

National Pavement Preservation Conference Nashville, TN

Testing of Bond Coat Emulsions

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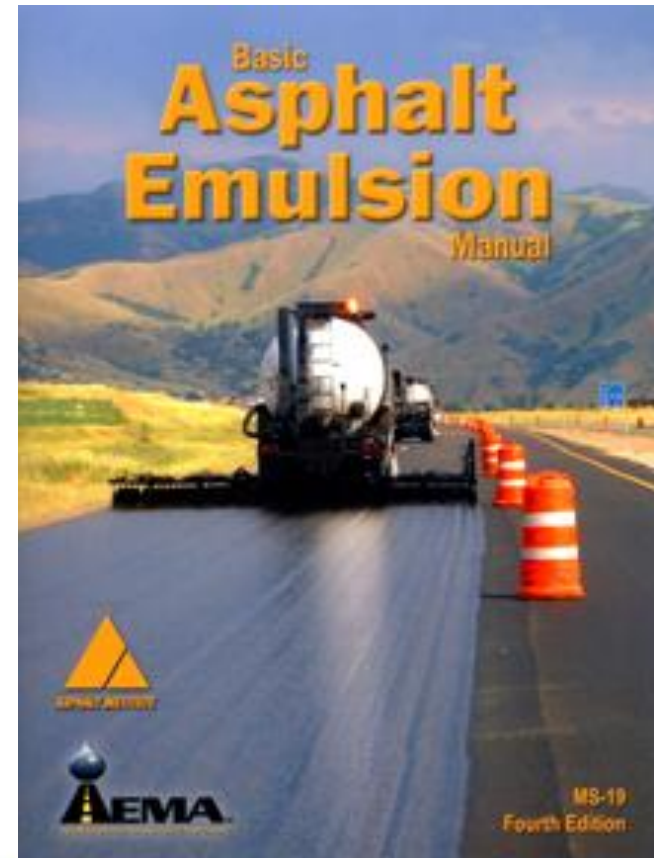
Testing of Tack/Bond Emulsions

- **Presentation Outline**
 - Definition of a bond (tack) coat
 - Typical Products and Application
 - Review of two Bond Coat Studies
 - Something Old and Something New
 - Emulsion and Residue Testing
 - Performance Related Testing
 - ❖ Tracking
 - ❖ Bond Strength



Tack/Bond Coat Definition

- **Basic Asphalt Emulsion Manual (Fourth Edition)**
 - A bond coat is a very light spray application of diluted asphalt emulsion. It is used to promote a bond between the existing surface and the new asphalt application.



Types of emulsions used

- **CSS-1h, CSS-1, SS-1h, SS-1**
 - These emulsions chosen for their stability and miscibility with dilution to water.
 - The base asphalt is chosen for the climate conditions and is usually similar, to slightly harder (more viscous), than the paving grade.
 - Polymers traditionally not used do to the lack of understanding as to what they could provide for the application
 - Cost/benefit
 - Polymers too sticky and create tracking scenarios



Tack Coat Emulsion Testing

- **What does the emulsion need to do?**
 - Be low enough viscosity to spray and cover properly
 - Meet Sieve (oversized particle) testing to not plug spray nozzles
 - Storage Stability/Settlement – to allow storage for the time required
 - Breaking time to allow paving in the required time frame



Tack/Bond Coat

What to look for – rates and precautions

- **Typical Rates**

- Application rate (emulsion) is usually 0.05-0.10 Gal/yd² of a 30-50% residue emulsion (diluted just prior to application)

- **Precautions**

- Dry/clean pavement
- Application rate for a thin uniform coating of emulsion
- Dilution of emulsion to aid in the uniform distribution
- Emulsion should be broken (brown to black in color), usually determined by application rate and environmental conditions.



Tack/Bond Coat

What to look for – rates and precautions

- **Precautions – More on application rate**
 - Proper amount for the surface
 - Is it asphalt rich or dry?
 - Is it a milled surface?



