# BENEFITS OF POLYMER MODIFIED ASPHALT (PMA)

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*Prepared for the Association of Modified Asphalt Producers Training Program*

# REASONS FOR PMA USE

**Decline in asphalt pavement performance**

**To meet Superpave PG requirements**

**Competition with Portland Cement Concrete (PCC) requires the asphalt industry to build economical pavements that perform for a long**

**time–*Perpetual Pavements***

# REASONS FOR PMA USE

**Distresses in asphalt pavements and changes over the years**

**PMA in the hot mix plant and in the field**

**Field performance of PMA**

# EVOLUTION OF TRAFFIC

**Interstate highways – 1956**

**AASHO Road Test – 1958-62**

- still widely used for pavement design
- legal truck load – 73,280 lbs.

**Legal load limit increased to 80,000 lbs in 1982**

- 10% load increase
- 40-50% greater stress to pavement

**Radial truck tires have higher contact pressure**

- Bias-ply truck tires – 75 psi
- Radial truck tires – 125 psi

# DISTRESSES IN ASPHALT PAVEMENTS

- **High Temperature Permanent Deformation**
- **Low Temperature Thermal Cracking**
- **Load-Associated Fatigue Cracking**
  - Bottom-up cracking
  - Top-down cracking
- **Aging**
- **Stripping**

# PMA AFFECTS MIX PERFORMANCE

**Pavement study using same mix, but different binders**

**PG 67-22**

**Unmodified Asphalt**

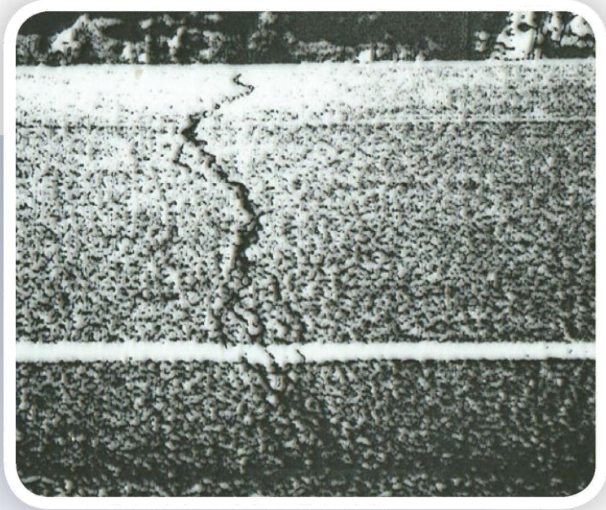
**15mm rutting**

**PG 63-22**

**Modified Asphalt**

**No rutting**

# LOW TEMPERATURE THERMAL CRACKING

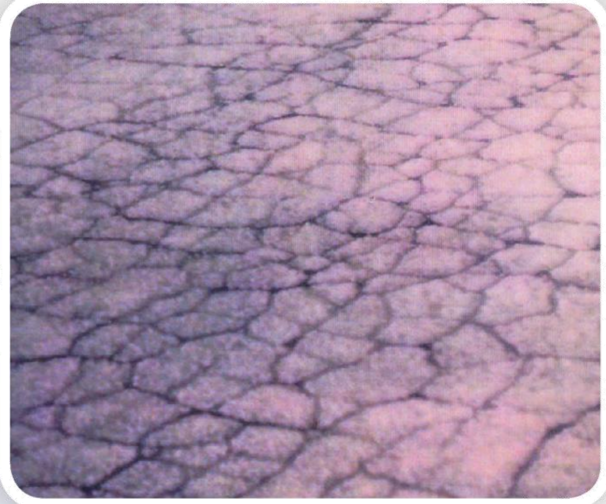


Thermal shrinkage cracking results from either a single thermal cycle where the temperature reaches a critical low temperature or from thermal cycling above the critical low temperature

Low temperature thermal cracking is predominantly influenced by the binder properties

Modifiers can improve the low temperature flexibility of the mixture

# LOAD-ASSOCIATED FATIGUE CRACKING



Load-associated fatigue cracking is caused by continuous application of loads over a period of time

Load-associated fatigue cracking is influenced by binder and mixture properties and pavement thickness

Two types of fatigue cracking

- Bottom-up
- Top-down

# HANDLING POLYMER MODIFIED ASPHALT

## (CONTRACTOR'S VIEW)

*Prepared for the Association of Modified Asphalt Producers Training Program*

# OUTLINE

- Handling of Asphalt Binder at the Terminal
- Handling of Asphalt Binder at the Hot Mix Asphalt Plant
- Recommended Plant Operations
- Laydown of Modified Asphalt Mix
- Contractor Liquid Asphalt QC Plan

