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Modified Asphalt Binders – Enhancing Pavement Performance

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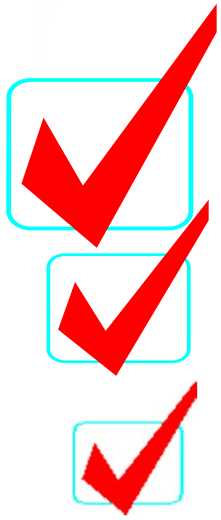
Focus

- Overview the effect of modified asphalt binders for enhancing pavement performance – extending the service life of new pavements and overlays.

Effect of Binder on Performance



1. Thermal Cracking
2. Fatigue Cracking
3. Rutting

Most, if not all agencies in U.S. have adopted the P-G specifications & many have reported reduced distress; especially thermal cracking.

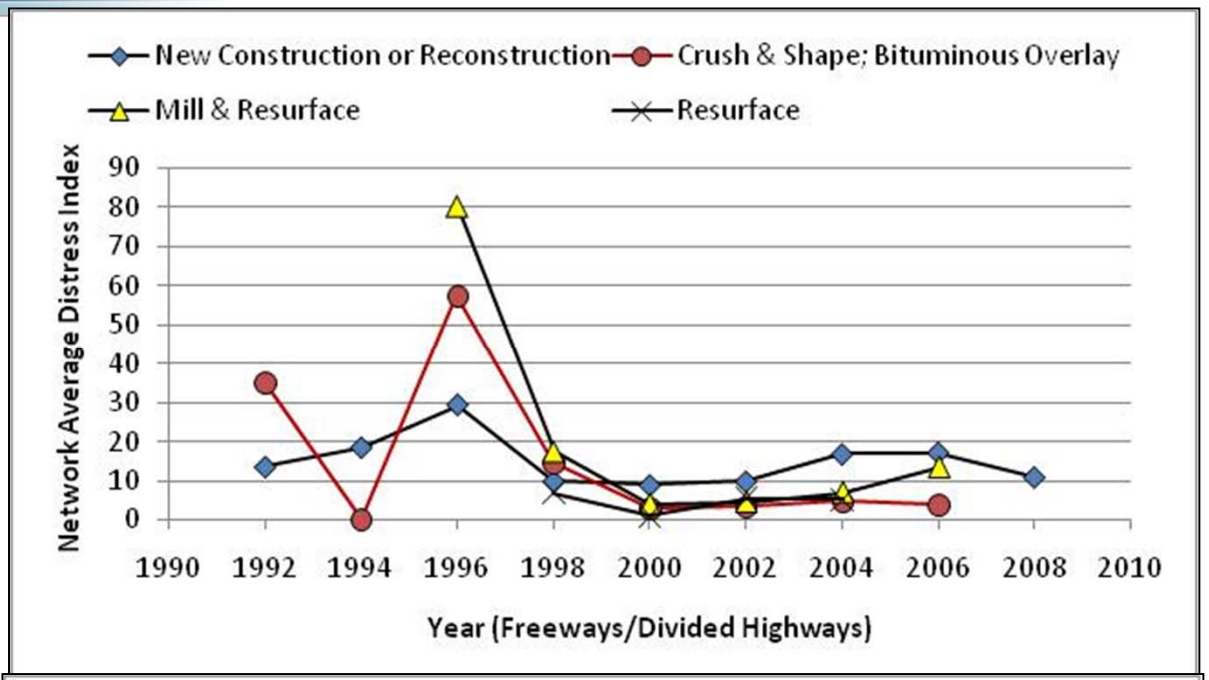
Effect of Binder on Performance

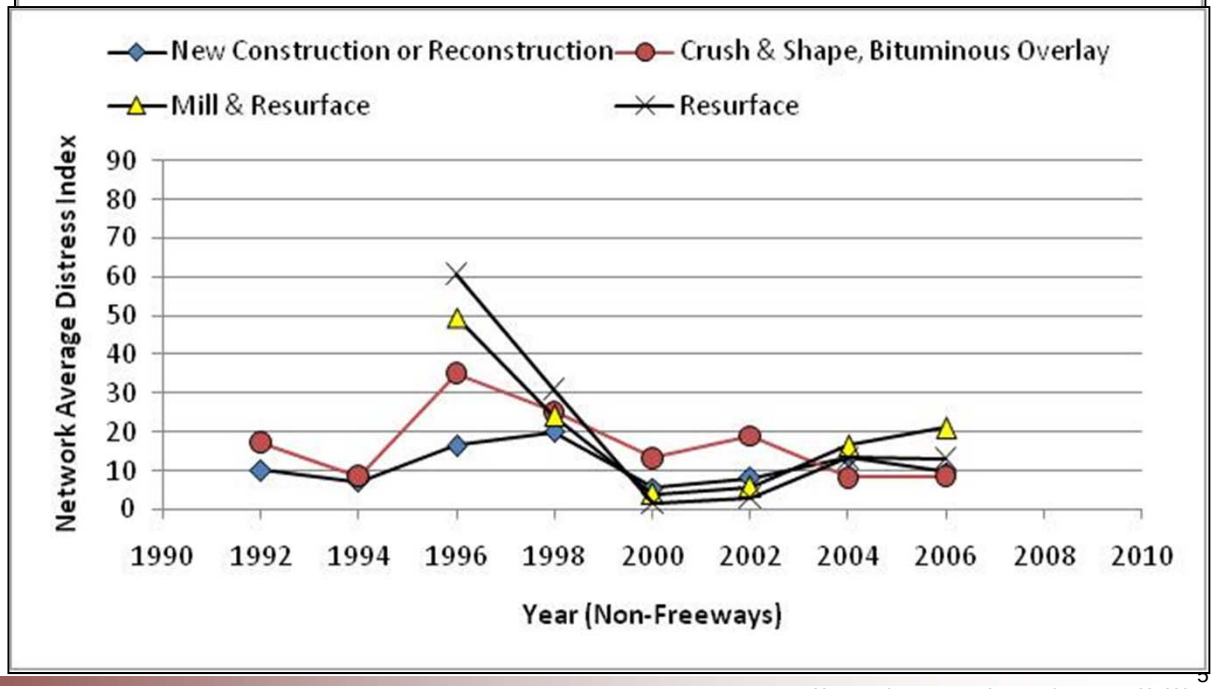
Improved pavement performance observations after implementing P-G binder specification

- Ministry of Transportation, Ontario
- Colorado
- Michigan
- Missouri
- Utah

BUT, other changes made: Gyratory compactor, use of polymer modified asphalt, revised QA specifications, pavement preservation, etc.