Slippage/Shear Cracks



Tack/Bond Coat Application

Proper Spraying - Even



Uneven or “Stripped”



Illinois Tack Coat Study - 2009

- SS-1hP, RC-70, & PG64-22
- Application rates (residual)
 - 0.02, 0.04, and 0.09 gal/yd²
- Highlighted Findings:
 - Recommended 0.04 gal/yd² residual application rate
 - SS-1hP and PG64-22 showed better rut resistance than RC-70
 - Uneven tack coat showed worse rut resistance



TACK COAT OPTIMIZATION FOR HMA OVERLAYS: ACCELERATED PAVEMENT TEST REPORT



LTRC TRB Paper – 2002

AMAP Presentation – 2008 (NCHRP 9-40)

Dr. Louay Mohammad

- CRS-2P, CSS-1, SS-1, & SS-1h + 2 binders – PG64-22 & PG7622M
- Application rates (residual)
 - 0, 0.02, 0.05, 0.1 & 0.2 gal/yd²
- Highlighted Findings:
 - 25 and 55°C Test Temperatures
 - CRS-2P was the best tack coat type, for both temperatures, at an application rate of 0.02 gal/yd².

The Influence of Asphalt Tack Coat Materials on the Interface Shear Strength



Tack Coat Residue Testing

Traditional

ASTM Evaporation or Distillation Procedures

Test	Emulsion Type		
	CSS-1	CSS-1h	Modified
Penetration @ 25°C, dmm	100 - 250	40 - 90	40 - 90
Ductility @ 25°C, cm	40 min.	40 min.	
Softening point, °C			60 min.
Elastic Recovery @ 10°C, %			50 min.



Tack Coat Residue Testing

DSR – Low Temperature Evaporation

Sample Id.			Method A	Method B
Phase Angle (delta)	64		72.2	72.4
G*/sin delta @ 10 rad/sec,kPa	64	1.0 min.	7.36	8.59
Phase Angle (delta)	70		75.0	75.0
G*/sin delta @ 10 rad/sec,kPa	70	1.0 min.	3.69	4.38
Phase Angle (delta)	76		77.5	77.5
G*/sin delta @ 10 rad/sec,kPa	76	1.0 min.	1.93	2.25
Phase Angle (delta)	82		79.6	79.6
G*/sin delta @ 10 rad/sec,kPa	82	1.0 min.	1.05	1.20
Phase Angle (delta)	88		81.0	81.3
G*/sin delta @ 10 rad/sec,kPa	88	1.0 min.	0.60	0.67

Method A - 24 hours at 25°C – 24 hours at 60°C

Method B – thin film – 6 hours at 60°C



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ROAD TRIP: DRIVING THE MESSAGE FOR CHANGE

Tracking Test Procedures

What is being looked at?

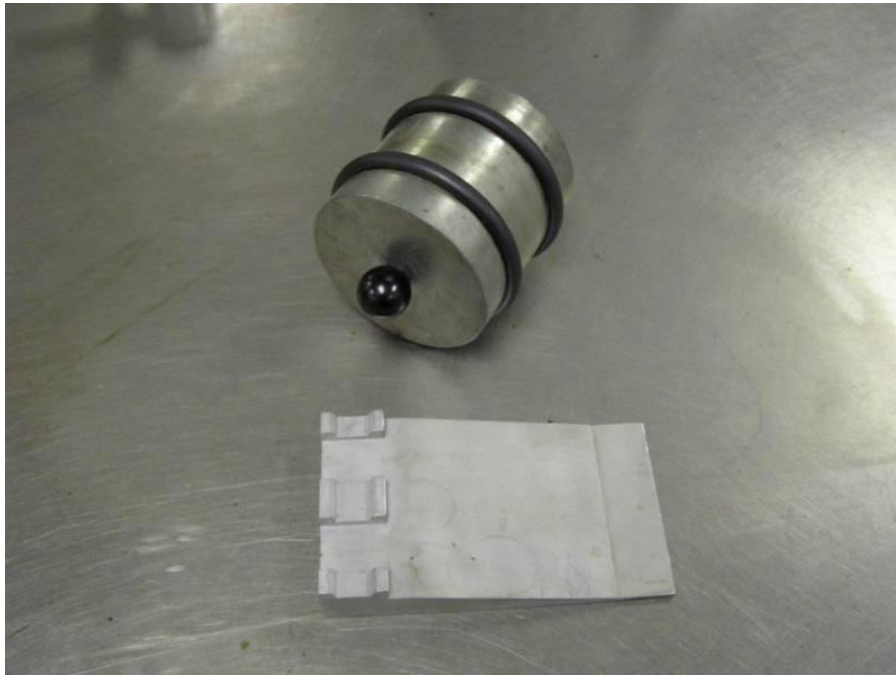
- **Variation on ASTM D711**
 - Information regarding Virginia DOT procedure
- **Modifications to improve the procedure**
 - Wheel changes
 - Drawdown adjustment
 - Felt paper consistency issues



