Comparison of Laboratory Performance Tests with In-situ Performance Data for Reflective Cracking Evaluation

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Introduction

Reflective cracking is one of the most prominent distresses 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.

Objective

- Investigate the correlation between various laboratory performance tests and in-situ reflective cracking performance data of 12 MnROAD test sections.

Project Background

- Develop a **simple decision tree based** tool for selecting suitable asphalt mixtures and overlay designs to **prolong overlay lives** by lowering reflective cracking and improving in-situ density.
- Combination of MnROAD test sections, laboratory performance testing and past field performance data.

MnROAD Test Sections

Control Section

9.5" PCC 27X12 PANELS 1.25" DOWELS
5" CLASS 5 BASE AGGREGATE
CLAY SUBGRADE

- 12 Test sections with varying surface course and interlayer properties
  - Surface course: *Thickness, gradation, density*
  - Interlayer: *Polymer modified, tack coat application and type*

1.75" HMA (12.5 mm, 3%, 4%, 5% AV) 2.25" HMA (19 mm)
9.5" PCC 27X12 PANELS 1.25" DOWELS

1.75" HMA (12.5 mm) Spray Paver (0.10 gal/sy)
9.5" PCC 27X12 PANELS 1.25" DOWELS

1.5" HMA (9.5 mm) 1" HMA (PSAB/PASSRC) Or 1" HMA (High Polymer Asphalt)
9.5" PCC 27X12 PANELS 1.25" DOWELS

1.5" HMA (12.5 mm or 9.5mm) Conventional Paver (0.05-0.06 gal/sy or 0.08-0.10 gal/sy)
9.5" PCC 27X12 PANELS 1.25" DOWELS

500 ft test cell sections 983-995 constructed in Summer 2017

Lab Performance Testing

Fracture Energy (FE)

$$G_f = \frac{W_f}{t * a}$$

Fracture Strain Tolerance (FST)

$$FST = \frac{G_f}{S_f} \quad \text{Where;} \quad S_f = \frac{2P_{max}(2w+a)}{b(w-a)^2}$$

Flexibility Index (FI)

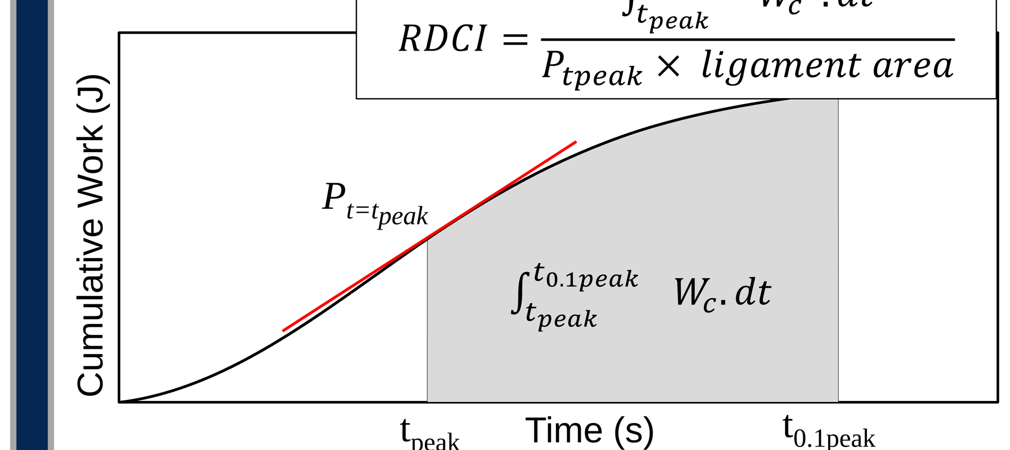
$$FI = \frac{G_f}{|m|} * 0.01$$

Cracking Resistance Index (CRI)

$$CRI = \frac{G_f}{P_{max}}$$

Rate-Dependent Cracking Index (RDCI)

