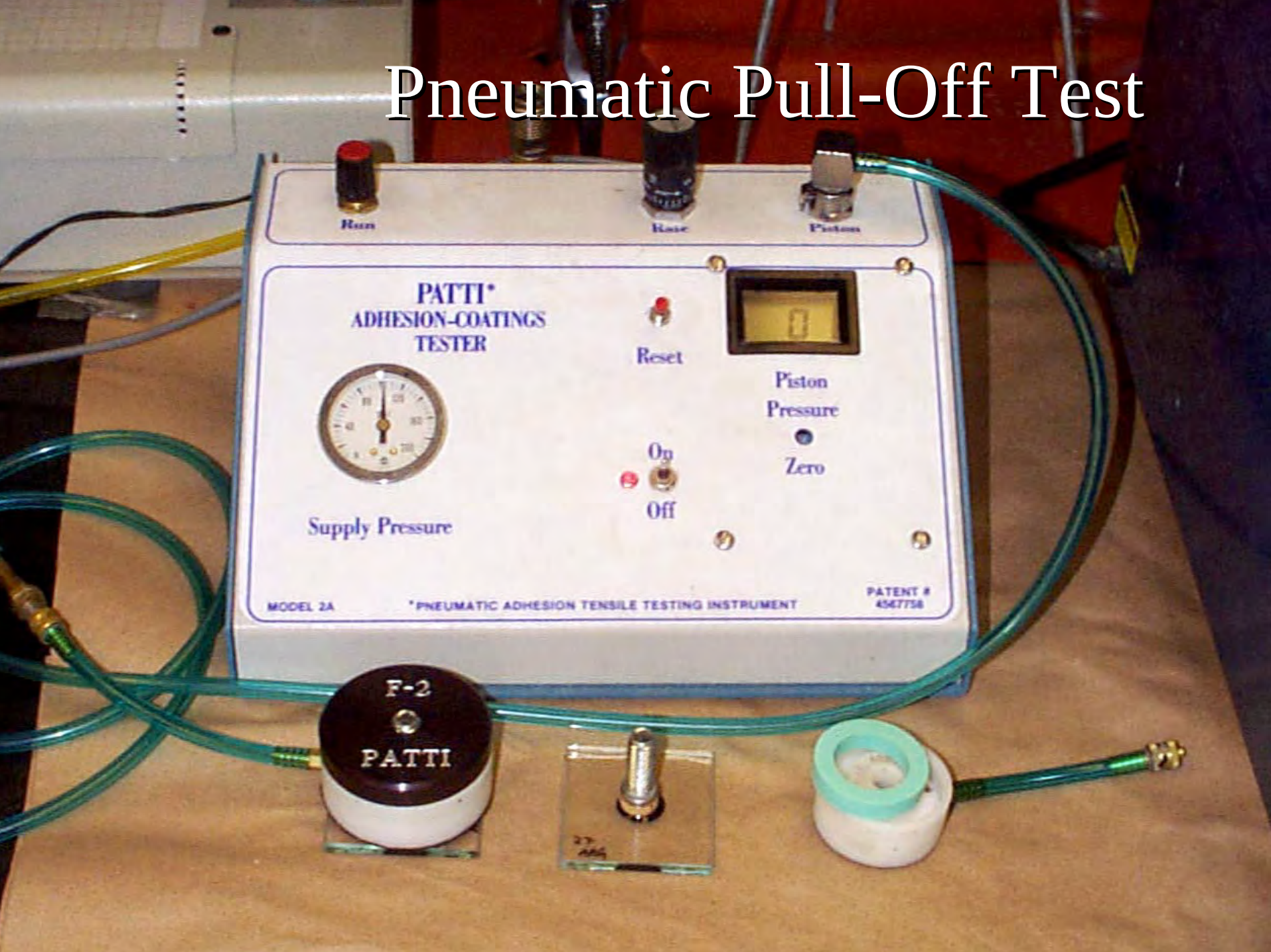
Moisture Sensitivity

Utility of the Pull-Off Test

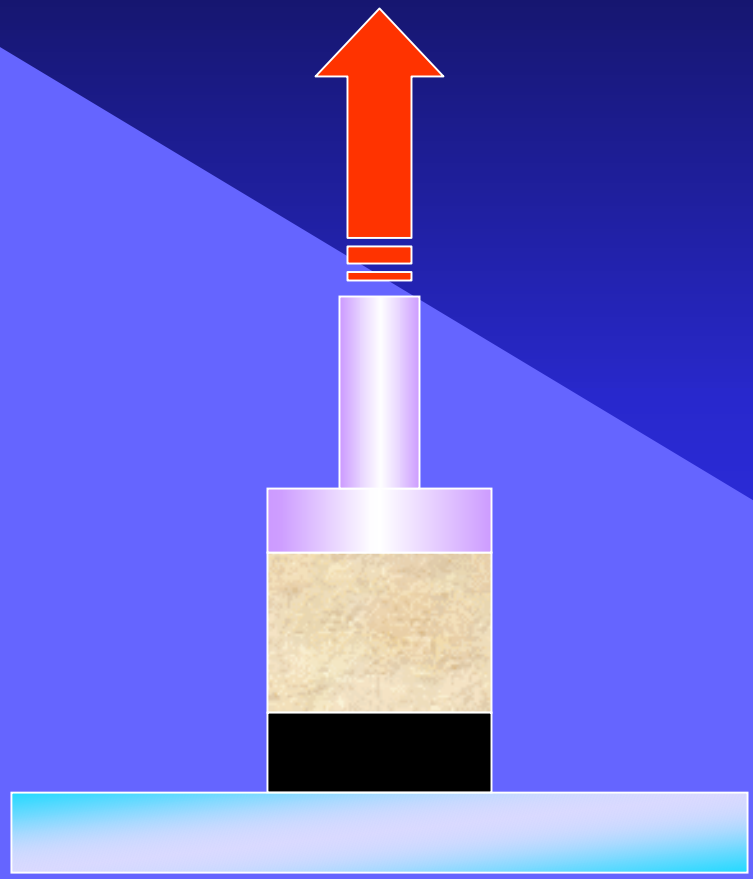
Pneumatic Pull-Off Test



Objectives

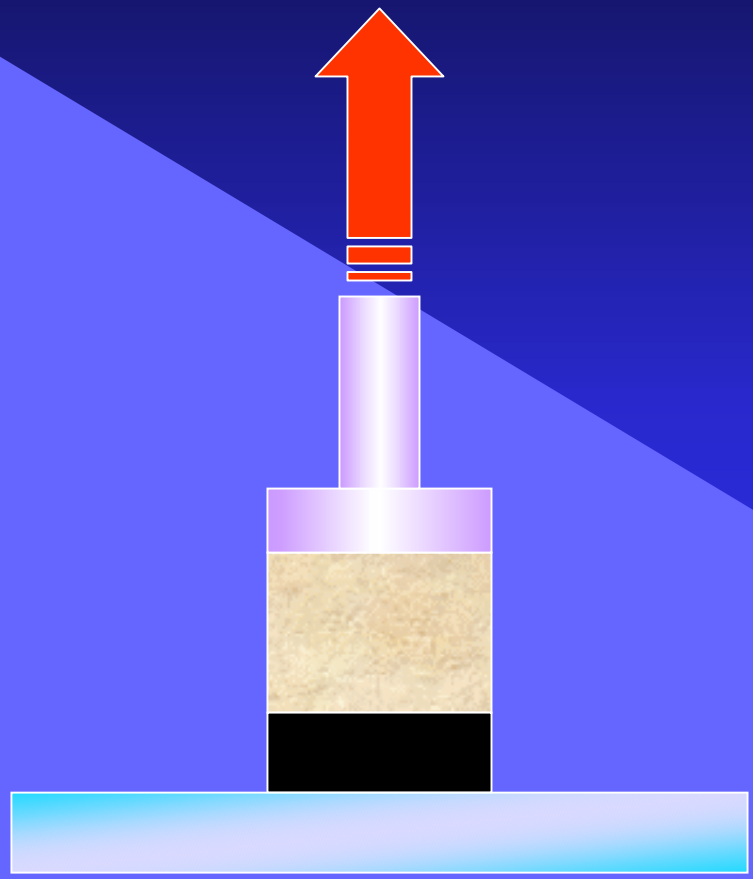
- Develop reliable and rapid method for evaluating the moisture susceptibility of neat and modified asphalt binders.
- Gain insight into the mechanisms by which water adversely affects asphalt pavements.
- Investigate aggregate systems that may contribute to adhesive failures, i.e., presence of surface active clays.