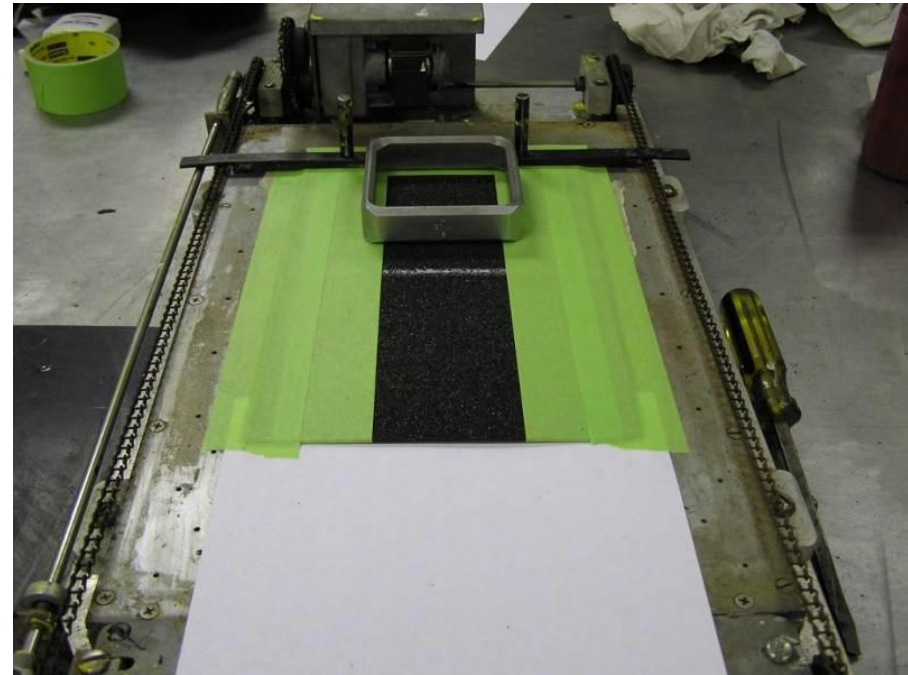
Tracking Testing

Example of ASTM D711 Equipment

Tracking Wheel



Drawdown Apparatus



Information from VADOT TRB Paper: Clark, Rorrer & McGhee



Tracking Test Procedure

Modified to reduce variability

- **Procedure**

- 30 lb roofing felt is glued to a particle board using a spray adhesive
- 0.015" thickness of emulsion is drawn down on the felt paper – wide enough for three test times
- Sample is cured at a specific temperature and time intervals prior to testing
- At testing interval, 10 lb wheel with 4" diameter rubber (cam-lock) rings are rolled across the tack coat onto poster board paper placed on the same thickness of particle board

- **Measurement**

- Visually determine the degree of tracking at each time interval and the time that no tracking appears