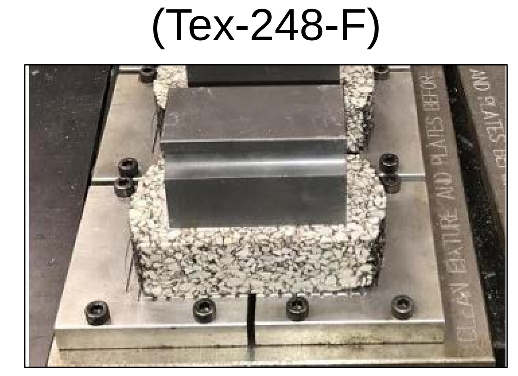
$$RDCI = \frac{\int_{t_{peak}}^{t_{0.1peak}} W_c \, .dt}{P_{tpeak} \times ligament\ area}$$



Disk-Shaped Compact Tension (ASTM D7313)

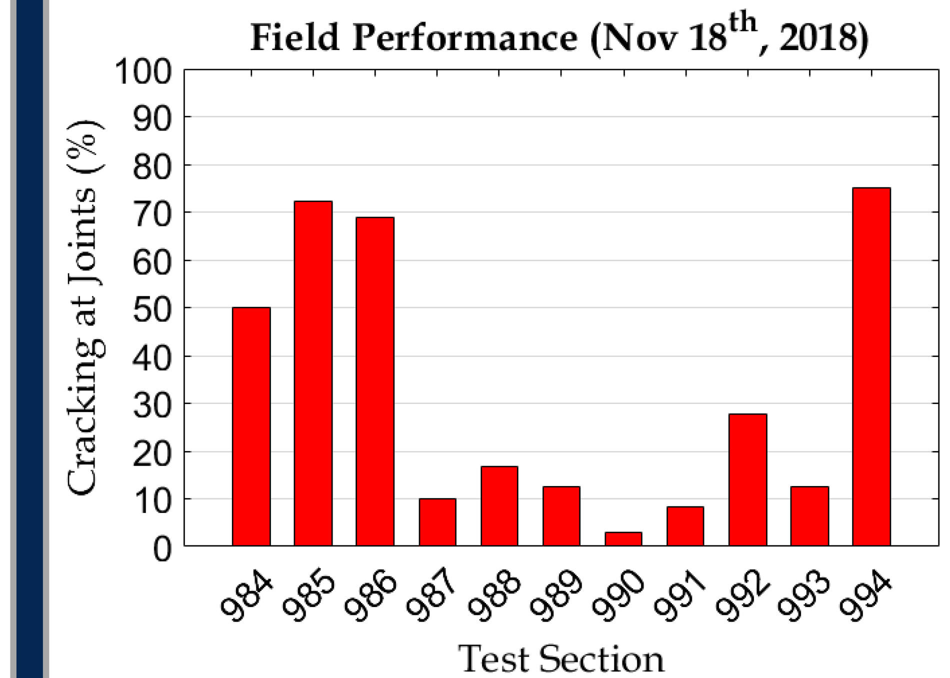
Semi-Circular Bend (AASHTO TP124)

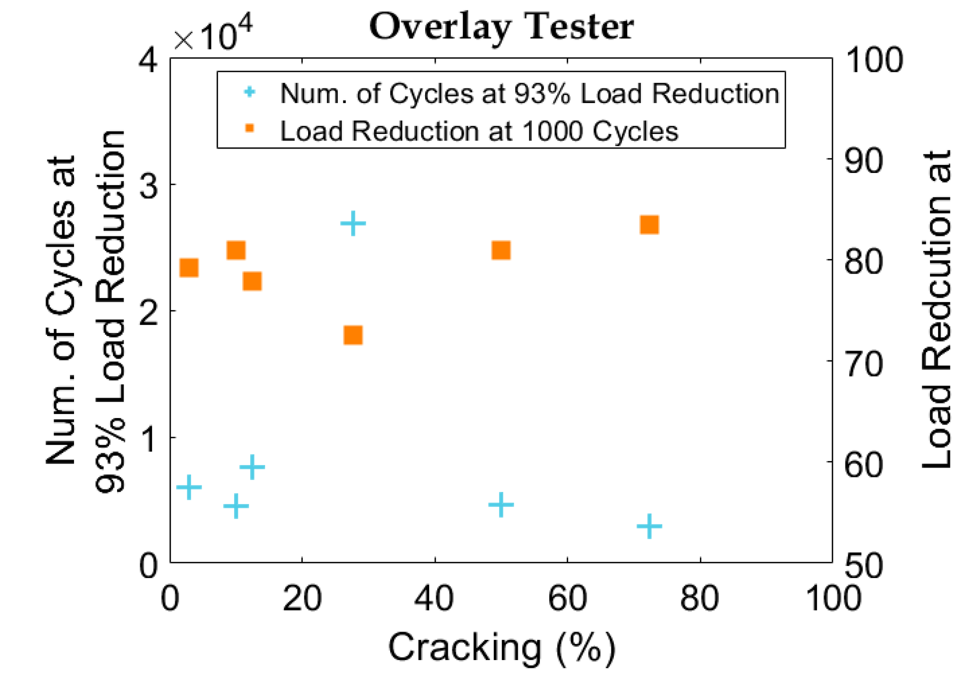
Texas Overlay Tester (Tex-248-F)

