

Performance of Polymer Modified Pavements in Louisiana PG 64-22, PG 70-22M, and PG 76-22M

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Association of Modified Asphalt Producers

Annual Meeting

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Outline

- Snapshot Facts about Louisiana
- Quick Summary of Polymer and Binder Properties
- Lab Performance
- 10 year performance of Interstates in LA.



Louisiana State Capital

Baton Rouge

2 million tons of polymer
modified asphalt per year



Louisiana State Flag

-LA DOTD is responsible for 35,000 lane miles of HMA surface





Louisiana State Flower

Magnolia



Average annual construction budget \$500 M

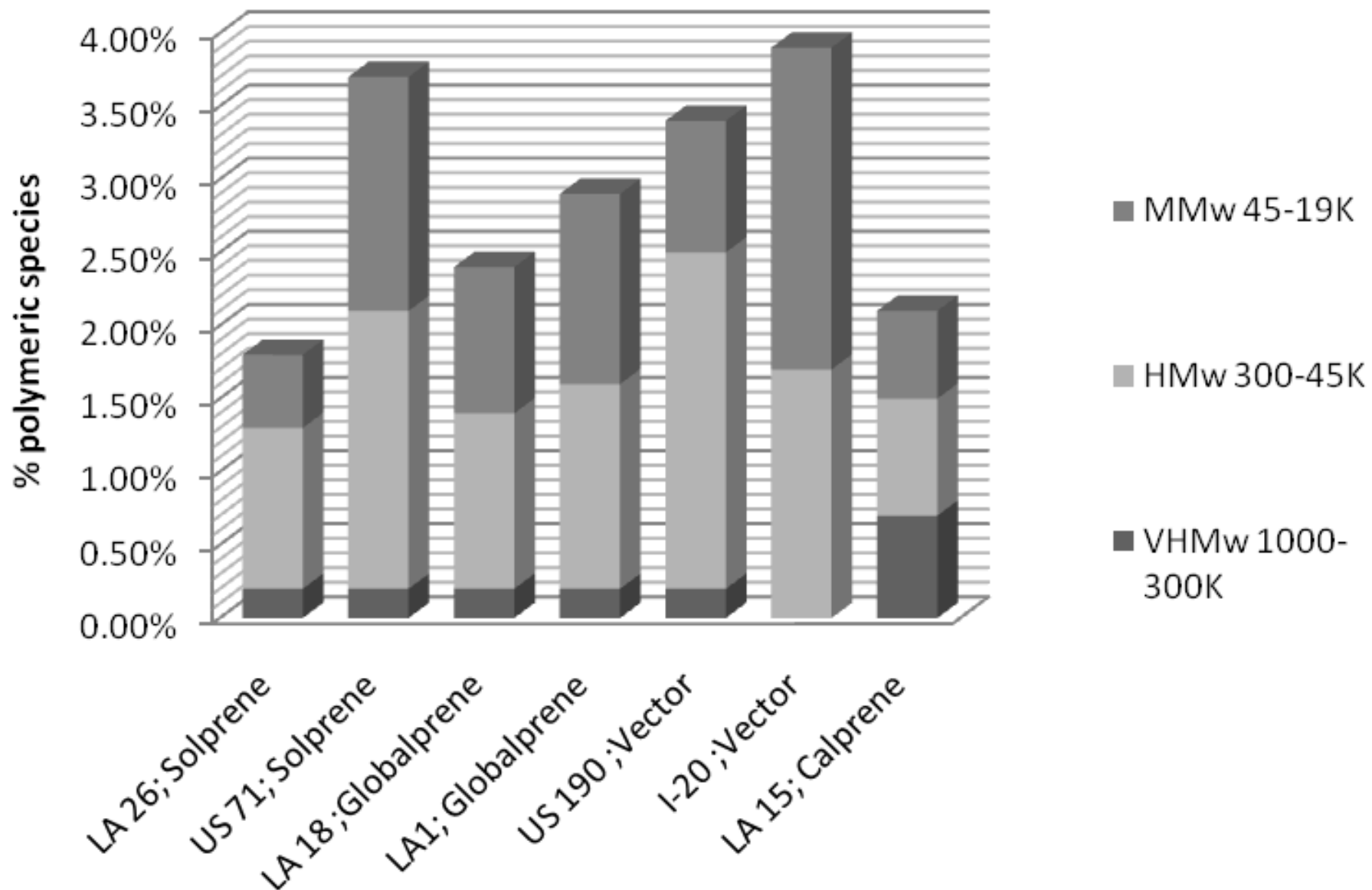
Chicot State Park



- Cost for stone = \$30/ton
- Cost for modified asphalt, PG76-22m = \$600/t
- Liquid Anti-strip is required in all HMAC



Molecular weights of Polymers used on LA roads



Average percentage concentration computed from GPC traces for different PG 64-22 sources

	MMW	LMW	Very LMW
Average original	11.90%	83.07%	5.03%
Average TFOT	13.26%	81.66%	5.08%
Average PAV	14.44%	80.57%	4.99%

	MMW	LMW	Very LMW
Average original	8.56%	86.61%	4.83%
TFOT	9.67%	85.46%	4.87%
PAV	10.51%	84.66%	4.83%

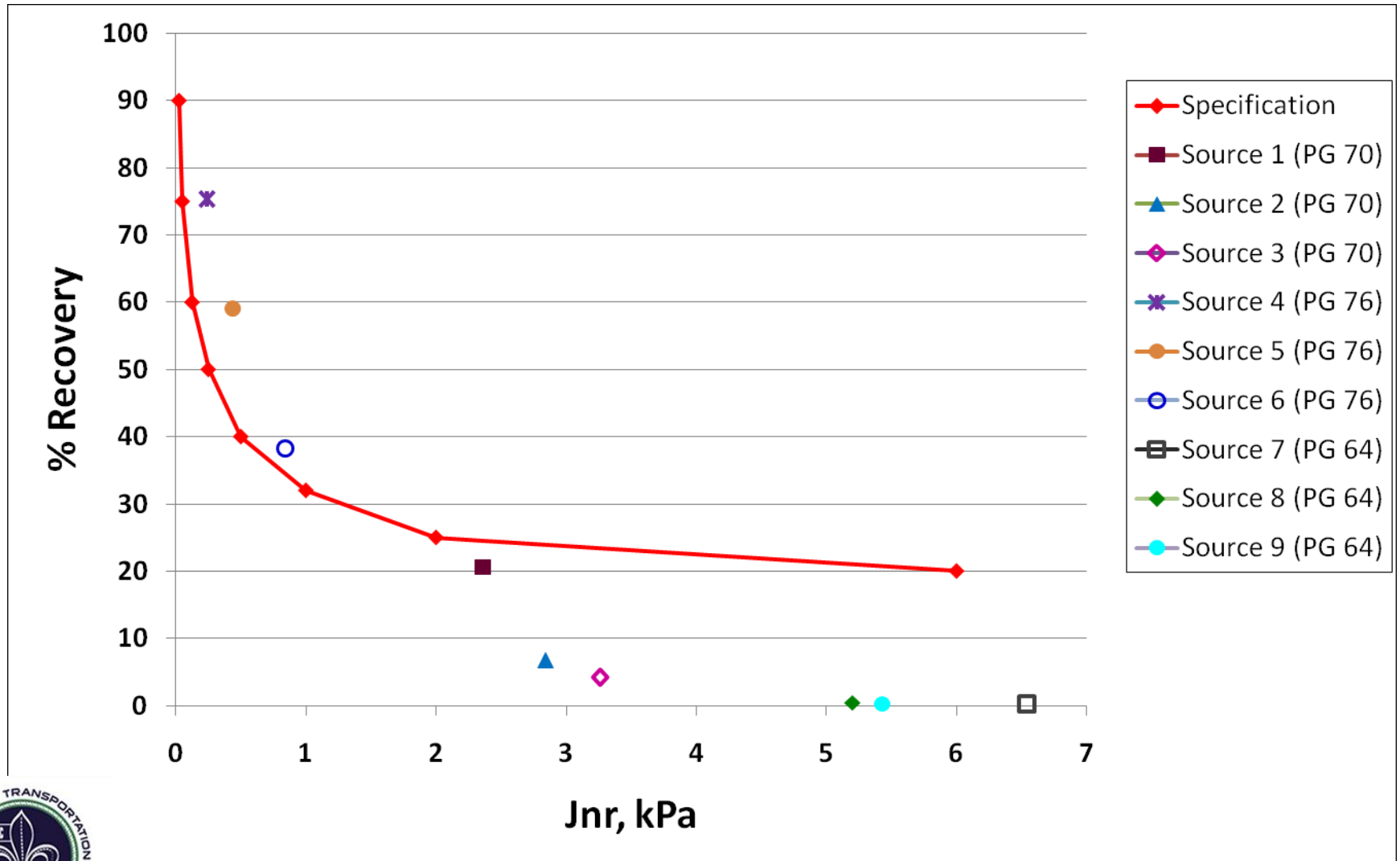
	MMW	LMW	Very LMW
Average original	13.95%	79.70%	6.35%
Average RTFO	16.09%	77.79%	6.12%
Average PAV	16.46%	77.32%	6.22%

	MMW	LMW	Very LMW
Average original	16.25%	77.36%	6.39%
Average RTFO	18.92%	75.06%	6.02%
Average PAV *	18.27%	75.59%	6.14%
RAP *	19.91%	74.62%	5.47%
RAP	18.73%	75.64%	5.63%

