2024 Field Technician Acronyms

01. AASHTO: American Association of State Highway Transportation Officials
    (www.transportation.org)
2. ACE: Assistant Construction Engineer
3. AET: Asphalt Emulsion Tack **(Publication 408, Section 460)**
4. AI: Asphalt Institute (www.asphaltinstitute.org)
5. ATPBC: Asphalt Treated Permeable Base Course **(Publication 408, Section 360)**
6. ASTM (American Society for Testing and Materials)
7. ESAL: Equivalent Single Axle Load
8. FHWA: Federal Highway Administration (www.fhwa.dot.gov)
9. HMA: Hot Mix Asphalt **(Publication 408, Sections 313 and 4013)**
10. IRI: International Roughness Index **(Publication 408, Section 404)**
11. JMF: Job Mix Formula
12. LTS: (PennDOT) Laboratory Testing Section
13. MTV: Materials Transfer Vehicle **(Publication 408, Section 105.05(c))**
14. MUTCD: Manual on Uniform Traffic Control Devices **(Publication 213)**
15. NAPA: National Asphalt Paving Association (www.asphaltpavement.org)
16. NECEPT: Northeast Center of Excellence for Paving Technology (www.superpave.psu.edu)
17. NMAS: Nominal Maximum Aggregate Size
18. NTT / CNTT: Non-Tracking Tack / Cationic Non-Tracking Tack **(Publication 408, Section 460)**
19. OSHA: Occupational Safety and Health Administration (www.osha.gov)
20. PAPA: Pennsylvania Asphalt Pavement Association (www.pahotmix.org)
21. PG: Performance Grade
22. PTM: Pennsylvania Test Method **(Publication 19)**
    (ftp://ftp.dot.state.pa.us/public/pdf/BOCM_MTD_LAB/PUBLICATIONS/PUB_19/PTM_TOC.pdf)
23. PWT: Percent Within Tolerance (**Publication 408, Sections 413 and 413)**
24. QC/QA: Quality Control / Quality Assurance
25. RPS: Restricted Performance Specifications **(Publication 408, Sections 413 and 413)**
26. RAM: Reclaimed Aggregate Material
27. RAP: Reclaimed Asphalt Pavement
28. RAS: Recycled Asphalt Shingles
29. SRL: Skid Resistance Level
30. SMA: Stone Matrix Asphalt (Stone Mastic Asphalt) **(Publication 408, Section 419)**
31. TAC: Time Available for Compaction
32. VMA: Voids in the Mineral Aggregate
33. WMA: Warm Mix Asphalt **(Publication 408, Sections 311 and 411)**

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	1760 Yards (yd.) *or 5280 feet*
1 Square Yard (sq. yd.)	9 Square feet (sq. ft.)
1 Cubic Yard (cu. yd.)	27 Cubic feet (cu. ft.)
1 Ton	2000 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.
Pounds of material for one lineal foot of paving	Multiply width (ft.) by pounds per sq. yd. and divide by 9.
Lineal feet of paving per ton of material (Yield per ton)	Divide 2,000 by pounds used for one lineal foot of paving.
Linear feet covered for each normal sublot of 500 tons	Multiply 500 by lineal feet per ton.
Truck load in pounds	Multiply truck load in tons by 2000.
Distance covered by one truck load (ft.) (Yield per truckload)	Divide truck load (in pounds) by amount of material for one lineal foot of paving (in pounds).
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 (feet)	Multiply total tonnage used (placed) by 2000 and divide by pounds per lineal foot.

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 Gmm)(1) by 46.7(2), and then by average percent density readings from the gauge OR Multiply Maximum Theoretical Density (MTD) by 0.75, and then by average percent density readings from the gauge
Paving Yield (pounds per sq. yd.)	Multiply placed tonnage by 2000 and divide by the total square yards which have been covered.
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 yield (pounds per sq. yd.)	Multiply tonnage placed in 900 feet by 20 and divide by width (feet).
1800-ft yield (pounds per sq. yd.)	Multiply tonnage placed in 1800 feet by 40 and divide by width (feet).
2700-ft yield (pounds per sq. yd.	Multiply tonnage placed in 2700 feet by 60 and divide by width (feet).

(1) Maximum Theoretical Specific Gravity from Job Mix Formula

(2) 46.7 is the result of multiplying 0.75 by 62.24 (density of water at 77°F in pounds per cubic foot)

Rolling Operation

TO GET THIS	DO THIS
Roller Speed (feet per minute, or FPM)	Multiply speed in MPH X 88
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.

Determining Lots & Sublots, and Sampling Locations

Contents:

Determining Lots & Sublots, and Sampling Locations

409.3(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)**

 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.

Determining Lots & Sublots, and Sampling Locations

<u>Problem 1</u> :
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 density 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 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 61.

<u>Problem 2</u> :

A Contractor is placing 18000 yd^2 of Superpave HMA Wearing Course with a PG76-22, 3 to <10 million ESALS, 9.5mm mix, 1 ½” depth, 12 foot lane. Assume yield of 115 lb/ 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?

<u>Problem 3</u> :

A Contractor is placing approximately 6500 tons of Superpave HMA 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 lb/yd^2/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.

