Historical Performance of Polymer Modified Asphalt Pavements: Part I

Laurand Lewandowski, Ph.D.
Goodyear Chemical
June 23, 2004

GOODYEAR CHEMICAL

Acknowledgements

- Ultrapave for supporting the original LCCA study in 1997-1998.
- AMAP for providing copies of some of the pavement performance presentations
  - www.modifiedasphalt.org
- Asphalt Institute's Affiliate Group for allowing the data to be presented.

GOODYEAR CHEMICAL

Outline

- Objectives
- Pavement Performance Studies
  - Types of Pavement Studies
- Lifecycle Cost Analysis
- Summary
- Forward Program

GOODYEAR CHEMICAL

Objectives

- The objective of this presentation is two-fold:
  - Review some the polymer modified asphalt pavement performance studies performed by State DOTs and Industry.
  - To discuss the potential life-cycle cost impact

GOODYEAR CHEMICAL

Pavement Performance Studies

- Types of Pavement Studies
  - Pavement Performance (mod. Versus unmod) Type 1
  - Pavement Performance (Correlation with Specifications) Type 2
  - Pavement Performance(Quantify Performance) Type 3
  - Pavement Performance (Life Cycle Cost) Type 4

GOODYEAR CHEMICAL

Pavement Performance Studies

- State Studies (Type)
  - Utah DOT (1, ~3)
  - Colorado DOT (1)
  - Kentucky DOT (1,2, ~3)
- National Studies (Type)
  - Ultrapave Study (1,3)
  - Asphalt Institute Study (1,3)

GOODYEAR CHEMICAL

Utah Department of Transportation Study

- UDOT has been using polymers since the late 1960's.
- Prior to Superpave they used low-temp ductilities, Toughness and Tenacity and Pen-Vis to evaluate the binders.
- Through field validation, examined 33 projects (including AC-10, AC-20 and AC-20R) along I-70.

GOODYEAR CHEMICAL

Utah Department of Transportation Study Summary*

- "The AC-20R asphalt concrete pavement sections constructed in 1989 are performing with virtually no thermal cracking."
- "Comparing the PMA to the conventional asphalt indicates a 76% reduction in incremental rating loss per year."
- "This justifies the use of polymerized asphalt for mitigating thermal cracking."

* Peterson, C and Anderson, H, *Interstate 70 Polymerized Asphalt Pavement Evaluation, unpublished report, Utah Department of Transportation, Materials Division, February 1998*

GOODYEAR CHEMICAL

CDOT Study

- CDOT initiated a study in 1991 to look at polymers classified by AASHTO Task Group 31.
- Five locations were selected where both unmodified and modified pavement sections could be compared.
- They examined both longitudinal and transverse cracking. Rutting was not found to be a significant distress.

GOODYEAR CHEMICAL

CDOT Summary*

- **"The addition of various polymers used in this study did not enhance the rut resistance potential of the mix, however the addition of the polymer did reduce the amount of transverse and longitudinal cracking to some extent."**

* CDOT-DTD-R-97-3

GOODYEAR CHEMICAL

Kentucky DOT Study (1998)

- Initial studied “Are all PG 70-22’s the same?”
- Kentucky DOT wanted to know if unmodified performance graded binders manufactured with different different modifiers (SBR, chemically modified, and straight run) performs the same as modifiers they are currently using (SBS)
- Performed testing on binders, mixtures, performance test and proof test.
- Pavement placed on I-64 with a 33 MM ESAL’s load (20-year design)

GOODYEAR CHEMICAL

Kentucky DOT follow-up (2001)

- None of the pavements showed any substantial rutting.
- All of the pavements, but the SBR showed thermal cracking.
  - December 2000 was the second coldest on record
  - A low temperature of -17.2C was recorded near the pavement area.

GOODYEAR CHEMICAL

Pavement Performance - Cracking*

Least Cracking

Most

Section (Modifier)	Low Transverse (Thermal) Cracking	Moderate Blocking Cracking	*BBR Predictions
6-7 (SBR)	No cracking	None	NA
11-12 (SBS2)	Few, 1-2 cracks	None	NA
4-5 (Chemically Modified)	Less cracks	None	NA
1 PG (64-22)	Several cracks	None	NA
2-3 (Neat)	Several cracks	None	NA
8-9 (SBS1)	Most cracking	Moderate	-15.1C Sample C in AI Study

*AI data key is not available on all samples.

