An Industry Perspective on Performance-Related Specifications

David R. Jones, IV
Trumbull Asphalt
Tampa, Florida
(The 11th Province from Nov.-April)
(The fourth Territory from May-Oct.)

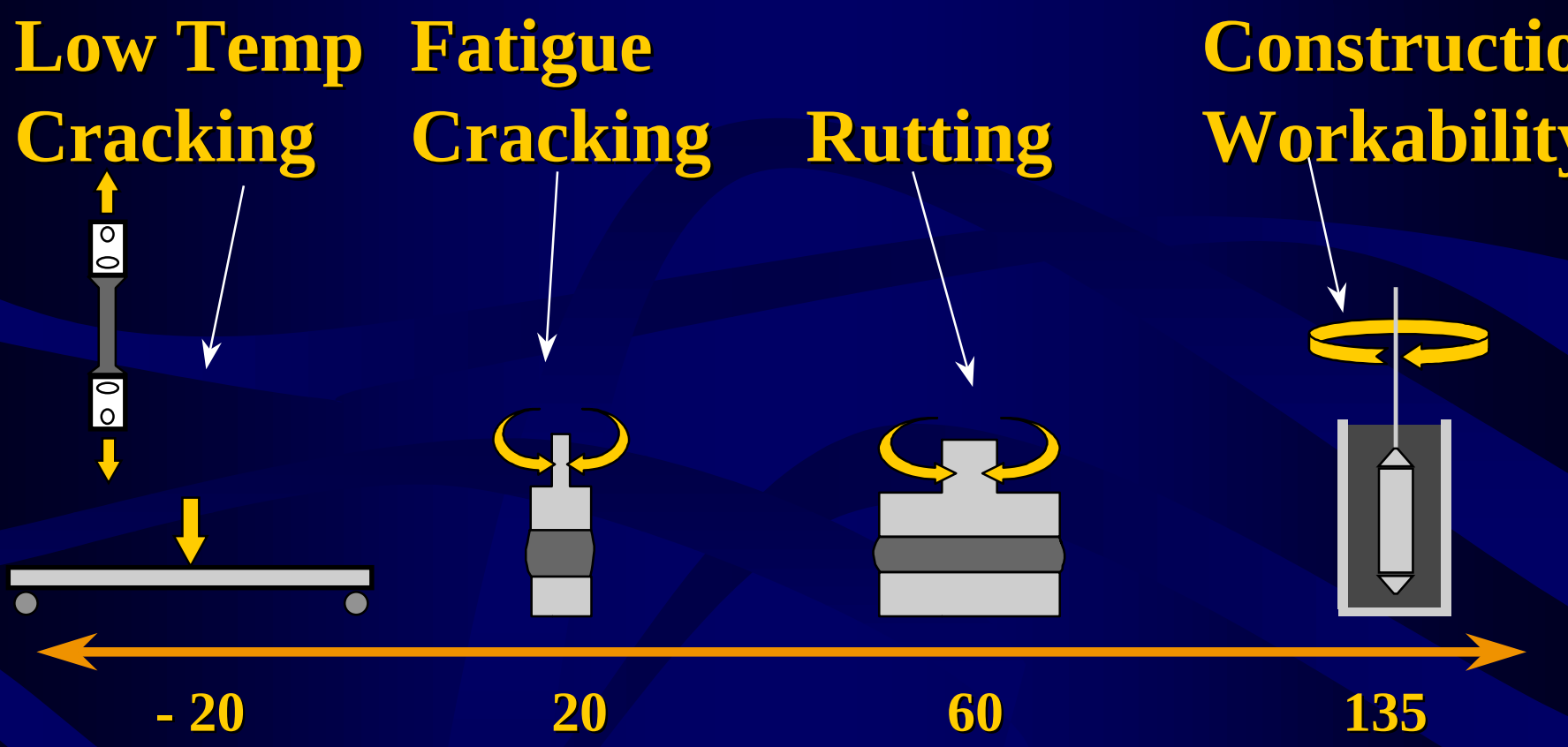
“Specifications are Important!”

