Ride Smoothness Measurement and Specification Issues

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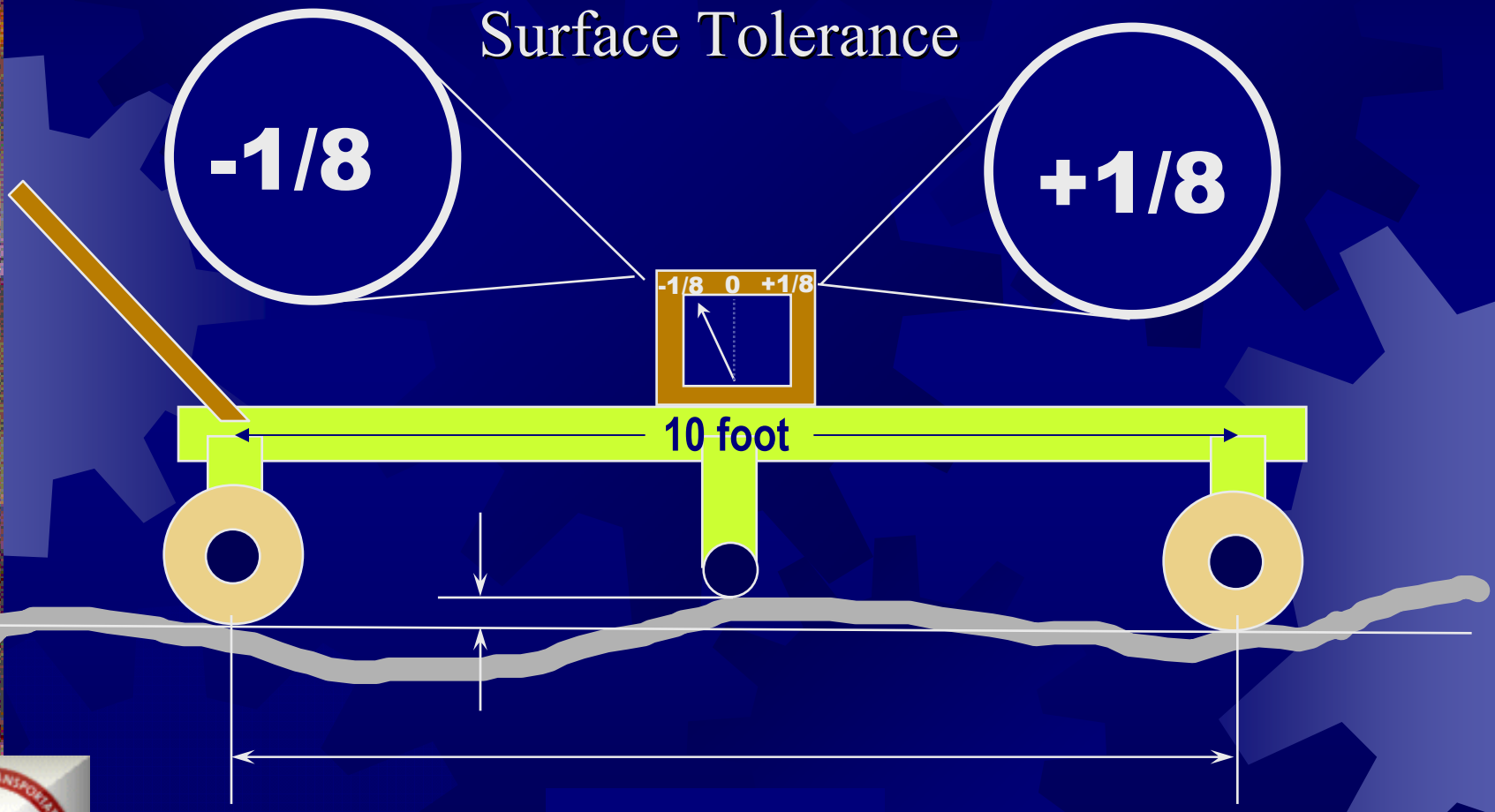
Components of Pavement Smoothness

- **Surface Tolerance – deviations for a flat surface**
- **Roughness – the summary of irregularly spaced variations in surface profile that induce vibrations in the vehicle defined over a length of the road**
- **Repeated Waves – regularly spaced unevenness that causes vibrations in the vehicle**