*Phil Blankenship, "Performance Neat and Modified Mixtures, 2002 AMAP annual meeting

GOODYEAR CHEMICAL

Ultrapave Study -Background

Life Cycle Cost Analysis

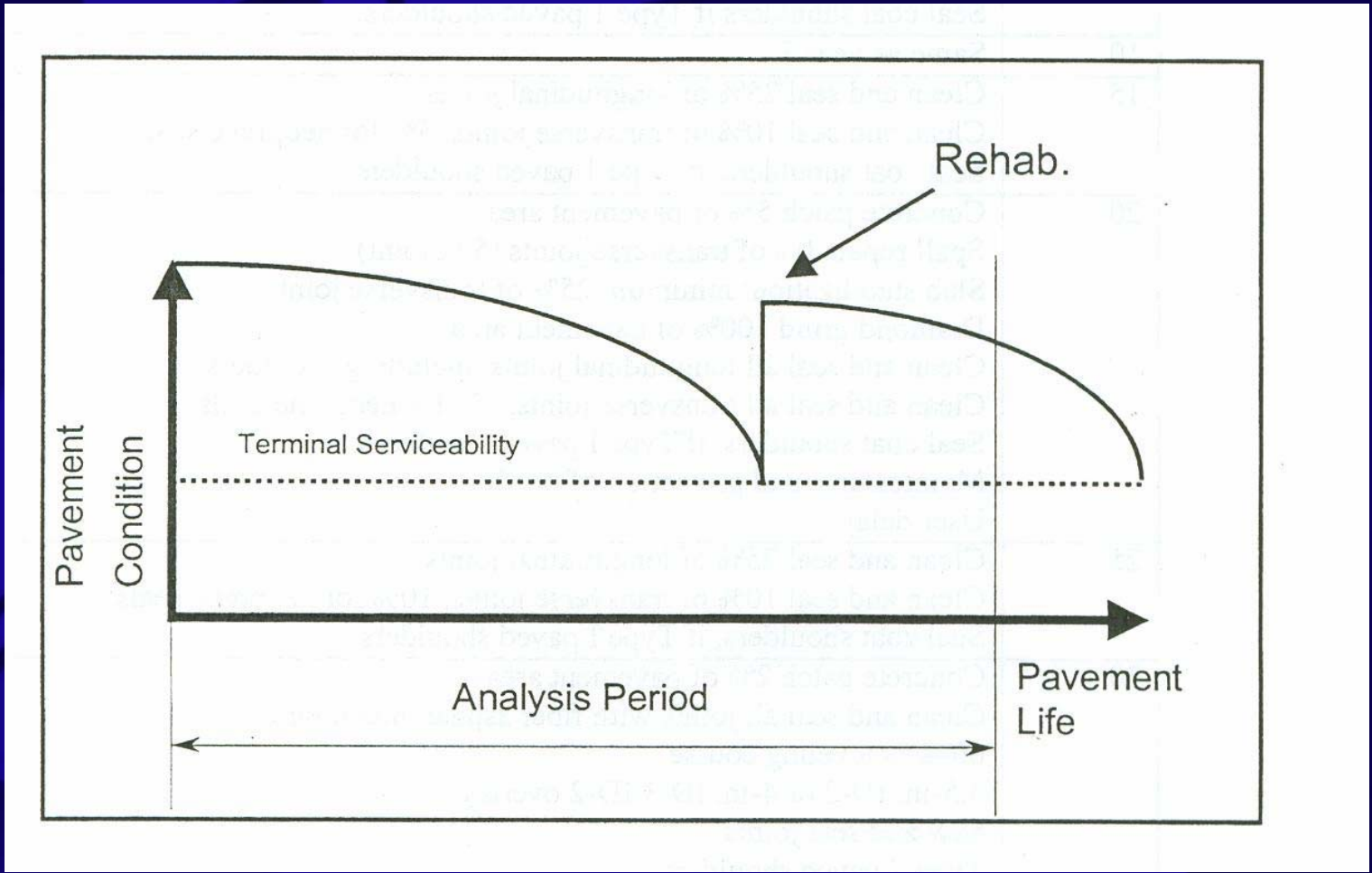
Pavement Traffic Data
ADT
% of Trucks
ESALs

Construction Information
Location of Project
Type of Mix
Mod. versus Unmod.