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 lb/yd^2/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.**

Acceptance sampling for any RPS or any **Standard** paving project   Pub 408, Sect. 409.3(h) 2.a, and 2.a.2

Rule #1

2500 ton or greater project quantity of ANY jmf-- 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 3994 tons, mathematically

3750 tons ÷500 tons = 7.5 or **8 sampling locations to be computed for loose box and 8 for core**

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)

#2 A project quantity of ANY jmf of > 500 to < 2500 tons-- divide entire quantity by 5 and there will be 5 equal sublots

Table D does not apply

2240÷5= **5 equal sublots of 448 tons----**   PTM 1 **X** value is multiplied by **448**

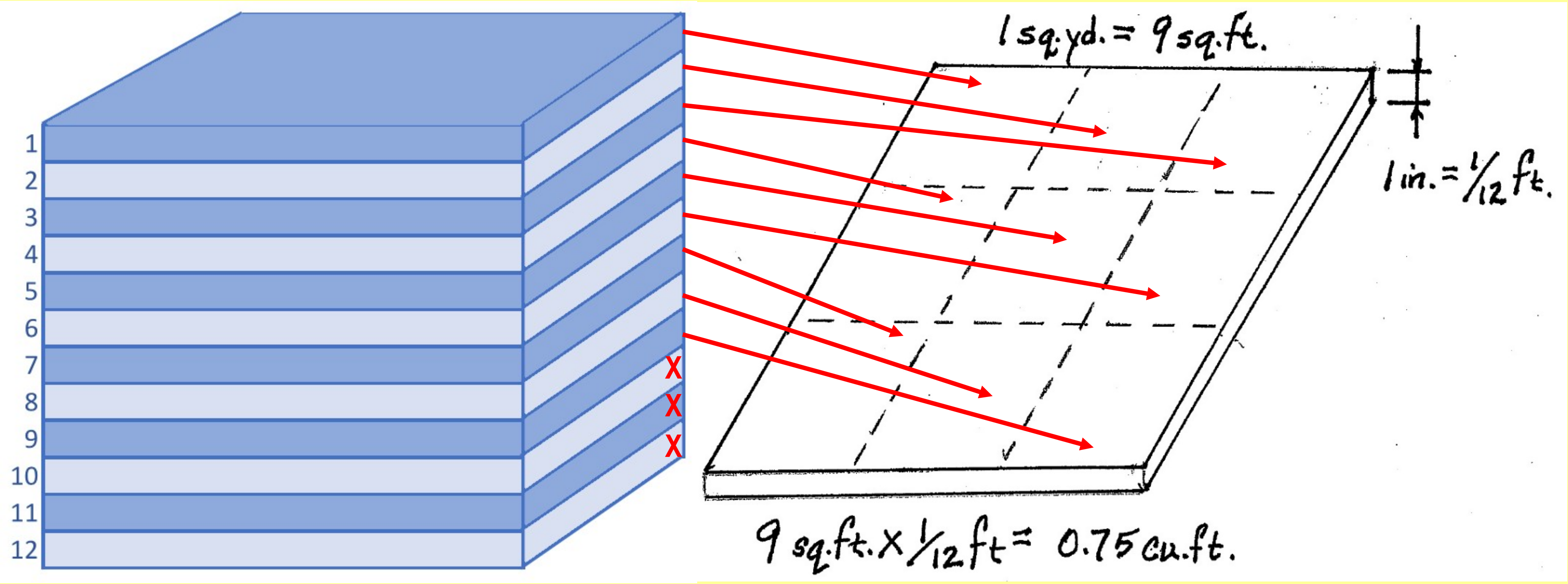
#3 A project quantity of ANY jmf of 500 tons or less-- divide by 3 to determine 3 equal sub-lots for core locations only. Material acceptance for Lots of 500 ton or less is by certification. Cores are an option.

Table D does not apply.

475÷3 = **3 equal sublots of 158.3 tons---**   PTM 1 **X** value is multiplied by **158.3**

Yield Calculations

Converting Density from “lbs./cu.-ft.” to “lbs./sq.-yd./in.”