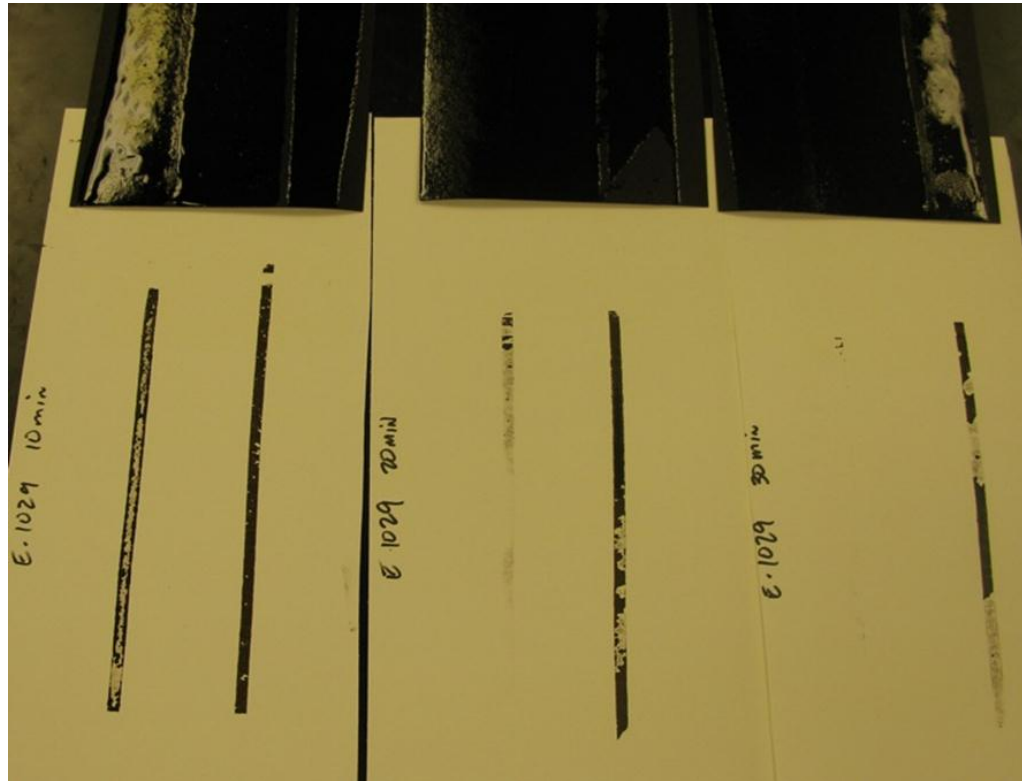


Tracking Testing – Original Procedure

Bond Coat Emulsion with CRS Chemistry

25°C Curing – 10, 20 and 30 Minutes

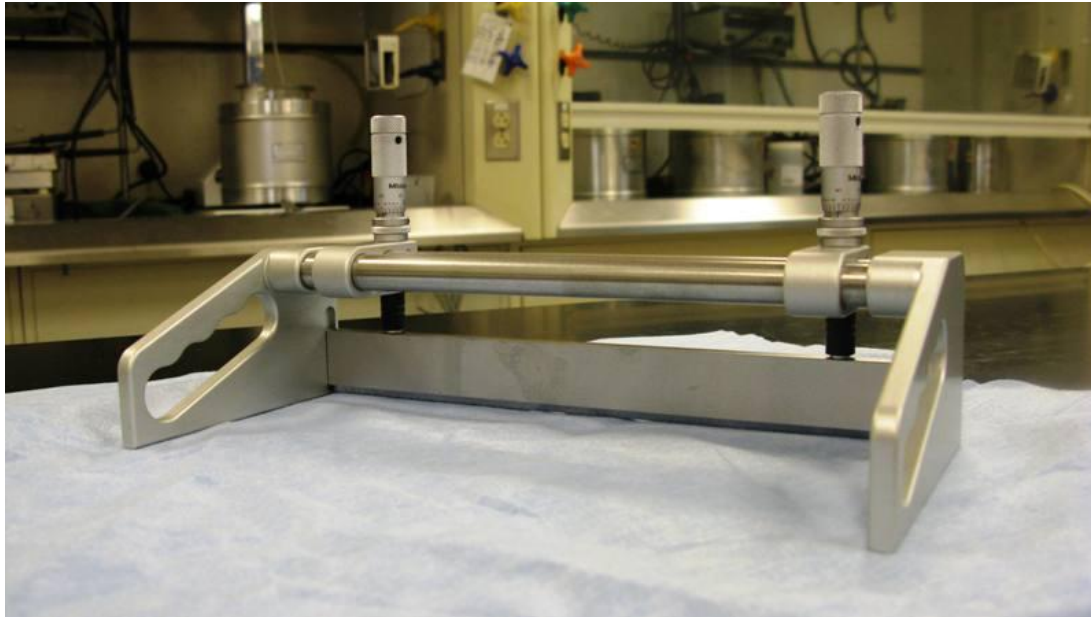
Prior to modification of felt paper to particle board and wider drawdown



Tracking Test Procedure

- **Draw Down Apparatus**

- Can be adjusted easily for varying thicknesses, and wide enough for at least three measurements with the wheel.



Distributor	Film Thickness
0.02 gal/yd ²	0.0036 in.
0.05 gal/yd ²	0.0089 in.
0.10 gal/yd ²	0.0180 in.



