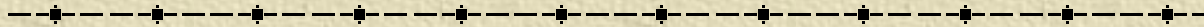


Superpave Plus Binder Specifications Why do We Have them.

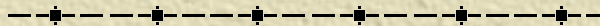


Presented by
John A D'Angelo

to the

2nd International Symposium on Binder Rheology

Sept. 10th and 11th, 2001



Superpave Plus Binder Spec.s

- ✦ To understand why we have Plus specifications we have to understand what the existing Superpave specifications provide to the industry.
- ✦ Do we have everything that we want?



Rutting

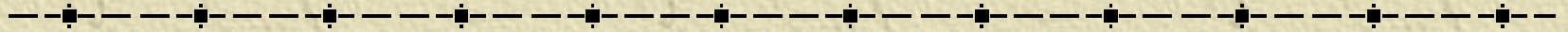
Fatigue Cracking

A photograph of a road showing fatigue cracking in the asphalt surface. The cracks are visible as a network of small, interconnected lines. The road has white lane markings and a yellow shoulder line. The background shows a dry, hilly landscape under a clear sky.

Low Temperature Cracking



Superpave Binder Specification FY 2001



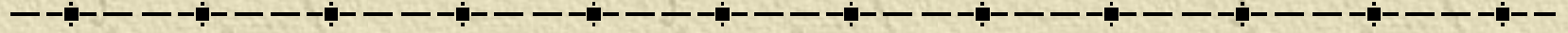
Time	Concern	Neat Asphalts	Modified
Production	Safety	Addressed	Addressed
	Constructability	Addressed	Not Yet
Early	Rutting	Addressed	Not Yet
Late	Fatigue	Not Yet	Not Yet
	Cracking	Addressed	Addressed

Why do agencies care about Modified Asphalt Binders.

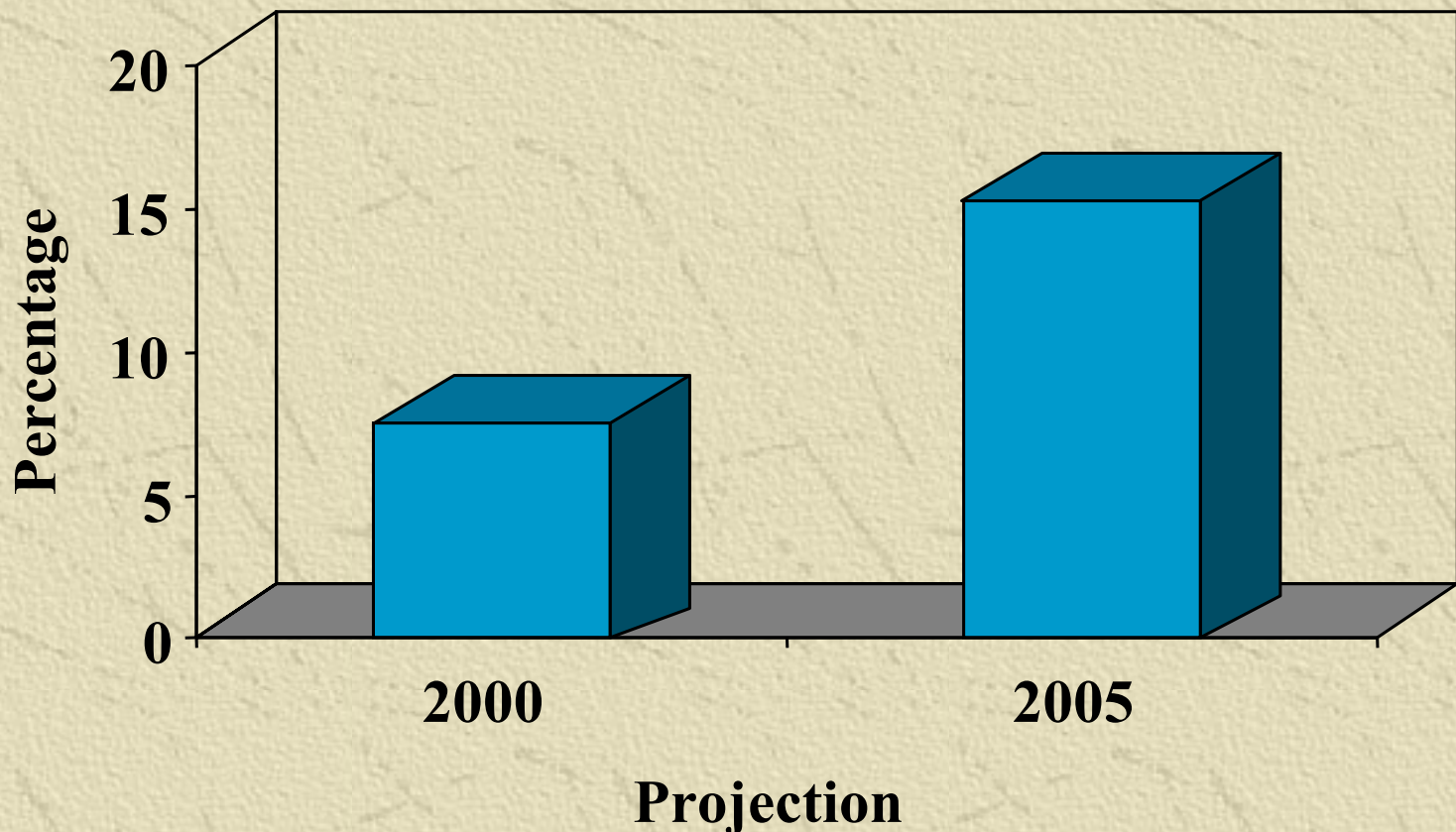
- ✦ Modifiers can improve performance
- ✦ Modifiers can increase the cost of the asphalt binder 30 to 100 percent.
- ✦ Modifiers can increase the cost of hot mix 10 to 30 percent.