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
Fatigue Cracking
Rutting
Construction Workability
- 20
20
60
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

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° 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 ~500° 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?

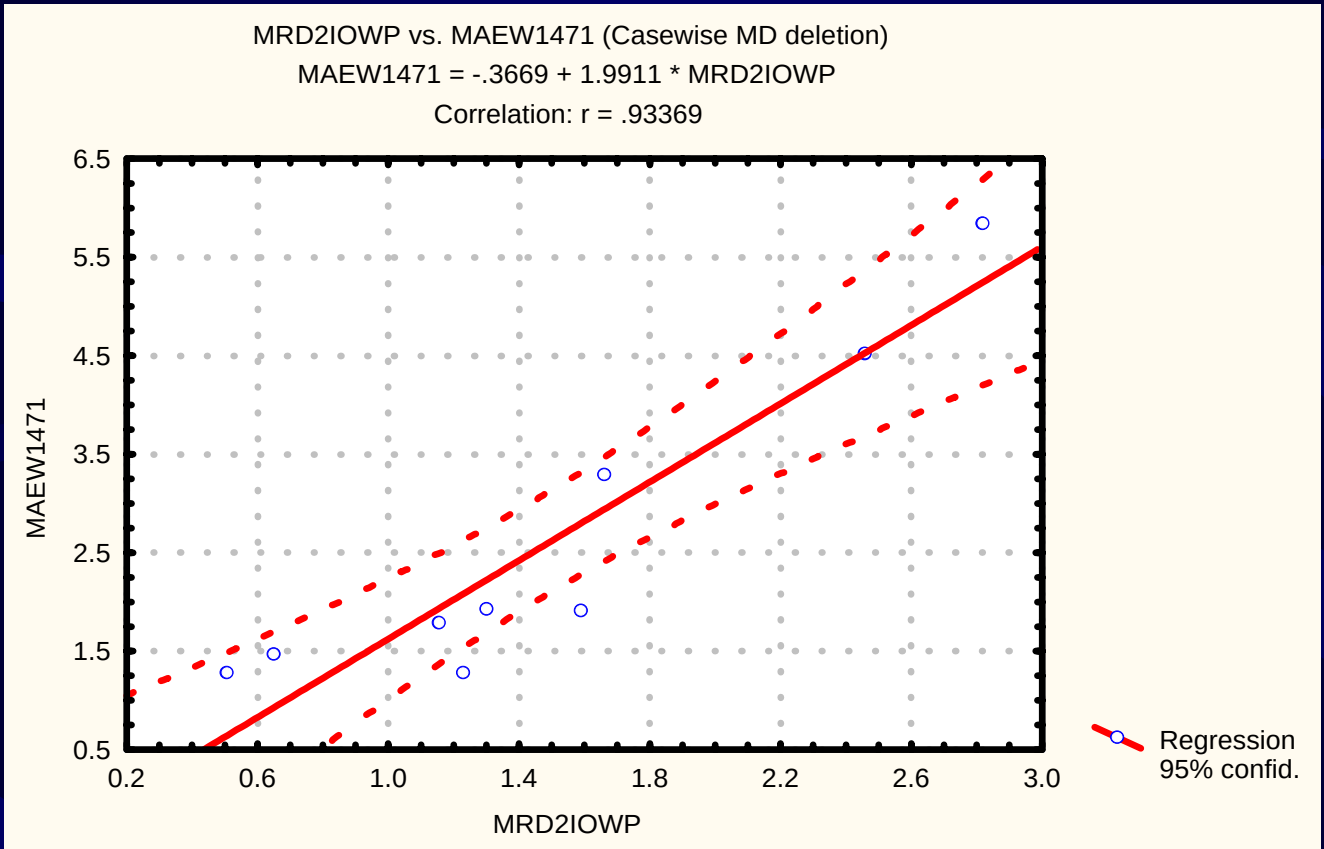
- Binder mostly complete
- Mix Testing & Specification lags behind
- Some good news - the Mississippi field trial