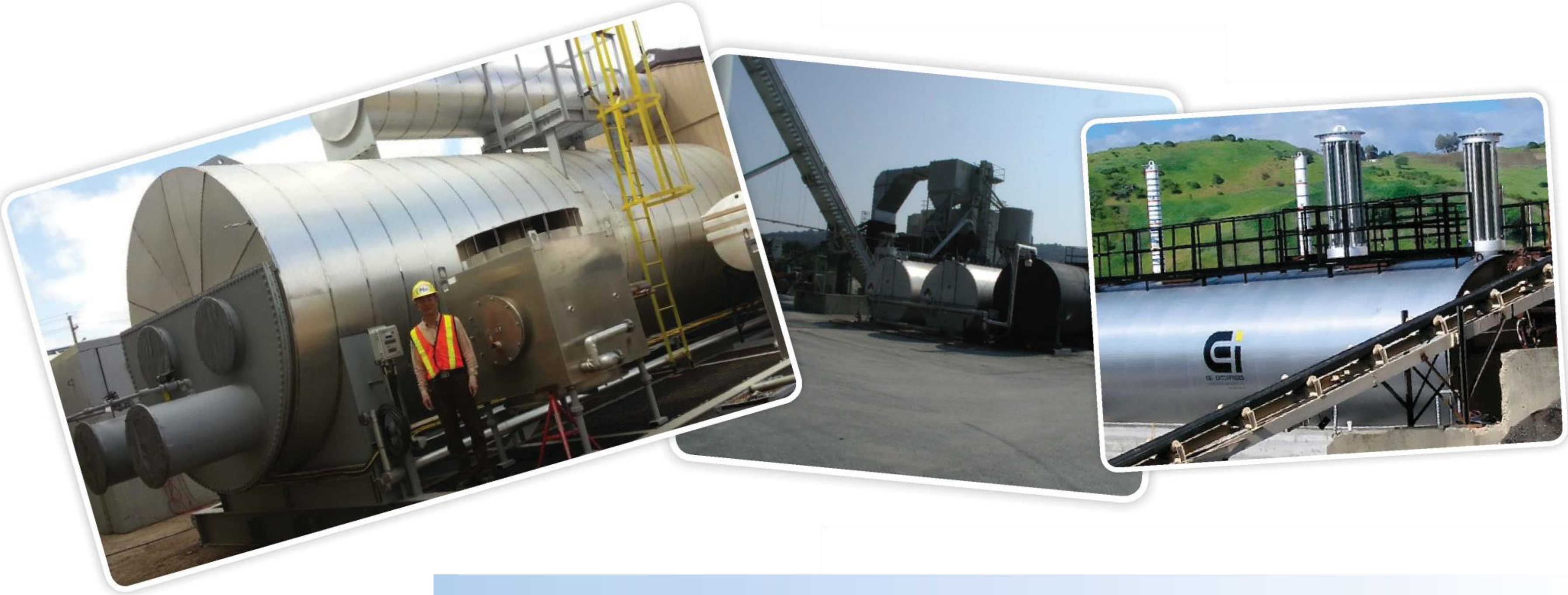
# HANDLING PMA AT THE PLANT

## Vertical Tanks

- Vertical tanks provide more efficient agitation
- PMAs typically do not require agitation to prevent separation
- Agitation is recommended for GTR modified asphalt
- Check with your supplier

## Check and Maintain Proper Temperatures

# HANDLING PMA AT THE PLANT



## Horizontal Tanks

- Horizontal tanks work fine for most PMAs
- Circulate to achieve uniform temperatures above and below heating coils