Why do agencies care about modified asphalt binders ?



State Highway Agencies Usage



How do Agencies assure they get the products they want?

- ✦ Performance Related Specification is one way.
- ✦ Superpave Specifications are supposed to be performance related.
- ✦ Do they live up to this claim?

Modified Binders Affect Performance

✦ Study same mix different binders.

PG 63-22 mod. no rutting

PG 67-22 unmod. 15mm rutting



Modified binders affect Cracking



Pennsylvania

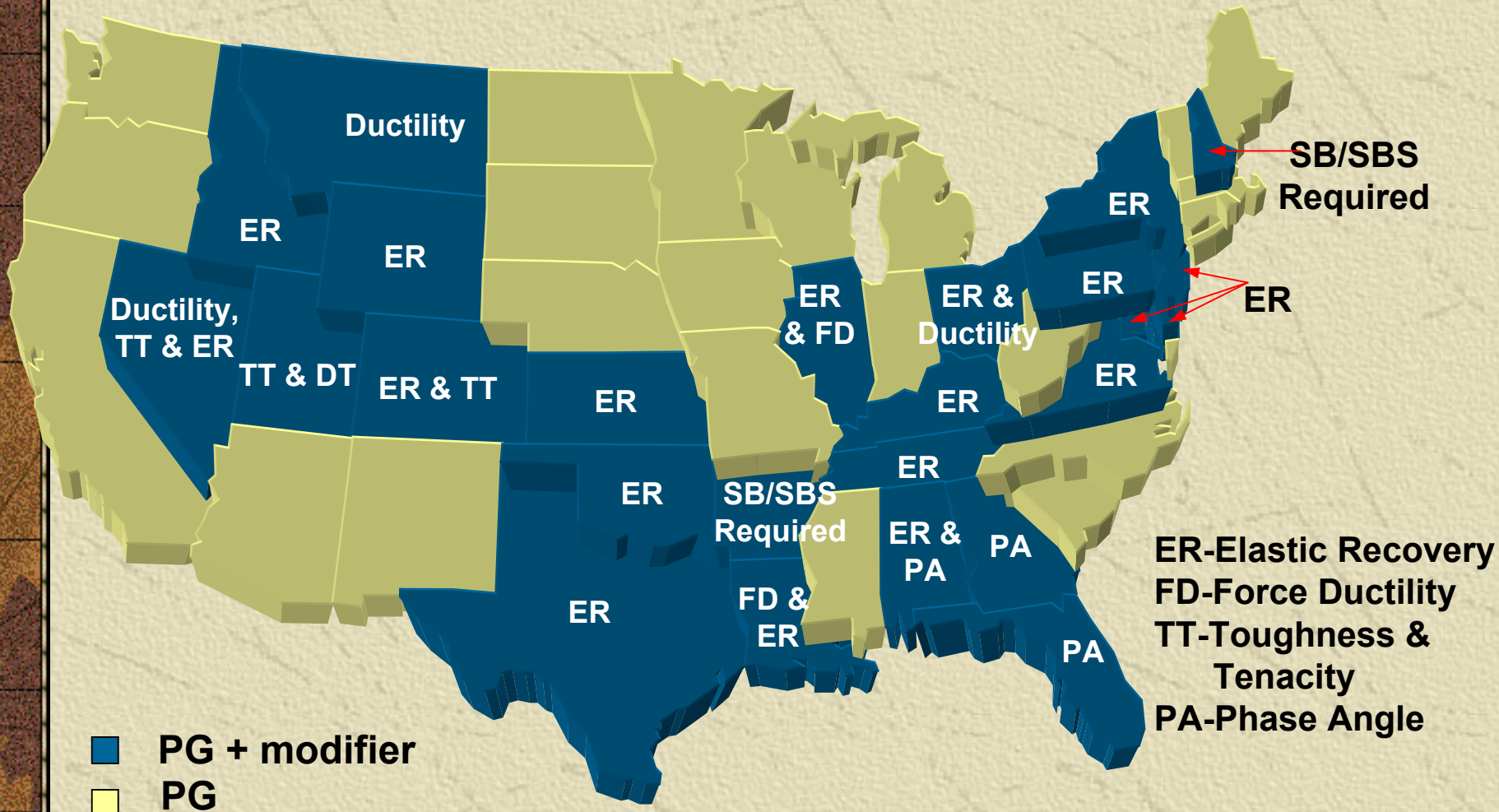
I-80

- ✦ AC-20, Minor Rutting
- ✦ All other sections did not rut
- ✦ Major distress was cracking & raveling
- ✦ Gilsonite had the greatest raveling followed by EVA

Why Superpave Plus Specs.