ROLLING STRAIGHT EDGE



NJ Smoothness Acceptance Specifications
100% for Rehabilitations

Lane 4

Lane 3

Lane 2

Lane 1

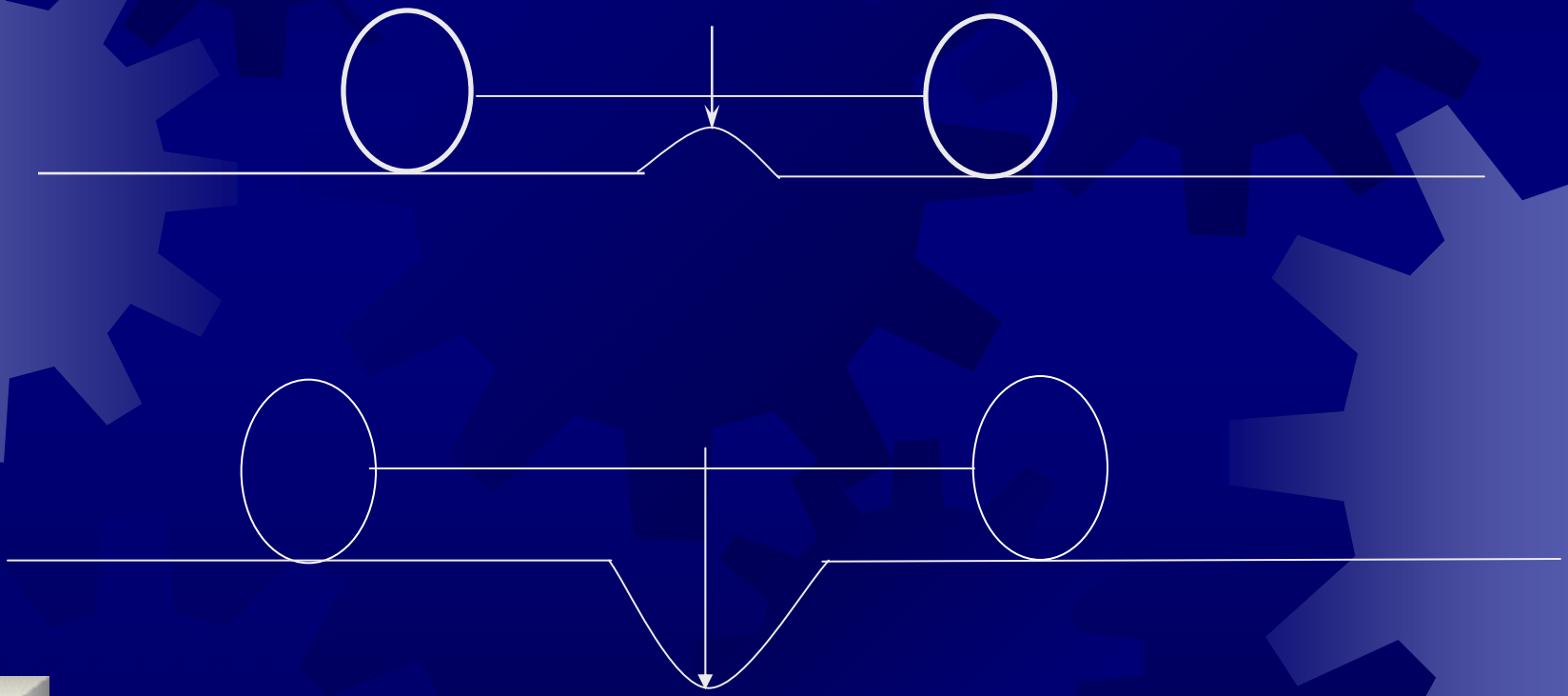
Sum of the length > 1/8" in 10 ft x 100 = % Defective Length
Total length measure

Rolling Straight Edge (RSE)

- Simple and Easy to Understand
- Does not Require Expensive Equipment or Operators with Engineering Training
- Time Consuming
- Cannot Address the Roughness Associated with Wave Lengths Longer than its Base Length
- Could be Misleading

Correct Results

True Data is Recorded



Misleading Results

Depression is Recorded in this Position

High Point is Recorded in this Position

Depression is Recorded in this Position

High Point is Recorded in this Position

Current Research Study

We are moving away from the use of the Rolling Straight Edge (RSE) to Profiler devices for measuring deviations in pavement wheel track profile and Ride Quality Acceptance.

Based on two recent NJDOT research studies, IRI measurements on the same pavement from different profilers produced significantly different results.

The new study will evaluate both profiler and ride statistics for use in evaluating ride quality of new pavements and pavement rehabilitations.