# MIXING AND COMPACTION TEMPERATURE GUIDANCE

**Superpave adopted AI procedure using rotational viscometer**

**Equiviscous laboratory mixing and compaction temperatures**

**Does not work for PMA**

- Yields extremely high temperatures
- Use suppliers' recommendations

***Not For Field Temperatures for Unmodified or Modified Asphalts!!!***

# COMPACTING MODIFIED HMA



**Compacting mixes with PMA may actually be easier than un-modified asphalt mixes**

- Compaction requires confinement
- PMA may eliminate tender zone

# PERFORMANCE OF POLYMER MODIFIED ASPHALT

*Prepared for the Association of Modified Asphalt Producers Training Program*

# DESIGN LIFE STAGES OF US HIGHWAYS*

***Stage 1:***
**Design**
**Formal planning of roadway to meet performance criteria**

***Stage 2:***
**Construction**
**Building of roadway start w/ perfect pavement condition)**

***Stage 3:***
**Slow Deterioration**
**Pavement weakens as result of traffic & climate**

***Stage 4:***
**Critical Structure Deterioration**

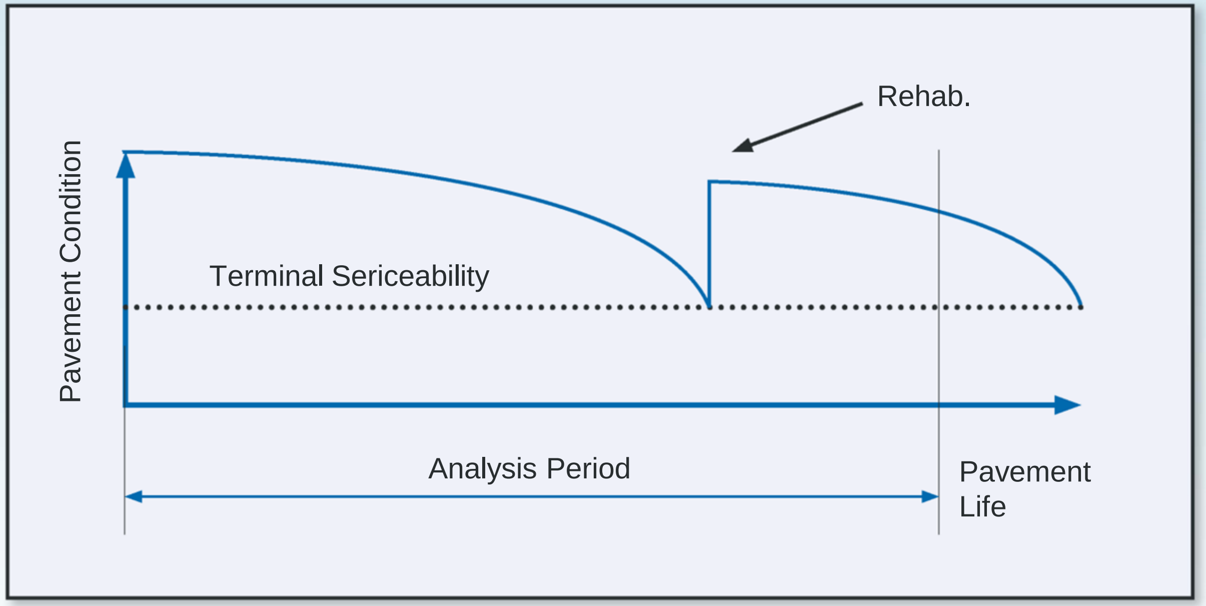
***Stage 4:***
**Total Destruction**

*"At the Crossroads preserving our Highway Investment"

# LIFE CYCLE COST ANALYSIS STUDIES

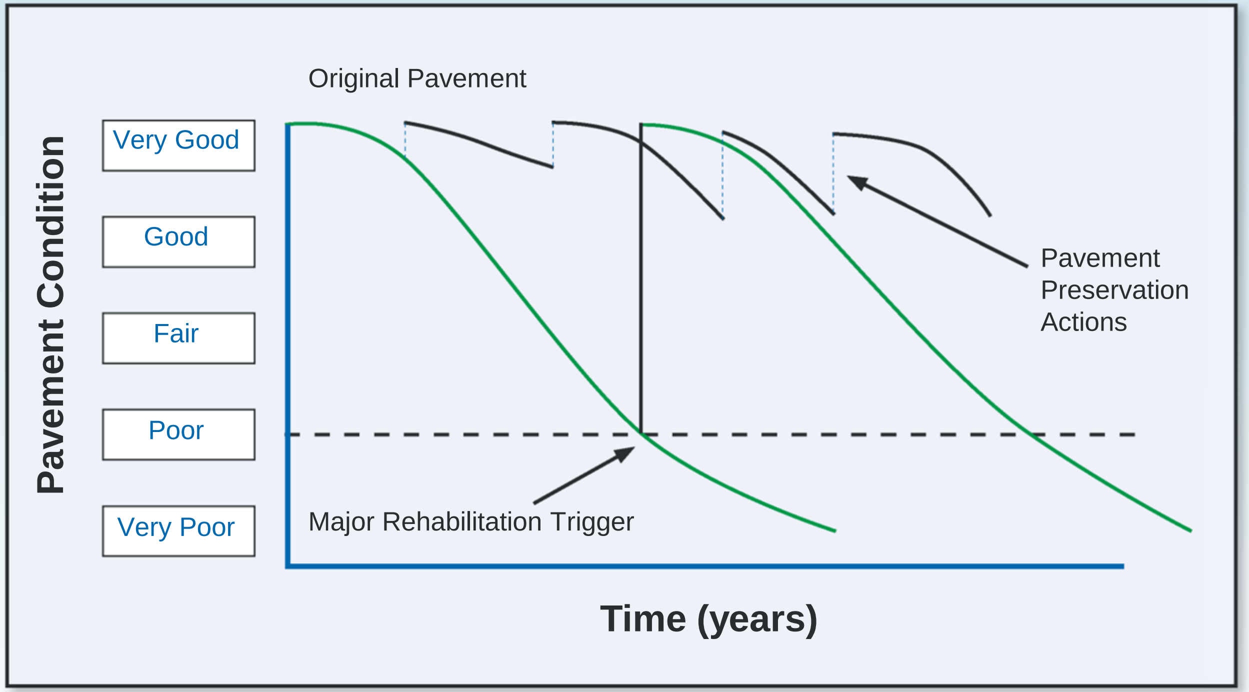
# LIFE-CYCLE COST ANALYSIS

**Analysis Period For A Pavement Design Alternative**




FHWA, “Life Cycle Cost Analysis in Pavement Design,”