- ✦ The existing specifications do not identify the performance characteristics of modified binders.
- ✦ The existing specifications do not have a criteria for fatigue of durability.
- ✦ Agencies look to other tests to identify modifiers

State DOT's Specifying Polymer PG (PG+)



Superpave Plus Specifications

- ✦ Most of the tests used today by agencies to identify modified binders are not performance related.
- ✦ Forced Ductility, Elastic Recovery, and Toughness and Tenacity do not relate to performance.

Superpave Plus Specifications

✦ From the existing suite of Superpave binder tests is there a test that can be used today to identify modifiers.

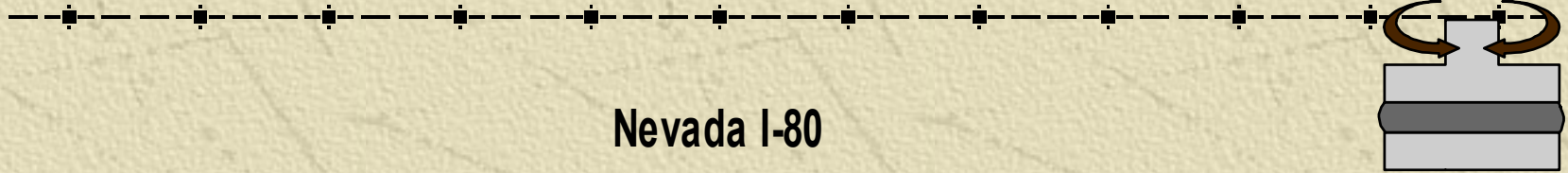


Superpave Test Equipment

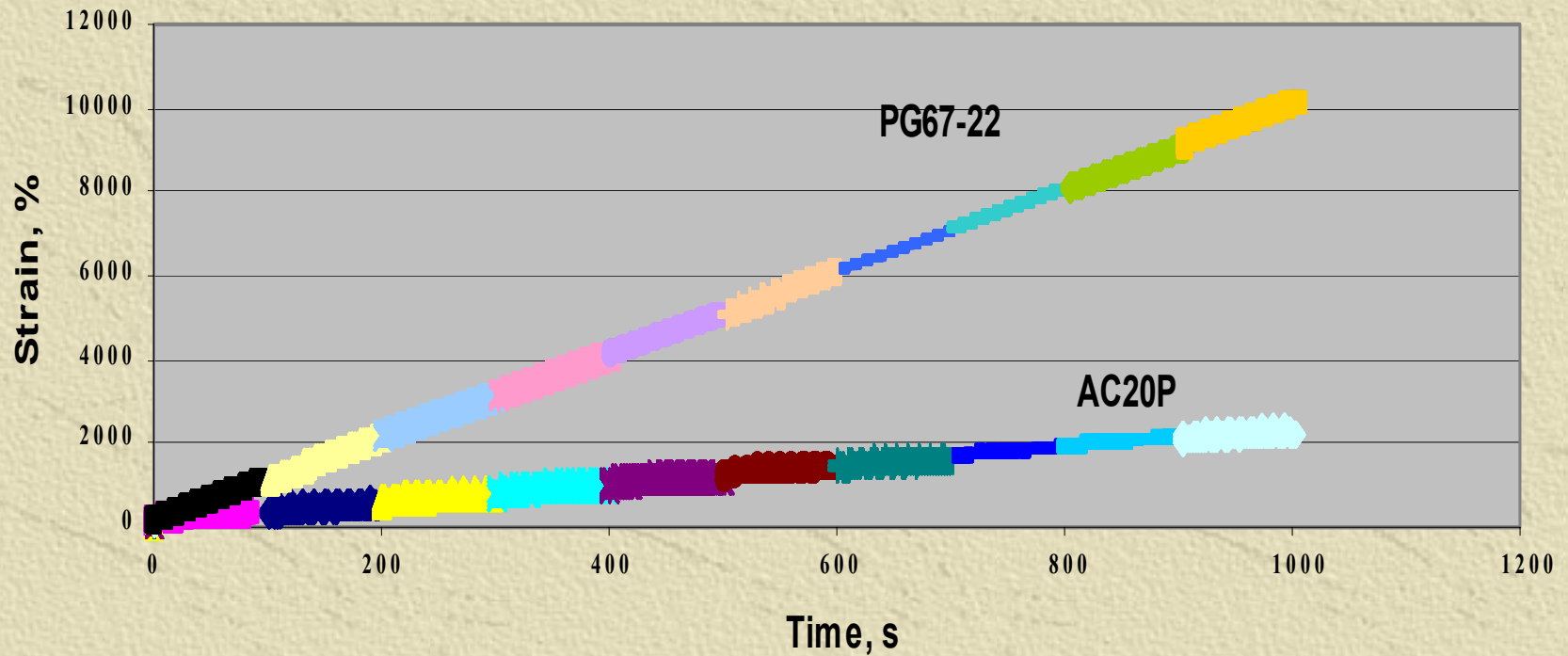
- ✦ The dynamic shear rheometer provides a great deal of information about the binder. It should be able to provide data on modified systems.



