Hydrated Lime
A Multi-functional Additive for Asphalt Pavements

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Adhesion & Cohesion of Asphalt in Pavement
Cheyenne, Wyoming
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Contributions of Hydrated Lime to Asphalt Pavements

- Aggregate/ asphalt bond
  - Alter aggregate surface chemistry
    - Improve compatibility
  - Improve surface energy components
- Active filler
  - Reacts with acid components of asphalt
  - Retards oxidation rate of many asphalts
  - Improves fracture toughness
    - Crack pinning
  - Provides mechanical & rheological benefits

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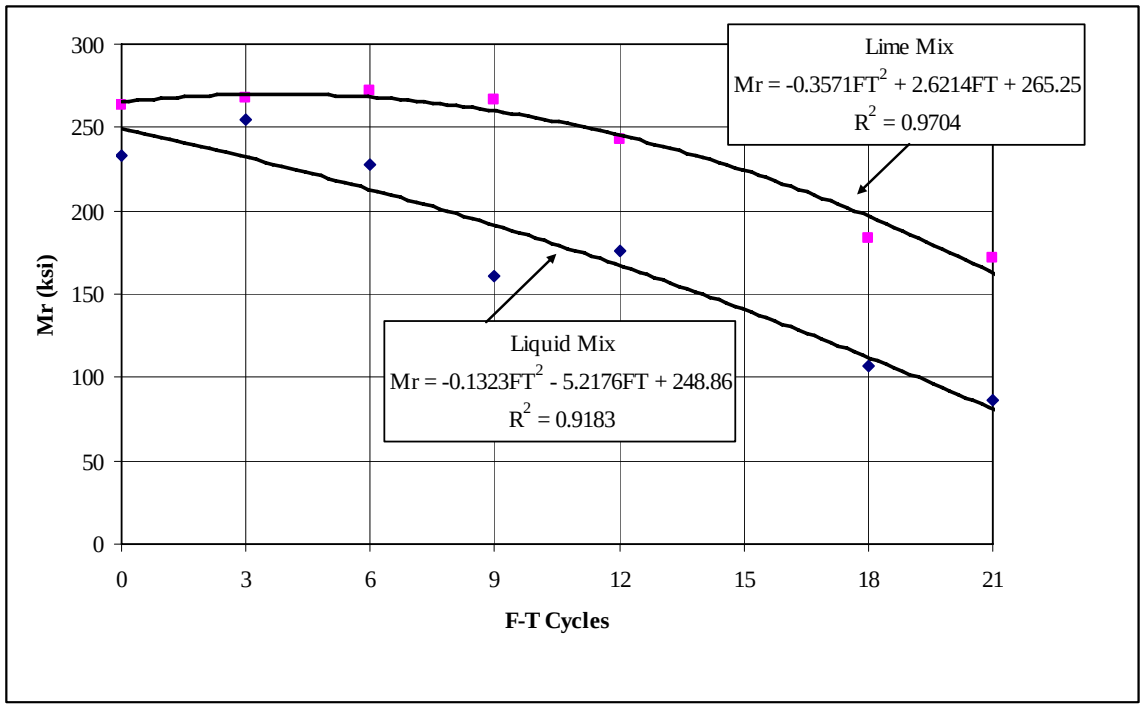
Impact of Multiple Freeze/Thaw Cycling Idaho Transportation Department



Ref: Sebaaly - 2005

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Liquid Mix Cores After 22 F-T Cycles Idaho Transportation Dept.

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Lime Mix Cores After 22 F-T Cycles Idaho Transportation Department