Pneumatic Pull-Off Test



Pneumatic Pull-Off Test
Cohesive Failure

Pneumatic Pull-Off Test

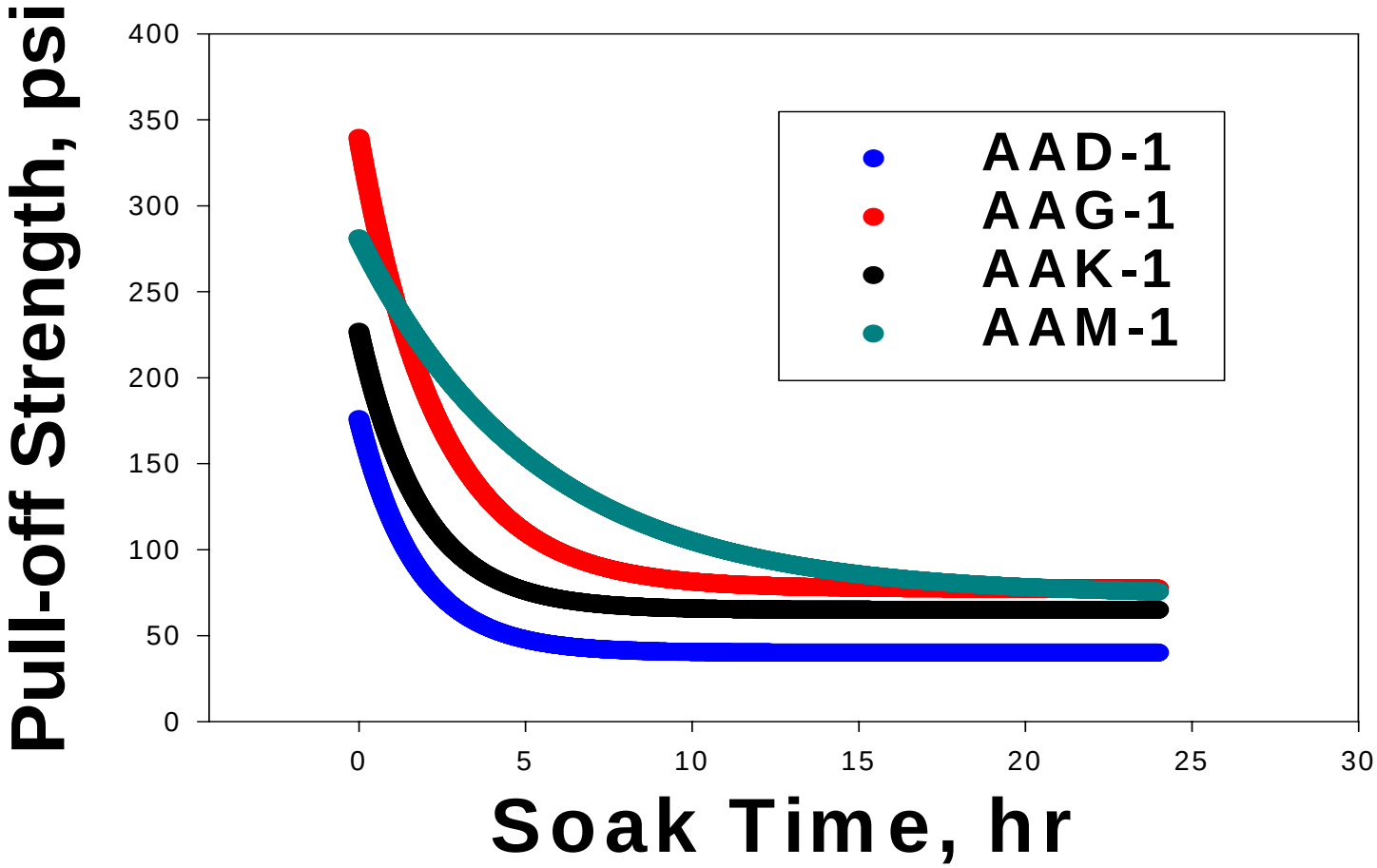


Pneumatic Pull-Off Test
Adhesive Failure

