Use of Traffic Speed Deflectometer Data at the Project Level for Pavement Rehabilitation Design

Presented by Nick Weitzel, PE

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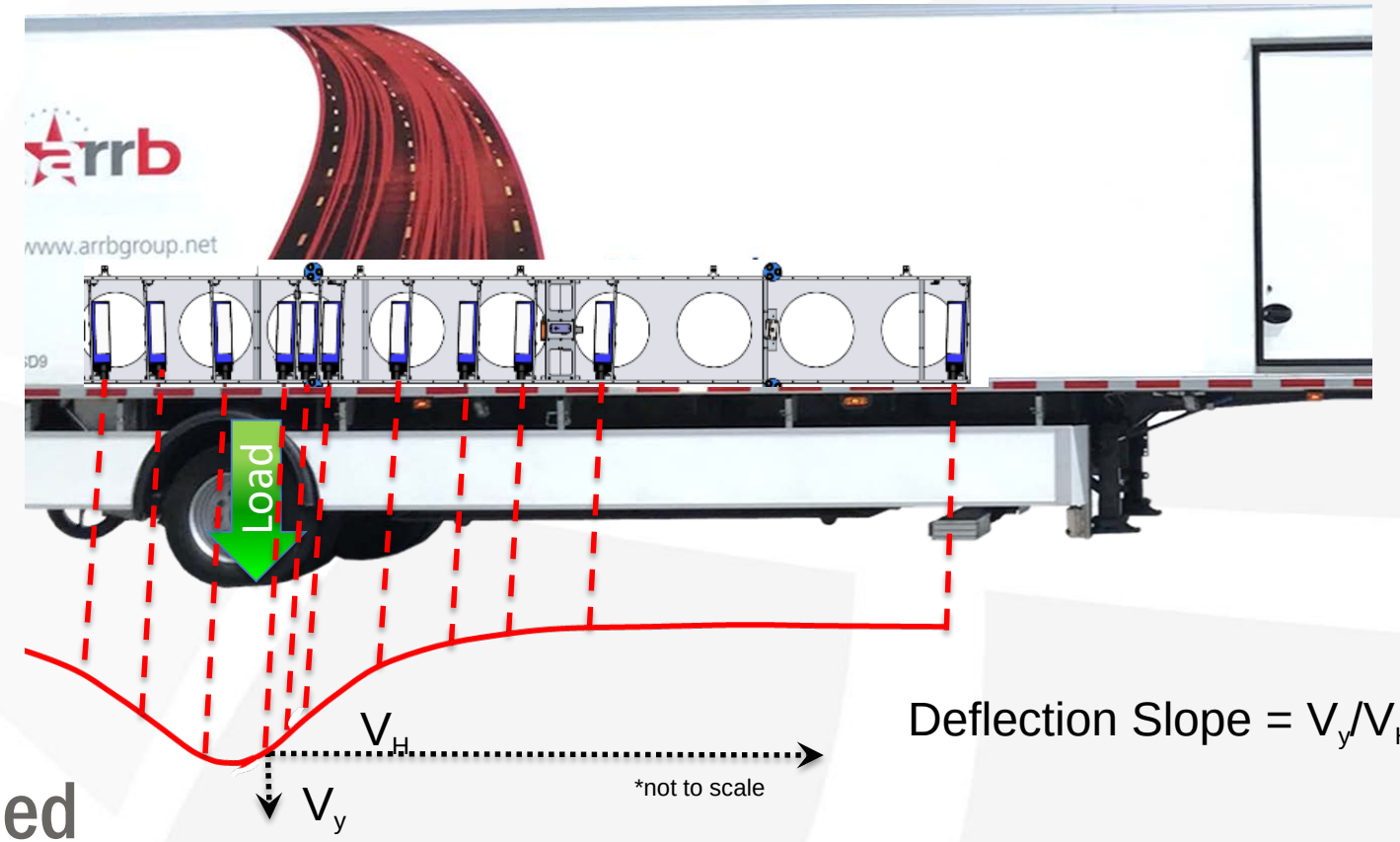
Presentation Outline

- TSD Data Analysis
- Case Studies:
  - Idaho DOT
  - New Hampshire DOT
  - Mississippi DOT
  - Georgia DOT
- Outcomes and Lessons Learned



Project Level Pavement Rehabilitation Design

Considerations

- Existing Material Condition
- Required Structural Capacity
- Pavement Layer Thicknesses
- Cracking and Distresses
- Grade Restrictions
- Budget!!

Tools

- Pavement Coring
- Ground Penetrating Radar
- Laboratory Testing
- Distress Surveys
- **FWD/TSD Deflection Testing**
  - May not be appropriate for all pavement design projects

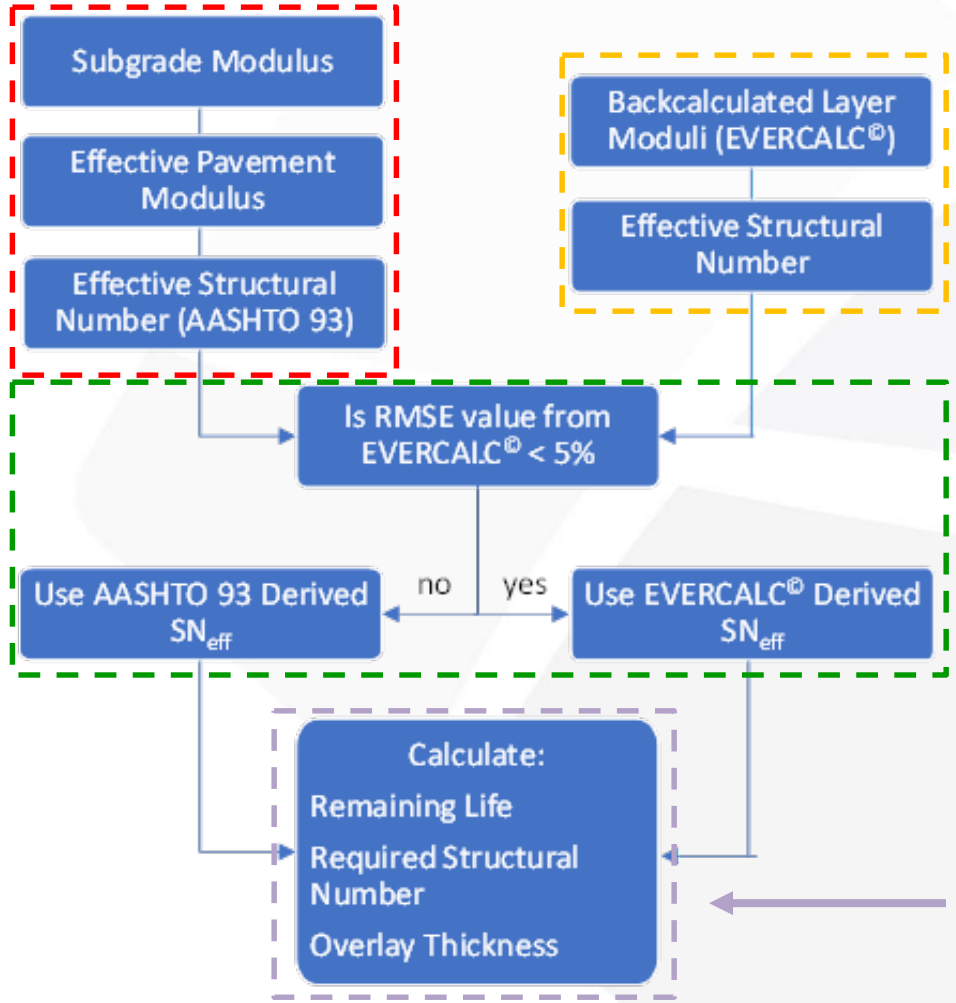
TSD Data Analysis

- Treat TSD data just like FWD data
- Analysis methodology used for all projects within this presentation dates to 2016
  - There are other ways to analyze the data
- Has been used to analyze over 3,500 miles of TSD data for several states
- Inputs:
  - TSD data, 3DGPR layer thicknesses, Projected future design traffic (equivalent single axle loads [ESALs])
- Results:
  - Subgrade modulus, layer moduli, effective structural number
    - Calculated for each TSD data point (every 52 feet)
- Project-level analysis at the network level

