encoder must be mounted on the vehicle to produce a pulse for units of distance traveled by the vehicle on the roadway. The DAS must accept these pulses and, in combination with the DAS software, must determine the distance traveled and vehicle speed.

9. The operational system software must allow the operator to perform a distance sensor calibration and use the calculated Distance Calibration Factor (DCF) to perform the operational distance measurements. The calibration software must also allow the operator to save the calculated DCF. The operator must only enter the distance traveled in feet, meters, kilometers, or miles and not make any calculations to determine the DCF. Five feet per mile (or 1 foot per 0.20 mile), accuracy is required.

    (1) The calibration software must also allow the operator to perform a profile system calibration. The values determined in calibration must be stored and recorded as above for use in the calculation.

10. The reference height of the vehicle above the pavement must be obtained through a laser or infrared module as required. The sensor must be totally enclosed in a case that may be sealed during bad weather or when not in use. The sensor must be formed in a manner so that it may be mounted on a vehicle approximately 1 foot above the pavement surface. The laser or infrared module shall be equivalent to a Selcom sensor, which has a resolution of 0.001 inch. The sensor must provide continuous coverage of the roadway. The sensor module must send an infrared beam to the pavement and sample the height value at a rate of 16,000 times per second. The sample data must be averaged and stored referenced to time and/or distance so that the data may be processed into transverse profile data or aligned with the accelerometer data to provide a longitudinal profile.

11. The displacement of the vehicle in the vertical direction used to calculate position shall be sensed using an accelerometer. The DAS must provide hardware and software to amplify and filter/integrate the signal as required to obtain the data required for storage and for further post processing of the required data.

12. The vehicle will be equipped with infrared sensors to allow the operational system to perform system functions (start test, end test, reset DMI value, etc.) without operator intervention when using roadside targets.

This page left intentionally blank

Commonwealth of Pennsylvania
Department of Transportation

PA Test Method No. 715
October 2013
5 Pages

LABORATORY TESTING SECTION

Method of Test for

# DETERMINATION OF BULK SPECIFIC GRAVITY OF COMPACTED BITUMINOUS MIXTURES

## 1. SCOPE

1.1 This method of test is intended for determining the bulk specific gravity of laboratory compacted bituminous mixtures or bituminous roadway samples, such as cores, small sawed slabs, density ring samples, etc. This method shall not be used if the samples contain open or interconnecting voids and/or absorb more than 3.0 percent water. For such samples, PTM No. 716 shall be used.

## 2. TEST SPECIMEN

2.1 Compacted specimens in accordance with PENNDOT Methods or obtained in accordance with PENNDOT methods of sampling a compacted roadway.

2.2 Size of specimens- It is recommended, (1) that the diameter of cylindrically molded or cored specimens, or the length of the sides of the sawed specimens, be at least equal to four times the nominal maximum size of the aggregate; and (2) that the thickness of the specimens be at least 1.5 times the nominal maximum size of the aggregate.

2.3 Specimens shall be free of foreign materials such as seal coat, tack coat, foundation material, soil, paper, or foil.

2.4 If desired, specimens may be separated from the other pavement layers by sawing or other suitable means. Care shall be exercised to ensure sawing does not damage the specimens.

**METHOD A (VOLUMETER)**

3. APPARATUS

3.1 Weighing Device-A weighing device conforming to the requirements of AASHTO M-231, Class G2

3.2 Water Bath- Thermostatically controlled so as to maintain the bath temperature at 25 ± 0.5ºC (77 ± 0.9ºF)

3.3 Thermometer- ASTM 17C (17F), having a range of 19 to 27ºC (66 to 80ºF), graduated in 0.1ºC (0.2ºF) subdivisions

3.4 Volumeter[1] - Calibrated, 1.2 L or an appropriate capacity depending upon the size of the test sample

4. PROCEDURE

4.1 Immerse the specimen in the water bath and let saturate for at least 10 minutes. At the end of the 10 minute period, fill a calibrated volumeter with distilled water at 25 ± 1ºC (77 ± 1.8ºF). Place the saturated specimen into the volumeter. Bring the temperature of the water in the volumeter to 25 ± 1ºC (77 ± 1.8ºF), and cover the volumeter making certain that some water escapes through the capillary bore of the tapered lid. Wipe the volumeter dry with a dry absorbent cloth and weigh the volumeter and contents to the nearest 0.1 of a gram.

4.2 Remove the immersed and saturated specimen from the volumeter, quickly damp dry the saturated specimen with a damp towel, and as quickly as possible weigh the specimen. Any water that seeps from the specimen during the weighing operation is considered as a part of the saturated specimen. Dry the specimen to constant mass (NOTE 1). Weigh the dried specimen to the nearest 0.1 of a gram.

> NOTE 1- Constant mass shall be defined as the mass at which further drying at 52 ± 3ºC (125 ± 5ºF) does not alter the mass by more than 0.05 percent. Samples saturated with water shall initially be dried overnight at 52 ± 3ºC (125 ± 5ºF), flipped top to bottom, then dried until a Minimum Standard Drying Time of 20 hours has elapsed. This Minimum Standard Drying Time shall be reestablished using the procedure in NOTE 1A if there are substantial changes in ovens, paving materials, or mix design methods from 2002 conditions. Laboratory compacted specimens and density ring samples need not be dried.

[1]Aluminum Volumeters of different sizes available from Pine Instrument Co., 101 Industrial Drive, Grove City, PA. 16127 and Rainhart Co., 604 Williams St., Austin, TX, 78765 have been found suitable.

NOTE 1A- PROCEDURE FOR DETERMINING A MINIMUM STANDARD DRYING TIME: Assemble a random sample of cores representing the compacted asphalt mixtures typically tested. Saturate the cores with water, and place the saturated cores in the 52 ± 3ºC (125 ± 5ºF) oven overnight. At the start of the following workday flip the cores top to bottom. Continue to dry and weigh the cores at two-hour intervals until constant mass is attained. Document and use the time it took for all cores to reach constant weight as the Minimum Standard Drying Time.

NOTE 2- If desired, the sequence of testing operations can be changed to expedite the test results. For example, first the dry mass of the specimen can be determined. Then the volumeter containing the saturated specimen and water can be weighed. The mass of the saturated specimen can be obtained last.

## 5. CALCULATIONS

5.1 Calculate the bulk specific gravity (dry basis) of the samples as follows (report the value to three decimal places):

$$GSm = \frac{WSm}{(0.997\ \text{g/mL}) \times [VVo - (1.003\ \text{mL/g}) \times (WT - WSa - WVo)]}$$

Where:

GSm = bulk specific gravity of the specimen at 25.0ºC (77ºF)

WSm = mass in grams of the dry specimen

VVo = volume in mL of the volumeter at 25.0ºC (77ºF) to the nearest tenth of a milliliter

WT = total mass in grams of the volumeter, saturated specimen, and water in the volumeter at 25.0ºC (77ºF)

WSa = mass in grams of the saturated specimen

WVo = mass in grams of the volumeter

5.2 Calculate the percent water absorbed by the specimen as follows (report the value to one decimal place):

$$\text{Percent Water Absorbed} = \frac{WSa - WSm}{(0.997\ g/mL) \times [VVo - (1.003\ mL/g) \times (WT - WSa - WVo)]} \times 100$$

If the percent water absorbed is more than 3.0 percent, use PTM No. 716.

## METHOD B (SUSPENSION IN WATER)

AASHTO T-166, Method A, except as follows:

NOTE 1- replace with the following: Constant mass shall be defined as the mass at which further drying at 52 ± 3ºC (125 ± 5ºF) does not alter the mass by more than 0.05 percent. Samples saturated with water shall initially be dried overnight at 52 ± 3ºC (125 ± 5ºF), flipped top to bottom, then dried until a Minimum Standard Drying Time of 20 hours has elapsed. This Minimum Standard Drying Time shall be reestablished using the procedure in NOTE 1A if there are substantial changes in ovens, paving materials, or mix design methods from 2002 conditions. Laboratory compacted specimens and density ring samples need not be dried.

Add: NOTE 4 – Referee Method- In case of discrepancies between the test results obtained by Method A and Method B, the referee test shall be Method A.

## METHOD C (RAPID TEST)

AASHTO T-166, Method C

This page left intentionally blank

Commonwealth of Pennsylvania
Department of Transportation

PA Test Method No. 716
October 2013
6 Pages

LABORATORY TESTING SECTION

Method of Test for

# DETERMINATION OF BULK SPECIFIC GRAVITY OF COMPACTED BITUMINOUS MIXTURES THAT ABSORB MORE THAN 3.0 PERCENT WATER BY VOLUME

## 1. SCOPE

1.1 This method of test is intended for determining the bulk specific gravity of laboratory compacted bituminous mixtures or bituminous roadway samples that contain open or interconnecting voids and/or absorb more than 3.0 percent of water by volume.

## 2. TEST SPECIMEN

2.1 Compacted specimens in accordance with PENNDOT Methods or obtained in accordance with PENNDOT Methods of sampling a compacted roadway.

## METHOD A (VOLUMETER)

## 3. APPARATUS

3.1 Balance- A balance conforming to the requirements of AASHTO M-231, Class G2

3.2 Water Bath- A thermostatically controlled bath, capable of maintaining the bath temperature at 25 ± 0.5ºC (77 ± 0.9ºF)

3.3 Thermometer- An ASTM 17 C (17 F), having a range of 19 to 27ºC (66 to 80ºF), graduated in 0.1ºC (0.2ºF) subdivisions

3.4 Volumeter[1] – Calibrated, 1.2 L or an appropriate capacity depending on the size of the test sample

[1]Aluminum Volumeters of different sizes available from Pine Instrument Co., 101 Industrial Drive, Grove City, PA. 16127 and Rainhart Co., 604 Williams St., Austin. TX 78765 have been found suitable.

## 4. PROCEDURE

4.1 Dry the specimen to constant mass (NOTE 1) and weigh the specimen to the nearest tenth (0.1) of a gram.

NOTE 1- Constant mass shall be defined as the mass at which further drying at 52 ± 3ºC (125 ± 5ºF) does not alter the mass by more than 0.05 percent of the test load.

4.2 Coat the specimen with melted paraffin sufficiently thick to seal all surface voids. Allow the specimen to cool in air at room temperature for 30 minutes, and then weigh to the nearest tenth (0.1) of a gram.

NOTE 2- Application of the paraffin may be accomplished by chilling the specimen in a refrigerating unit to a temperature of approximately 4.5ºC (40ºF) for 30 min. and then dipping the specimen in warm paraffin at 5.5ºC (10º F) above the melting point. It may be necessary to brush the surface of the specimen with added hot paraffin in order to fill any pinpoint holes.

4.3 Fill a calibrated volumeter with distilled water at 25ºC (77ºF). Place the coated specimen into the volumeter and cover the volumeter making certain that some water escapes through the capillary bore in the tapered lid. Wipe the volumeter dry with a dry absorbent cloth and weigh the volumeter and its contents to the nearest tenth (0.1) of a gram.

4.4 Determine the specific gravity of the paraffin at 25 ± 1ºC (77 F ± 2ºF), if unknown, using the bitumenometer method, as is used for determining the specific gravity of bitumen (AASHTO T-228).

5. CALCULATIONS

5.1 Calculate as follows:

$$GSm = \frac{WSm}{VVo - [(PWSm + WWa) - PWSm + \frac{(PWSm - WSm)}{GP}}$$

Where:

GSm = Specific gravity of the specimen at 25.0ºC (77ºF)

WSm= Mass in grams of the uncoated specimen in air at 25.0ºC (77ºF)

VVO = Volume in cc of the volumeter at 25.0 ºC (77$^{o}$F)

PWSm = Mass in grams of the paraffin coated specimen in air at 25.0 ºC (77ºF)

(PWSm + WWa) = Mass in grams of the paraffin coated specimen and water in the volumeter at 25.0ºC (77ºF)

GP = Specific gravity of the paraffin at 25.0ºC (77ºF)

5.2 Report the bulk specific gravity value to three decimal places.

NOTE 3- The mass of the specimen and water in the above formula does not include the mass of the volumeter. The use of a tare weight for the volumeter is recommended.

NOTE 4- If the bulk specific gravity value of the sample is to be converted to kg/m$^3$ (pounds per cubic foot), it shall be multiplied by 1000 (62.4) and the value rounded to the nearest tenth.

## METHOD B (SUSPENSION IN WATER)

## 6. APPARATUS

6.1 Balance-Conforming to the requirements of AASHTO M- 231, Class G2. The balance shall be equipped with a suitable suspension apparatus and holder to permit weighing the specimen while suspended from the center of the scale pan of the balance (NOTE 5).

NOTE 5- The holder should be immersed to a depth sufficient to cover it and the sample during weighing. Wire suspending the holder should be the smallest practical size to minimize any possible effects of a variable immersed length.

6.2 Water Bath- For immersing the specimen in water while suspended under the balance, equipped with an overflow outlet for maintaining a constant water level. The water bath temperature shall be maintained at 25 ± 1ºC (77 ± 2ºF).