NCHRP 9-10 Rutting Test Repeated Creep Recovery Test



Nevada I-80



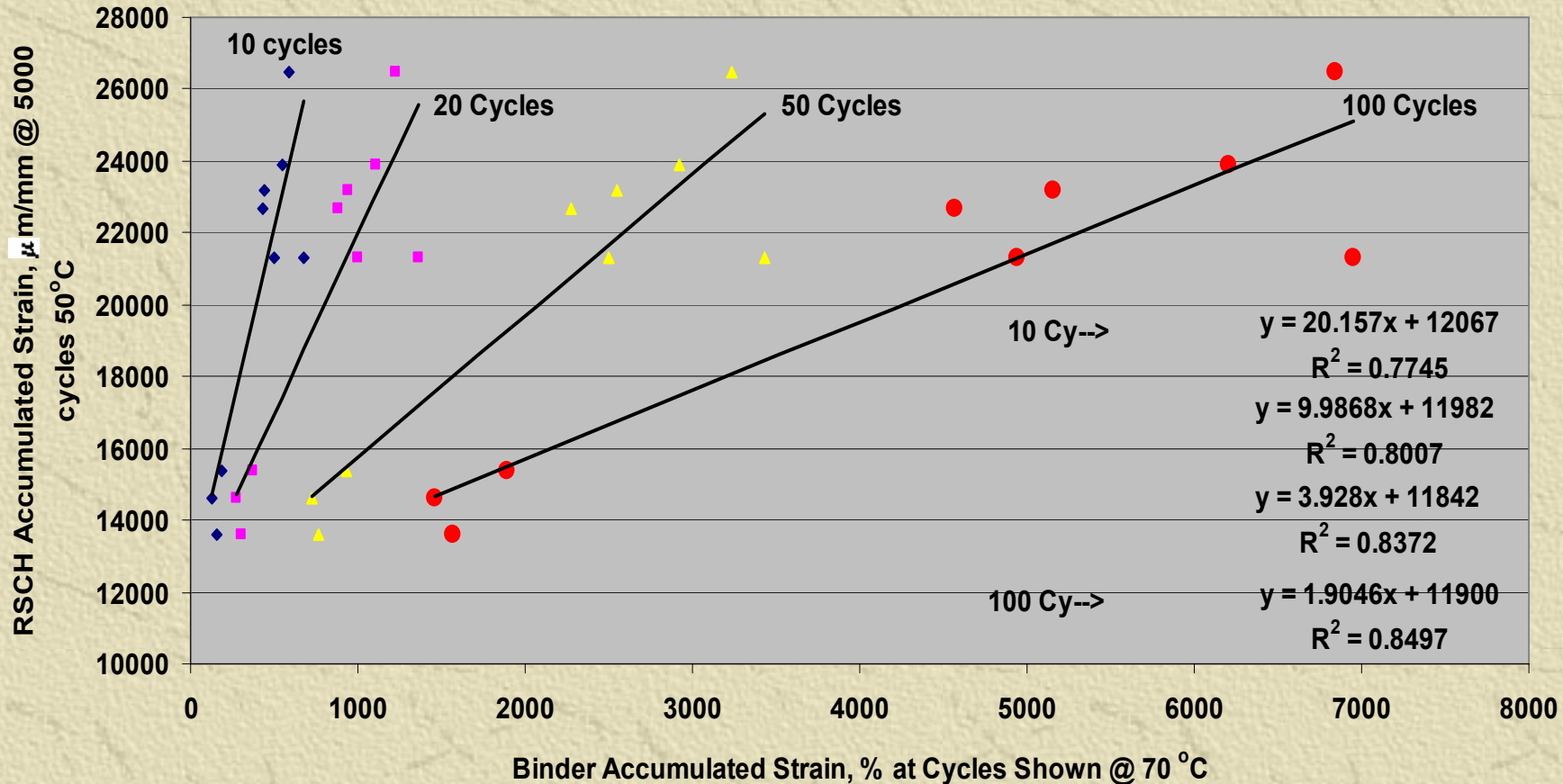
Performance Grades of MODIFIED BINDERS: PG 73-28 (*)

