Flexible Pavement Research Initiatives

Outline

- R27-204 – Optimized HMA Lift Configuration for Performance
- R27-216 – Optimizing the Use of Local Aggregates in SMA
- R27-221 – Chip seal Quality Assurance using Percent Embedment
- R27-227 – Moisture Content and In-Place Density of Cold Recycle Treatments
- R27-233 – Mechanistic-Empirical Design Procedures for Flexible Pavements
- EDC-6 Targeted Overlay Performance Solutions
- In-House micro surfacing research

R27-204 Objective

This project supports IDOT in developing specifications and updating policies to implement a performance-based approach for asphalt concrete mixes and lift configurations. Large-scale pavement testing using various mix designs and lift thicknesses will help develop a sound overlay policy.

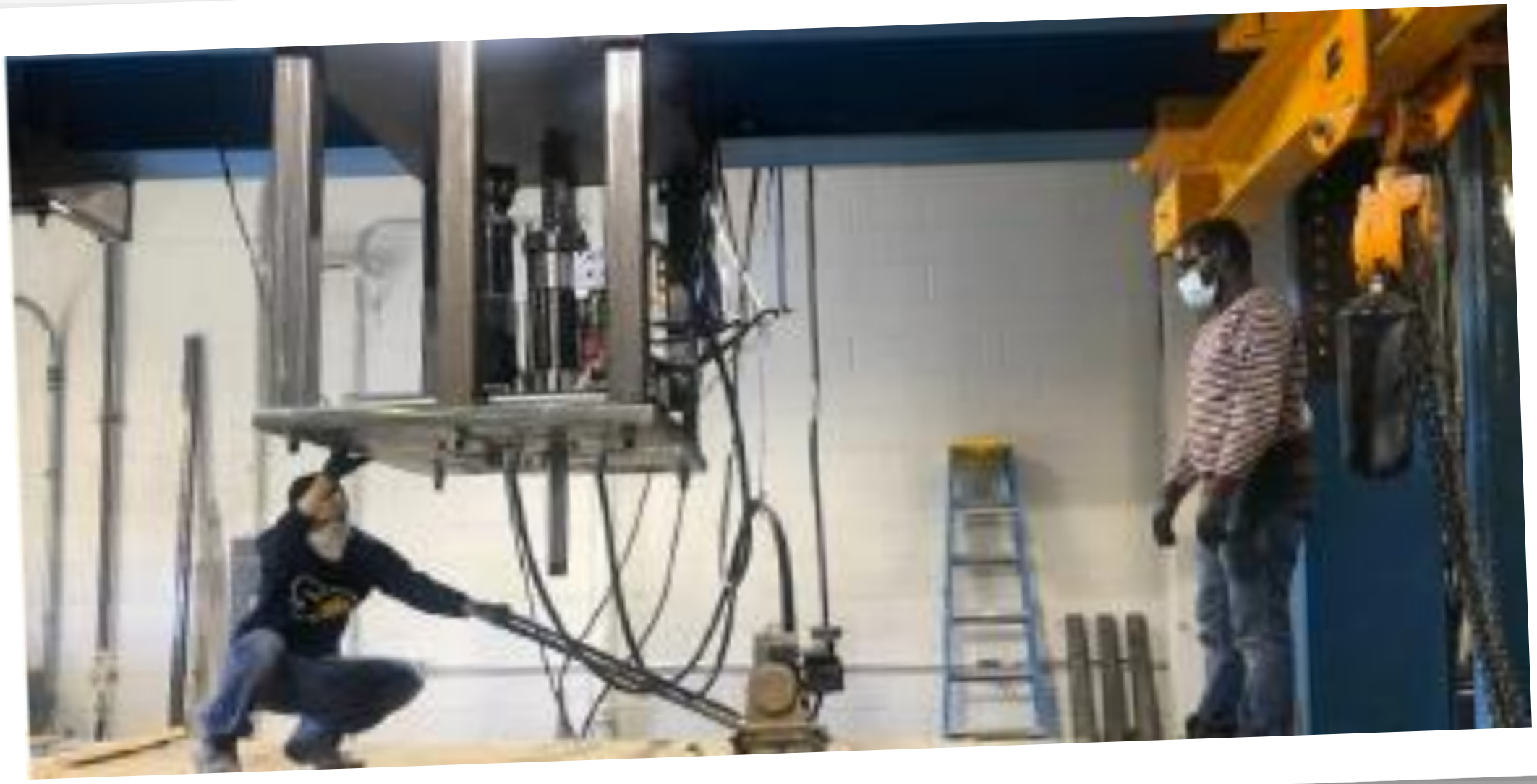
R27-204 Status

65% of project complete

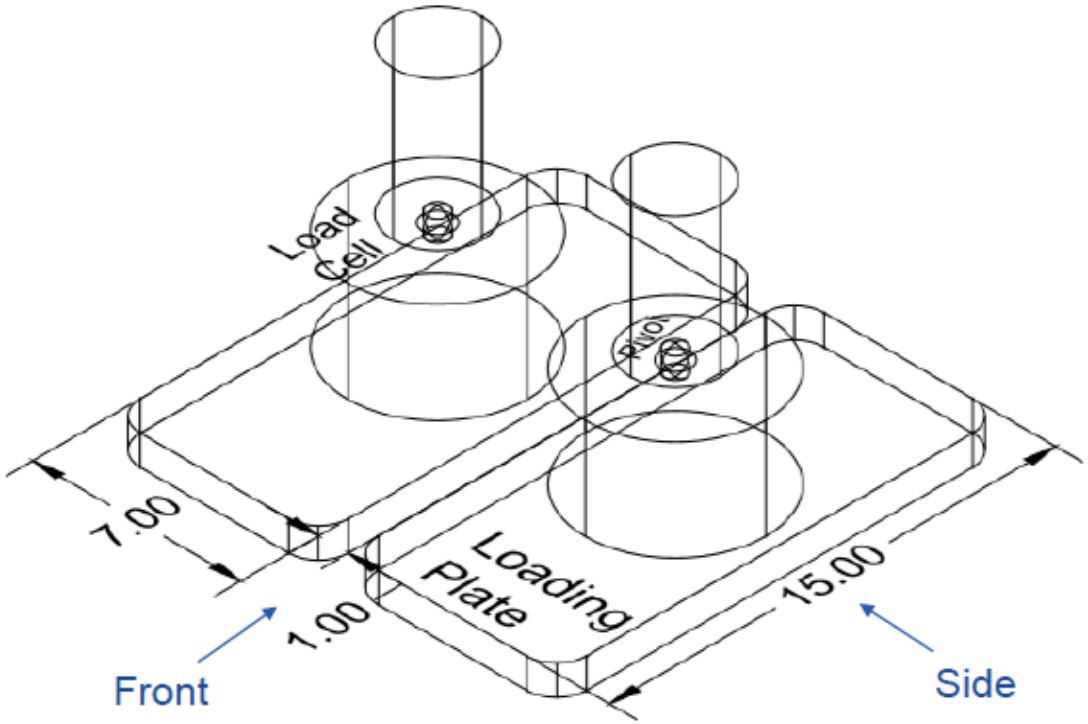
Tasks completed – lit review, testing plan, modifications to large scale equipment, materials and mix designs

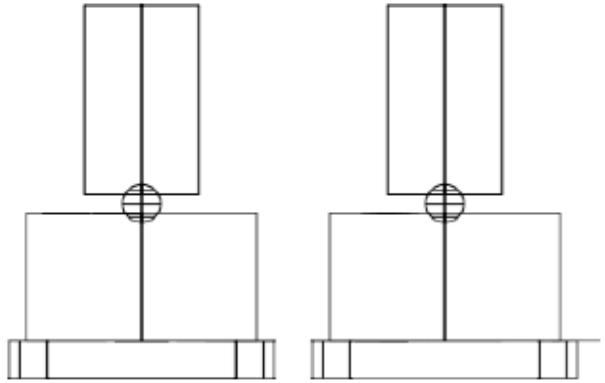
Remaining work – mix verification and lab experiments, lift production and large scale testing, Mechanistic analysis and cost effectiveness

End date is 2/15/2023

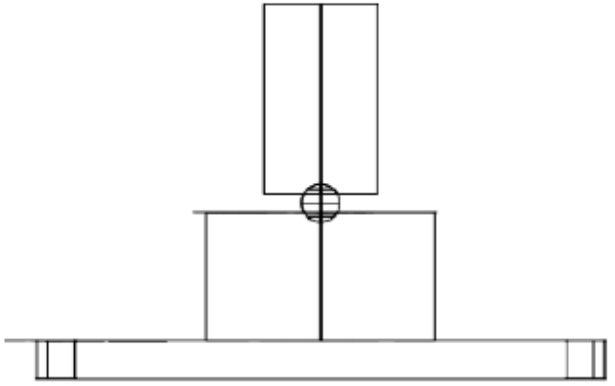


Actuator Configurations





Front View

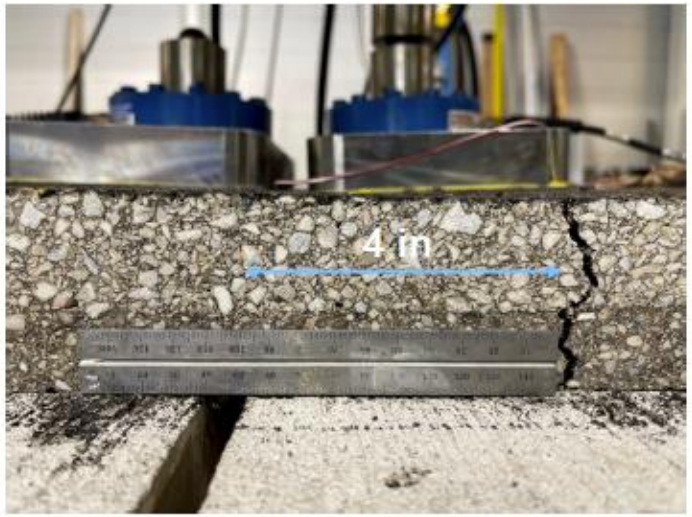


Side View

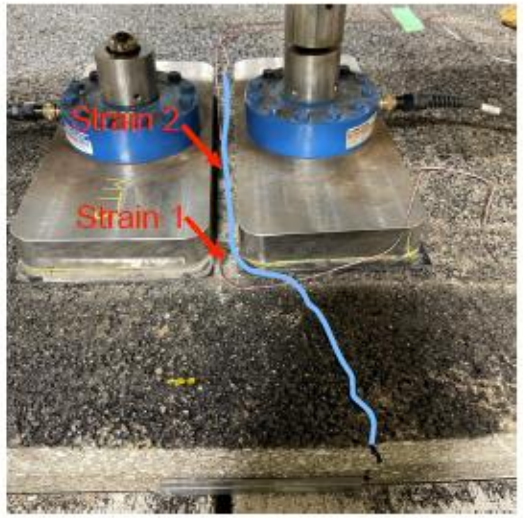
- Simulates dual-tire assembly contact
- Maximizes both bending and shear effects
- Experimentally practical

