Implementation of the Traffic Speed Deflectometer (TSD) for Network Level Pavement Management

by

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Pavement Evaluation, 2019

Roanoke, VA

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Background

- Current PMS are based on surface distress
  - Continuous distress survey systems are available
- Remaining life depends on roadway structure
  - Below the surface
- TSD can now provide continuous roadway deflection data
  - Over 200 miles per day/no closures
- GPR provides continuous layer structure data
- Combination can produce layer mechanical properties for roadway structural analysis

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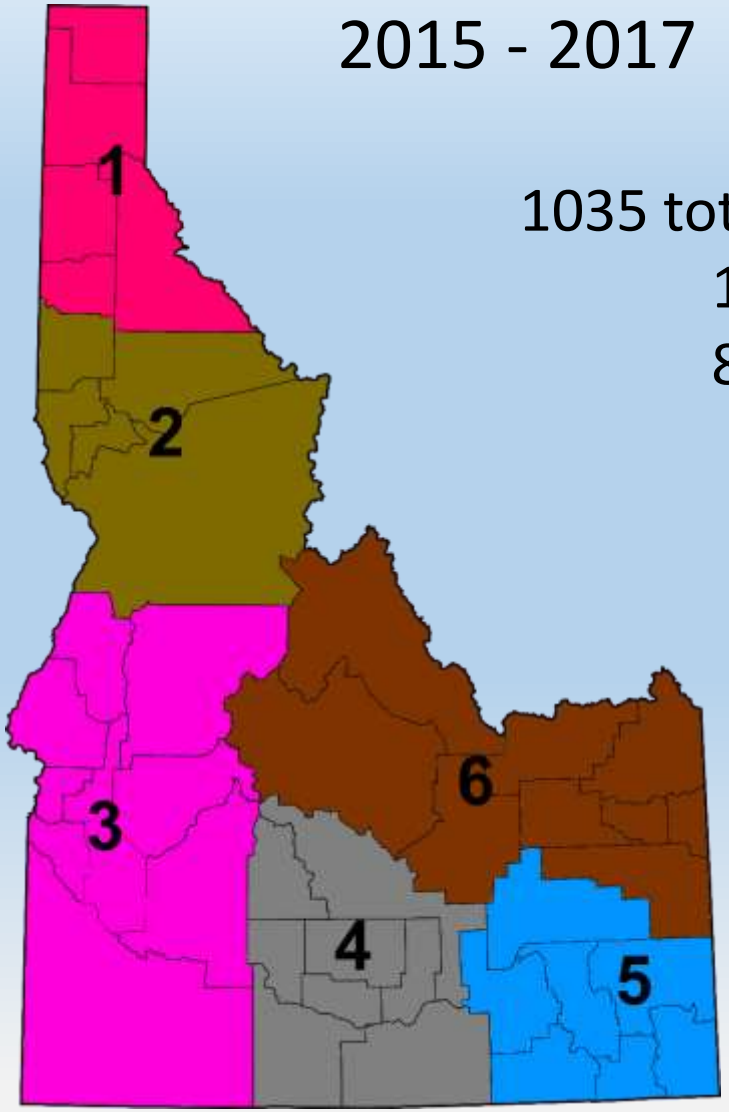
Idaho Pilot Project

- Develop a more effective strategy for project selection and design
- Use TSD deflection data with GPR layer thickness data to calculate pavement structure properties
- Publish the data as a geospatial database usable to a wide audience
- Demonstrate the use of the data at both network and project levels

Pilot Project – Idaho District 6

2015 - 2017



1035 total miles of roadway

168 miles Interstate

867 miles primary roads

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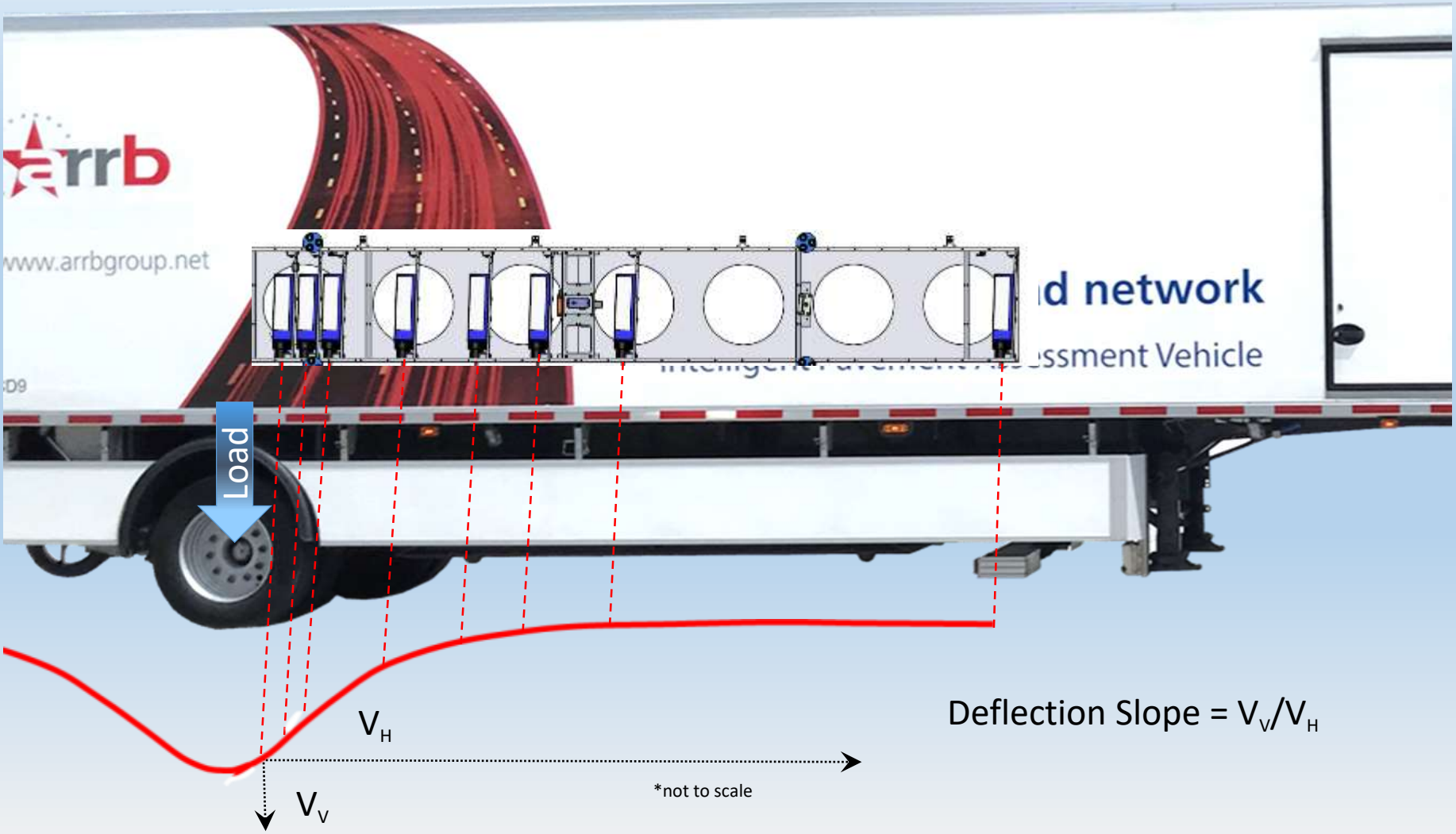
Data Collection

