

Polymers in Pavement Preservation

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National Pavement Preservation Conference

npcc23

IMPACTS AND BENEFITS FROM PAVEMENT PRESERVATION
September 18-21 • J.W. Marriott Hotel • Indianapolis, Indiana



**MICHIGAN STATE
UNIVERSITY**



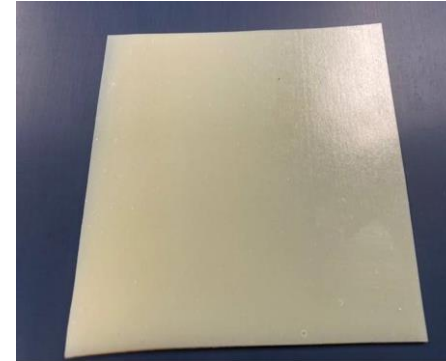
Outline

- **What Polymers are used?**
- **Handling of Polymers**
- **Effect of Performance with Polymers**
 - **Residual Asphalt testing**
 - **Micro Surfacing**
 - **Chip Seal**

Polymers for Asphalt Emulsion Modification

▶ Latex Types

- SBR
- Neoprene
- Natural Latex
- Acrylics



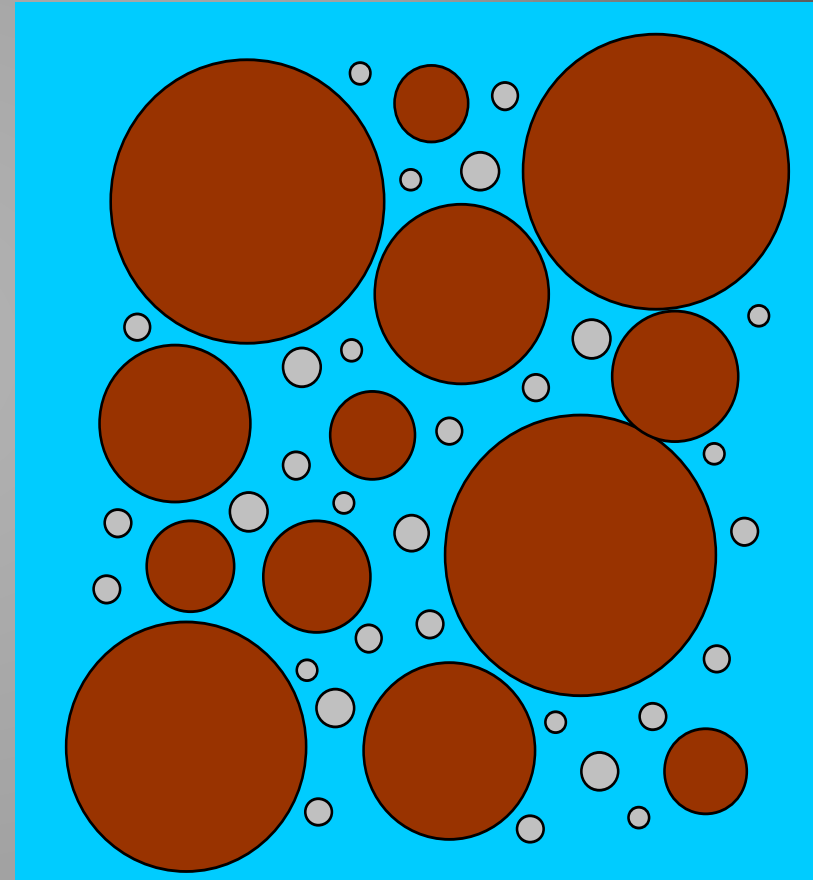
▶ Dry Polymers

- SBS
- EVA
- Ground tire rubber (GTR)



Latex Modification of Asphalt Emulsions

- ▶ **Add latex external to asphalt**
 - **Methods**
 - soap batching
 - co-milling – asphalt or soap
 - post addition – **NOT RECOMMENDED**
 - **Polymers** – SBR, Natural latex, Neoprene
 - **Lower asphalt viscosity**
 - **No special mill, handling**
- ▶ **Polymer in water phase**
- ▶ **Continuous polymer film formation on curing**