Tracking Test Procedure

- **Tracking Wheel**
 - Ten pound stainless wheel that can accommodate two four inch square (cam-lock) o-rings



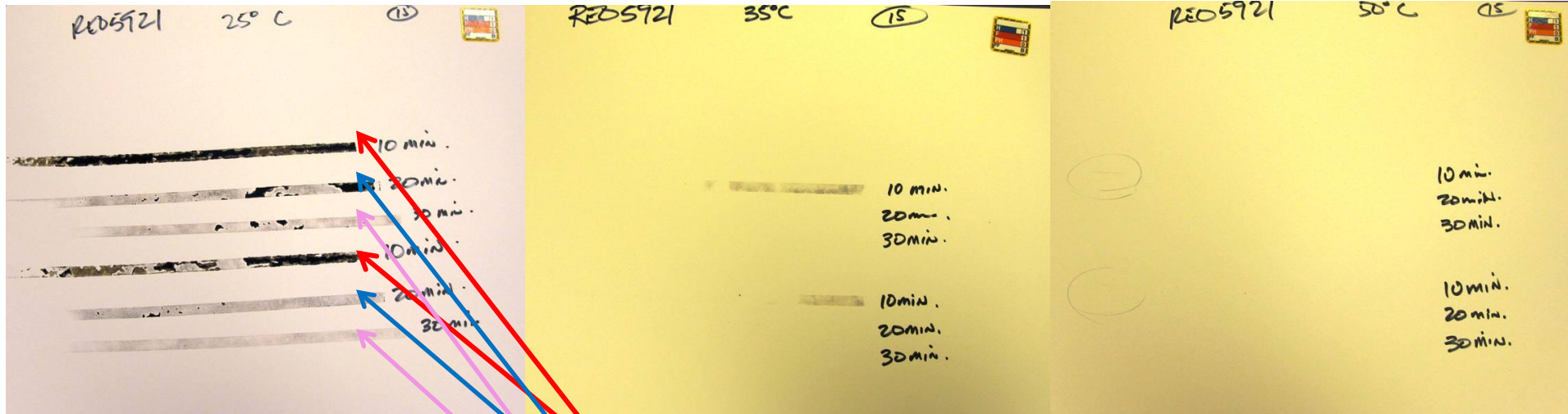
Tracking Testing at various temperatures

Bond Coat Emulsion with CRS Chemistry

Ambient – 25°C

35°C

50°C



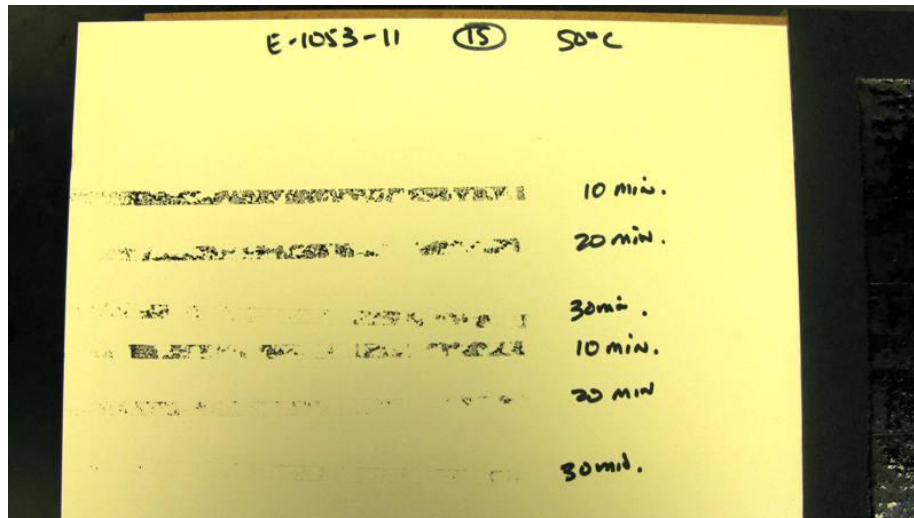
10 Minute
20 Minute
30 Minute



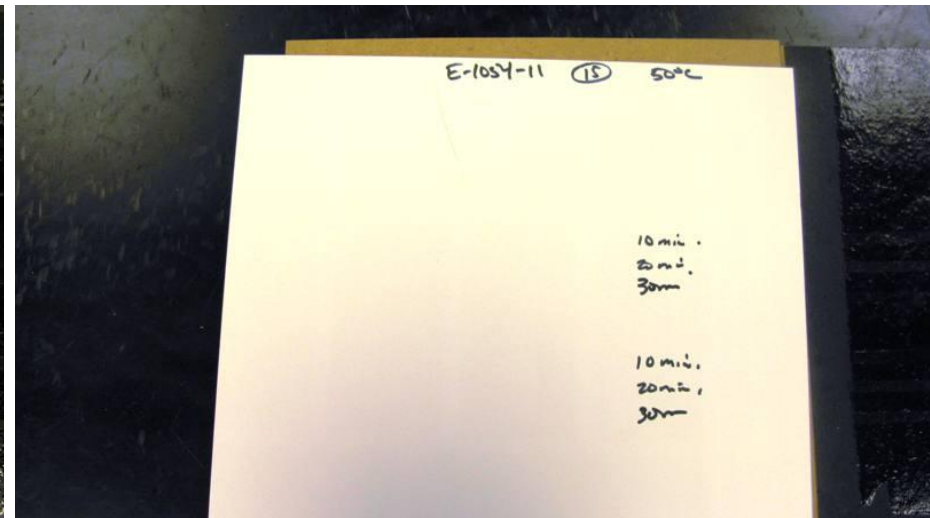
Tracking Testing at 50°C (122°F)