Ref: Sebaaly - 2005

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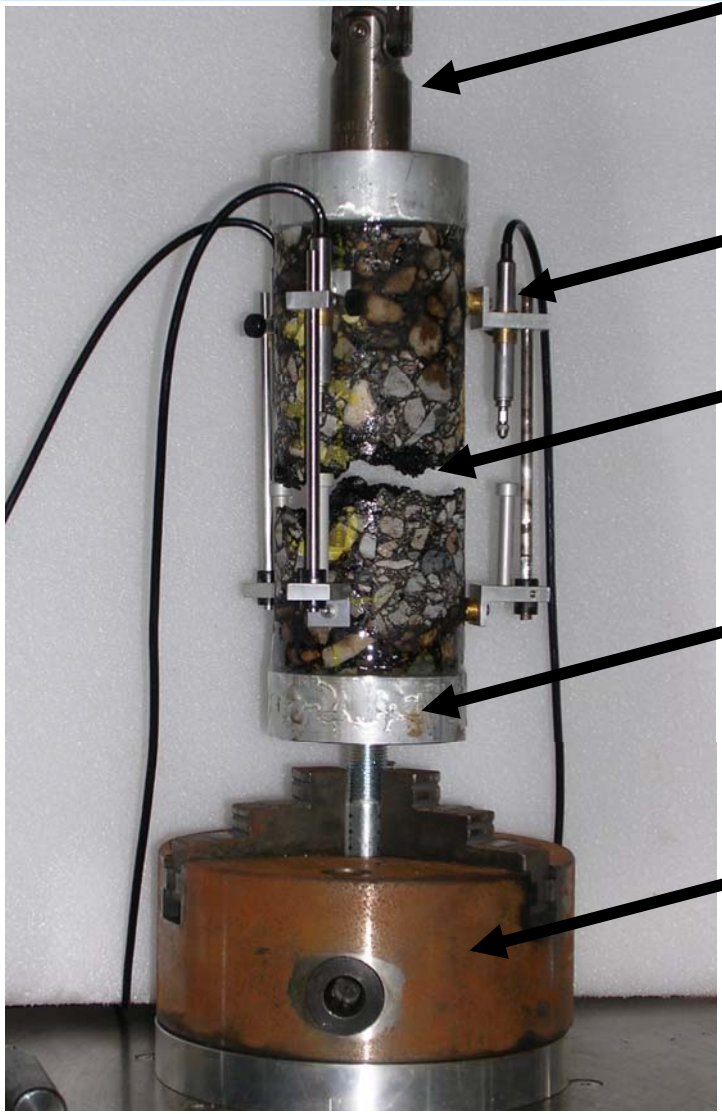
Complex Modulus (E^*) – Tension Test Setup



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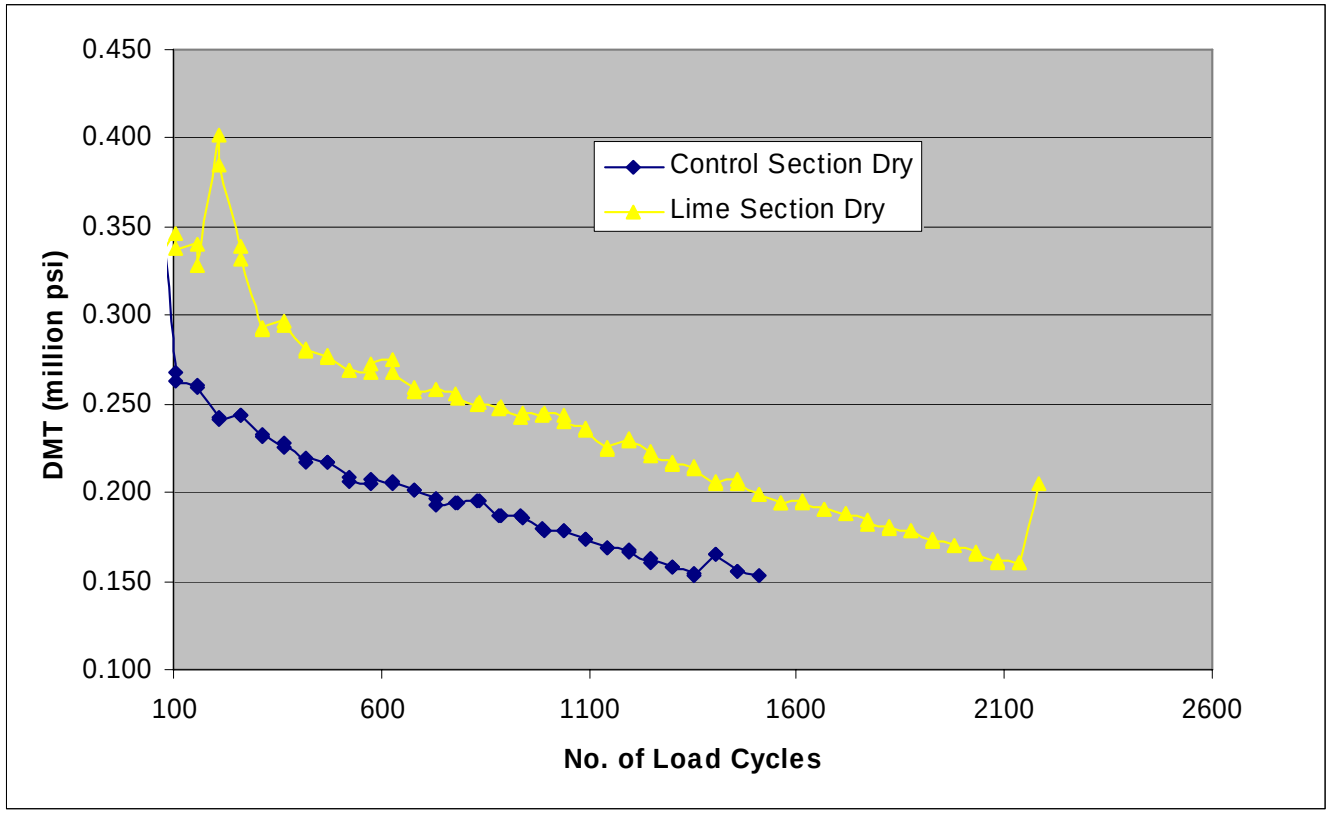
E* (Tension) - Typical Results Idaho Transportation Department