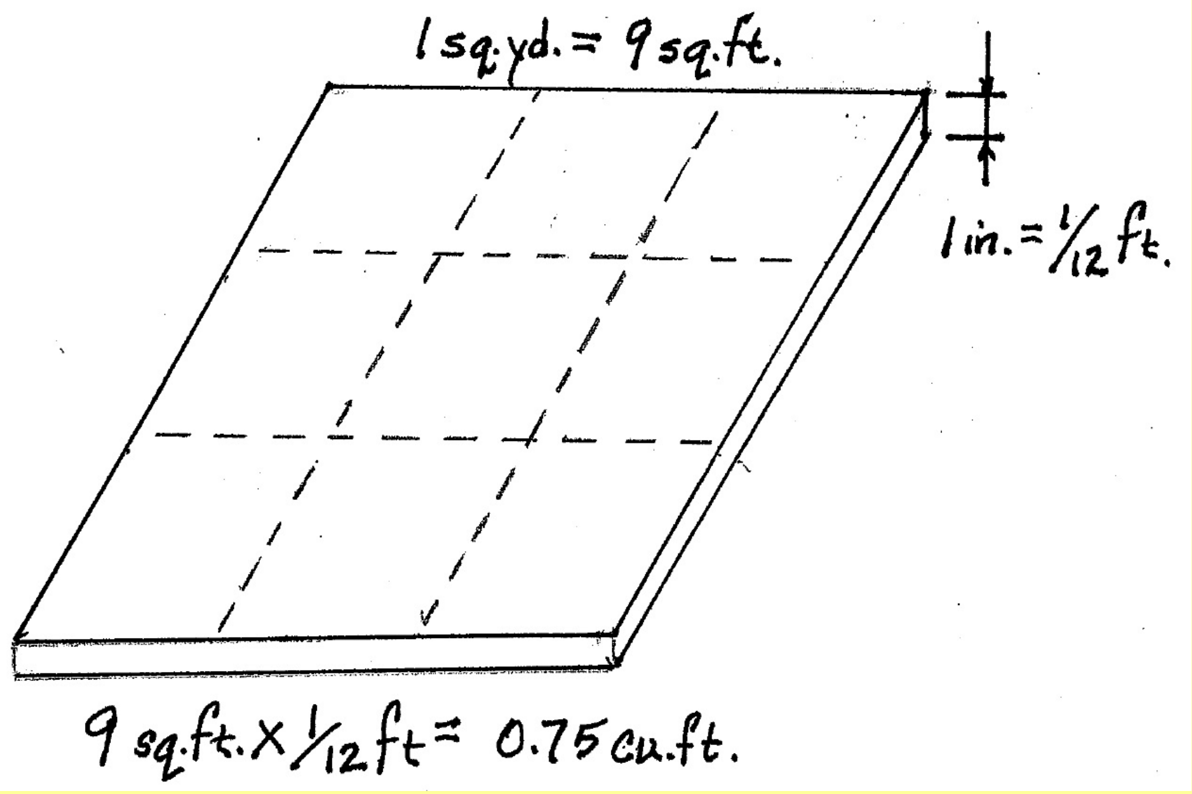


Since we only need 9 of the 12 (9/12=.75 or 75%) one-inch thick “tiles” to fill one square yard,

1 pound/square-yard/inch = 75% of 1 pound/cubic-foot, therefore, multiply lbs./cu.-ft. x 0.75 to get lbs./sq.-yd./in.

Yield Calculations

Theoretical Max Density = 156 lbs/cu.ft (from JMF)



Assume: 94% average density

So, 156 lbs/cu.ft. x 0.75 cu.ft. x 0.94 = 110 lbs/sq. yd./in. (unit of measure)

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 (______) = (_______) ≥ (______)

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)

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

<u>Density Calculations</u> 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

<u>Paver Production Rate at 85 % efficiency (waiting for trucks, etc)</u>

___ 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

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 *minimum required average speed*

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 *minimum required average speed* 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

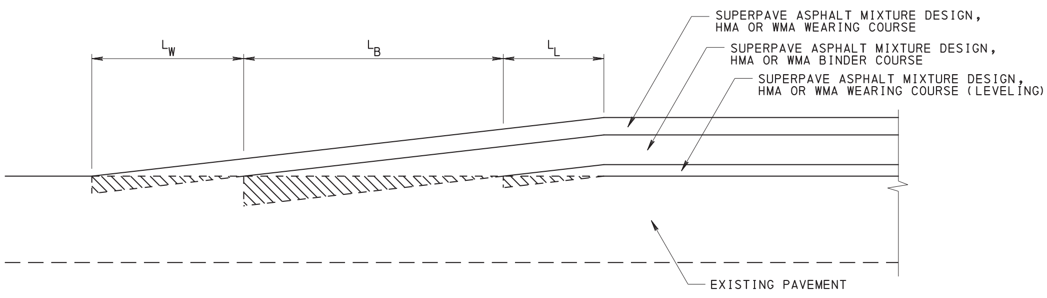
2700 VPM / 12 IPF = ____ FPM　　225 FPM / 88 = _____ (___) MPH

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.



TYPICAL PAVING NOTCH DETAIL

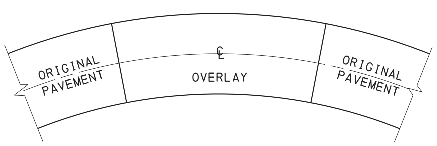
LEGEND

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.

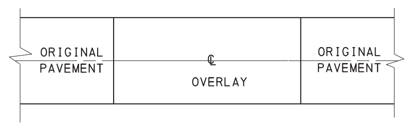
L_B = THE MINIMUM LENGTH OF EXISTING PAVEMENT TO BE MILLED FOR THE BINDER COURSE.

L_L = THE MINIMUM LENGTH OF EXISTING PAVEMENT TO BE MILLED FOR THE LEVELING COURSE.



PLAN VIEW

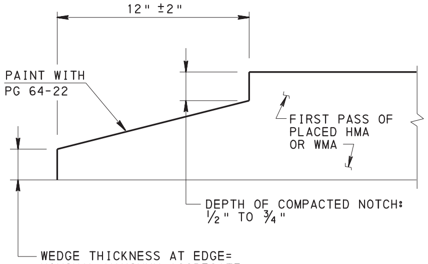
SUPERELEVATION SECTION



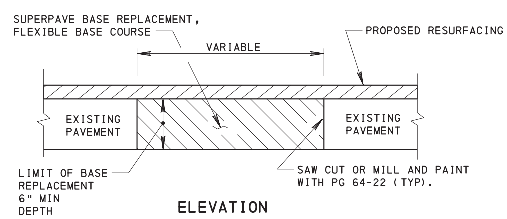
PLAN VIEW

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"