Michigan: Distress Index – systematic reduction over time.





Effect of Binder

- Difficult to quantify because multiple changes made or materials implemented within the same time period.
- Asphalt binders by themselves will not *significantly* improve performance – *my opinion*.

HISTORY: Many laboratory studies have shown PMA enhances fracture and distortion resistant properties – BUT field quantification of benefit is limited.

Performance Comparisons: Neat versus Modified Binders

Quantification of the Effects of Polymer-Modified Asphalt to Enhancing HMA Performance, **Sponsored by the Affiliate Committee, Asphalt Institute**.

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Distress Comparison for Companion Sections

1. Fatigue Cracking; Area & longitudinal combined
2. Rutting
3. Thermal Cracking

Companion Sections – Two sections where the only difference is the asphalt binder.

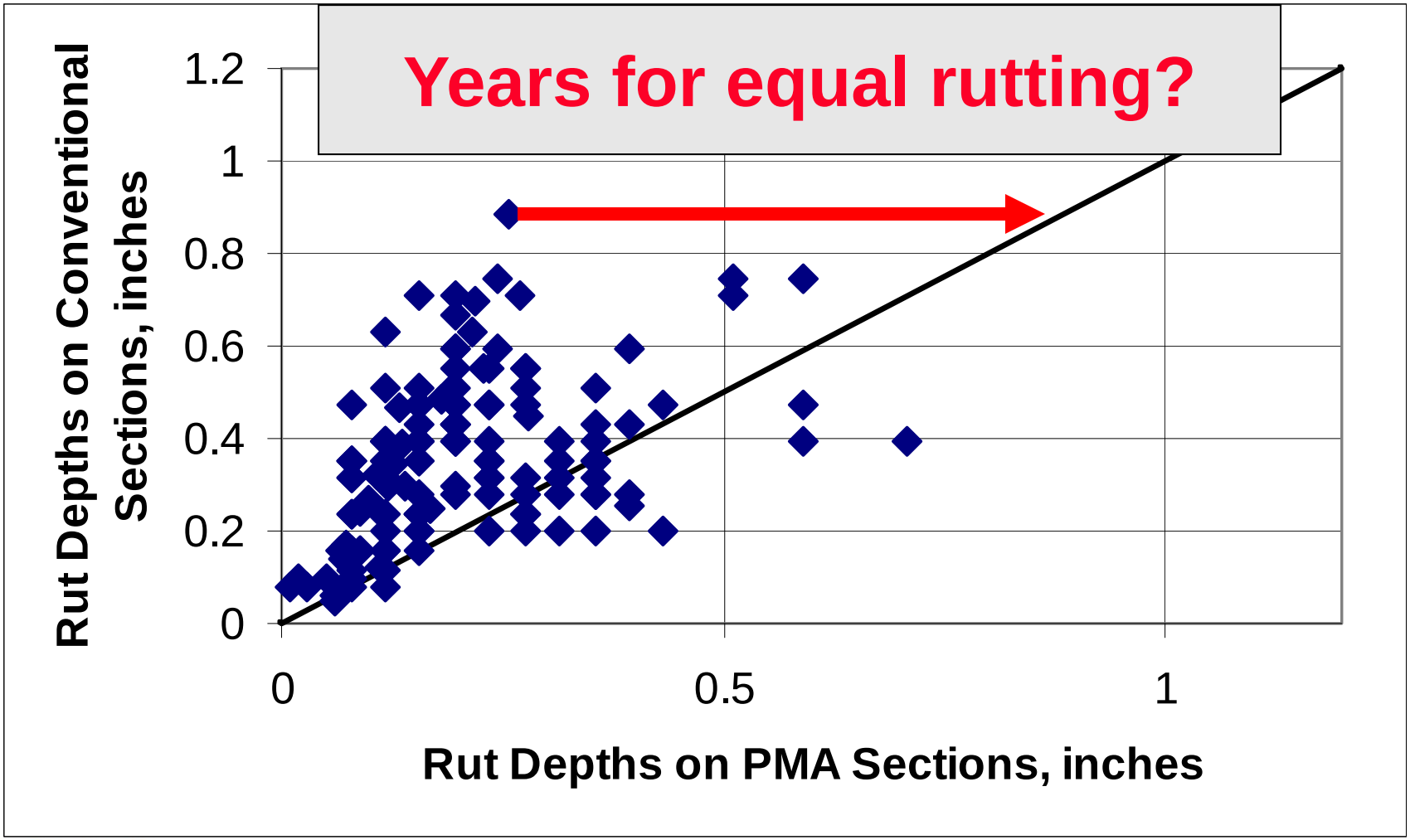
PMA Versus Neat Sections

- Comparison of Actual Distresses
  - Rutting
  - Fatigue Cracking
  - Transverse Cracking
- M-E Analysis of Performance
  - Distortion
  - Fracture