# PAVEMENT PRESERVATION CONCEPT*




*"At the Crossroads-Preserving Our Highway Investment"

# LET'S FIRST LOOK AT PMA PAVEMENT PERFORMANCE

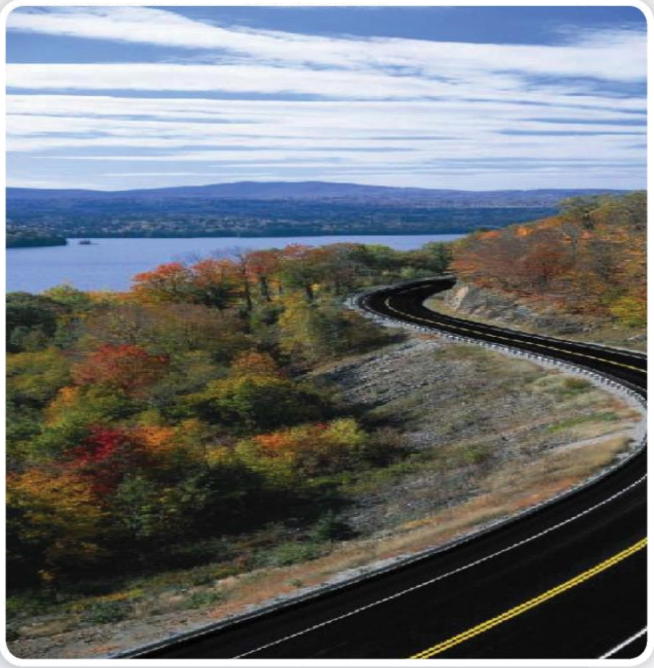
Polymers have been used in asphalt pavements for over 30 years

How have these pavements performed

## Pavement studies

- Texas, Alabama and Utah
- Asphalt Institute/AMAP Study

# TXDOT RATING SYSTEM

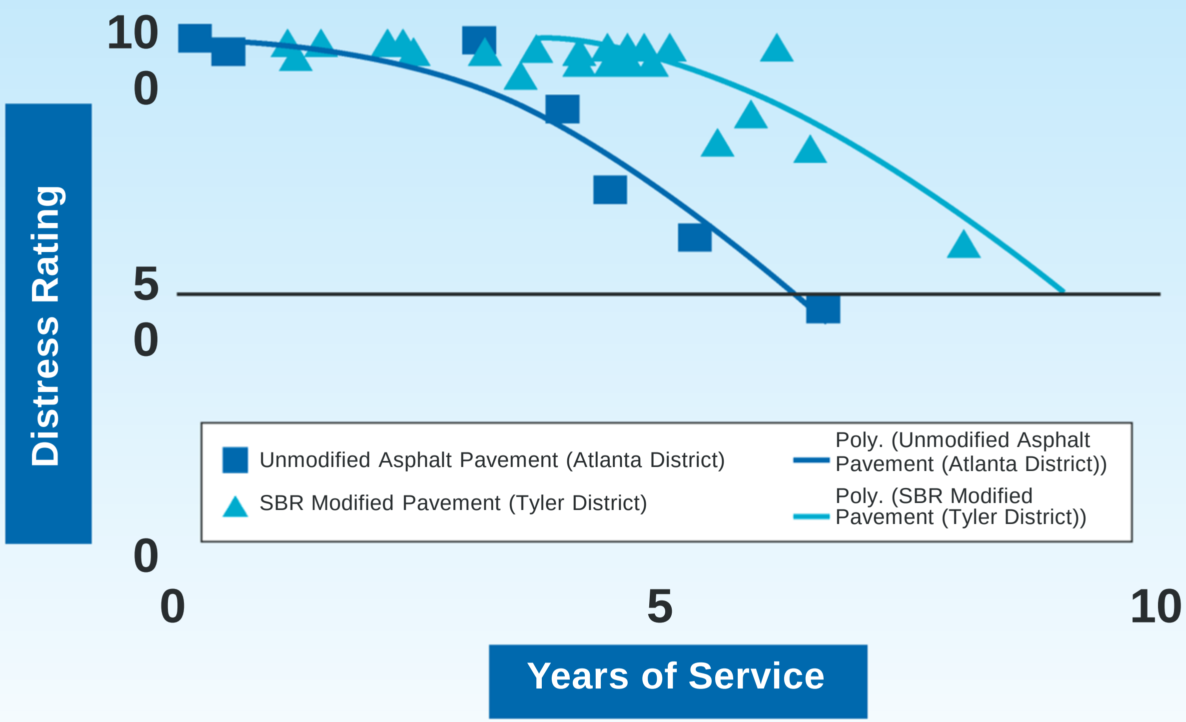


The Condition Score and Distress Score are based on 0-100 scale.