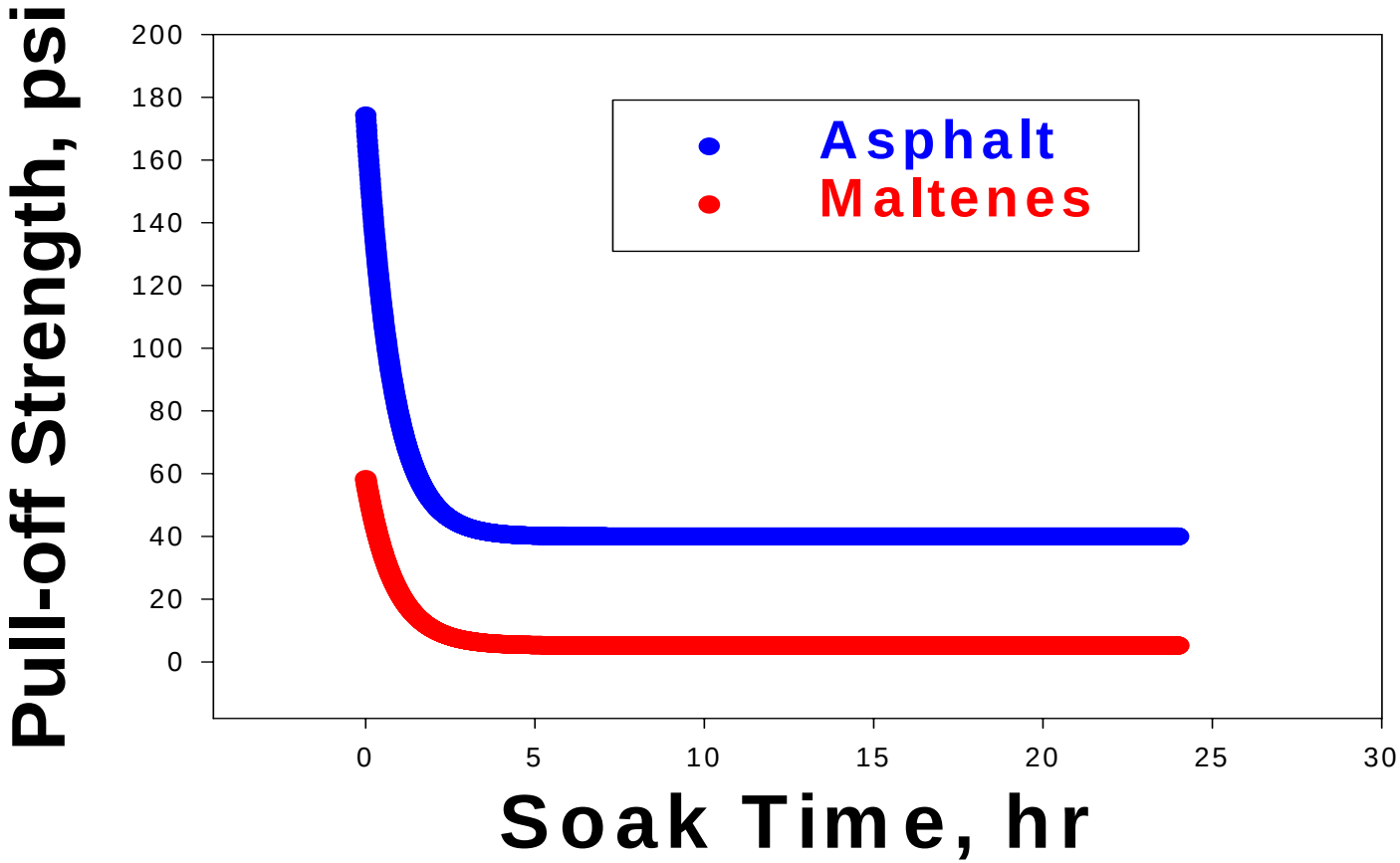
Test Parameters

Glass Beads	1 wt.%
Film Thickness	200 microns
Loading Rate	65.7 kPa/sec
Test Temperature	25°C
Soak Temperature	25°C
Soak Times	0 - 24 hr