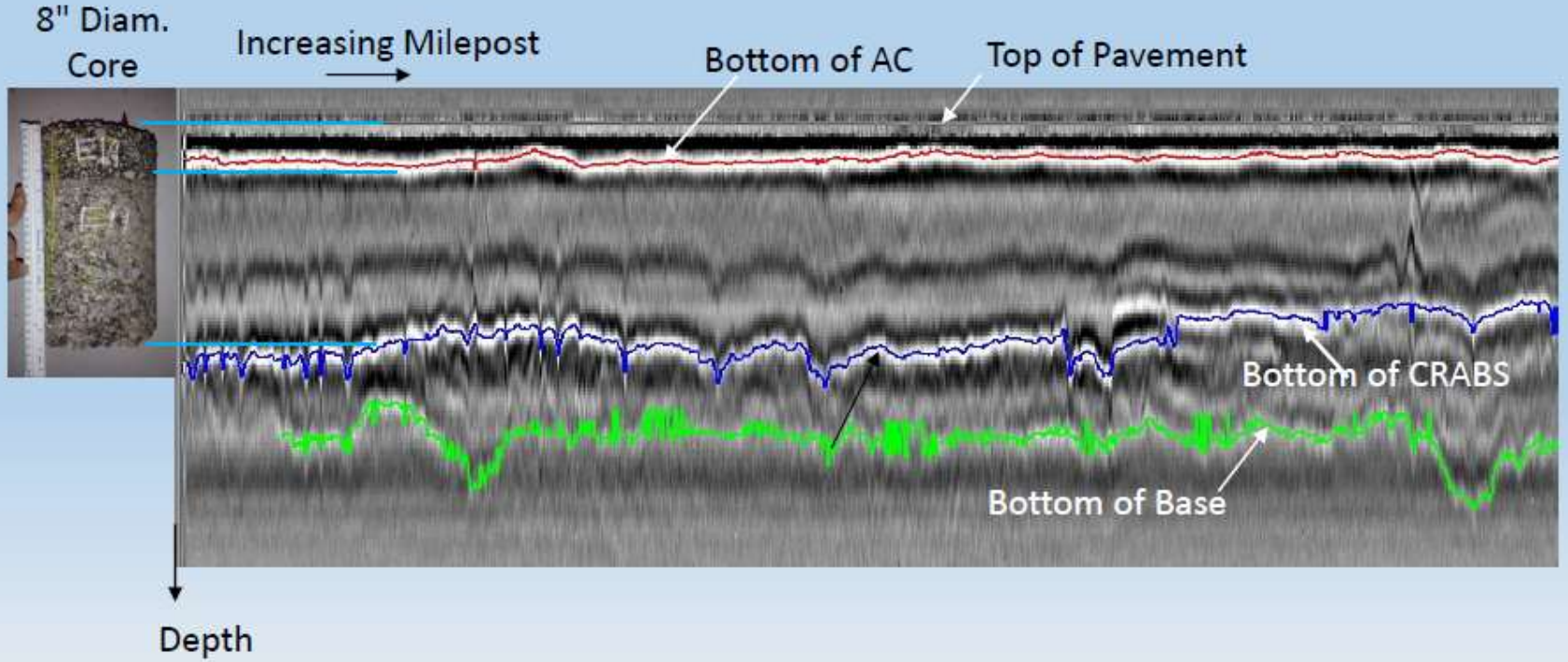
- TSD continuous at 10m and 0.01 mi. intervals
  - Provides deflection slope at various offsets from load
- FWD data in select areas for comparison
- Ground Penetrating Radar (GPR)
  - 1 GHz Horn Antenna, continuous at 1 foot intervals
- Selective coring for layer structure clarification