## 7. PROCEDURE

7.1 Weigh the uncoated specimen after it has been dried to constant mass (NOTE 1). Designate this as mass A.

7.2 Coat the test specimen on all surfaces with melted paraffin sufficiently thick to seal all voids. Allow the specimen to cool in air at room temperature for 30 minutes, then weigh the specimen. Designate this as mass D (NOTE 2).

7.3 Weigh the coated specimen in the water bath at 25 ± 1ºC (77 ± 2ºF). Designate this as mass E.

7.4 Determine the specific gravity of the paraffin at 25ºC (77ºF), if unknown, and designate this as mass F.

## 8. CALCULATION

8.1 Calculate the bulk specific gravity of the specimen as follows (report to three decimal places):

$$\text{Bulk Specific Gravity} = \frac{A}{D - E - \frac{(D - A)}{F}}$$

Where:

A = mass of the dry specimen in air

D = mass of the dry specimen plus paraffin in air

E = mass of the coated specimen in water

F = specific gravity of the paraffin at 25ºC (77ºF)

## 9. REFEREE METHOD

9.1 In case of discrepancies between the test results obtained by Methods A and B. The referee test shall be Method A.

This page left intentionally blank

Commonwealth of Pennsylvania
Department of Transportation

PA Test Method No. 729
October 2013
14 Pages

LABORATORY TESTING SECTION

Method of Test for

# SAMPLING ROADWAY BITUMINOUS CONCRETE

## 1. SCOPE

1.1 This method covers the procedure for sampling of bituminous paving mixtures taken from the finished pavement for determination of the characteristics of the compacted mixture. Alternative methods of sampling may be found in AASHTO T- 230.

## CORING OF BITUMINOUS CONCRETE

## 2. EQUIPMENT

2.1 Powered core drill, water cooled, equipped to core cylindrical samples.

2.2 Diamond drill bit of six (6) inch size.

2.3 Incidental materials and equipment.

2.4 Hand-held core sample extraction tool capable of grasping and removing a drilled cylindrical pavement core sample from the pavement without damage to the core sample.

2.5 A rigid plate or a suitable container large enough to hold the sample without distortion after it is removed from the pavement.

2.6 Masking tape

2.7 A marking pencil or lumber crayon.

## 3. SELECTION OF ACCEPTANCE SAMPLES

3.1 Density acceptance of the bituminous mixture from the roadway shall be on the basis of test results from consecutive probability samples for each Lot. One probability sample shall be taken from each Sublot. Samples are to be selected by means of a stratified random sampling plan. Refer to Illustrative Examples No. 1 & No. 2 in the Appendix of PTM No. 746 for examples of how to select samples using a stratified random sampling plan for pavement courses. Density acceptance samples must be cross referenced to a corresponding mixture acceptance sample on Form TR-447.

3.2 The testable sampling width is determined by taking the nominal paving width and subtracting one (1) foot from each edge (supported and/or unsupported edges). Refer to Illustrative Example No. 1 in the Appendix of this PTM.

3.3 Areas within one (1) foot from the edge of obstructions to normal paving such as manhole covers, inlets, and utility valve covers are considered non-testable areas for core sampling. When a sample location falls within a non-testable area, adjust the location of the core sample longitudinally in the direction of paving to a location at the edge of the non-testable area. Refer to Illustrative Example No. 2 in the Appendix of this PTM.

## 4. SELECTION OF LONGITUDINAL JOINT INCENTIVE/DISINCENTIVE SAMPLES

4.1 Incentive/Disincentive samples shall be taken on the basis of consecutive probability samples for each Lot. Lots shall be established as specified in Pub. 408, Section 405. One probability sample shall be taken from each Sublot. Samples are to be selected by means of a stratified random sampling plan. Refer to Illustrative Example No. 3 in the Appendix of this PTM for an example of how to select samples using a stratified random sampling plan. Each joint core will be comprised of portions of two lanes, with the potential for two different JMFs within each core. All cores within a lot having the same JMF combination shall be included on one TR-447 (except work stoppages of greater than five (5) days which will require the first portion of the lot to be included on one TR-447 with the remaining portion of the lot to be included on a second form when work continues). The theoretical maximum specific gravity value to place on Form TR-447 will be the overall average of each core’s average value. Sublots with different JMF combinations or work stoppages of more than five (5) days will require a separate Form TR-447. Refer to Illustrative Example No. 4 in the Appendix of this PTM for an example of how to evaluate JMF combinations and arrive at the proper theoretical maximum specific gravity.

4.2 A core sample taken from a longitudinal vertical joint shall be centered on the line where the joint between the two adjacent lifts abut at the surface as illustrated on the next page. The center of all vertical joint cores shall be within one (1) inch of this joint line. A core sample taken from a longitudinal notched wedge joint shall be centered six (6) inches or one-half the width of the joint taper away from the joint line in the direction of the wedge as illustrated on the next page. When the two lanes forming the longitudinal joint have daily theoretical maximum specific gravity values differing by more than 0.050, examine each longitudinal joint core sample to ensure that approximately one-half of the longitudinal joint core sample is from each lane. If the materials in the longitudinal joint core are unbalanced, adjust the location of the core drill relative to the joint line to ensure approximately equal material. Take a replacement sample at a location within twelve (12) inches longitudinally of the original sample location.

**Vertical Joint**

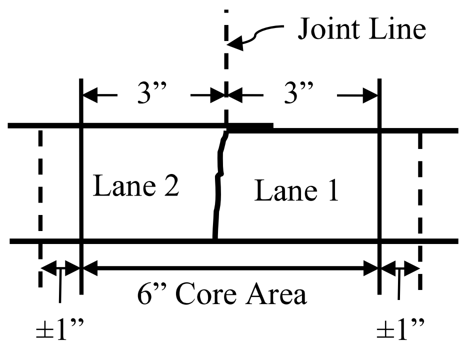



Figure not to scale

**Notched Wedge Joint**

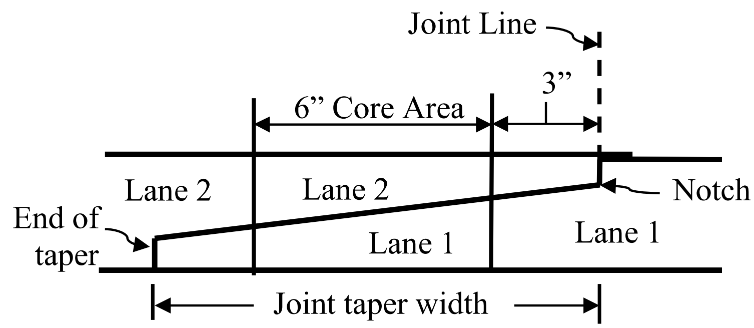



Figure not to scale

5. PROCEDURE

5.1 In the presence of the Department Representative, core and identify the density acceptance samples as specified in Pub. 408, Section 409.

5.1.1 With the powered core drill, drill core samples to the specified diameter and to a depth sufficiently below the depth of the pavement course to be sampled. Ensure sufficient water is dispersed through the core drill during drilling to keep the drill bit and core sample cool enough to prevent damage to the bit and sample. Carefully and slowly lower the drill bit to the surface of the pavement course at the start of drilling to prevent the drill bit from moving and to obtain a smooth clean initial drill cut at the surface of the core sample. After drilling to a sufficient depth, carefully raise the core drill bit to prevent any damage to the core sample.

5.1.2 Carefully dislodge or break the core sample away from the underlying pavement layer. Do not distort, bend, crack, damage or physically change the physical condition of the core sample during this operation.

5.1.3 Using a hand-held core sample extraction tool, carefully grasp and remove the core sample from the pavement. Do not distort, bend, crack, damage or physically change the physical condition of the core sample during removal from the pavement.

5.1.4 Immediately after removing the core sample from the pavement, wash off the core sample with water to remove the fine material generated from the drilling operation. Air dry or towel dry the core sample sufficiently to allow identification of the Lot and Sublot number on each core sample by using a marking pencil or lumber crayon.

5.1.5 If a core sample includes materials other than the material or pavement course to be tested, clearly show and mark with a marking pencil or lumber crayon the section(s) of each core sample to be discarded. Core samples suspected of including more than one material and not clearly showing the section to test, and the section(s) to discard, will be considered non-conforming samples and will not be tested by the Laboratory Testing Section (LTS) until the section to test is identified.

5.2 Once the core sample has been obtained and identified as outlined in Section 5.1, the Department Representative will take immediate possession of the core sample and store it in a proper environment while awaiting packaging and delivery. Overheating or impact can damage core samples and prevent accurate test results.

5.3 After the Lot is completed or has been terminated, the Department Representative will perform the following:

5.3.1 Complete a Form TR-447 for proper Lot identification. In the event that both 9.5 mm and 12.5 mm materials are incorporated in the same joint cores, use the 12.5mm mix to identify the material class.

5.3.2 Place the appropriate Bar Code Sticker from Form TR-447 on each core sample (Bar Code Sticker Axxxxxx-1 on the core sample for Sublot 1, etc.). For core samples identifying materials other than the material or pavement course to be tested as outlined in Section 5.1.5, place the appropriate Bar Code Sticker from Form TR-447 on the section of each core sample to be tested.

5.3.3 Package the pavement cores in a suitable container.

5.3.3.1 Plastic concrete cylinder molds have proven to be satisfactory and convenient containers for shipping core samples. Core samples placed in plastic concrete cylinder molds shall be cushioned /separated with crumpled newspaper. If other containers are used, such as, 6-inch diameter PVC plastic pipes, they shall not exceed 24 inches in length and shall not weigh more than 50 lbs. when packaged with core samples. Place an unused bar code sticker from Form TR-447 on the outside of all containers.

5.3.3.2 Secure the ends of the core sample containers with masking tape.

5.3.4 Deliver the core samples to a Department pick-up point within three (3) days for shipment to the LTS.

## APPENDIX

**Illustrative Example No. 1 – Adjustment for Edges**

Using the parameters of Illustrative Example No. 2 in the Appendix of PTM No. 746, for a normal Lot of 2,500 tons with five (5) Sublots of 500 tons each, the following sampling plan was developed for density core samples. The Lot length is 22,727 ft. and the Sublot length is 4,545.4 ft. This example is for a 12 ft. lane width placed next to a previously placed lane. Therefore, there is one supported edge at the centerline longitudinal joint and one unsupported edge longitudinally at the shoulder joint.

A typical random plan would be similar to the following:

The testable sampling width would be:
12 ft. - 1 ft. (supported Left edge) - 1 ft. (unsupported Right edge) = 10 ft.

| RANDOM NUMBER | | | LENGTH | WIDTH OF PAVEMENT |
|---|---|---|---|---|
| | X | Y | X | Y |
| #17 | .08 | .70L | .08 x 4545.4 ft. = 364 ft. | .70 (10 ft.) = 7.00 ft. L |
| #18 | .67 | .68L | .67 x 4545.4 ft. = 3045 ft. | .68 (10 ft.) = 6.80 ft. L |
| #19 | .83 | .97R | .83 x 4545.4 ft. = 3773 ft. | .97 (10 ft.) = 9.70 ft. R |
| #20 | .54 | .58R | .54 x 4545.4 ft. = 2455 ft. | .58 (10 ft.) = 5.80 ft. R |
| #21 | .82 | .50R | .82 x 4545.4 ft. = 3727 ft. | .50 (10 ft.) = 5.00 ft. R |

Note: The “X” value equals the station
The “Y” value has been corrected for the non-testable edge conditions