OBJECTIVES

The objectives of this study are to:

1. Select the Standard pavement profiling device to measure the pavement wheeltrack profiles for calibration,

2. Tabulate profiler equipment characteristics from selected manufacturers,

3. Develop procedures, using the Standard pavement profiling device, for calibrating the NJDOT ride quality Acceptance device (ARAN) and other profiling devices for use by contractors for quality control,

OBJECTIVES

4. Develop a procedure for correlation between NJDOT Standard pavement profiler, the NJDOT ride quality acceptance device (ARAN), and other profiling equipment (for QC),

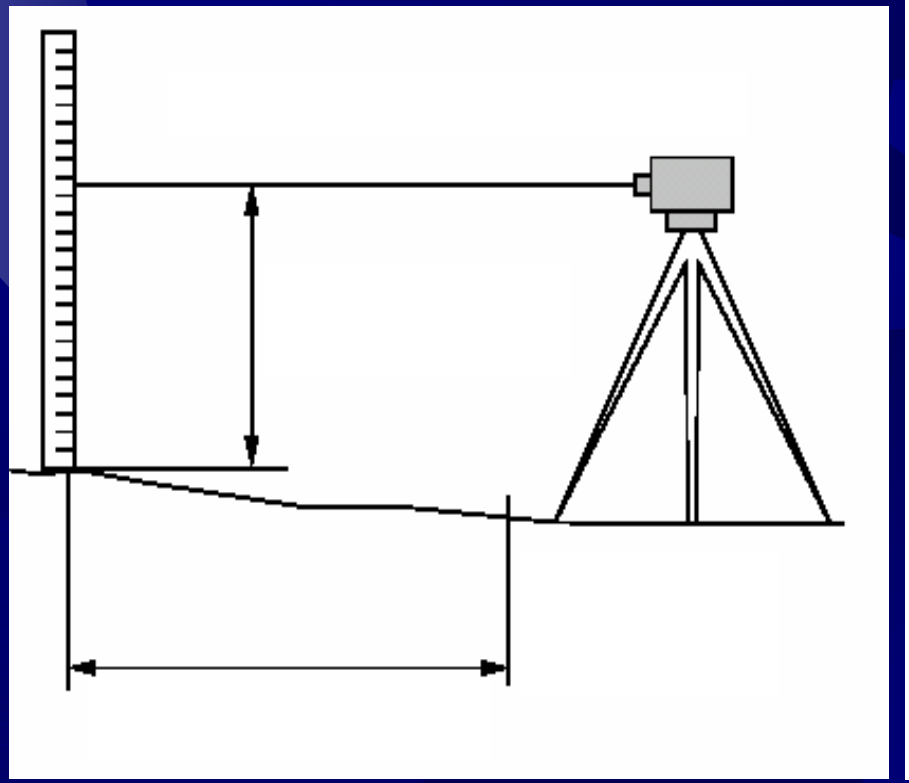
5. Evaluate or develop standard software to process profile data for calculation of accepted ride statistic for use on new pavements or pavement rehabilitation projects and for comparison with the output from the profiler equipment manufacturer.