Raw TSD Measurements



Deflection Slope = V_V/V_H

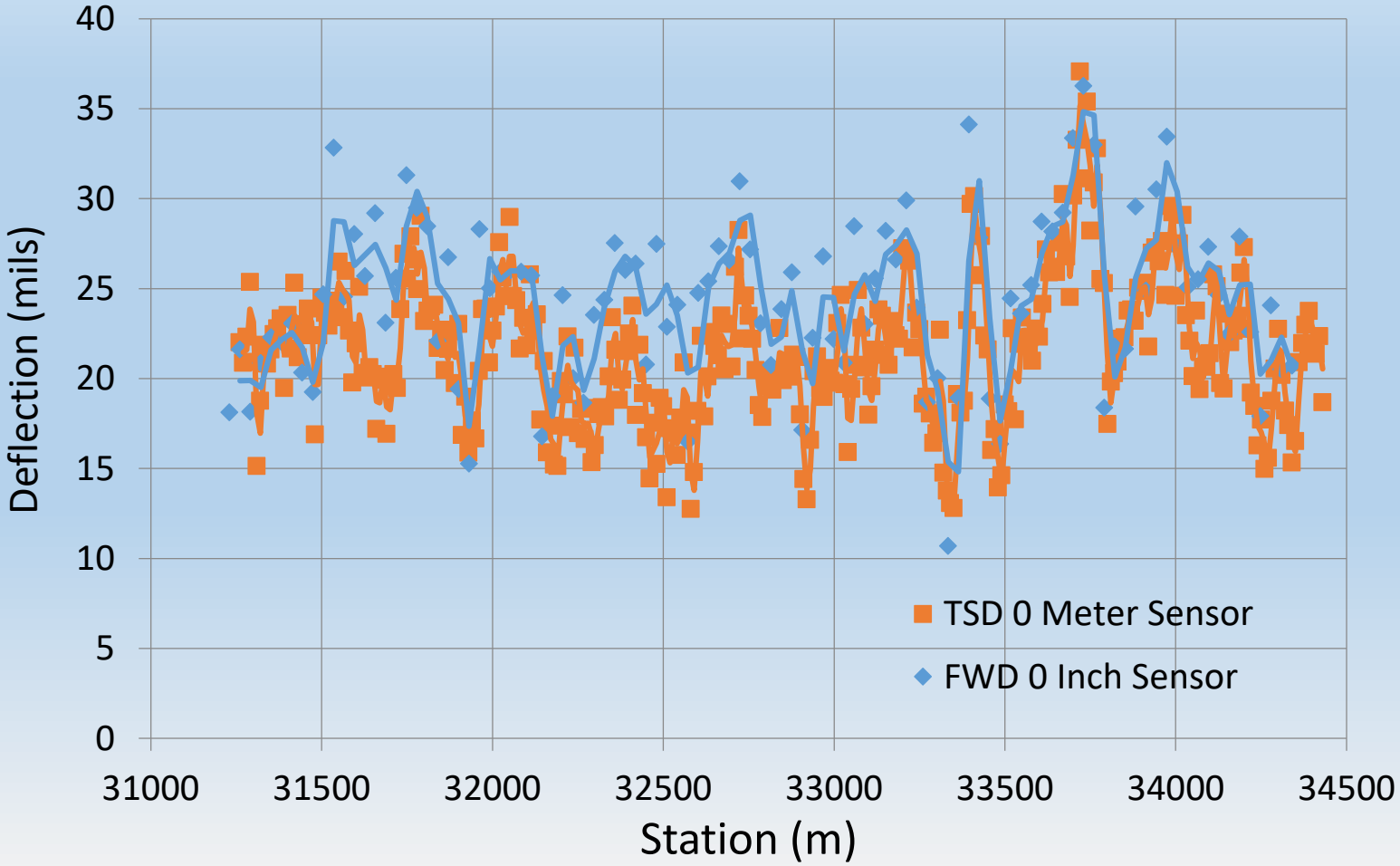
GPR Thickness Data Analysis



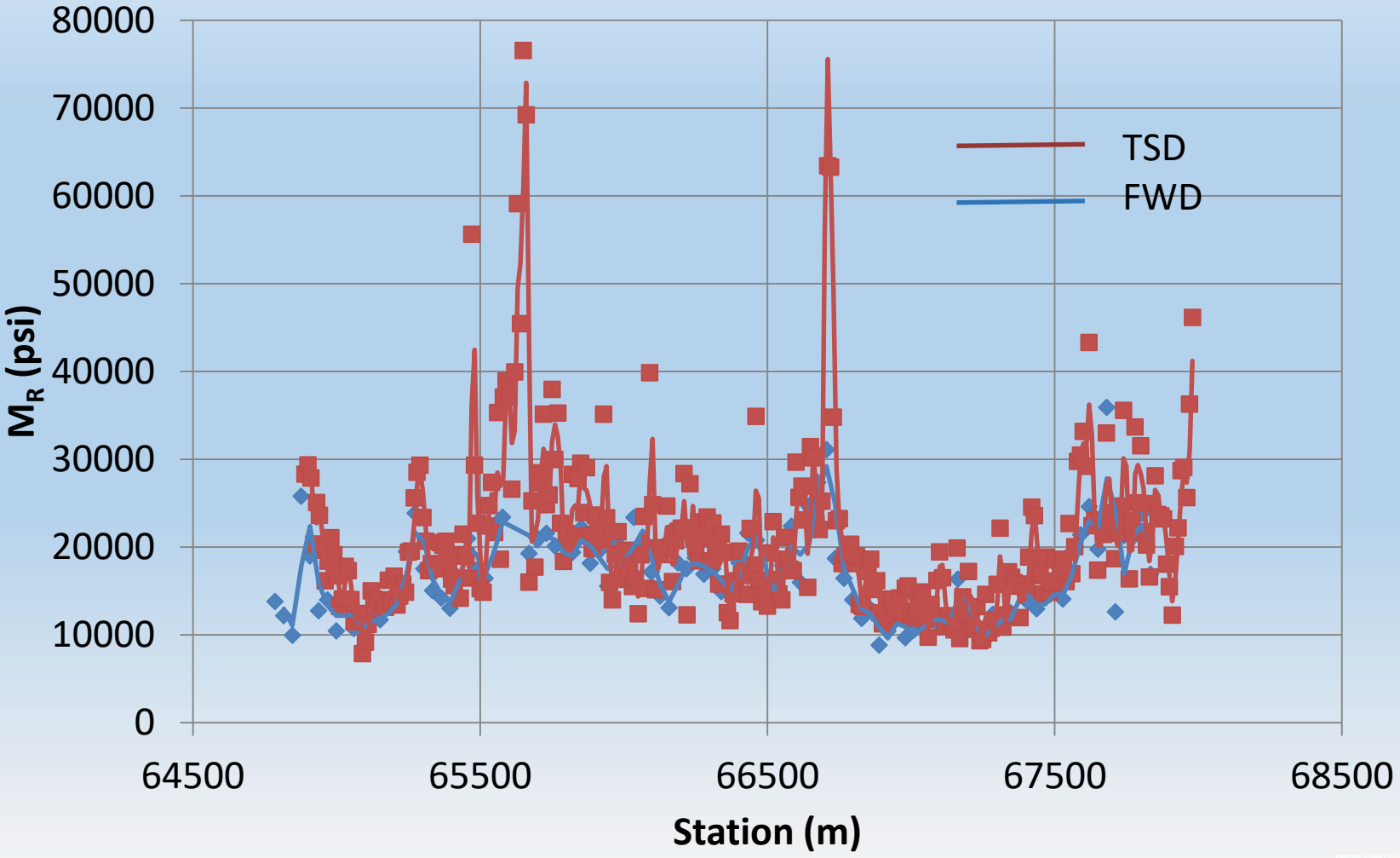
Data Analysis Calculations

1. Deflections (from TSD slopes)
2. Layer Thickness (GPR)
3. Layer Moduli (steps 1+ 2 using Evercalc)
4. Effective Structural Number (2 + 3)
5. Required Structural Number for 20-year life (3 + W_{18})
6. Required Overlay Thickness (from 5)
7. Remaining Service Life (from 3, 4, and W_{18})