Distress Data
Pavement Management
System Information

GOODYEAR CHEMICAL

What is the Life Cycle Cost



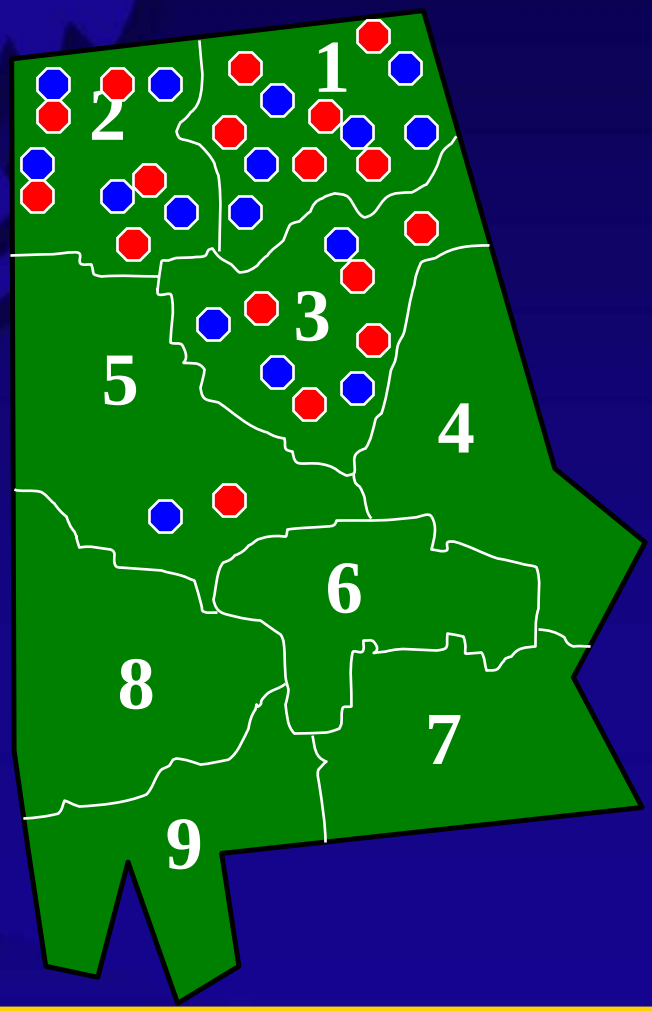
GOODYEAR CHEMICAL

Alabama Department of Transportation

- ADOT has been using SBR in overlays since 1983.
- Distress and Ride data are collected on a biannual basis.
- The data is put into a statistical model to produce a rating