Trial Test 2 – Crack Pattern

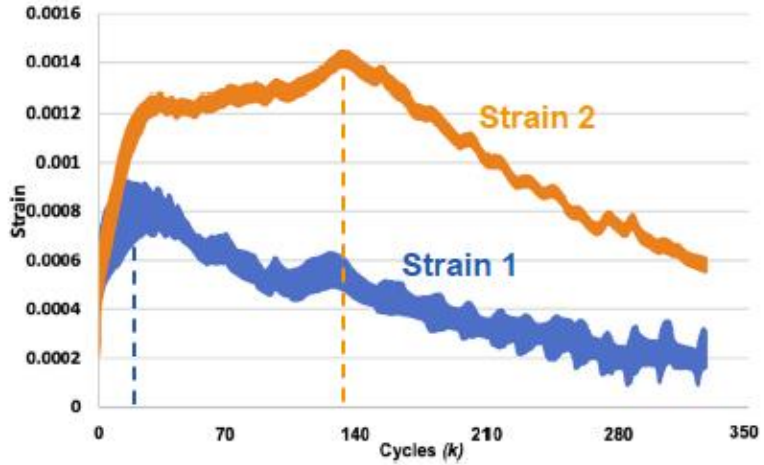
Test Slab Failed in Less Than 300k Cycles after 3-day testing



A single well-defined crack on edge cross section



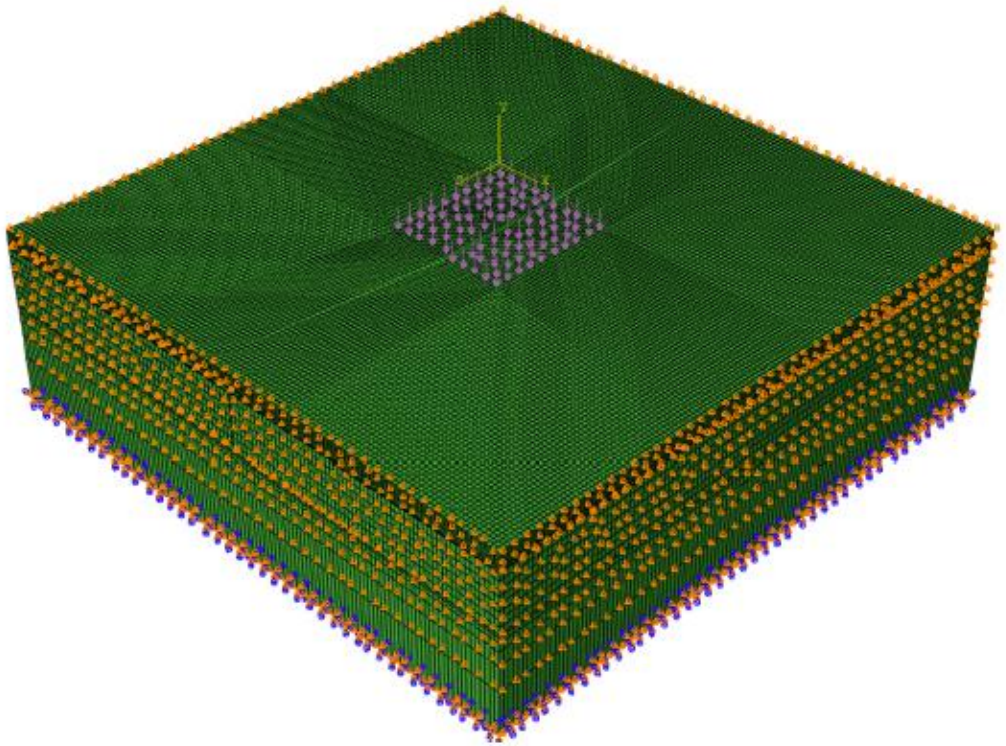
Crack path on the surface



Crack initiated at
Plate edge @ *25k cycles*
Plate center @ *135k cycles*

Testbed Modeling

Simulates testbed configuration and loading conditions:



1 Materials

- Viscoelastic HMA layers
- Linear elastic PCC
- Linear elastic subgrade

2 Interfaces

- No connection between PCC
- Stick-slip model for layer interfaces

3 Loading

- Uniform rectangular pressure
- Amplitude simulates pulse load
- Plate = 15 x 7 in
- Loading plate spacing: 1 in

4 Slab Dimensions

- Subgrade = 12 in
- L = B = 6ft; PCC = 7 in,
- HMA BC = 0.75 in, WS = 1.5 in,
- Notch width = 10 mm

R27-216 Objective

Stone-matrix asphalt is a durable and stable hot-mix asphalt with a proven long service life. This project aims to determine whether Illinois Department of Transportation can use locally available aggregates in SMA to reduce the cost and environmental impact of its production without sacrificing resistance to pavement rutting or cracking. The researchers will determine cracking resistance by evaluating the results of SMA mixtures using local as well as traditional imported aggregates. Reducing the cost of SMA will allow it to be used more widely in Illinois. Widespread use of SMA will result in less frequent pavement rehabilitation, fewer traffic interruptions from road construction and substantial cost savings.

