

An Industry Perspective on Performance-Related Specifications

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(The fourth Territory from May-Oct.)**

“Specifications are Important!”

Not All Asphalt Binders Exhibit
Equal Performance



Strategic Highway Research Program

- 5 Years, \$150 million

- ◆ *asphalt (\$50 million)*

- ◆ cement and concrete

- ◆ long term pavement performance

- ◆ maintenance effectiveness

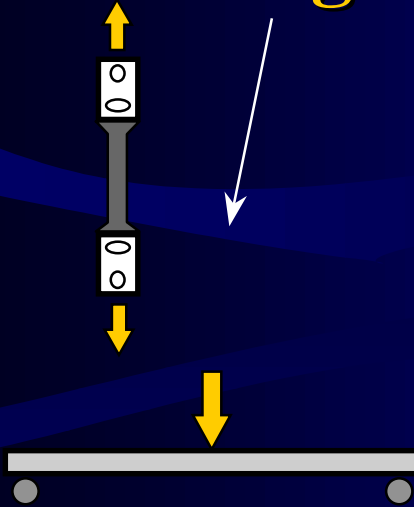
- ◆ bridge protection

- ◆ snow and ice control



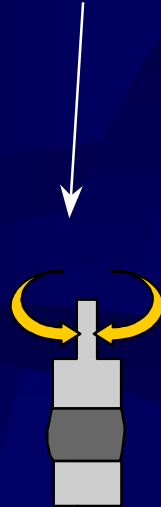
The Tools

Low Temp
Cracking



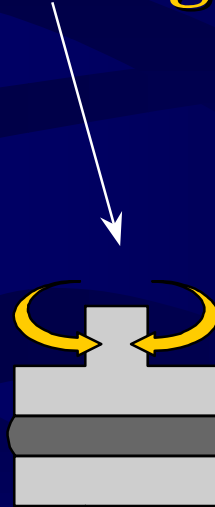
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Fatigue
Cracking



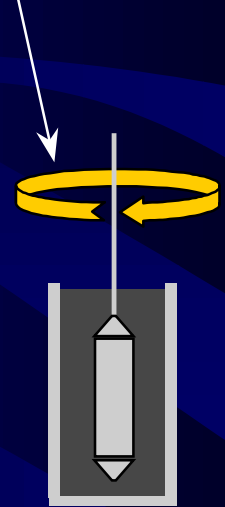
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Rutting



60

Construction
Workability



135

Service Temperature, °C

Grading of Asphalt Binders

- Prior to 1970 asphalts the US used penetration grades
- Beginning in 1970, asphalts were specified as viscosity grades.
- In the 1990's state DOT's began to specify SHRP Performance Grades of asphalts using SuperPave.
- Now, in 2000, all but three states are SuperPave*
for binders

SHRP Asphalt Binder Spec

- Grading System Based on Climate

PG 64-22

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graph BT; A[Performance Grade] --> B[PG 64-22]; C[Average 7-day max pavement design temp] --> B; D[Min pavement design temp] --> B;
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**Performance
Grade**

**Average 7-day
max pavement
design temp**

**Min pavement
design temp**

SuperPave made Simple: Useful Temperature Interval

- The “useful temperature interval” of an asphalt is the differential between the high temperature grading and the low temperature grading.
- For example, a 76-22 has a UTI of 98°C

UTI of Performance Grade Asphalts

- As a rule of thumb, to achieve a UTI of $>92^{\circ}\text{C}$, the asphalt has to be modified.
- If we needed a PG 76-22, which has a UTI of 98°C - how is this accomplished?

Modification of Asphalt Binders

- Modification may be accomplished by addition of:
 - Extending agents
 - Chemical additives
 - Air blowing
 - Polymer addition
 - Use of tetra-hydroxyl, n-tri-butyl mouse fur

Addition of Extending Agents

- Additives referred to as “extending agents” are materials added to asphalt to improve or extend asphalt properties.
 - In the past, asbestos was one of the more popular additives used to improve the strength and longevity of asphalt.
 - Today, due to safety hazards attributed to asbestos, other materials are utilized including cellulose fibers, mineral wool, and synthetic fibers.

Chemically Modified Asphalt

- Some asphalt binders may be modified chemically by the addition of chemicals which improve the properties of asphalt. These chemical additives include:
 - Sodium Hydroxide, and other materials of alkaline nature.
 - Phosphorous Pentoxide, and other acids
 - Sulfur, or sulfur donating materials.
 - Tall Oil, VGO, other organic streams...