From our analysis the Distress and Condition Scores were found to be equal.

A score of 50 indicates the pavement requires some type of remedial attention

# LIFE CYCLE COST ANALYSIS–TEXAS*




*Ultrapave Study 1997-1998

# AL DOT–PMIS

Distress and Ride data are collected on a biannual basis.

Information on cracking, rutting, patching, bleeding, etc. is gathered for the first 200 feet of each lane mile.

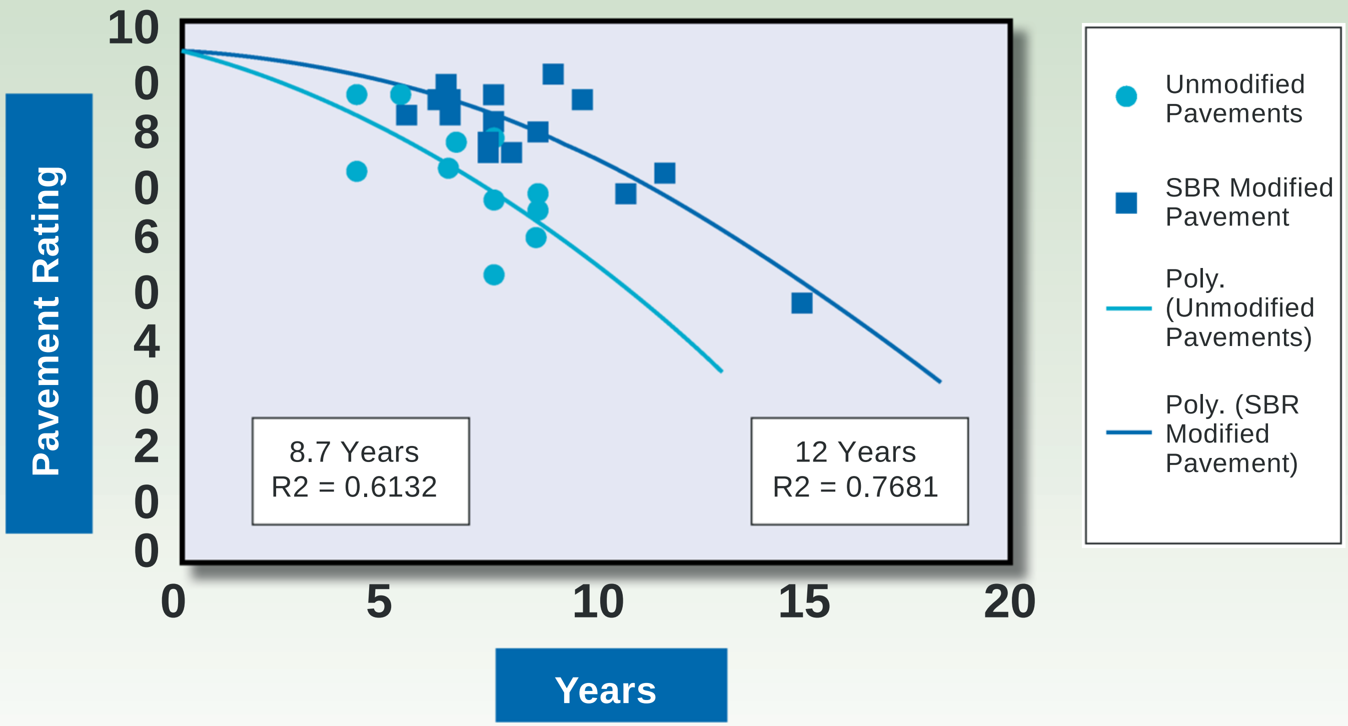
The data is put into a statistical model to produce a rating from 0 to 95.

AL DOT designs their pavements to last 28 years (12 years initially and then two 8 year overlays).