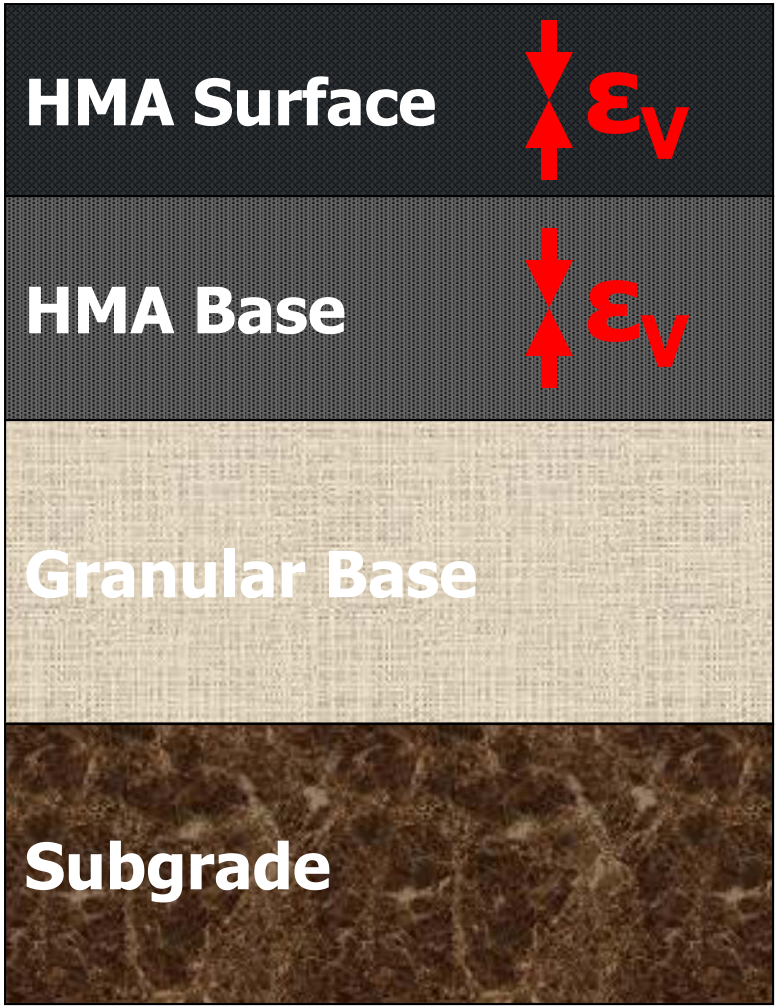
M-E Based Procedure normalizes any difference between companion sections.

Rutting

What is the time difference between different rut depths?