TSD Data Analysis

AASHTO 1993 Backcalculation

Determine which effective structural number is utilized



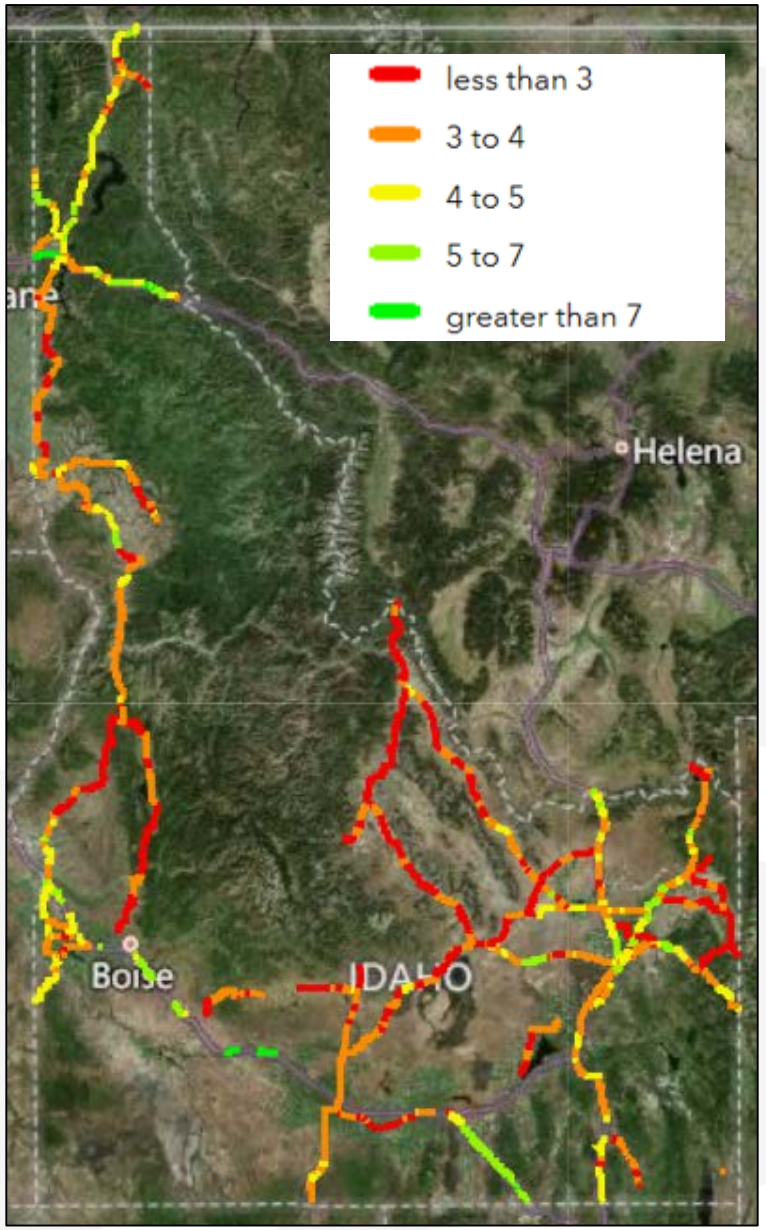
EVERCALC© Backcalculation

The Good Stuff

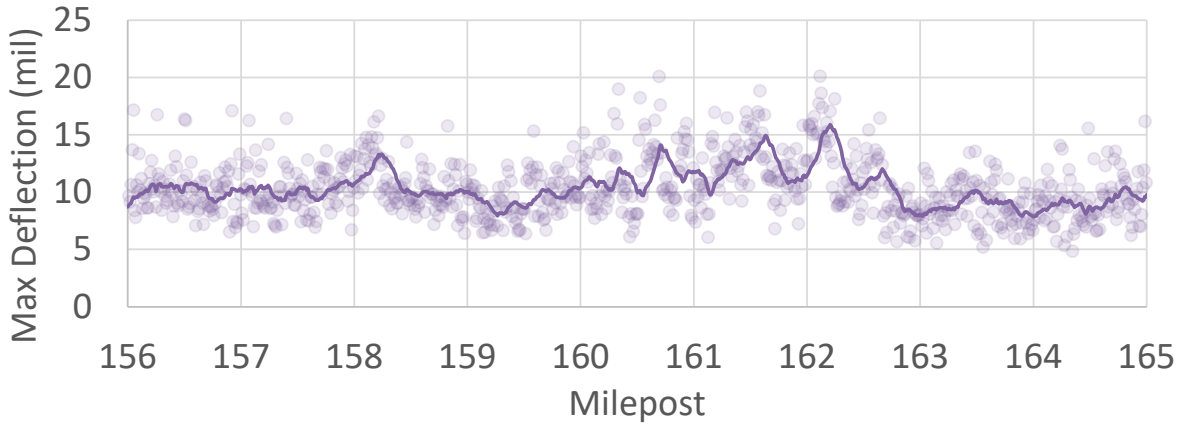
ITD Project Description

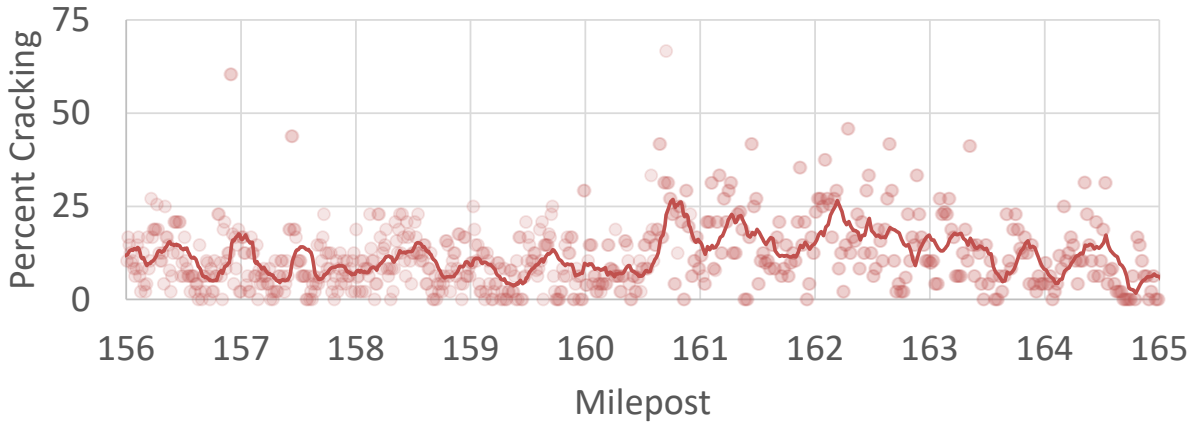
- In 2021, NCE analyzed over 1,300 miles of TSD data on several highways within Idaho
- Network-level analysis for pavement management systems usage
  - Help identify rehabilitation treatment
- There are project-level applications of this data