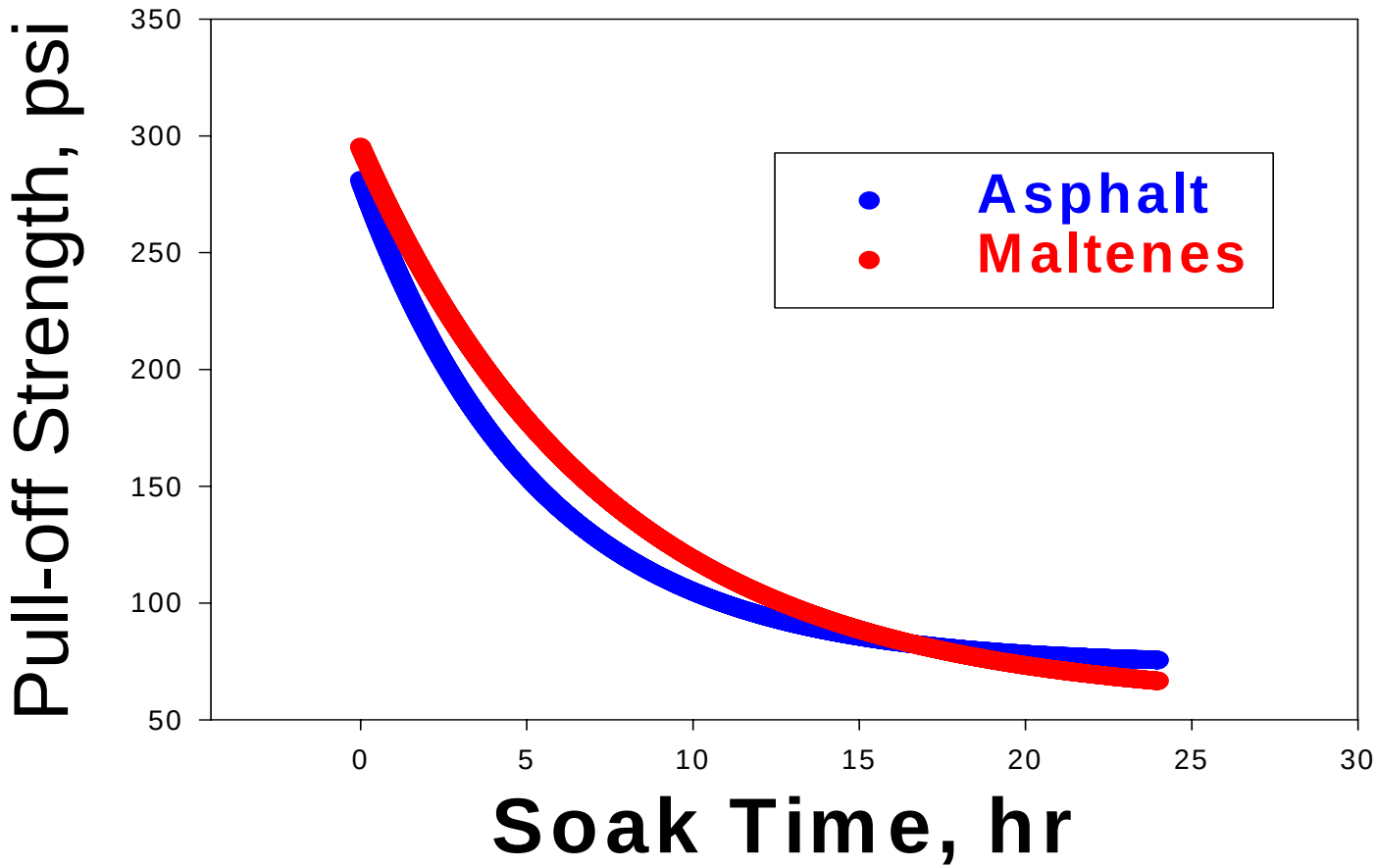
Effect of Soak Time on SHRP Core Asphalts