Distortion Analysis

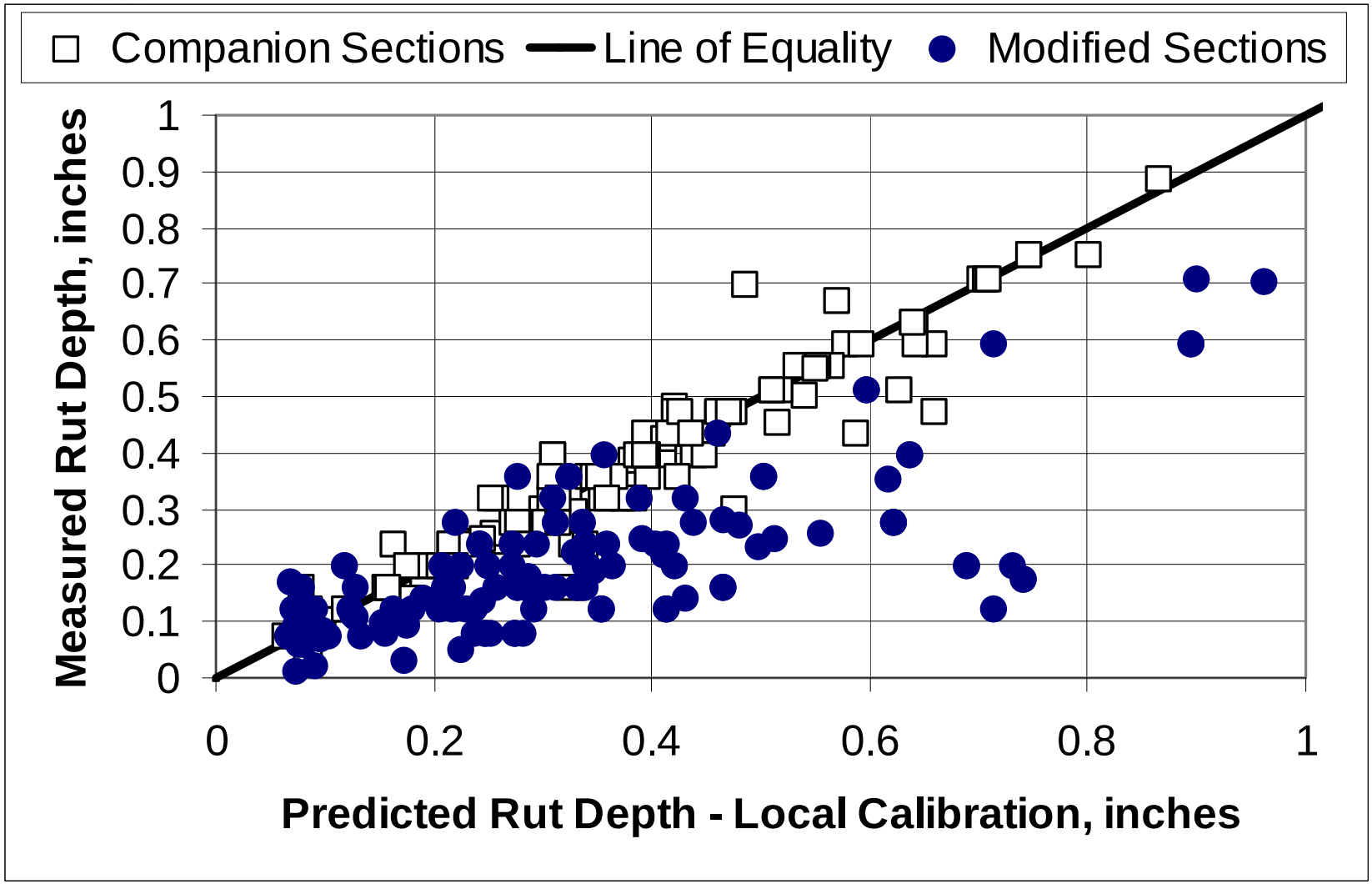


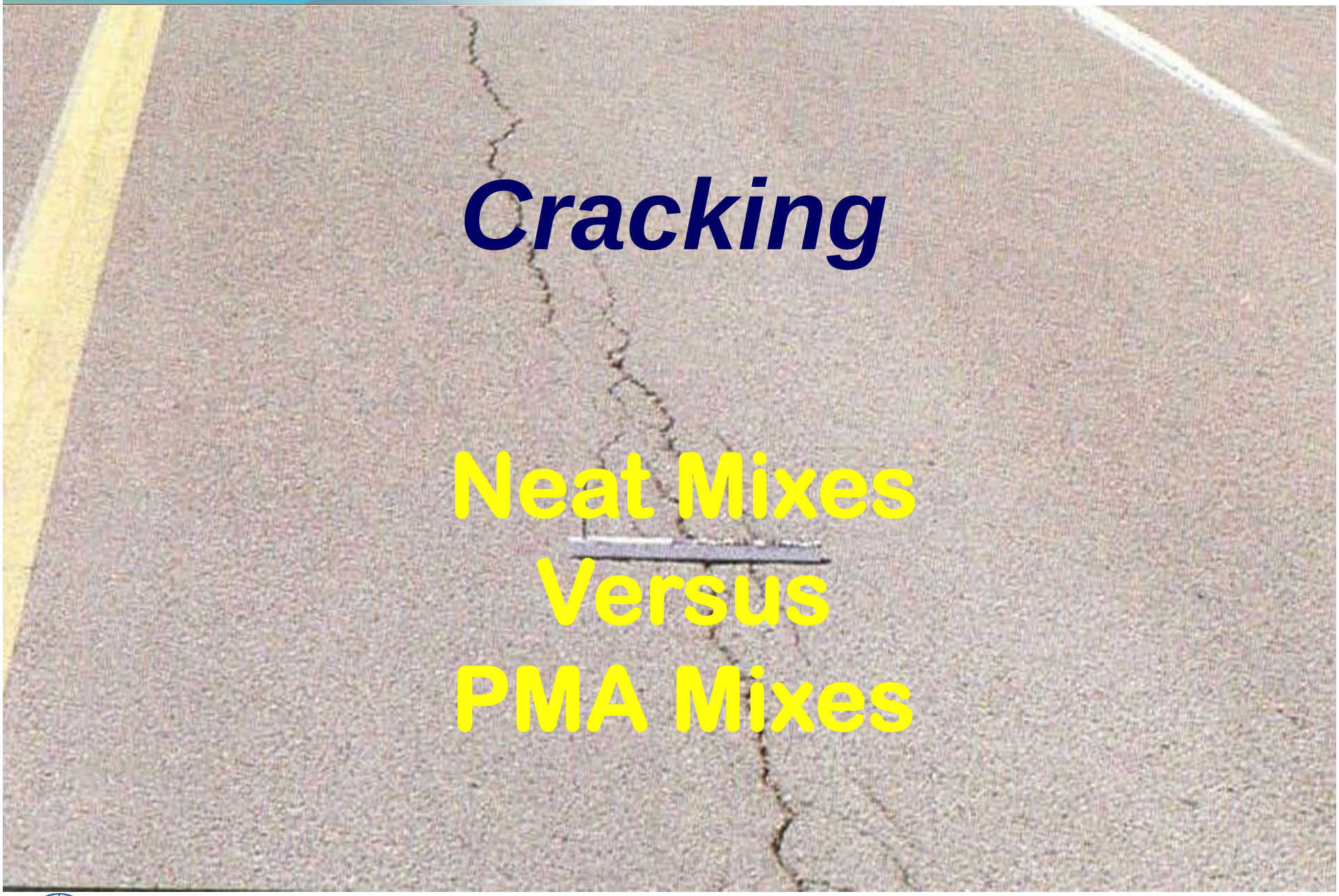
- Vertical strain at specific depths
- Neat sections individually calibrated & used to predict PMA rutting.

$$RD = \sum_{i=1}^{n} \left(\begin{array}{l} 5.37x10^{-7} (C_{r1})(N)^{0.4289(C_{r2})} \\ (T)^{2.5896} (V_{beff})^{1.0057} (V_a)^{0.5213} \\ (C_3)(\varepsilon_r)(t) \end{array} \right)_i$$