# AL DOT RATING SYSTEM

| AL DOT Rating System | |
|---|---|
| **100** | Perfect Pavement |
| **95** | New Pavement |
| **76** | Routine Maintenance Needed |
| **57** | Resurfacing Needed |
| **38** | Major Structural Work Needed |
| **0** | Totally Unsuitable Pavement |

# LCCA–ALABAMA*




*Ultrapave Study 1997-1998

# UTAH DOT–POLYMER MODIFIED ASPHALT STUDY

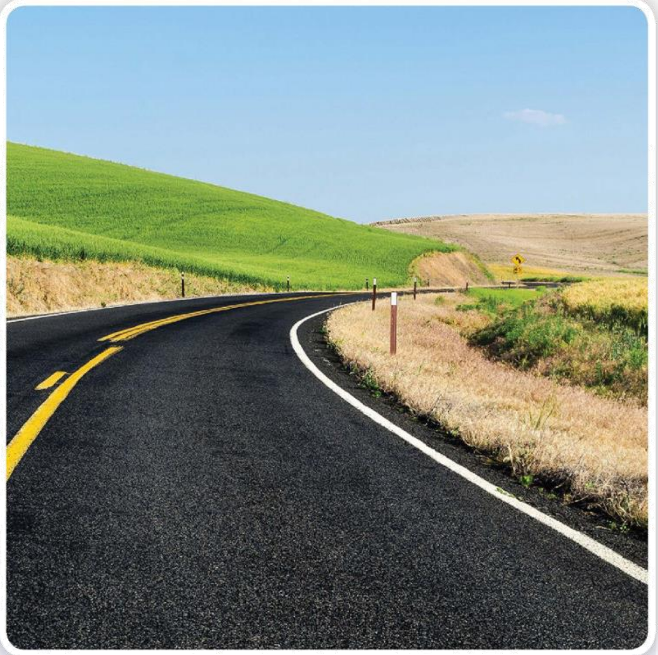
UDOT has been using polymers since the late 1960s.

In the past, UDOT has used low-temp ductilities, Toughness and Tenacity and Pen-Vis to flatten out the temperature susceptibility curve.

Through field validation, determine the benefits of PMA.

Examined 33 projects using AC-10, AC-20 and AC-20R along I-70.

# 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."*

*Cameron Peterson, Interstate 70-Polymerized Asphalt Pavement Evaluation, Utah Department of Transportation, Materials Division,1996.

# ASPHALT INSTITUTE STUDY

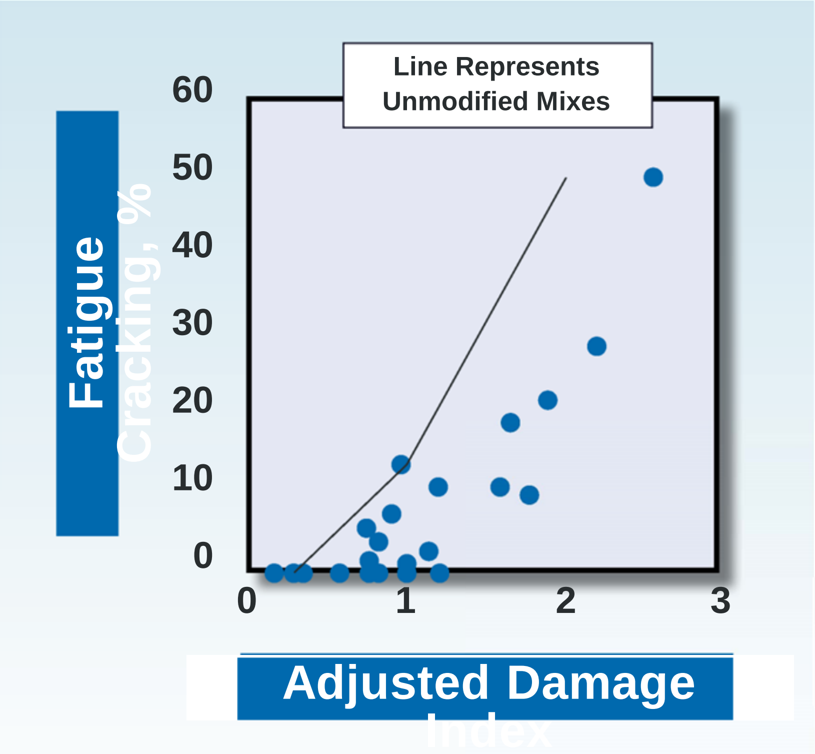
**Titled “PMA for Enhancing HMA Performance”**