Air Blown Asphalt

- Air blowing is a process in which an asphalt is heated to $\sim 500^{\circ}$ F and contacted with air. The finished product is called oxidized or blown asphalt. Very little oxygen is added ($< 2\%$ by weight.)
- This is a widely misunderstood process and product in the US transportation community.
- This may be partly due to the belief that oxidation on the roadway = air blowing

Polymer Modified Asphalt

- Addition of polymer additives to improve performance. Also referred to as PMAC.
 - The most common polymers used in PMAC are from the family of synthetic polymers, such as:
 - SBR Latex
 - Styrene-Butadiene Block Copolymers (SBS)
 - Ethylene Vinyl Acetate
 - Polyolefins such as Polyethylene, Polypropylene
 - Ground Tire Rubber

Tetra-hydroxyl, n-tri-butyl mouse fur

- Over the years, just about everything has been tried as a modifier of asphalt
- Few have proven their mettle
- New “things” are still being developed
 - New polymers
 - New devices

Special Instructions for PG Binders

- Performance-grade binders may be used and handled in the same manner as conventional asphalt binders.
- Mixing and compaction of mixtures made with performance-grade binder are generally in the same range as conventional binders.
- Some mix types may require extra attention.



What the Refiners feared from SHRP

- Grade Proliferation
- Increased Testing & Certification
- TANKS!!!!
- TANKS!!!!!!

What has Really Happened

- In most cases, there are two or three grades, as before
- There is more testing, and more equipment has been required.
- In many cases more care is required in manufacture of PG grades.

What have the US Refiners Done?

- Block Runs
- Segregated crudes
- Improved process control
- Make asphalt on purpose
- In short, everything they said they'd never do.

What is Today's Situation in the US Refinery?

- Their name isn't the same as it was pre-SHRP
- They've rationalized their process control and are now producing reliable PG grades
- The modified grades are being produced by second-tier producers (or non-refiners)

Differences between Canada & US Asphalt Supply

- In US, many more, and generally poorer crudes available.
- Most native US crudes make poor asphalt
- In Canada, western crudes generally make excellent asphalts
- East coast of Canada more like US

Then and Now (Specification Properties)

AC-20

PG 64-22

Then & Now, Low Temperature Properties

- Then:
 - Little to no Low-Temperature property control
- Now
 - Full (!) predictive capability for low-temperature cracking
 - Some argument on predictive software (SHRP, LTPP, etc.)

*Has SHRP been Implemented as Expected?

- No, not really; We have SHRP+ in most states
- Several forces drive “SHRP Plus”
 - Desire to keep products with proven field performance (AC-30 led to 67-22 in the South)
 - Fear of “Zupa-Link” fostered by proprietary producers

Has SHRP caused any catastrophes?

- Not Really
 - The *Gary Busey Rule* applies to road building
- States with “true” SHRP don’t seem to be having tremendous problems
- However, NCHRP 9-10 has shown performance of modified asphalts may not be captured by SHRP tests

What's on the Horizon?

- DT and the new MP-1A Specification
 - Uses both BBR and DT to determine T_{cr}
 - More testing, more temperatures
- Impact on commerce grades uncertain
 - Use for temperate PMA grades (-22?)
 - Use for unmodified grades?

What's Still Needed?