R27-216 Status

- Project is 31% complete
- Completed tasks – lit review, material investigation and selection, Material sampling and testing,
- Remaining tasks – Lower N-Design Evaluation, SMA design, Lab Perform. Characterization of SMA, Large Scale Testing of SMA Wearing Courses, LCA and LCCA Quantification
- End date is 8/15/2023

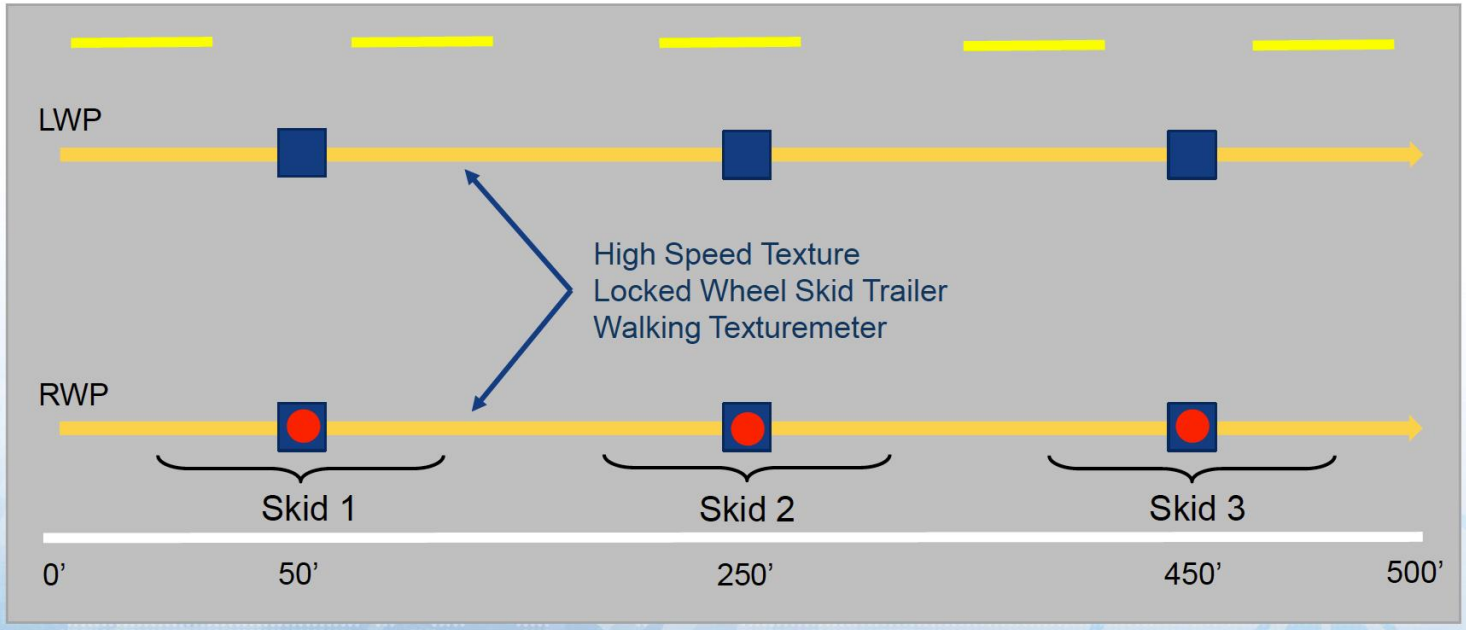
R27-221 Objective

The objectives of this proposed study are (1) to determine if texture measurements can be used to accurately calculate the percent embedment, (2) to identify the appropriate surface texture measurement as well as other parameters to be correlated with percent embedment, and (3) to identify an accurate and cost-effective method for chip seal texture measurement using the best available technology.

R27-221 Status

- Project is 31% complete
- Completed tasks – lit review
- Remaining tasks – field studies and development of guidelines
- End date is 2/15/2023

Field Testing Plan



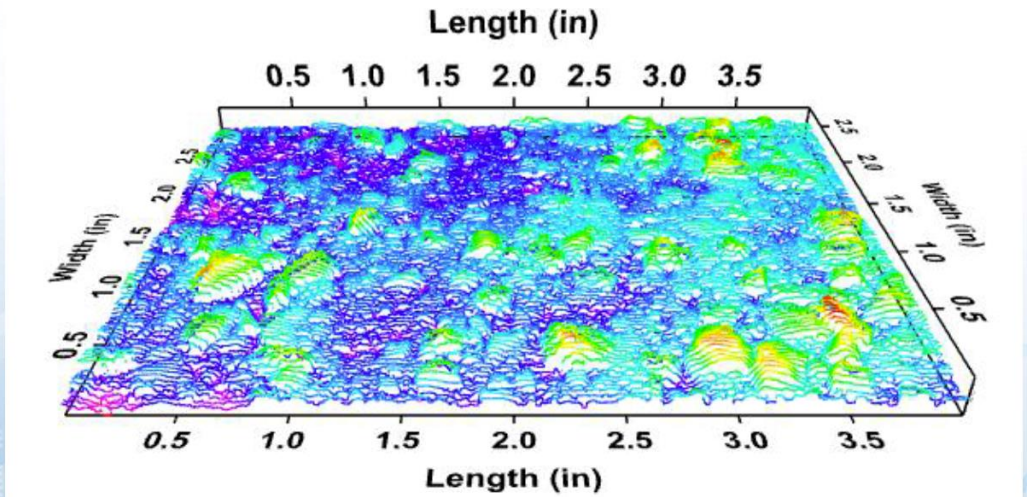
Texture Data (High Speed Texture Profiler)