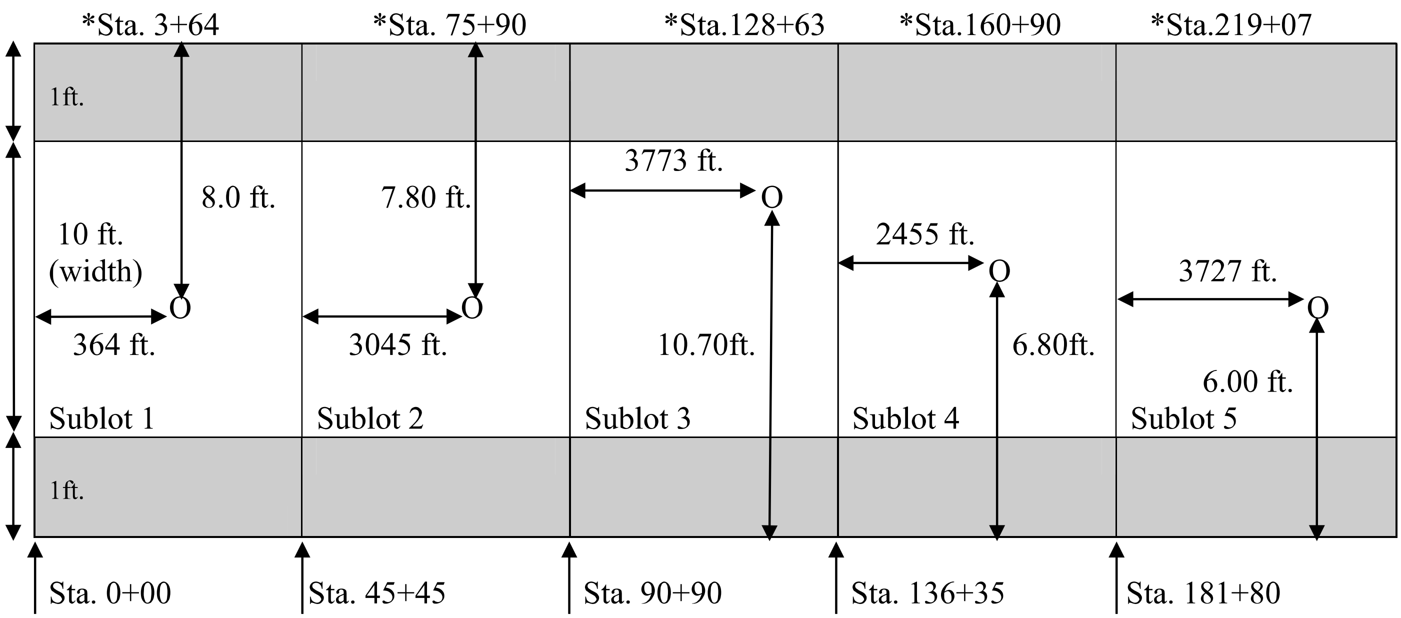
The sampling for the Lot (22,727 ft. in length) would be:

Sta. 3+64 7.00 ft. from lt. edge + 1 ft. for supported edge = 8.00 ft. from lt. edge of lane
Sta. 75+90 6.80 ft. from lt. edge + 1 ft. for supported edge = 7.80 ft. from lt. edge of lane
Sta. 128+63 9.70 ft. from rt. edge + 1 ft. for unsupported edge = 10.70 ft. from rt. edge of lane
Sta. 160+90 5.80 ft. from rt. edge + 1 ft. for unsupported edge = 6.80 ft. from the rt. edge of lane
Sta. 219+07 5.00 ft. from rt. edge + 1 ft. for unsupported edge = 6.00 ft. from the rt. edge of lane

*Note: Refer to Illustrative Example No. 2 in the Appendix of PTM No. 746 for the beginning and ending stations of the Lot and each Sublot. Each density acceptance sample must have a corresponding mixture acceptance sample.

**Illustrative Example No. 1: Adjustment for Edges (continued)**

Centerline Longitudinal Joint (supported edge)

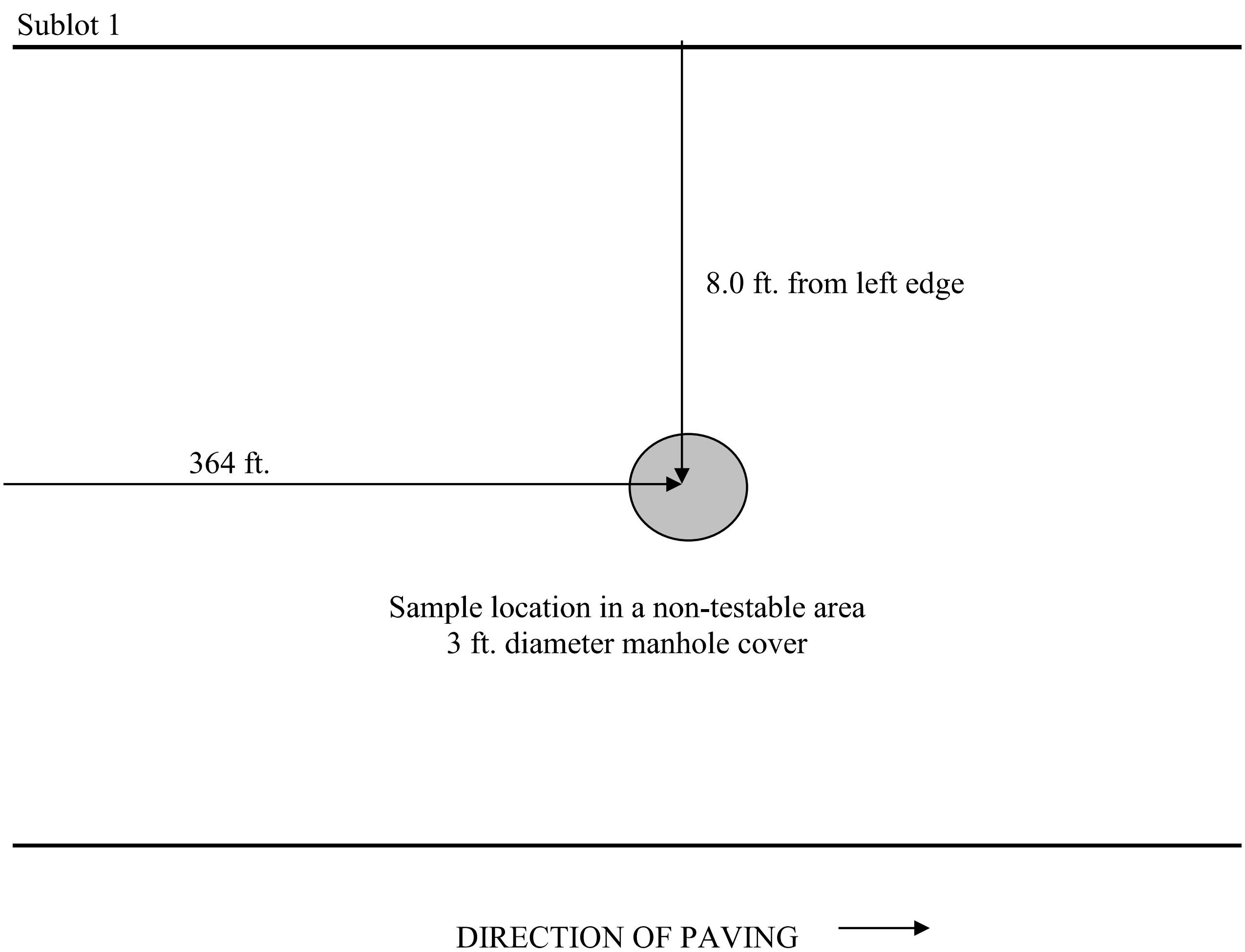



Shoulder Joint (unsupported edge)

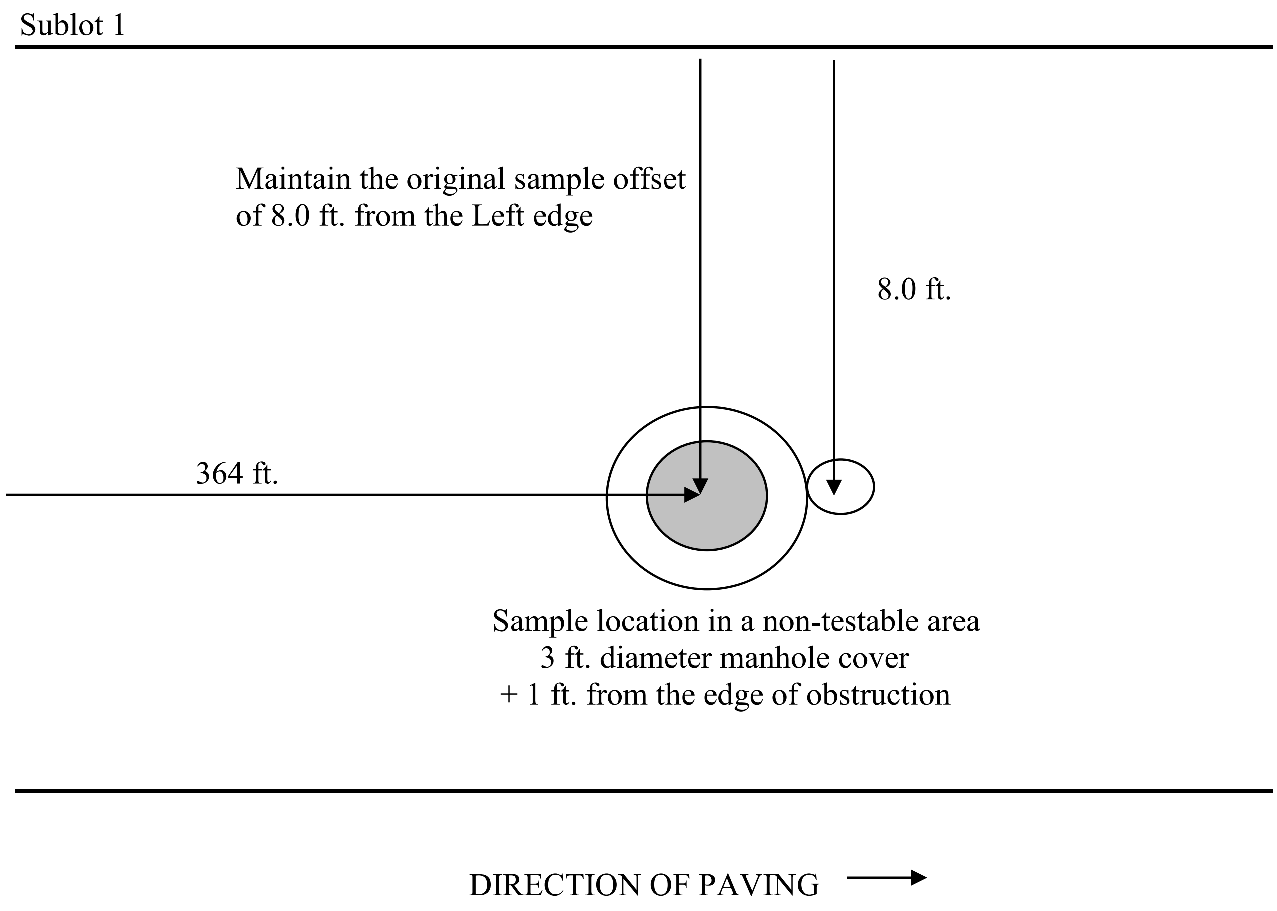
DIRECTION OF PAVING →

Note: Drawing not to scale

**Illustrative Example No. 2: Adjustments for Obstructions**



**Illustrative Example No. 2: Adjustments for Obstructions (continued)**




Note: Maintain the original transverse co-ordinate of the sample. In this illustration the transverse co-ordinate of 8.0 ft. from the Left edge is maintained. The longitudinal co-ordinate is adjusted in the direction of paving to a location just outside the non-testable area (refer to Section 3.3 for the definition of non-testable areas). If the adjusted location also falls into another non-testable area or outside the sublot, move the core back longitudinally to the other side of the obstruction.

**Illustrative Example No. 3: Longitudinal Joint Samples**

A paving project 21,000 feet in length for a two lane roadway consists of four paving lanes on the surface course (left and right shoulders, left and right travel lanes). The density for all four paving mats is being accepted via pavement cores. This results in three eligible longitudinal joints for joint pavement cores.

Example Pavement Project Information

| | | |
|---|---|---|
| Length of Project Paving | 21,000 | linear feet |
| Number of Eligible Joints | 3 | (2 shoulder joints, 1 centerline joint) |
| No. of Lots at 12,500 linear feet | 5 | (21,000 ft. x 3 joints /12,500 ft. per lot) |
| No. of Sublots in each Lot | 5 | (potentially 6 for the final lot) |
| Length of each Sublot | 2,500 | linear ft. (last sublot varies in length) |

## Lot and Sublot Determination

Lots are determined as paving progresses. Select at random a series of five (5) consecutive numbers from PTM No. 1, Table 1 for the first Lot. Multiply the length of each Sublot by the two place decimal value "X" to obtain the sample location within that Sublot.

| RANDOM NUMBER | X | Y | LINEAR FEET BY SUBLOT |
|---|---|---|---|
| #47 | .93 | N/A | .93(2,500 ft.) = 2,325 ft. |
| #48 | .43 | N/A | .43(2,500 ft.) = 1,075 ft. |
| #49 | .99 | N/A | .99(2,500 ft.) = 2,475 ft. |
| #50 | .61 | N/A | .61(2,500 ft.) = 1,525 ft. |
| #51 | .87 | N/A | .87(2,500 ft.) = 2,175 ft. |

The sampling sequence for the Lot (12,500 linear feet) shall be:

| | | |
|---|---|---|
| Sublot 1 | 2,325 = Sta. | 23+25 |
| Sublot 2 | 2,500 + 1,075 = Sta. | 35+75 |
| Sublot 3 | 5,000 + 2,475 = Sta. | 74+75 |
| Sublot 4 | 7,500 + 1,525 = Sta. | 90+25 |
| Sublot 5 | 10,000 + 2,175 = Sta. | 121+75 |

1. Core samples shall be cut at the above stations to obtain the five (5) Sublot samples for calculating the incentive/disincentive value for Lot 1.

2. Repeat the same operation for Lots 2 through 5 using other randomly selected starting points for numbers under Column X.