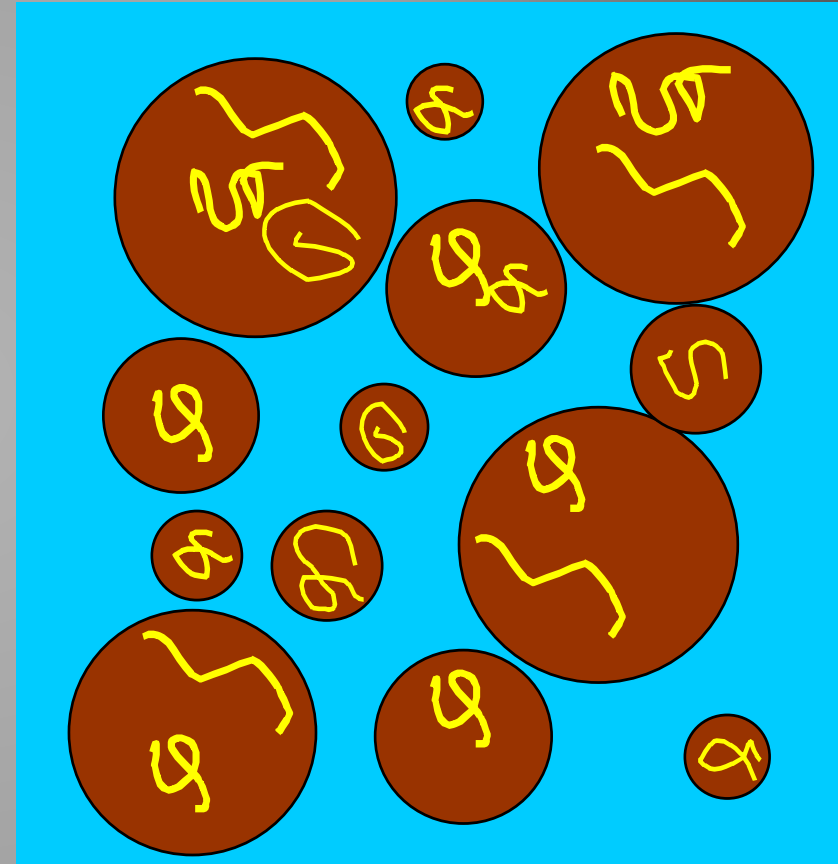


Latex Separation Example in Asphalt Emulsions



Polymer Modified Asphalt in Emulsion Production

- ▶ **Emulsify polymer modified asphalt**
 - “Pre-modified” emulsion
 - Polymers – SBS, SB-, EVA
 - Higher modified asphalt viscosity
 - higher asphalt + mill temperature
 - Exit temperature > 100°C
 - Heat exchanger, back pressure
- ▶ **Polymer inside asphalt droplet**

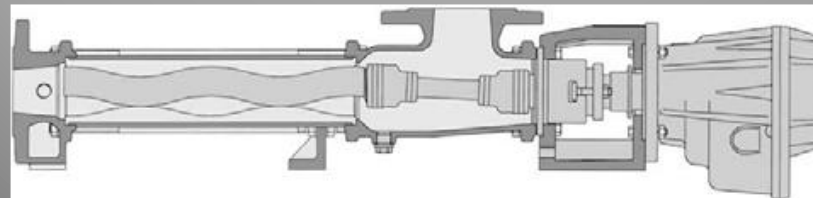


Storage of Latex Dispersions

- **BASF uses both stainless steel (304L or 316 types and fiberglass reinforced polyester (FRP) storage tanks.**
- **Carbon steel tanks may be used.**
 - **Lined or unlined**
 - **Can cause initial discoloration of latex**

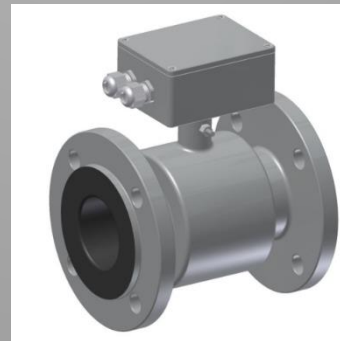
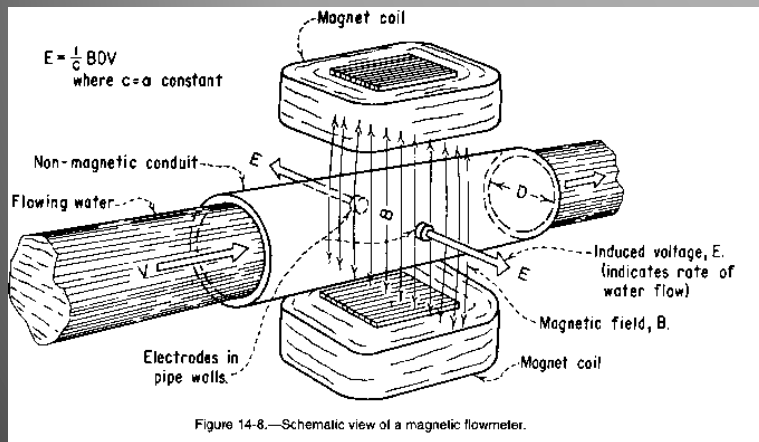
Pumping of Latex Dispersions

- **Air diaphragm pumps are recommended as good multi-purpose dispersion handling and transfer pumps.**
- **Progressive cavity pumps (e.g. Netzsch, Moyno and Seepex) are also used. Provide dual shutdown devices to protect pump against overpressure (e.g. pressure transmitter and high pressure switch).**



Metering of Latex Dispersions

- BASF uses MicroMotion and Endress & Hauser Coriolis mass flow meters for metering of dispersions in pipelines.
- Magnetic inductive flow meters or mass-flow meters are preferred.

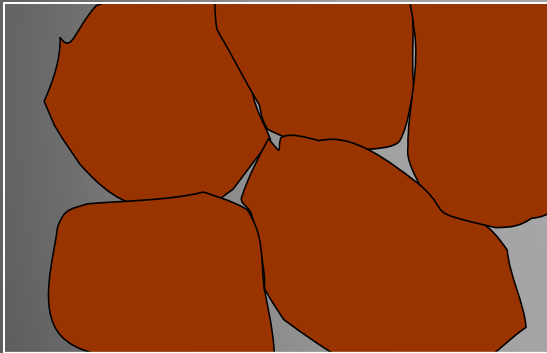


Use of Polymers in Pavement Preservation Applications

Residue Evaluation – Polymer Modified Asphalt vs. Latex Modified Emulsions

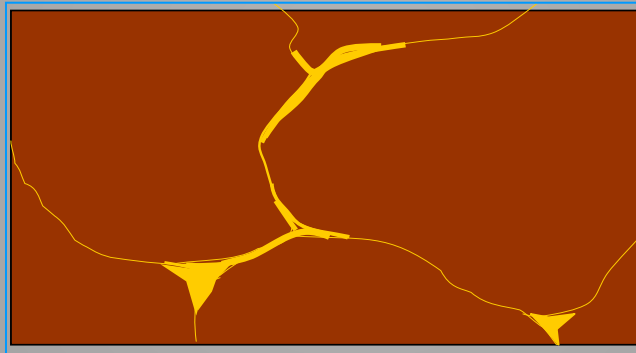
Dried emulsion residues (coalesced asphalt particles)