Measuring the "True" Profile

<u>Standard</u> pavement profiling devices

Calibration/Correlation

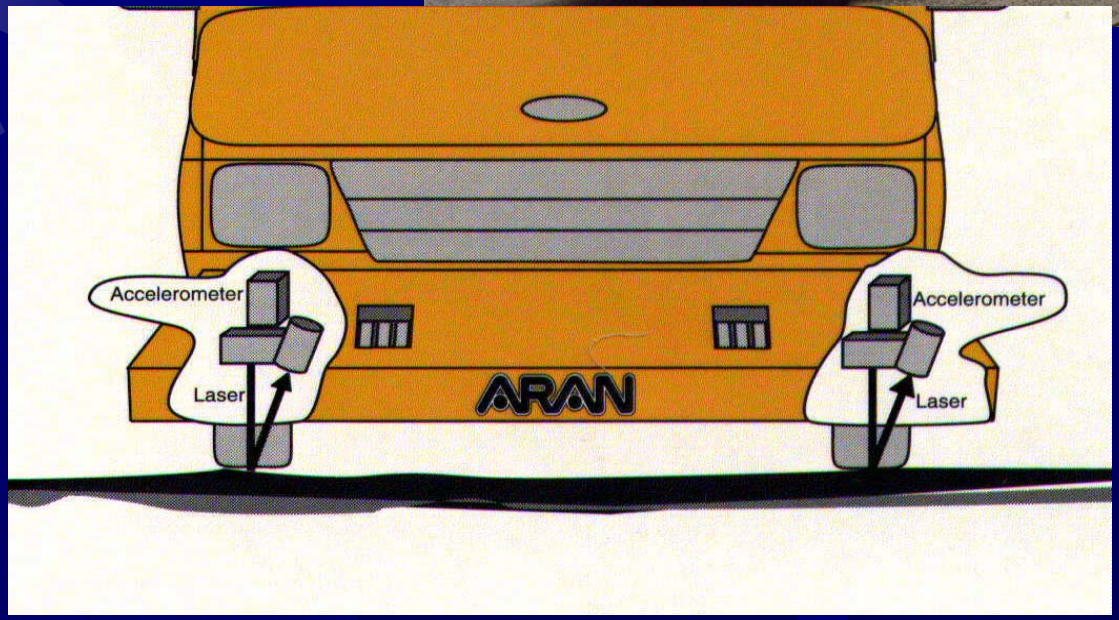
Rod and Level



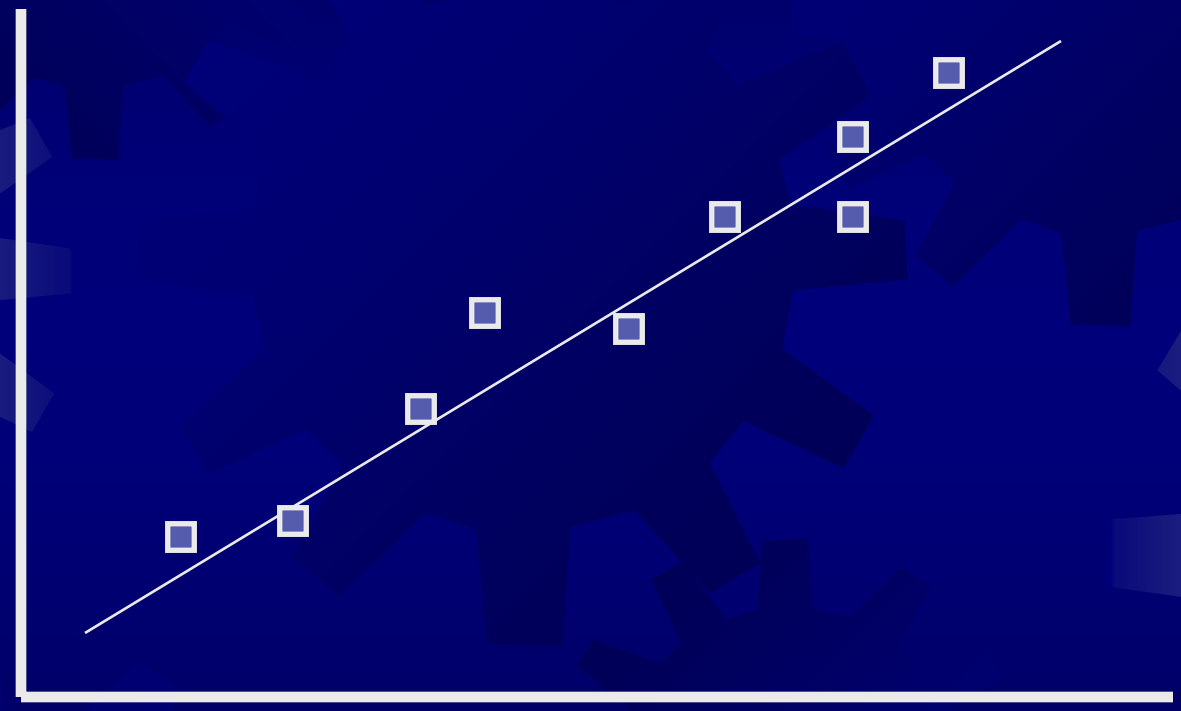
Walking Profiler

Profilers - High Speed

- ARAN