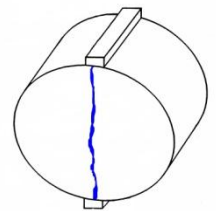
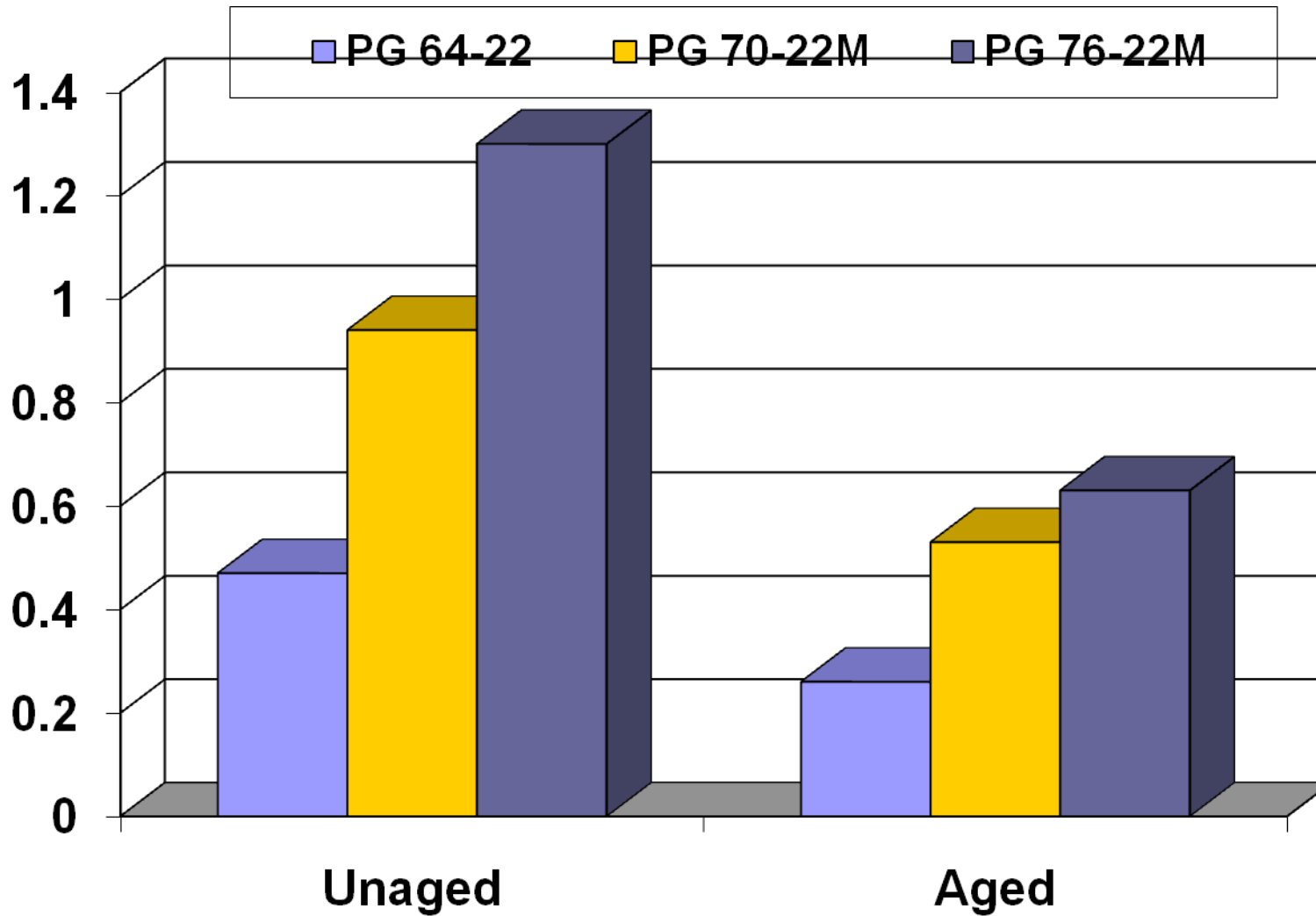


Route	Age	VHMw	HMw	MMw	Sum	Asphaltenes	Maltenes
		1000-300K	300-45K	45-19K	1000-19K	19-3.5K	3.5-0.2K
LA 26	new	0.2%	1.5%	1.4%	3.1%	25%	72%
LA 26	6 months	0.0%	0.9%	1.5%	2.5%	22%	76%
LA 26	1 year	0.0%	0.7%	1.7%	2.4%	22%	76%
US 71	new	0.0%	0.4%	1.9%	2.3%	22%	76%
US 71	1 year	0.0%	1.3%	1.8%	3.1%	25%	72%
LA 18	new	0.0%	1.2%	2.3%	3.5%	26%	70%
LA 18	1year	0.1%	1.6%	3.8%	5.5%	22%	73%
LA 1	new	0.1%	1.0%	1.8%	2.8%	24%	73%
LA 1	1 year	0.1%	1.3%	2.5%	3.9%	21%	75%
US 190	new	0.1%	2.0%	1.5%	3.6%	21%	75%
US 190	1 year	0.3%	1.6%	1.6%	3.5%	13%	84%
LA 15	new	0.2%	1.2%	0.9%	2.3%	20%	77%
LA 15	6 months	0.2%	1.1%	1.1%	2.4%	22%	76%
LA 15	1 year	0.2%	1.3%	2.2%	3.6%	16%	80%

MSCR test



ITS Strain, % – 25C



Summary

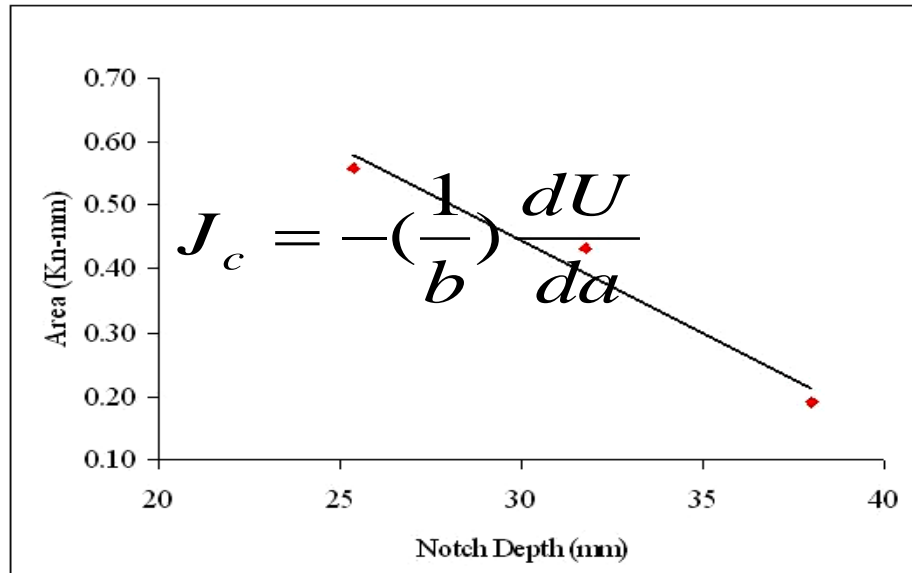
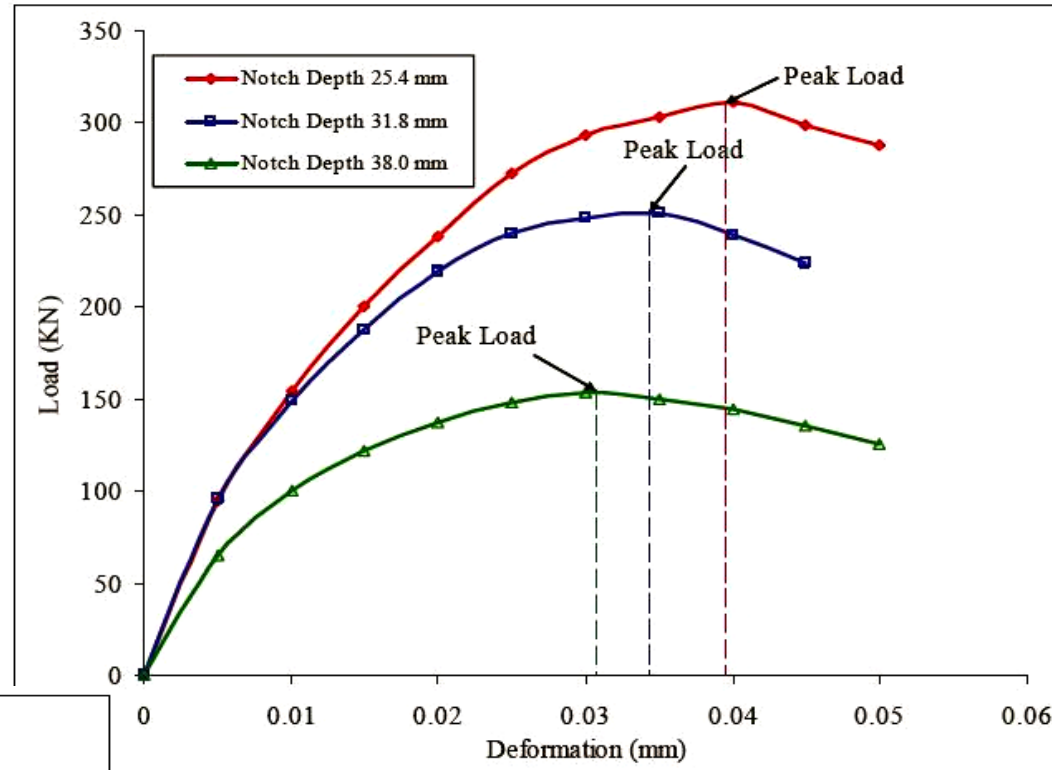
ITS Test Results