Neat asphalt



Asphalt rheology only

Latex modified emulsion



Improved binder properties

- Improved low temperature fatigue properties
- Reduced rutting at high temperature
- Improved early strength development

Emulsion of polymer modified asphalt



CRS-2 vs. CRS-2P(LM)

- Physical Properties

	Test Method	CRS-2	CRS-2P
R&B Softening Point (°F)	ASTM D 36	115	128
Ductility (25°C, cm)	ASTM D 113	21	150+
Elastic Recovery (10°C, %)	AASHTO T 301	5	60

3 wt.% SBR latex polymer (on asphalt)

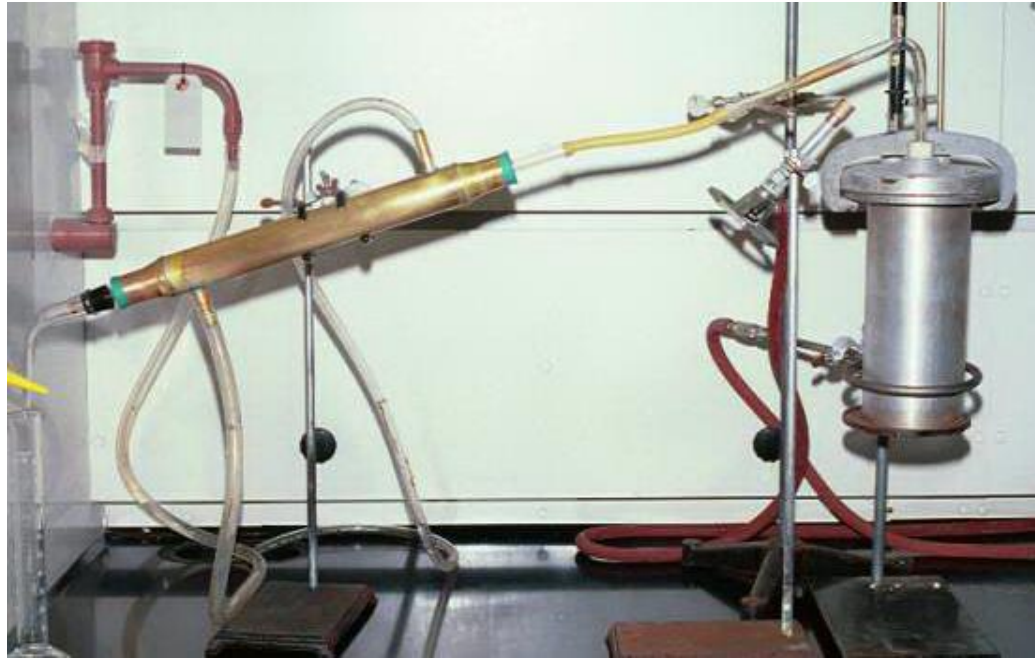
▶ Residue

- ASTM D 6934 – Oven evaporation at 163°C

▶ Polymer

- Raises SP, drastically increases ductility and ER

Residue Recovery



Residue Recovery by Distillation



Residue Recovery by Low Temperature Evaporation

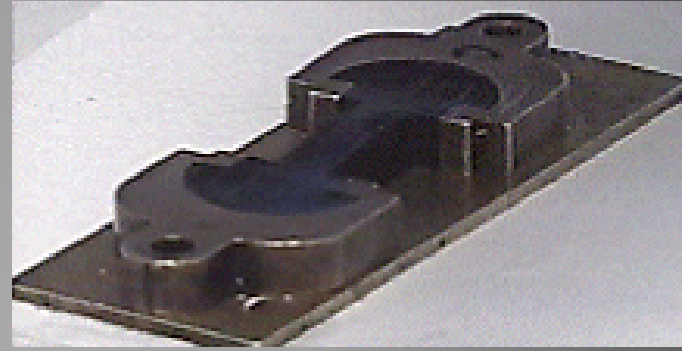
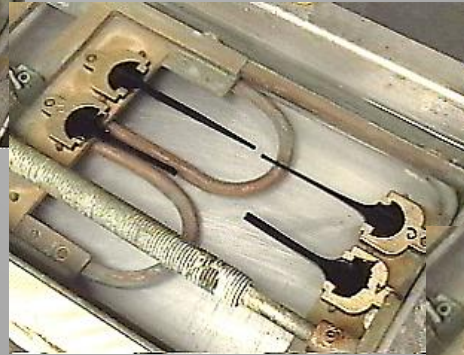
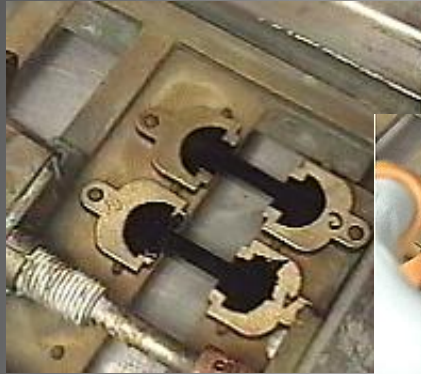
Recovery Methods (High Temperature)

- ▶ **Distillation Recovery procedures**
 - **Modified ASTM D6997 to 350°F or 400°F with hold times either 15 or 20 minutes for modified emulsions**
 - **Temperatures can affect the polymers**
- ▶ **High Temperature Evaporative procedures > 275°F**
- ▶ **Much higher than pavement temperatures that the emulsions see during application or service life**
- ▶ **Polymers can change or degrade in some of the high temperature recovery techniques**

Traditional Testing

- ▶ **Force Ductility**
- ▶ **Softening Point**
- ▶ **Toughness/Tenacity**
- ▶ **Torsional Recovery**
- ▶ **Elastic Recovery**