GOODYEAR CHEMICAL

Pavement Location



- SBR modified
- Unmodified

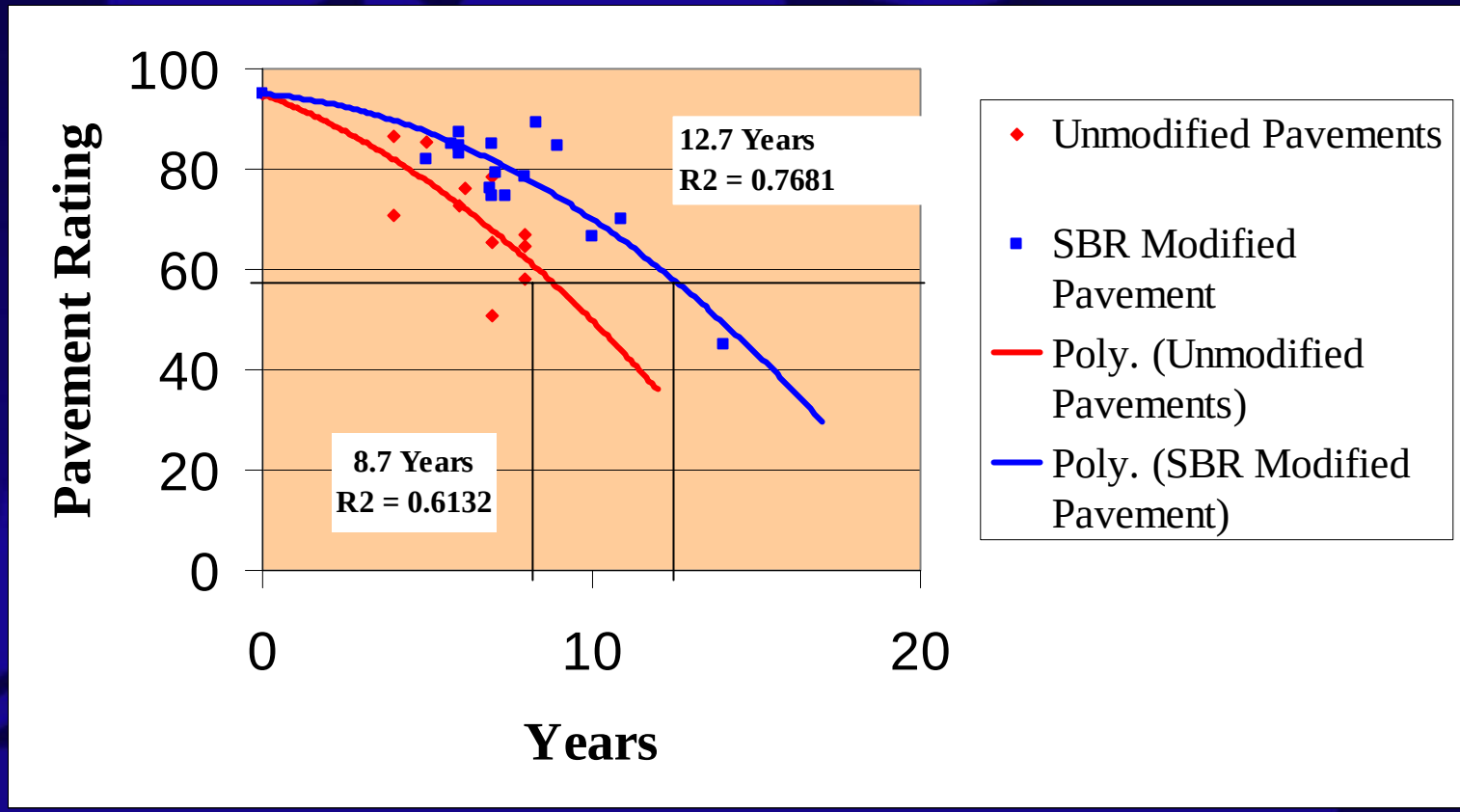
GOODYEAR CHEMICAL

Alabama Traffic/Pavement Data

Unmodified								
Mix	SR	Year	Months	ADT	TADT	Daily ESALS	96 Rating	Division
416	4	92	48	2930	34	1000	70.7	2
416	75	88	96	1380	12	168	57.9	1
416	117	90	72	2727	9	250	72.7	1
416	118	89	84	7740	23	1792	65.4	2
416	133	85	132	11675	5	606	72.9	2
416	168	92	48	4630	13	610	86.6	1
416	243	90	60	2335	14	331	85.5	2
SBR Modified								
Mix	SR	Year	Months	ADT	TADT	Daily ESALS	96 Rating	Division
417	4	87	108	4740	38	1807	74.8	2
417	75	88	96	6863	7	493	72.9	3
417	75	88	96	6908	6	427	86.4	1
417	117	88	96	807	6	50	77.1	1
417	118	89	84	13957	14	1978	78.6	2
417	133	88	96	9630	7	692	77.4	2
417	168	88	96	5513	11	616	82.8	1
417	243	91	72	3400	10	346	81.8	2