<u>Modifier</u>	<u>Initial</u>	<u>Scale Up</u>
Air Blown(*)	73-28	75-29
Elvaloy®	74-29	78-32
SBS lg	74-29	72-33
SBS l	72-28	71-31
SBS rg	73-28	72-32
EVA	73-31	76-31
EVA g	75-31	74-32

- Low Temp based on BBR only, DT may change value

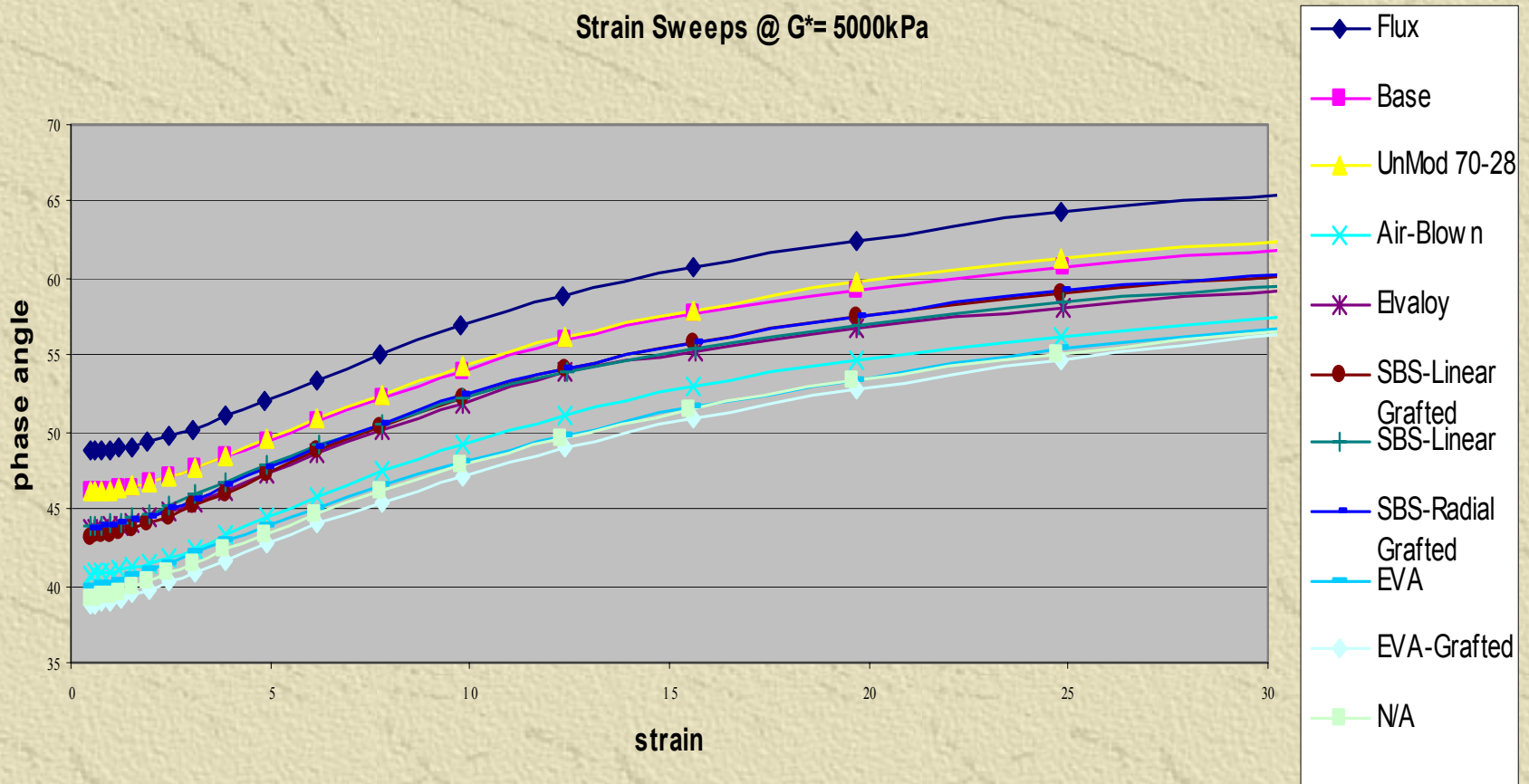
NCHRP 9-10 Rutting Test Repeated Creep Recovery Test