Elastic Recovery



Unmodified binder doesn't recover

Modified binder does



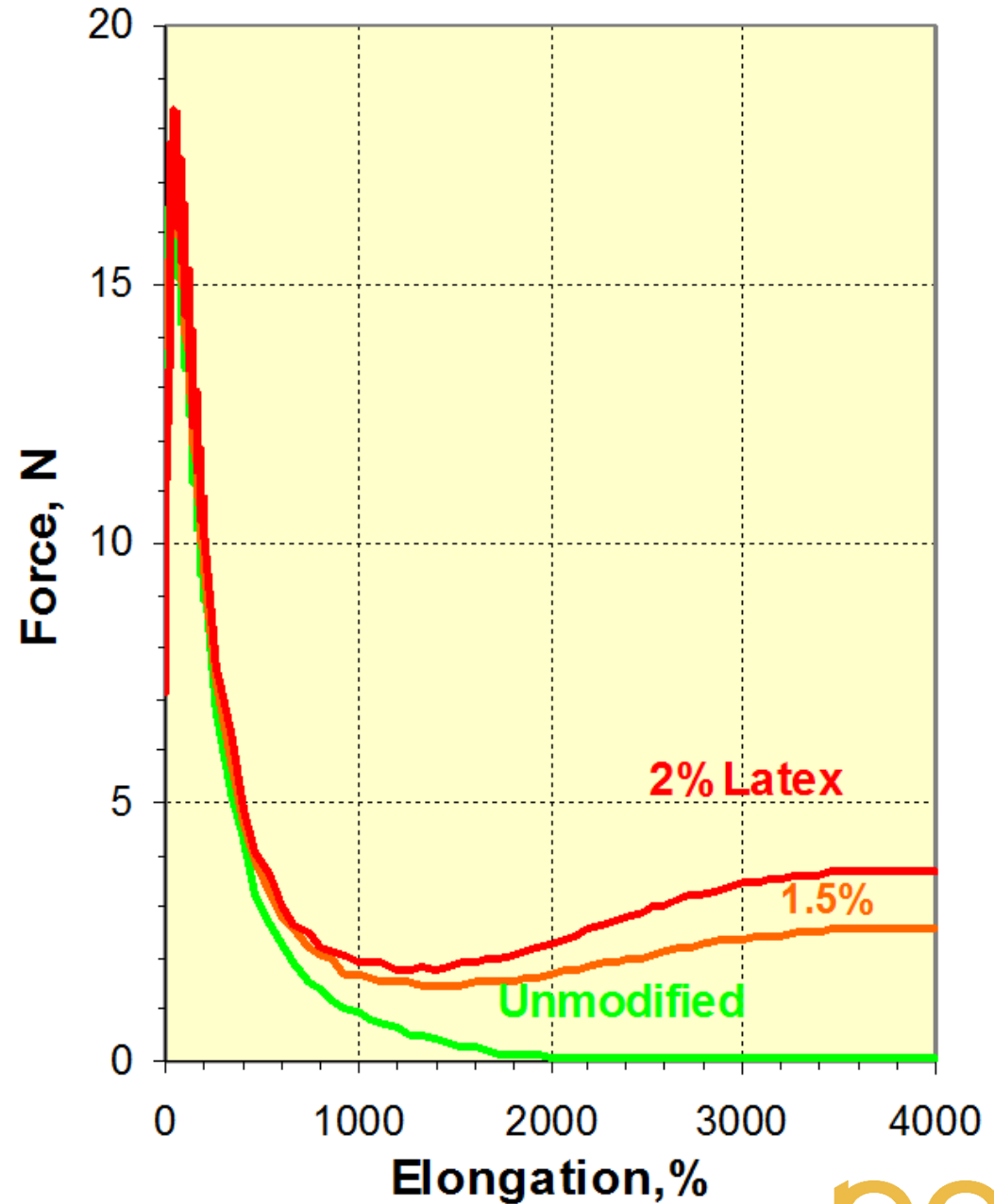
Force Ductility

▶ Stress-Strain measurement

- Easier temperature to measure stress and strain
 - large elongation at break

▶ Does not represent traffic load

- Too high elongation
- Cold
Fracture < Temperature < Fatigue



Ash Content test for emulsion residues

- ▶ **Solubility test does not work well with modified emulsion residues.**
 - Plugs filter due to polymer swell
 - Solubility test was not designed for polymer systems
- ▶ **Ash content test performs well on all emulsion residues, whether they are modified or not**
 - ASTM Standard D8078 was developed for asphalt and asphalt emulsion residues
- ▶ **Getting rid of solubility will remove a chlorinated solvent from some laboratories**
 - Emulsion Task Force drove the change of AASHTO M316 to eliminate solubility, and put in ash content

