

Polymer-Modified Asphalts – Enhancing HMA Performance

Wilkes-Barre, PA.

October 23, 2003

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Study Sponsors:

Industry Associations

- The Asphalt Institute
- The Association of Modified Asphalt Producers

Federal Highway Administration

Corporate Sponsors

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- Ultrapave

Presentation Overview

1. Study Objectives & Status
2. Overview of ***Users Opinions***
3. Performance Comparisons
4. Summary of Initial Findings

Study Objectives

1. Quantify the effect of using PMA as compared to conventional-unmodified HMA mixtures.
2. Identify conditions that maximize effect of PMA to increase HMA pavement & overlay life.

Phase I Tasks:

1. Update literature review.
- 2. Update contacts with selected agencies.**
3. Review test sections with PMA mixes.
- 4. Select companion PMA & unmodified HMA test sections.**

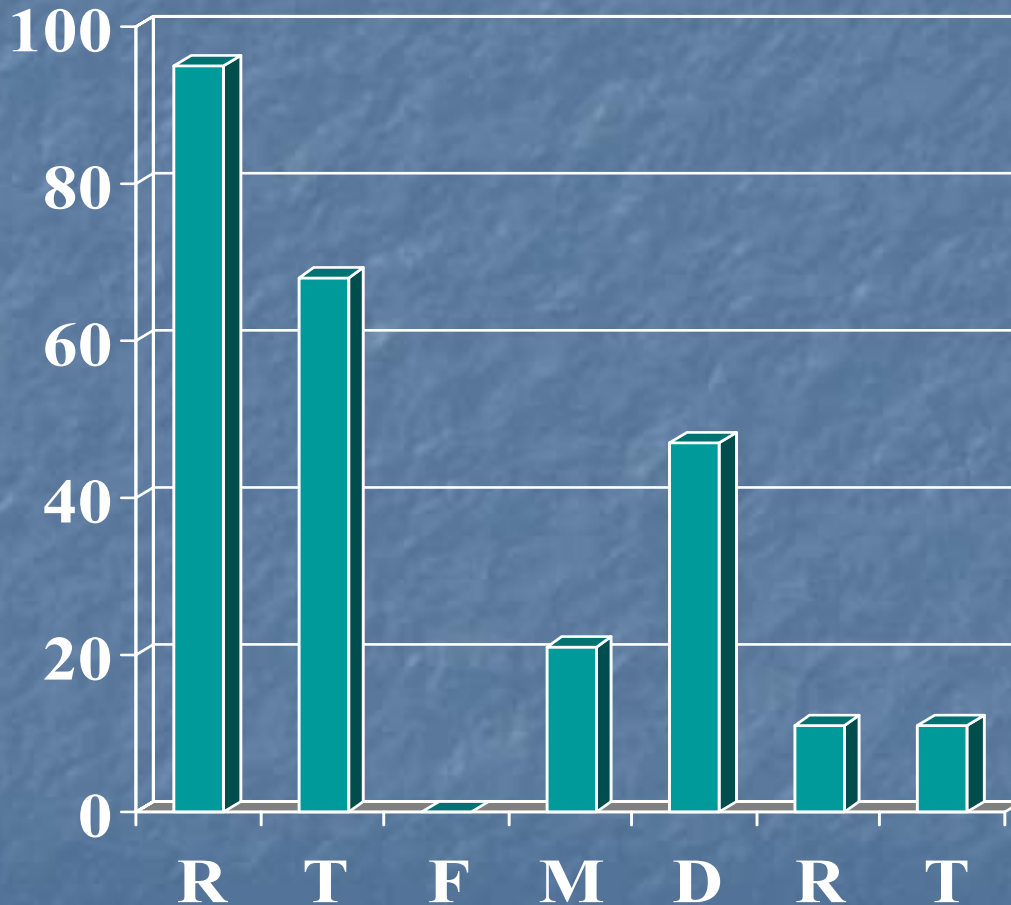
Completed

Phase II Tasks:

5. Predict performance of test sections.
6. Compare performance characteristics of PMA & unmodified HMA pavements.
7. Prepare study documents.

90% Complete

Reason for Using PMA?