PG58-28 Base – CRS Chemistry

Without Modification



With Modification



Tracking Testing at 60°C (140°F)

PG58-28 Base – Modified & CRS Chemistry

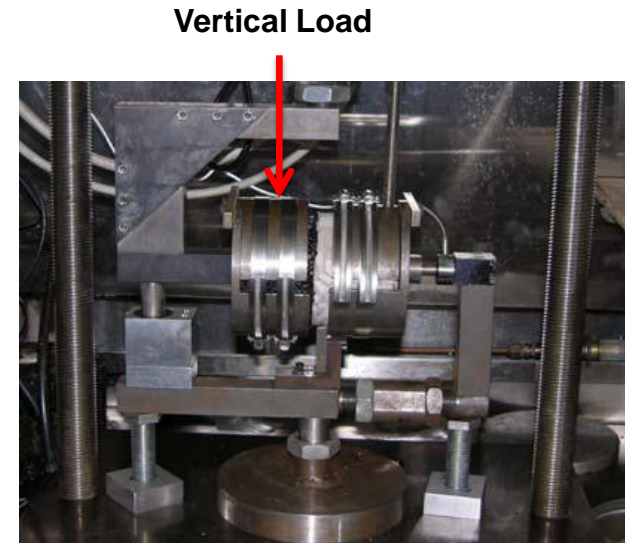
Bond Coat on felt and paper



INTERNAL

Bond Strength Testing

- **Types of Bond strength testing**
 - Shear or tensile
 - Shear testing applies a horizontal force to the pavement section to “shear” the specimen
 - Tensile testing “pulls” the top section away from the existing pavement
- **How strong do you need a bond to be?**
 - Just like gluing or welding two materials together, the strength of the bond needs to be greater than the materials being bonded.



Shear testing



Bond Strength Testing

Florida procedure

- **PG58-28 based emulsion**

- Tack coat at 0.1 Gallon/yd²
- Tested at 25°C
- Bond Strength
 - **182.1 psi (1.26 MPa)**