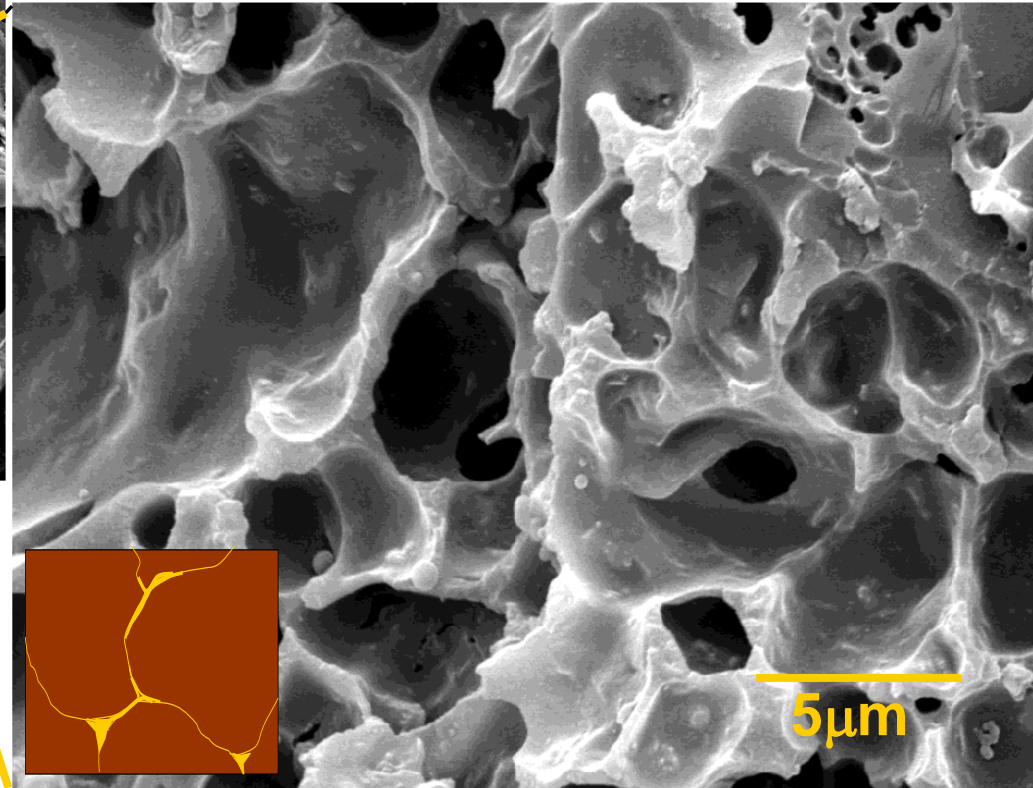
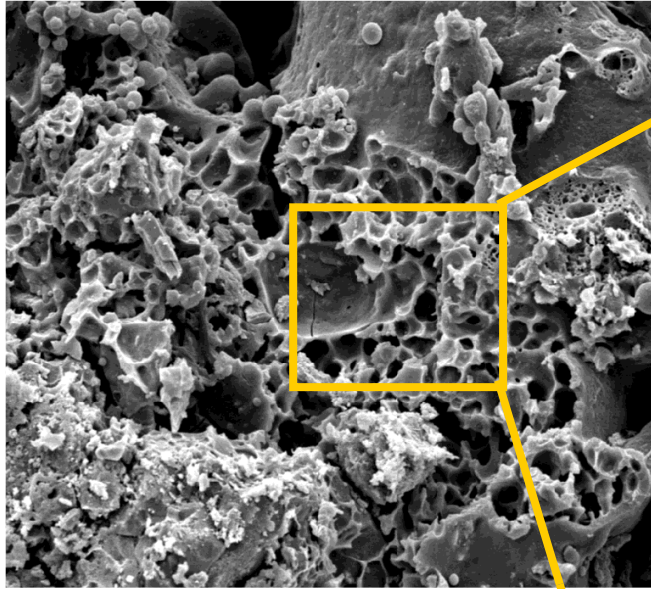
Micro Surfacing