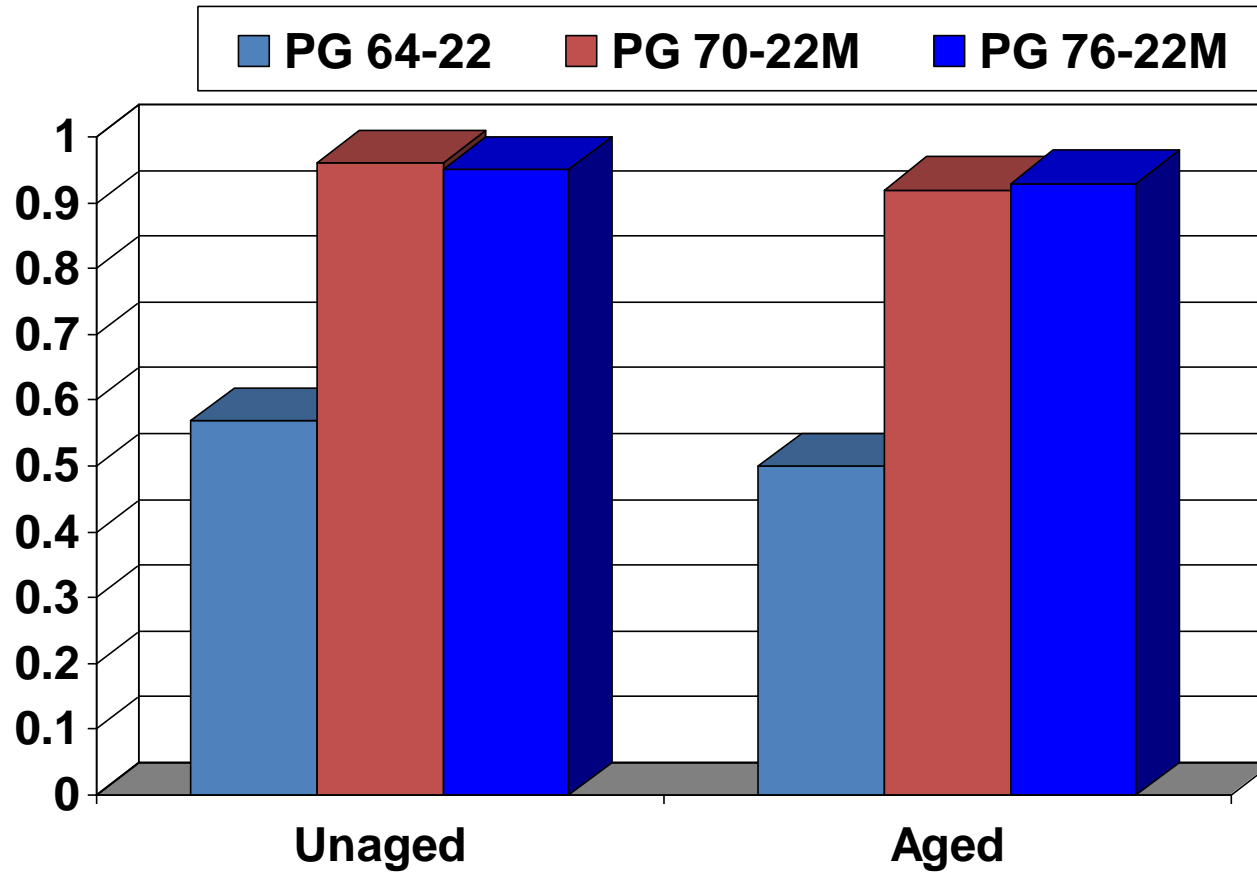
- Mixtures containing polymer-modified asphalt binders (i.e. PG 70-22M and PG 76-22M) possessed **higher IT strain** values than PG 64.
 - Presence of SB polymer improved the elastic property of those HMA mixtures.
 - Relative value: 50% more cost for PG 76 provides 150% more strain; 25% more for PG 70 provides 100% more strain (aged briqs)

Semi-Circular Bend (SCB) Test

- Protocol: Mohammad et al. [2004]
- Test Temperature: 25°C
- Unaged and Aged Mixtures
- Three Notch Depths
- Load: 0.5 mm/min vertical deformation rate



Jc from SCB Test, 25C

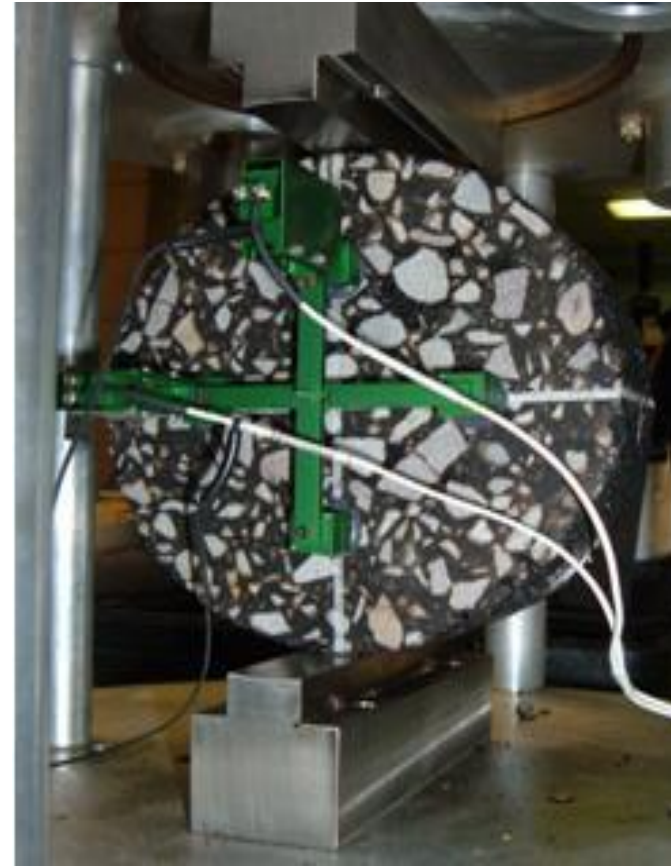
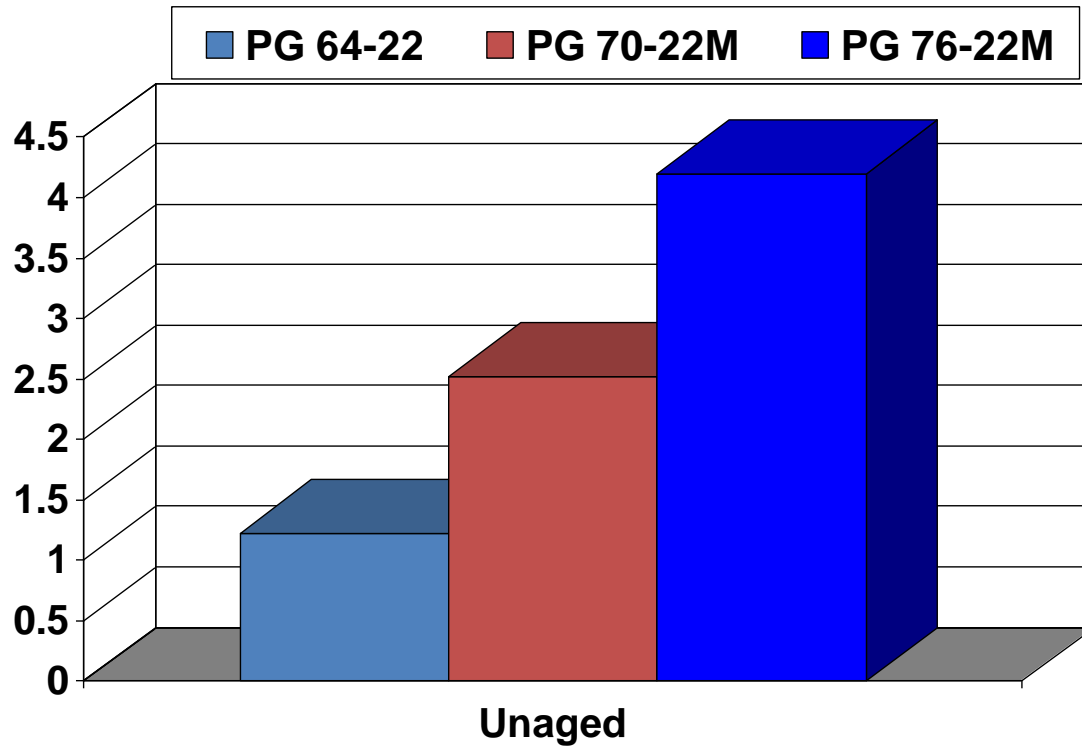


Summary – SCB Test



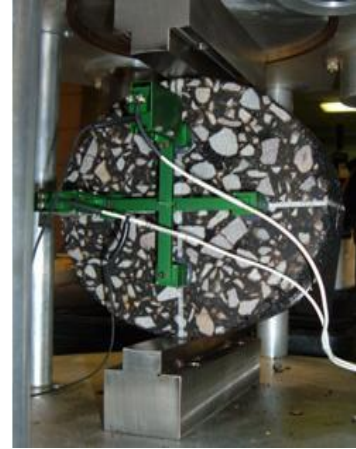
- Presence of SB polymer in asphalt binder improved the elastic property of HMA mixtures
- Mixtures with Pg 70m (%25 more cost) and PG 76m (50% more cost) were 80% more resistant to initial cracking than unmodified mixtures using PG 64 at \$400/ton.

Dissipated Creep Strain Energy, 10C

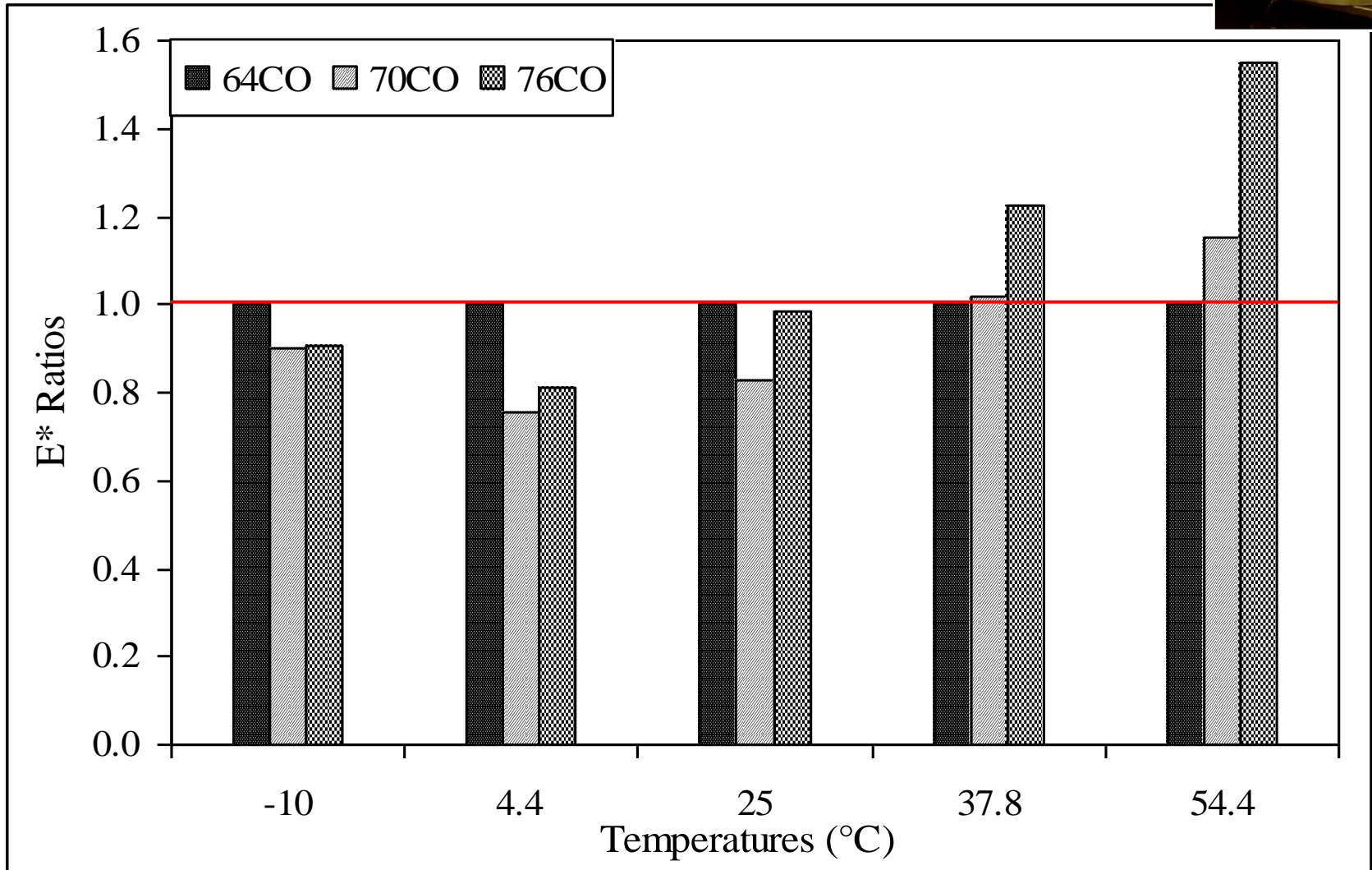
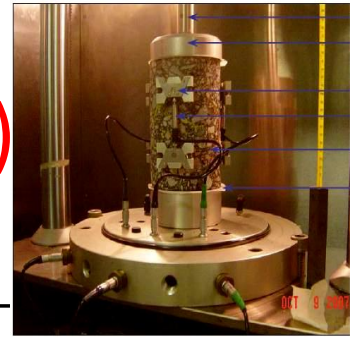