High Speed Measurements

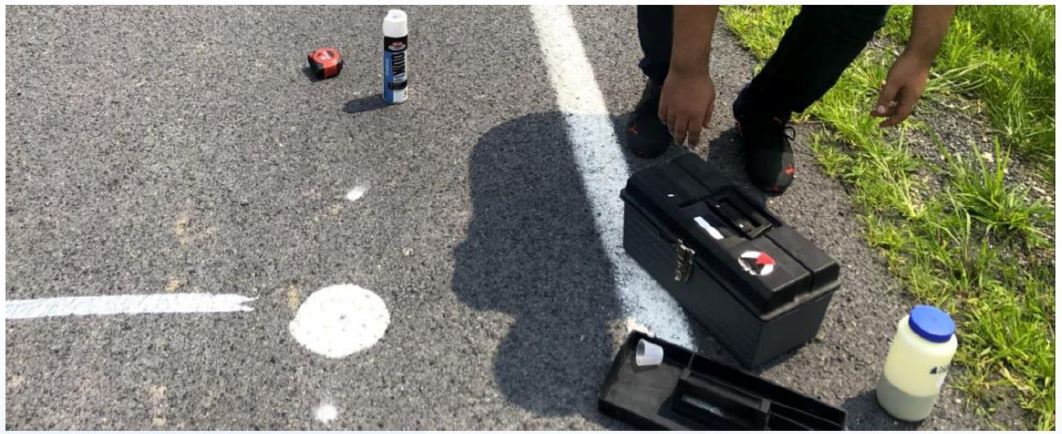
Texture Data (LTS)

Stationary High-Resolution Measurements

Texture Data (LTS Line Scans)



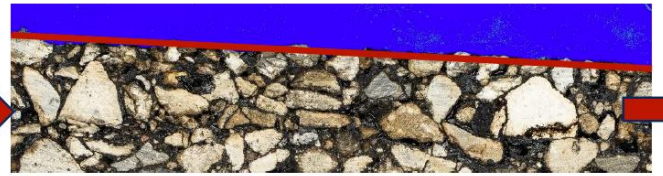
Sand Patch Test



Pre-Processing of Images

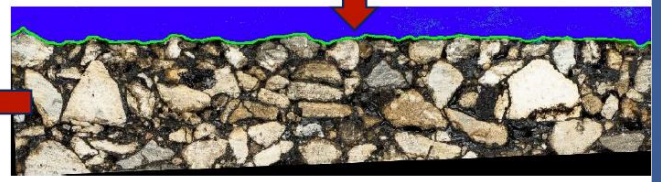
- Applied to all images

Original Image

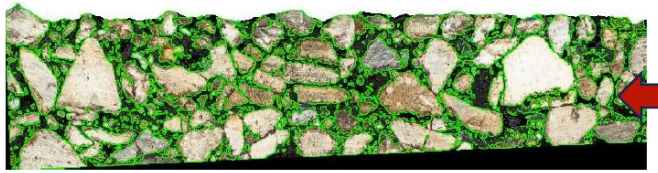


Crop out Background

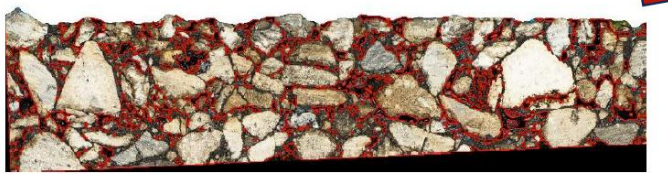
Rotate Image (Flat Surface)



Detect Pavement Surface



Detect Aggregates



Detect Binder

Analysis Methods

- Peak Method (Similar to MSU's Peak & Valley Method)
- Surface Coverage Method
- Average Elevation Method
- Area Method
- Percent Embedment of Each Aggregate Method
- Aggregate Circumference Method

R27-227 Objective

This study proposes investigating the feasibly of monitoring moisture content and density of an emulsified asphalt mixture during curing. The dielectric properties and resilient modulus of the CIR will be evaluated using GPR and the light weight deflectometer (LWD), if available. The relationship between the dielectric constant and the moisture content of the emulsified asphalt mixture will be evaluated, and the moisture content will be predicted or indicated based on GPR measurements. A moisture content prediction or an indicator model will be proposed to assist in the decision-making of traffic-opening time. In addition, it is proposed to modify the ALL model for in situ density prediction of CIR treated AC mixtures based on the results from this project. This suggests that the effect of internal moisture content will be considered.

R27-227 Status

- Project is 72% complete
- Completed tasks – lit review, In-situ Measurement of CIR Dielectric properties, Moisture content predictions using Dielectric Constant,
- Remaining Tasks – CIR Density Prediction using Modified ALL Model, Data Processing and Results Delivery
- End Date – 5/15/2022