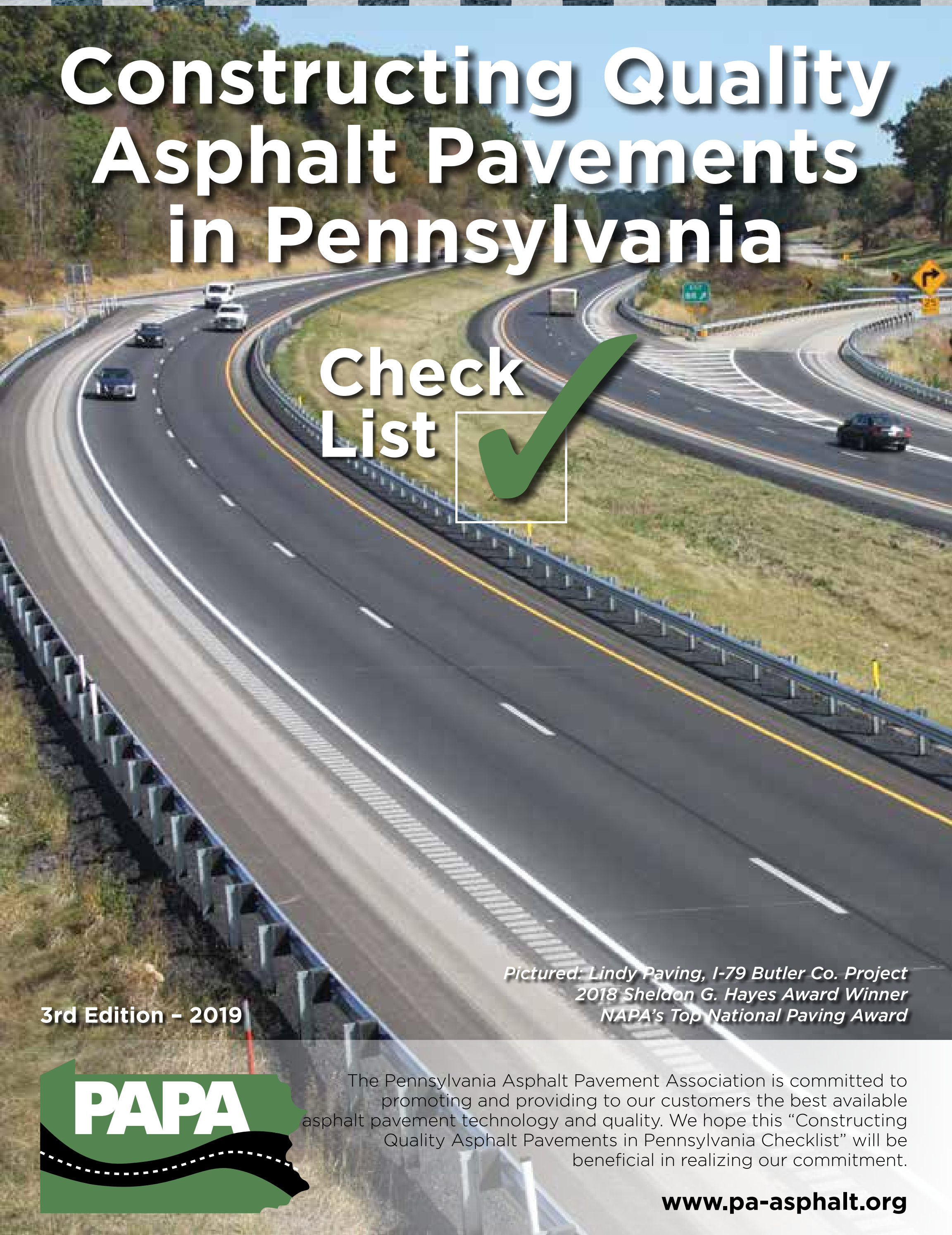
NOTES

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



Constructing Quality Asphalt Pavements in Pennsylvania

Check List

Pictured: Lindy Paving, I-79 Butler Co. Project
2018 Sheldon G. Hayes Award Winner
NAPA's Top National Paving Award

3rd Edition – 2019

PAPA

The Pennsylvania Asphalt Pavement Association is committed to promoting and providing to our customers the best available asphalt pavement technology and quality. We hope this "Constructing Quality Asphalt Pavements in Pennsylvania Checklist" will be beneficial in realizing our commitment.

www.pa-asphalt.org

How Far Does 1-Ton of Mix Go?

Ref. "Caterpillar Paving Calculator"
https://www.cat.com/en_US/articles/solutions/paving/paving-calculator-app.html

(in feet) assuming 110 lb/sy/in or 147 lbs/cft

Mat Width	Compacted Thickness			
	1.0′	1.5′	2.0′	3.0′
8′	20.5′	13.7′	10.3′	6.8′
9′	18.0′	12.1′	9.2′	6.1′
10′	16.5′	11.0′	8.3′	5.5′
11′	14.9′	9.9′	7.4′	5.0′
12′	13.7′	9.1′	6.8′	4.5′
14′	11.7′	7.8′	5.8′	3.9′
16′	10.2′	6.8′	5.1′	3.4′

Q How many tons will it take to pave a 12-foot wide lane for 1-mile (5,280 ft) if the compacted mat thickness is 1.5 inches?

