Developing Best Practices for Rehabilitation of Concrete with Hot Mix Asphalt Overlays Related to Density and Reflective Cracking

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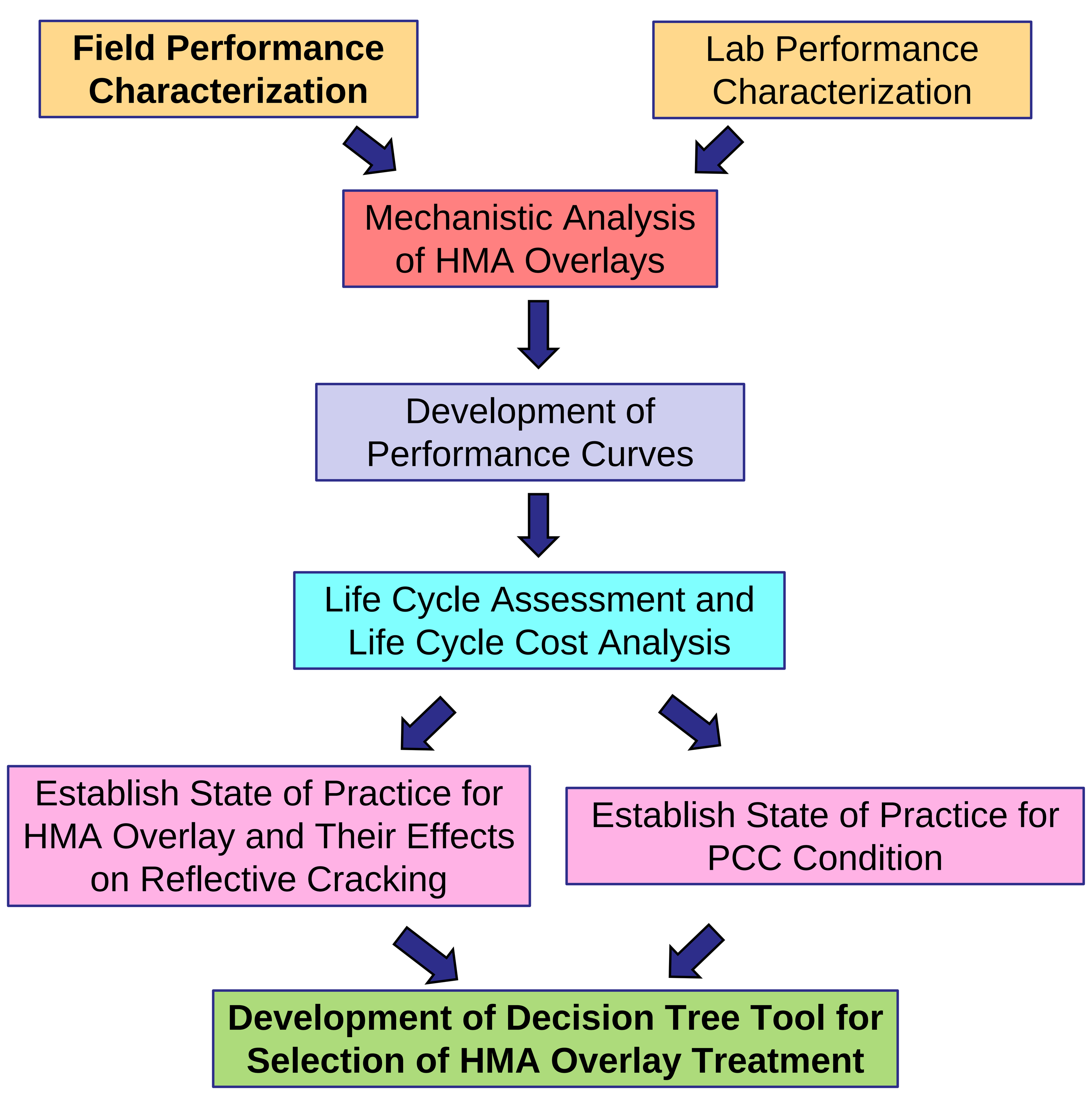
Introduction and Motivation

- **Reflective cracking** is one of the primary distress in asphalt concrete overlays.
- It occurs due to **traffic** or **thermally-driven** movements at joints and cracks in the underlying pavement.
- Allows **moisture to infiltrate** in the pavement structure and cause **shortened service life** of overlays.