Research Approach

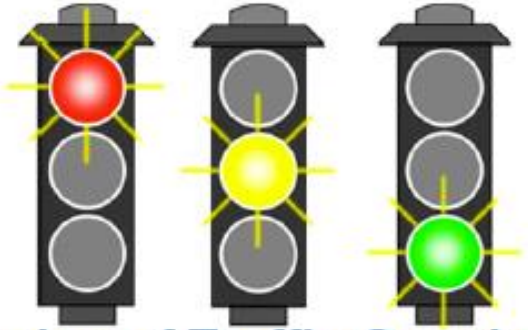
Moisture Content Monitoring

- Field and Lab Tests
- Simulation
- Statistical Analysis

Dielectric Constant

Moisture Content

Dielectric Constant-Moisture Content Relationship



Timing of Traffic Opening/ Overlay Placement

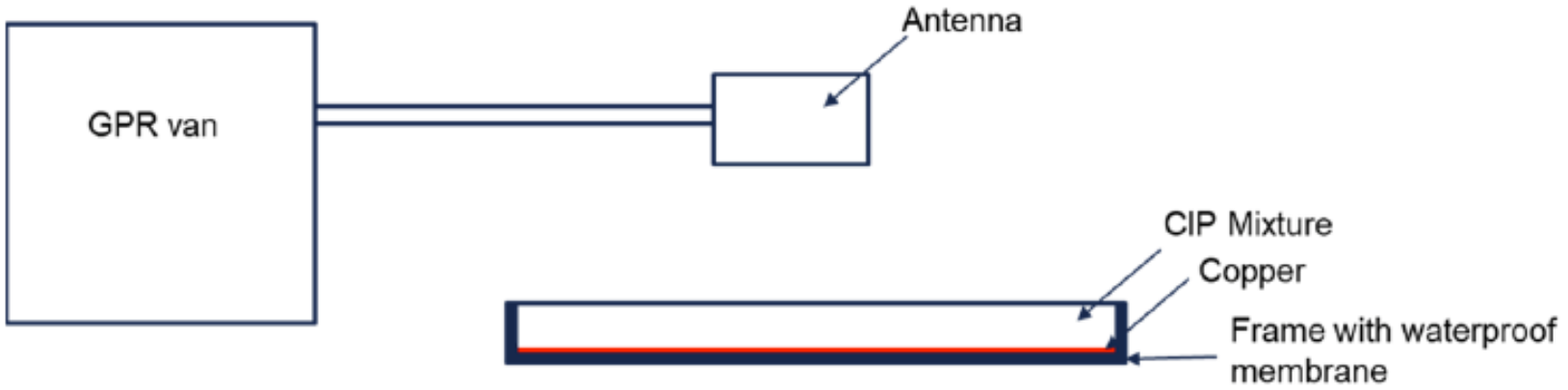
Moisture Content/ Density Prediction

Field Testing during Covid-19

- Face Masks
- Sanitizing Accessories
- Social Distancing
- In-situ Safety Training

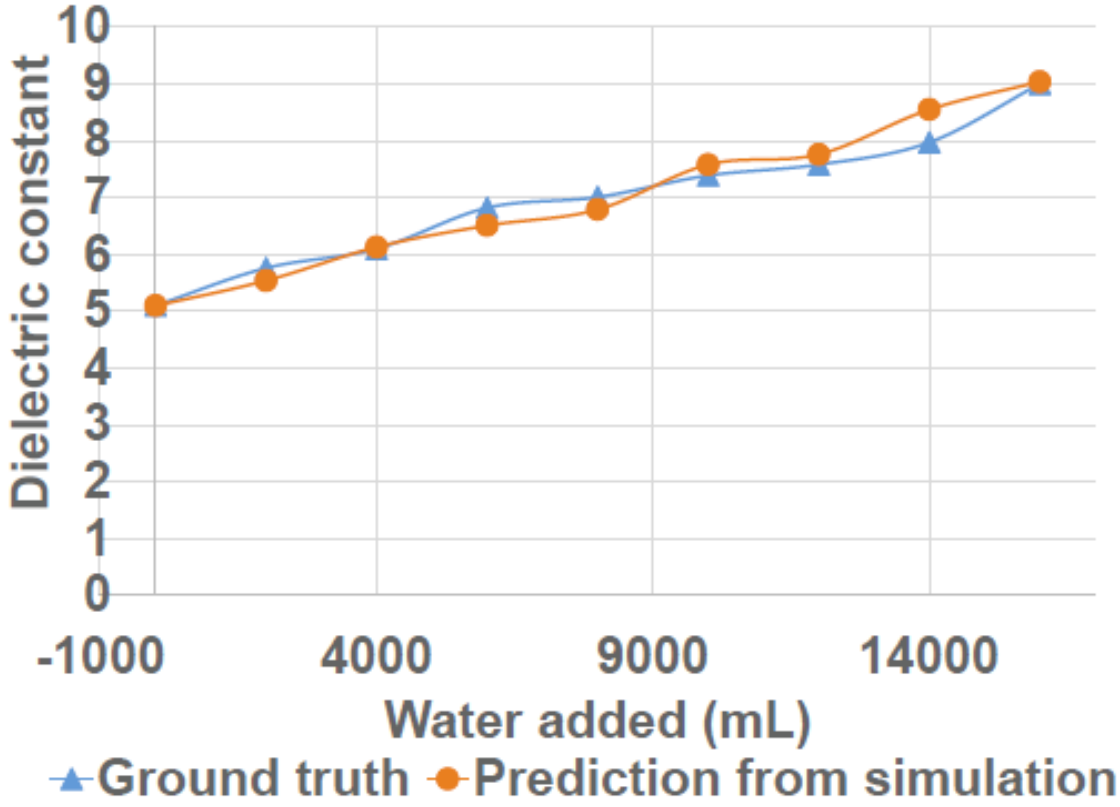
Indoor Test Plan

- Validate and fine-tune moisture prediction model under a controlled environment
- Extrapolate the ALL density-prediction model to non-dry AC pavement