Summary, DSCE

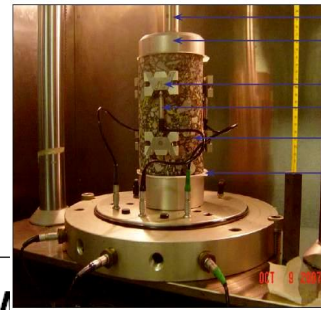
- SBS Polymer = better crack resistance.
- Relative value;
 - 25% increase in binder cost provides 2.5x mixtures crack resistance
 - 50% increase in binder cost w/ SB polymer provides 4x mixture's crack resistance.



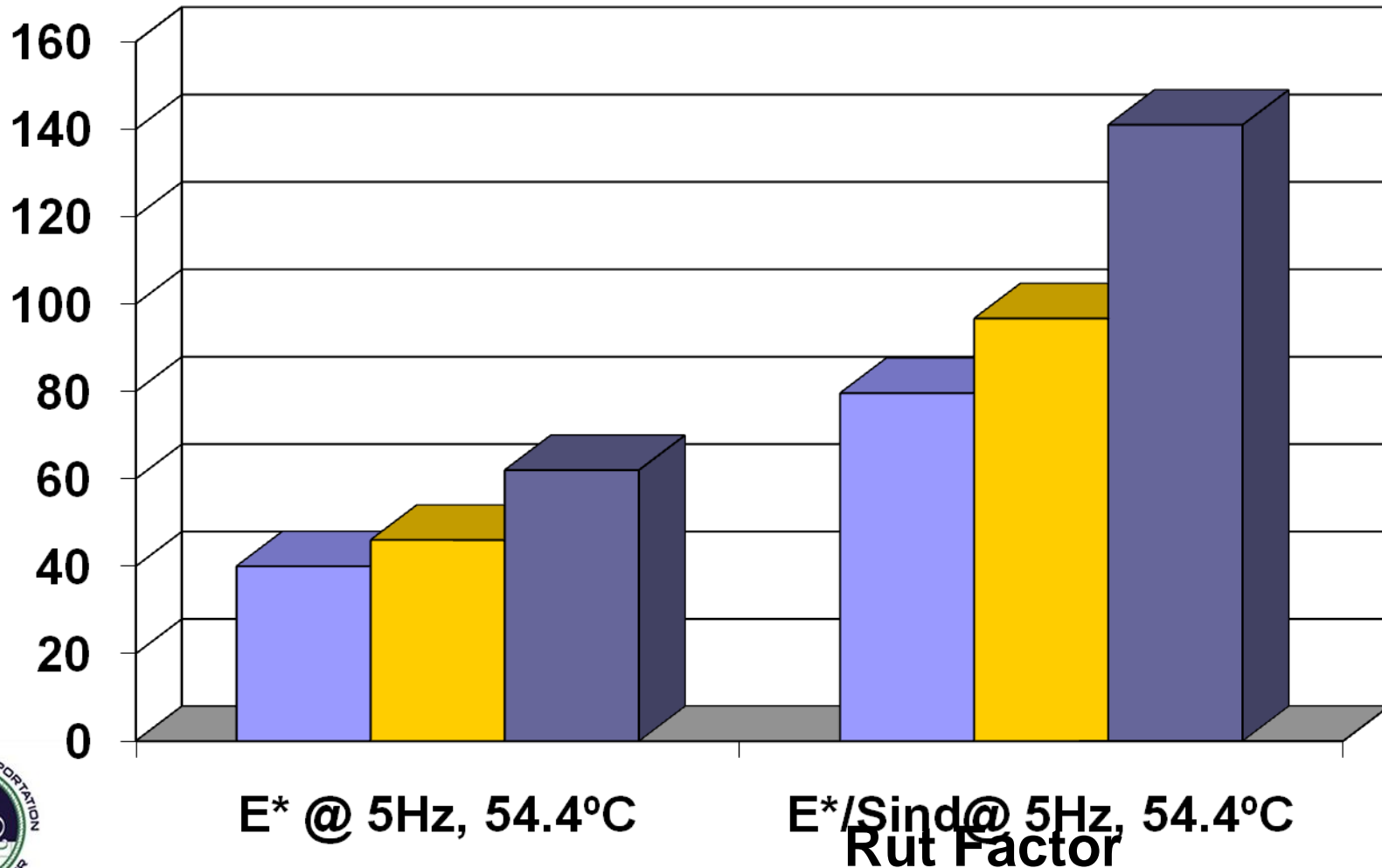
Dynamic Modulus Test Results (5Hz)



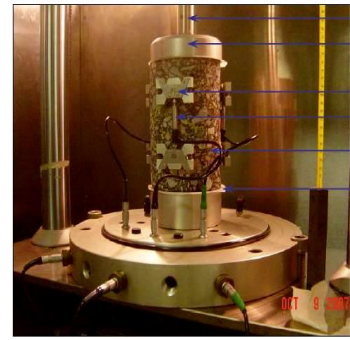
Dynamic Modulus Test Results, E^* (Ksi) @ 5Hz, 54.4°C



PG 64-22 PG 70-22M PG 76-22M



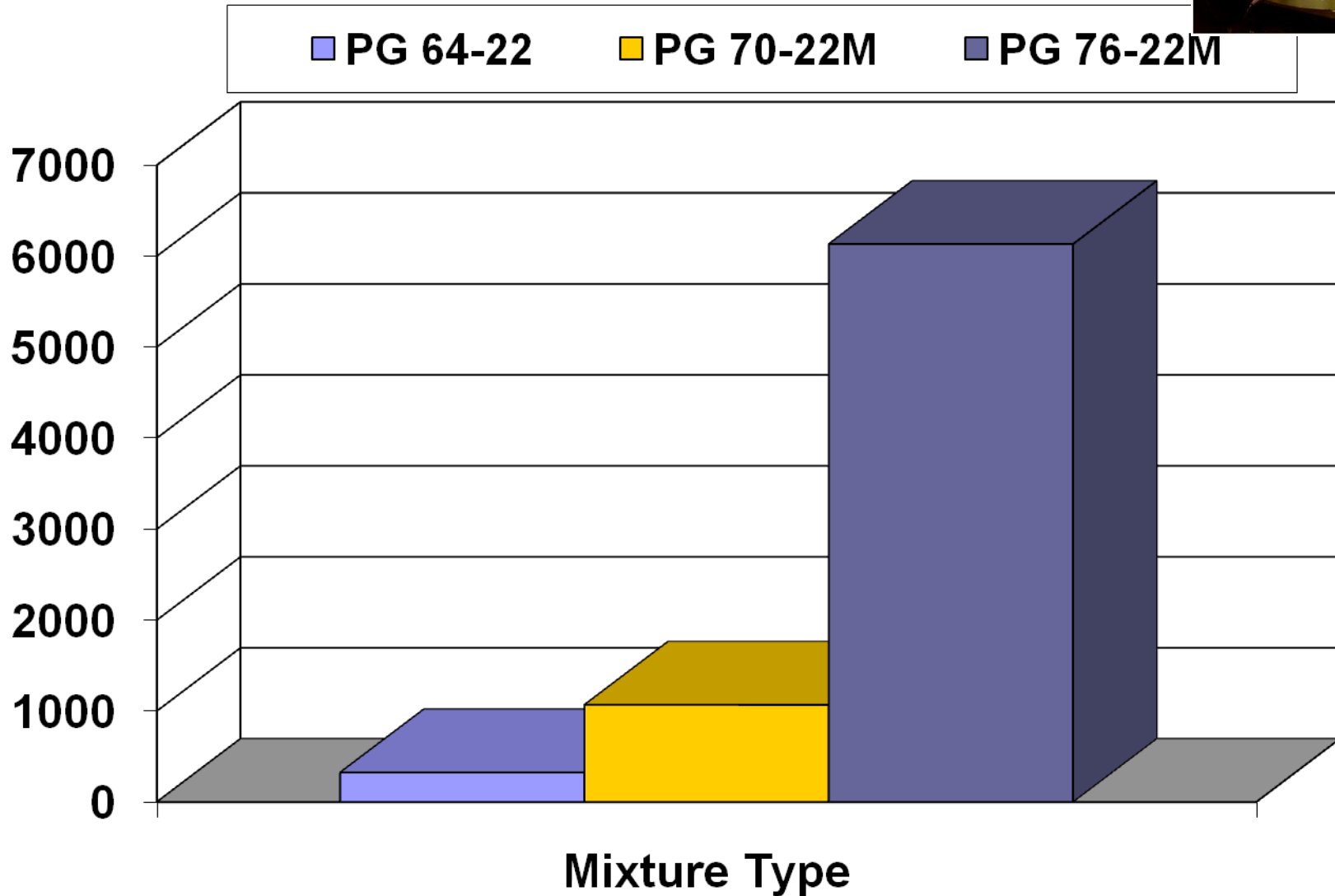
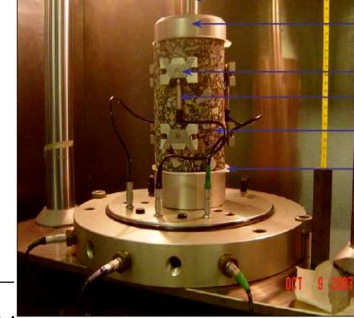
Summary, E^* Test Results