Bond Strength Testing

Florida procedure

- **PG64-22 – Based Emulsion**

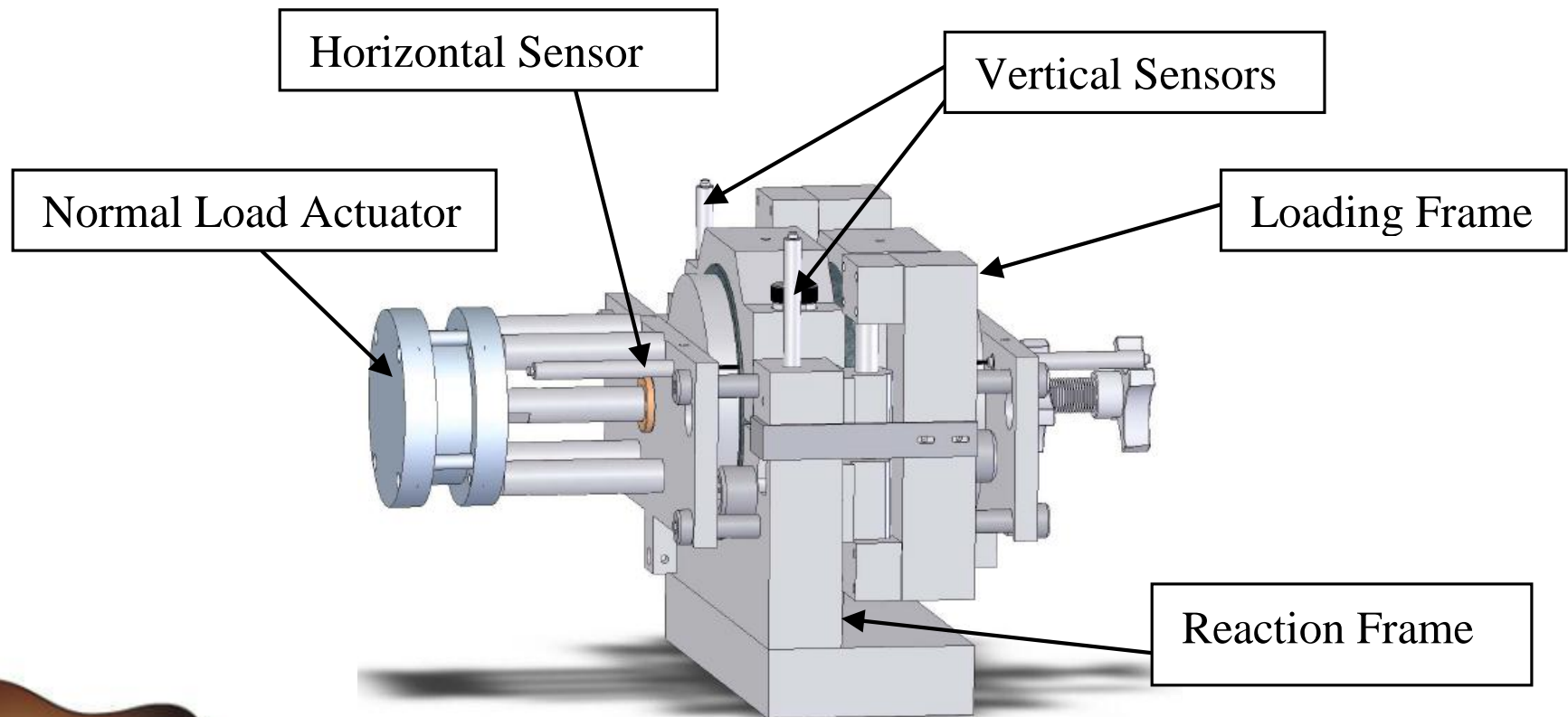
- Tack coat at 0.1 gallon/yd²
- Tested at 25°C
- Bond Strength
 - **207.9 psi (1.43MPa)**