■ Response, %

R = Rutting

T = Thermal Cracking

F = Fatigue Cracking

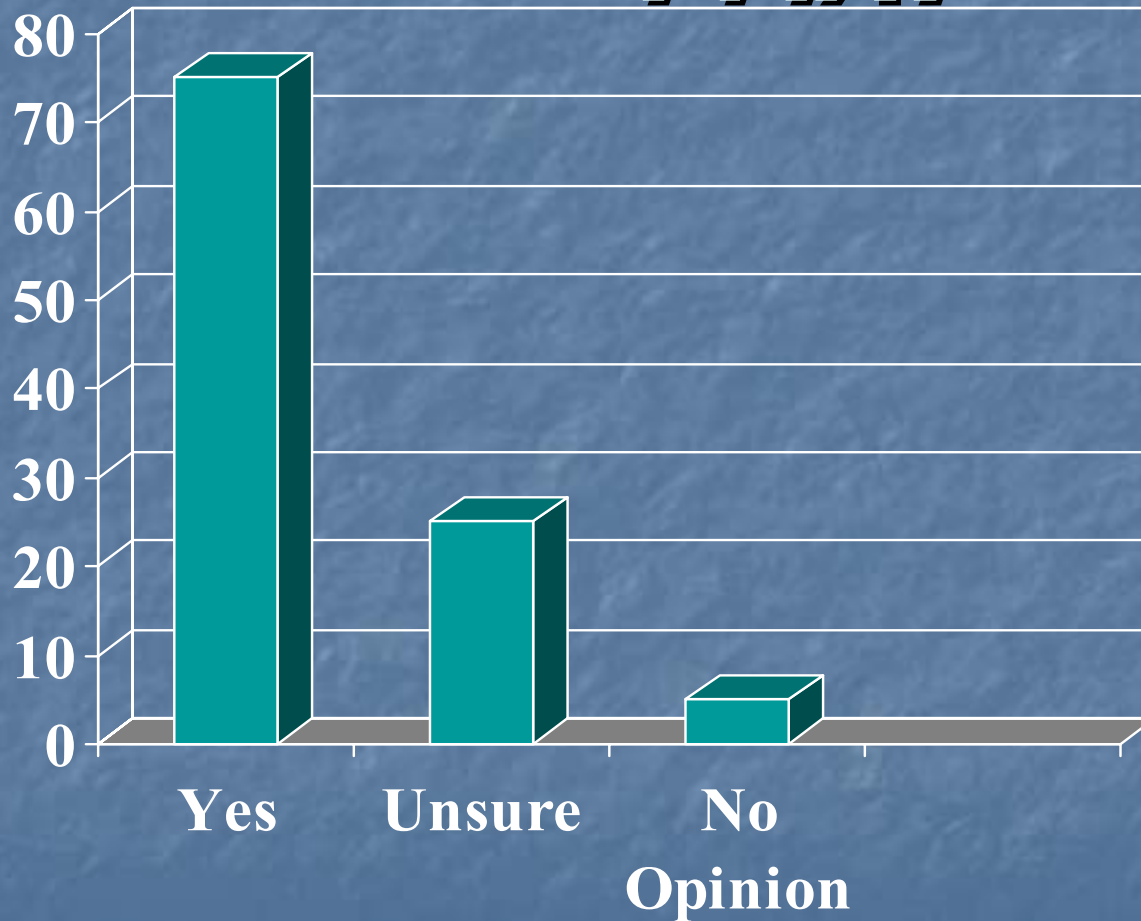
M = Moisture Damage
or stripping

D = Durability

R = Raveling

T = Tenderness

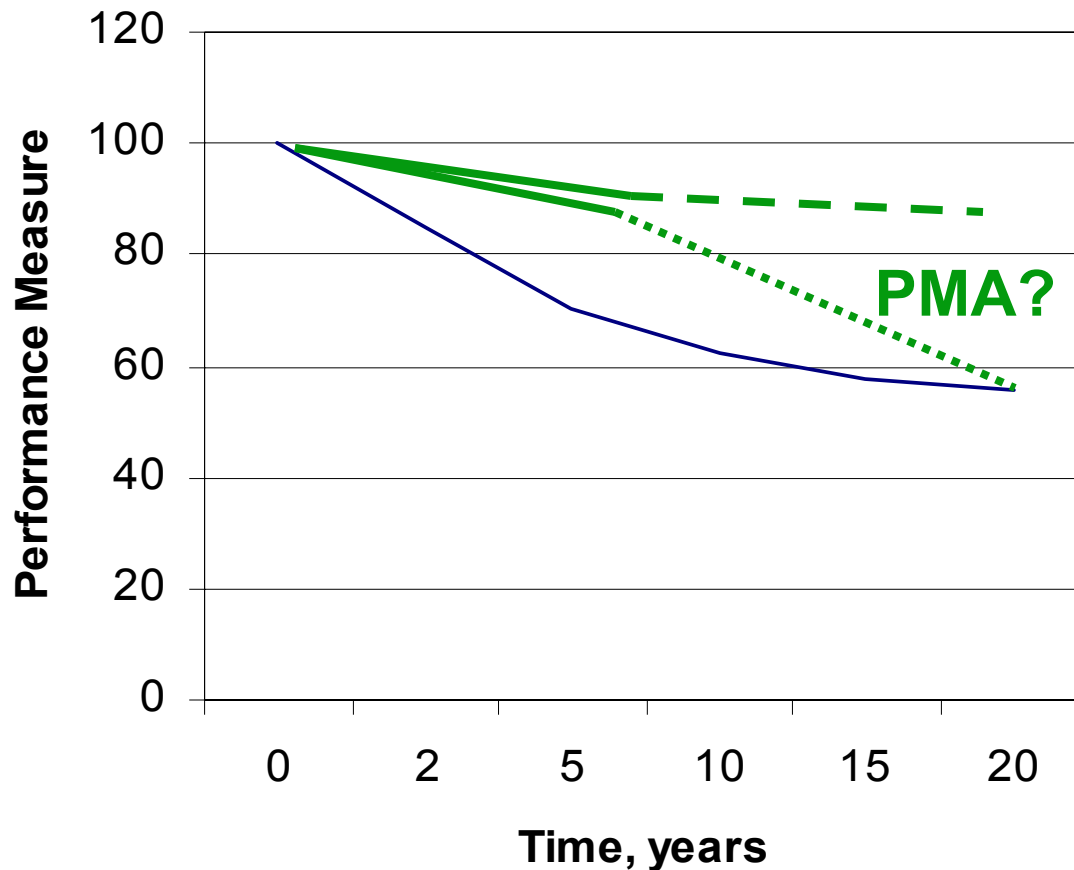
Is There a Benefit Using PMA?



Yes, **BUT**:
Insufficient
data to
quantify that
benefit.

Response, %

Concern: Short-Term versus Long-Term Benefit?



— Conv.

Data needed
to quantify
long-term
benefit.

Finding & Conclusion

- PMA mixtures do extend the service life of HMA pavements & overlays.

The real issue is:

***QUANTIFICATION OF THE
INCREASE IN SERVICE LIFE.***

Selected Pavement Locations for Detailed Analyses in Phase II



Not all LTPP sites
located on map.

Test Sections - Experiments

- LTPP: Core & Supplemental Sections
 - **SPS-1; SPS-5; SPS-6; SPS-9**
 - **GPS-1; GPS-2; GPS-6; GPS-7**
- MTO Modifier Study
- Accelerated Pavement Tests, examples
 - **FHWA ALF, Turner Fairbanks**
 - **NCAT Test Road**
 - **California HVS Studies**
- Individual State Agency Test Sections

Experimental Factorial

Pavement Cross Section	Foundation	Climate			
		Freeze		Non-Freeze	
		Wet	Dry	Wet	Dry
Thin HMA	Fine-Grained	2	2	4	3
	Coarse-Grained	3	3	3	3
Thick HMA	Fine-Grained	2	2	2	3
	Coarse-Grained	2	2	3	2
Full-Depth	Fine-Grained	0	1	2	2
	Coarse-Grained	0	1	2	2
HMA	HMA	3	3	6	6
Overlays	PCC	4	3	4	4
Total No. PMA Sections		16	17	26	25

Types of Analyses: PMA Versus Unmodified Mixes

- Comparison of actual distress observations; companion sections
- Mechanistic-empirical analysis of performance history:
 - Fracture, Load Related
 - Distortion, Load Related