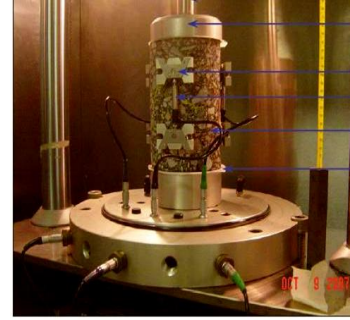
- PG grade = rut resistance
- Polymer = better performance at all temperatures
- Relative value, rut factor:
 - \$400 for PG 64 – $E^* = 40$
 - \$500 (+25%) for PG 70 – $E^* = 46$ (12% increase)
 - \$600 (+50%) for PG 76 – $E^* = 62$ (50% increase)



Flow Number Test Results, 54.4°C



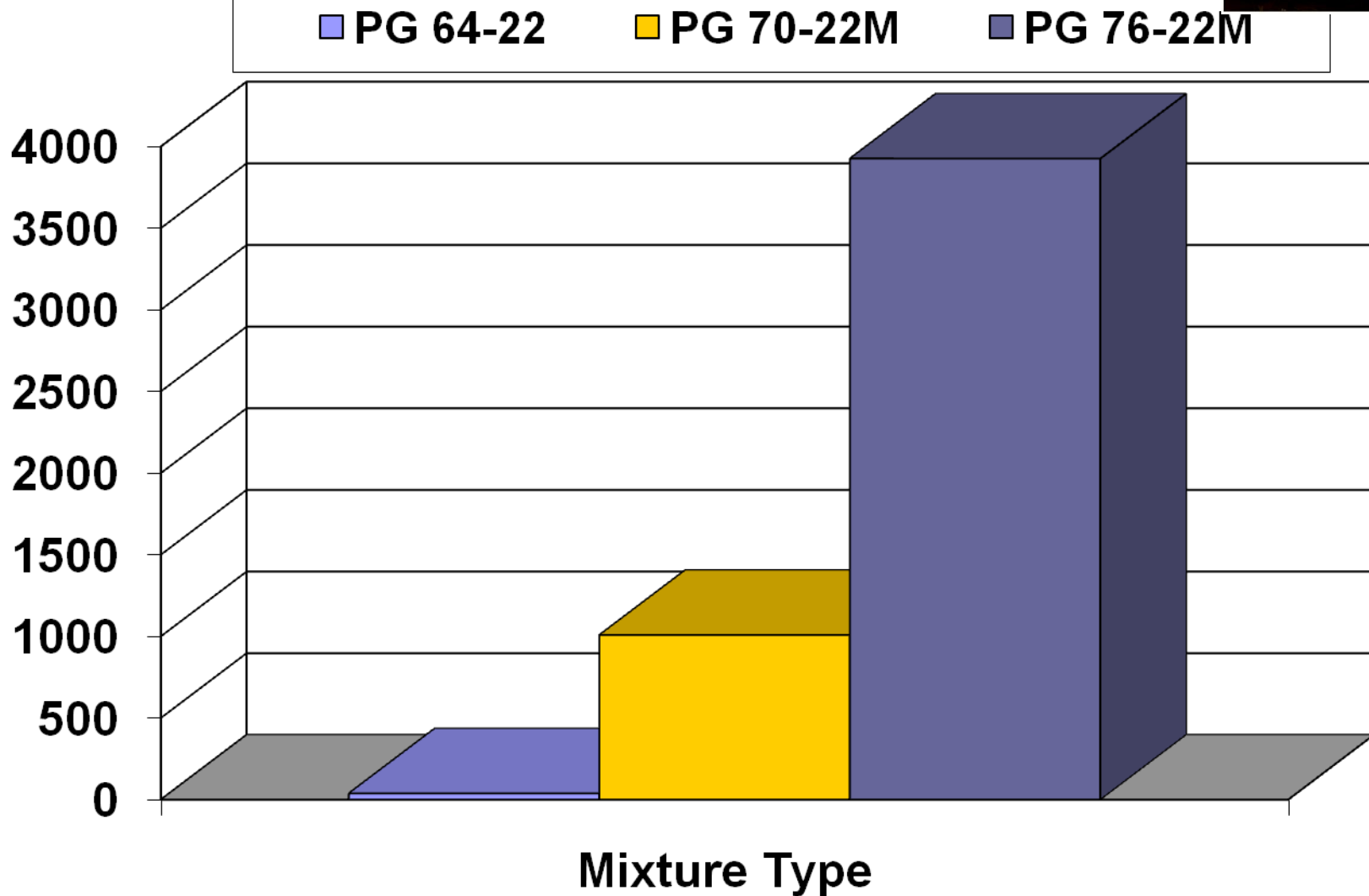
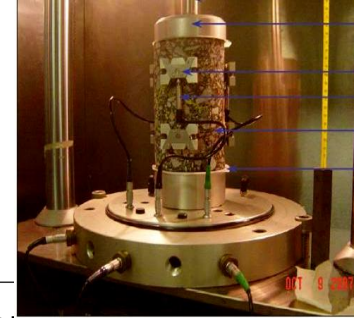
Summary, Flow Number



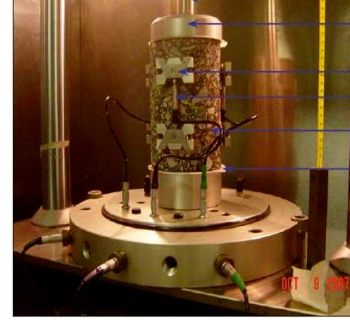
- Given PG64 = \$400/ton
- For 25% more/ton or \$100/ton yields 100% increase in flow number
- Add 50% or \$200/ton for PG 76-22 yields 1000% increase in flow number



Flow Time Test Results, 54.4°C



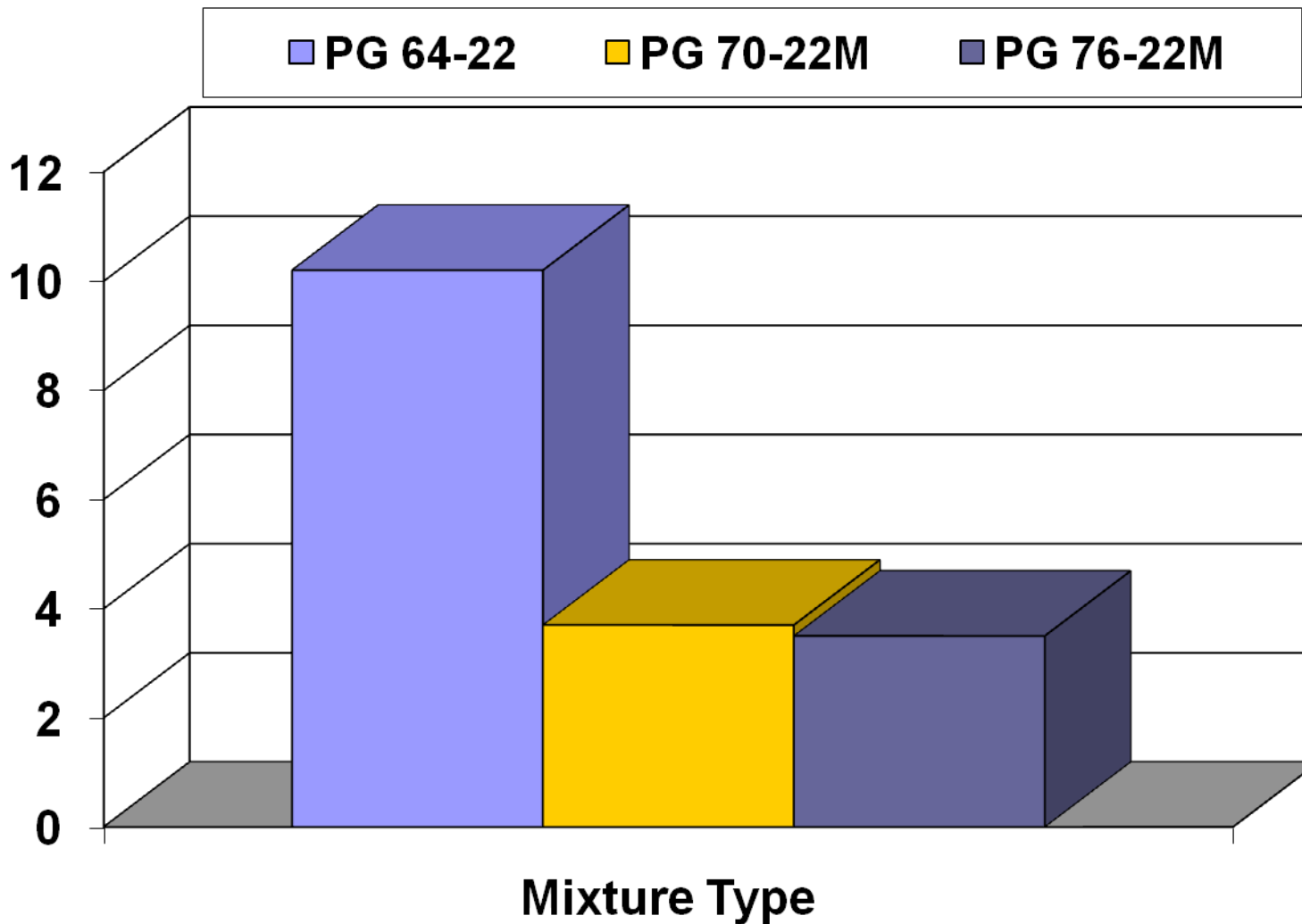
Summary, Flow Time



- PG +Polymer = Rut resistance
- Relative value of \$400/ ton for PG 64
 - 50% higher cost = 100 x more flow time
 - 25% higher cost = 1000 x more flow time



LWT Test Results, 50%



Summary, LWT test Results



- SBS Polymer = excellent performance in LWT
- Relative Value: Using PG64 at \$400/ton
 - 25% higher cost provides 3 x performance
 - 50% higher cost provides 3.1 x performance

Summary of pavement mixtures performance in lab

- Polymer mixtures exhibit better performance in both rutting and fatigue test, and better performance at high temperatures in the presence of water.