Micro Surfacing

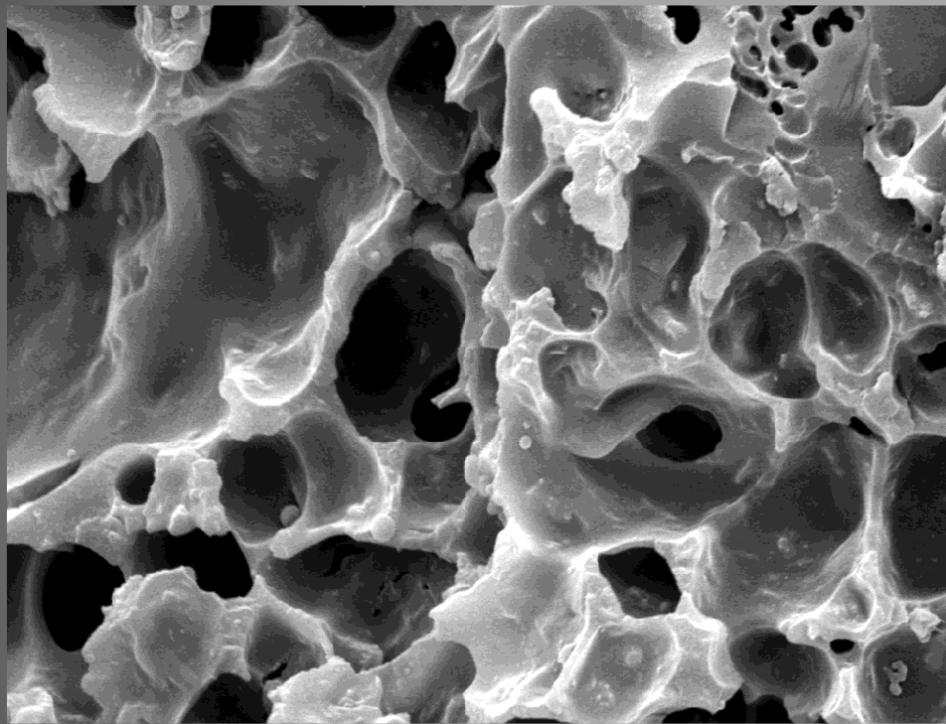


Micro Surfacing – Polymer Morphology Field Application

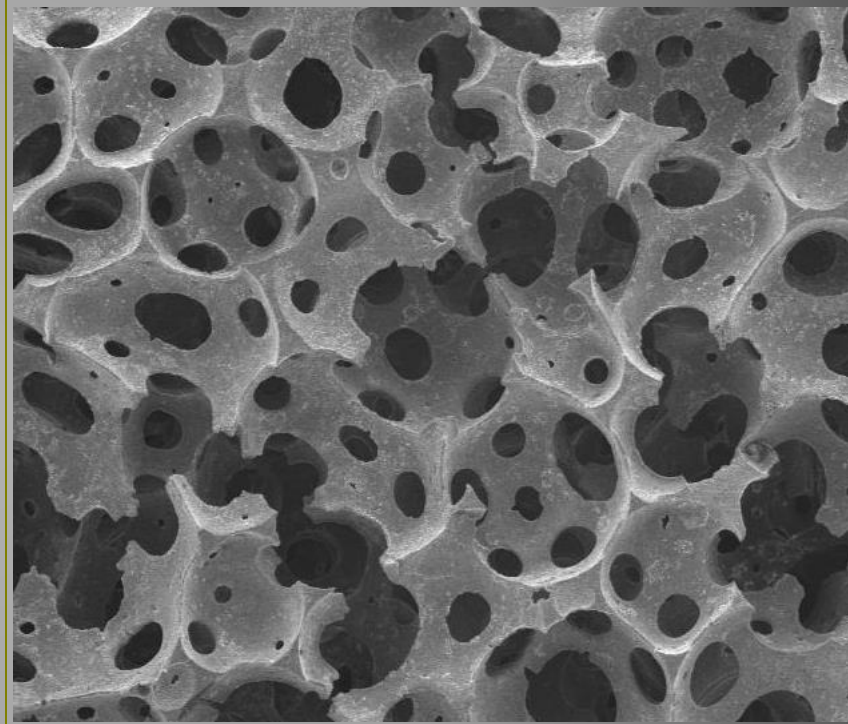


Texas State Highway 84
Near Waco, TX

Cured Latex Polymer Network



Micro Surfacing

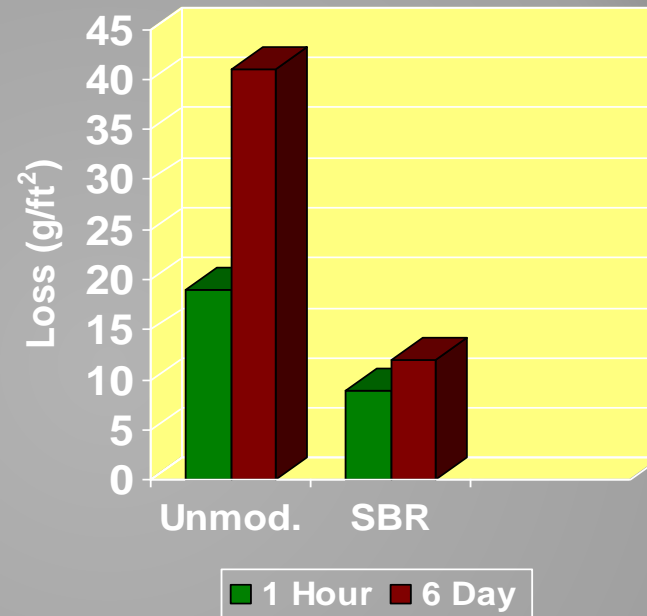


Latex Foam

Wet Track Abrasion Loss ISSA TB-100

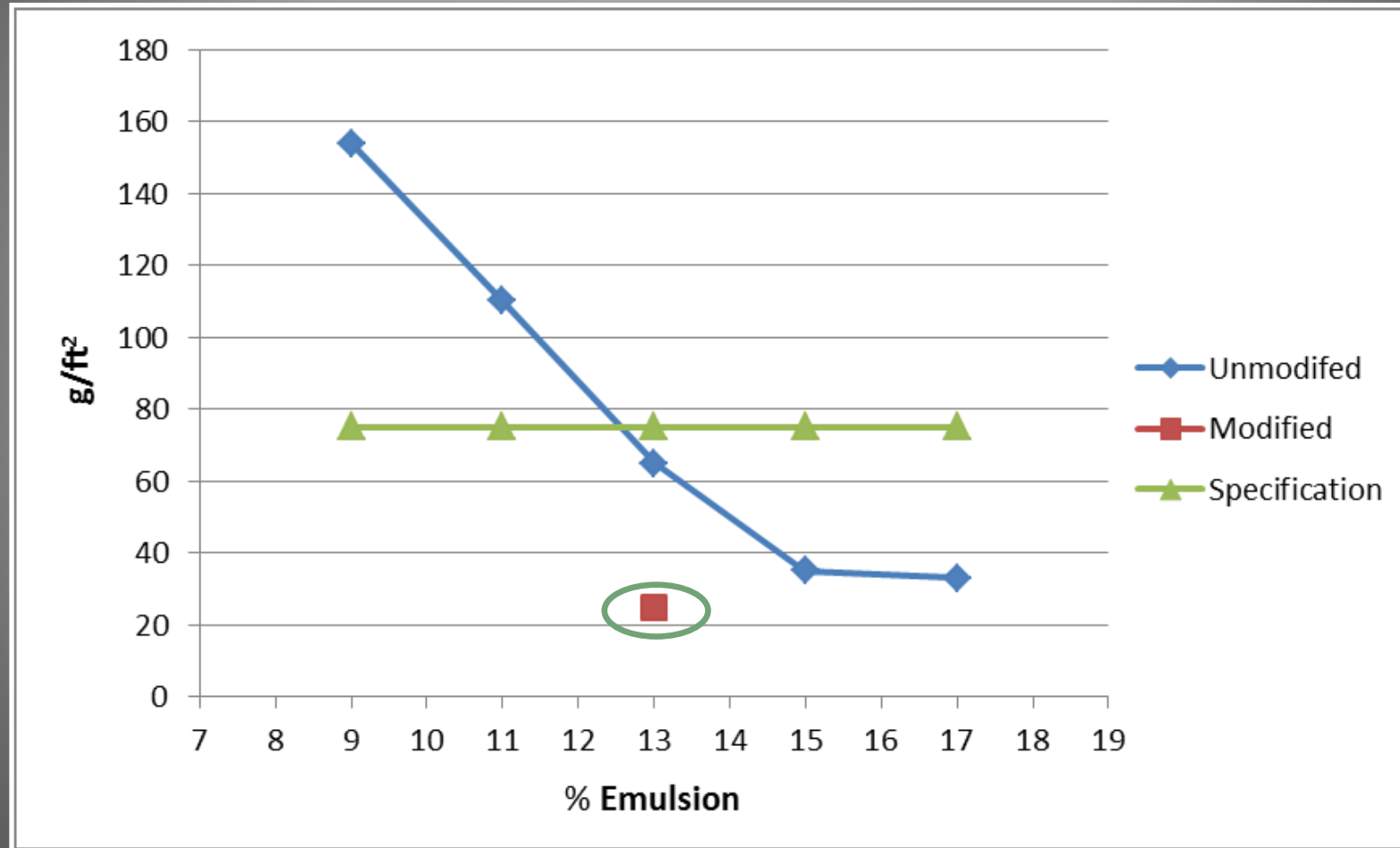
SBR latex polymer

- **50% reduction in loss**
 - one hour soak
- **67% reduction in loss**
 - six day soak
- **Surface of mix**
 - tougher
 - more abrasion res.
- **Adhesion + water resistance**
 - improved