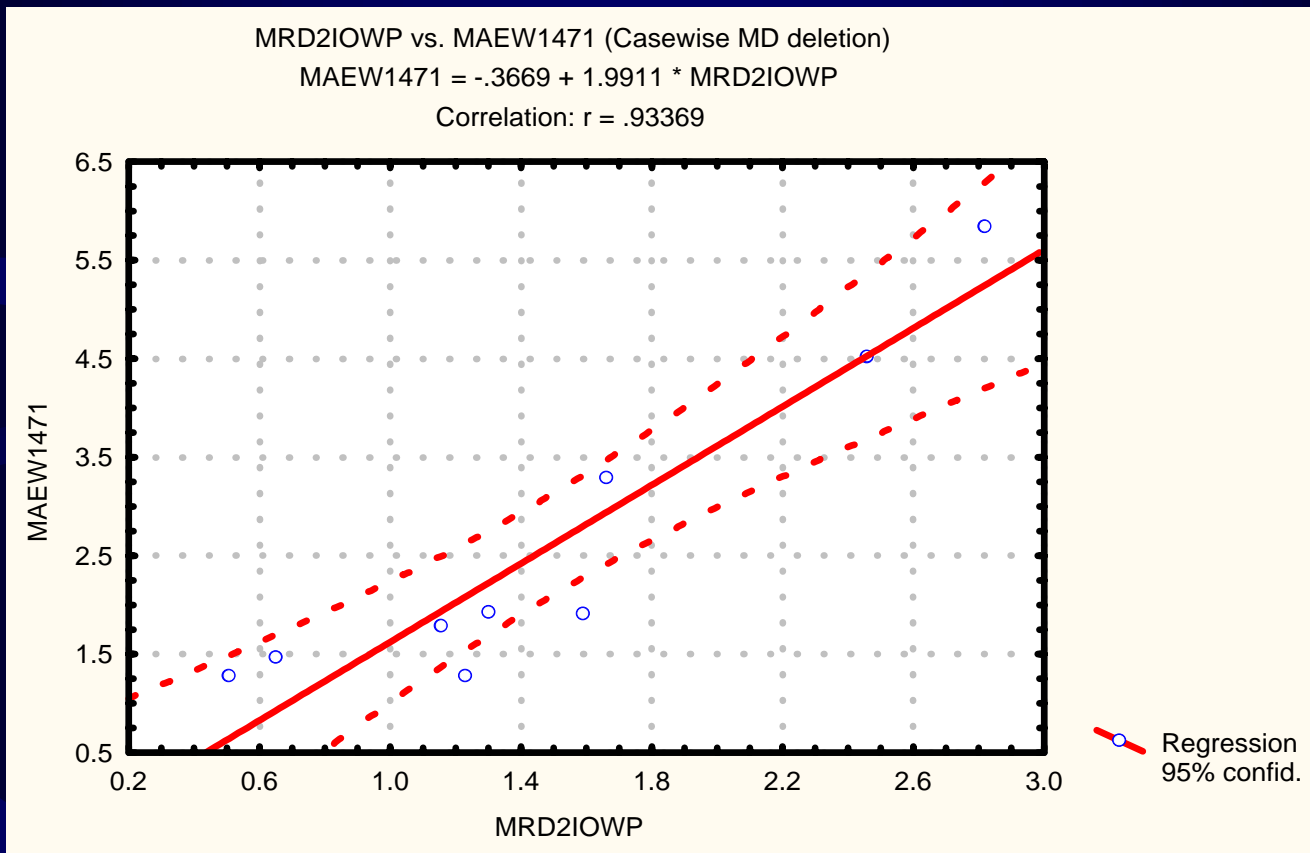
- Binder mostly complete
- Mix Testing & Specification lags behind
- Some good news - the Mississippi field trial

Asphalt True-Grade & Modifier Loading

<u>ID</u>	<u>Tradename</u>	<u>True-Grade</u>	<u>Modifier (wt. % of AC)</u>
• P	Kraton	PG 71-25	4.00
• A	Ultrapave	PG 70-27	3.00
• R	Novophalt	PG 76-23	5.50
• T	Stylink	PG 77-29	6.00
• Y	GF-80	PG 75-29	10.0
• G	Sealoflex	PG 82-27	4.25
• E	Multigrade	PG 72-24	Indeterminable
• N	Cryo-80	PG 75-28	10.0
• C	Control	PG 70-24	0.0