Value Based Summary: PG 64, PG70m and PG 76m

	<u>PG 64 =</u> <u>\$400, \$80</u>	<u>PG70m =</u> <u>\$500</u>	<u>PG76 m=</u> <u>\$600</u>
<u>Binder Cost (\$400 /T=1)</u>	<u>1</u>	<u>25%</u>	<u>50%</u>
<u>HMA cost (\$80 /T=1)</u>	<u>1</u>	<u>6.5%</u>	<u>13%</u>
<u>DSCE, 10C</u>	<u>1</u>	<u>250%</u>	<u>400%</u>
<u>SCB, 25 C</u>	<u>1</u>	<u>80%</u>	<u>80%</u>
<u>Dyn Mod (E*)</u>			
<u>-10 C</u>	<u>1</u>	<u>10%</u>	<u>10%</u>
<u>25 C</u>	<u>1</u>	<u>15%</u>	<u>5%</u>
<u>54 C</u>	<u>1</u>	<u>15%</u>	<u>50%</u>
<u>Flow no. 54 C</u>	<u>1</u>	<u>100%</u>	<u>1000%</u>
<u>Flow time 54C</u>	<u>1</u>	<u>10000%</u>	<u>100000%</u>
<u>LWT, 50C</u>	<u>1</u>	<u>275%</u>	<u>290%</u>



Life Cycle Cost Analysis

Med Volume Road 4" asphalt base

**2:1 EASL
advantage**

4" Modified Asphalt
Base w/ 2" modified
binder and 2"
modified wearing
(40 yr design life)

4" structure 4" base
Construction (\$90 /ton)
\$580,000 per mi

Mill 2" & Overlay 2"

\$145,000

\$145,000

Annualized cost = \$21,750 / mi / yr

4" structure 4" base
Construction (\$80/ton)
\$550,000 per mi

Mill 2" &
Overlay 2"
\$145,000

Reconstruct
\$550,000

30%

savings

PG 64-22 4" Asphalt
Base (20 yr life) with 2"
modified binder and 2"
modified wearing
(reconstruct at 30 yr)

Annualized cost = \$31,125 / mi / yr

●

PERFORMANCE : 10 YR

Interstate PG 76-22m Overlay

(7" -9") over Rubbelized JCP & 4" over CRCP

- IRI
- Cracking
- Rutting



Rubblized and Overlay

- 450-04 – I10 District 03 Acadia
- 450-91 – I10 District 07 Calcasieu
- 451-05 – I20 District 05 Lincoln
- 454-02 – I12 District 62 Livingston



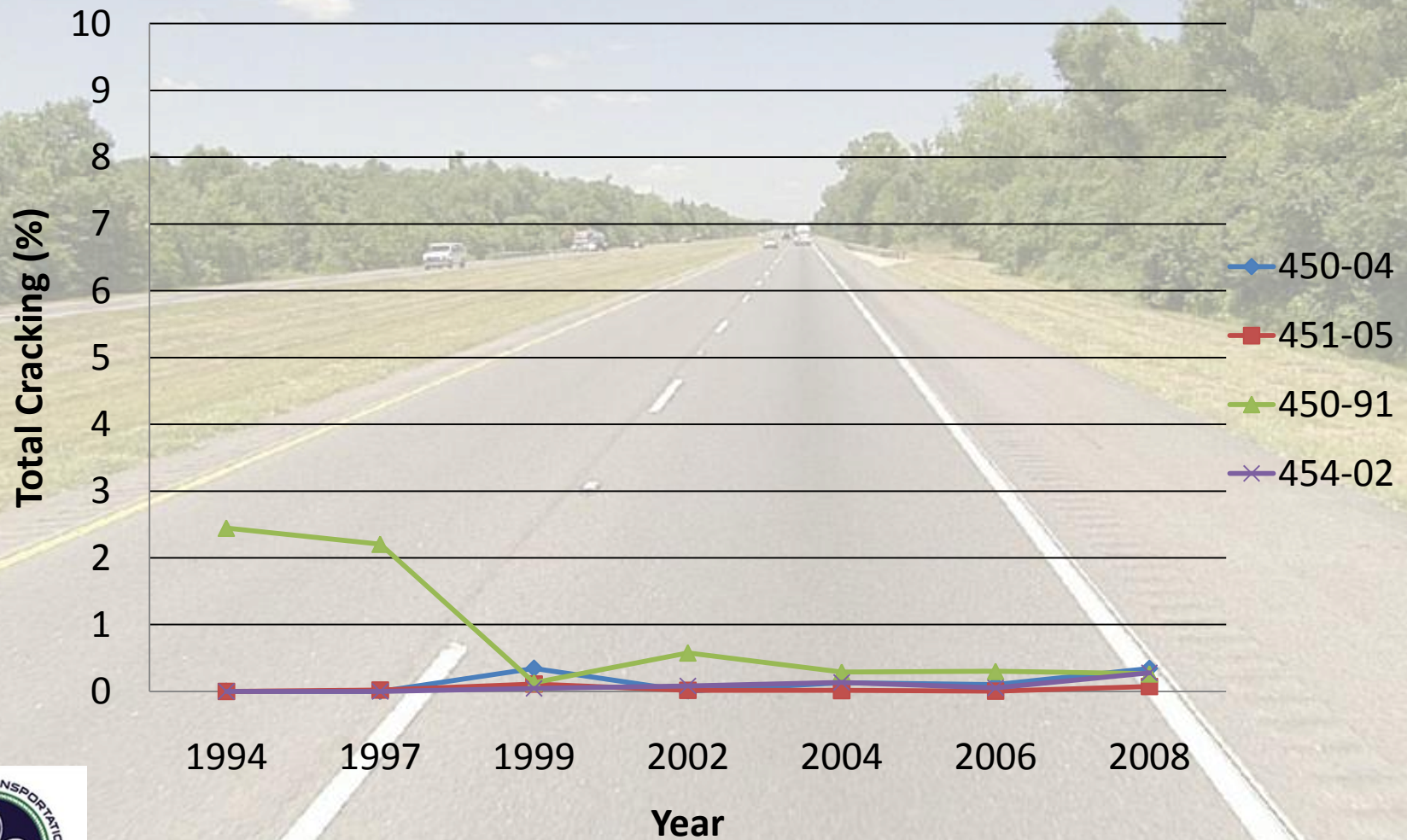
Superpave Overlay

- 450-11 – I10 District 61 Ascension
- 450-13 – I10 District 62 St. John
- 455-02 – I49 District 03 St. Landry