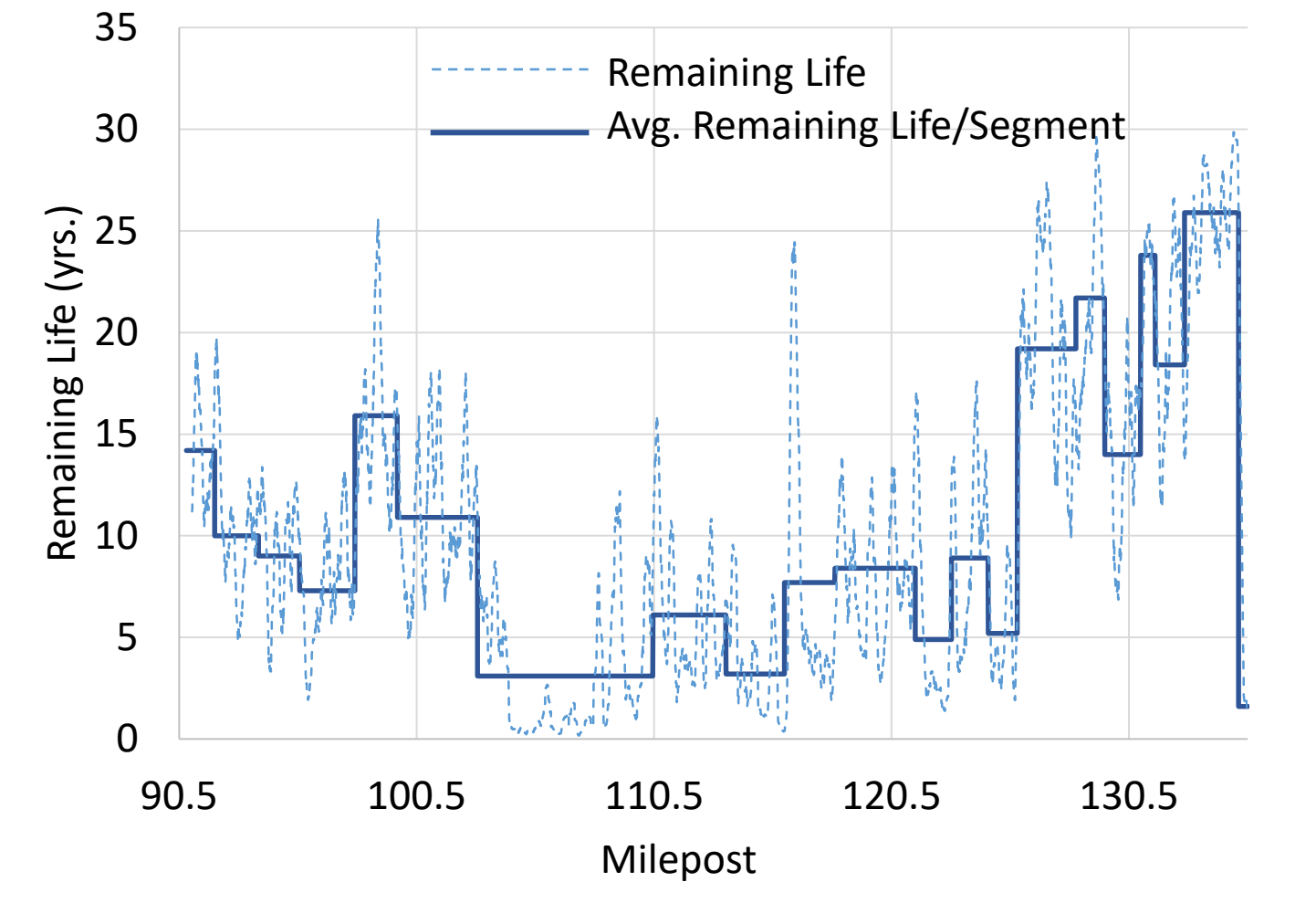
TSD vs. FWD – Maximum Deflection (D0)



TSD vs. FWD – Subgrade Modulus (M_R)