Comparison of Binder strain to Mix strain



Binder Characterization Superpave + Specifications

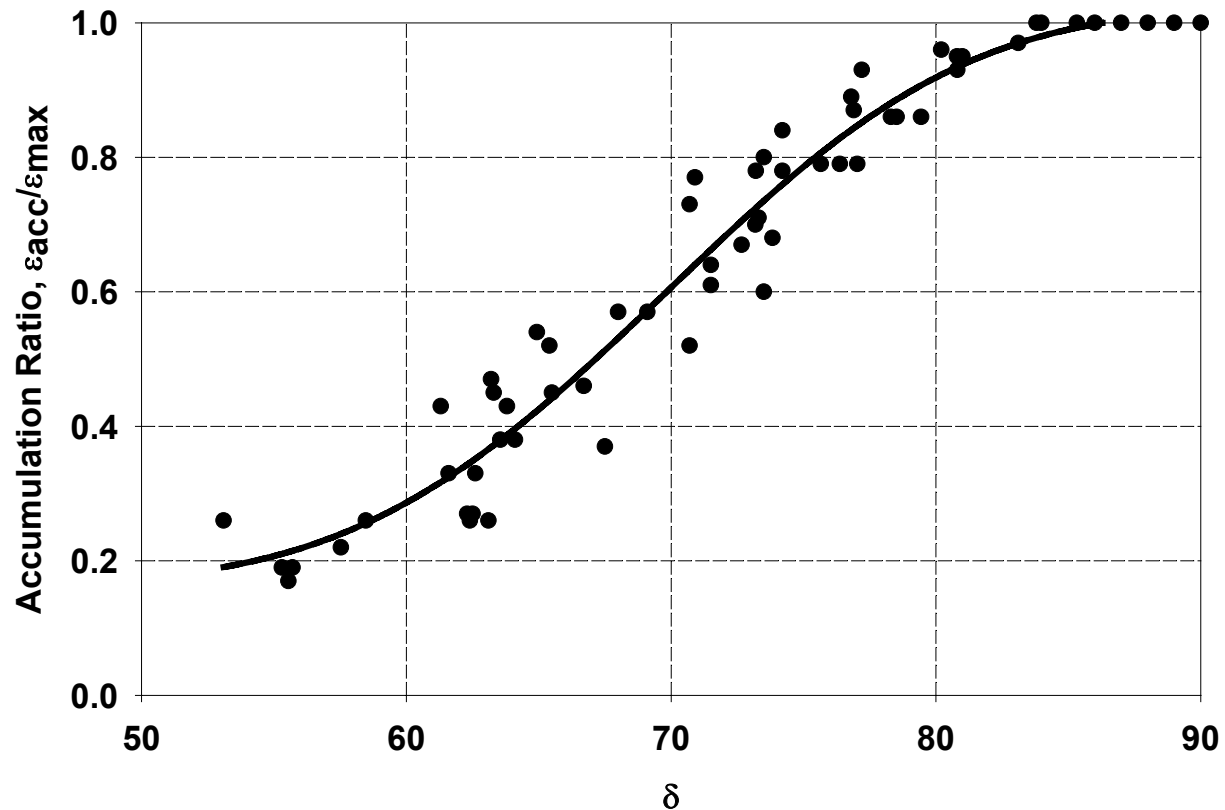
Strain Sweeps @ $G^* = 5000\text{kPa}$



Superpave Plus Specification

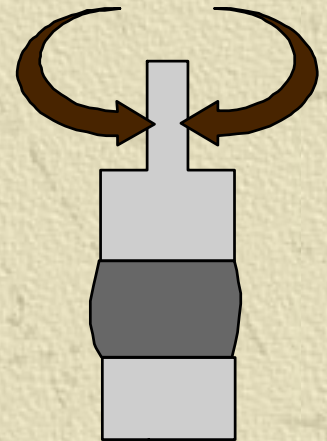
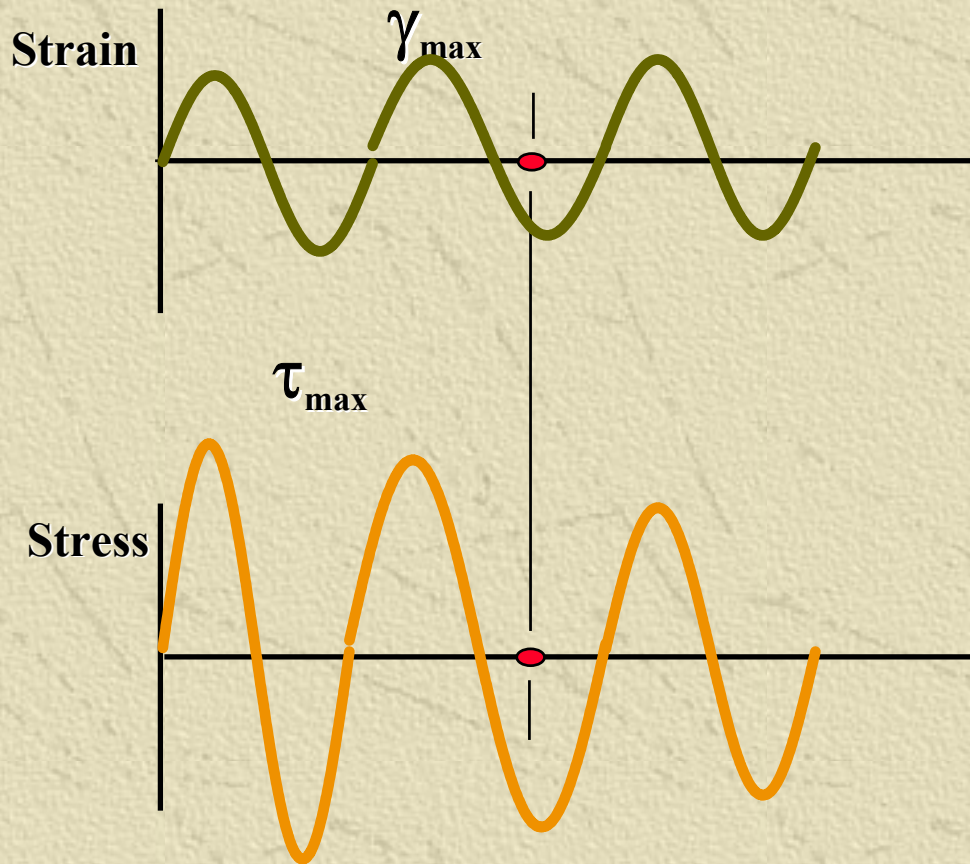
- ✦ The repeated creep and recovery testing is not yet ready for specification testing.
- ✦ There are questions about test procedure, repeatability, and specification criteria.
- ✦ Testing does indicate the binder phase angle does relate to binder modification.