**Illustrative Example No. 3: Longitudinal Joint Samples (continued)**

3. Calculate the sample for the final anticipated Sublot, use a length of 2,500 linear feet and multiply by the random number. If the resulting sample location falls beyond the actual length of joint, then the Sublot will not be counted and no sample will be taken. If the sample location falls within the actual length of joint, then the sample will be taken and the Sublot will be added to the final Lot.

Based on the sketch on the next page, since the centerline joint was the first joint paved, Lot 1 will come from the centerline joint. Each Lot will follow as paving progresses thereafter, consisting of 12,500 feet per Lot.

**Final Lot Determinations:**

1. The length of the final Lot shall be adjusted to ensure that the final Lot has between three and seven Sublots. In this example the final joint, Lot 5, shall be 13,000 linear feet as shown.

   21,000 LF x 3 joints = 63,000 LF total    63,000 LF – (4 x 12,500 LF) = 13,000 LF

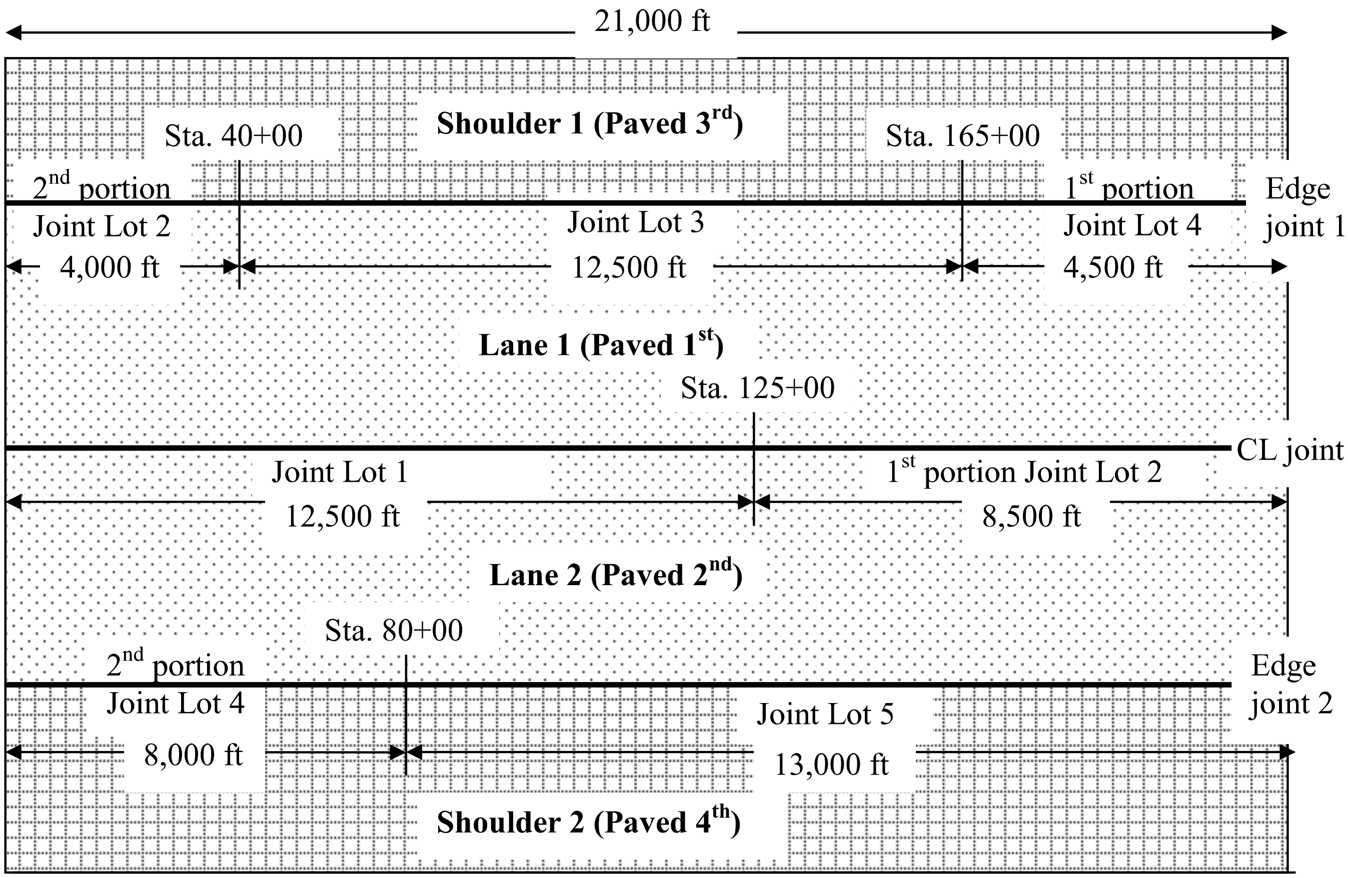
2. Sublots 1 - 5 will be 2,500 LF, leaving 500 LF at the end. 13,000 LF - (5 x 2,500 LF) = 500 LF. Calculate the sample location for the final Sublot based on 2,500 LF.

3. The random number will determine if a sample will be taken in this 500 LF. Two scenarios are shown illustrating the two possibilities.

   3.1 Random No. ("X") = 0.12   2,500 LF x 0.12 = 300 LF, so a sample shall be obtained 300 LF into Sublot 6. The final Lot would have six (6) Sublots.

   3.2 Random No. ("X") = 0.67   2,500 LF x 0.67 = 1,675 LF, so since this is beyond the 500 LF available. No sample shall be obtained and the final Lot would have five (5) Sublots.

**Entire Project Lots:**



**Illustrative Example No. 4: Longitudinal Joint Lot Submittal Calculations for Theoretical Maximum Specific Gravity (Gmm)**

Joint Core 1-1 = comprised of JMF#1 (2.451 daily Gmm) and JMF#1 (2.447 daily Gmm), joint paved on day 1

Joint Core 1-2 = comprised of JMF#1 (2.451 daily Gmm) and JMF#1 (2.447 daily Gmm), joint paved on day 1

Joint Core 1-3 = comprised of JMF#1 (2.451 daily Gmm) and JMF#1 (2.447 daily Gmm), joint paved on day 2

Joint Core 1-4 = comprised of JMF#1 (2.447 daily Gmm) and JMF#1 (2.443 daily Gmm), joint paved on day 3

Joint Core 1-5 = comprised of JMF#1 (2.447 daily Gmm) and JMF#2 (2.483 daily Gmm), joint paved on day 5

Step 1 – Verify JMF combinations for each sublot and any time impacts

- No work stoppages exceeded five (5) days, so no required break in TR-447's due to time
- Sublots 1 through 4 are comprised of the same JMF combination (JMF#1 and JMF#1). Include sublots 1 through 4 on one Form TR-447 (in the remarks, list the other TR-447's that will comprise the remainder of the lot)
- Sublot 5 is comprised of a different JMF combination (JMF#1 and JMF#2). Sublot 5 must be placed on a separate Form TR-447 (in the remarks, list the other TR-447's that comprise the remainder of the lot)

Step 2 – Calculate theoretical maximum specific gravity values for each TR-447

- FIRST FORM TR-447
  Joint core 1-1: (2.451 + 2.447) / 2 = 2.449
  Joint core 1-2: (2.451 + 2.447) / 2 = 2.449
  Joint core 1-3: (2.451 + 2.447) / 2 = 2.449
  Joint core 1-4: (2.447 + 2.443) / 2 = 2.445
  Overall average of the 4 cores = (2.449 + 2.449 + 2.449 + 2.445) / 4 = 2.448
  Use 2.448 as the value for AASHTO T-209 on the first TR-447 form and to calculate the density for each sublots 1 through 4 when calculating Percent within Tolerance.

- SECOND FORM TR-447
  Joint core 1-5: (2.447 + 2.483) / 2 = 2.465

Use 2.465 as the value for AASHTO T-209 on the second TR-447 form and to calculate the density for sublot 5 when calculating Percent within Tolerance.

This Page Left Intentionally Blank

Commonwealth of Pennsylvania
Department of Transportation

PA Test Method No. 737
October 2013
3 Pages

LABORATORY TESTING SECTION

Method of Test for

# MEASURING THE THICKNESS OF BITUMINOUS CONCRETE COURSES

## 1. SCOPE

1.1 This method covers the procedure for determining the thickness of bituminous concrete courses from the cores taken from bituminous concrete roadways.

## 2. APPARATUS

2.1 Ruler - Standard ruler with 1 mm (1/16") graduations

## 3. TEST SPECIMENS

3.1 Cores used as specimens for thickness measurement shall be representative of the pavement from which they are removed. The specimen shall be drilled with the axis normal to the surface of the pavement. The upper and lower surfaces shall be free from all conditions not typical of the surfaces of the pavement. Cores that show abnormal defects or that have been damaged appreciably in the drilling operation shall not be used.

## 4. PROCEDURE

4.1 Place the core horizontally on a smooth flat surface with the end that represents the upper surface facing left.

4.2 Four measurements ninety degrees apart shall be made for each course (layer). Measurements shall be made from the top to bottom of each layer and recorded to the nearest 1 mm (1/16 inch) (Note 1).

NOTE 1-When the bottom of a layer is uneven at least two additional diametrical measurements shall be made.

5. CALCULATION

5.1 The thickness of each course shall be determined from the average of all readings.

6. REPORT

6.1 The thickness of the desired course shall be reported to the nearest 3 mm (1/8 inch).

This page left intentionally blank

Commonwealth of Pennsylvania
Department of Transportation

PA Test Method No. 746
October 2013
11 Pages

LABORATORY TESTING SECTION

Method of Test for

# SAMPLING BITUMINOUS PAVING MIXTURES

## 1. SCOPE

1.1 Loose Mixture Samples (Box Samples) - These methods cover the procedures for sampling mixtures of bituminous materials with mineral aggregate as prepared for use in paving. The samples shall be used for either of two purposes:

1.1.1 To represent an average bituminous mixture for acceptance purposes.

1.1.2 To ascertain the periodic variations in characteristics of the mixture for the purpose of quality control.

## 2. EQUIPMENT

2.1 A flat-bottom, high sided scoop.

2.2 Sample Containers-

2.2.1 For 3/4" (19 mm) and smaller Nominal Maximum Aggregate Size (NMAS) mixtures, use cardboard boxes dimensioned approximately 3 3/4 inches x 4 3/4 inches x 9 1/2 inches.

2.2.2 For 1” (25 mm) and larger NMAS mixtures, use cardboard boxes dimensioned approximately 5 inches x 5 1/2 inches x 9 inches.

2.3 Putty knife for scraping the **INSIDE** of the scoop.

2.4 Incidental materials and equipment.

2.5 Permanent marker

2.6 Masking tape

## 3. SELECTION OF SAMPLES

### 3.1 Sampling on the Roadway

3.1.1 Acceptance of the bituminous mixture from the roadway shall be on the basis of test results from consecutive probability samples for each Lot. One probability sample shall be taken from each Sublot. Samples are to be selected by means of a stratified random sampling plan. Refer to Illustrative Examples No. 1 & No. 2 in the Appendix of this PTM for examples of how to select samples using a stratified random sampling plan. If density acceptance is by pavement cores, mixture acceptance samples must be cross referenced to the corresponding density acceptance samples on Form TR-447.

3.1.2 Bituminous mixture samples shall be taken directly from the un-compacted mixture placed by the paving equipment using a procedure described in Section 5 of this PTM.

3.1.3 Areas within the handwork required at the edge of obstructions to normal paving such as manhole covers, inlets and utility valve covers are considered non-testable areas for obtaining bituminous mixture samples. When a sample location falls within a non-testable area, adjust the location of the sample longitudinally in the direction of paving to a location at the edge of the non-testable area.

### 3.2 Sampling at a Bituminous Producer

3.2.1 Sampling shall be on a random basis in accordance with an approved quality control program.

3.2.2 Plant samples of the mixture shall be taken after the mixture has been discharged in hauling units using the procedure described in Section 6 of this PTM.

3.2.3 An integral part of each quality control program shall require that samples be selected using a random number selection procedure such that all hauling units have an equal chance of being sampled by means of a stratified random sampling plan. Random numbers from PTM No. 1, Table 1, Column “X” shall be used to select the random tons to be sampled. These tons shall be obtained by multiplying the random numbers by the number of tons. The hauling units containing these random tons shall be sampled. Refer to Illustrative Example No. 1 in the Appendix of this PTM for an example of a typical stratified random sampling plan based on tonnage.

3.3 Quality Assurance (QA) Sampling

3.3.1 QA Sampling at a Bituminous Producer- Three (3) samples of bituminous mixture shall normally be obtained from each day's production from hauling units using the procedure stated in Section 6 of this PTM. The producer may obtain a companion sample with each of the three (3) QA samples for quality control purposes. Samples are to be selected by means of a stratified random sampling plan to distribute the sampling over a given period of time using the following procedure:

3.3.1(a) Divide the anticipated time of the plant operation review into three (3) approximately equal time intervals.