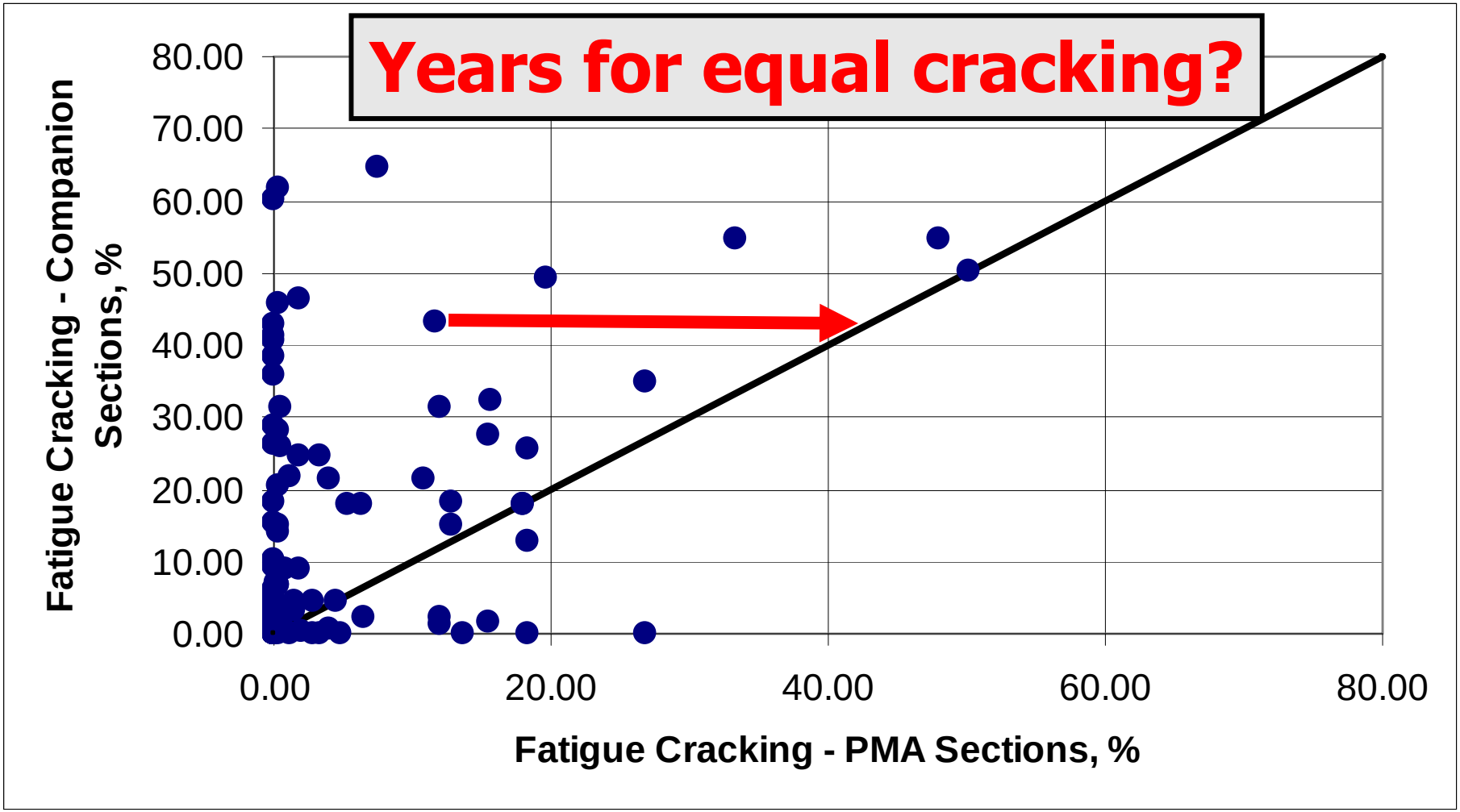
$$DI = \frac{n}{N_R}$$

Rutting – Neat Vs PMA

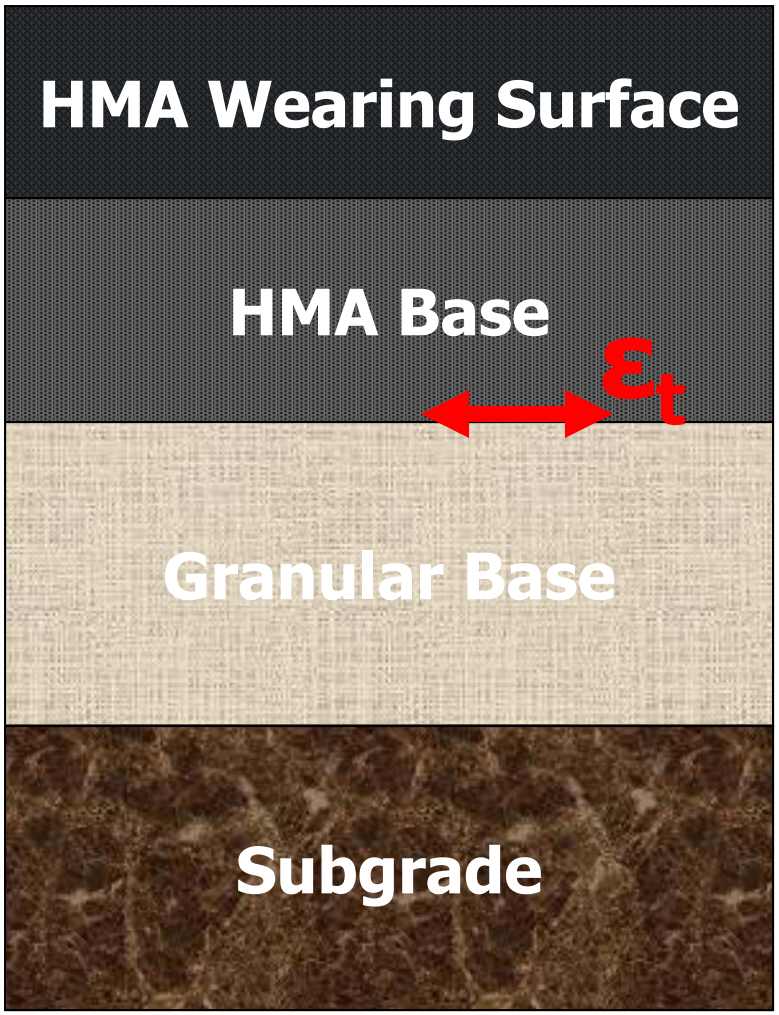



Cracking
Neat Mixes
Versus
PMA Mixes

What is the time difference between different amounts of cracking?