Performance Evaluations



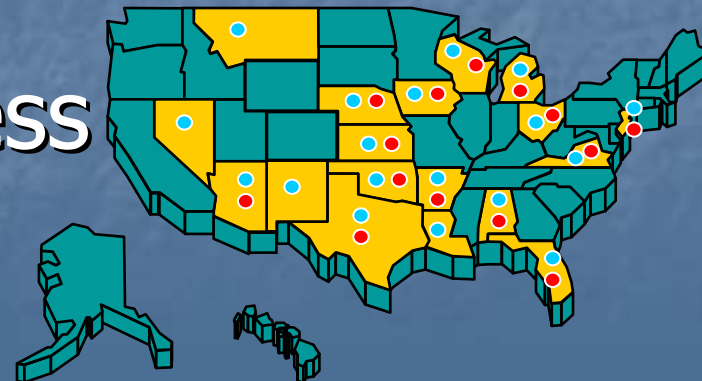
Load Related Cracking

Rutting

Thermal Cracking

IRI, Smoothness

Other Surface Distress

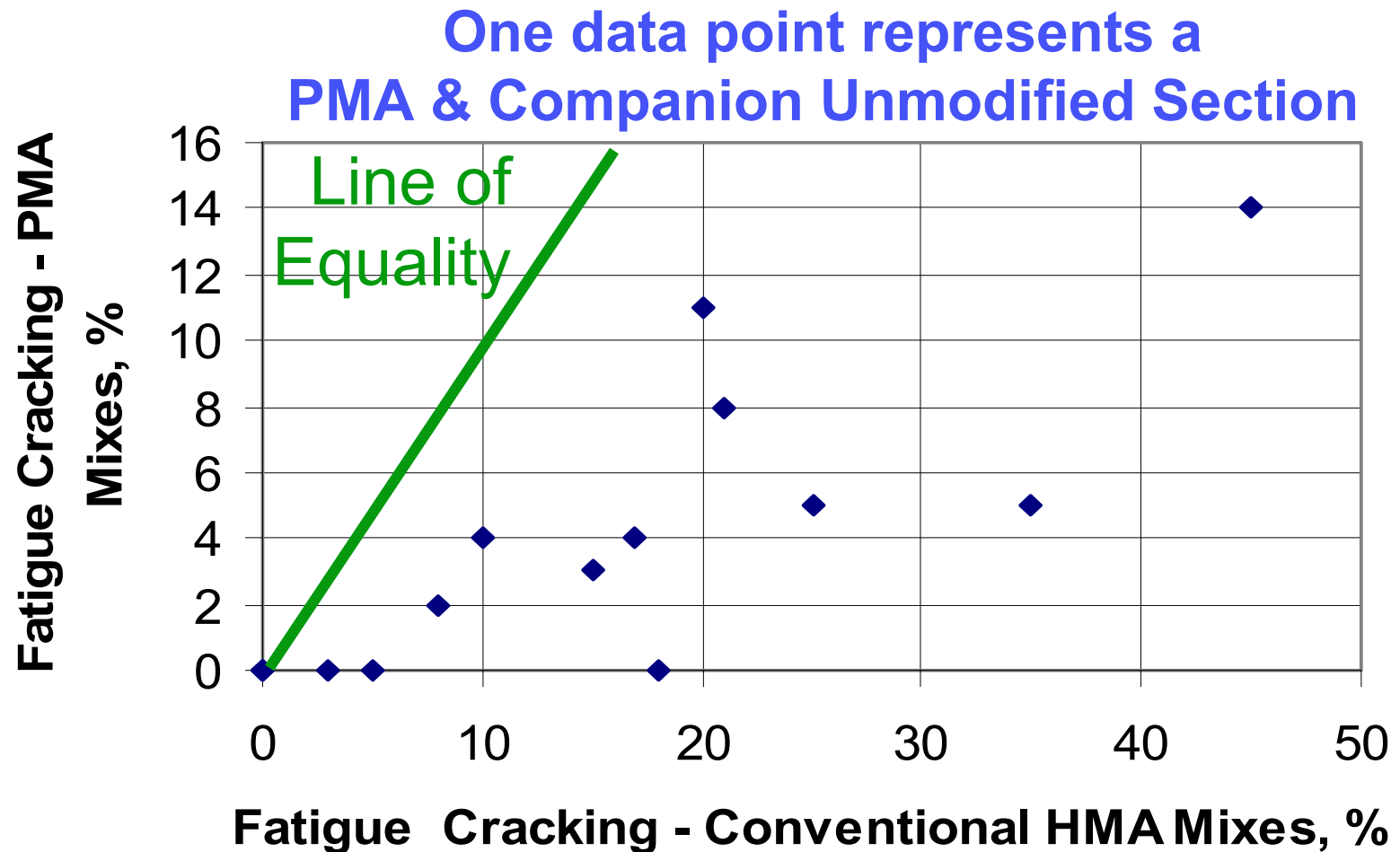


Load Related Cracking Analysis



**Unmodified Mixes
Versus
PMA Mixes**

Load Related Cracking: PMA Versus Unmodified Mixes

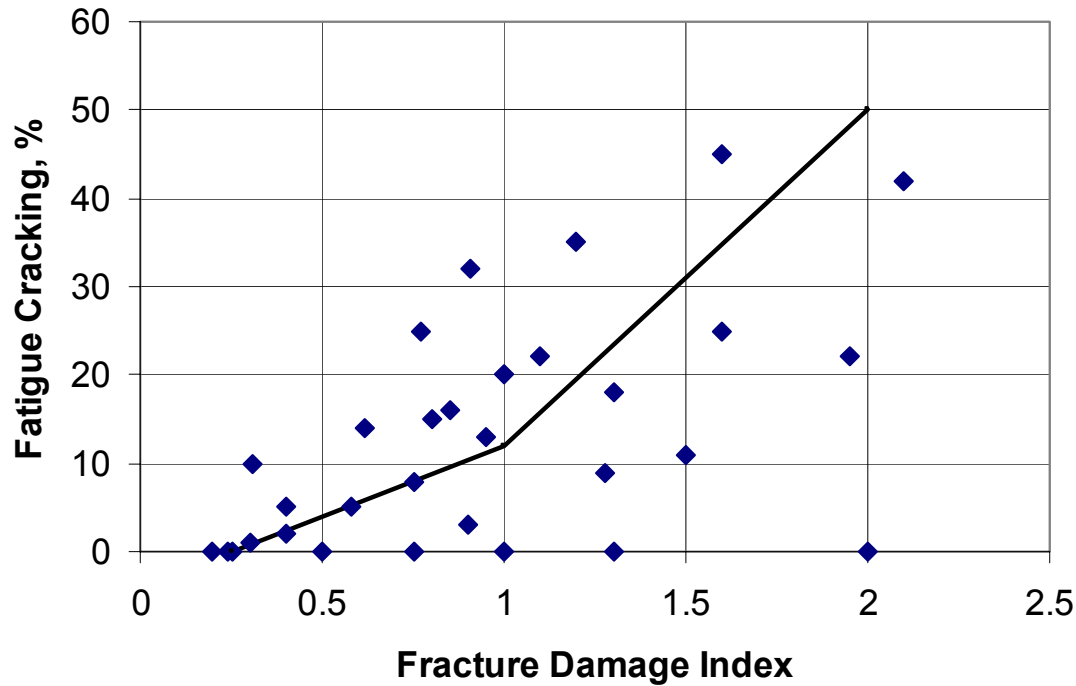


Fatigue Cracking Analysis

PDMAP Fatigue Curve initially used in fatigue analysis.