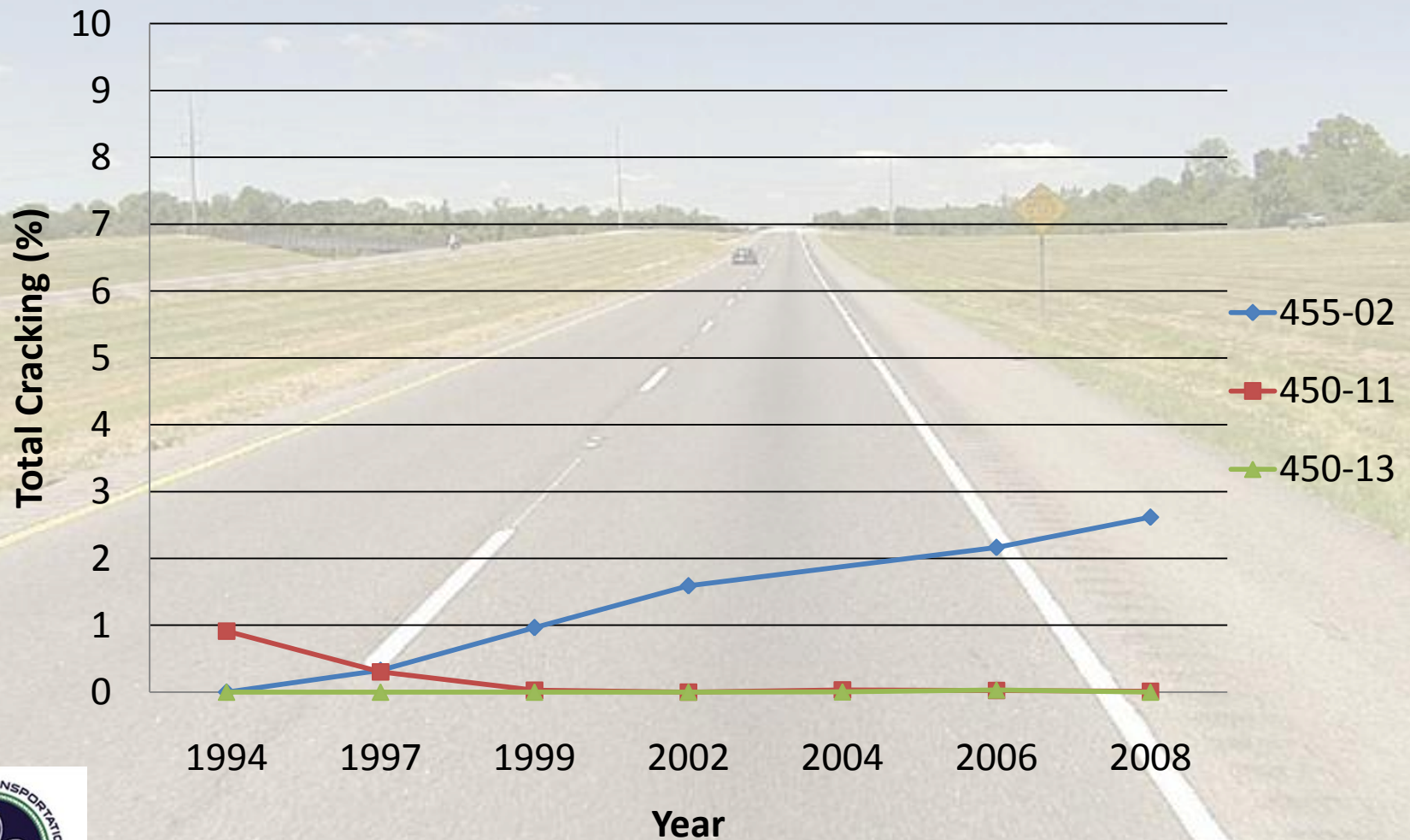


Rubblized and Overlay

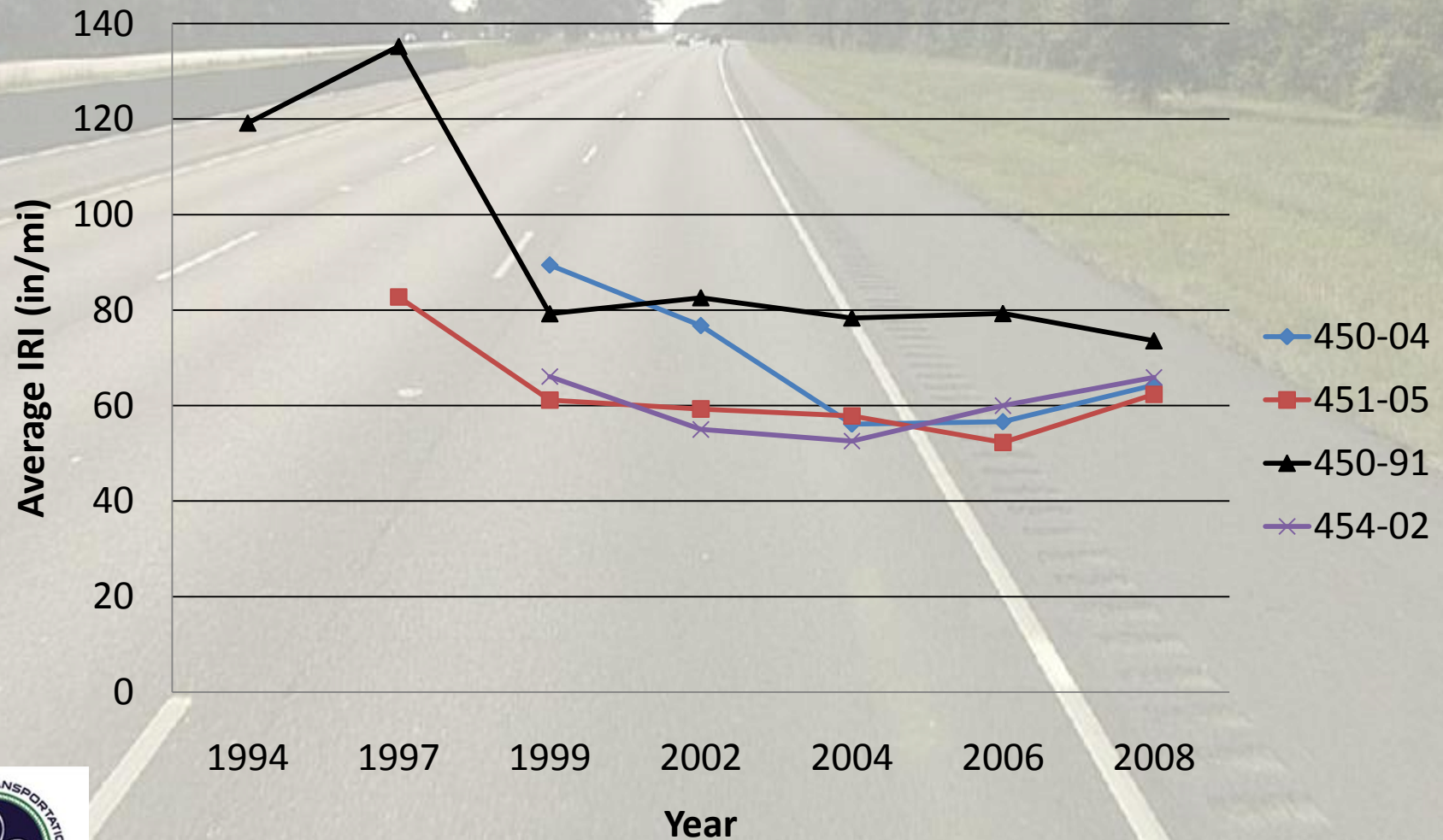
Total Cracking



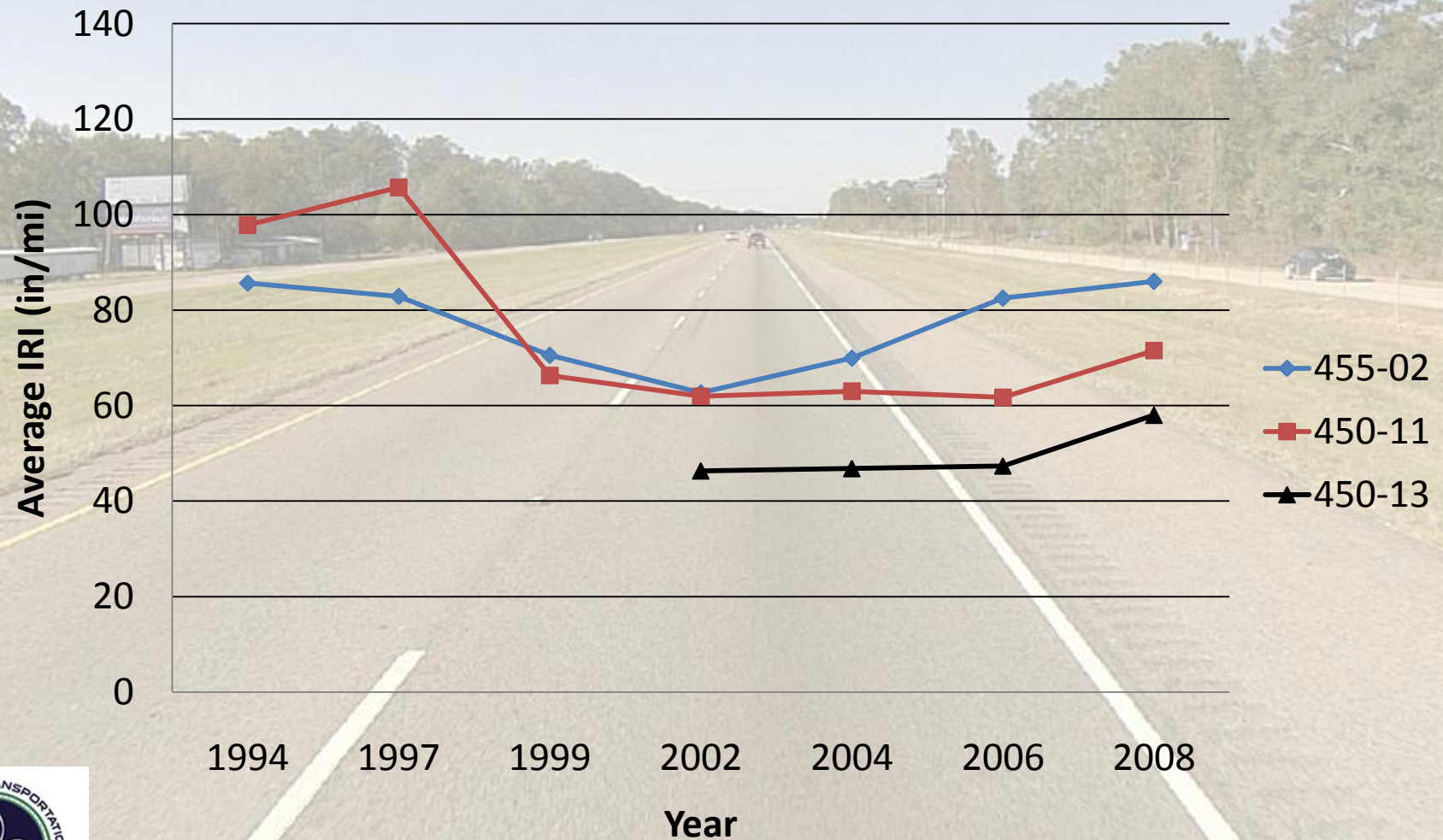
Superpave Overlay Total Cracking



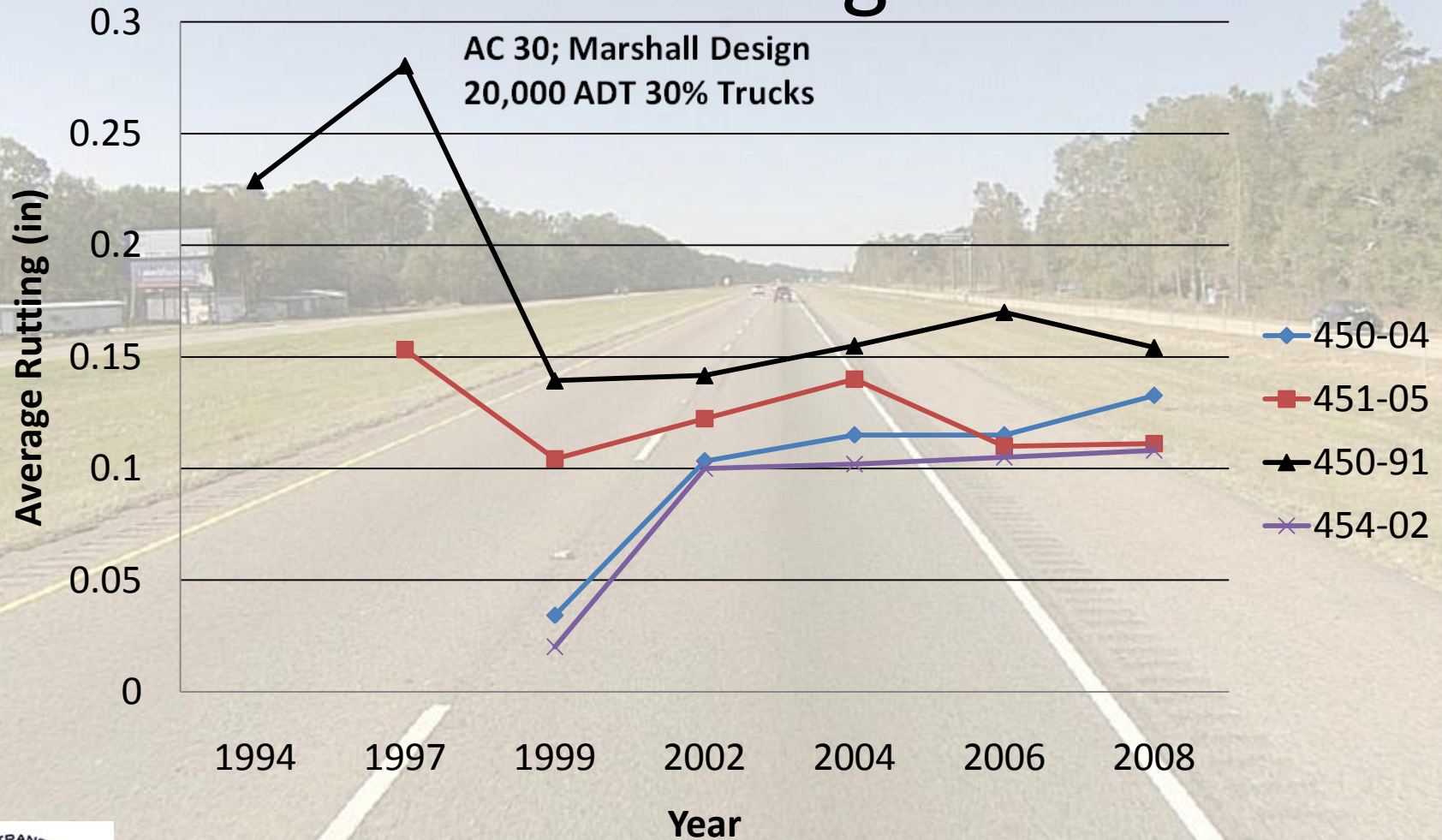
Rubblized and Overlay IRI



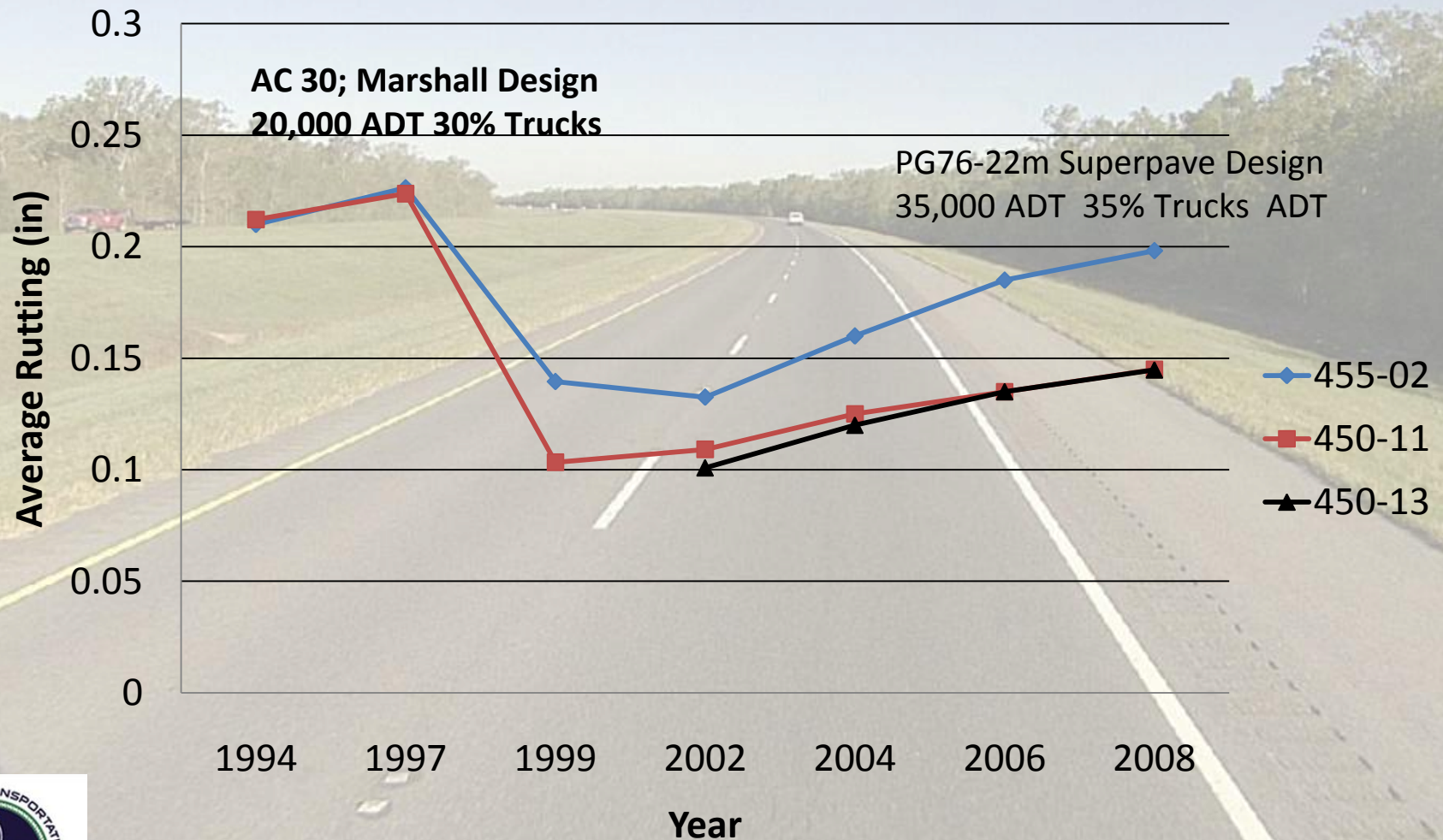
Superpave Overlay IRI



Rubblized and Overlay Rutting