3.3.1(b) Select, at random, a series of three (3) consecutive numbers from PTM No. 1, Table 1.

3.3.1(c) Determine the first sampling time by multiplying the first two place decimal value "X" by the number of minutes in the first time interval and add the product to the clock time at the beginning of the review. The load of mixture to be sampled is the first load (hauling unit) that leaves the plant following the computed sampling time.

3.3.1(d) Repeat the operation, using the other two random numbers in the same order they appear in PTM No. 1, Table 1 to determine the sampling times for the two remaining time intervals. In each case, the product of the random number and the number of minutes in the particular interval is added to the clock time at the beginning of the interval to determine the sampling time. Refer to Illustrative Example No. 3 in the Appendix of this PTM for an example of a typical stratified random sampling plan based on time.

3.3.2 QA Sampling on the Roadway- Quality Assurance samples of the bituminous mixture are to be obtained directly from the un-compacted mixture placed by the paving equipment using a procedure described in Section 5 of this PTM.

3.3.2(a) Divide the anticipated period of the paving operation review into three (3) approximately equal time intervals.

3.3.2(b) Select, at random, a series of three (3) consecutive numbers from PTM No. 1, Table 1.

3.3.2(c) Determine the first sampling time by multiplying the first two place decimal value "X" by the number of minutes in the first time interval and add the product to the clock time at the beginning of the review. The load of mixture to be sampled is the first load (hauling unit) placed by the paving equipment following the computed sampling time. Multiply the pavement width by the two place decimal value "Y" to obtain the offset location for the sample.

3.3.2(d) Repeat the operation, using the other two random numbers in the same order they appear in PTM No. 1, Table 1 to determine the sampling times for the two remaining time intervals. In each case, the product of the random number and the number of minutes in the particular interval is added to the clock time at the beginning of the interval to determine the sampling time. Refer to Illustrative Example No.3 in the Appendix of this PTM for an example of a typical stratified random sampling plan based on time.

4. SIZE OF SAMPLES

4.1 The size of the bituminous mixture samples shall be enough material to fill the appropriate sample container selected for the NMAS of the mixture as outlined in Section 2.2.

5. PROCEDURE FOR SAMPLING BEHIND PAVING EQUIPMENT ON THE ROADWAY

5.1 In the presence of the Department Representative, bituminous mixture samples shall be lifted at pre-determined random locations, directly from the un-compacted mixture placed by the paving equipment, with a flat bottom, high-sided scoop. The scoop shall pass completely through the entire depth of the lift of material being sampled. When transferring the mixture into a clean cardboard sample box, any fines sticking to the INSIDE of the scoop shall be scraped and included with the sample.

5.1.1 For 3/4" (19 mm) and larger NMAS mixtures, a sample larger than is required in Section 4.1 may be obtained and placed on a mixing board, thoroughly mixed, formed into a flat pile and carefully quartered to provide a representative sample of the required size. Scrape the INSIDE of the scoop at each transfer point to incorporate any fines sticking to the inside of the scoop.

6. PROCEDURE FOR SAMPLING FROM A HAULING UNIT

6.1 In the presence of the Department Representative, use a flat-bottom, high-sided scoop to obtain a bituminous mixture sample. Starting low on the pile and extending upward, sample the mixture by creating an approximately two (2) foot long and three (3) inches to four (4) inches deep vertical furrow. If the mixture is sampled from at least two places in the truck, place the material removed in this manner on a mixing board, thoroughly mix, form into a flat pile and carefully quarter to provide a representative sample of the required size. Scrape the INSIDE of the scoop at each transfer point to incorporate any fines sticking to the inside of the scoop.

## 7. IDENTIFICATION AND DELIVERY OF SAMPLES

7.1 Identify, using a permanent marker, package and immediately deliver bituminous mixture acceptance samples to the Department Representative as specified in Pub. 408, Section 409.

7.2 Bituminous mixture acceptance samples shall be stored in a proper environment until the Lot is completed or has been terminated.

7.3 After the Lot is completed or has been terminated, the Department Representative shall do the following:

7.3.1 Complete a Form TR-447 for proper Lot identification.

7.3.2 Using a permanent marker, write the TR-447 Sample Reference Number (A######) on the outside of each sample box and place the appropriate Bar Code Sticker from Form TR-447 on the outside of each sample box (Bar Code Sticker A######-1 on the sample box for Sublot # 1, etc.).

7.3.3 Secure all the samples for the Lot together.

7.3.4 Deliver the mixture acceptance samples to a Department pick-up point within three days for shipment to LTS.

## 8. REFERENCES

AASHTO T-168
PTM No. 1

## APPENDIX

**Illustrative Example No. 1: Sampling Based on Tonnage**

Total tonnage of Wearing Course

| | |
|---|---|
| Normal Lot size | 2500 tons |
| Number of Sublots in each Lot | 5 |
| Number of tons per Sublot | 500 tons |
| Number of samples per Sublot | 1 |

Select at random a series of five (5) consecutive numbers from PTM No. 1, Table 1 for the first Lot. Multiply the number of tons in a Sublot by the two place decimal value "X" to obtain the sample location within that Sublot. Multiply the pavement width by the two place decimal value "Y" to obtain the offset location for the sample. A typical stratified random sampling plan shall be similar to the following:

| RANDOM NUMBER | | | NUMBER OF TONS/SUBLOT | WIDTH OF PAVEMENT |
|---|---|---|---|---|
| | X | Y | | |
| #41 | .27 | .52L | .27(500 tons) = 135 tons | .52(12 ft) = 6.24 ft. L |
| #42 | .39 | .91R | .39(500 tons) = 195 tons | .91(12 ft) = 10.92 ft. R |
| #43 | .57 | .10L | .57(500 tons) = 285 tons | .10(12 ft) = 1.20 ft. L |
| #44 | .82 | .12L | .82(500 tons) = 410 tons | .12(12 ft) = 1.44 ft. L |
| #45 | .14 | .94L | .14(500 tons) = 70 tons | .94(12 ft) = 11.28 ft. L |

The sampling sequence for a Lot of 2500 tons shall be as follows:

Sublot 1 = 135 tons; Sublot 2 = 500 + 195 = 695 tons; Sublot 3 = 1000 + 285 = 1285 tons;
Sublot 4 = 1500 + 410 = 1910 tons; Sublot 5 = 2000 + 70 = 2070 tons

Looking at the information above this would mean the following: Hauling units containing the 135$^{th}$ ton would be sampled 6.24 ft. from the left edge of the paved lane; the 695$^{th}$ ton would be sampled 10.92 ft. from the right edge of the paved lane; the 1285$^{th}$ ton would be sampled 1.20 ft. from the left edge of the paved lane; the 1910$^{th}$ ton would be sampled 1.44 ft. from the left edge of the paved lane; the 2070$^{th}$ ton would be sampled 11.28 ft. from the left edge of the paved lane.

Note: When collecting samples from the roadway a Material Transfer Vehicle (MTV) is used in the paving train. Determine the amount of material carried in the paver hopper and the MTV. When the hauling unit carrying the sample tonnage empties into the MTV, allow the amount of material carried by the MTV and hopper to be placed prior to obtaining the sample from the roadway.

**Illustrative Example No. 2: Sampling Based on Square Yards**

Computing Theoretical Yield of Bituminous Pavement (from POM C/4/6)

| Lift Depth (inch) | × | Compacted Conversion Factor (0.75 $ft^3/yd^2 \cdot in$) | = | Cubic Feet Per Square Yard ($ft^3/yd^2$) |
|---|---|---|---|---|
| ½ | | 0.75 | | 0.3750 |
| ¾ | | 0.75 | | 0.5625 |
| 1 | | 0.75 | | 0.7500 |
| 1¼ | | 0.75 | | 0.9375 |
| 1½ | | 0.75 | | 1.1250 |
| 1¾ | | 0.75 | | 1.3125 |
| 2 | | 0.75 | | 1.5000 |
| 2¼ | | 0.75 | | 1.6875 |
| 2½ | | 0.75 | | 1.8750 |
| 2¾ | | 0.75 | | 2.0625 |
| 3 | | 0.75 | | 2.2500 |

Example:

Starting Station of Paving = 0 +00
Pavement Design depth = 1½ inches
Paving Width = 12ft.
Mix Design Laboratory (MDL) Specific Gravity ($N_{des}$ Density $G_{mb}$ from Mix Design) = 2.352

| | |
|---|---|
| Normal Lot size | 2500 tons |
| Number of Sublots in each Lot | 5 |
| Number of tons per Sublot | 500 tons |
| Number of samples per Sublot | 1 |

1. Calculate the theoretical yield to determine the weight of a square yard of pavement at the given depth:

   (*Cubic Feet Per Square Yard $ft^3/yd^2$) x (MDL Specific Gravity) x (62.4 $lbs/ft^3$) = $lbs/yd^2$

   (1.1250 $ft^3/yd^2$) x (2.352) x (62.4 $lbs./ft^3$) = 165 $lbs./yd^2$

*From the chart above for the compacted lift depth being placed (1½ inches for this example)

**Illustrative Example No. 2: Sampling Based on Square Yards (continued)**

2. Find the length of the Lot in feet:

   (2,500 tons) x (2,000 lbs./ton) ÷ (165 lbs./$yd^2$) = 30,303 $yd^2$

   (30,303 $yd^2$) x (9 $ft^2$ /$yd^2$) ÷ (12 ft. lane width) = 22,727 ft./Lot

   22,727 ft./Lot ÷ 5 Sublots/Lot = 4545.4 ft./Sublot

3. Determine sample locations:

Select at random a series of five (5) consecutive numbers from PTM No.1, Table 1 for the first Lot. Multiply the length of each Sublot by the two place decimal value "X" to obtain the sample locations within each Sublot. Multiply the pavement width by the two place decimal value "Y" to obtain the offset location for the sample. A typical stratified random sampling plan shall be similar to the following:

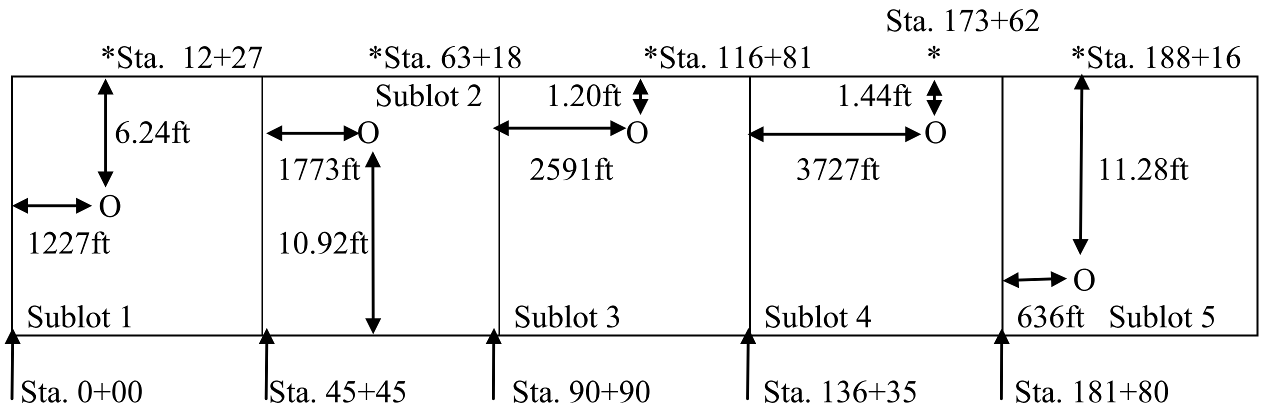
| RANDOM NUMBER | | | LENGTH | WIDTH OF PAVEMENT |
|---|---|---|---|---|
| | X | Y | X | Y |
| #41 | .27 | .52L | .27 x 4,545.4 ft. = 1227 ft. | .52 x (12 ft.) = 6.24 ft. L |
| #42 | .39 | .91R | .39 x 4,545.4 ft. = 1773 ft. | .91 x (12 ft.) = 10.92 ft. R |
| #43 | .57 | .10L | .57 x 4,545.4 ft. = 2591 ft. | .10 x (12 ft.) = 1.20 ft. L |
| #44 | .82 | .12L | .82 x 4,545.4 ft. = 3727 ft. | .12 x (12 ft.) = 1.44 ft. L |
| #45 | .14 | .94L | .14 x 4,545.4 ft. = 636 ft. | .94 x (12 ft) = 11.28 ft. L |

Note: The "X" value equals station along the pavement centerline.
The "Y" value equals the distance from the left or right edge of the paving lane.