$$\begin{aligned} \text{Log}(N_f) = & 15.947\beta_{f1} - 3.291\beta_{f2}\text{Log}\left(\frac{\varepsilon_t}{10^{-6}}\right) \\ & - 0.854\beta_{f3}\text{Log}\left(\frac{E_{HMA}}{10^3}\right) \end{aligned}$$

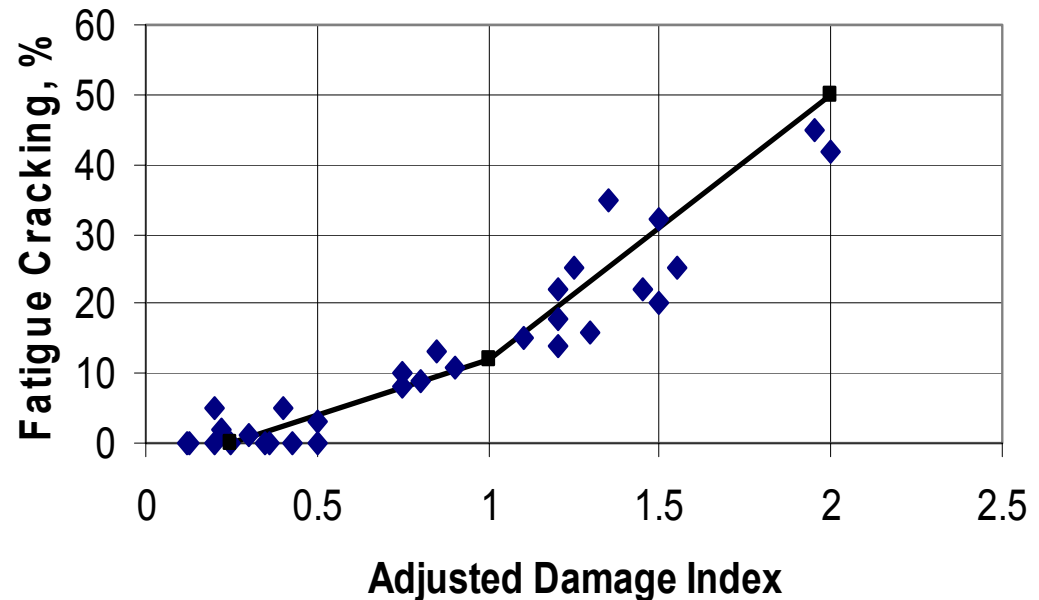
$\beta_f = 1.0$ for initial damage analyses