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E* (Tension) in ksi
Idaho Transportation Department

Sample No.	Dry		Moisture Cond.	
	Lime	Control	Lime	Control
1	337	308	265	206
2	354	287	269	171
3	385	320	340	201
4	419	261	330	243
Avg.	374	294	301	205
CV(%)	10	9	13	14

Mixtures tested at 25C & 10 Hz

Ref: Little - 2005

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Phase Angles (Tension)
Idaho Transportation Department

Sample No.	Dry		Moisture Cond.	
	Lime	Control	Lime	Control
1	26.20	26.50	28.70	31.40
2	21.40	24.10	24.10	37.70
3	23.00	27.20	23.80	29.60
4	26.20	28.70	26.50	27.20
Avg.	24.20	26.63	25.78	31.48
CV(%)	10	7	9	14

Mixtures tested at 25C & 10 Hz

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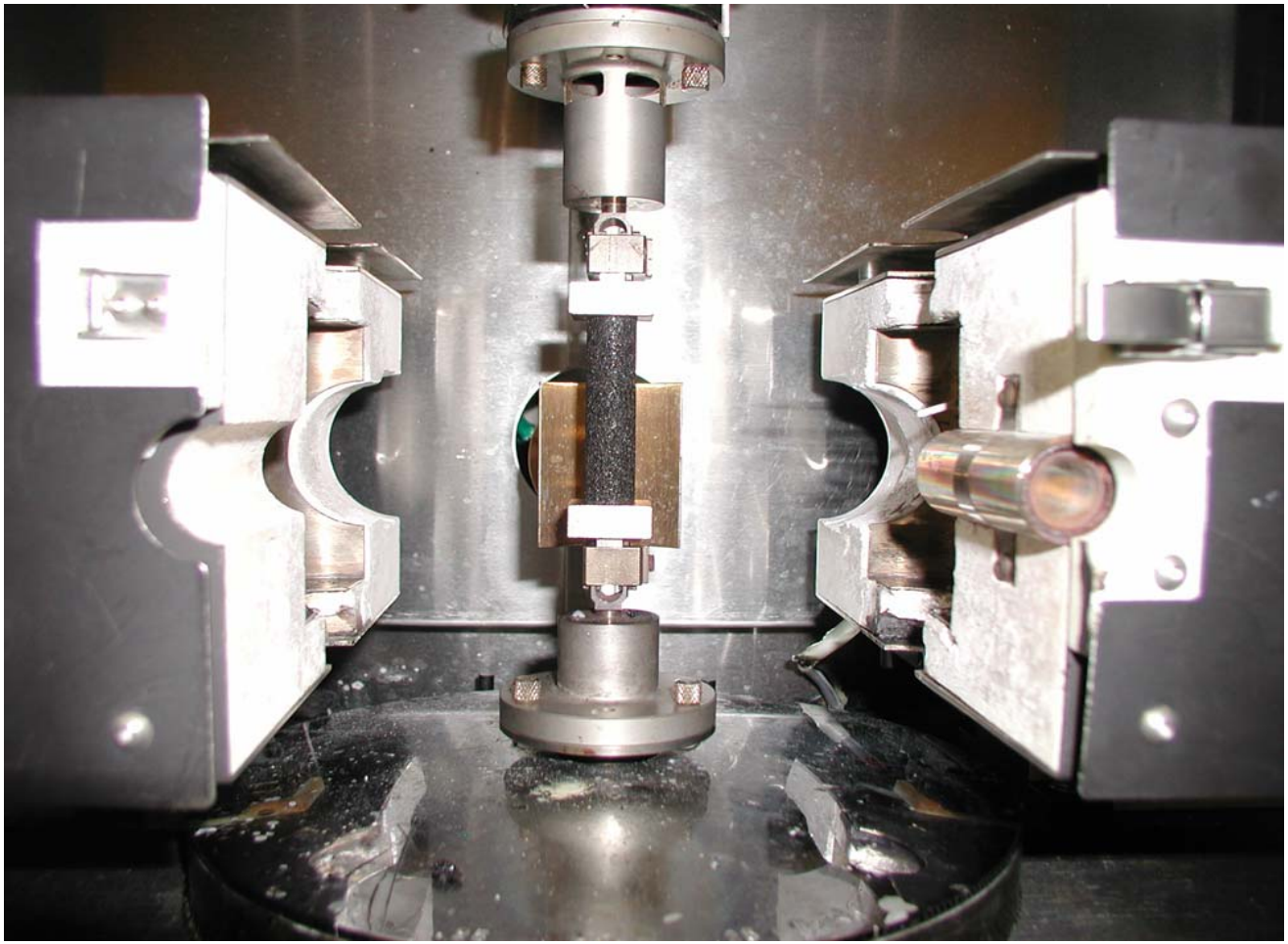
DMA Testing Apparatus Intermediate Temperature (25°C)



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Impact of HL on Cycles to Failure (dry and wet)

Asphalt	Mineral Filler	N_f (dry)	N_f (wet)
AAM-1	Limestone	4,000	2,100
AAM-1	Hydrated Lime	8,200	6,200
AAD-1	Limestone	5,200	2,500
AAD-1	Hydrated Lime	10,000	8,500

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Repeated Load Permanent Deformation Testing (Dry and Near Saturation)