Project Objectives:

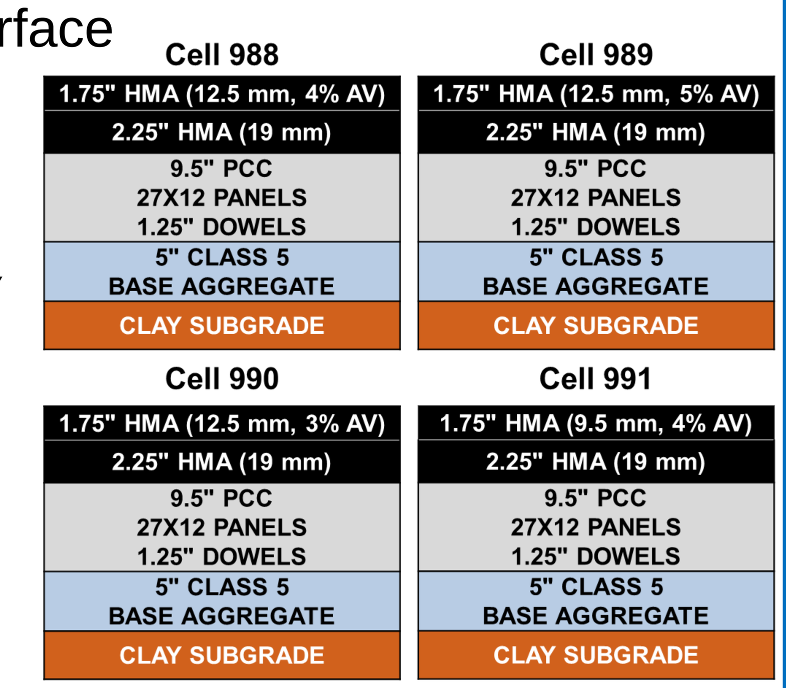
- To develop a **simple decision tree tool** for selecting suitable asphalt **mixtures and overlay designs** to prolong overlay lives by **lowering reflective cracking** and **improving in-situ density.**
  - Slow reflective (and thermal and fatigue) cracking.
  - Assess density evolution of mixtures.
  - Evaluate suitability of lab and field performance tests and corresponding indices for reflective cracking and correlation to field performance.