Bond Strength Testing

Louisiana Interlayer Shear Strength Tester

- **Test Apparatus**

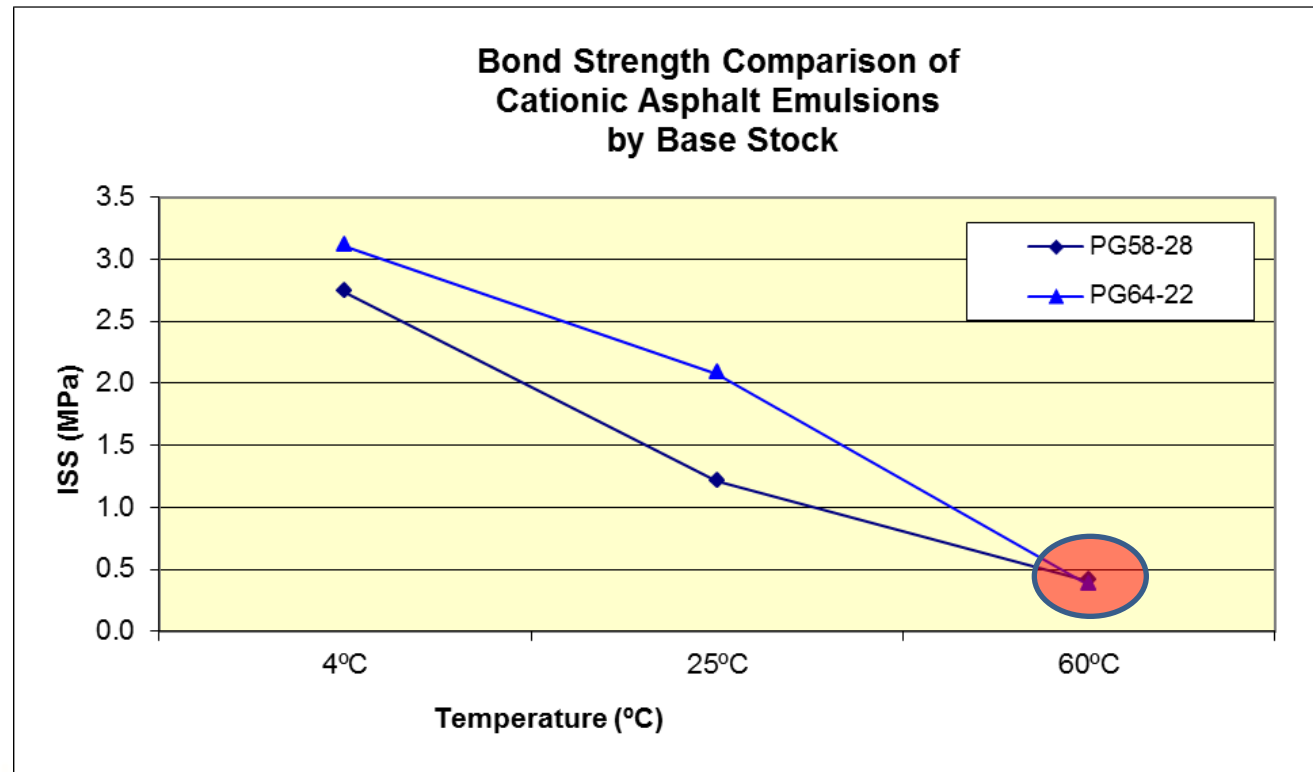


Taken from Louay Mohammad's Draft Test Procedure

Bond Strength Testing

Louisiana Interlayer Shear Strength Tester

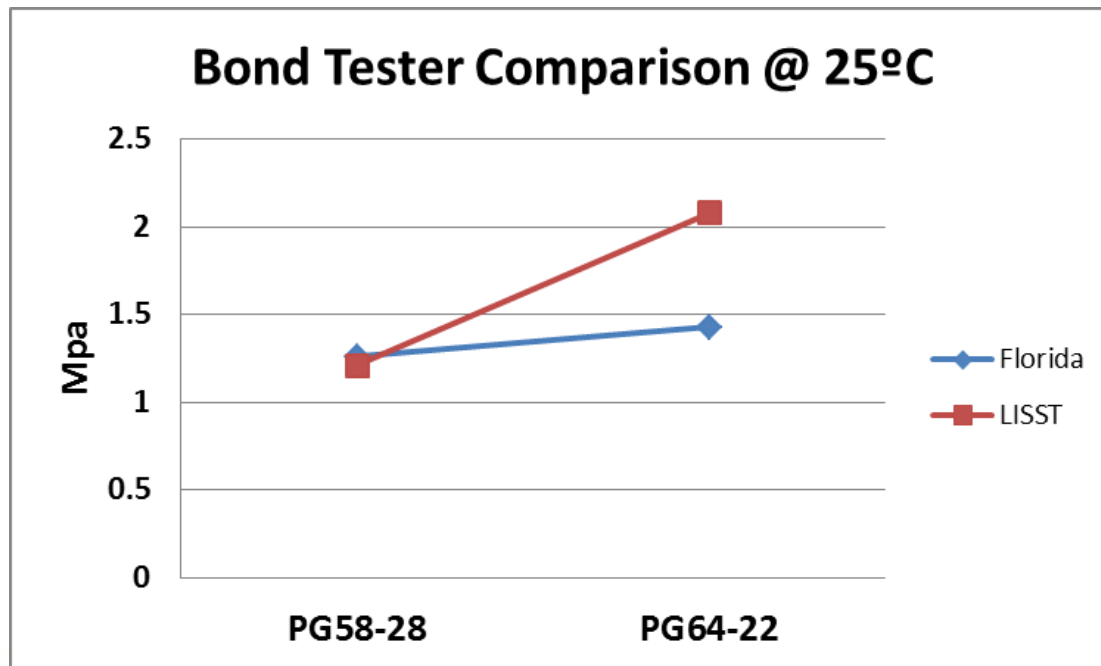
- **PG58-28 and PG64-22 based cationic emulsion**
 - 4, 25 and 60°C Temperatures – 0.05 gal/yd²



Bond Strength Comparison

Florida vs. LISST Procedure

- **Similar Emulsion Manufactured for both**
 - Converted to MPa for both



Florida Data converted to MPa
1MPa = 145 lb/in²

	Emulsion Base	
	PG58-28 MPa	PG64-22 MPa
Florida	1.26	1.43
LISST	1.21	2.08



Additional Resources

- **Basic Asphalt Emulsion Manual**
 - Gives general guidance
- **Asphalt Institute MS-4 (7th Edition)**
 - Gives some information on tack/bond coat applications
- **SFERB Bitumen Emulsions**
 - Chapter 11 deals exclusively with Bond coats
 - Discusses polymer modified and rapid-setting bond coat emulsions, as well as the use of breaking agents.



Questions??



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