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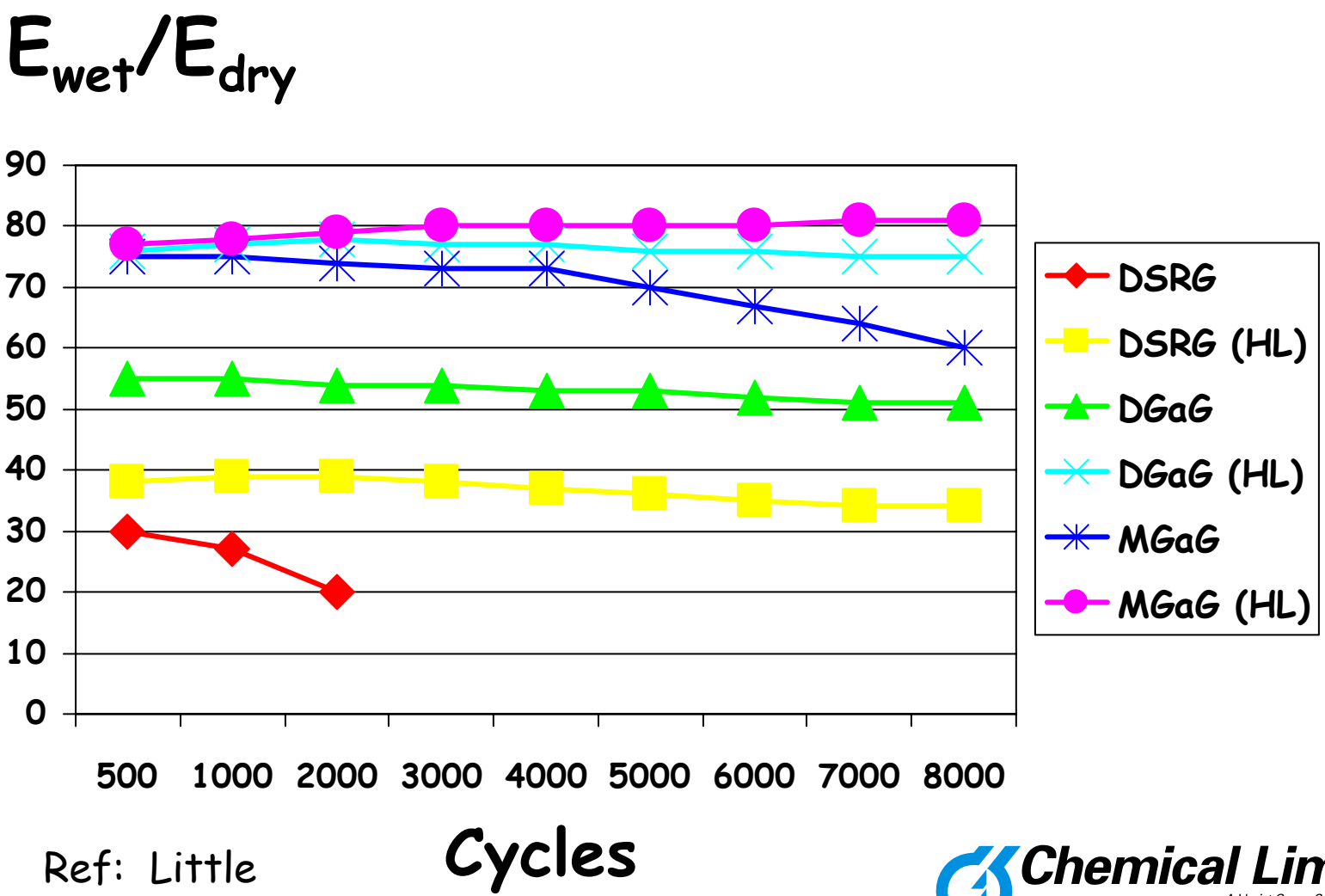
E_{wet}/E_{dry} in Repeated Load Testing (85% Saturation)