Fracture Damage Analysis

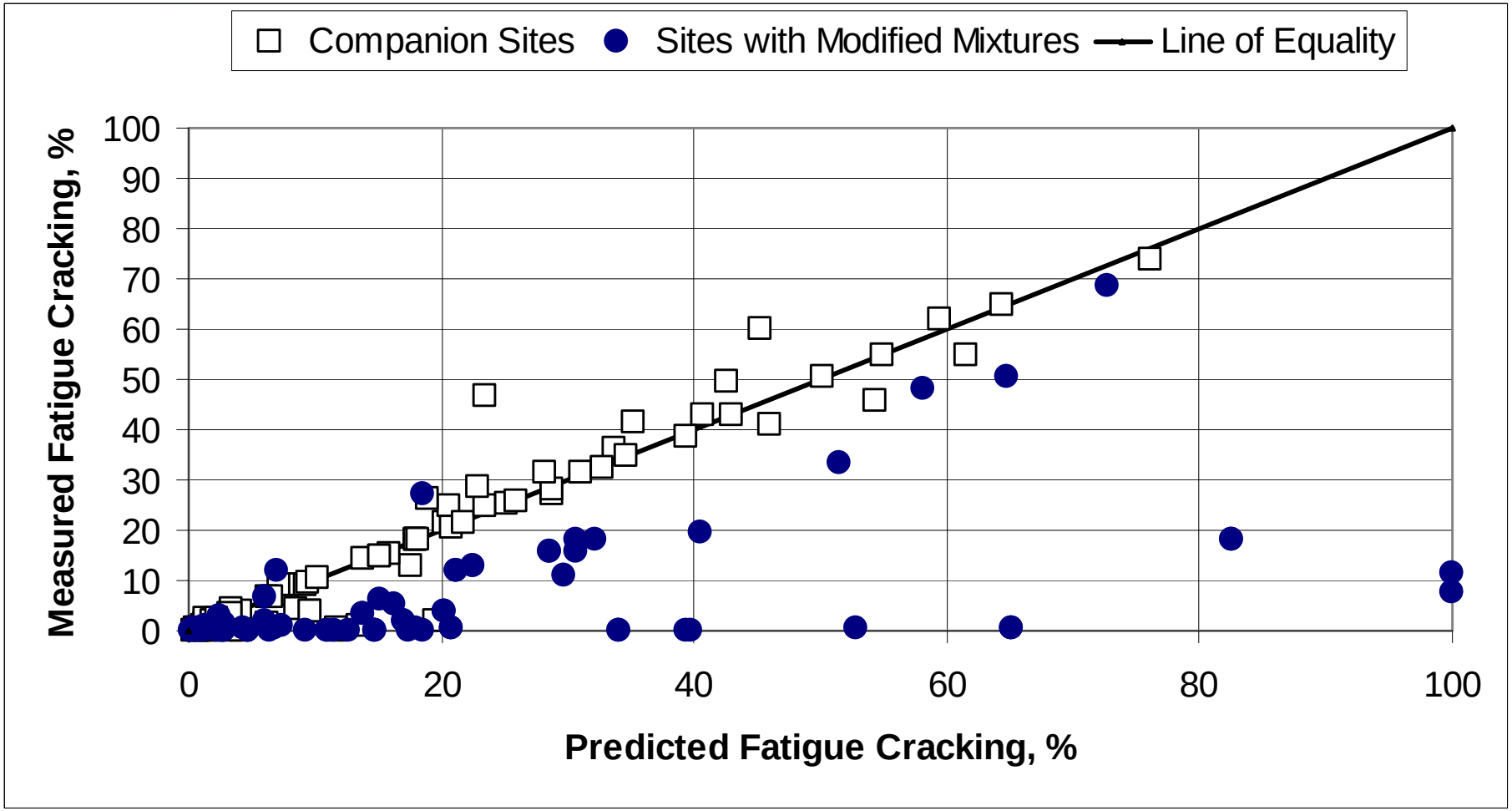


- Tensile strain at bottom of HMA layer.
- Neat sections individually calibrated & used to predict PMA cracking.

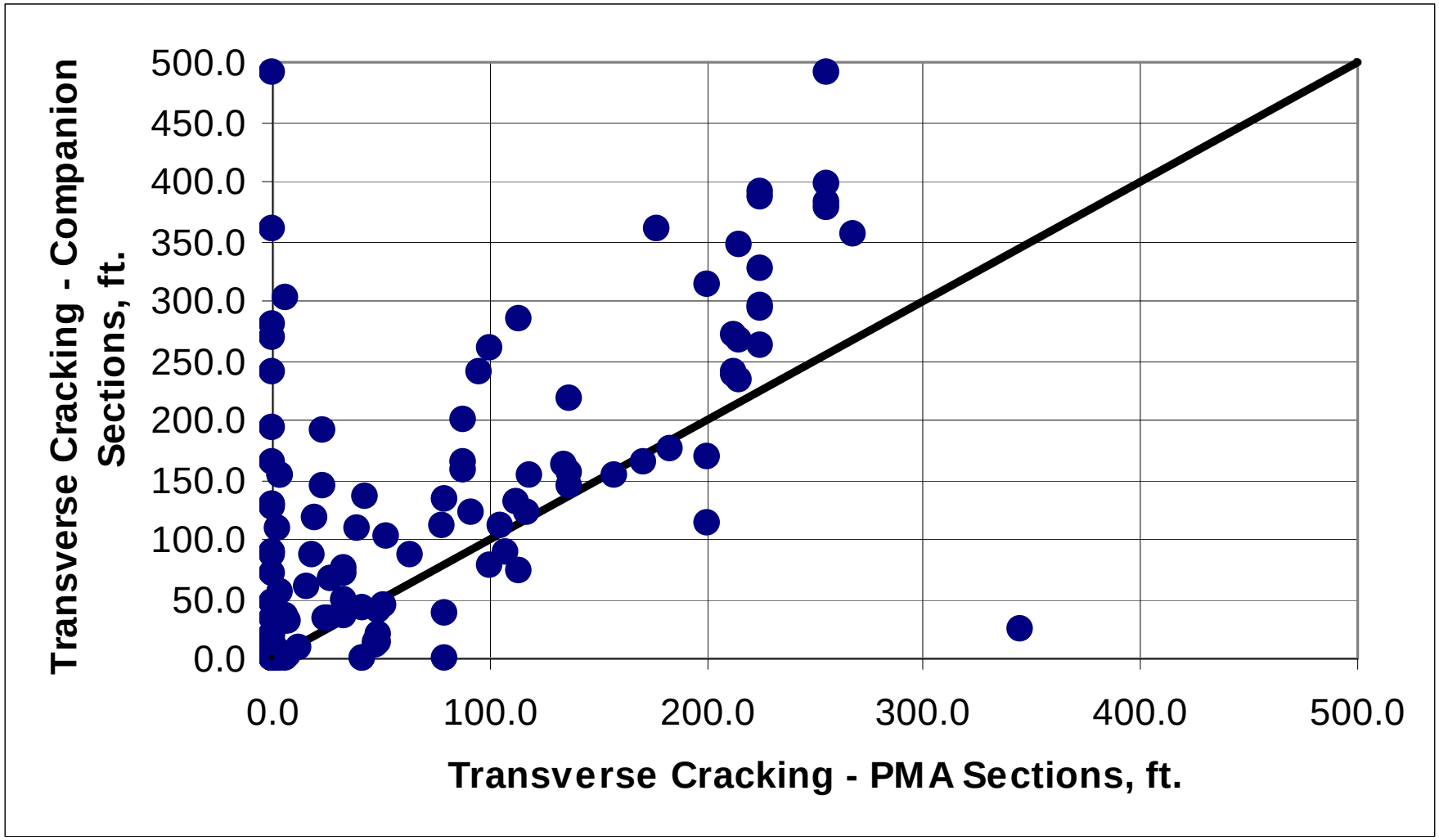
$$N_f = 0.00432\left(C_{f1}\right)\left(10\right)^{M}\left(\varepsilon_t\right)^{-3.291}\left(E\right)^{-0.854}$$