- Dynatest
- ICC

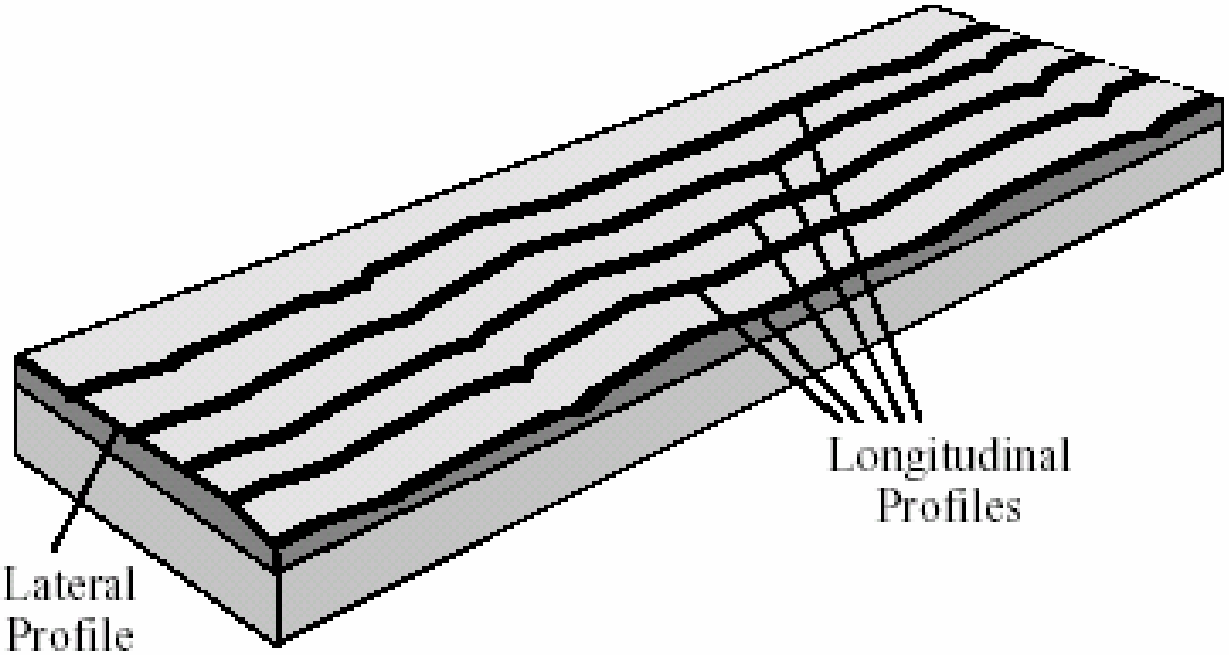


Correlation of Data

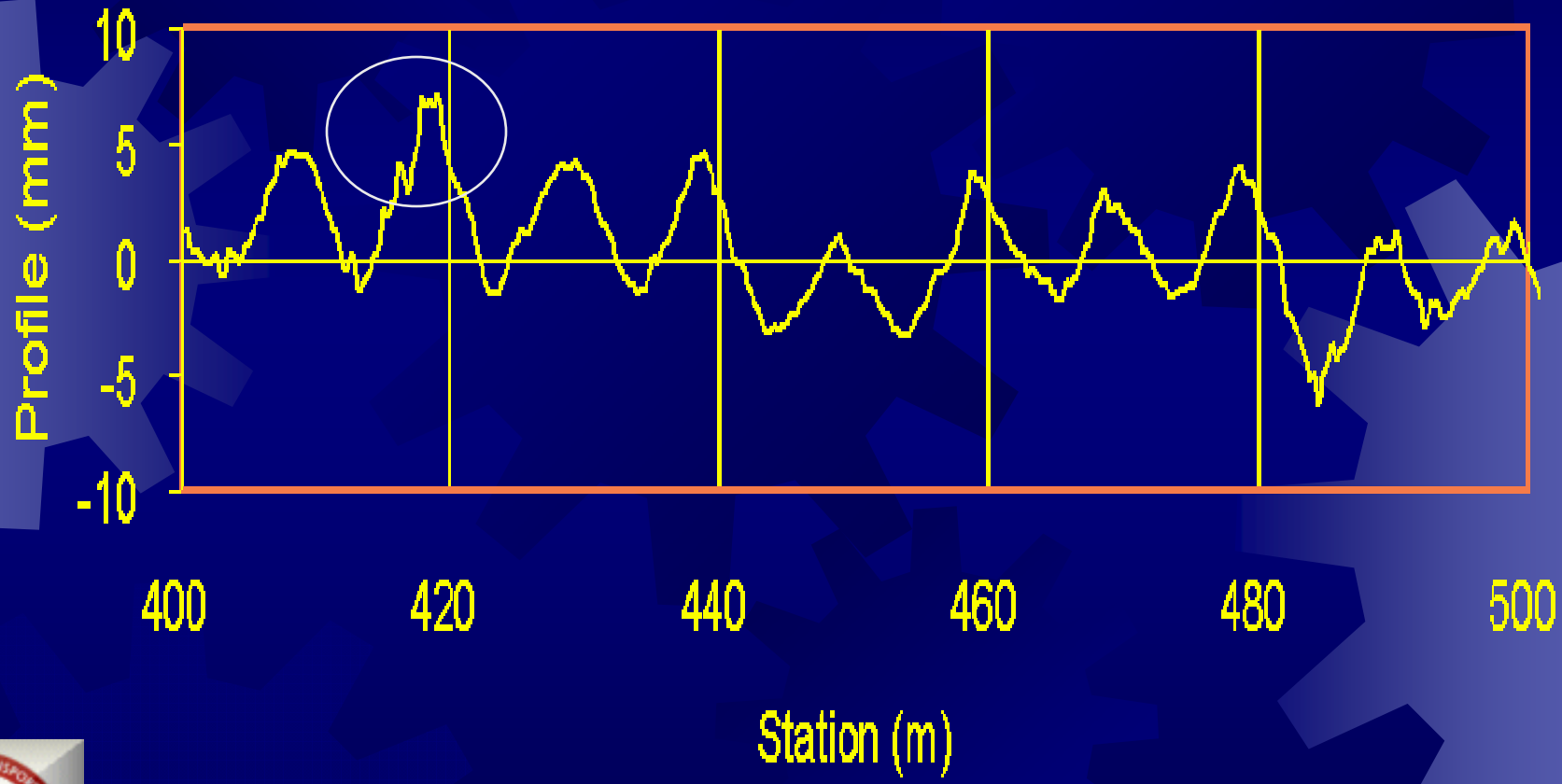


Wheel Track Profile

Longitudinal Slices of the Pavement Surface

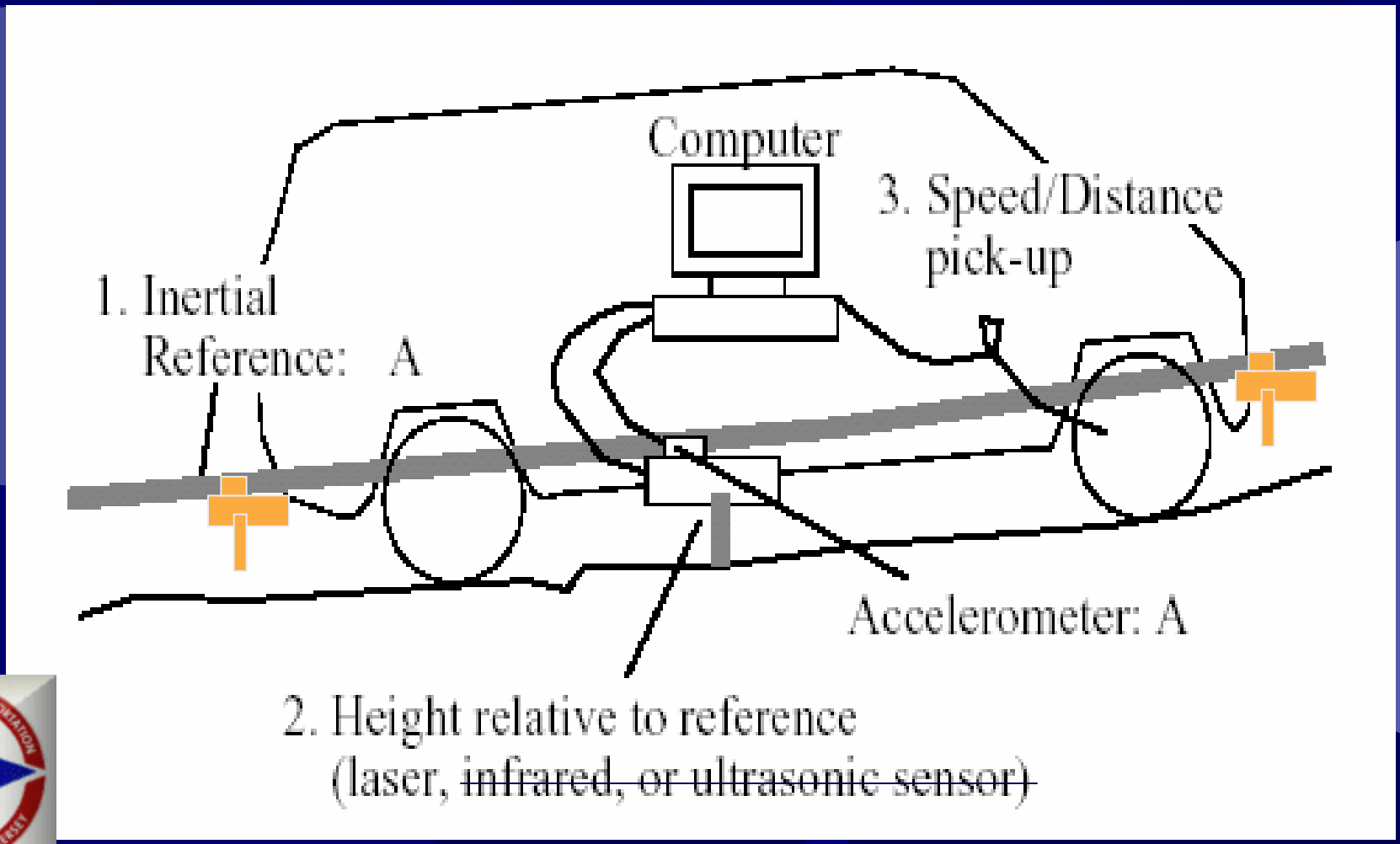


Wheel Track Profile