Slab Results - Slab #2

- Dielectric constant prediction from simulation model



ACA Model

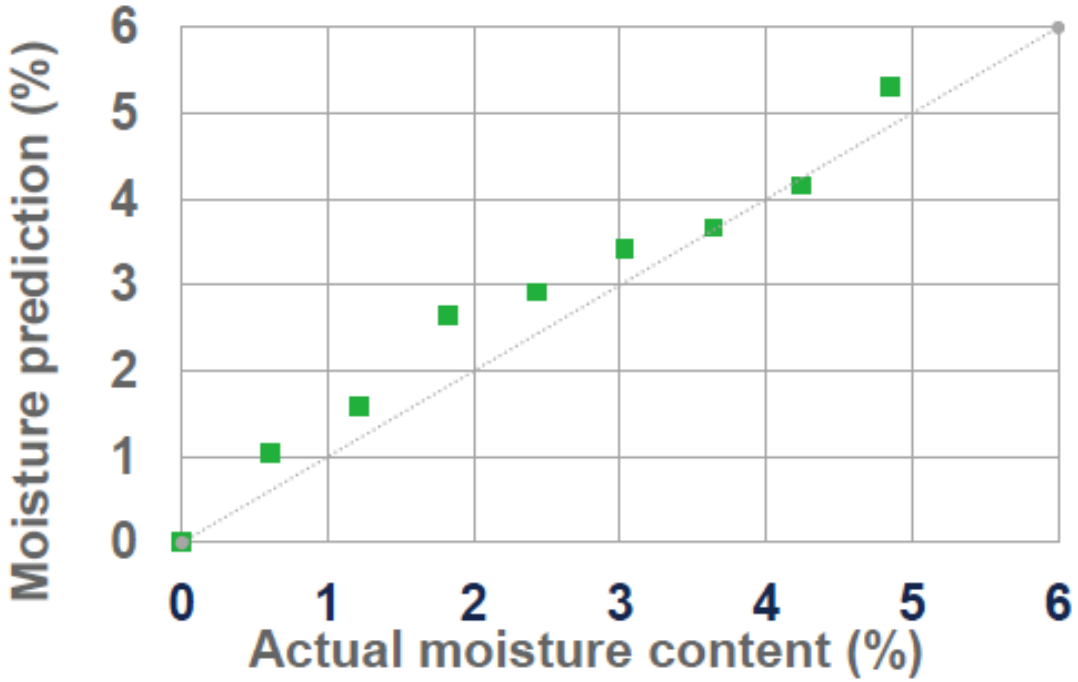
- Moisture content could be estimated by ACA model:

$$W = -\frac{\left((G_{mb}(C+D-B))^2 - 4DG_{mb}(A+G_{mb}(C-B)\right)^{1/2} + G_{mb}(B-C-D)}{2DG_{mb}}$$