A **5280 ft ÷ 9.1 ft / ton = 581 tons**

Q What will be the yield (lineal feet of paving) for a 22-ton truckload of mix when paving a 12-foot wide lane and the compacted mat thickness is 2-inches?

A **22-tons x 6.8 ft / ton = 150 feet**

Q How many tons of mix will it take to pave a 150-feet by 300-feet parking lot with a 3-inch thick compacted base layer? The area, in square yards, of a rectangle or square is length X width in feet divided by 9 sft/sy.

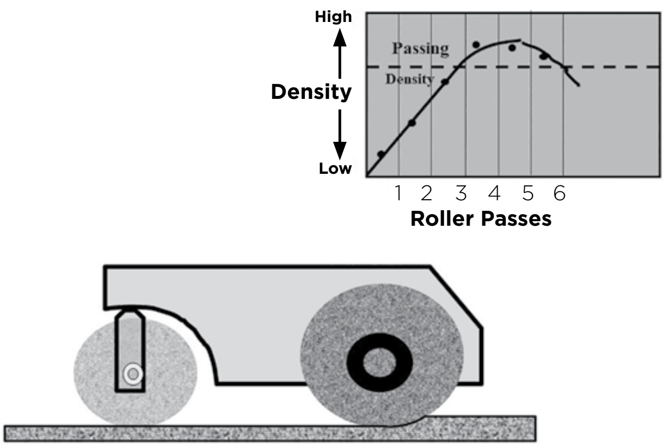
A **300 ft x 150 ft ÷ 9 sf / sy = 45,000 sf ÷ 9 sf / sy = 5,000 sy**
110 lb / sy / in X 3-inches X 5,000 sy = 1,650,000 lbs
1,650,000 lbs ÷ 2,000 lb / ton = 825 tons

Note: A typical compacted asphalt mix will weigh in the range of 108 to 120 pounds per square yard per inch thickness (lbs/sy/in) or 144-160 lbs/cft. This varies with the specific gravity of the aggregate, AC content and in-place density. When making calculations, check the mix design (JMF) for your project to get this specific information.

Actions of the Field Technician

- **Communicate** regularly with the paving foreman and roller operators to achieve the highest quality mat.
- **Have a clear understanding** of the crew's production goals for the day and what resources are available to achieve them.
- **Ensure** the proper JMF is being produced and delivered to the project.
- **Calibrate** the density gauge yearly and standardize it, at a minimum, daily.
- **Establish and monitor** roller pattern to assure desired results are achieved.
- **Monitor** tack coat application rate and uniformity and ensure tack coat has "broken" before paving.
- **Maintain** communication with the plant throughout the day. Monitor volumetrics testing results as they may affect compactive efforts in the field. Inform the plant if noticeable changes in the mix occur.
- **Continually monitor** the mat for density, surface texture, temperature, thickness, width (roll out), appearance, and construction of the joints.
- **Periodically check** the mat behind the finish roller for things such as segregation, flushing, shear cracking and crushed aggregate.
- **Specify** box sample and core locations (PTM1)
- **Observe** cutting cores as soon as practical.
- **Take custody** of acceptance samples.

Develop a Rolling Pattern



Projects with a Ride Specification

(SECTION 404)

- **Understand** the requirements of the spec and the number of construction operations provided to achieve them.
- **Ensure** balanced production and placement operations.
- **Strive** for continuous and consistent paving speed. This would be facilitated by the use of an MTV.
- **When practical,** run the profiler over the roadway before any work is done and profile each course to see the ride improvement that has been achieved.
- **Use** as long a ski on the paver as practical.
- **Mount** sensors as close to the midpoint of the reference as possible and closer to the tow point than the screed.
- **Have a readily available contact** who is familiar with the paver mechanics and grade sensing automation.
- **Make adjustments** to the operation if improvements in ride with each course or operation do not assure that final results will be within specification limits.

Certified Lightweight Profiler

Pre-Construction

- **Review** applicable specifications, special provisions, and drawings
- **Discuss** contractor's QC plan and sequence of operations
- **Review** the Traffic Control Plan
- **Review** acceptance sampling and care/custody of samples
- **Review** surface preparation requirements
- **Discuss** JMFs for the project materials
- **Discuss** mix and paving temperature requirements
- **Review** types and quantities of various equipment on the project
- **Ensure** proper preparation of density gauges (PTMs 402 and 403)
- **Review** applicable PTMs (1, 428, 729, 746, 747, 751)
- **Check** paving and compaction equipment
- **Establish** optimum rolling pattern

Surface Preparation

- **Verify** existing stability (proof roll) of surface/subgrade to be paved
- **Remove** existing "cold patch" material and all unstable material
- **Remove** full depth and patch fatigued cracked areas
- **Seal** cracks ≥ ¼ in. in width
- **Cut or mill** paving notches
- **Ensure** existing surfaces are dry and clean
- **Apply** Tack Coat beyond the width of the mat and in accordance with Section 460 in the range of 0.03 to 0.08 gal/sy of residue given the existing surface type (Table B). Wait for the tack to "break" before paving.