GOODYEAR CHEMICAL

Alabama Pavement Analysis

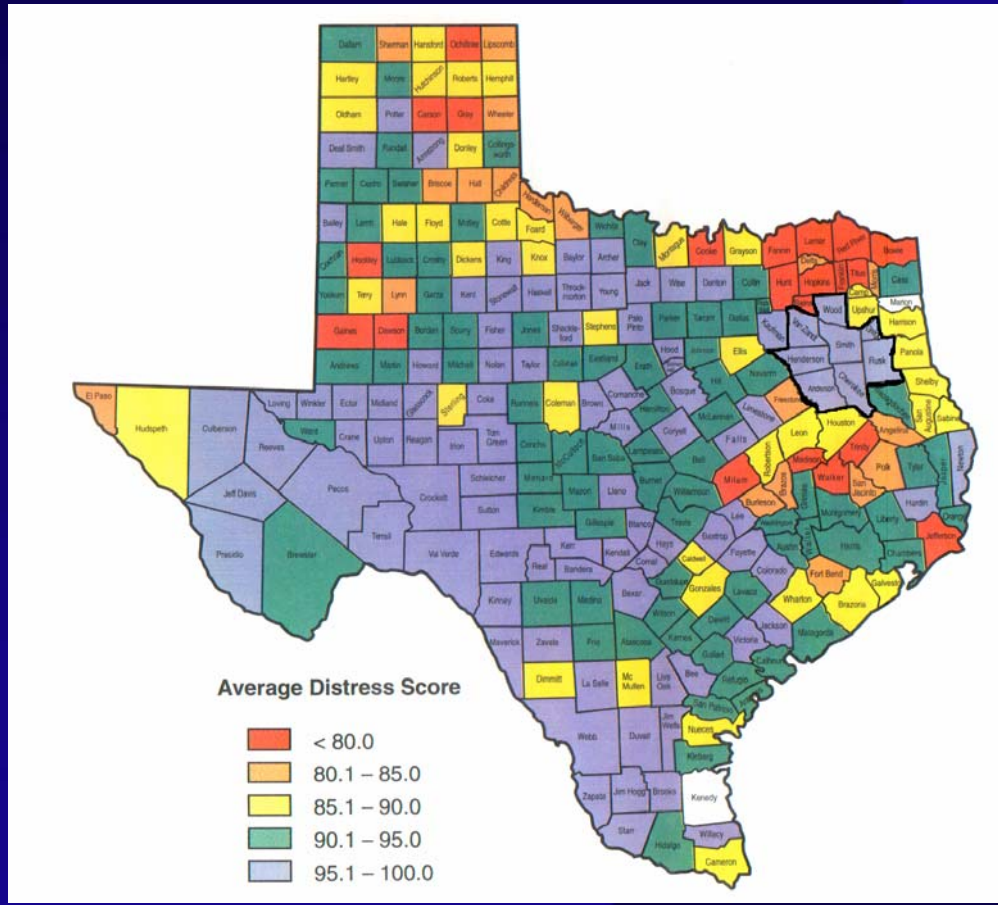


The modified pavements lasted on average 4 years longer

GOODYEAR CHEMICAL

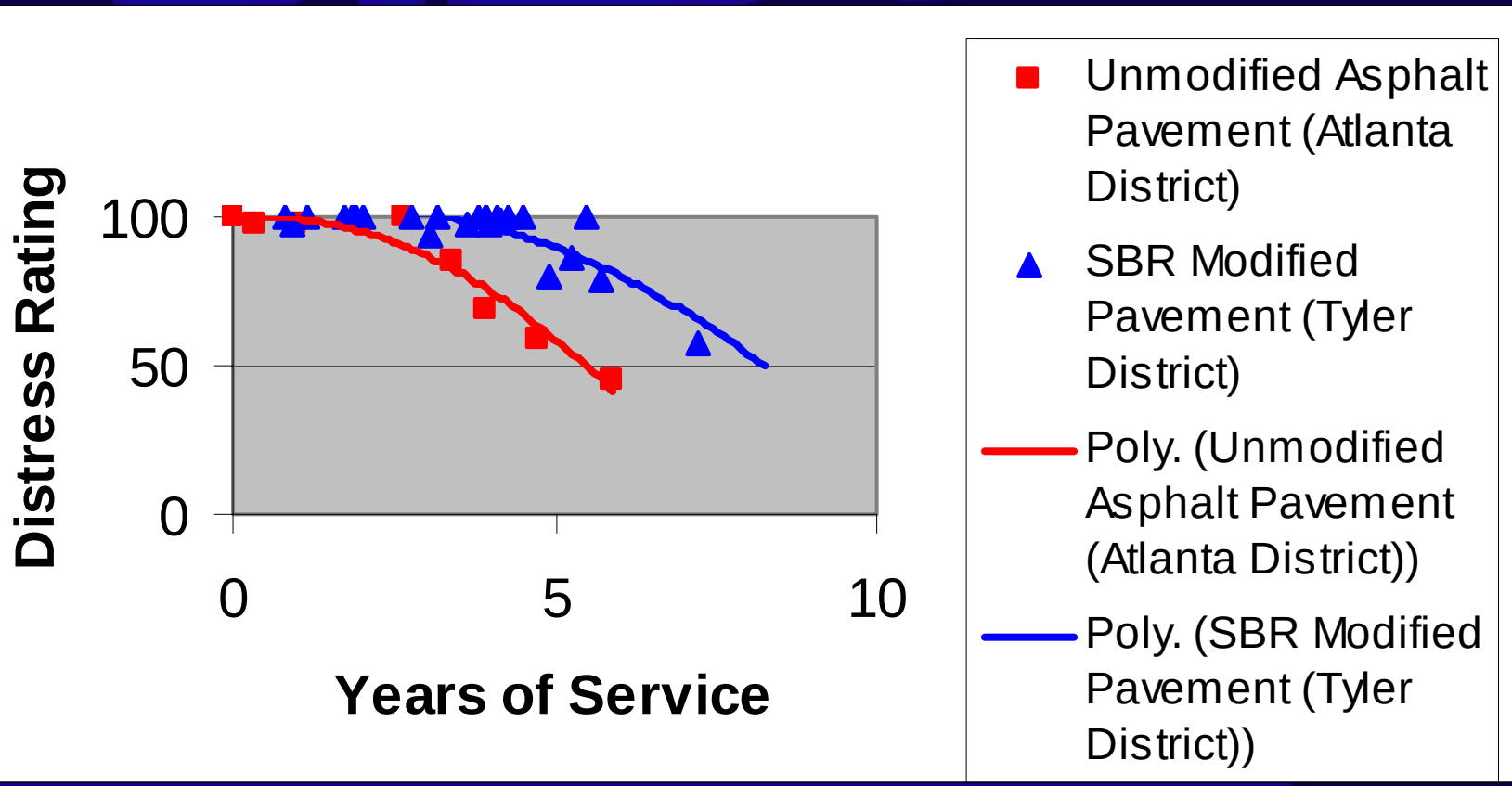
Texas Pavement Management System

- TxDOT's PMIS uses Distress and Ride to define the Condition Score of a pavement.
- The Condition Score goes from 0-100 scale, with 50 representing some pavement remedial attention required.
- In the analysis two different districts were compared (Tyler and Atlanta)



GOODYEAR CHEMICAL

Texas Pavement Analysis