**Illustrative Example No. 2: Sampling Based on Square Yards (continued)**

In summary the sampling for the Lot (22,727 ft.) shall be:

| | Stations | X | Sample Location | Offset |
|---|---|---|---|---|
| Sublot 1 | 0+00 to 45+45 | 1227 ft. | 12+27 | 6.24 ft. from L edge |
| Sublot 2 | 45+45 to 90+90 | 1773 ft. | 63+18 | 10.92 ft. from R edge |
| Sublot 3 | 90+90 to 136+35 | 2591 ft. | 116+81 | 1.20 ft. from L edge |
| Sublot 4 | 136+35 to 181+80 | 3727 ft. | 173+62 | 1.44 ft. from L edge |
| Sublot 5 | 181+80 to 227+27 | 636 ft. | 188+16 | 11.28 ft. from L edge |




DIRECTION OF PAVING →

**Illustrative Example No. 3: Quality Assurance Samples Based on Time**

Assume the plant or project will be paving continuously throughout the day. Estimate the time needed for the plant/operation review. Divide this time into three (3) equal time intervals. For this example assume three (3) hours.

Each time interval will be one hour duration.

Select at random a series of three (3) consecutive numbers from PTM No. 1, Table 1. A typical stratified random sampling plan shall be similar to the following:

| RANDOM NUMBER | | | TIME | WIDTH OF PAVEMENT |
|---|---|---|---|---|
| | X | Y | X | Y |
| #41 | .27 | .52L | .27 x 60 min. = 16 min. | .52 x (12 ft.) = 6.24 ft. L |
| #42 | .39 | .91R | .39 x 60 min. = 23 min. | .91 x (12 ft.) = 10.92 ft. R |
| #43 | .57 | .10L | .57 x 60 min. = 34 min. | .10 x (12 ft.) = 1.20 ft. L |

The sampling times are indicated below:

| 8:00 am – 9:00 am | 9:00 am – 10:00 am | 10:00 am – 11:00 am |
|---|---|---|
| x | x | x |
| 8:16 am | 9:23 am | 10:34 am |

For plant samples ignore the "Y" value. For roadway samples, determine the sample location on the mat using the "Y" value as indicated in the previous examples.

When it is not possible to obtain scheduled samples because of breakdown, weather, schedule, or other causes, it is still necessary to obtain a total of three samples wherever possible. Adjust the remaining intervals according to the situation and apply the originally selected random numbers as discussed above.

This Page Left Intentionally Blank

Commonwealth of Pennsylvania
Department of Transportation

PA Test Method No. 747
October 2013
4 Pages

LABORATORY TESTING SECTION

Method of Test for

# DETERMINATION OF DISTRIBUTOR APPLICATION RATE IN THE FIELD

## 1. SCOPE

1.1 This test method covers the procedure for determining the application rate in liters per square meter (gallons per square yard) of an approved pressure distributor (Note 1).

NOTE 1- Prior to the test, the pressure distributor shall be calibrated and any necessary adjustments made to give the desired rate of application. The height of the spray bar above the pavement surface shall be adjusted to assure uniformity of spread of the bituminous material without causing any streaking.

## 2. EQUIPMENT

2.1 Carpenter's level- 1.2 m (48 inches) long

2.2 Manufacturer's certificate of calibration for the tank (Note 2)

2.3 A dipstick for the tank

NOTE 2- Most dipsticks furnished by manufacturers are calibrated in 95 to 189 liters (25 to 50 gallon) increments, depending upon tank size, however, it is necessary to check the contents of the tank more closely. Therefore, a calibration curve shall be prepared from the measurements on the dipstick so that the tank contents can be measured to the nearest 20 or 40 liters (five or ten gallons).

## 3. SIGNIFICANCE

3.1 It is essential that the tank be level at the time of gauging.

3.2 The field application rate of the bituminous material at higher temperatures shall be determined by correcting for temperature using a Bulletin 25 conversion chart (Design Application Rate).

## 4. PROCEDURE

4.1 Place a level on top of the tank. Raise or lower the front wheels of the truck until the tank is level (Note 3). The tank shall be level both lengthwise and width wise.

NOTE 3- The truck may be leveled by driving the front wheels into a gutter or up a slight incline.

4.2 Using a dipstick, measure the level of bituminous material in the tank. Calculate the contents of the tank in liters (gallons) ($Q_1$) from the calibration table (Section 2.2). Interpolate the quantities, if necessary (Note 4).

NOTE 4- For maximum accuracy in gauging, the tank should either be nearly full or nearly empty.

4.3 Select a test strip of a suitable length according to Table l and apply the bituminous material at the temperature corrected application rate.

TABLE l. LENGTH OF THE TEST STRIP

| Application Rate $L/m^2$(gal/sq yd) | Length of the Test Strip, m(ft.) |
|---|---|
| Less than or equal to 0.45 (0.1) | 300 (1000) |
| More than 0.45 (0.1) | 150 (500) |

4.4 Level the tank again and determine the level of bituminous material in the tank using the dipstick. Calculate the remaining contents of the tank in liters (gallons) ($Q_2$) from the calibration table. Interpolate the quantities, if necessary.

## 5. CALCULATIONS

5.1 Calculate the application rate (G) in $L/m^2$ ($gal/yd^2$) as follows:

$$G = \frac{Q_1 - Q_2}{LW}$$

METRIC EQUATION

Where:

$G$ = application rate in liters/$m^2$

$Q_1$ = quantity of bituminous material in liters in the tank before application

$Q_2$ = quantity of bituminous material in liters in the tank after application

$L$ = length of the test strip in meters

$W$ = width of the test strip in meters

$$G = \frac{9\,(Q_1 - Q_2)}{LW}$$

ENGLISH EQUATION

Where:

$G$ = application rate in gallons/sq yd.

$Q_1$ = quantity of bituminous material in gallons in the tank before application

$Q_2$ = quantity of bituminous material in gallons in the tank after application

$L$ = length of the test strip in feet

$W$ = width of the test strip in feet

This page left intentionally blank

Commonwealth of Pennsylvania
Department of Transportation

PA Test Method No. 751
October 2013
10 Pages

LABORATORY TESTING SECTION

Method of Test for

# MEASURING SURFACE MACROTEXTURE DEPTH USING A VOLUMETRIC TECHNIQUE AND DETERMINING PATTERN SEGREGATION

## 1. SCOPE

1.1 This method of test, which is a modification of ASTM E965, outlines the procedure for determining the average depth of a pavement surface macrotexture by careful application of a known volume of material on the pavement surface and subsequent measurement of the total area covered. This technique is designed to provide an average depth value of only the pavement macrotexture and is considered insensitive to pavement microtexture characteristics. This method of test is also used to determine pattern segregation in bituminous concrete pavements.

NOTE 1- Pavement macrotexture is defined as the deviations of a pavement surface from a true planar surface. Average texture depth is the average depth between the bottom of the pavement surface voids and the tops of the surface aggregate particles. This test method is considered insensitive to distinguishing between (+) and (-) deviations of a pavement surface from a true planar surface.

NOTE 2- The pavement surface to be measured using this test method must be dry and free of any construction residue, surface debris, and loose aggregate particles that would be displaced or removed during normal environmental and traffic conditions.

## 2. APPARATUS AND MATERIAL

2.1 Scale- A standard 300-millimeter (12-inch) scale having 2.0 millimeter (0.1 inch) divisions.

2.2 Sample Container- A cylindrical plastic or metal container with an internal volume of approximately 20,000 cubic millimeters (1.2 cubic inches) used to determine the volume of material to be spread on the pavement surface. An 18 mL polyethylene vial with a friction fit snap closure (Fisher Cat. #03-388-E) is suitable and is the standard container used to develop Table 1 in Section 4.

2.3 Spreader Tool- A #14 solid rubber stopper (Fisher Cat. #14-130V) or an ice hockey puck is suitable.

2.4 Brushes- Any size of paint brush with a soft bristle is suitable for cleaning loose debris and aggregate particles away from the test locations.

NOTE 3- If it is necessary to test locations that are contaminated with dried mud or other tightly adhering foreign material, a stiff wire brush shall be used to thoroughly clean the area prior to testing.

2.5 Material Storage Container- A one (1) liter (1-quart) plastic sample bottle with a lid is suitable for storing, transporting, and maintaining dry testing material. The container shall be kept sealed except for filling sample containers and recharging.

2.6 Material- Either of the following dry, clean materials is suitable.

NOTE 4- Use the same material for testing each area when conducting pattern segregation tests.

2.6.1 Solid glass beads- Tested by ASTM Test Method D1155 (70% roundness). The beads shall be graded such that 100% of the sample passes a 1.18 mm (No. 16) sieve, and no more than 5% of the sample passes the 150 µm (No. 100) sieve.

2.6.2 Standard graded sand- Meeting the requirements of ASTM Specification C778, Table 1.

2.7 Wind Screen- Any suitable method may be used to prevent turbulence from disturbing the material during the test. A 330 millimeter (13-inch) tubeless tire is the minimum sized tire that is suitable to be used as a shield. This tire is to be placed on the pavement surface around the test site when sufficiently windy conditions prevail or turbulence is created by traffic such that the test procedure is disturbed without the shield.

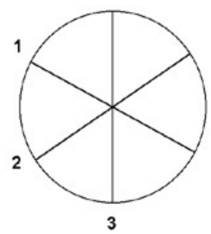
3. PROCEDURE

3.1 Test Surface- Inspect the pavement surface to be measured and select a dry, homogeneous area that contains no unique, localized features such as cracks or joints. Thoroughly clean the pavement surface using a soft bristle brush to remove any residue, debris, or loosely bonded aggregate particles that are on the surface (See NOTES 2 and 3). Position the portable windscreen around the surface test area, if necessary.

3.2 Material Sample Preparation- Fill the sample container with dry material and gently tap the base of the cylinder three times on a rigid surface. Add more material to fill the cylinder to the top, and level the cylinder with a straight-edge.

3.3 Test Measurement- Pour the measured volume of material onto a clean test surface within the area protected by the windscreen. Carefully spread the material in a circular patch with the spreader tool, filling the surface voids flush with the aggregate particle tips. Measure and record the diameter of the circular area covered by the material using the scale. Perform a minimum of three readings on the circular patch. Determine the radius by dividing the average diameter reading by 2. Record the measurements to the nearest 2.5 millimeters (0.1 inch).

Example of circular patch measurements:




NOTE 5- For very smooth pavement surfaces where test patch diameters exceed 203 millimeters (8-inches), it is recommended that the pavement be re-tested using a smaller sample container. (A 12 mL polyethylene vial, Fisher Cat. #03-388C, with an actual volume of 14 000 $mm^3$ is suitable for such cases).

NOTE 6- For coarse open pavements, it may be necessary to use two or more 18 mL polyethylene vials.

3.4 Number of Test Measurements for Determining Surface Macrotexture when Used to Evaluate Surface Frictional Characteristics- The same operator shall perform at least 5 randomly selected measurements, utilizing PTM No. 1, per lane kilometer (mile) of a given test pavement surface type. Measurements shall be determined in either the right or left wheel path for each longitudinal offset calculated.

3.5 Number of Test Measurements for Determining Pattern Segregation- Perform a minimum of three tests in the suspected segregated area. Perform an equal number of tests in an acceptable area using PTM No. 1. Calculate the average radius for each area, suspected and acceptable. Determine the average texture depth for each area in accordance with Section 4. Calculate the difference between the average texture depths of suspected and acceptable areas to determine pattern segregation.

Example:


## 4. CALCULATION

4.1 When using a standard sample container (18 mL Fisher vial), refer to the Table 1 Conversion Table, and convert each radius measurement to an average Texture Depth (T.D). Calculate and record an Average Surface Macrotexture Depth (ASMD) to 0.0254 mm (0.001 in.), and a Standard Deviation (S) for the measurements for each pavement surface type. Use Table 2 for the two 18 mL polyethylene vials. When more than two 18 mL polyethylene vials are used, follow the calculation procedure listed in Section 4.2.

4.1.1 Calculate the ASMD by:

$$ASMD = \frac{\text{Sum of T.D. Measurements}}{\text{Number of Measurements}}$$

4.1.2 Calculate the S by:

$$S = \sqrt{\frac{\sum_{i=1}^{n} (X_i - \overline{X})^2}{n - 1}}$$

Where:

S= Standard deviation

n = Number of measurements

$\overline{X}$ = ASMD

$X_i$= Individual T.D. measurement

$\sum_{i=1}^{n}$ = Sum of the squares of the deviation from ASMD

4.2 When using a container other than the standard sample container, use the following procedure:

4.2.1 Cylinder Volume- Calculate the internal volume of the sample cylinder as follows:

$$V = \frac{\pi d^2 h}{4}$$

Where:

V = Internal cylinder volume, $mm^3$ ($in^3$)

d = Internal cylinder diameter, mm(in.)

h = Cylinder height, mm (in.)

4.2.2 Average Texture Depth - Calculate the average Texture Depth (T.D.) using the following equation:

$$T.D. = \frac{V}{\pi R^2}$$

Where:

T.D. = average texture depth, mm (in.)

V = sample volume, $mm^3$ ($in^3$)(calculated in Section 4.2.1)

R = average radius of the area covered by the material, mm (in.)

Calculate and record an Average Surface Macrotexture Depth (ASMD) to 0.025 mm (0.001 in.) and a Standard Deviation (S) as shown in Sections 4.1.1 and 4.1.2 for each pavement surface type.