The binder phase angle is related to modification.



NCHRP 9-10 Binder Fatigue Test:

Time Sweep in the DSR



Superpave Plus Specifications

- ✦ The 9-10 procedure may characterize the fatigue properties of the binders. There is still quite a bit of work needed to finalize the test procedure and specification requirements.

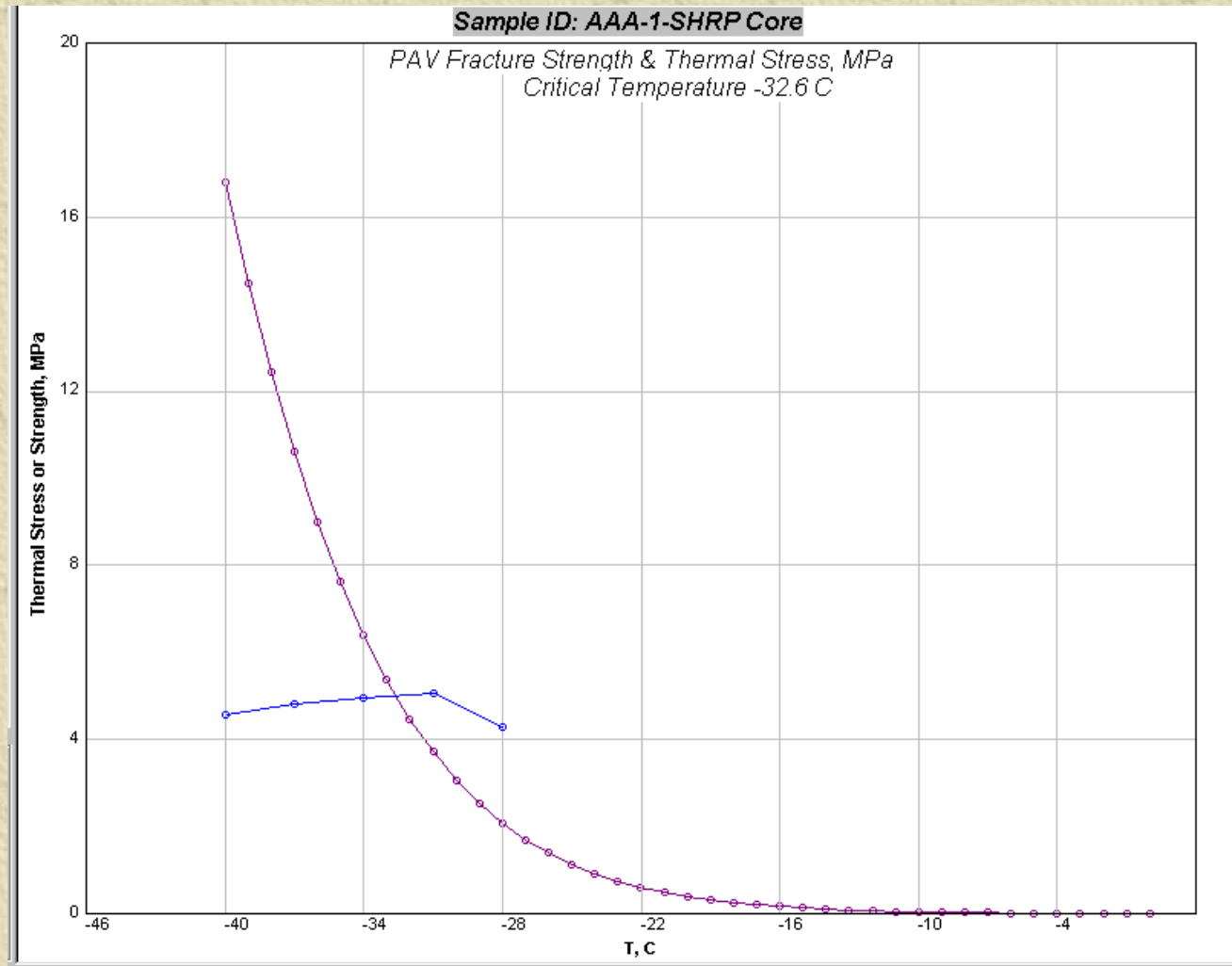
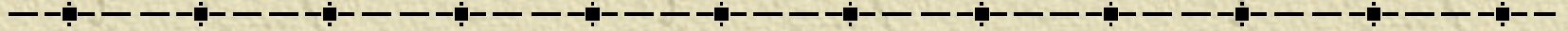
Direct Tension Test