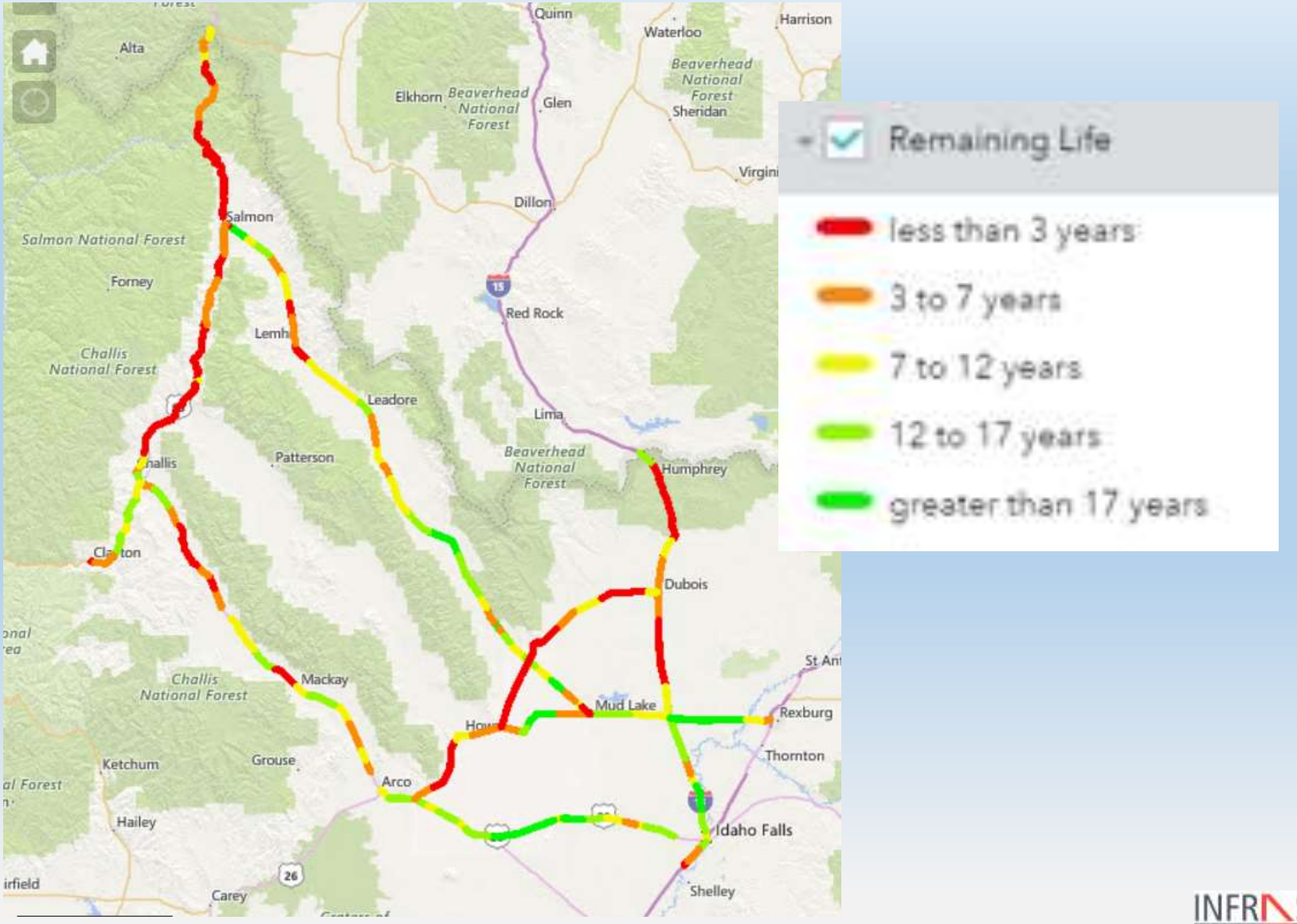
Segmentation and Remaining Life (SH 28)



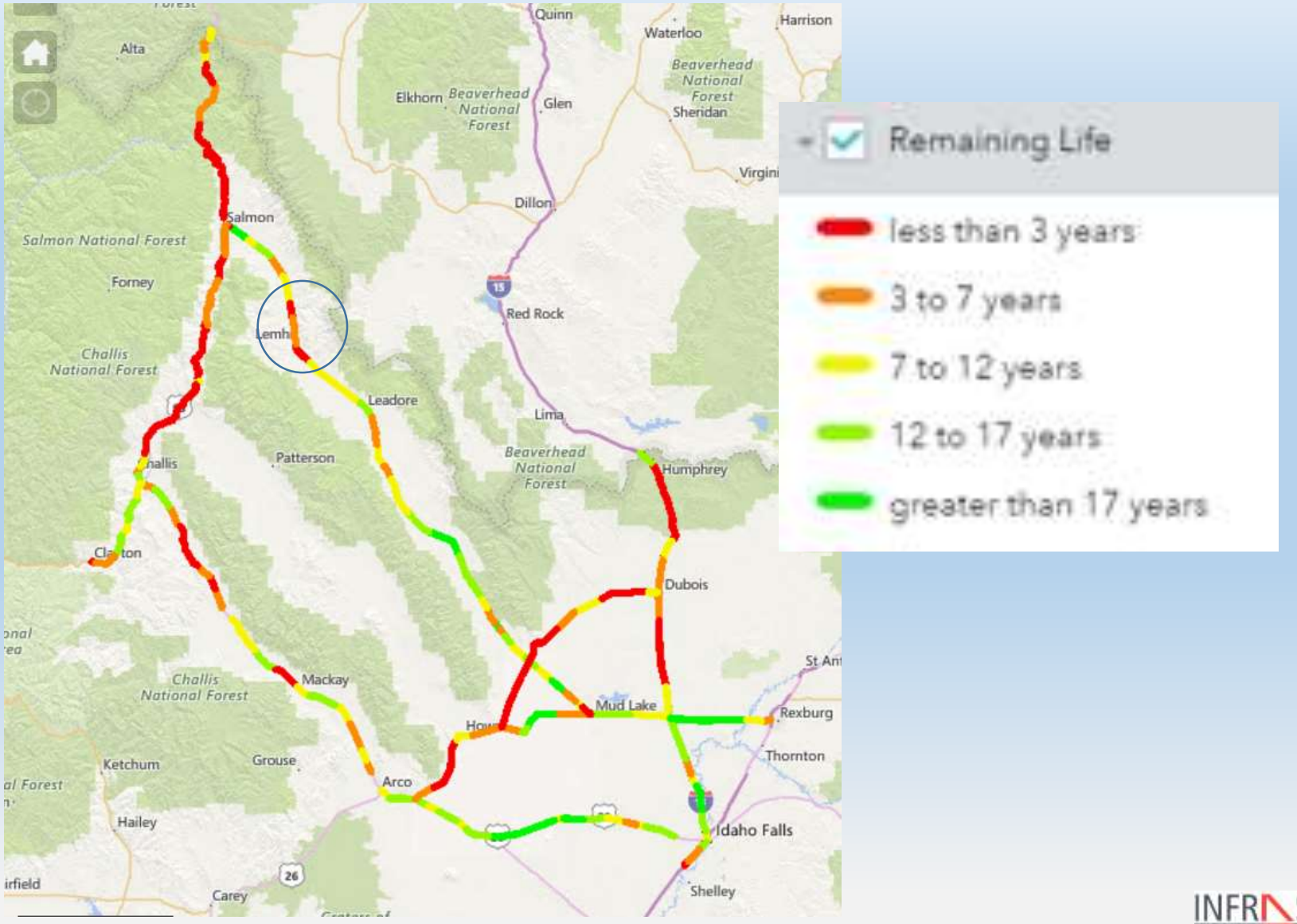
Roadway Structure GeoDatabase

- Data is recorded in a series of tables
- Data is displayed spatially using ArcGIS
- Database is accessible through iPLAN
- http://iplan.maps.arcgis.com/apps/webappviewer/index.html?id=8099d313c7ac45119d44af98eeb98dfe