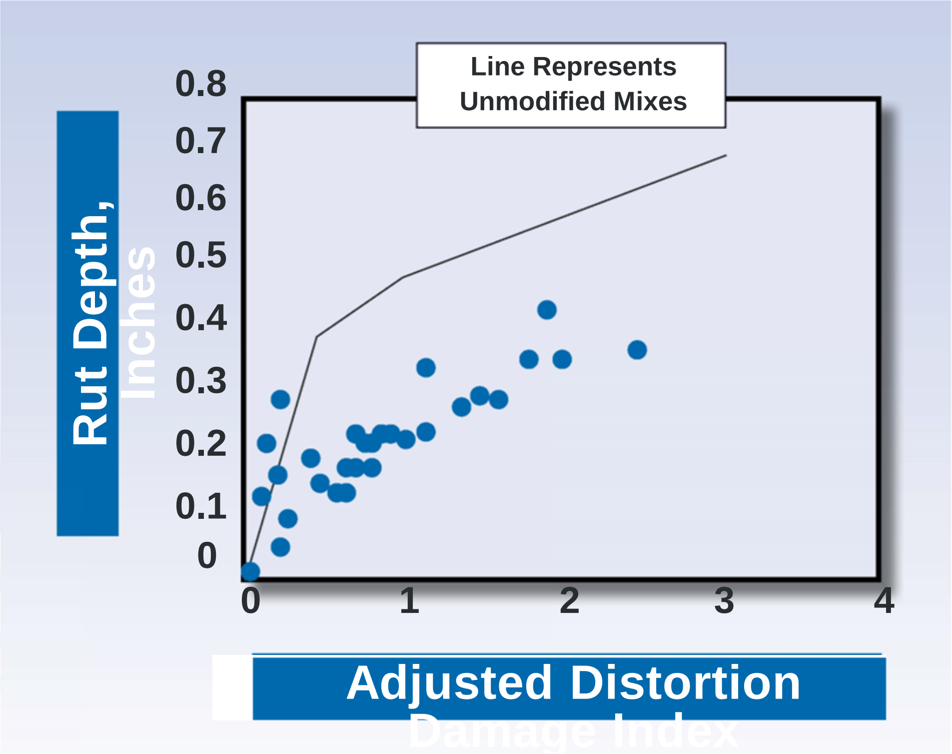
**Two Objectives:**

- 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

# MODIFIED VS. UNMODIFIED PERFORMANCE

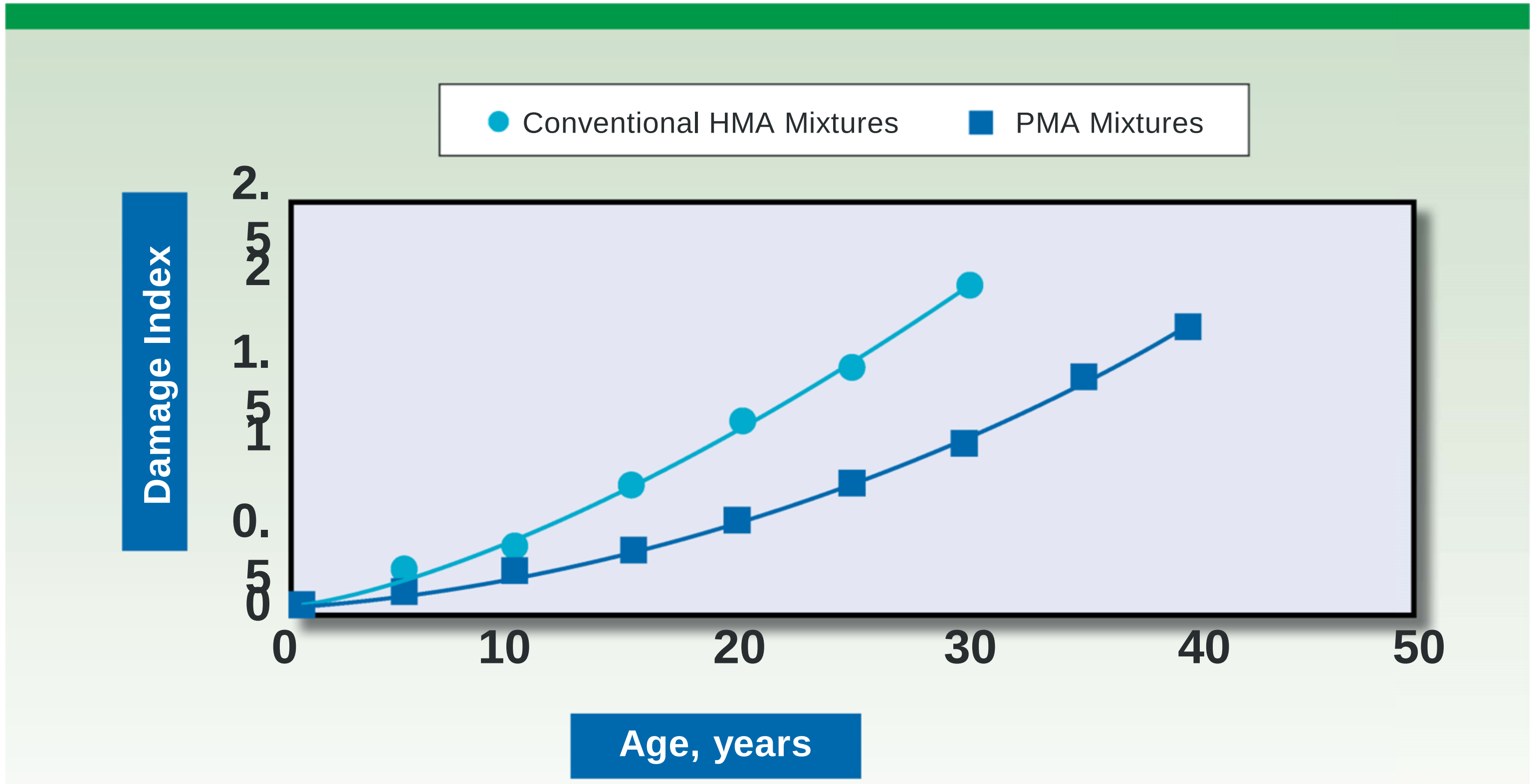
**Polymer Modified HMA shows a substantially lower Rut Depth and less % Fatigue Cracking**