SBR modification increased the pavement life by 2.5 years

GOODYEAR CHEMICAL

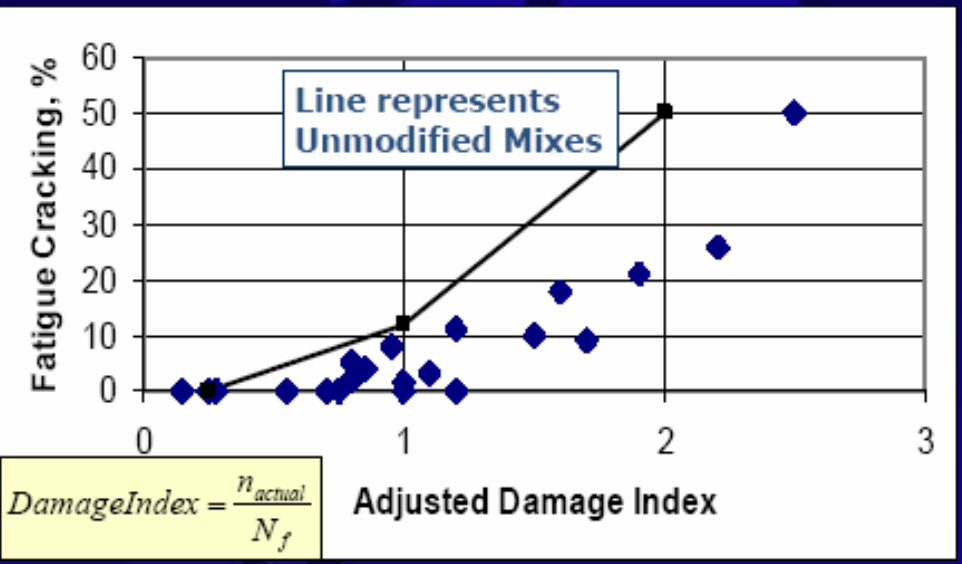
Asphalt Institute Study*

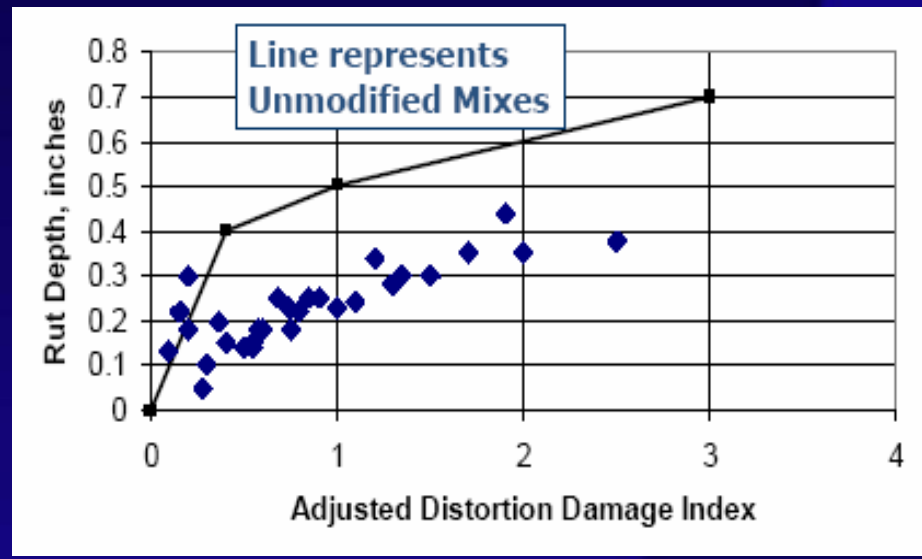
- Titled "PMA for Enhancing HMA Performance"
- Two objectives:
  - Quantify the effect of using PMA as compared to conventional mixtures in terms of increasing pavement life and reducing the occurrence of surface distress.
  - Identify the conditions or site features (for example, traffic levels, layer thickness, climate, etc..) that maximize the effect of PMA on performance