Segmented Remaining Life (years)



Segmented Remaining Life (years)



US-28 Project-Level Segment Analysis

Remaining Life

US-28 Project-Level Segment Analysis

Remaining Life

Structural Number

US-28 Project-Level Segment Analysis

Remaining Life

Structural Number

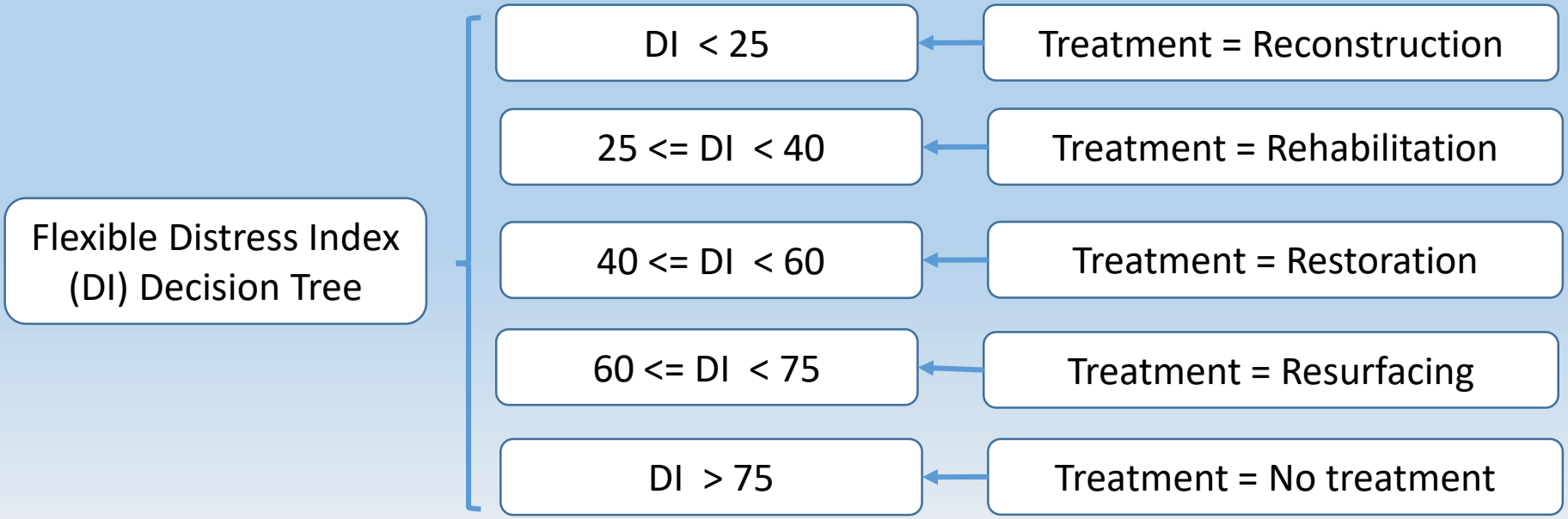
Subgrade Modulus, M_r

Use of Structure Data in Pavement Management

- Incorporate Data into PMS database
  - (ITD TAMS uses Agile Assets)
- Decision Rules - Add structure parameters to supplement surface distress
- Performance Curves - modify existing curves using structure data