Measurement Issues

All Profilers are NOT created equal



Measurement Issues

All Profilers are NOT created equal

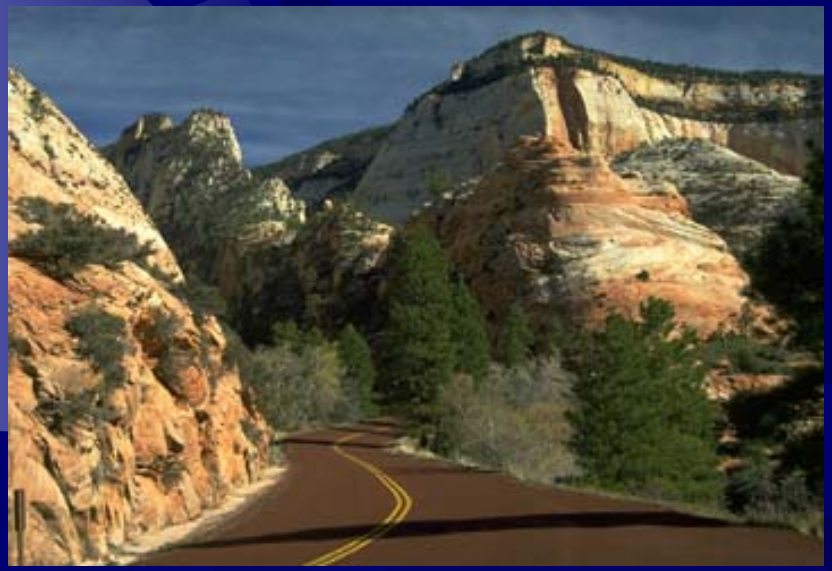
Different Sampling Intervals

Different Accelerometers

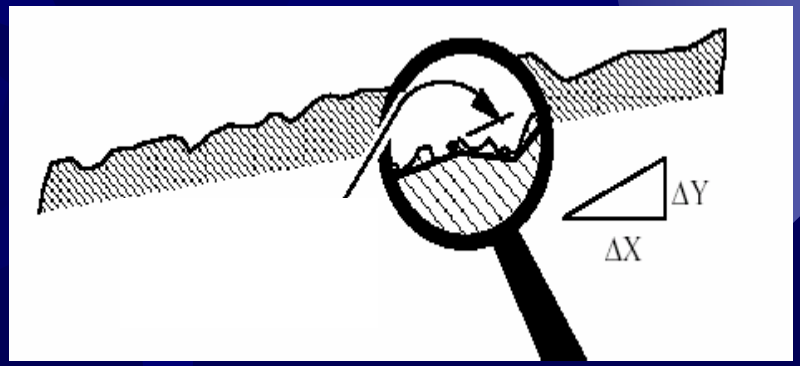
Different Data Processing – “Black Box”

Filters

Pavement profiles are made up of an infinite number of profiles of different wave lengths



Filters help to remove the information that is not needed



Filters Types:

Smoothing (low pass)