## 5. REPORT

5.1 The report for each pavement test surface type shall contain the following items:

5.1.1 Date of Testing

5.1.2 Identify the roadway (Co., SR, Seg.) and pavement surface type (seal coat, etc.)

5.1.3 Record each test location (Seg. offset, L or R wheel path) with an average texture depth (T.D.) determined for each location.

5.1.4 For each pavement surface type report the following: Average Surface Macrotexture Depth (ASMD), Range (R) of measurements, and the Standard Deviation (S).

## 6. REFERENCES

ASTM E965
British Standards - Sand Patch Method

TABLE 1- STANDARD MIXES
AVERAGE TEXTURE DEPTH*
CONVERSION FROM RADIUS

| Radius | | Texture Depth | | Radius | | Texture Depth | |
|---|---|---|---|---|---|---|---|
| mm | (in) | mm | (in) | mm | (in) | mm | (in) |
| 50.8 | 2.0 | 2.47 | 0.097 | 129.5 | 5.1 | 0.380 | 0.015 |
| 53.3 | 2.1 | 2.24 | 0.088 | 132.1 | 5.2 | 0.365 | 0.014 |
| 55.9 | 2.2 | 2.04 | 0.080 | 134.6 | 5.3 | 0.352 | 0.014 |
| 58.4 | 2.3 | 1.87 | 0.073 | 137.2 | 5.4 | 0.338 | 0.013 |
| 61.0 | 2.4 | 1.71 | 0.067 | 139.7 | 5.5 | 0.326 | 0.013 |
| 63.5 | 2.5 | 1.58 | 0.062 | 142.2 | 5.6 | 0.315 | 0.012 |
| 66.0 | 2.6 | 1.46 | 0.057 | 144.8 | 5.7 | 0.304 | 0.012 |
| 68.6 | 2.7 | 1.35 | 0.053 | 147.3 | 5.8 | 0.294 | 0.012 |
| 71.1 | 2.8 | 1.26 | 0.050 | 149.9 | 5.9 | 0.283 | 0.011 |
| 73.7 | 2.9 | 1.17 | 0.046 | 152.4 | 6.0 | 0.274 | 0.011 |
| 76.2 | 3.0 | 1.10 | 0.043 | 154.9 | 6.1 | 0.265 | 0.010 |
| 78.7 | 3.1 | 1.03 | 0.040 | 157.5 | 6.2 | 0.257 | 0.010 |
| 81.3 | 3.2 | 0.964 | 0.038 | 160.0 | 6.3 | 0.249 | 0.010 |
| 83.8 | 3.3 | 0.907 | 0.036 | 162.6 | 6.4 | 0.241 | 0.009 |
| 86.4 | 3.4 | 0.853 | 0.034 | 165.1 | 6.5 | 0.234 | 0.009 |
| 88.9 | 3.5 | 0.806 | 0.032 | 167.6 | 6.6 | 0.227 | 0.009 |
| 91.4 | 3.6 | 0.762 | 0.030 | 170.2 | 6.7 | 0.220 | 0.009 |
| 94.0 | 3.7 | 0.721 | 0.028 | 172.7 | 6.8 | 0.214 | 0.008 |
| 96.5 | 3.8 | 0.684 | 0.027 | 175.3 | 6.9 | 0.207 | 0.008 |
| 99.1 | 3.9 | 0.649 | 0.026 | 177.8 | 7.0 | 0.201 | 0.008 |
| 101.6 | 4.0 | 0.617 | 0.024 | 180.3 | 7.1 | 0.196 | 0.008 |
| 104.1 | 4.1 | 0.588 | 0.023 | 182.9 | 7.2 | 0.190 | 0.007 |
| 106.7 | 4.2 | 0.559 | 0.022 | 185.4 | 7.3 | 0.185 | 0.007 |
| 109.2 | 4.3 | 0.534 | 0.021 | 188.0 | 7.4 | 0.180 | 0.007 |
| 111.8 | 4.4 | 0.510 | 0.020 | 190.5 | 7.5 | 0.176 | 0.007 |
| 114.3 | 4.5 | 0.488 | 0.019 | 193.0 | 7.6 | 0.171 | 0.007 |
| 116.8 | 4.6 | 0.467 | 0.018 | 195.6 | 7.7 | 0.166 | 0.007 |
| 119.4 | 4.7 | 0.447 | 0.018 | 198.1 | 7.8 | 0.162 | 0.006 |
| 121.9 | 4.8 | 0.429 | 0.017 | 200.7 | 7.9 | 0.158 | 0.006 |
| 124.5 | 4.9 | 0.411 | 0.016 | 203.2 | 8.0 | 0.154 | 0.006 |
| 127.0 | 5.0 | 0.395 | 0.016 | | | | |

* Valid only when using ONE standard container as specified in Section 2.2 (18 ml vial, Fisher Cat. # 03-388-E, with an actual volume of 20,000 $mm^3$) or an equivalent container with a measured volume of 20,000 $mm^3$ (1.2204 $in^3$).

**TABLE 2 - COARSE MIXES**
AVERAGE TEXTURE DEPTH*
CONVERSION FROM RADIUS

| Radius mm | Radius (in) | Texture Depth mm | Texture Depth (in) | Radius mm | Radius (in) | Texture Depth mm | Texture Depth (in) |
|---|---|---|---|---|---|---|---|
| 50.8 | 2.0 | 4.94 | 0.194 | 129.5 | 5.1 | 0.760 | 0.030 |
| 53.3 | 2.1 | 4.48 | 0.176 | 132.1 | 5.2 | 0.730 | 0.029 |
| 55.9 | 2.2 | 4.08 | 0.161 | 134.6 | 5.3 | 0.703 | 0.028 |
| 58.4 | 2.3 | 3.74 | 0.147 | 137.2 | 5.4 | 0.677 | 0.027 |
| 61.0 | 2.4 | 3.42 | 0.135 | 139.7 | 5.5 | 0.653 | 0.026 |
| 63.5 | 2.5 | 3.16 | 0.124 | 142.2 | 5.6 | 0.630 | 0.025 |
| 66.0 | 2.6 | 2.92 | 0.115 | 144.8 | 5.7 | 0.608 | 0.024 |
| 68.6 | 2.7 | 2.71 | 0.107 | 147.3 | 5.8 | 0.587 | 0.023 |
| 71.1 | 2.8 | 2.52 | 0.099 | 149.9 | 5.9 | 0.567 | 0.022 |
| 73.7 | 2.9 | 2.35 | 0.092 | 152.4 | 6.0 | 0.548 | 0.022 |
| 76.2 | 3.0 | 2.19 | 0.086 | 154.9 | 6.1 | 0.531 | 0.021 |
| 78.7 | 3.1 | 2.06 | 0.081 | 157.5 | 6.2 | 0.514 | 0.020 |
| 81.3 | 3.2 | 1.927 | 0.076 | 160.0 | 6.3 | 0.498 | 0.020 |
| 83.8 | 3.3 | 1.814 | 0.071 | 162.6 | 6.4 | 0.482 | 0.019 |
| 86.4 | 3.4 | 1.706 | 0.067 | 165.1 | 6.5 | 0.467 | 0.018 |
| 88.9 | 3.5 | 1.612 | 0.063 | 167.6 | 6.6 | 0.454 | 0.018 |
| 91.4 | 3.6 | 1.525 | 0.060 | 170.2 | 6.7 | 0.440 | 0.017 |
| 94.0 | 3.7 | 1.442 | 0.057 | 172.7 | 6.8 | 0.427 | 0.017 |
| 96.5 | 3.8 | 1.368 | 0.054 | 175.3 | 6.9 | 0.415 | 0.016 |
| 99.1 | 3.9 | 1.297 | 0.051 | 177.8 | 7.0 | 0.403 | 0.016 |
| 101.6 | 4.0 | 1.234 | 0.049 | 180.3 | 7.1 | 0.392 | 0.015 |
| 104.1 | 4.1 | 1.176 | 0.046 | 182.9 | 7.2 | 0.381 | 0.015 |
| 106.7 | 4.2 | 1.119 | 0.044 | 185.4 | 7.3 | 0.371 | 0.015 |
| 109.2 | 4.3 | 1.068 | 0.042 | 188.0 | 7.4 | 0.360 | 0.014 |
| 111.8 | 4.4 | 1.019 | 0.040 | 190.5 | 7.5 | 0.351 | 0.014 |
| 114.3 | 4.5 | 0.975 | 0.038 | 193.0 | 7.6 | 0.342 | 0.013 |
| 116.8 | 4.6 | 0.934 | 0.037 | 195.6 | 7.7 | 0.333 | 0.013 |
| 119.4 | 4.7 | 0.894 | 0.035 | 198.1 | 7.8 | 0.325 | 0.013 |
| 121.9 | 4.8 | 0.857 | 0.034 | 200.7 | 7.9 | 0.316 | 0.012 |
| 124.5 | 4.9 | 0.822 | 0.032 | 203.2 | 8.0 | 0.309 | 0.012 |
| 127.0 | 5.0 | 0.790 | 0.031 | | | | |

* Valid only when using TWO standard containers as specified in Section 2.2 (Two 18 mL vials Fisher Cat. #03-388-E with an actual total volume of 40 000 $mm^3$) or an equivalent container with a measured volume of 40 000 $mm^3$ (2.4408 $in^3$).

**TABLE 3 - VERY SMOOTH MIXES**
AVERAGE TEXTURE DEPTH*
CONVERSION FROM RADIUS

| Radius mm | Radius (in) | Texture Depth mm | Texture Depth (in) | Radius mm | Radius (in) | Texture Depth mm | Texture Depth (in) |
|---|---|---|---|---|---|---|---|
| 50.8 | 2.0 | 1.73 | 0.068 | 129.5 | 5.1 | 0.266 | 0.010 |
| 53.3 | 2.1 | 1.57 | 0.062 | 132.1 | 5.2 | 0.256 | 0.010 |
| 55.9 | 2.2 | 1.43 | 0.056 | 134.6 | 5.3 | 0.246 | 0.010 |
| 58.4 | 2.3 | 1.31 | 0.051 | 137.2 | 5.4 | 0.237 | 0.009 |
| 61.0 | 2.4 | 1.20 | 0.047 | 139.7 | 5.5 | 0.228 | 0.009 |
| 63.5 | 2.5 | 1.11 | 0.044 | 142.2 | 5.6 | 0.220 | 0.009 |
| 66.0 | 2.6 | 1.02 | 0.040 | 144.8 | 5.7 | 0.213 | 0.008 |
| 68.6 | 2.7 | 0.95 | 0.037 | 147.3 | 5.8 | 0.205 | 0.008 |
| 71.1 | 2.8 | 0.88 | 0.035 | 149.9 | 5.9 | 0.198 | 0.008 |
| 73.7 | 2.9 | 0.82 | 0.032 | 152.4 | 6.0 | 0.192 | 0.008 |
| 76.2 | 3.0 | 0.77 | 0.030 | 154.9 | 6.1 | 0.186 | 0.007 |
| 78.7 | 3.1 | 0.72 | 0.028 | 157.5 | 6.2 | 0.180 | 0.007 |
| 81.3 | 3.2 | 0.675 | 0.027 | 160.0 | 6.3 | 0.174 | 0.007 |
| 83.8 | 3.3 | 0.635 | 0.025 | 162.6 | 6.4 | 0.169 | 0.007 |
| 86.4 | 3.4 | 0.597 | 0.024 | 165.1 | 6.5 | 0.164 | 0.006 |
| 88.9 | 3.5 | 0.564 | 0.022 | 167.6 | 6.6 | 0.159 | 0.006 |
| 91.4 | 3.6 | 0.534 | 0.021 | 170.2 | 6.7 | 0.154 | 0.006 |
| 94.0 | 3.7 | 0.505 | 0.020 | 172.7 | 6.8 | 0.149 | 0.006 |
| 96.5 | 3.8 | 0.479 | 0.019 | 175.3 | 6.9 | 0.145 | 0.006 |
| 99.1 | 3.9 | 0.454 | 0.018 | 177.8 | 7.0 | 0.141 | 0.006 |
| 101.6 | 4.0 | 0.432 | 0.017 | 180.3 | 7.1 | 0.137 | 0.005 |
| 104.1 | 4.1 | 0.411 | 0.016 | 182.9 | 7.2 | 0.133 | 0.005 |
| 106.7 | 4.2 | 0.392 | 0.015 | 185.4 | 7.3 | 0.130 | 0.005 |
| 109.2 | 4.3 | 0.374 | 0.015 | 188.0 | 7.4 | 0.126 | 0.005 |
| 111.8 | 4.4 | 0.357 | 0.014 | 190.5 | 7.5 | 0.123 | 0.005 |
| 114.3 | 4.5 | 0.341 | 0.013 | 193.0 | 7.6 | 0.120 | 0.005 |
| 116.8 | 4.6 | 0.327 | 0.013 | 195.6 | 7.7 | 0.117 | 0.005 |
| 119.4 | 4.7 | 0.313 | 0.012 | 198.1 | 7.8 | 0.114 | 0.004 |
| 121.9 | 4.8 | 0.300 | 0.012 | 200.7 | 7.9 | 0.111 | 0.004 |
| 124.5 | 4.9 | 0.288 | 0.011 | 203.2 | 8.0 | 0.108 | 0.004 |
| 127.0 | 5.0 | 0.276 | 0.011 | | | | |

* Valid only when using ONE standard container as specified in Section 3.3 (12 mL vial Fisher Cat. #03-388-C with an actual volume 0f 14 000 $mm^3$) or an equivalent container with a measured volume of 14 000 $mm^3$ (0.8543 $in^3$).