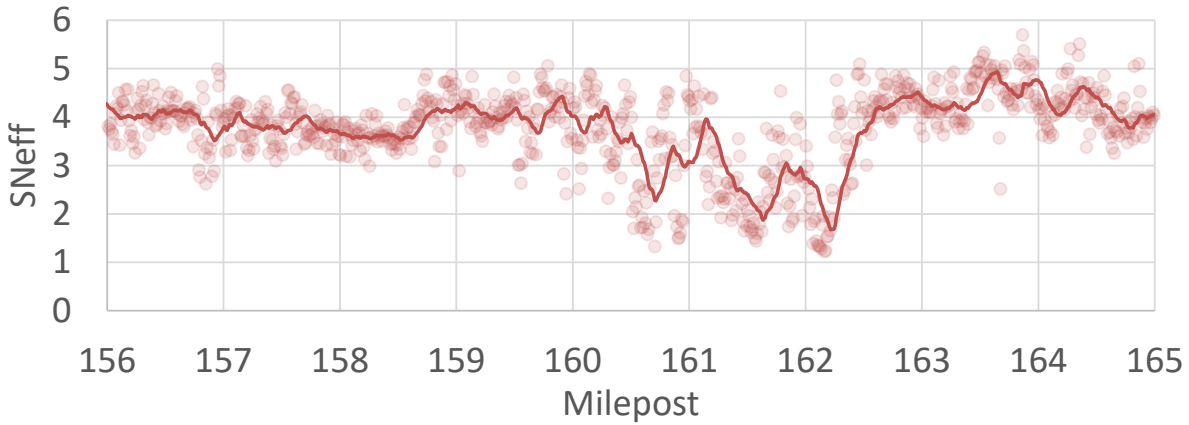
Effective Structural Number

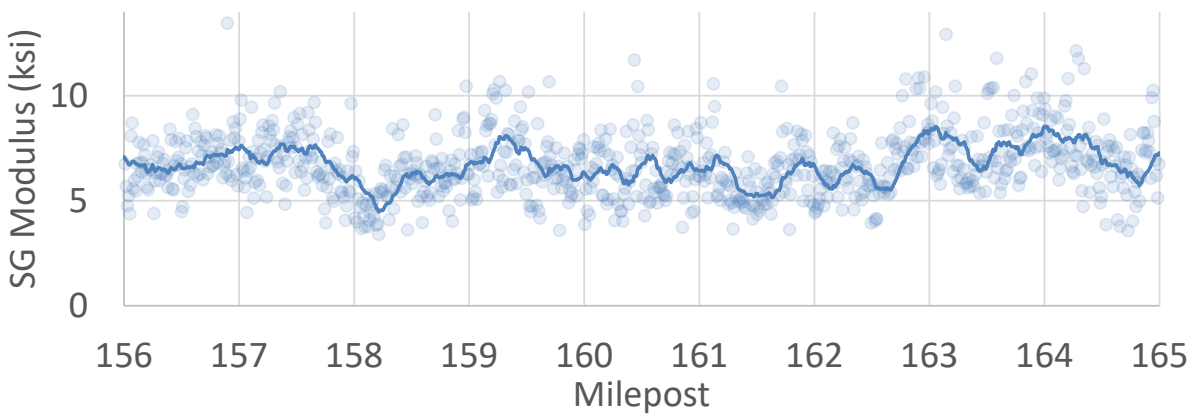


ITD TSD Results









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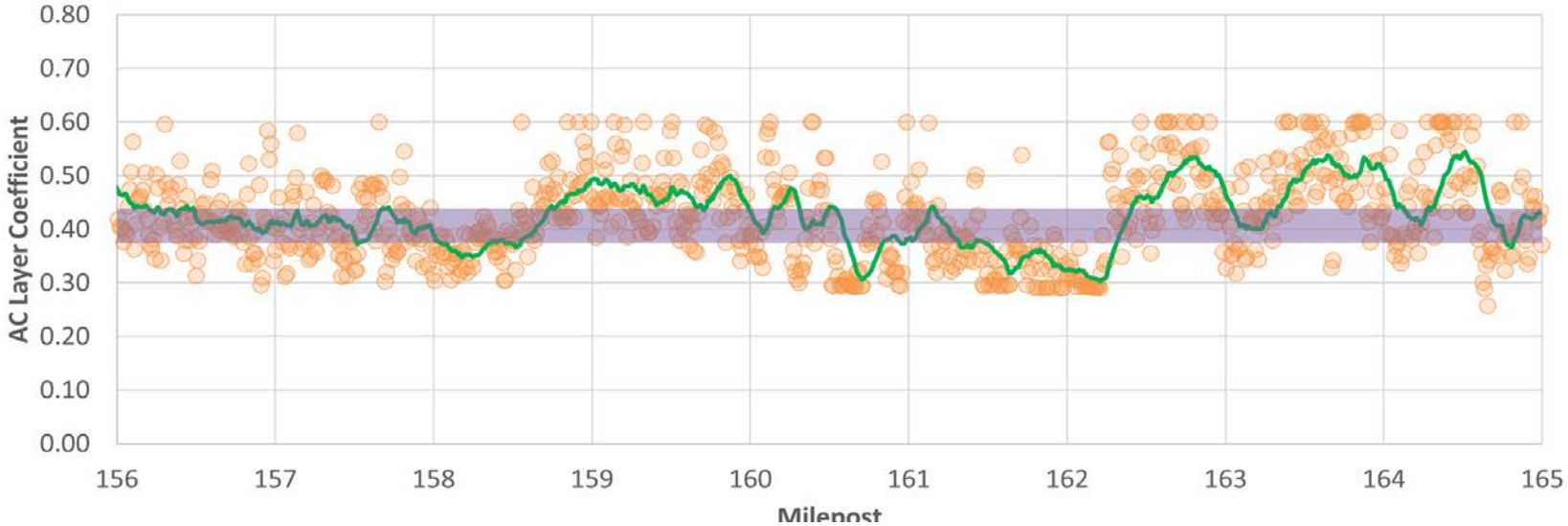
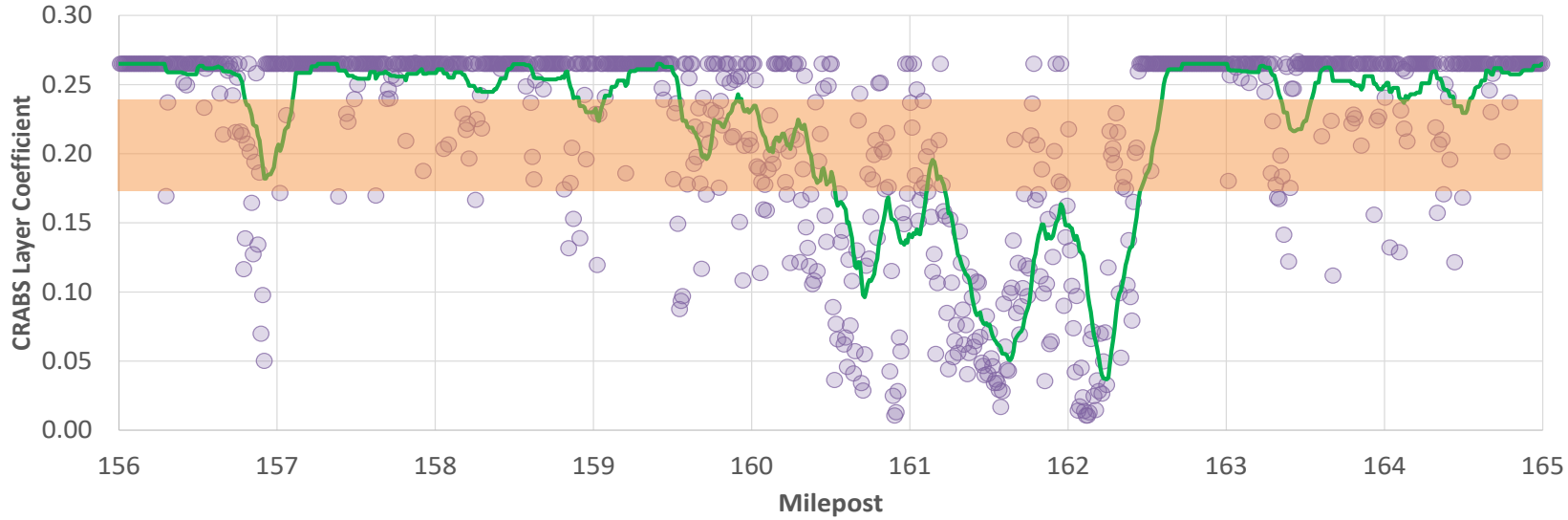
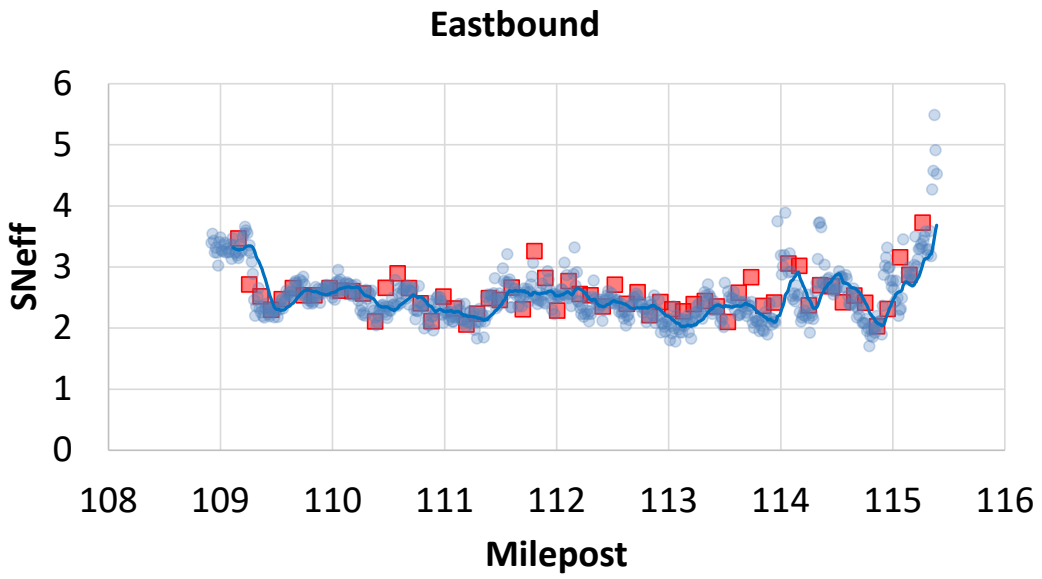