*Harold von Quintus, "Polymer-Modified Asphalts–Enhancing HMA Performance," AMAP Annual Meeting, February 10, 2004

# EXPECTED SERVICE LIFE INCREASE FOR A 20-YEAR DESIGN*




*Harold von Quintus, “Polymer-Modified Asphalts–Enhancing HMA Performance,” AMAP Annual Meeting, February 10, 2004

# EXPECTED SERVICE LIFE INCREASE

| Site Factor | Condition Description | Years |
|---|---|---|
| **Foundation Soils** | Non-expansive soils; coarse-grained soils | 5 – 10 |
| | Expansive soils; moderately to highly plastic soils (PI>35) | 2 – 5 |
| | Frost susceptible soils in cold climates; moderaly to highly frost susceptible (Class 3 and 4) | 2 - 5 |

Assumptions: PMA in surface and base layers. 20 year design.

Harold von Quintus, “Quantification of the Effects of Polymer-Modified Asphalt for Reducing Pavement Distress,” Asphalt Institute Engineering Report ER-215, February 10, 2005

# EXPECTED SERVICE LIFE INCREASE

| Site Factor | Condition Description | Years |
|---|---|---|
| Water Table Depth | Deep | 5 – 10 |
| | Shallow; adequate drainage | 2 – 8 |
| | Shallow; inadequate drainage | 0 - 2 |

Assumptions:
PMA in surface and base layers.
20 year design.

Harold von Quintus, “Quantification of the Effects of Polymer-Modified Asphalt for Reducing Pavement Distress,” Asphalt Institute Engineering Report ER-215, February 10, 2005

# EXPECTED SERVICE LIFE INCREASE

| Site Factor | Condition Description | Years |
|---|---|---|
| **Climate** | Hot | 5 – 10 |
| | Mild | 2 – 5 |
| | Cold | 3 – 6 |

Assumptions: PMA in surface and base layers. 20 year design.

Harold von Quintus, “Quantification of the Effects of Polymer-Modified Asphalt for Reducing Pavement Distress,” Asphalt Institute Engineering Report ER-215, February 10, 2005

# EXPECTED SERVICE LIFE INCREASE

| Site Factor | Condition Description | | Years |
|---|---|---|---|
| Traffic | Low volumes | Stop & go/intersections | 5 – 10 |
| | | Thoroughfares | 3 – 6 |
| | | Heavy loads/special containers | 5 – 10 |
| | Moderate volumes | | 5 – 10 |
| | High volumes | | 5 - 10 |

Assumptions: PMA in surface and base layers. 20 year design.

*Harold von Quintus, “Quantification of the Effects of Polymer-Modified Asphalt for Reducing Pavement Distress,” Asphalt Institute Engineering Report ER-215, February 10, 2005

# 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 |

Assumptions: PMA in surface and base layers. 20 year design.

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

*Harold von Quintus, "Quantification of the Effects of Polymer-Modified Asphalt for Reducing Pavement Distress," Asphalt Institute Engineering Report ER-215, February 10, 2005

# GENERIC TREATMENT TIMELINES FOR LCAA

| Years | 0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 |
|---|---|---|---|---|---|---|---|---|
| HMA Mix | Preservation app at year 10: Mill & fill | | Structural overlay at year 18 | | Preservation app at year 28: mill & fill | | Structural overlay at year 34 | |
| PMA surface HMA base | Structural overlay, with PMA wearing surface at year 18 | | | | Structural overlay with PMA wearing surface at year 34 | | | |
| PMA surface & base | Preservation application at year 18: mill & fill with PMA wearing surface | | | | Preservation application at year 34: mill & fill with then PMA overlay and wearing surface. | | | |

Assumption: 20 year design.

*Harold von Quintus, "Quantification of the Effects of Polymer-Modified Asphalt for Reducing Pavement Distress," Asphalt Institute Engineering Report ER-215, February 10, 2005

# THANK YOU!

## ANY QUESTIONS? COMMENTS?