Asphalt True-Grade & Modifier Loading

ID	Tradename	True-Grade	Modifier (wt. % of AC)
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

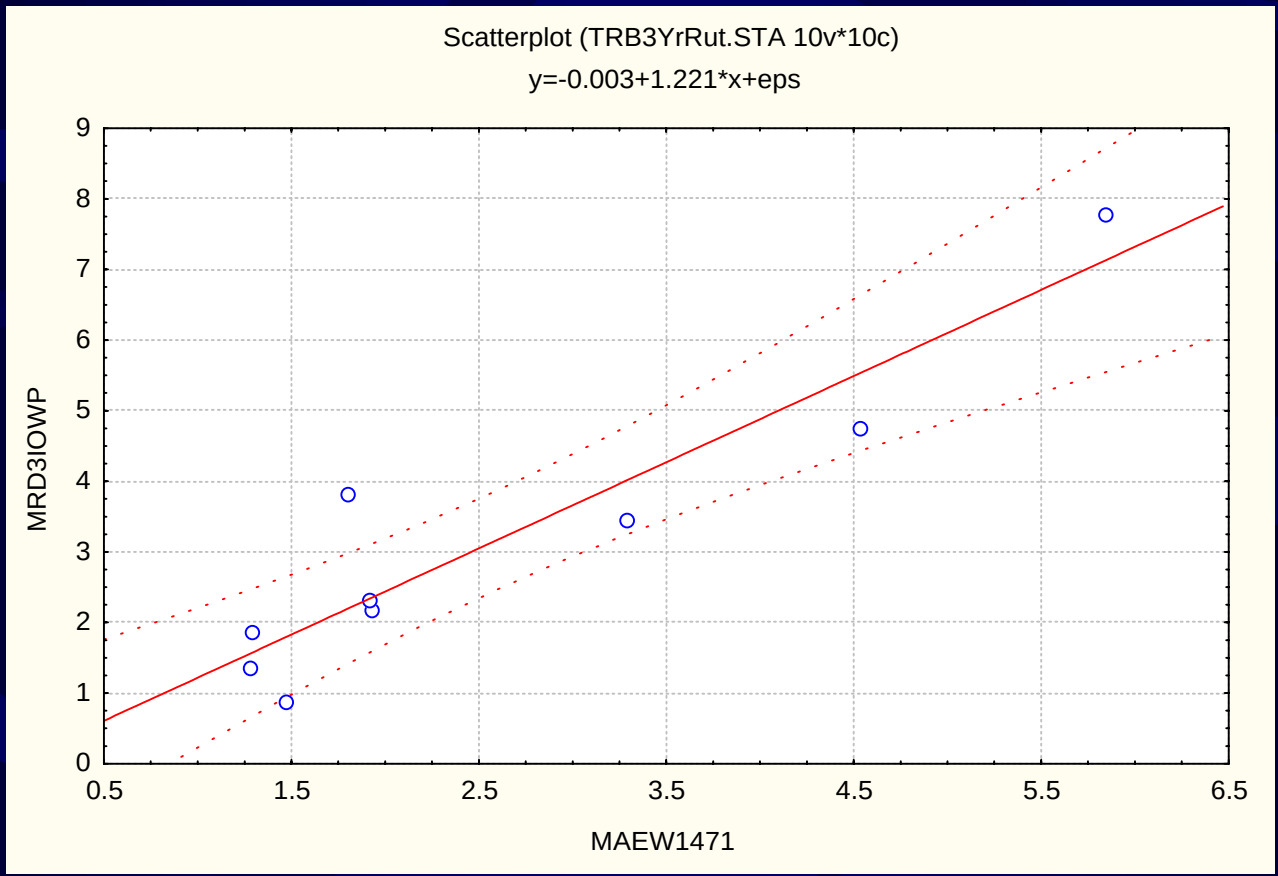
Mississippi Trial Results

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