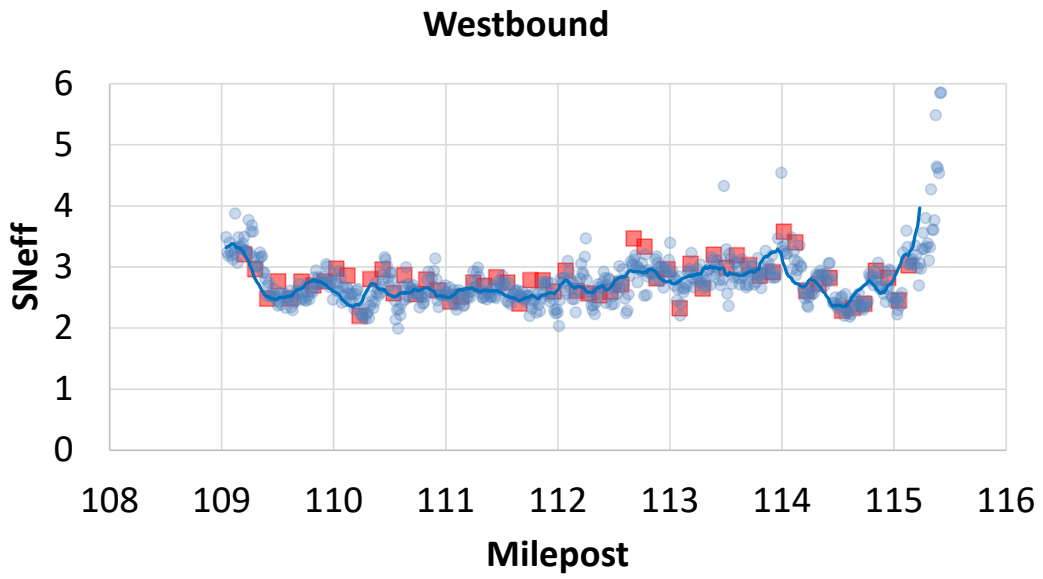


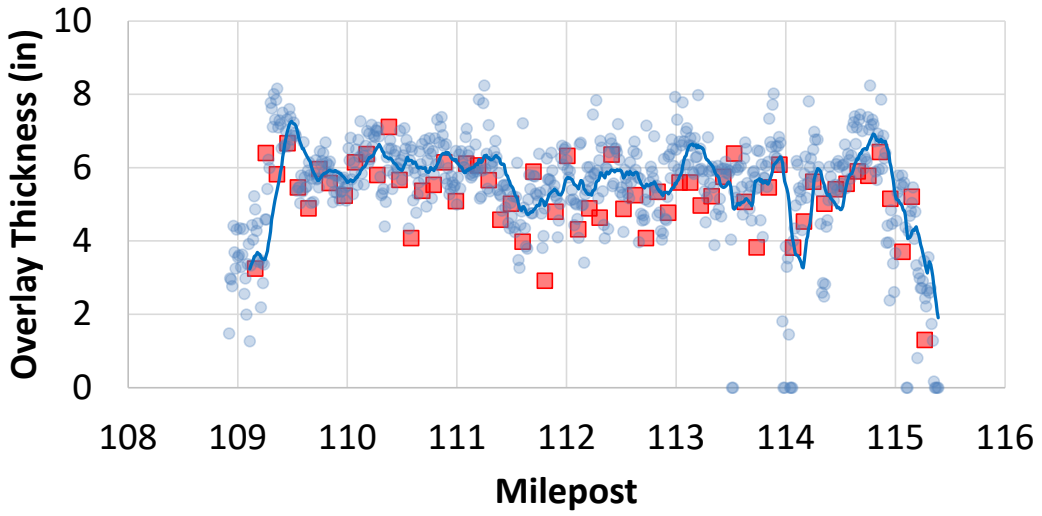
NHDOT Project Description

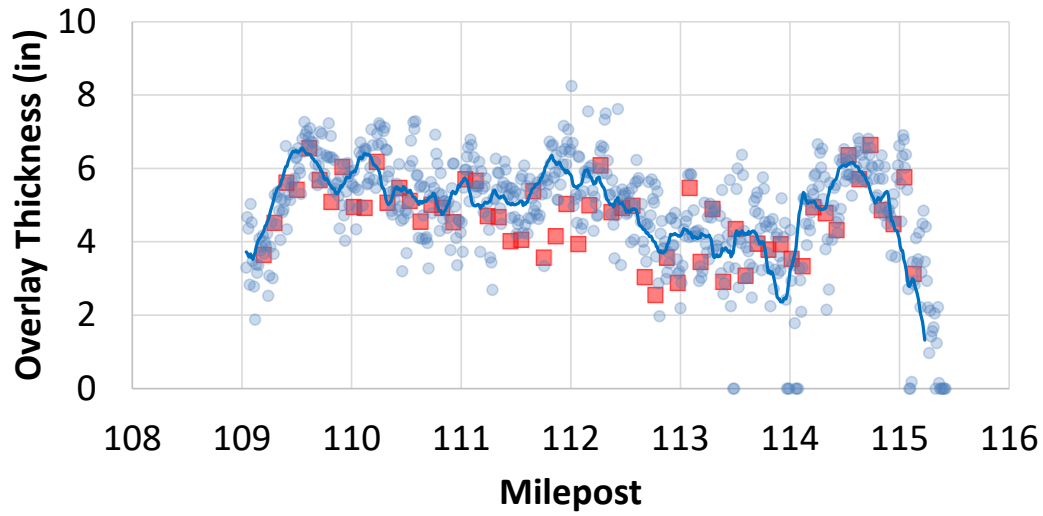
- NHDOT wanted deflection testing and analysis on a portion of state highway.
- TSD data already collected and NHDOT interested in how it compared with FWD data
- Pavement was 5.5 inches of AC on top of 5.5 inches AB
- 20-year design ESALs of 12 million

NHDOT: Comparison of Results









Mississippi DOT

- Overall, NCE team to analyze several hundred miles of TSD data for network-level decision making.
- Work also includes multiple project-level analyses for a few short roadway segments.
- 13-mile segment was selected by MsDOT for deeper dive into pavement's condition
- Objective to analyze 3DGPR/TSD data and develop rehab recommendations.

Mississippi DOT

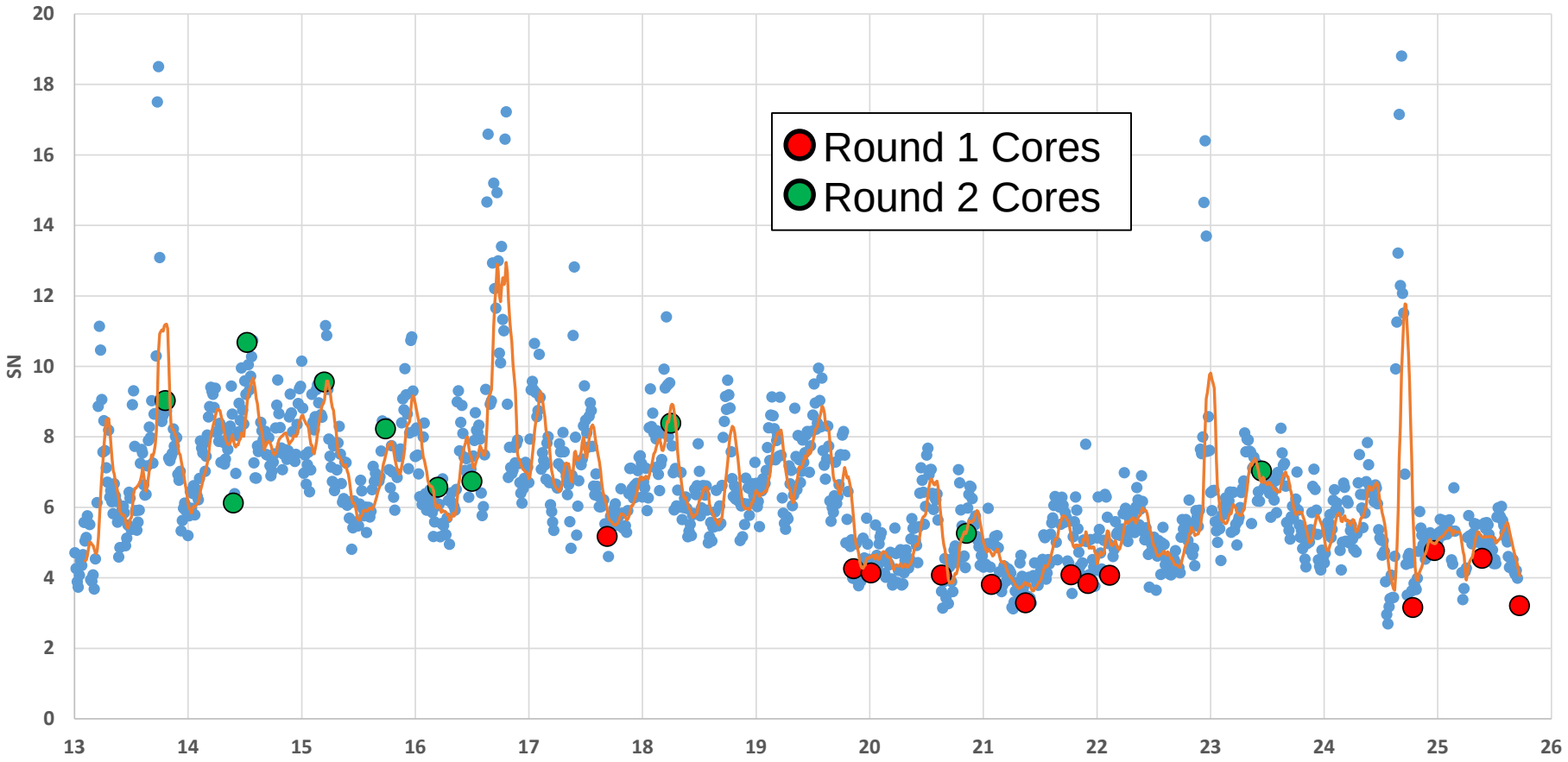
Round 1 Cores

- DOT identified 13 core locations targeting areas of weak asphalt (based on TSD deflections)
- All exhibited stripped material