This page left intentionally blank

# FORMULAS

**Purpose:**

1. **To help you with determination of quantities of various parameters during the paving process**
2. **To help you with determination of sampling locations**
3. **To make it easier for doing the required paperwork**

## Unit Conversions

| UNIT | EQUIVALENT TO |
|---|---|
| 1 Yard (yd.) | 3 Feet (ft.) |
| 1 Mile | 1,760 Yards (yd.) or 5,280 feet |
| 1 Square Yard (sq. yd.) | 9 Square feet (sq. ft.) |
| 1 Cubic Yard (cu. yd.) | 27 Cubic feet (cu. ft.) |
| 1 Ton | 2,000 Pounds |
| 1 Gallon | 3.8 Liters |

## Material Quantity and Distance Calculations

| TO GET THIS | DO THIS |
|---|---|
| Area in Square Yards | Multiply Length (ft.) by Width (ft.) and Divide by 9. |
| Pound of material used per sq. yd. for compacted mat thickness of 1 inch @ **100%** Compaction | Multiply the amount of material in pounds per cubic foot by 0.75.<br>157.9 is lbs/cu.ft ( MTD from job mix formula)<br>157.9 X .75 = 118.425 lbs/in/sq.yd |
| **Estimated** yield per sq. yd. per inch of thickness | Multiply answer from above by .94<br><br>.94 X 118.425 = 111.32 lbs./in/sq.yd **estimated yield** |
| **ESTIMATED** Pounds of material for one lineal foot of paving at 12' wide @ **1"** depth | Divide width (ft by 9. And multiply times above<br>12÷9 = 1.33, 1.33 X 111.32 = 148.06 lbs. / lineal ft. |
| **ESTIMATED** Lineal feet of paving per ton of material @ **1"** depth<br>(Yield per ton) | Divide 2,000 by pounds used for one lineal foot of paving.<br>2000÷148.06 =13.51 lineal ft./ton |
| **ESTIMATED** Linear feet @**1**" depth covered for each normal sublot of 500 tons | Multiply 500 by lineal feet per ton. 500 X 13.51 = 6755 lineal feet / sub-lot |
| Truck load in pounds | Multiply truck load in tons (from delivery ticket by 2000) 2000 x 23.5 = 47,000 lbs. |
| **ESTIMATED** Distance covered by one truck load @ **1 "** depth<br>(Yield per truckload) | Divide truck load (in pounds) by amount of material for one lineal foot of paving (in pounds).<br>47,000÷148.06= 317.44 lineal ft/ truckload |
| Total tonnage used (or total tonnage placed) | Total tonnage delivered minus what is left in MTV ,paver, and in clean-out area |
| Total distance that **should be covered** with a given amount of material @ **1"** depth | Multiply total tonnage used (placed) by 2000 and divide by pounds per lineal foot.<br><br>2,100 tons placed X 2000=4,200,000 lbs<br>4,200,000 ÷ 148.06 = 28,366.88 lineal ft @ 12 ft wide |

## Yield Calculations

| TO GET THIS | DO THIS |
|---|---|
| Yield of Tack Coat (gallons per sq. yd.) | Multiply total gallons used by percent of asphalt residue and divide by total square yards. |
| Tack Application Rate (gallons per sq. yd.) | Divide target (desired) residue (gallons per sq. yd.) by percent of asphalt in emulsion. |
| Approximate expected yield (pounds per sq. yd.) for one-inch thick mat. | Multiply Maximum Theoretical Density (MTD) in pounds per cubic foot by 0.75, and then by average percent density readings from the gauge |
| **Actual** Paving Yield (pounds per sq. yd.) AKA ***running yield***—done throughout the day | Multiply placed tonnage by 2000 and divide by the total square yards which have been covered. |
| **Actual** Daily Yield (pounds per sq. yd.) | Multiply total tonnage placed in one day by 2000 and then divided by total square yards covered. |
| 900-ft **actual** yield (pounds per sq. yd.) | Multiply tonnage placed in 900 feet by 20 and divide by width (feet). |
| 1800-ft **actual** yield (pounds per sq. yd.) | Multiply tonnage placed in 1800 feet by 40 and divide by width (feet). |
| 2700-ft **actual** yield (pounds per sq. yd. | Multiply tonnage placed in 2700 feet by 60 and divide by width (feet). |

## Rolling Operation

| TO GET THIS | DO THIS |
|---|---|
| Roller Speed (feet per minute, or FPM) | Multiply speed in MPH X 88<br>3.2 MPH from gauge,X 88 = 281.6 FPM |
| Roller Impacts per foot of paving (IPF) [1], also referred to as Impact Spacing | Divide number of vibrations per minute (VPM) [2] by FPM. |
| Maximum Paver FPM[3] | Multiply tons delivered in one hour by 2000, divide by pounds per lineal foot, and divide by 60. |

(1) Twelve Impacts per foot (IPF) is a typical number, but may range from 10 to 14.
(2) Some rollers are equipped with a gauge indicating VPM.
(3) Attempts should be made not to exceed maximum FPM to avoid having the paving operation run out of material and to allow a continuous operation.

# 2024 Field Technician Certification - Acronyms

01. AASHTO: American Association of State Highway Transportation Officials (www.transportation.org)
02. ACE: Assistant Construction Engineer
03. AET: Asphalt Emulsion Tack **(Publication 408, Section 460)**
04. AI: Asphalt Institute (www.asphaltinstitute.org)
05. ATPBC: Asphalt Treated Permeable Base Course **(Publication 408, Section 360)**
06. ASTM (American Society for Testing and Materials)
07. ESAL: Equivalent Single Axle Load
08. FHWA: Federal Highway Administration (www.fhwa.dot.gov)
09. HMA: Hot Mix Asphalt
10. HOLA: Hands-On Local Acceptance
11. IRI: International Roughness Index **(Publication 408, Section 404)**
12. JMF: Job Mix Formula
13. LTS: (PennDOT) Laboratory Testing Section
14. MTV: Materials Transfer Vehicle **(Publication 408, Section 105.05(c))**
15. MUTCD: Manual on Uniform Traffic Control Devices **(Publication 213)**
16. NAPA: National Asphalt Paving Association (www.asphaltpavement.org)
17. NECEPT: Northeast Center of Excellence for Paving Technology (www.superpave.psu.edu)
18. NMAS: Nominal Maximum Aggregate Size
19. NTT / CNTT: Non-Tracking Tack / Cationic Non-Tracking Tack **(Publication 408, Section 460)**
20. OSHA: Occupational Safety and Health Administration (www.osha.gov)
21. PAPA: Pennsylvania Asphalt Pavement Association (www.pahotmix.org)
22. PG: Performance Grade
23. POM: Project Office Manual
24. PTM: Pennsylvania Test Method **(Publication 19)**
25. PWL: Percent Within Limits
26. PWT: Percent Within Tolerance
27. QC/QA: Quality Control / Quality Assurance
28. RPS: Restricted Performance Specifications **(Publication 408, Section 413)**
29. RAM: Reclaimed Aggregate Material
30. RAP: Reclaimed Asphalt Pavement
31. RAS: Recycled Asphalt Shingles
32. SRL: Skid Resistance Level
33. SMA: Stone Matrix Asphalt (Stone Mastic Asphalt) **(Publication 408, Section 419)**
34. TAC: Time Available for Compaction
35. VFA: Voids Filled with Asphalt
36. VMA: Voids in the Mineral Aggregate
37. WMA: Warm Mix Asphalt

# Field Technician Certification Program

## Practice Problems

1. A core sample of a 19-mm NMAS mix has a bulk density of 139.2 lbs. per cubic foot (pcf), a maximum theoretical density of 150.5 pcf, and 6% asphalt content. What is approximately the density (or percent compaction) of the core?

2. How many pounds (lbs.) are in Equivalent Single Axle Load (ESAL)?

3. While paving a non-expressway, the IRI reading in accordance with PTM No. 428 for the first lot was 42 inches/mile. In accordance with Section 404, what should be the ride quality incentive payment for that lot?

4. The contractor placed 3162 tons of material on the first day. The contractor then placed 2650 tons on the second day. The contractor was delayed for one day but resumed paving on the fourth day and placed another 2952 tons to finish the project. The contractor took a complete combination of loose box samples and core samples from each sublot. Using Table D, the last lot on the fourth day contained how many tons and had how many sublots?

5. The contractor placed 3606 tons of RPS material on the first day. The contractor was delayed for one day but resumed paving on the third day and placed another 2354 tons to finish the project. The contractor got a full combination of loose box samples and core samples. The final lot on the third day contained how many tons and had how many sublots?

6. You are paving the first 12-foot lane on the paving project. Using the following numbers from PTM 1 to determine density acceptance sample locations, what is the location of the 3rd (third) core sample? The sublots are 2400 feet in length.

| Core # | Random Number | |
|---|---|---|
| | X | Y |
| 1 | 0.82 | 0.12 L |
| 2 | 0.14 | 0.94 L |
| 3 | 0.50 | 0.58 R |
| 4 | 0.93 | 0.03 L |
| 5 | 0.43 | 0.92 R |

7. While performing PTM 751 for pattern segregation on a <u>standard</u> mix, you find that the average <u>diameter</u> of the circle covered by the material in the segregated area is 6.0 inches. What would be the average macrotexture depth in inches?

8. A SuperPave project with a single JMF for two SR's at an intersection has a paving quantity of 480 tons. For density cores, what will be the lot and sublot sizes?

# Field Technician Certification Program

## Practice Problems

9. CNTT with a water/asphalt ratio of 33% / 67% (it means 33 percent is water and 67 percent is asphalt) is being applied at a rate of 0.09 gallons per square yard on a milled asphalt surface. Which of the following conditions now apply (See Spec Section 460)?

10. A contractor placed 260 gallons of a cationic emulsion tack coat with a water/asphalt ratio of 33%/67% (that means 33% is water and 67% is asphalt) on 2100 feet of a milled roadway. The width covered by the distributor was 13 feet. What will be the asphalt residue rate, in gallons/sq.yd.? (Hint: first determine the total area, in square yard, using the width and the length.)

11. Cationic non-tacking tack (CNTT) is applied as tack coat with an asphalt/water ratio of 69%/31% (that means 31% is water and 69% is asphalt.) This tack is being applied at a rate of 0.065 gallons per square yard. What amount of uniform asphalt residue is left in place once emulsion sets?

12. The plant plans to provide 300 tons per hour of the required HMA. A 7-hour paving day is scheduled. Average truck capacity is 20 tons. The truck load delivery cycle is 80 minutes (that means it takes 80 minutes for the truck to travel from the plant to the job site and return to the plant.) What is the minimum number of trucks needed to supply the project for continuous paving with no interruption?

13. A paver, traveling at 25 feet per minute, is placing a 2-inch lift of 9.5 mm wearing course. The yield is 110 lbs. /sq. yd. per inch of mat thickness. The mat is placed at a 12-ft wide lane with a 3-foot monolithic shoulder. What is the minimum tons per hour required for non-stop paving?

14. The project calls for placing a 2-inch lift of a Superpave asphalt surface course of 9.5mm mix, using a PG64 –22 binder, 3 to <10 million ESALS. You stick your ruler into the mat immediately behind the paver, prior to rolling, to check the thickness. Approximately, how thick should the uncompacted mat be?

15. A truck arrives at the job site with 18 tons of asphalt. You are placing a 9.5 mm mix at 2.0 (two) inches thick for a 12-foot wide lane. Approximately, how many feet down the road will that truckload of material reach, assuming that the yield is 115 lb. /in. /sq. yd.?

16. A 3,000 VPM (Vibrations per Minute) roller produces 12 impacts per foot (IPF). The roller must be traveling at what speed?

# Field Technician Certification Program

## Practice Problems

ANSWERS

1. 92.5 %
2. 18,000
3. $600
4. 1264 tons with 3 sublots
5. 3460 tons with 7 sublots
6. 1200 feet from the beginning of the sublot and 6.8 feet from the right edge of the lane
7. 0.043
8. One 480-ton lot, with 3 sublots of 160 tons each
9. The residue on the mat is 0.06 gal/sq. yd. and is within specification.
10. 0.057
11. 0.045 gallons/sq. yd.
12. 21
13. 275 tones per hour
14. 2 1/2 inches
15. 117 feet
16. 250 feet per minute