$$M = 4.84\left(\frac{V_{beff}}{V_a + V_{beff}} - 0.69\right)$$

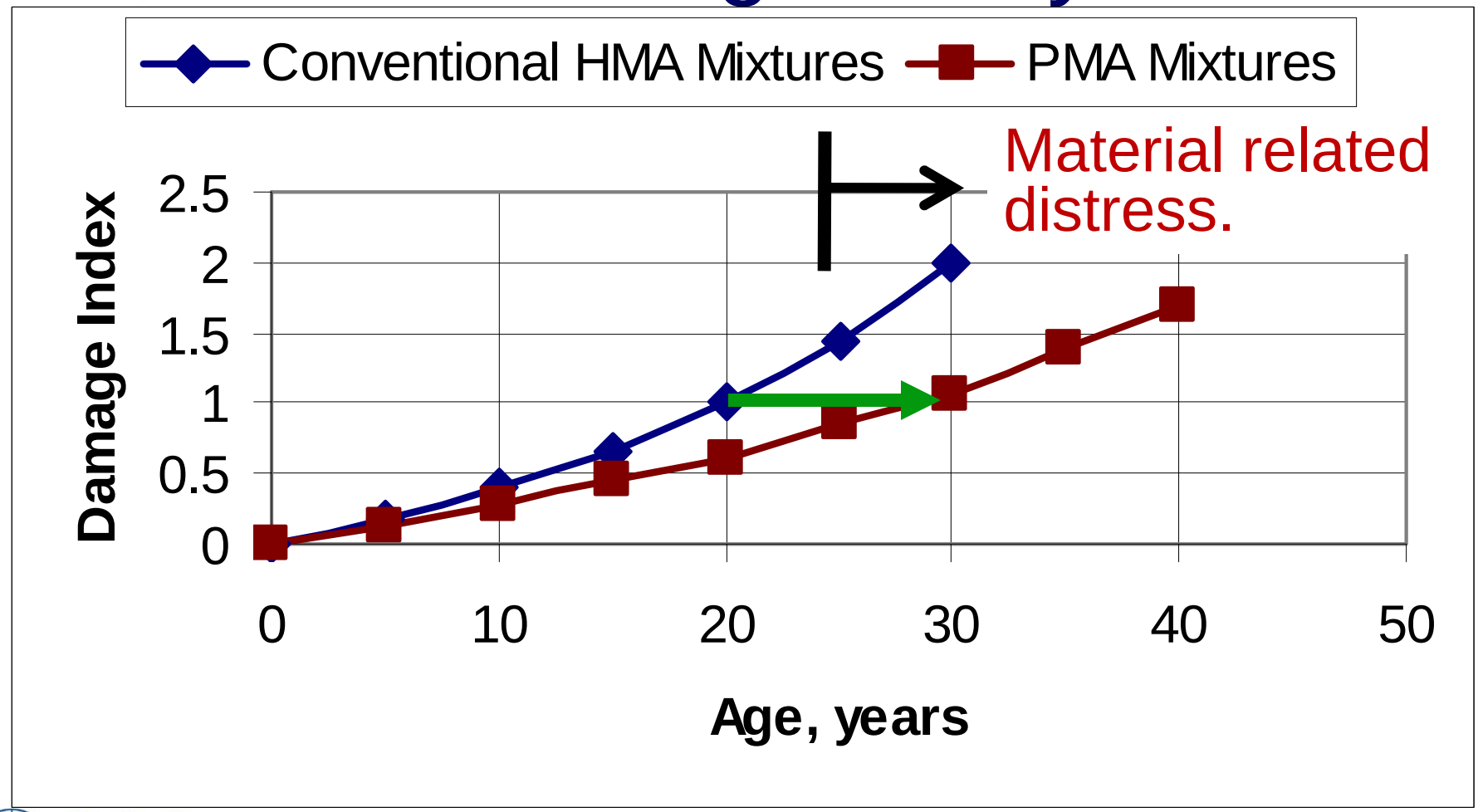
Fatigue Cracks – Neat Vs PMA



Transverse Cracking – Neat Vs PMA



Enhanced Performance Based on Damage Analysis



Expected Increase in Service Life, yrs

Site Factor	Condition Description		Added Life
Foundation	Non-Expansive		5-10
	Expansive		2-5
	Frost Susceptible – Cold Climate		2-5
Water Table & Drainage	Deep		5-10
	Shallow; Adequate		5-8
	Shallow; Inadequate		0-2
Existing Pavement Condition	HMA	Good	5-10
		Poor-Extensive Cracking	1-3
	PCC	Good	3-6
		Poor-Faulting & Cracking	0-2

Expected Increase in Service Life, yrs

Site Factor	Condition Description		Added Life
Climate; Temp. Fluctuations	Hot	Hot Extremes	5-10
	Mild		2-5
	Cold	Cold Extremes	3-6
Traffic, Truck Volumes	Low	Intersections	5-10
		Thoroughfares	3-6
		Heavy Loads	5-10
	Moderate		5-10
	High		5-10

Summary Comments

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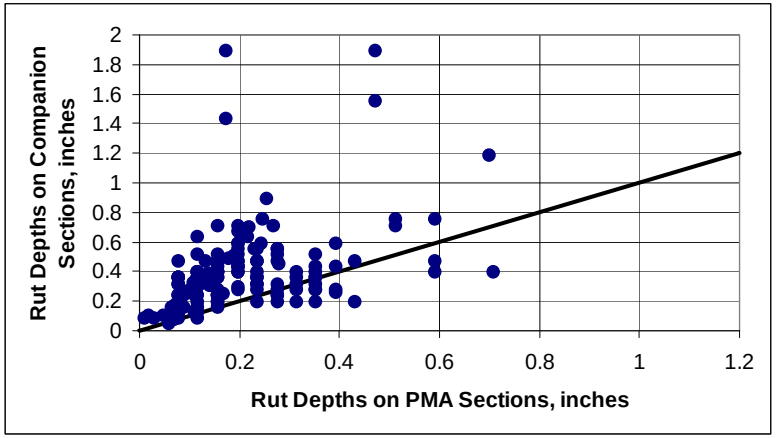
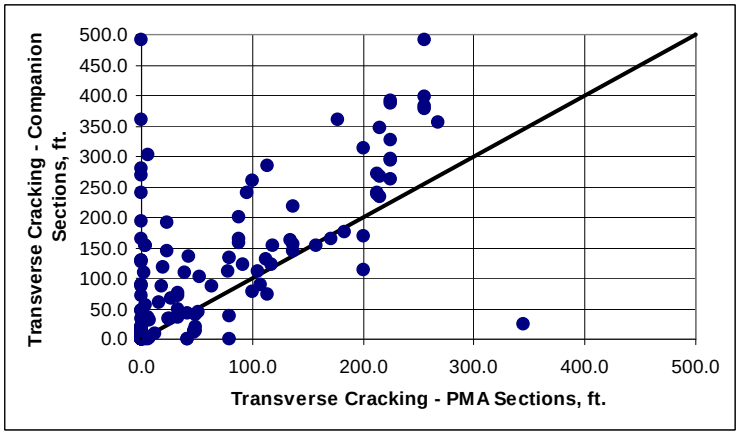
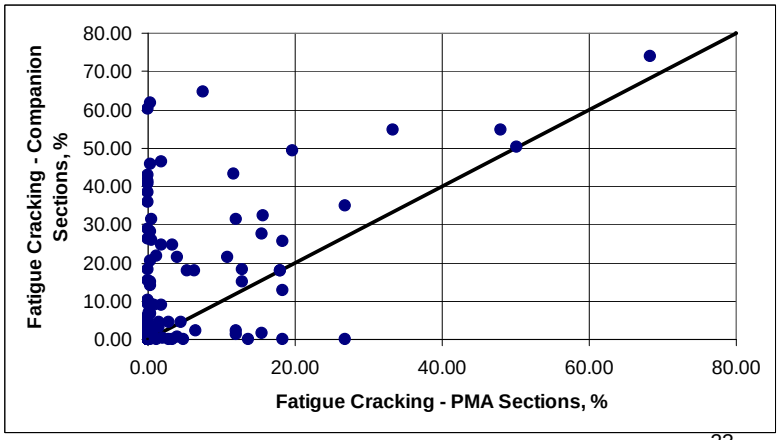
Summary