Research Approach



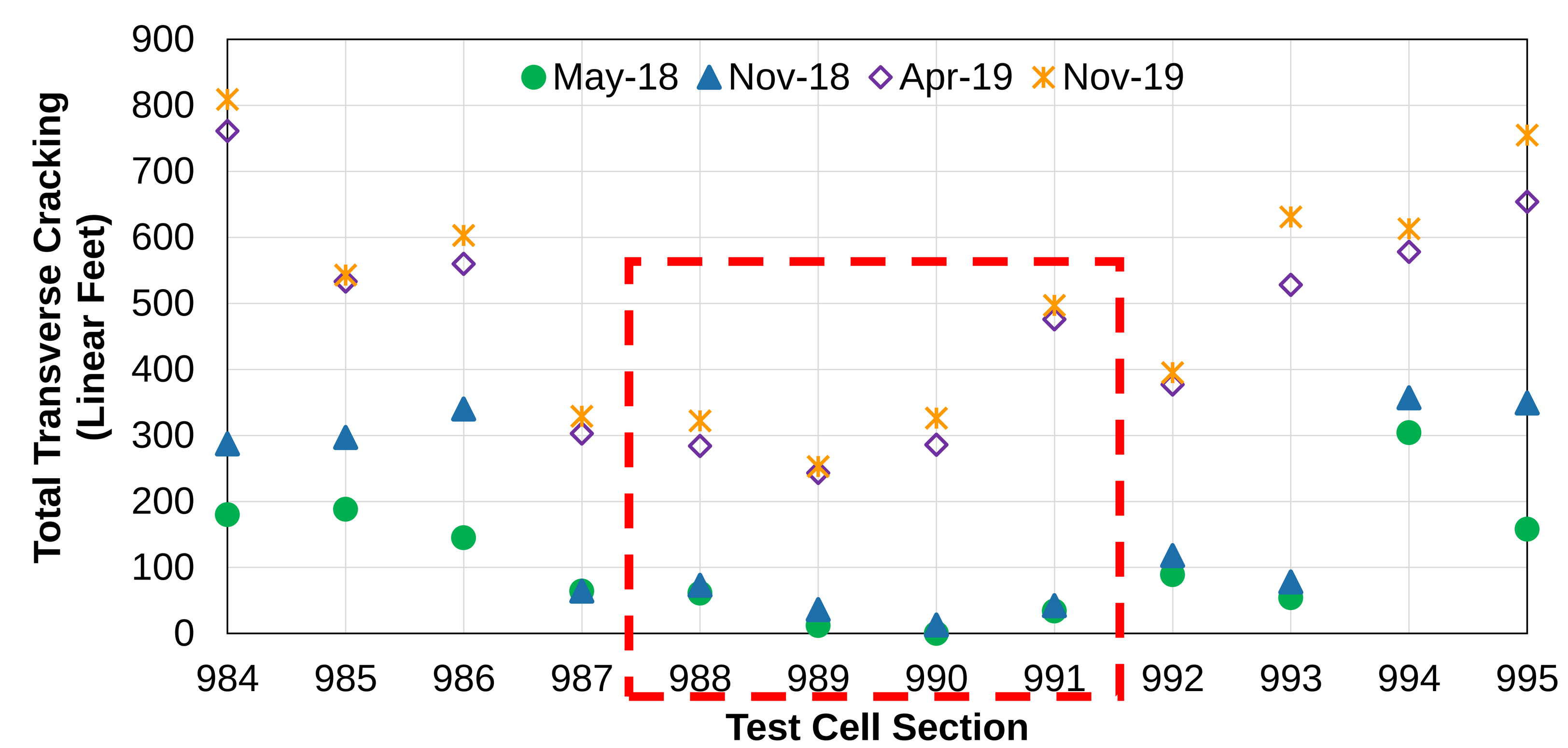
MnROAD Test Sections

- **12 test sections** with varying surface course and interlayer properties (MnROAD Cells 984-995)
  - Surface course
    -Thickness, gradation, density
  - Interlayer
    -Polymer modified, tack coat application and type
- Constructed in September 2017
- **4 test sections** dedicated to studying **impact of enhanced in-situ density**



Field Performance Data

- Variety of field performance data (**Distress surveys, DPS**, IRI, field cores) recorded after **8, 14, 19 and 26 months in-service**.