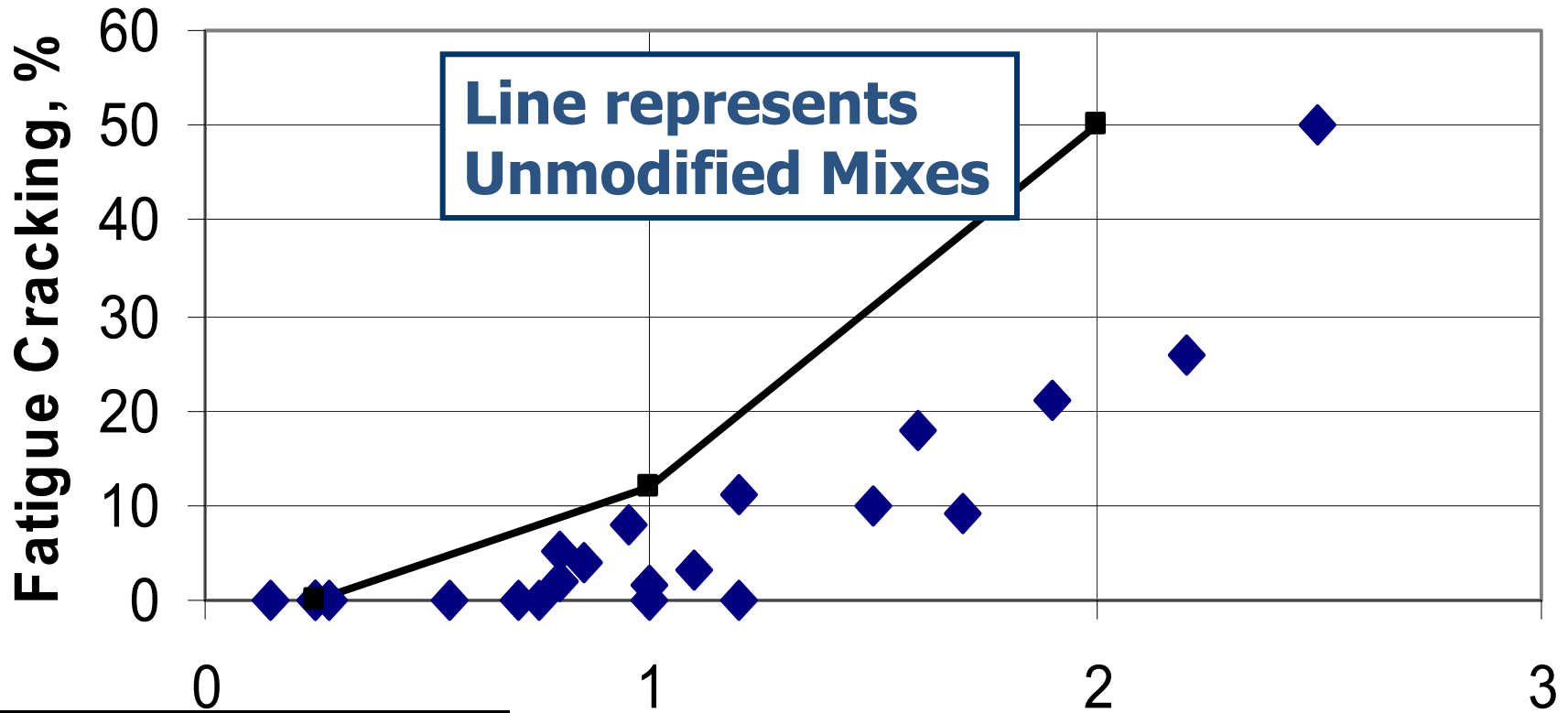
***Importance
of Local
Calibration***

**Fatigue Cracking
Evaluations**

Local = Cell



Cracking versus Damage Index



$$DamageIndex = \frac{n_{actual}}{N_f}$$

Adjusted Damage Index

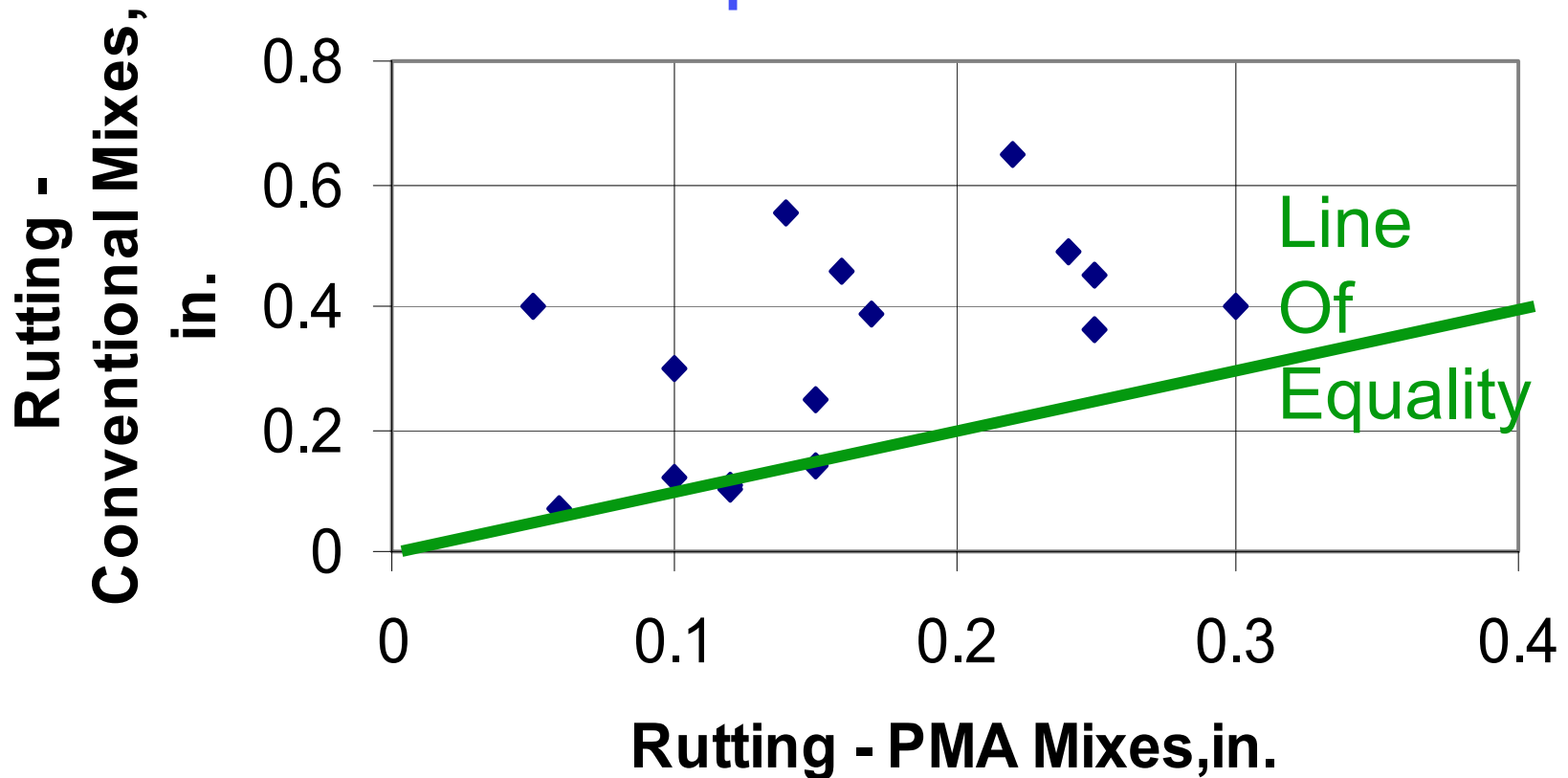
Rutting Analysis



**Unmodified Mixes
Versus
PMA Mixes**

Rutting: PMA Versus Unmodified Mixes

One data point represents a
PMA & Companion Unmodified Section

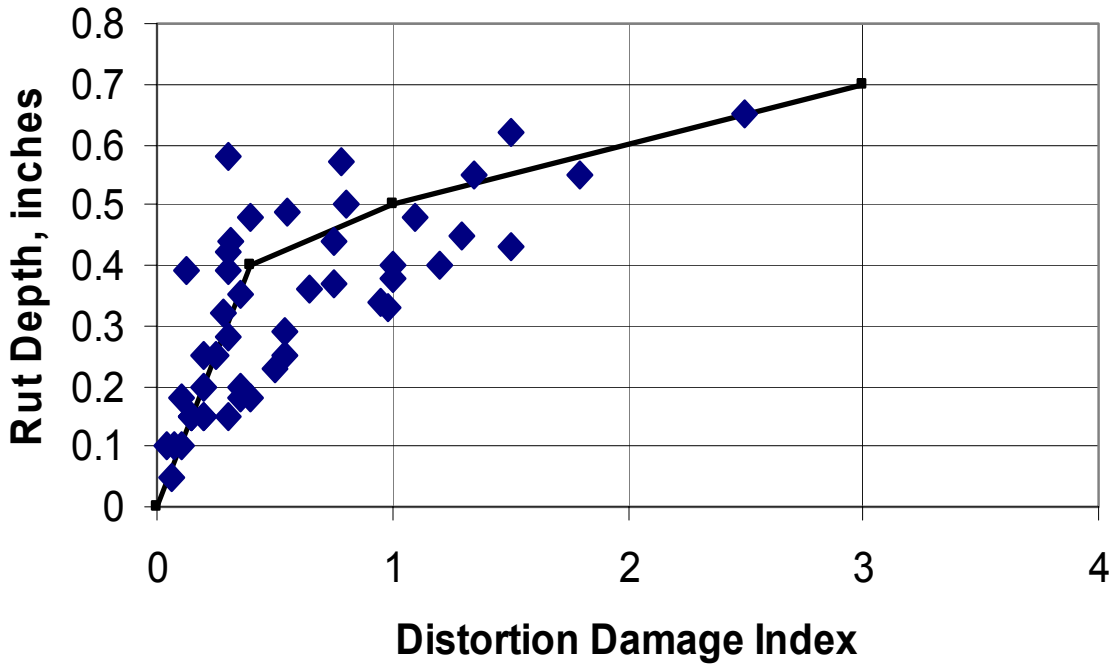


Rutting Evaluation

Permanent-resilient strain ratio used in initial analysis.