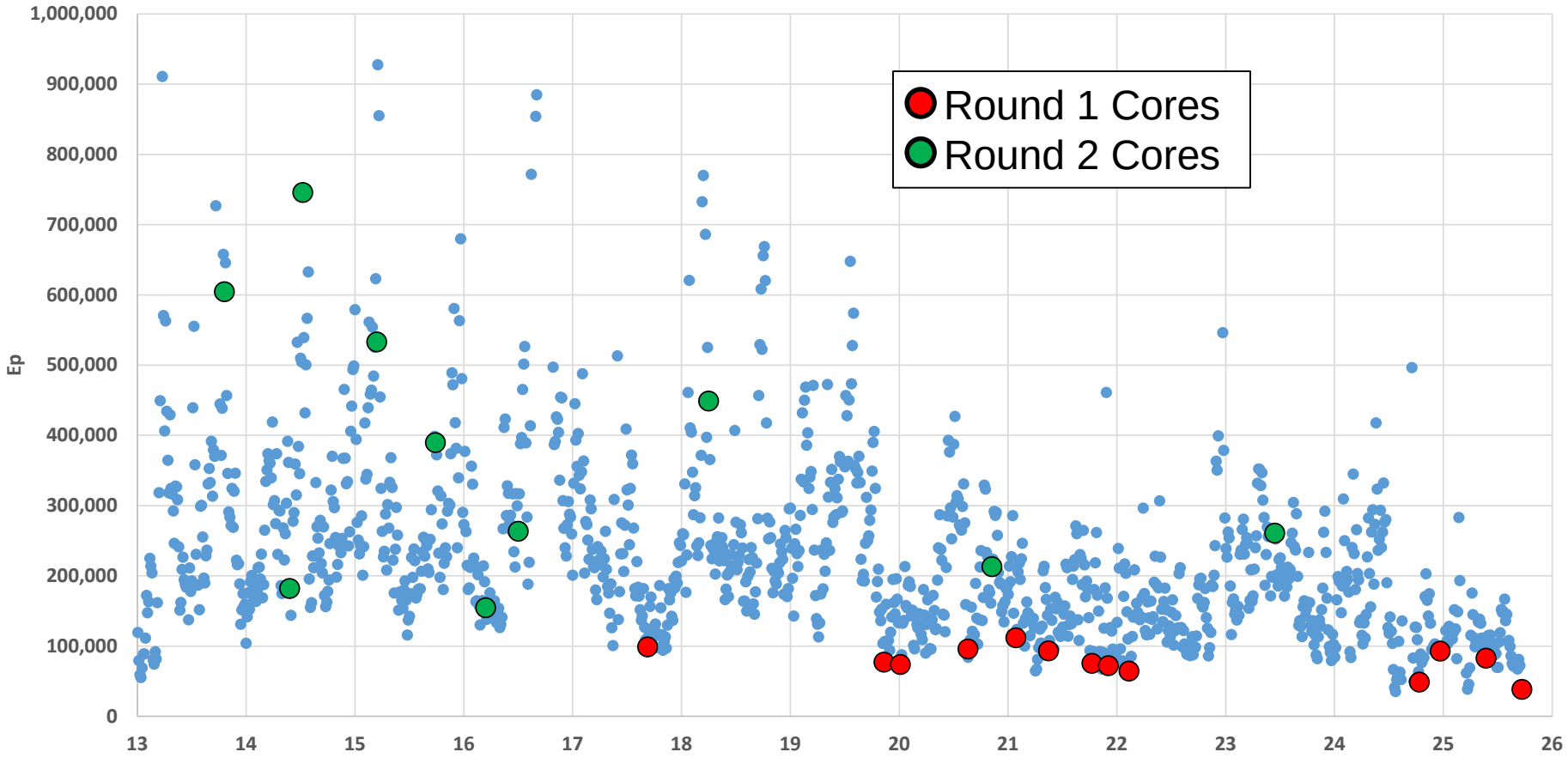
Round 2 Cores

- NCE identified an additional 10 cores targeting areas of strong asphalt (based on pavement moduli)
- Most showed AC material was competent