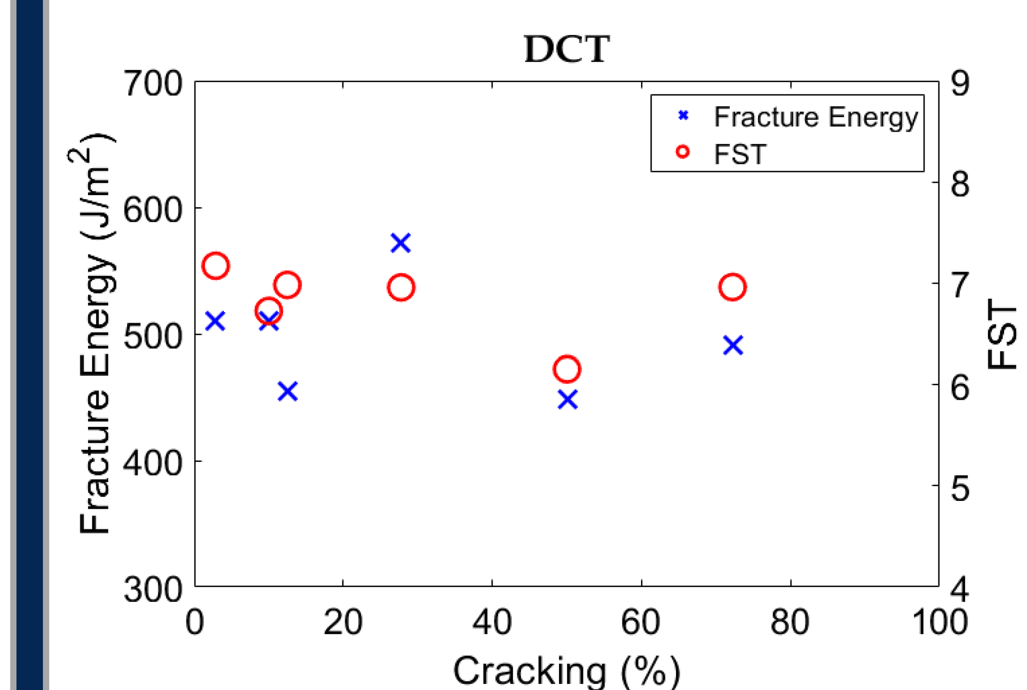


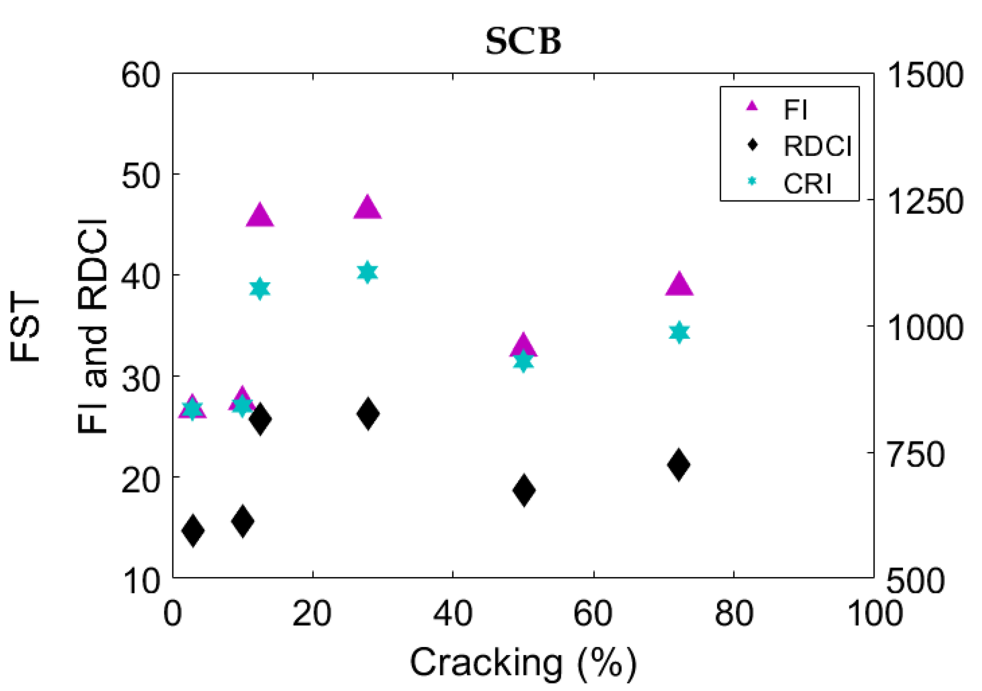
Lab vs Field Performance

- Field crack counts from MnROAD test sections compared to DCT, SCB and Overlay Tester.