- Use of PMA reduces distress in pavements & overlays
  - Less Fatigue Cracking
  - Fewer Transverse Cracks
  - Smaller Ruts







Summary

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
  - Eliminate Traffic Delays

Summary

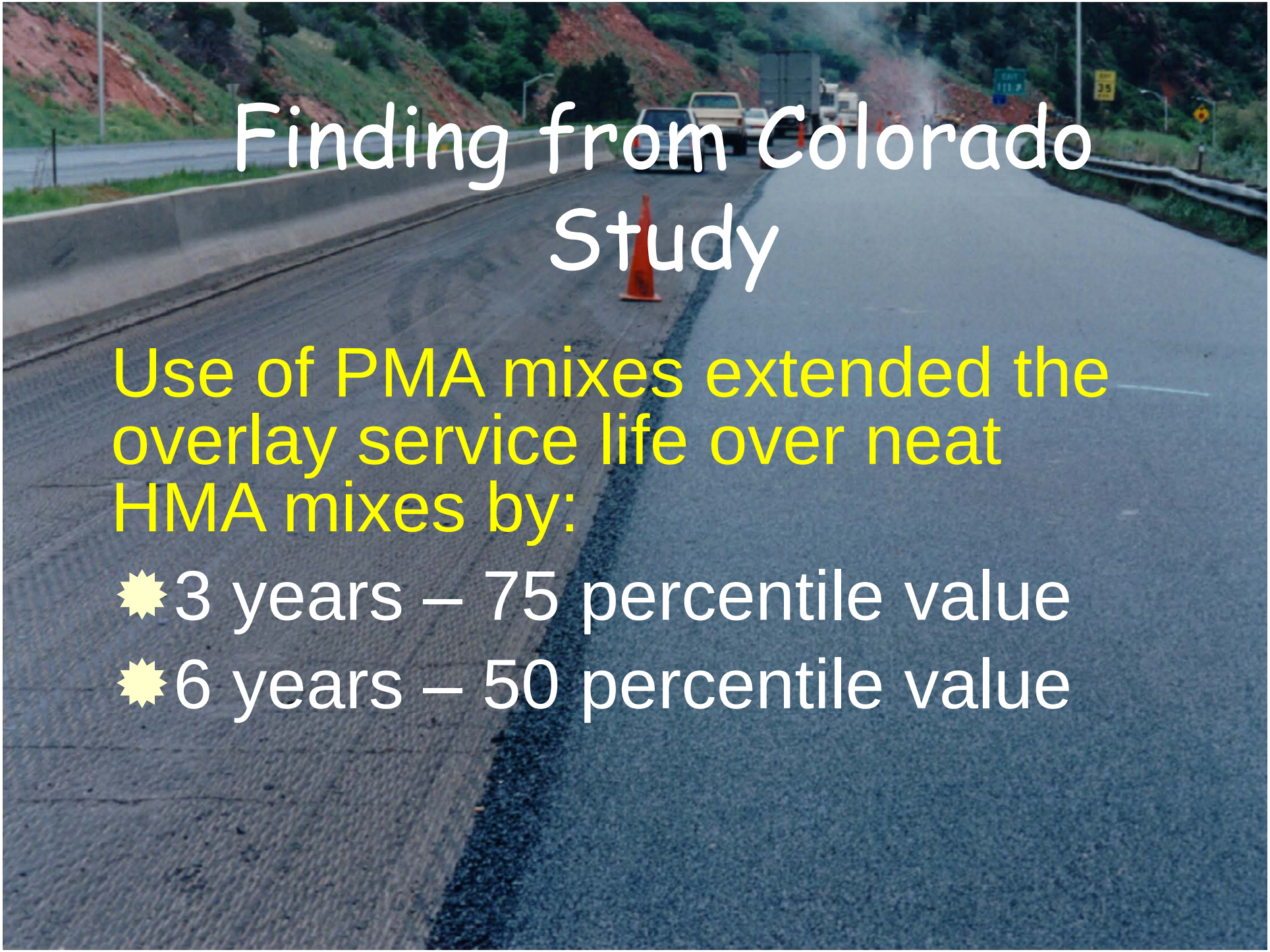
- Quality of Construction –

  STILL IMPORTANT, IF NOT THE MOST IMPORTANT FACTOR.

- Many M-E Transfer Functions are stiffness based for binder & mix –

  OTHER MATERIAL PROPERTIES ARE MORE IMPORTANT.

Thank you for your attention - Any questions?



Finding from Colorado Study

Use of PMA mixes extended the overlay service life over neat HMA mixes by:

- 3 years – 75 percentile value
- 6 years – 50 percentile value