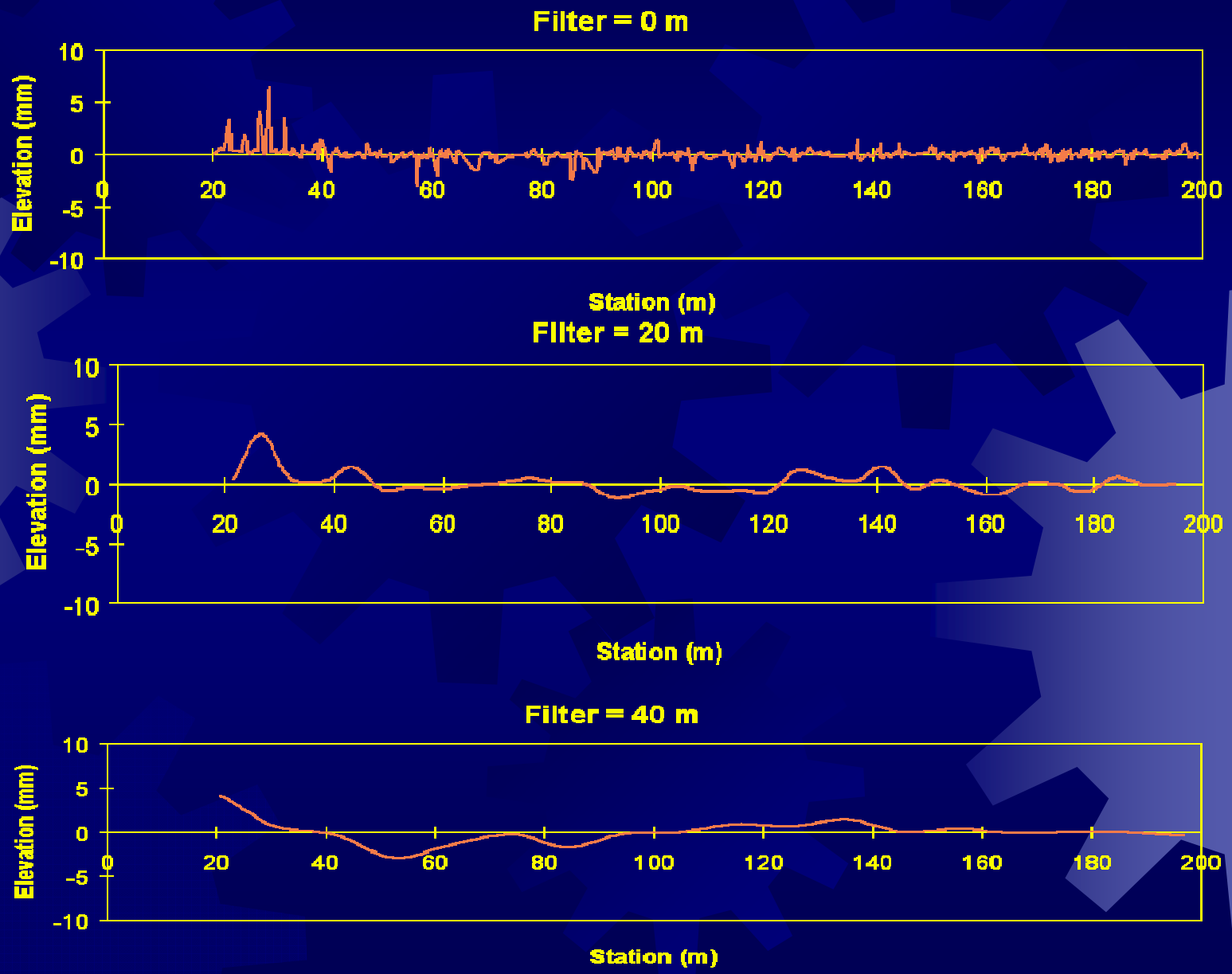
Removes the short wave lengths – Rumble strips

Anti-smoothing (high pass)

Removes the long wave length – Rolling hills

Filter Sets can be specified and developed that get rid of wave lengths at both ends to leave the wave lengths that influence the roughness that we feel when riding on the pavement

Filters - Smoothing (low pass)



Filter Issues

Some profilers process the collected profiles through their "black box" filters on board the vehicle. The filtering algorithms are proprietary.

Other profilers allow output of unfiltered profile data for processing by third party software (RoadRuf or ProVal).

There are numerous types of filters available to process the profiles.

The calculation of the smoothness statistic is dependent on the filter set(s) used.

Summary Ride Statistics

- **International Roughness Index (IRI)**
- **Profile Index**
- **Ride Number**

Ride Statistic Issues

There is a certain wavelength range, which makes a maximum contribute to road roughness and this range lies between 0.3 ft to 328 ft, but no better information is known at this time.

It can be determined by carrying out sensitivity analysis of various wavelengths on different roughness indices such as IRI, PI, and RN and comparing them to mean panel ratings (people's opinion).

Ride Statistic Issues

The wave length range at which different roughness parameters are most sensitive are different for different indices.

The wave length related to ride quality which addresses user comfort is different than those that produce damage from heavy trucks.

Specification Issues

The equipment used, the filters used, the ride statistic used and the acceptance levels set all effect the level of bonus or penalty awarded to the contractor.

How well does the level set by specification address user comfort or dynamic forces that causes pavement damage from heavy trucks?

Was the calculated ride statistic based on a single pass of the profiler or average of multiple runs?

Specification Issues

Was the ride statistic calculated from the profile in each wheel path separately and then averaged or was the ride statistic summed for both wheel paths?

Are the levels specified achievable on the current section of roadway? (manholes, inlets, cross streets)?

Is the specification based on a single level of acceptance (70 in/mi) or percent improvement over the existing pavement smoothness (20%)?

Smoothness Issues

With a Little Work And Patience You Can Get Through

Questions?

http://www.state.nj.us/transportation/refdata/research