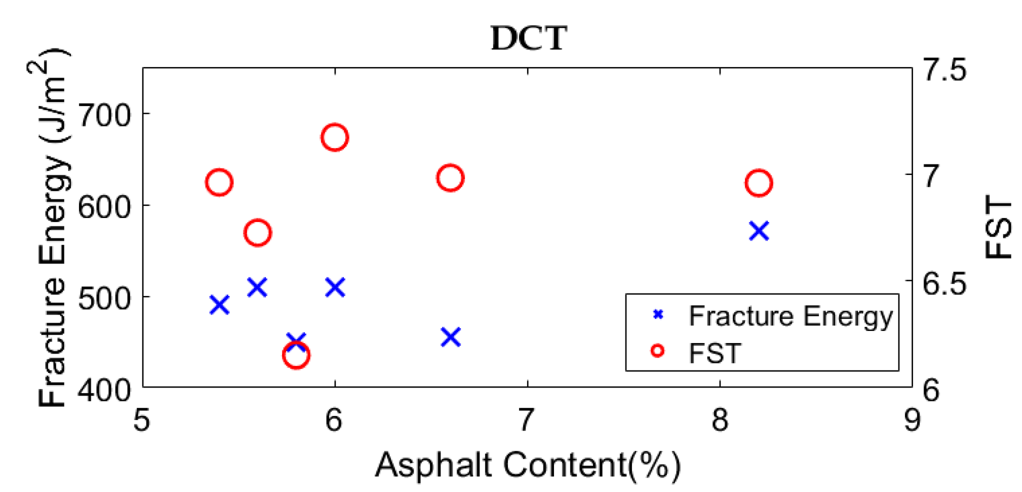
Volumetric vs Lab Performance

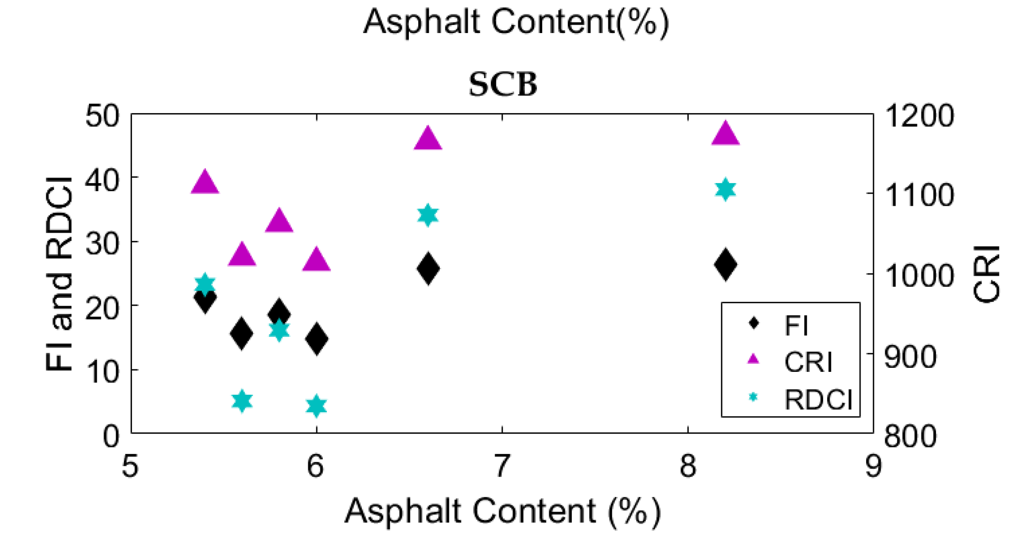
Pearson Correlation

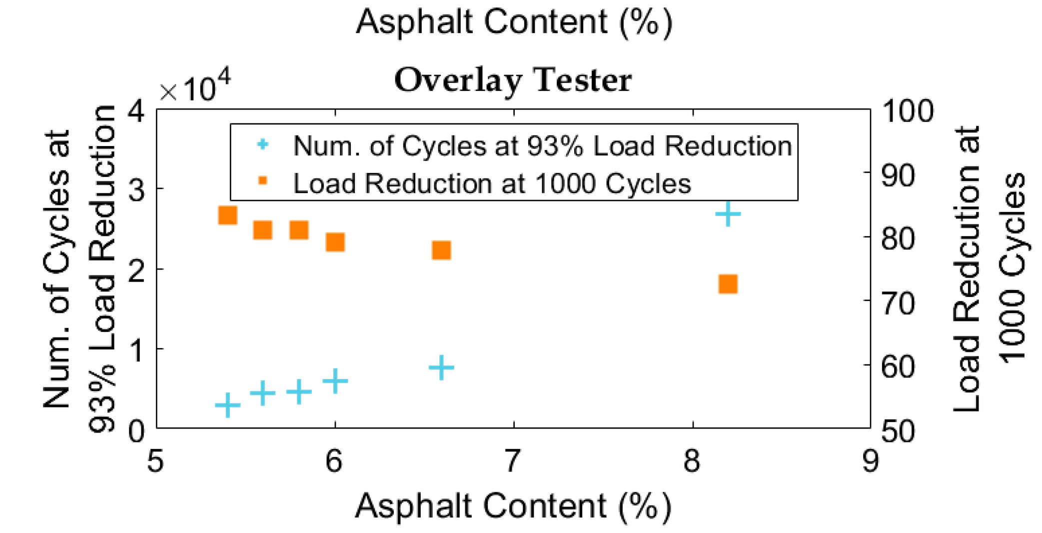
- *Scale from 1 (strong positive) to -1 (strong negative)*

Strong
Mild
Weak

	OT Avg % Load Reduction (2000 cycles)	Average Fracture Energy, G_f (J/m^2)	Avg FI
Gmm	0.87	-0.31	-0.42
AC%	-0.98	0.63	0.57
AV %	0.87	-0.21	-0.33
VMA	-0.81	0.25	0.44
% Passing #200	-0.79	0.42	0.31







Conclusions

Comparison of volumetrics, lab testing and field performance data from MnROAD test sections indicated the following:

- In general **strong correlation** of volumetrics with OT Avg. % reduction at 2000 cycles.
- Field sections with **less that 10% cracking** at joints after 1:

Cell 990: 1.5”, 9.5 mm (3% AV) and 2.25” HMA, 19 mm
Cell 991: 1.75”, 9.5 mm(AASHTO M323 #8) and 2.25” HMA,19 mm
Cell 987: 1.5” HMA, 9.5 mm and 2.5” HMA, 19mm

- From lab testing, **FST** appears to have better correlation with field performance.

Future Work

Comparison of other lab tests with field performance over time in addition to developing a mechanistic analysis of the HMA overlays using NCHRP 1-41 model and finite element software.

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