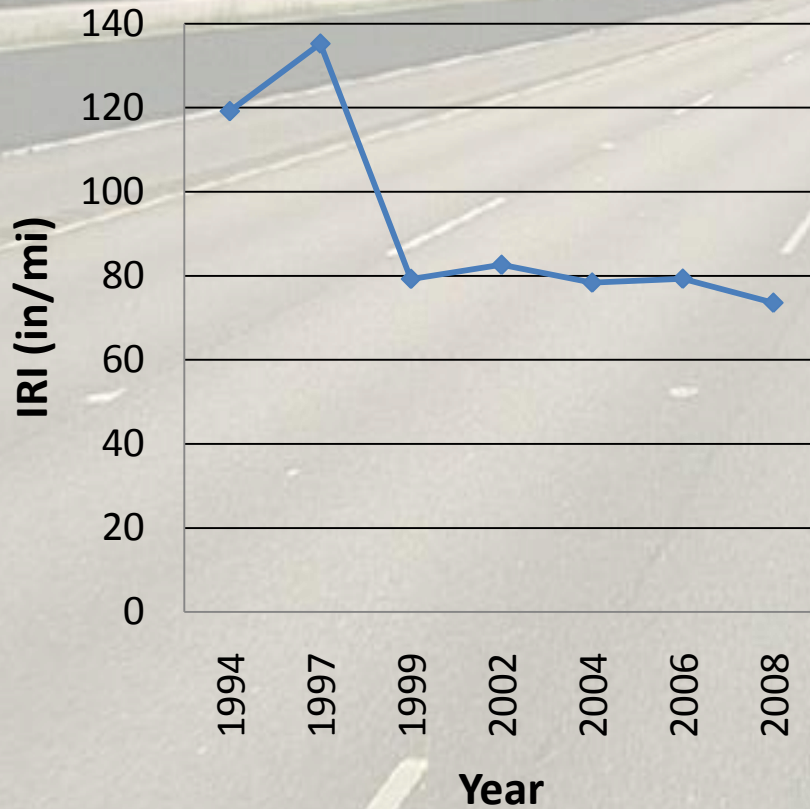


Interstate Overlay Rutting

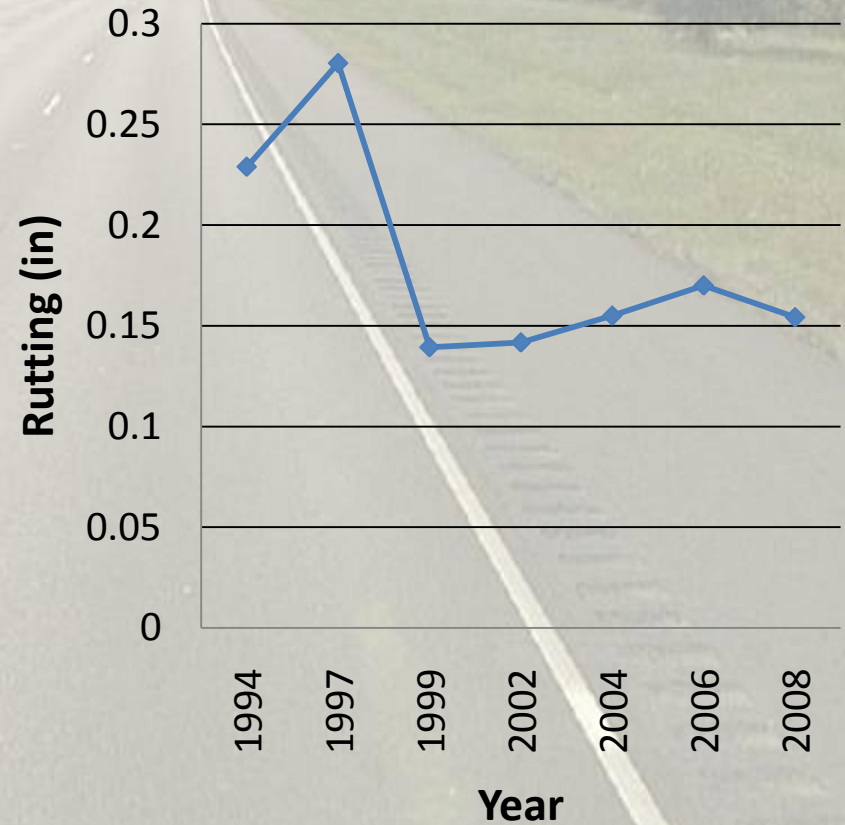


450-91 – I10 Calcasieu

IRI



Rutting



1995 – 18 mi Ovly, 1997 – 5 mi. Ovly, 1999 – 6 mi Ovly,
2003 – 8 mi. Ovly, 2007 – 13 mi. Ovly





Summary

Modified asphalts add value thru reduced rutting and cracking.

This added value improves the reliability of our asphalt pavements.