Balance Plant/Trucks/Paver/Rollers

Ref. "Caterpillar Paving Calculator"
https://www.cat.com/en_US/articles/solutions/paving/paving-calculator-app.html

Given: The schedule calls for placing 1600 tons of 9.5mm wearing course in an 8 hour day, and the round-trip time for a truck (hauling 20 tons of mix) is 1.5 hours.

Assume: 80% efficiency for both the paver and vibratory roller and a frequency of 4,000 VPM

Weight of compacted wearing course equals 110 lbs / sy / in

A.) How many trucks are required?

B.) How many lineal feet per minute should the paver travel if it places 1.5 inches of compacted material 12 feet wide (12 sf = 1.33 sy/lin ft)?

C.) How many MPH should the roller travel when making 3 passes and 2 coverages (7 total passes)?

D.) Is the roller able to keep up with the paver?

A.) 8 hrs ÷ 1.5 hrs/trip=5.33 trips (round down). SAY 5 trips / 8 hr shift
5 trips/shift X 20 tons/truck = 100 tons/truck/shift
1600 tons/shift ÷ 100 tons/truck/shift = **16 trucks** needed (round up)

B.) 2000 lbs/ton ÷ (110lbs/sy/in X 1.5 in) = 12.12 sy/ton
12.12 sy/ton X 200 tons/hour = 2424 sy/hour
2424 sy/hour ÷ 1.33 sy/lin ft = 1823 lin ft/hour
1823 lin ft/hour ÷ 60 min/hour = 30 lin ft/min
30 in ft/min ÷ 0.80 = **38 lin ft/min (FPM)**

C.) 1823 lin ft/hour X 7 passes = 12,761 lin ft/hour
12,761 lin ft/hour ÷ 0.80 = 15,951 lin ft/hour
15,951 lin ft/hour ÷ 5280 ft/mile = **3.0 MPH**

D.) 4,000 VPM X 60 min/hour = 240,000 VPH
240,000 VPH ÷ 15,951 lin ft/hour = **15 impacts/ft**
15 impacts/ft > 12 impacts/ft (recommended minimum)

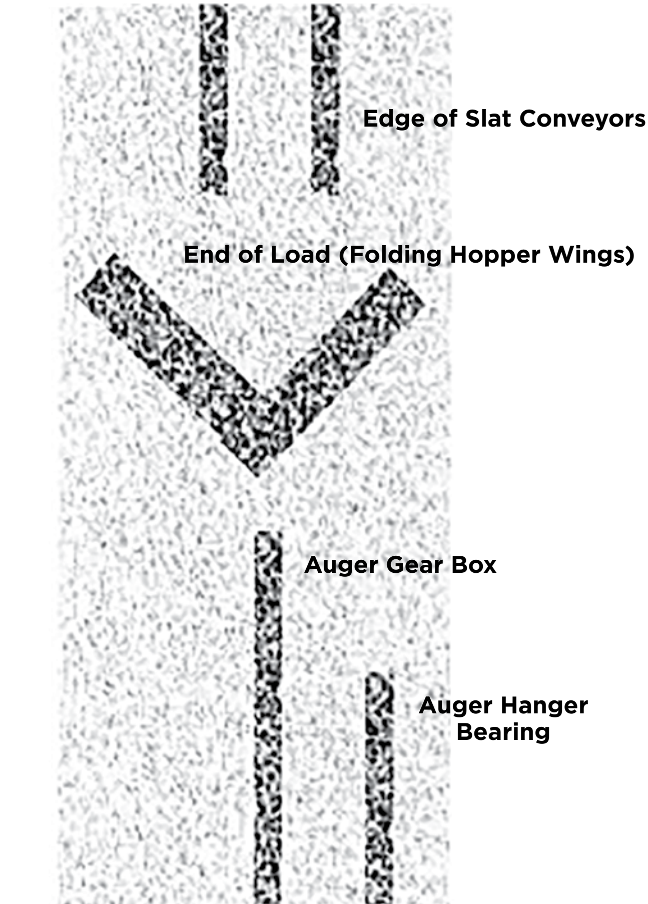
Mix Delivery

- **Use** biodegradable release agent
- **Dump** excess release agent in approved area
- **Load** truck using 3-drop method to reduce segregation
- **Always tarp** the truck body to sufficiently cover the entire load
- **Use** insulated/heated truck body when required
- **"Break"** load against tailgate before opening
- **Paver** engages and pushes the truck while material is dumped into paver hopper

Mix Placement

- **Pre-heat** paver screed
- **Set** shims, null screed and set angle of attack
- **Set** grade and cross-slope of the paver
- **Always activate** screed vibrator
- **Establish** straight line for longitudinal joint
- **Adjust** conveyors/flow gates and feed to maintain a constant head of material at or slightly above auger shaft
- **Always maintain** material in the hopper at least above the bottom of the flow-gates. Never expose the slat conveyors
- **Ensure** mix is in the proper temperature range:
  - ➢ PG 58-28 230 to 310° F
  - ➢ PG 64-22 240 to 320° F
  - ➢ PG 76-22 255 to 330° F
- **Maintain** consistent paver speed, minimize stops and starts. When starting, get paver up to desired speed as quickly as possible
- **Dump** hopper wings frequently into full hopper as the truck pulls away or not at all until the end of the shift
- **Extend** augers at least to within 18 inches of the end gate
- **Overband** finished longitudinal joint with PG 64-22

Possible Segregation Locations



- **Perform** "sand patch" test (PTM 751) to confirm if segregation or flushing exists.