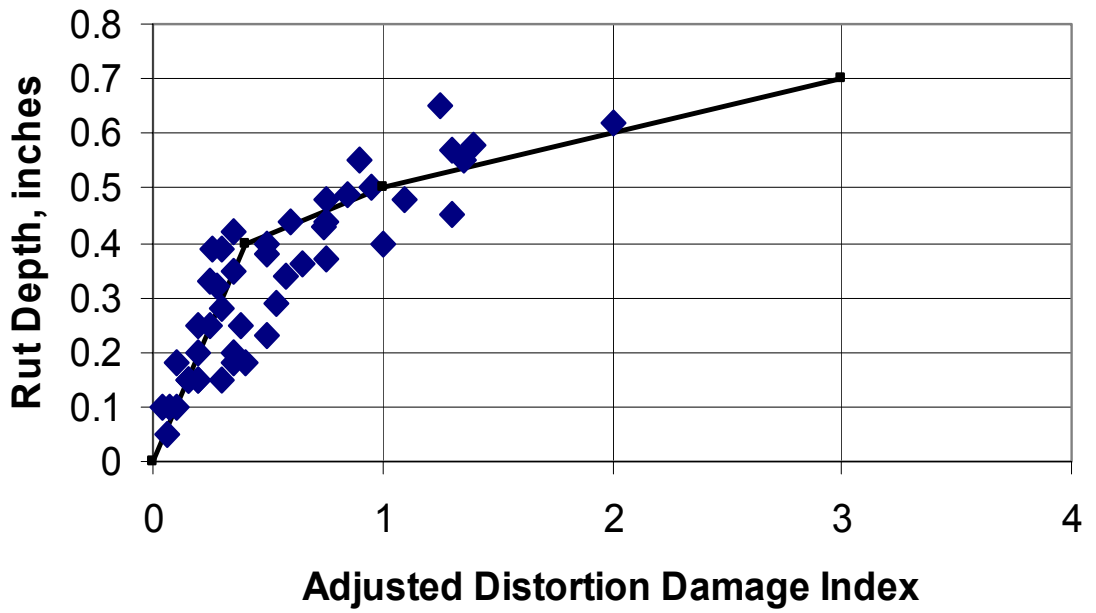
$$\begin{aligned} \text{Log}(N_R) = & 4.587 \beta_{R1} + \frac{\beta_{R2} \text{Log}\left(\frac{\varepsilon_p}{\varepsilon_r}\right)}{0.4471(\beta_d)} \\ & - 3.491 \beta_{R3} \text{Log}(T) \end{aligned}$$

$\beta_R = 1.0$ for initial distortion damage analyses

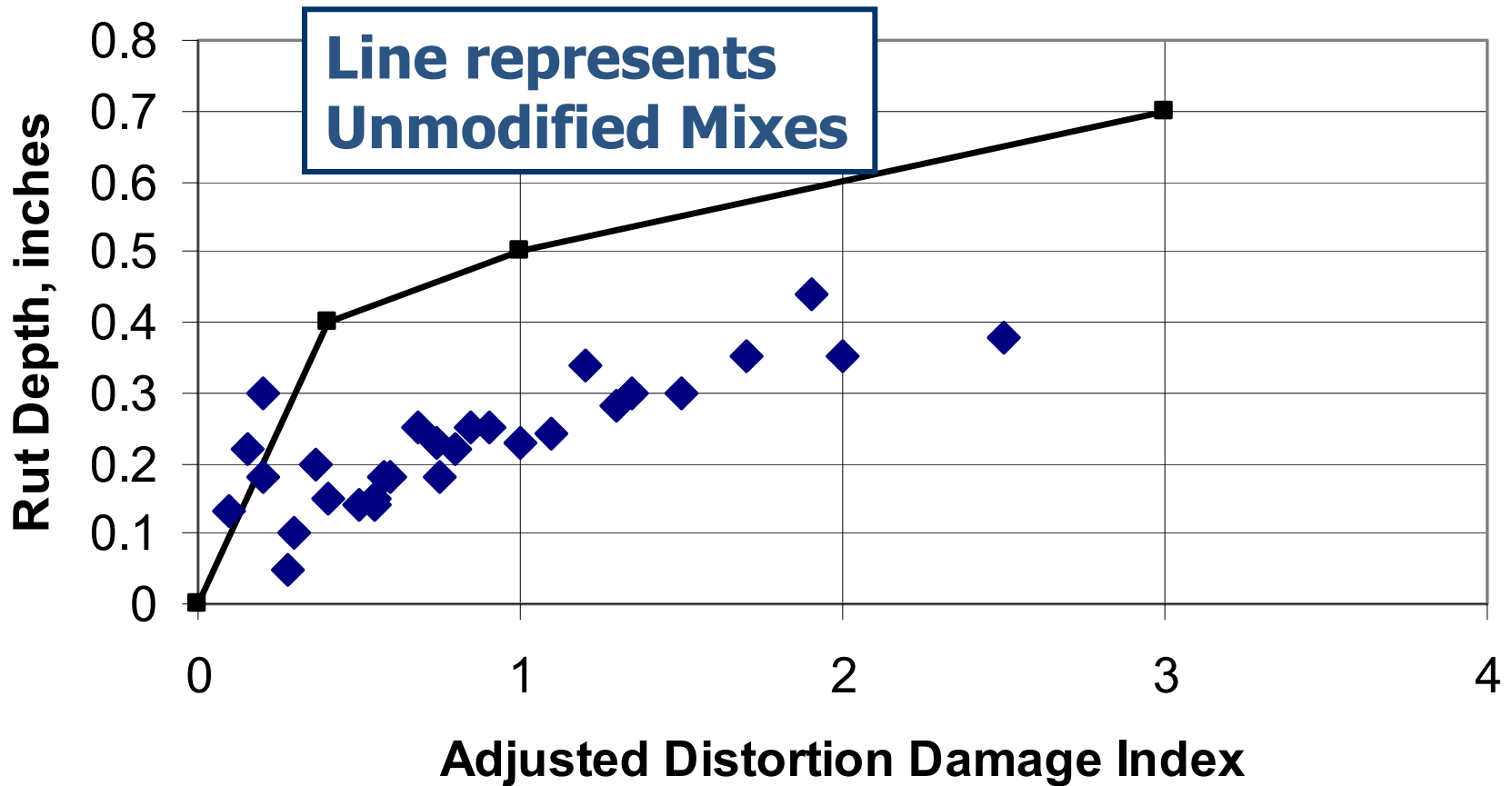


***Importance
of Local
Calibration***

**Rutting
Evaluations
Local = Cell**



Rutting versus Damage Index



Findings

Field & laboratory investigations of PMA mixes suggest:

- Enhanced Performance

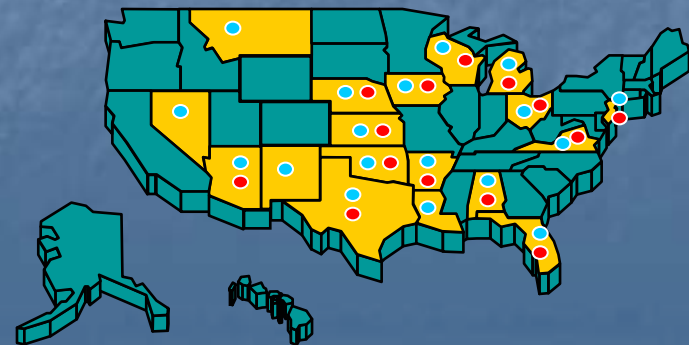
- 25 to 100 % increase in service life

- 3 to 10 years increase in service life

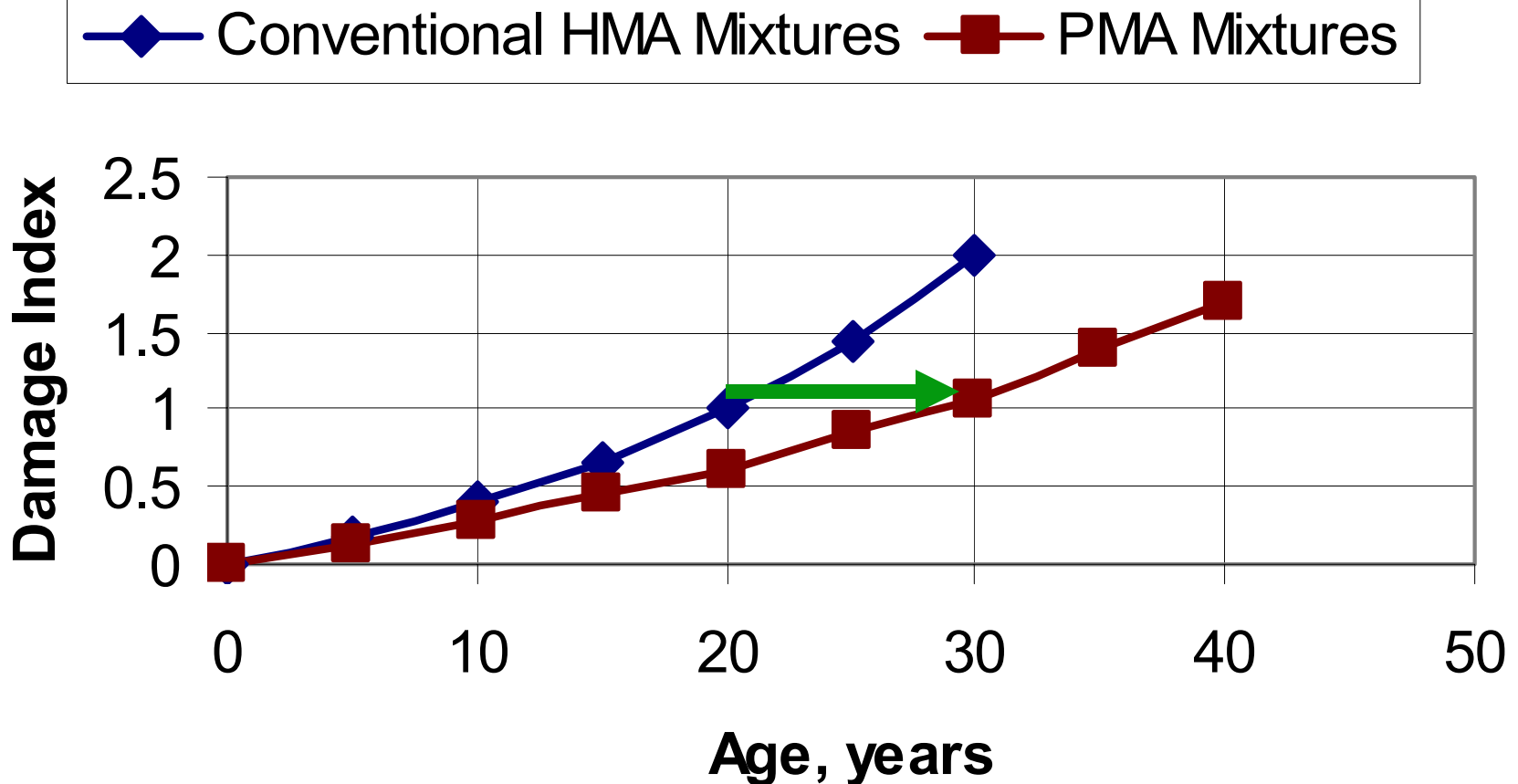
- Reduced Maintenance Activities

- Crew Safety

- Traffic Delay

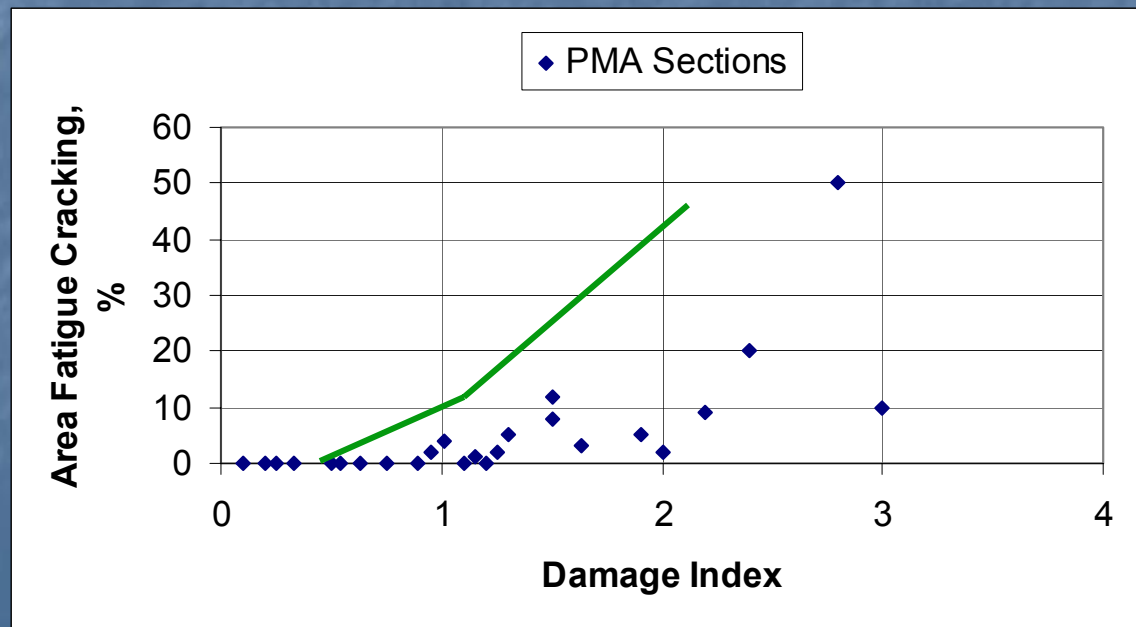
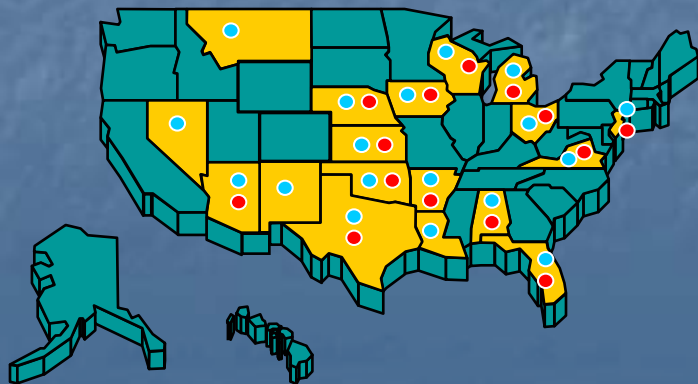


Estimate of Enhanced Performance Based on Damage Analysis



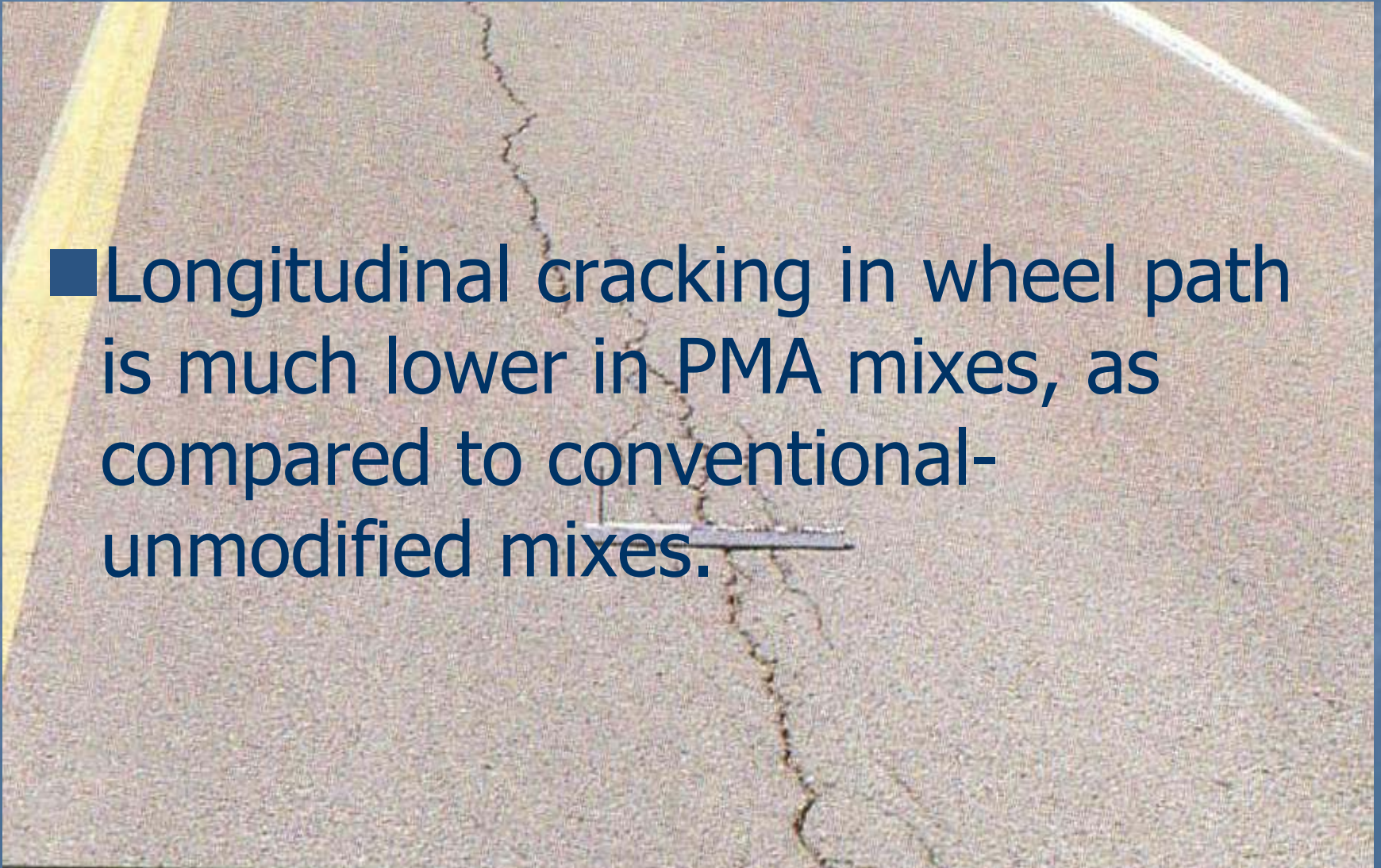
Finding

- Mechanistic-empirical analysis confirms need for **different calibration factors** for predicting performance of PMA mixes.



Observation

- Longitudinal cracking in wheel path is much lower in PMA mixes, as compared to conventional-unmodified mixes.



Products from Study

1. Detailed Study Report
2. Executive Summary of Findings
3. Guidelines for Application & Use

?

**Pavement
Structural
Design**



?

**Life Cycle
Cost
Analysis**

**Thank you for your attention -
Any questions?**

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