Mississippi DOT TSD Results: Structural Number



Mississippi DOT TSD Results: Effective Pavement Modulus



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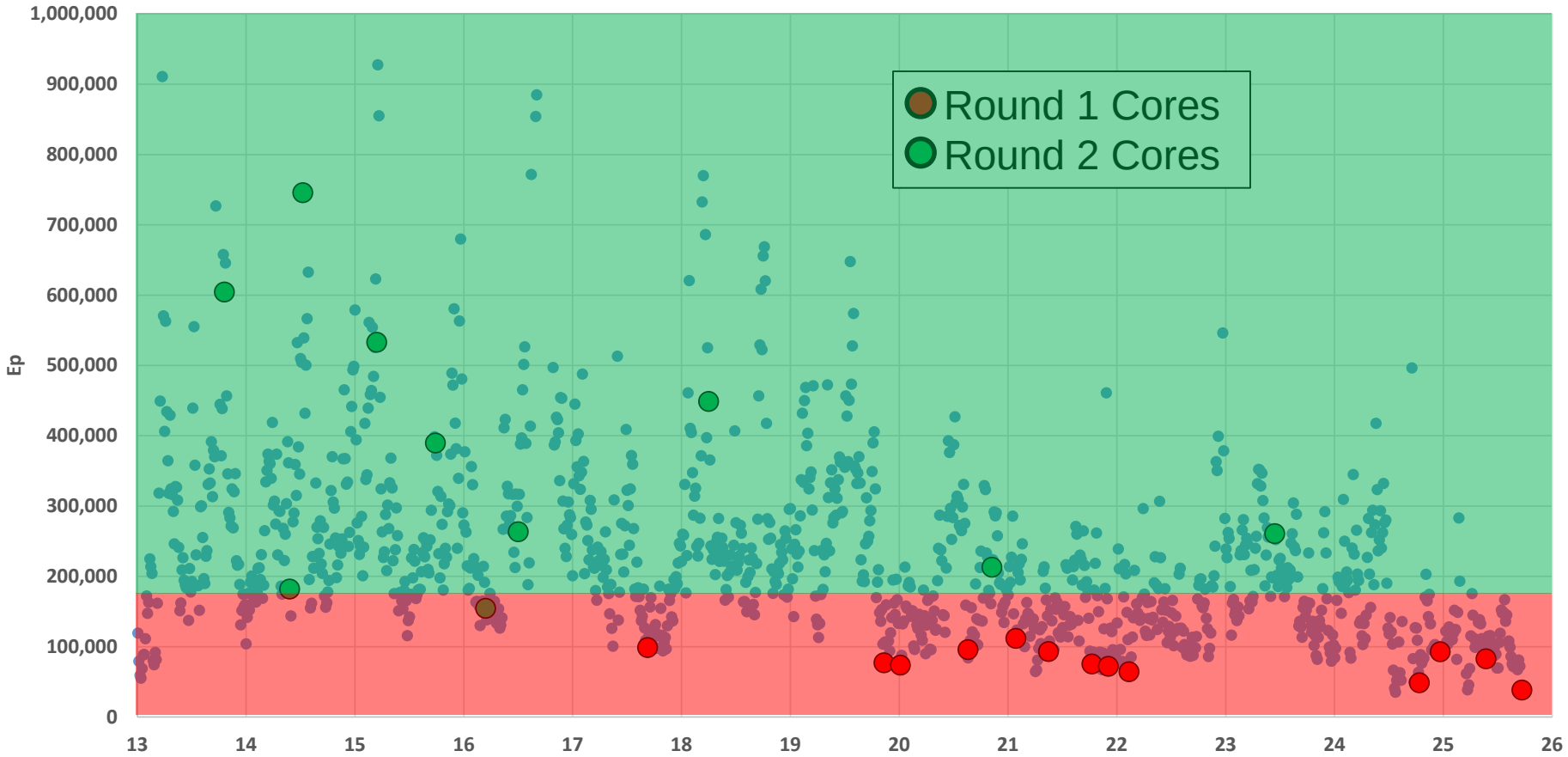
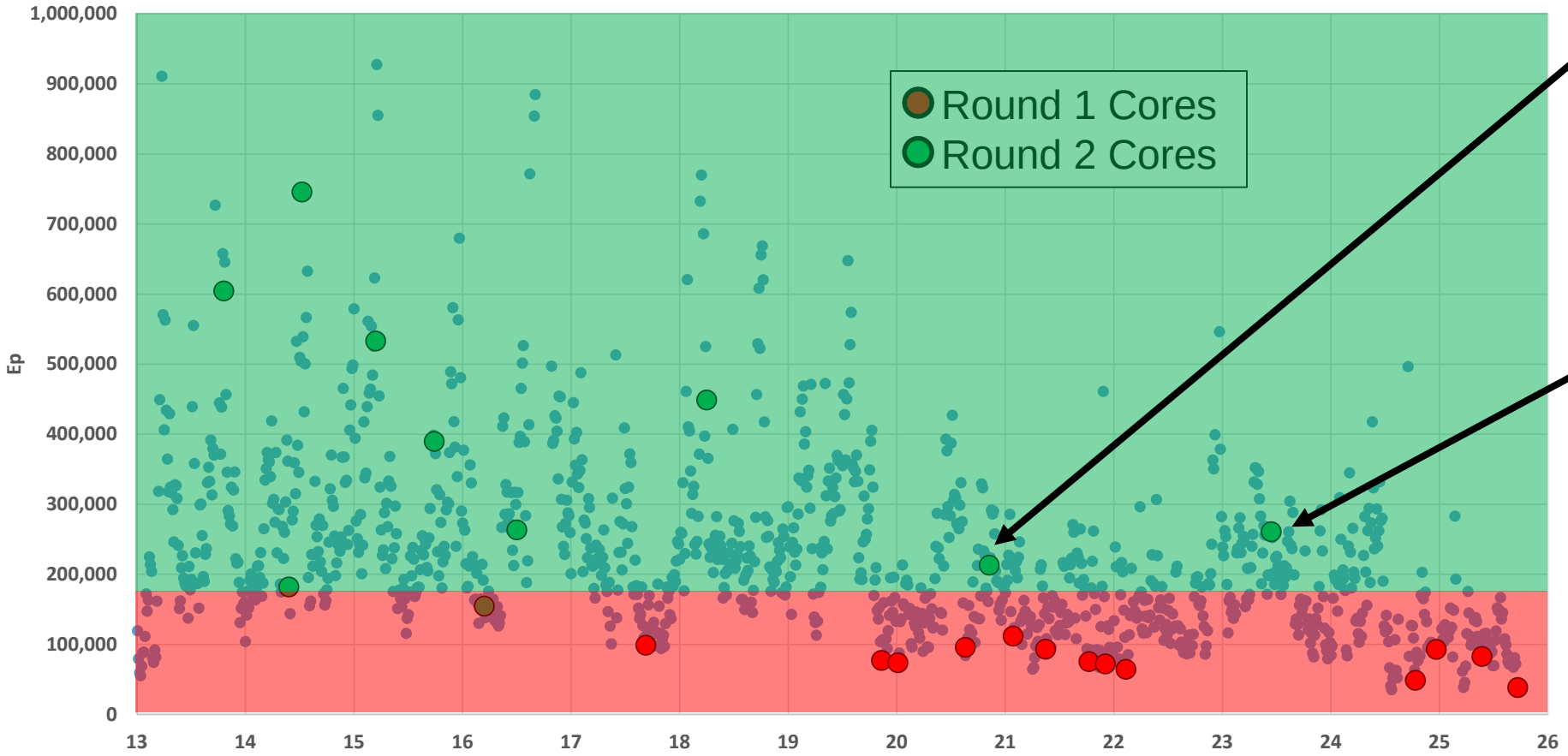