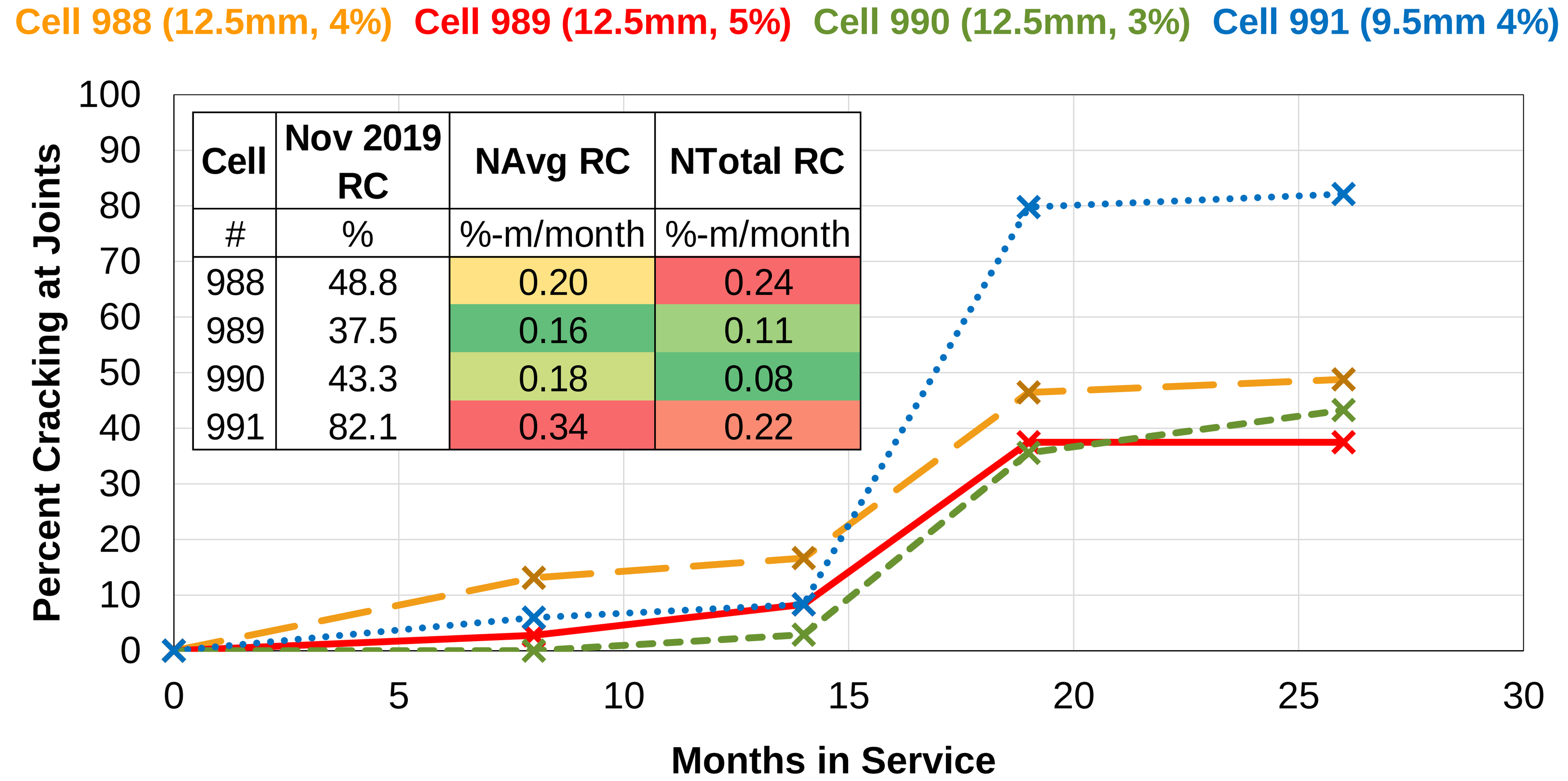
- Two different field performance indices considered:
  1. Normalized average reflective cracking rate index (NAvg RC)

$$NAvg\ RC = \frac{Reflective\ cracking\ at\ latest\ survey}{Life\ at\ latest\ survey} * Pavement\ thickness$$

  2. Normalized total reflective cracking performance index (NTotal RC)

$$NTotal\ RC = \frac{Reflectice\ cracking\ work}{Life\ at\ latest\ survey^2} * Pavement\ thickness$$

Cell 988 (12.5mm, 4%) Cell 989 (12.5mm, 5%) Cell 990 (12.5mm, 3%) Cell 991 (9.5mm 4%)



Cell	Nov 2019 RC	NAvg RC	NTotal RC
#	%	%-m/month	%-m/month
988	48.8	0.20	0.24
989	37.5	0.16	0.11
990	43.3	0.18	0.08
991	82.1	0.34	0.22