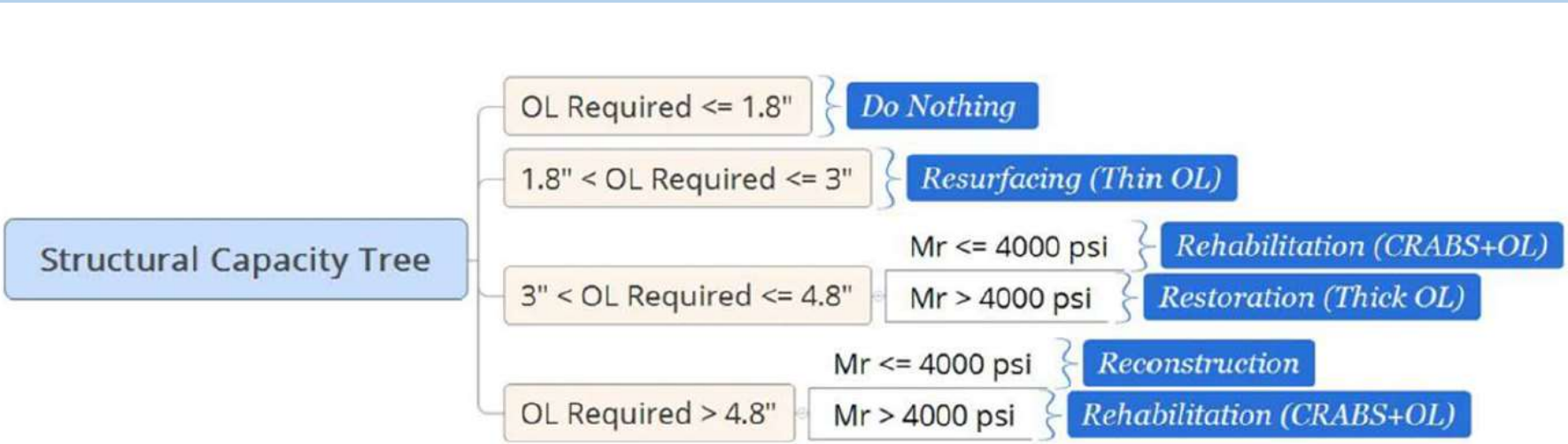
Typical PMS Decision Rule

- Distress index based on fatigue cracking, patching, and edge cracking



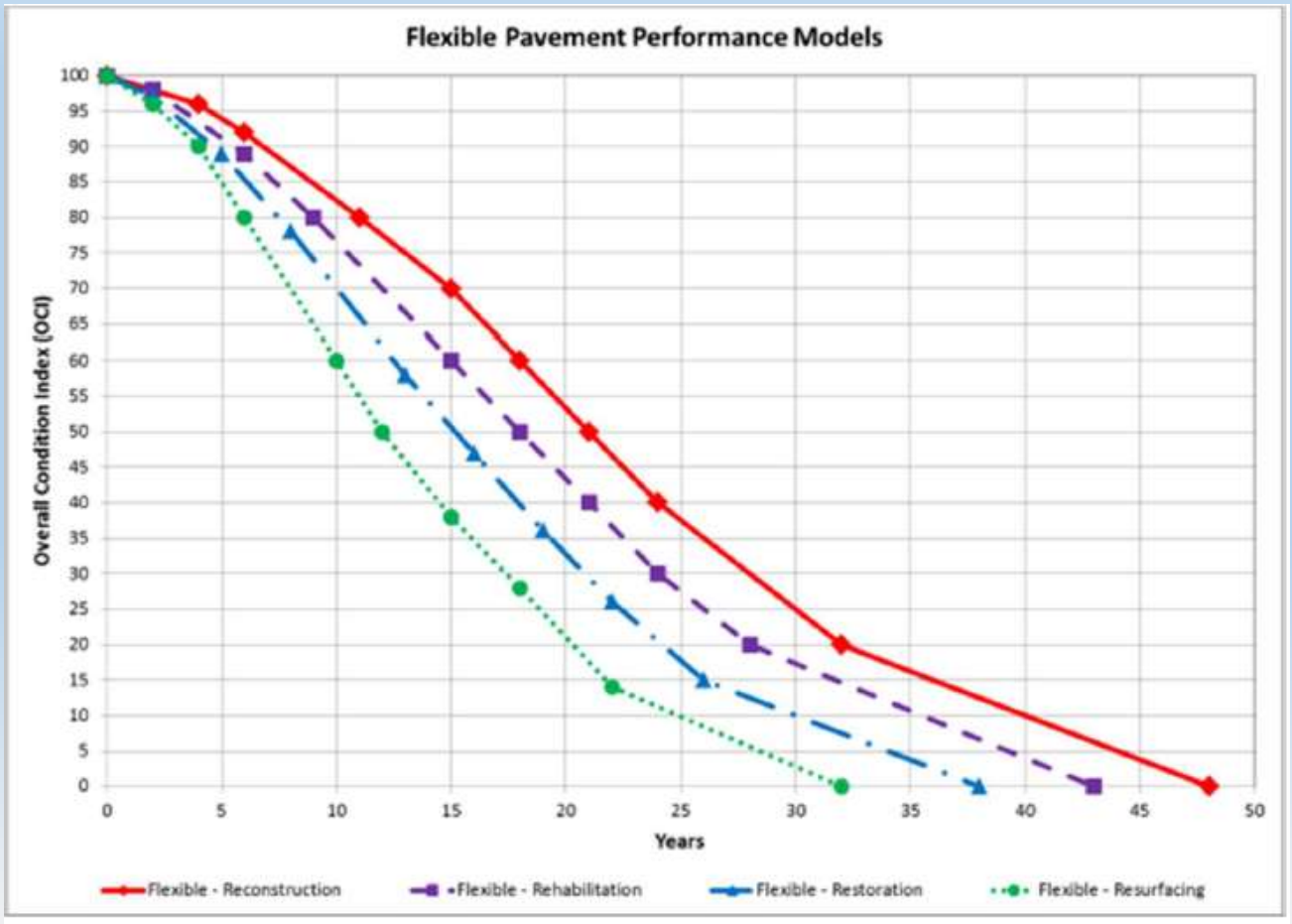
Add Structural Capacity Decision Tree

- Add Decision Rules based on Required Overlay Thickness (OL) and subgrade modulus Mr