Non-stripped AC

Stripped AC

Mississippi DOT TSD Results: Effective Pavement Modulus



Non-stripped AC

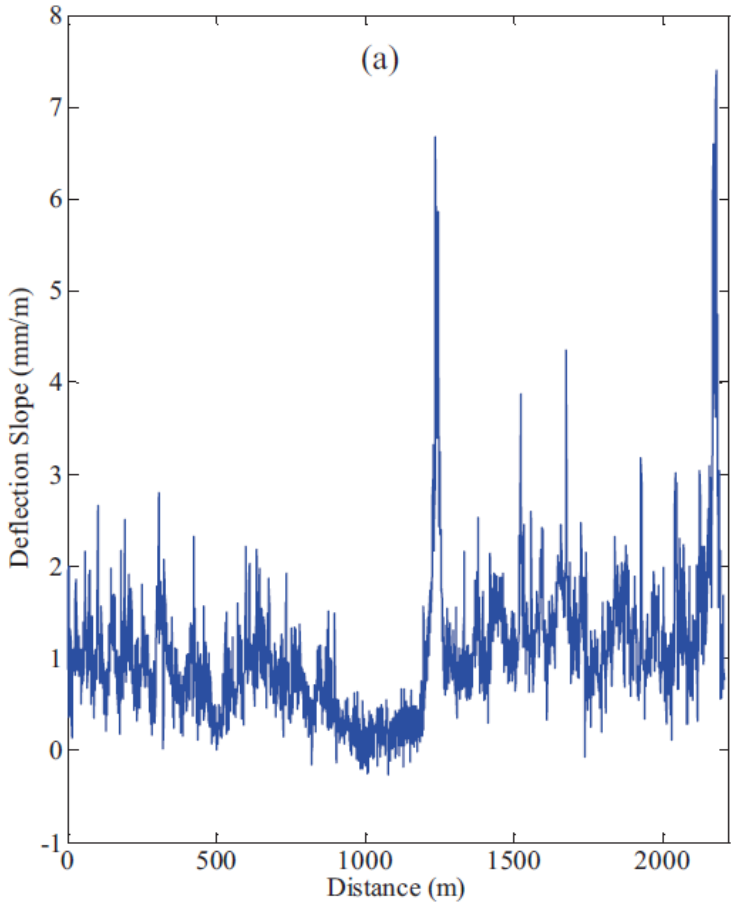
Stripped AC

GDOT Project Description

- TSD data collected on concrete pavement
- Primary interest was assessing condition of joints
  - Load transfer efficiency
- This type of application has been performed sparingly within the US

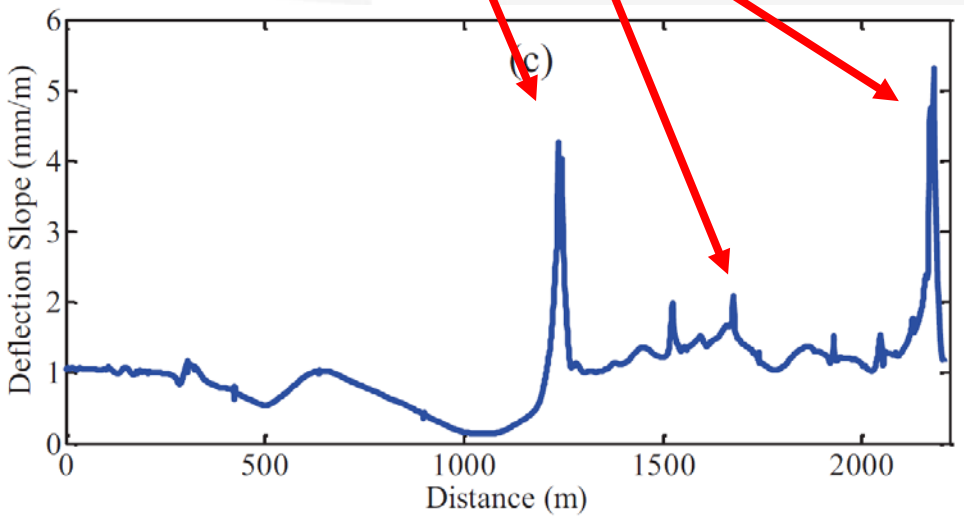
GDOT TSD Analysis Methodology

- TSD vertical velocities plotted against station (5 cm spacing)
- Utilize wavelet denoising to identify underlying trends