Compaction

- **Good compaction** is the mat characteristic that is most well correlated with pavement longevity!
- **Establish** a roller pattern (number of coverages, density testing, impact spacing) for optimum and uniform density.
- **Ensure** the roller pattern is accomplished to provide uniform mat coverage throughout the project.
- **Balance** the number of and types of compaction equipment with the paver speed to maintain an appropriate rolling zone for good compaction.
- **Use "best practices"** rolling sequence.
- **End each pass** with an arc. Roll off the mat onto a previously placed course to reverse direction if possible.
- **Ensure** roller drums are clean and water systems operational.
- **Establish** a water refill plan.
- **Use rubber tire rollers** on scratch course.
- **Be aware** of the Time Available for Compaction (TAC) given project environmental conditions (see page 11).

Acceptance/Quality Control

- **Maintain** the International Roughness Index (I.R.I.) less than the target value (Section 404)
- **Mat density** needs to be ≥92% and ≤97% of maximum theoretical (Gmm) density. Density needs to be ≥93% and ≤98% of Gmm for SMA mixes.
- **Target** mat density around 94-95% of Gmm at the center of the acceptable range.
- **Maintain** minimum density for base 90%.
- **Do not open** to traffic before mat has cooled to 140°F
- **Obtain** loose box samples and density cores for each sublot in accordance with PTMs 1, 729, and 746.

Pave Cool 3.0 Report

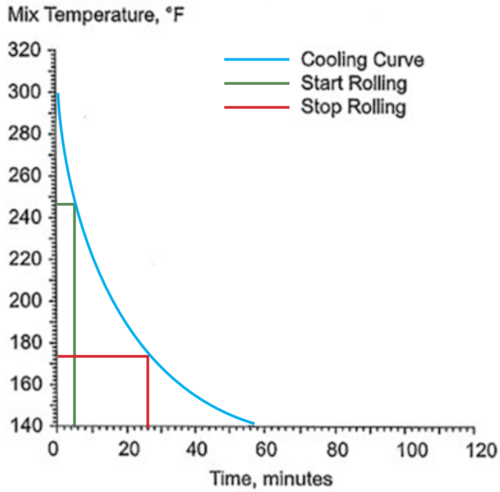
Reference: www.dot.state.mn.us/app/pavecool
www.asphaltpavement.org/multicool

Date & Time	Start Rolling*	Stop Rolling*
4/23/2019 9:39 AM	5 minutes (248 °F)	26 minutes (175 °F)

Mix Type	Binder Grade	Thickness	Delivery Temp.
Fine/Dense	PG 76-22	2.00 in.	300 °F

Air Temp.	Wind Speed	Sky	Latitude
50 °F	5 mph	Humid & Hazy	42 ° North

Existing Surface	Moisture	State	Surface Temp.
Asphalt			50 °F



*Some asphalt mixtures will require compaction times and temperatures different from those recommended by this program. Good judgement must be exercised in order to ensure a properly compacted surface. Special considerations should be made for polymer modified asphalt binders and warm-mix asphalt (WMA). In these cases, manufacturer guidelines should supersede recommendations made by this program. Consult the Help file for further details. In no event will the Minnesota Department of Transportation, the University of Minnesota or their suppliers be liable for damages or expenses arising out of the use of this program.

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- **Applications use 175°F** as the stop rolling temperature in determining the time available for compaction. Rolling a mat that has cooled too much may result in fractured aggregates in some cases.

Determining Lots and Sublots

(SECTION 409.3(h)2: TABLE D)

Rules

- Lots established cumulatively and specifically for each JMF
- Normal lot size = 2500 tons
- Normal sublot size = 500 tons (5 per lot)
- 1 box sample plus 1 core per sublot (PTM No. 1)

1. For total JMF quantity ≤ 500 tons, the tonnage may be considered a lot if density acceptance is by pavement cores; however, mixture acceptance will be by certification. The lot will be divided into 3 EQUAL sublots.
2. For total JMF quantity > 500 tons and < 2500 tons, the tonnage will be considered a lot, and the lot will be divided into 5 EQUAL sublots.
3. For total JMF quantity ≥2500 tons, lot sizes and associated number of sublots will be re-adjusted in accordance with TABLE D Section 409.3(h)2a. only with remaining total JMF quantities beyond the last full 2500 ton lot.

Example: The project calls for 3745 tons of 9.5mm SuperPave wearing course at 1 ½ in thick. You intend to get a combination of mixture acceptance box and density core samples for each sublot. How many total LOTS and SUBLOTS will you have?

Answer: For 3745 tons total JMF

- 1st LOT = 2500 tons = 5 SUBLOTS @ 500 tons each
- 3745 tons – 2500 tons = 1245 tons remaining quantity
- Using TABLE D, if you get a combination box sample and core for each sublot, a new LOT is defined with 3 SUBLOTS.
- 2nd LOT = 1245 tons = 3 SUBLOTS (2 @ 500 tons, 1 @ 245 tons)
- **TOTAL: 2 LOTS and 8 SUBLOTS**

Example: Using Table D, if you did **NOT** get a combination of three box samples and three core samples:

- Two new sublots are defined and included in the previous lot
- **TOTAL: 1 LOT and 7 SUBLOTS**

Using Random Numbers (PTM 1) For Stratified Box Sample Locations (PTM 746)

SECTION 409.3(h)2

Select a random series of consecutive numbers for the first lot (2500 tons) from PTM 1 table. Assume the first number "randomly" selected is #17 and the paving mat width is 12 feet.