*Harold Von Qunitus, "Polymer-Modified Asphalts- Enhancing HMA Performance," AMAP Annual Meeting, February 10, 2004

GOODYEAR CHEMICAL

Performance versus % Fatigue Cracking



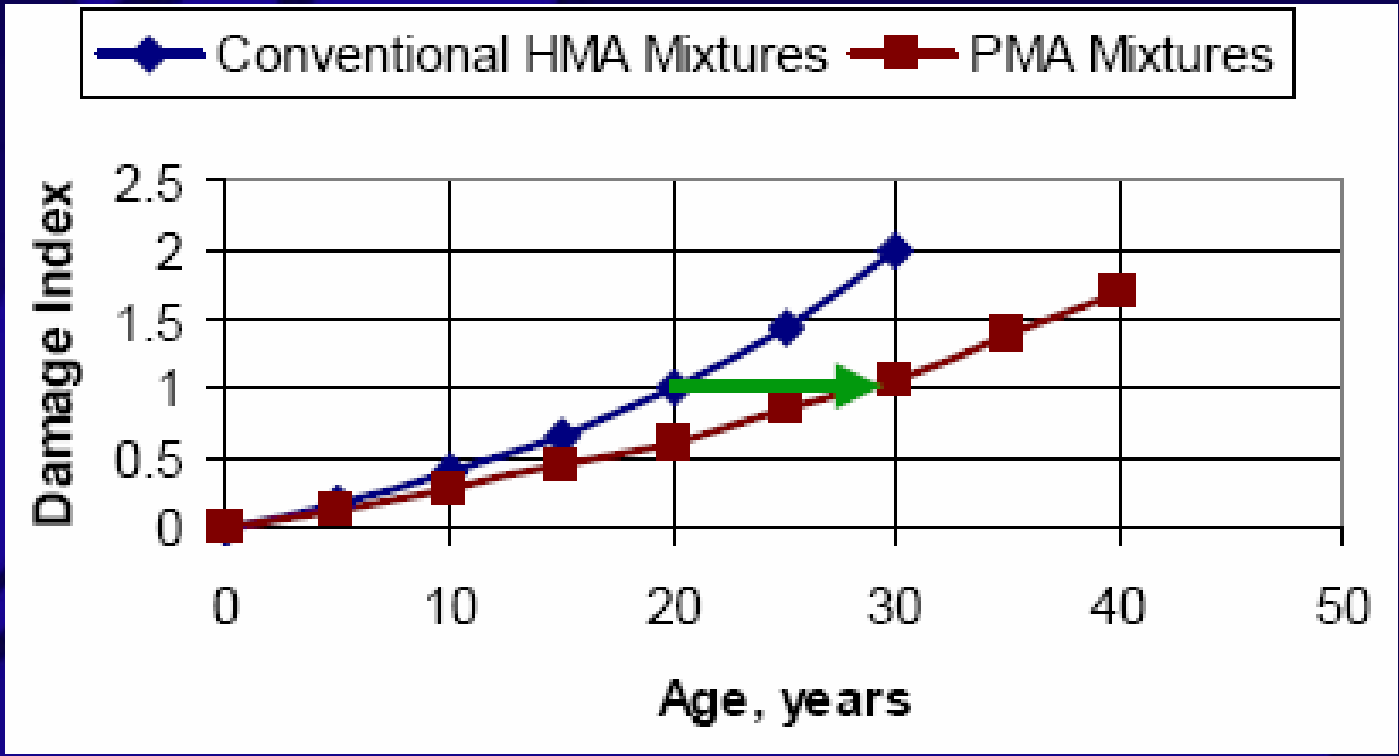


Polymer Modified HMA shows a substantially lower Rut Depth and less % Fatigue Cracking

*Harold Von Qunitus, "Polymer-Modified Asphalts- Enhancing HMA Performance," AMAP Annual Meeting, February 10, 2004

GOODYEAR CHEMICAL

Expected Service Life Increase for a 20-year Design*



*Harold Von Qunitus, "Polymer-Modified Asphalts- Enhancing HMA Performance," AMAP Annual Meeting, February 10, 2004