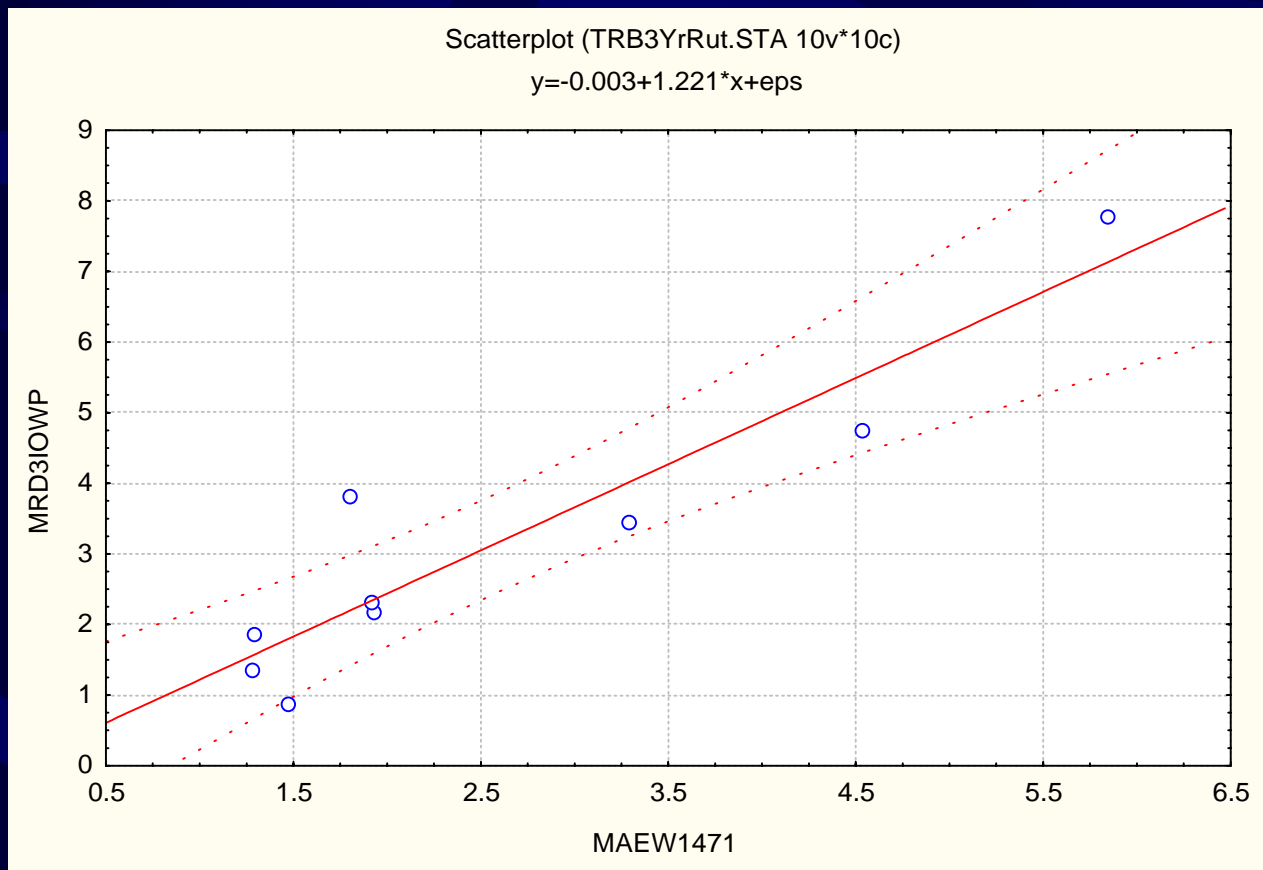
Mississippi Trial Results

2 Yr. Field Rut Depth vs. APA Wet @
147°F - 1,000 cycles ($R = 0.93$ $R^2 = 0.87$)



Mississippi - Part Two

3 Yr. Field Rut Depth vs. APA Wet @
147°F - 1000 Cycles ($R = 0.93$ $R^2 = 0.86$)



THIRD YEAR MS SUMMARY

Manufacturer	ID	True Grade	UTI	% Mod.	FRD in.	FRD mm
Rouse	Y	75-29	104	10.0	0.0341	0.87
Stylink	T	77-29	106	6.0	0.0540	1.37
Sealoflex	G	82-27	109	4.25	0.0739	1.88
Kraton	P	71-25	96	4.0	0.0853	2.17
Novophalt	R	76-23	99	5.5	0.0909	2.31
Ultrapave	A	70-27	97	3.0	0.1364	3.47
Multigrade	E	72-24	96	0	0.1420	3.61
Cryopolymers	N	75-28	103	10.0	0.1875	4.76
Control	C	70-22	94	0	0.3068	7.79

- All modified binders show better rut resistance than the control - at least 1/2 as much
- With one exception, modified binders with UTI < 100 had less than 1/2 rutting of Control
- With one exception, modified binders with UTI > 100 had less than 1/4 rutting of Control

Conclusions

- Field results indicate differences in performance between same PG grades produced by different modification.
- Mix testing helps differentiate
- My view: The cup is half full