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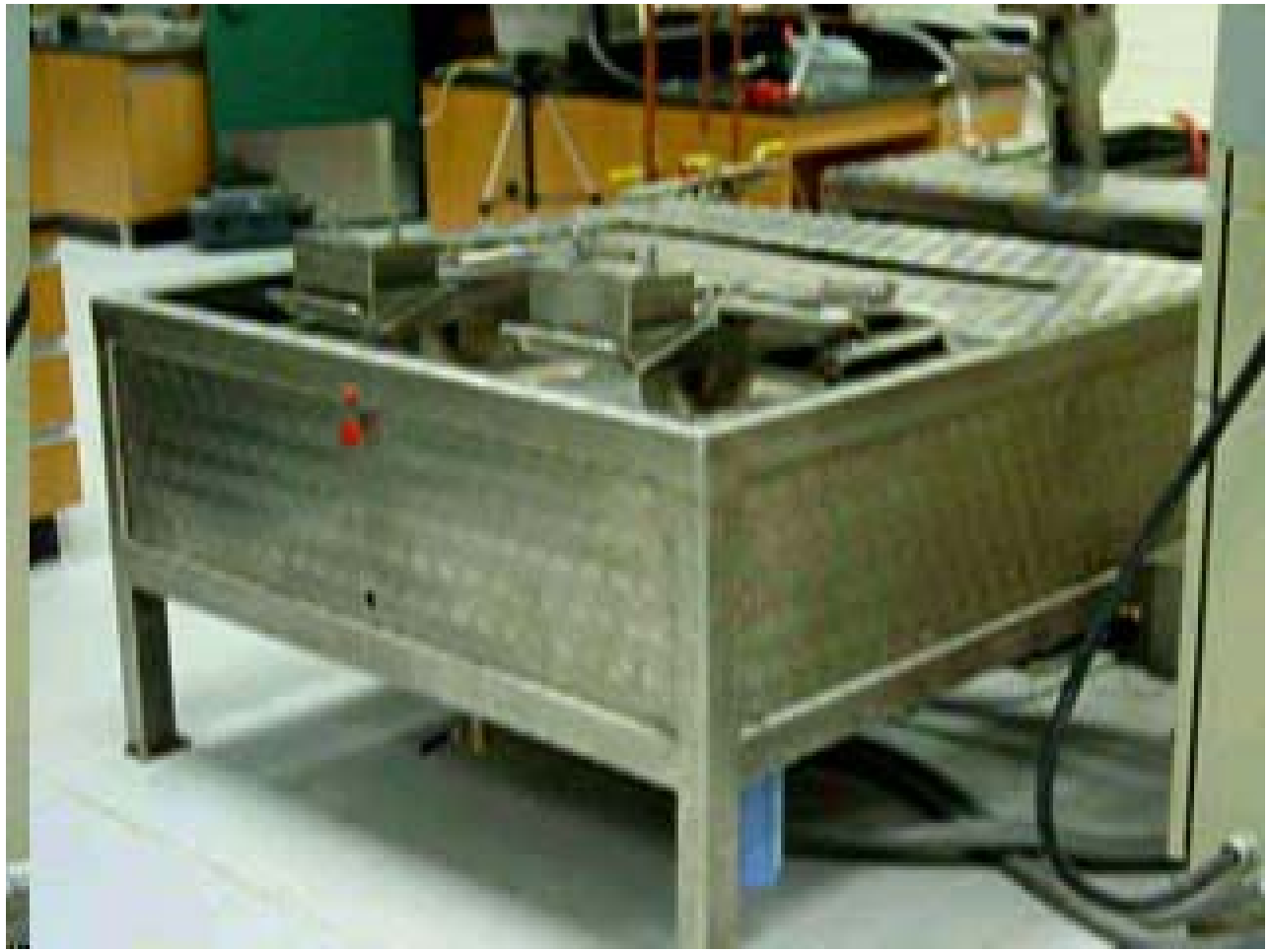
Hamburg Wheel Tracking Device