	X	Y
#17	0.08	L0.70
#18	0.67	L0.68
#19	0.83	R0.97
#20	0.54	R0.58
#21	0.82	R0.50

Procedure:

- Determine lot size and number of sublots
- Randomly select a set of consecutive numbers from PTM 1 table — one for each sublot
- Values in X and Y columns give coordinates of the sample location
- X is in TONS or FEET. Y is the offset in feet from left or right edge of TESTABLE area

Sublot 1

Random Numbers

	X	Y
#17	0.08	0.70L

0.08 X 500 tons = **40th ton**

0.70L X 12 ft = **8.4 ft from left edge**

Sublot 2

#18	0.67	0.68L

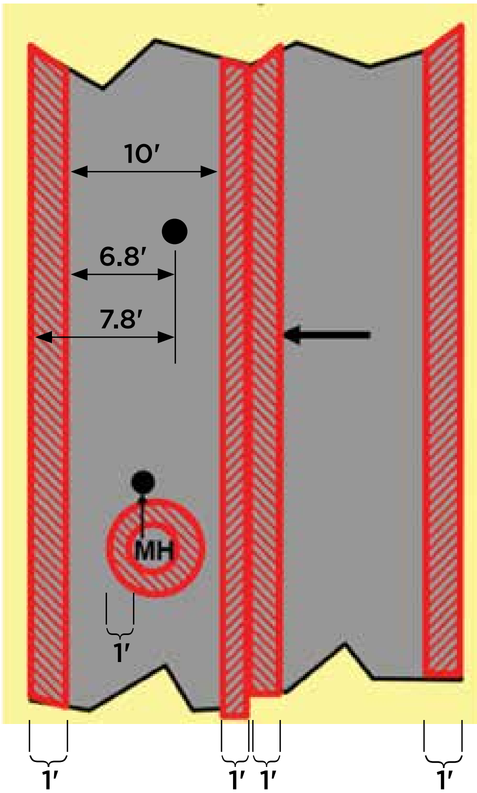
0.67 X 500 tons = 335 ton + 500 tons = **835th ton**

0.68L X 12 ft = **8.2 ft from the left edge**

Continue for the remaining sublots using the consecutive random numbers.

Non-Testable Areas for Core Sampling

(PTM 729)



Adjustments for non-testable edges

Sublot 2

Random Numbers

	X	Y
#18	0.67	0.68L

0.67 X 500 tons = 335th ton in 2nd sublot

0.68 (12ft-2ft) = 6.8ft L in testable area

6.80 + 1.00 ft = **7.80 ft from left edge of paving mat**

Adjustments for manhole covers and other obstructions

Move at least one foot beyond the edge of the obstruction in the direction of paving.

Project # ______________________________

SR ______________________________

Limits ______________________________

Mix JMF # ______________________________

PG ____________ – ____________

Deliver Temp Max ____________ Min ____________

Target Density ______________________ lb/cf

(Gmm) Min. ____________ (____________ %)

Max ____________ (____________ %)

IRI ______________________________

Notes: ______________________________

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- **All references to specification SECTIONS are from PennDOT Publication 408**
- **All references to Pennsylvania Test Methods (PTMs) are from PennDOT Publication 19**

Asphalt Paving Safety!

24/7, 365

- **Know and wear** what Personal Protective Equipment is needed to work on the project.
- **Do not wear** loose clothing or jewelry that could be caught on things like moving equipment parts.
- **Be continuously aware** of your surroundings. Know traffic flow direction and areas, location of traffic control devices, and any obstacles that could cause tripping hazards or impede escape from work zone.
- **Keep constantly aware** of the location of equipment. Watch out for equipment that is just starting in motion.
- **Pay attention** to back-up alarms.
- **Use tablets and smart phones** only as tools for the project and not for personal issues. USE OF THESE ELECTRONIC DEVICES SHOULD ONLY BE AT SAFE LOCATIONS AWAY FROM EQUIPMENT AND TRAFFIC.
- **NO DRUG OR ALCOHOL USE** SHALL BE ALLOWED!
- **Pay attention** to all DANGER, WARNING, and CAUTION labels on equipment and around the project.
- **Only trained and competently qualified** personnel shall be allowed to operate the equipment.
- **Asphalt materials** are very hot and can cause extreme injury. Know the proper emergency response procedures. Know where and how to get assistance in case of emergency.
- **Know** where the first aid kit is located.
- **When trucks are dumping** into the paver hopper, STAND CLEAR!
- **Stay hydrated** by drinking plenty of water and observe conditions of other workers.
- **Watch out** for overhead power lines and other obstructions.

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)

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*

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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.

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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

2700 VPM / 12 IPF = 225 FPM

270 FPM / 88 = 3.068 (3.1) MPH

225 FPM / 88 = 2.556 (2.6) MPH

If 3000 VPM machine:

3000 VPM / 10 IPF = 300 FPM

3000 VPM / 12 IPF = 250 FPM

Divide FPM by 88 to obtain Miles per Hour (MPH)

300 FPM / 88 = 3.40 (3.4) MPH

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.

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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

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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

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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

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