GOODYEAR CHEMICAL

Expected Service Life Increase*

Site Factor	Condition Description		Years
Existing Pavement Condition	HMA	Good Condition	5-10
		Good Condition; Extensive cracking (1)	1-3
	PCC/ JPCP	Good Condition	3-6
		Poor Condition; Faulting & mid-panel cracking (1)	0-2

(1) Without the use of any reflection cracking mitigation techniques

*Harold Von Qunitus, "Polymer-Modified Asphalts- Enhancing HMA Performance," AMAP Annual Meeting, February 10, 2004

GOODYEAR CHEMICAL

Summary of Different Studies

- Modification increases the life of the asphalt pavement overlay by 2.5-10 years.
- The most apparent result from the studies is that polymer modification increased the resistance to cracking.
- PMA performance is dependent on a large amount factors, for example: Traffic, Climate, Existing Pavement Condition, etc..

GOODYEAR CHEMICAL

Pavement Construction Cycle

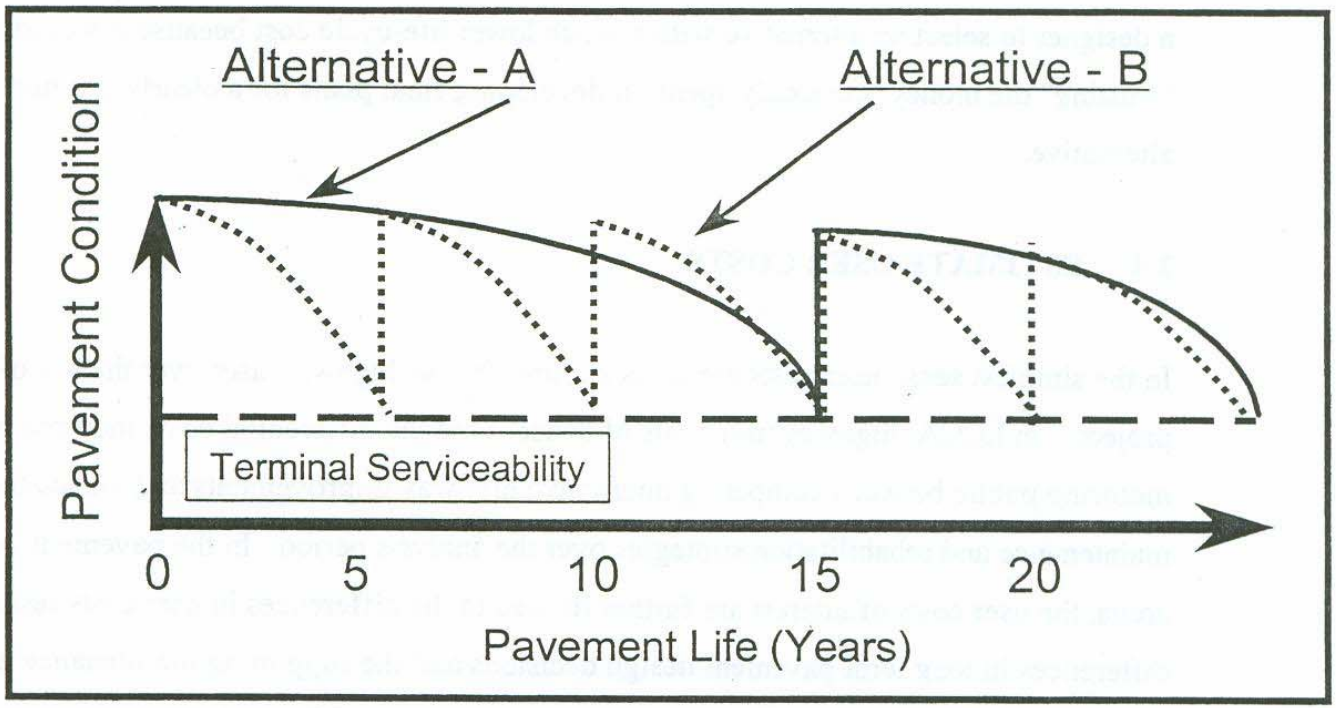


Figure 2. 2 Performance Curve verses Rehabilitation Strategy.

GOODYEAR CHEMICAL

Forward Program

- Use the existing pavement performance data to determine the Life Cycle Cost of pavement under different base, traffic and climate conditions.
- Review the sites in Texas and Alabama that were studied in 1997 and 1998.
- Define the optimum use of polymer-modified asphalt pavements.

GOODYEAR CHEMICAL