Recent Developments at WRI in Chip Seal Emulsion Recovery, Aging, and Testing

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4-mm Dynamic Shear Rheometry (DSR)

- Low Amplitude Oscillatory Shear (-40° to ~ 45°C)
- 4 mm Diameter Parallel Platens
- Instrument Compliance Correction
- Small Sample (25 mg) (1.75 mm gap)
- Low Heat (<60°C) During Sample Loading on the DSR
4-mm DSR Spin-Offs Update

25 mg Asphalt Sample

4 mm Dia. Plate DSR

Rheology
Low and Intermediate Temp.
- Asphalt
- Modified Binder
- Emulsion Residue
- Crack Sealant

Specifications
Asphalt
- AASHTO T 313
- AASHTO R 49-09
- Emulsion Residue
- Crack Sealant

USAT
Short and Long-Term
- Asphalt
- Modified Binder
- Warm Mix
- Emulsion Residue

Field Sampling
- Hammer Drill
- Rapid Sampling
- Easy Extraction

T_{ref} = -28^\circ C

\begin{align*}
G'(\omega), G''(\omega) & [\text{Pa}] \\
\text{Reduced Frequency (rad/sec)} & \\
1 \times 10^{-14} & 1 \times 10^{-11} \\
1 \times 10^{-8} & 1 \times 10^{-5} \\
1 \times 10^{-2} & 1 \times 10^{0} \\
1 \times 10^{4} & 1 \times 10^{7} \\
1 \times 10^{9} & 1 \times 10^{10} \\
\end{align*}
Remaining Issues

• AASHTO Method
• Moisture Content After Recovery
• Establish PAV Time and Temperature to Simulate Field Aging

The SAT Recovery Method Has Several Advantages as Compared to AASHTO PP 72-11 Method B

• No Silicone Mat
• No Wet Film Applicator
• More Uniform Residue Surface and Thickness (300 µm)
• Designed to Be Placed Directly in the PAV
• PAV Time is Reduced from 20 to 8 Hours

Farrar, Michael J., Steve Salmans, Jean-Pascal Planche, Recovery and Laboratory Testing of Asphalt Emulsion Residue: Application of the Simple Aging Test (SAT) and 4mm DSR, TRB 2013
KF Applied to Asphalt
Emulsion Residue Sampling in the Field

Portable pavement heating unit.

- Modified Tile Scraper
- Putty Knife
- Sawzall with Tile Blade
- Hammer Drill with Venturi Collector

Cordless hammer drill with chisel
Federal Lands - Field Emulsion Residue Sampling Sites

Watch Out for Flash Floods!

Sampling the Chip Seal in Death Valley!

FIELD SAMPLING AND TESTING OF DEATH VALLEY CHIP SEAL EMULSION RESIDUE: A CASE STUDY
Michael J. Farrar,* Qian Qin, R. William Grimes, Jean-Pascal Planche, Ryan Boysen, Jenny Loveridge, Steve Salmans, and Alec Otto Cookman
Low temperature evaporative recovery

In this case, rheology does not appear to follow morphology
G*/sin δ = 1.0 kPa, continuous high temperature grade (10 r/s)
WYDOT Chip Seal
Snow Plow Damage

Chips that Survived
Snow Plowing

Chip Loss

Snow Plow Damage on a Chip Seal
Near Medicine Bow, Wyoming
Concept for a New Chip Seal Emulsion Test
WYDOT Chip Seal
Snow Plow Damage
Some Chips Were Lost. Why Do We Care?

Indicates lower benefit in terms of extending the useful lifetime of the underlying pavement

Safety issues related to traction and visibility

Esthetics, a failed chip seal does not look good

Increased maintenance costs
Who Cares?

Emulsion Producers and Suppliers
Contractors
DOTs, Purchasers
The Public
How Are These Products Currently Selected?

User experience

Manufacturers’ recommendations and product descriptions

Regional manufacturers
A Test That Can Help Predict Performance Would Be Valuable

Testing that can show how a particular product can be expected to perform in a particular service environment over the course of the desired lifetime of the chip seal could benefit manufacturers, contractors, and end users.
Test Criteria

- Relevant
- Reliable
- Simple
- Versatile
- Quantitative
- Low cost
What Properties Are Most Relevant to Chip Seal Performance?

Adhesion

Elastic limit

Ductile Brittle Transition Temperature

Crack spanning
Chip Adherence Stability Test

Adhesion test with tensile and shear loading components

Variable controlled stress rate and test temperature

Stress or Strain Control Capabilities

Multiple measurements made simultaneously to provide statistically significant data

Representative film thicknesses relevant to field application

Can measure creep compliance and various moduli values as well as adhesion
CAS Test Basic Concept

• Form test adhesive joints

• Age joints in a prescribed manner

• Measure the strength of the aged joints
Some Types of Data that the CAS Test Can Provide

- Adhesion relative to temperature and stress rate
- Elastic limit
- Ductile Brittle Transition Temperature
- Tensile creep compliance
- Various Modulus Values
Questions?
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Thank You