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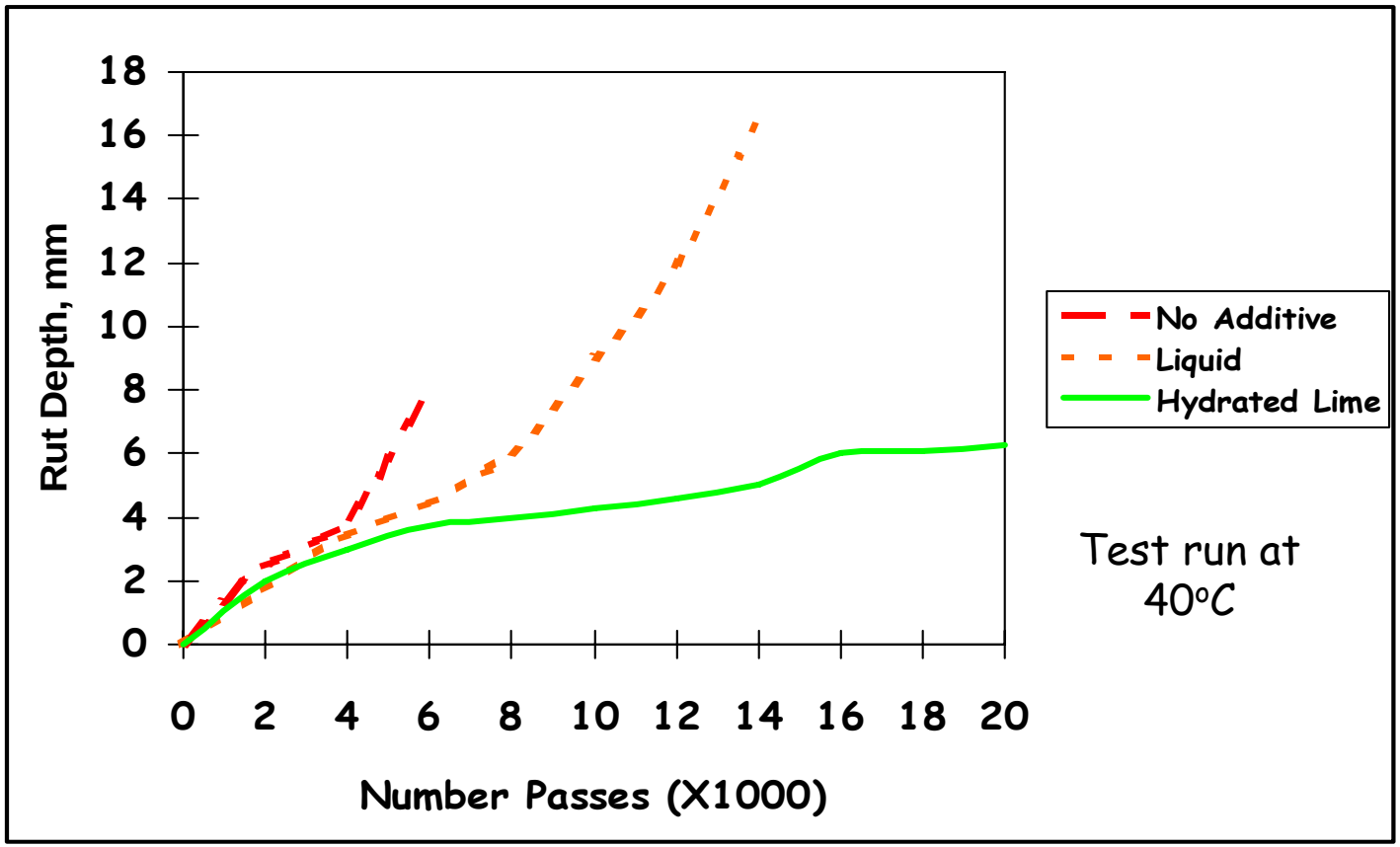
Moisture Sensitivity/ Rutting (1)

- **Hamburg Wheel - Corpus Christi Gravel**