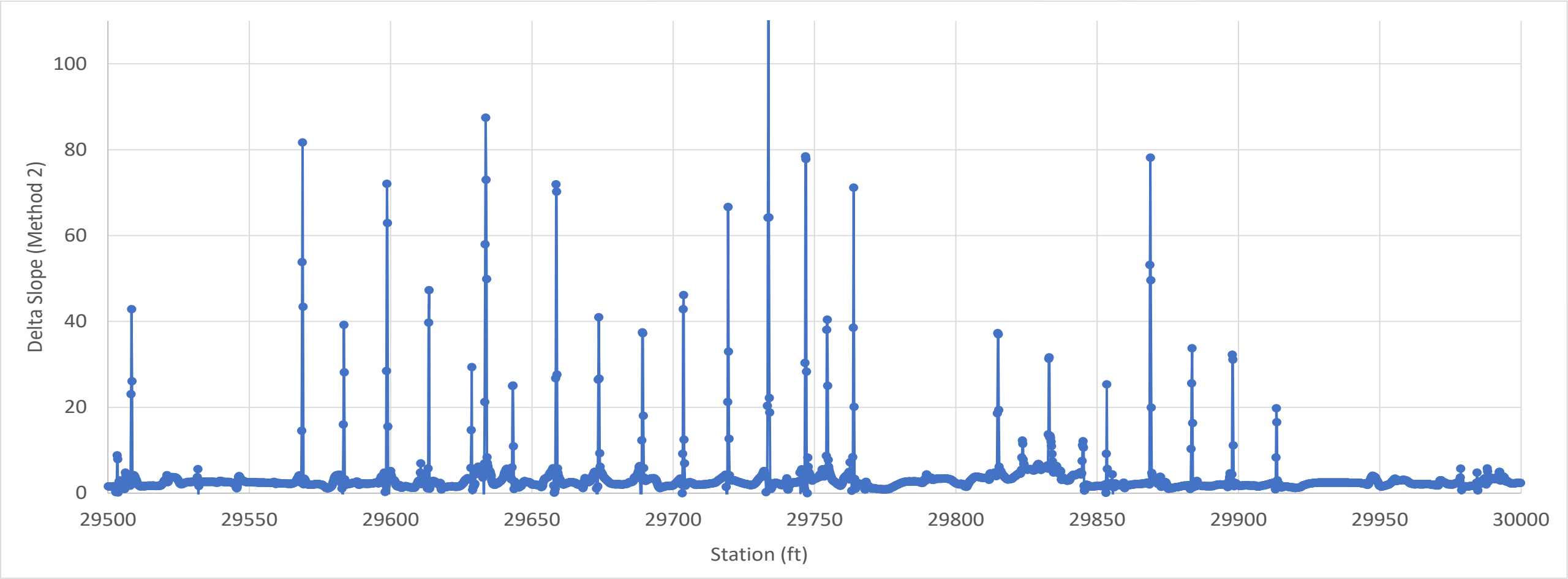
Filtering

Spikes in filtered data correspond to PCC joints



GDOT TSD Results

Measure Utilized: “Delta Slope” = (Slope_130 – Slope_neg130) * TSD speed



GDOT TSD Results

Use of Deflection Data at Project Level

- Deflection testing is not needed on every single project
  - Need to identify a reason to justify collecting data
- Deflection data in a vacuum is meaningless
  - Structural number has no significance without context
- Integrate TSD data with other information
  - Distresses, coring, thickness

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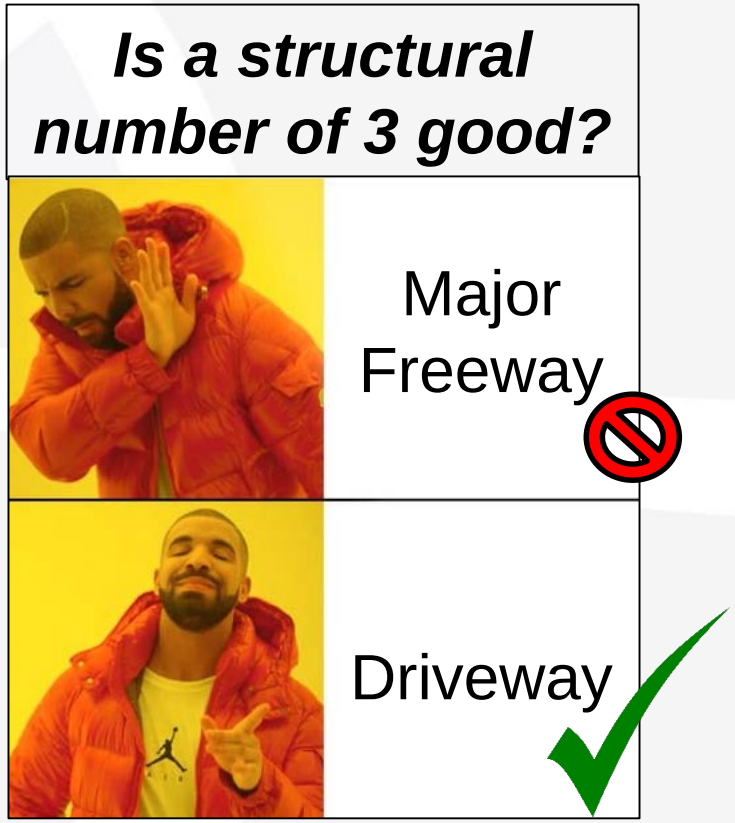

Lessons Learned-Asphalt

- Results are very similar to those obtained from the FWD
- Identify areas of weak subgrade
  - Estimate base repair quantities
- Delineate areas of stripped asphalt
  - Fill in the gaps between cores
- 52-foot spacing allows for optimization of budget by specifying multitude of rehab strategies, each with precise station limits

Lessons Learned-Asphalt

- Use of AASHTO 93 and EVERCALC can give project-level inputs at the network level
  - Computationally easy to run
- Easy to get overwhelmed by amount of TSD data
  - Utilize averages/percentile values at network level
    - Segment network into “uniform” project-sized pieces
  - Utilize point-by-point data at project level
- It’s FWD data, just at a much closer spacing

Lessons Learned-Concrete

- Not all joints could be “seen” with the TSD slope data
  - It is assumed there was minimal differential movement between slabs, thus good load transfer
- It is unknown how the TSD velocity values correlate with FWD-derived LTE values
  - Does pavement thickness/stiffness impact this correlation?
  - Is this a universal relationship or will it vary from project to project?
- The shape of the filtered velocity values may give further insight into the joints’ properties
  - Further research is being conducted

Questions?

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