ACA Model Performance

Indoor slab: predicting moisture content

R^2 =0.97 and
RMSE is 0.46%



ACA Model Performance

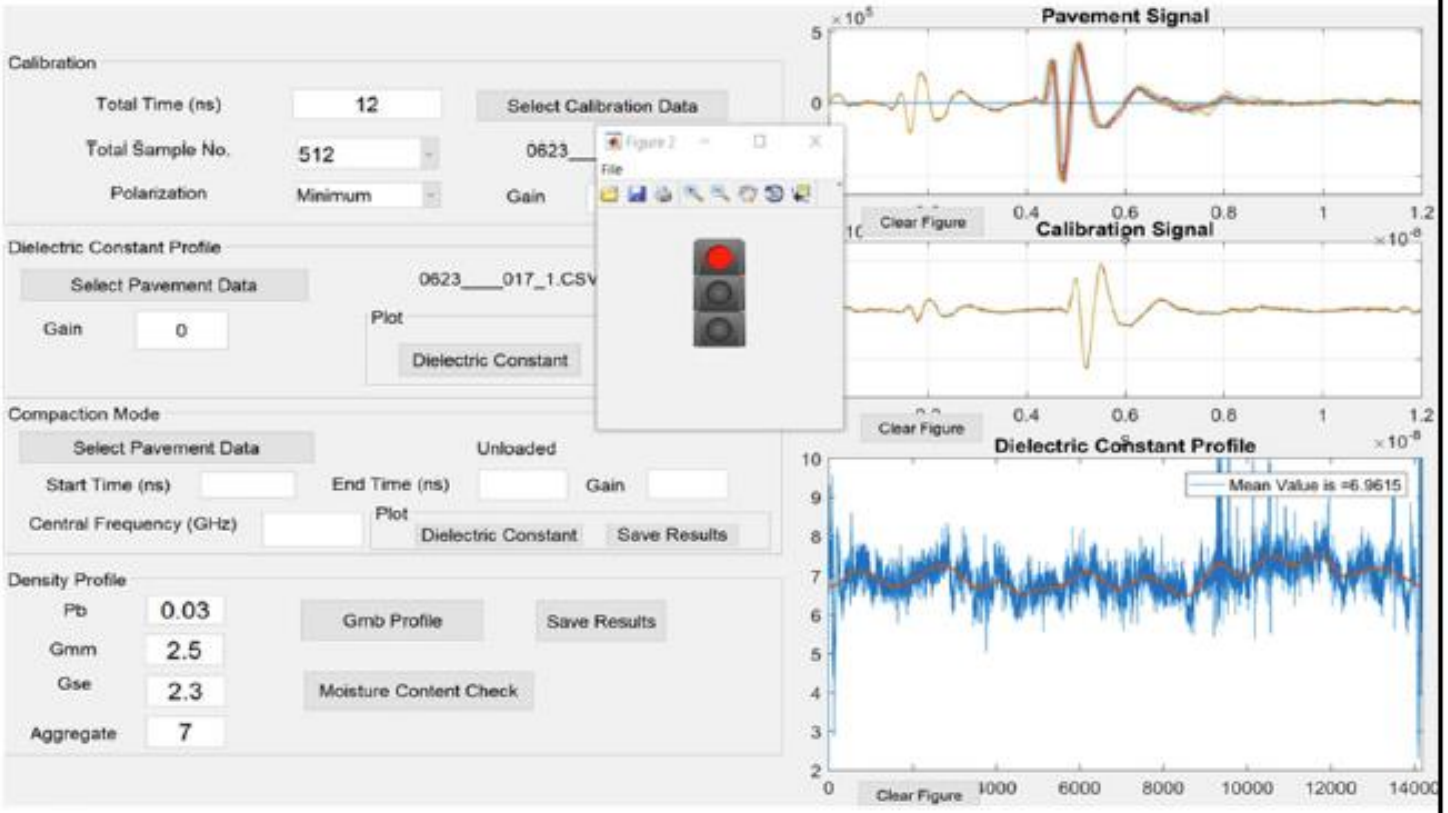
Indoor slab: predicting G_{mb}

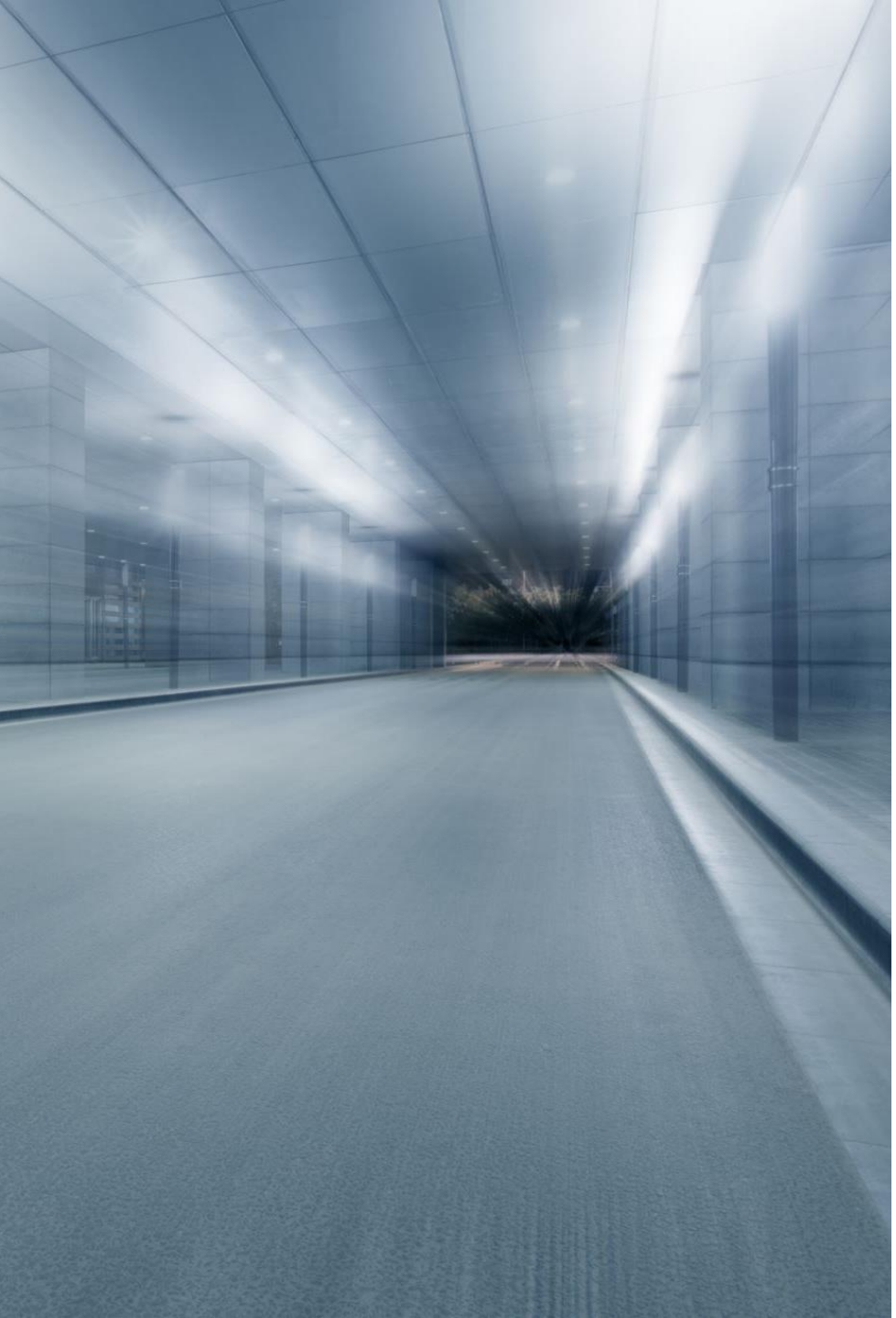
Actual slab G_{mb} is 2.184

Moisture Content (%)	Predicted G_{mb}	Error (%)
0.0	2.185	0.0
0.6	2.238	2.5
1.2	2.231	2.2
1.8	2.293	5.0
2.4	2.247	2.9
3.0	2.235	2.3
3.6	2.189	0.2
4.2	2.173	0.5
4.9	2.246	2.8
Average error %		2.0%
RMSE		0.059

Tool Introduction

- Incorporate moisture prediction model
- Compare MC results with a threshold
  - Guidance overlay/ road opening guidance





R27-233 Objective

Design procedures and policies for flexible (asphalt) pavements are continually evolving. This project aims to review the Illinois Department of Transportation's current design method and policy documents. Researchers will make recommendations to ensure that the design processes reflect the latest technology. Improved pavement designs are expected to result in cost savings and improved long-term pavement performance.

R27-233 Status

- Project is 10% complete
- Completed tasks – N/A
- Remaining tasks – lit review / monitoring, FWD and TSD data, BDE Ch. 54, FEL Criteria, FEL vs. Other Tests, Propose New Design Guidelines
- End date is 5/15/2024

EDC-6 TOPS

- Flexible options showcased
  - Crack Attenuating Mixture (CAM)
  - Highly Modified Asphalt (HiMA)
  - High Performance Thin Overlay (HPTO)
  - Stone Matrix Asphalt (SMA)
  - Asphalt Rubber Gap-Graded
  - Enhanced Friction Overlay
  - Open-Graded Friction Course (OGFC)
  - Ultra-Thin Bonded Wearing Course (UTBWC)

Micro surfacing Research

Central Bureau of Materials and the Bureau of Research are continuing to refine the residual asphalt extraction process

Extraction process has been proven to be accurate and repeatable

Several sampling containers have been tested and best option has been selected

Round robin testing in progress

Questions

Illinois Department of Transportation

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