Micro Surfacing WTAT Comparison

One hour unmodified vs. modified



Chip Seal Road



Chip Seal – Emulsion application

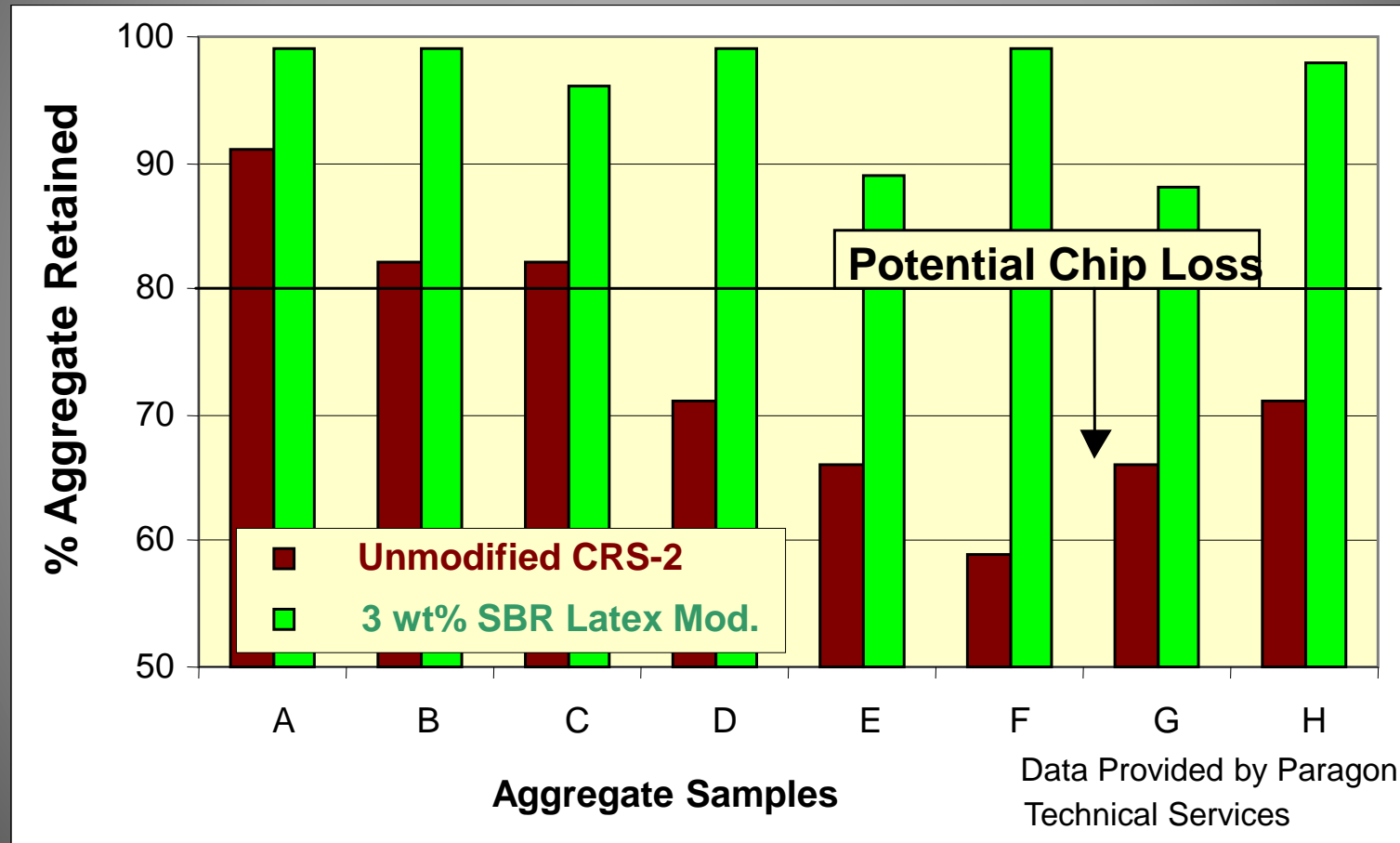


Chip Seal – Aggregate application



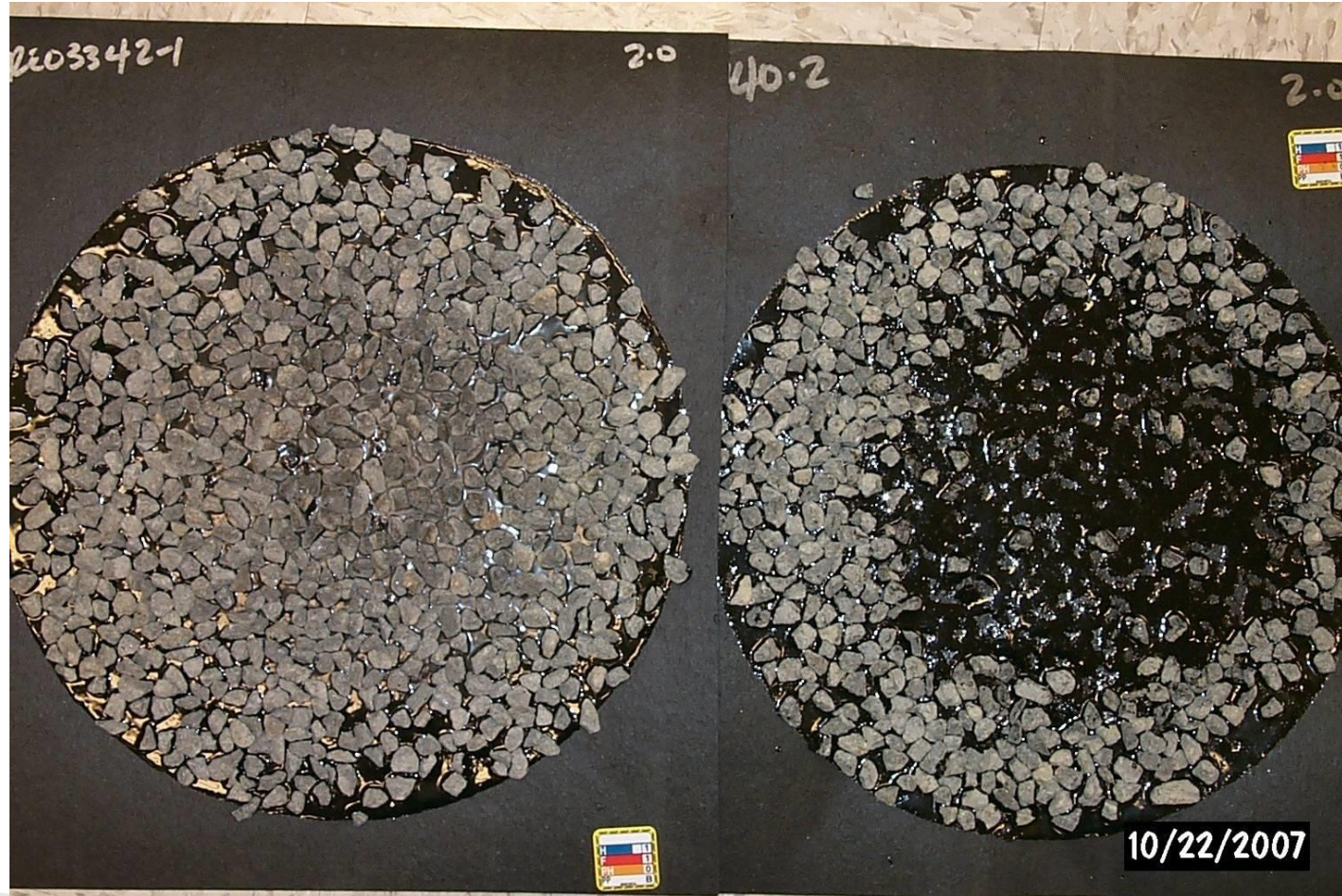
Early Strength Develop. – CRS-2P

ASTM D7000



Sweep Testing – CRS-2 vs CRS-2P

ASTM D7000

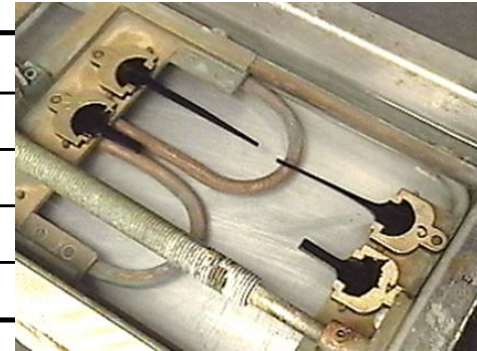


DSR Testing – Polymer comparison

Elastic Recovery and Sweep Testing

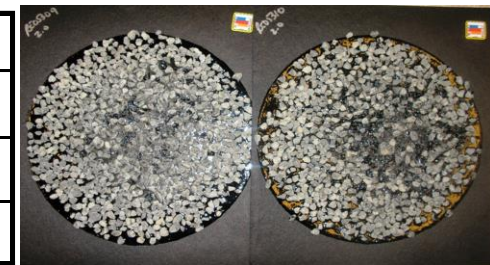
Elastic Recovery @10°C – 350°F Distillation Residue

SAMPLE #	AUT- W	Reference	<i>Polymer A</i>	<i>Polymer B</i>
ER 10C SS 20cm 5mn, %	103	D113 Mod	70.0	78.8
ER 10C SS 20cm 5mn, %	103	D113 Mod	70.0	78.8
ER 10C SS 20cm 5mn, %	103	D113 Mod	70.0	77.5
AVG			70.0	78.3



Sweep Testing @35°C

Sweep Testing		Polymer A	Polymer B
Mass loss % - 2.0 hours	D-7000 - mod	12.05	28.09
Mass loss % - 2.0 hours	D-7000 - mod	20.36	28.32
AVG		16.2	28.2



Mass loss % - 1.0 hour	D-7000 - mod	44.8	44.6
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Benefits of Polymer Modified Asphalt Emulsions

- **Overall improvement in performance + durability**
- **Reduced life cycle cost – preserve pavement**
- **Cost-effective (vs.HMA) access to other applications**
 - Chip Seal Surface dressings for high volume roads
 - Micro Surfacing

Questions?



Speaker: Arlis Kadrmas – BASF

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