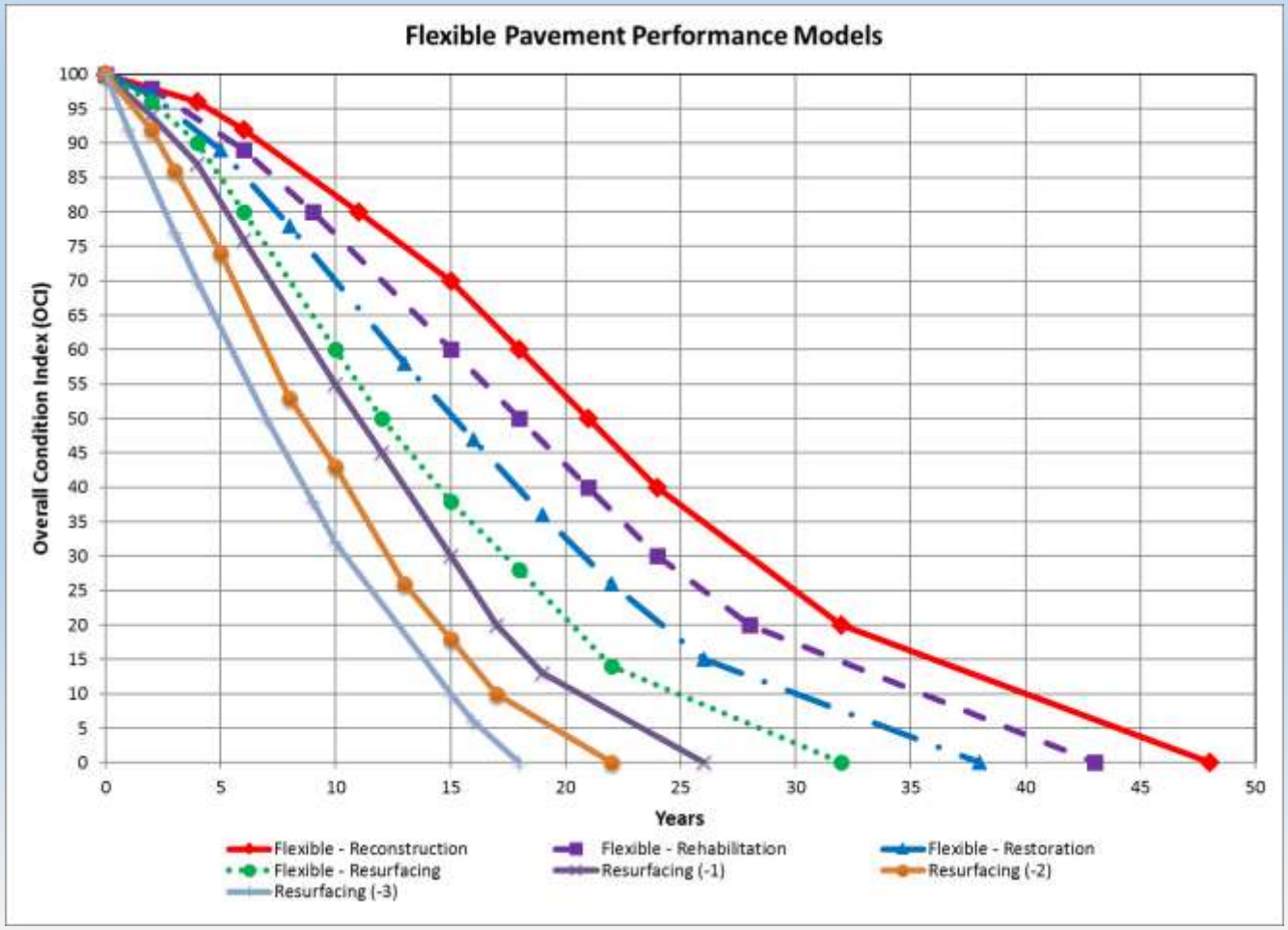
TSD Roadway Structure Data in PMS

- Standard Performance Curves



TSD Roadway Structure Data in PMS

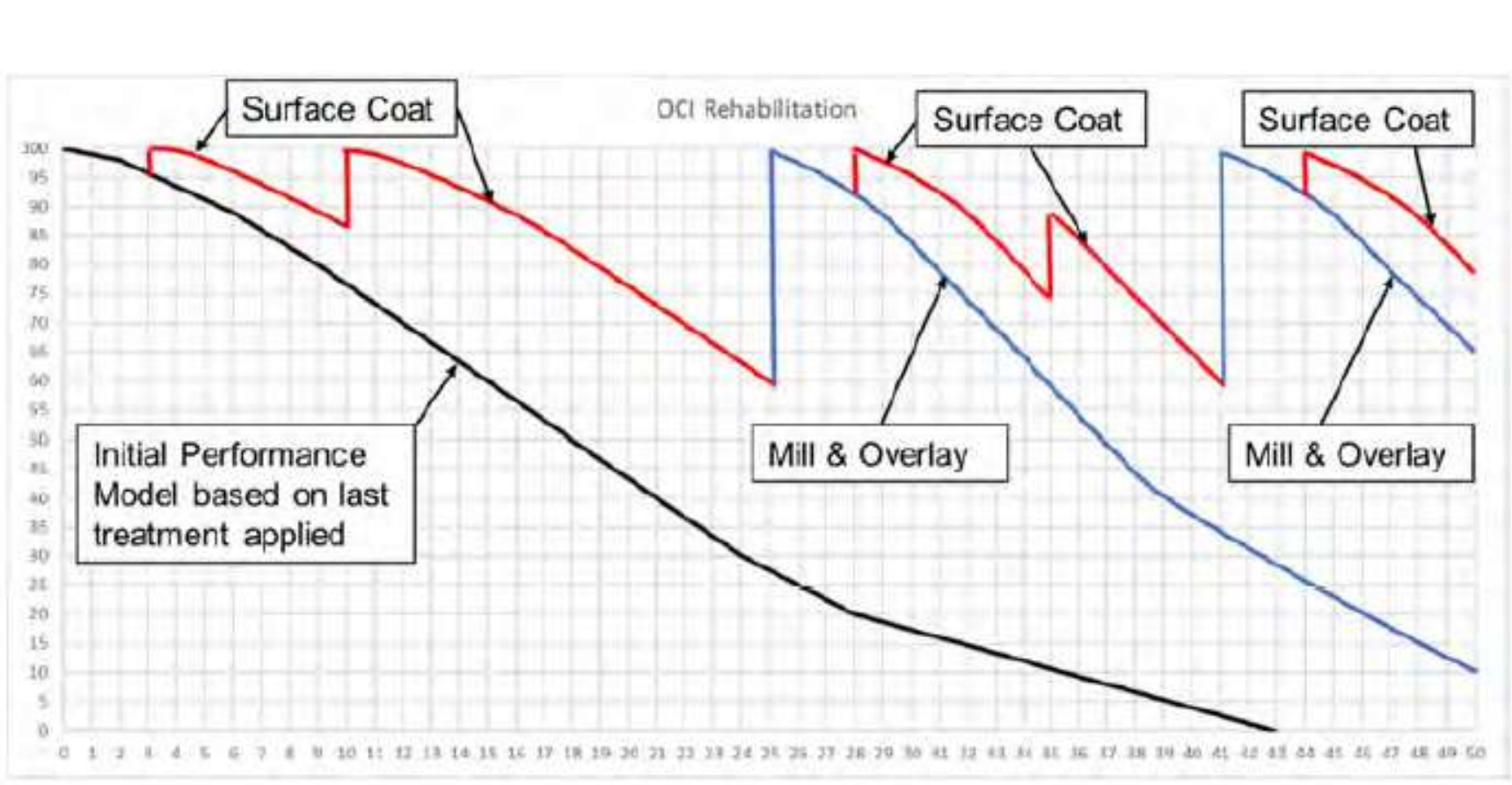
- Modified Performance Curves



Life-Cycle Simulation for 217 Segments

- Evaluate decisions and resource allocation
  1. Treatment options using surface distress only
  2. Treatment options adding structure data to the treatment decision trees
- Compare the two over a 50-year life cycle
- Examine the benefit

Life Cycle Modeling per Pavement Segment



50 year 'Network' Life Cycle Results

217 sections (735 miles) analyzed

Benefit

- Est. Cost Savings Using Structure Data : $15,572,100
- $15,572,100/735 miles = $21,186/mile over 50 years

Cost/Benefit

- If ITD collects this data every 5 years, then:
  $21,186/10 = $2,118/mile per rating cycle in savings
- Assume data collection cost is $300/mile
- Return on Investment (ROI) = $2,118/$300 = ~7

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Summary of TSD + GPR

- Combination of TSD and GPR has been demonstrated for determining network-level roadway structure data
- Process has been completed on over 1000 miles of roadway
- Resulting data is available via a statewide geodatabase
- Results support network overview and project planning
- Use of results in PMS can produce significant cost savings
- These results will be extended statewide using additional TSD data provided by the pooled fund study

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