Ref: Texas Department of Transportation

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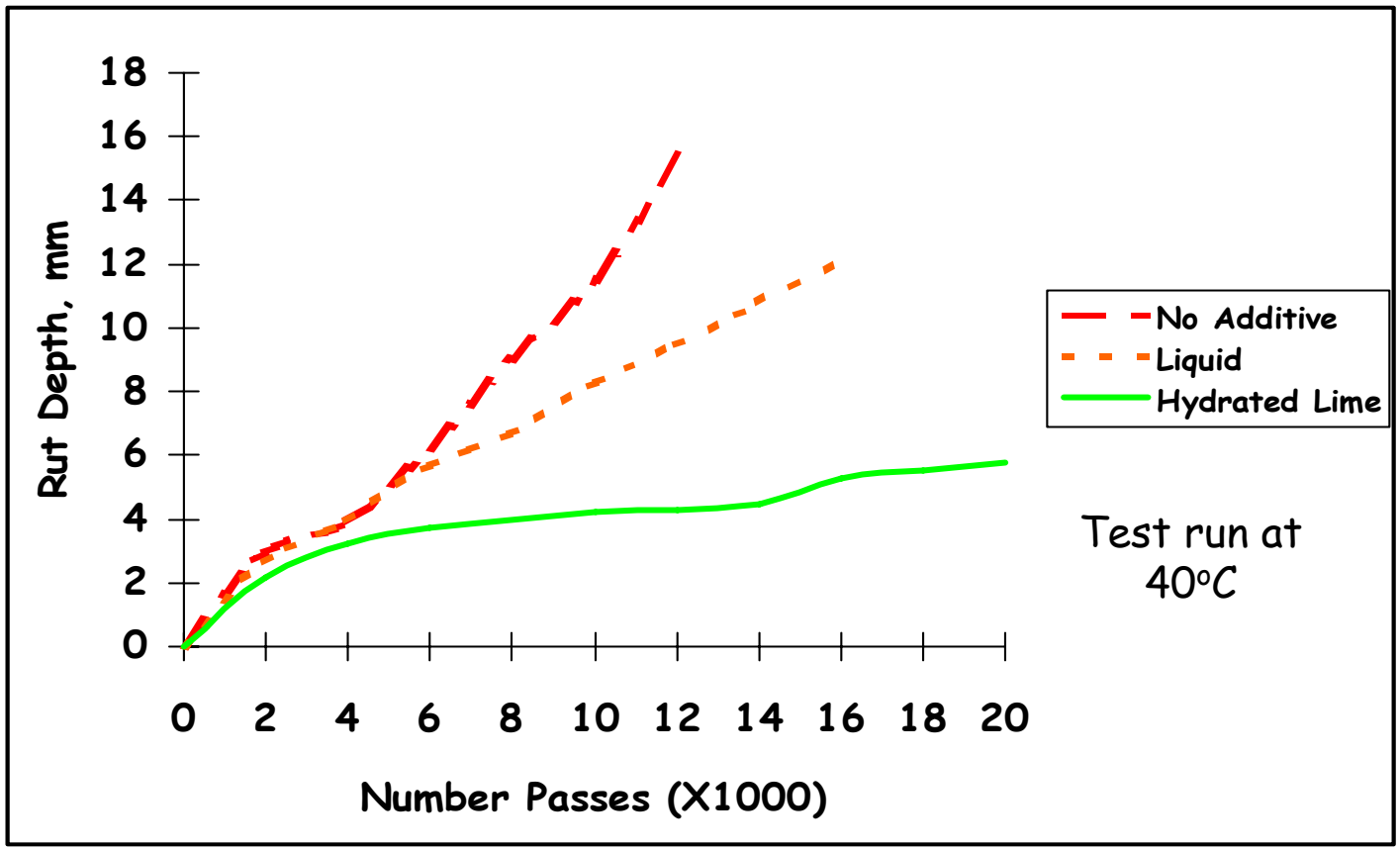
Moisture Sensitivity/Rutting (2)