The Direct Tension Test provides a tremendous amount of information about the binder.

New low temperature binder Spec.

Thermal stress compared to strength.



New Superpave MP1a Spec.

Binder	T _{cr} Current Spec	T _{cr} Proposed Spec
70-22 Air Blown	-24.5	-22.5
70-22 Conventional	-25.1	-22.5
70-22 SBS Modified	-26.0	-30.5
Chemically Modified 64-28 A	-29.0	-28.0
Chemically Modified 64-28 B	-27.5	-27.0
Chemically Modified 64-28 K1	-29.5	-27.5
Chemically Modified 58-28 M1	-27.3	-27.0
Elvaloy Modified 64-34 DP	-34.7	-36.0

Superpave Plus Specifications

- ✦ The Direct Tension Tester provides a great deal more information about the binder and its make-up.
- ✦ The strain at failure can tell a lot about what is in the binder.

Montana Study DTT Results

PG grade	Modifier	Test Temp	Strain	Stress
76-28	EVA	-18°C	1.8	3.4
76-28	EVA	-18°C	1.5	3.5
76-28	EVA	-18°C	1.7	4.0
76-28	EVA	-18°C	2.0	3.6
76-28	EVA	-18°C	1.7	4.2
76-28	SBS	-18°C	3.5	5.5
76-28	SBS	-18°C	4.0	5.9
76-28	SBS	-18°C	2.9	5.9

FHWA Polymer Study DTT

Results

PG GRADE	Modifier	Test Temp	Strain	Stress
70-28 (72-33)	SBS-Lin_GRF	-18°C	5.81	4.81
70-28 (72-31)	SBS-Linear	-18°C	2.09	5.37
70-28 (71-32)	SBS_RAD_GRF	-18°C	7.05	4.65
70-28 (70-31)	EVA	-18°C	1.94	4.81
70-28 (73-31)	EVA_GRF	-18°C	1.78	4.76
70-28 (73-31)	EVA_GRF	-24°C	1.15	6.24
64-34	Stylink	-24°C	2.07	5.07
64-34	Elvaloy	-24°C	2.3	4.98
64-40	EVA	-30°C	1.74	4.35
64-40	EVA	-30°C	0.59	1.53
63-22	SBS	-12°C	2.6	4.2

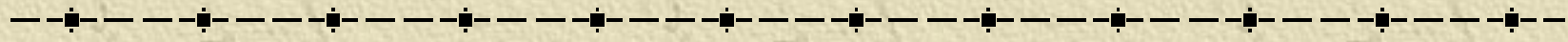
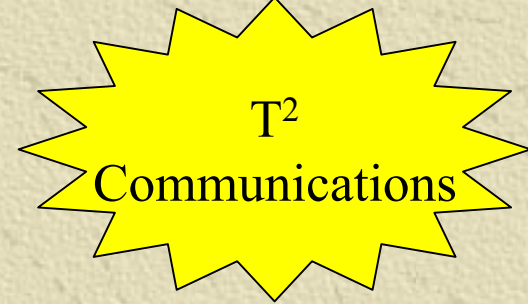
Superpave Plus Specifications

- ✦ The strain at failure from the DTT does distinguish between modifiers.
- ✦ The DSR phase angle plus the DTT strain at failure can replace the FD, ER, or T&T.

Superpave Plus Specifications

- ✦ Benefits of using phase angle and DTT for Superpave Plus specifications.
 - ◆ Using phase angle and DTT strain does not require the additional time and testing.
 - ◆ Superpave Plus Specifications using the phase angle and the DTT strain at failure are based on rheological properties.
 - ◆ Future Superpave Specifications will use these properties to define performance related characteristics.

Superpave Binder Specification FY 2005



Time	Concern	Neat Asphalts	Modified
Production	Safety	Addressed	Addressed
	Constructability	Addressed	Addressed
Early	Rutting	Addressed	Addressed
Late	Fatigue	Addressed	Addressed
	Cracking	Addressed	Addressed

Superpave Binder Specification FY 2005

✦ Superpave Binder Specification

◆ A true Performance Related Specification.

- Rutting
- Fatigue
- Cracking
- Aging
- Blind to modification