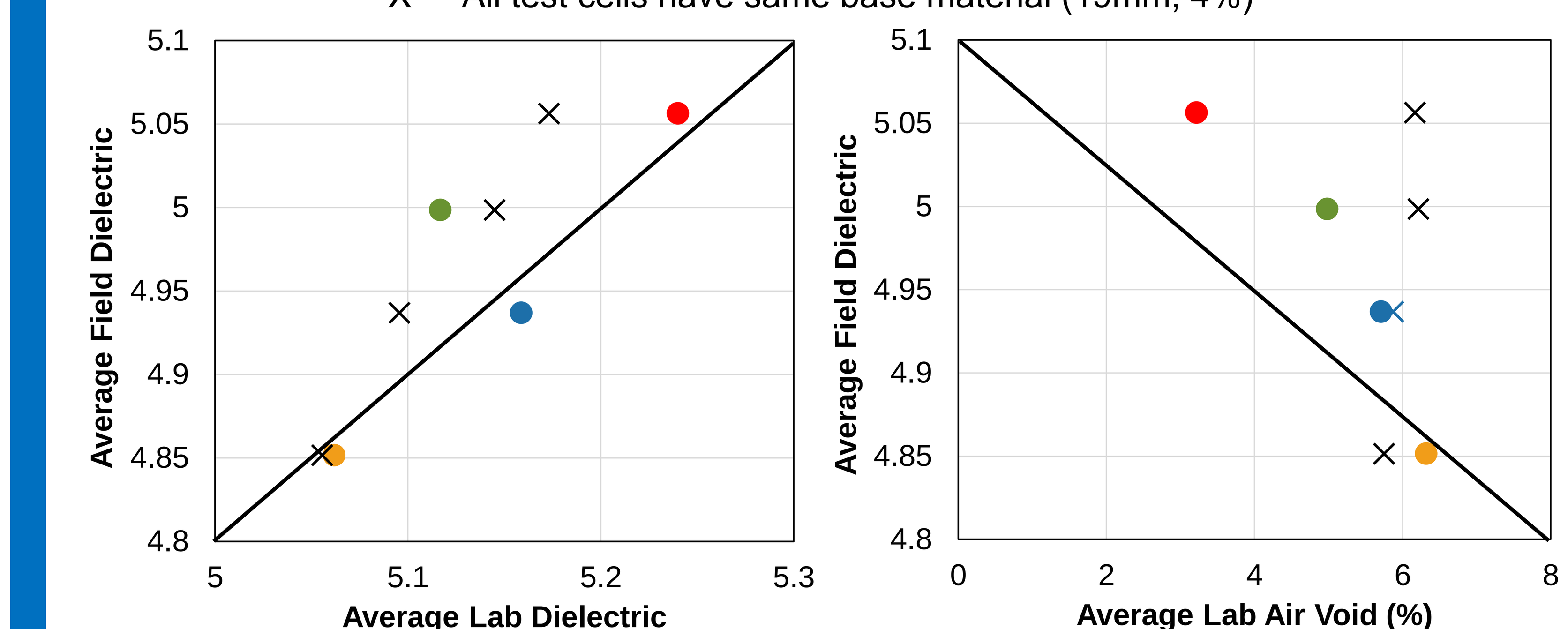
Dielectric Profiling System (DPS)

- Dielectric constant of an asphalt mixture is derived from the dielectric values of its constituents:
  - Air ≈ 1
  - Binder ≈ 2.6 to 2.8
  - Aggregate ≈ 4.5 to 6.5

- In general, it is expected that asphalt mixtures with higher density (fewer air voids) would have higher dielectric values.
- Dielectric measurements taken in field at core locations compared to lab measured DPS values, bulk specific gravity and lab measured air void content.

Cell 988 (12.5mm, 4%) Cell 989 (12.5mm, 5%) Cell 990 (12.5mm, 3%) Cell 991 (9.5mm 4%)

"X" = All test cells have same base material (19mm, 4%)



- Good correlation between field and lab dielectric measurements.
- Inverse relationship observed between lab measured air void and field dielectric measurements as expected.

Conclusions and Future Work

- Important to monitor field performance periodically and to **consider pavement structure** and **service life duration.**
- Conversion of dielectric constant to air voids using mix specific calibration factors (Hoegh-Dai Model) to **monitor density evolution of test sections**.
- **Development of performance curves** based on results from mechanic analysis of HMA overlays using PavementME and ABAQUS FE software with consideration to test section field performance.
- Perform **life cycle assessment and life cycle cost analysis** in development of decision tree tool for selection of HMA overlay treatment.

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