- **Hamburg Wheel - Basalt Mixtures**



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Stripping Susceptible Mix

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EFFECT OF LIME TREATMENT ON OXIDATIVE AGE HARDENING

Asphalt	Aging Index	
	Untreated	Lime Treated
Boscan	214	27
California Coastal	134	52
W. Texas-Maya Blend	338	52
N. Slope-Maya Blend	90	33

Notes: 1. Aged by TFFAT procedure at 113°C, 72 hours. Lime left in asphalt.

2. Rheological data obtained at 60°C, 15.85 rad/sec for unaged asphalts and 60°C, 0.125 rad/sec for aged asphalts.

Ref: Petersen, Plancher and Harnsberger, AAPT, v. 56, 1987, 632-653.

Hydrated Lime – An Active Filler

- Lime removes molecular agglomerates (lime reactive asphaltenes and pre-asphaltenes) that contain strongly bonding carboxylic acids and 2-quinolone types.
- Benefits:
  - Reduces chemical oxidation rate & viscosity sensitivity to oxidation products.
  - Asphalt is more compatible – fewer asphaltenes
  - Higher tan delta (ratio G″/G′) along with greater stiffness
  - Improved stress releasing flow properties and micro-crack healing
  - Increased low temperature tensile strength and elongation to break
- Result: hydrated lime helps asphalt to maintain better high and low temperature flow properties while aging at a slower rate

Ref: Petersen, Little - 2005

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Life Cycle Benefits – Nevada DOT

- Lime treatment of Nevada's aggregates significantly improves the moisture sensitivity of HMA.
- More resistance to multiple freeze-thaw cycles.
- Improvement in WP and BWP properties indicates that lime helps HMA in resisting the combined effect of environment and traffic stresses. Lime can extend the life of the pavement by an average of 3 years.
- Average increase of 38% in the expected pavement life.
- Increase in cost of only 12%.

Ref: Sebaaly, et al

Global Conclusions

- Hydrated lime has multi-functional benefits:
  - Reduces moisture sensitivity
    - Multiple freeze/thaw cycles
  - Improves fracture characteristics
  - Reduces rate of oxidation in many asphalts
  - Reduces rutting
- Improves life cycle & reduces costs