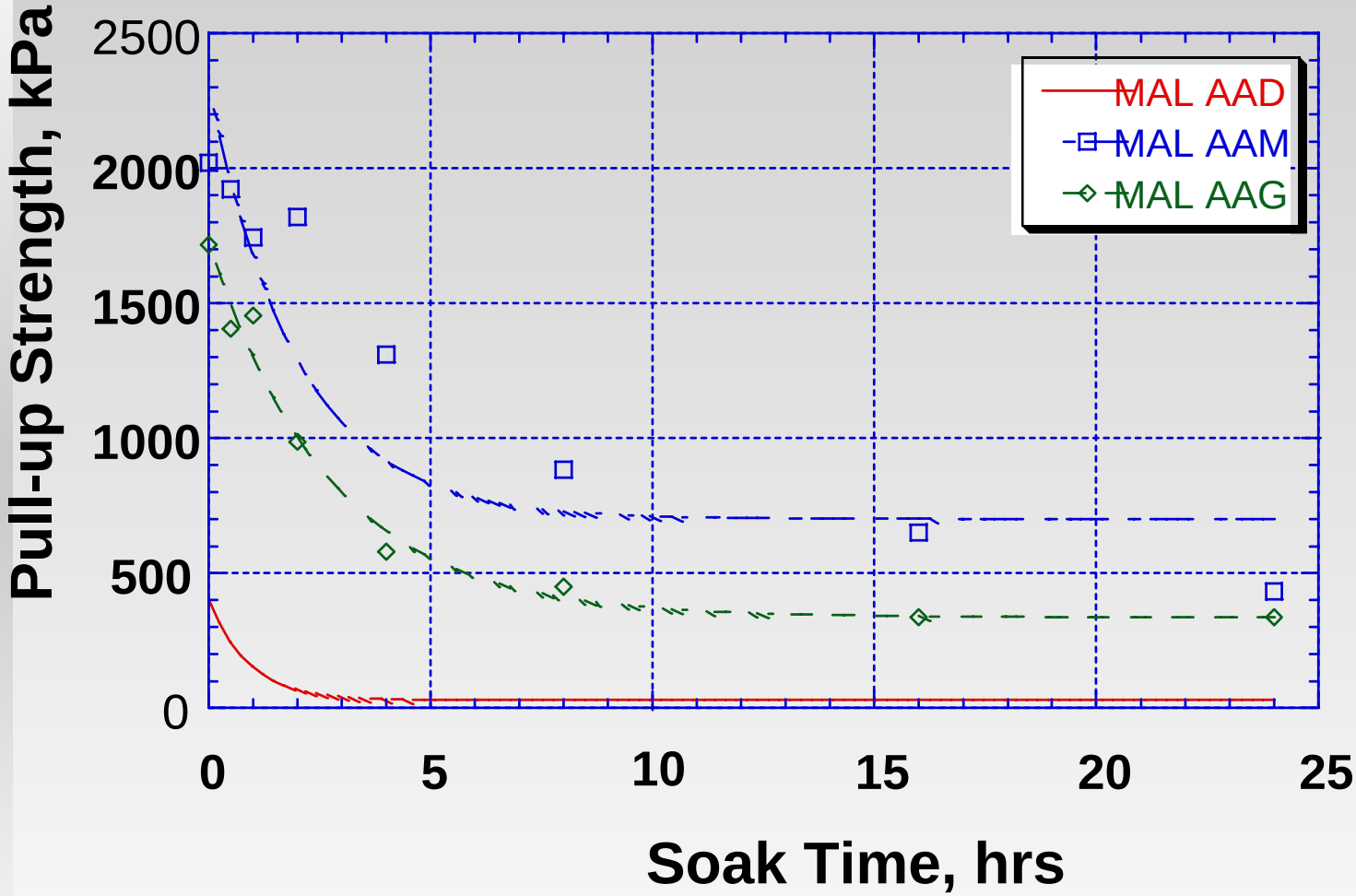


Effect of Soak Time on AAD-1 Asphalt and Maltenes



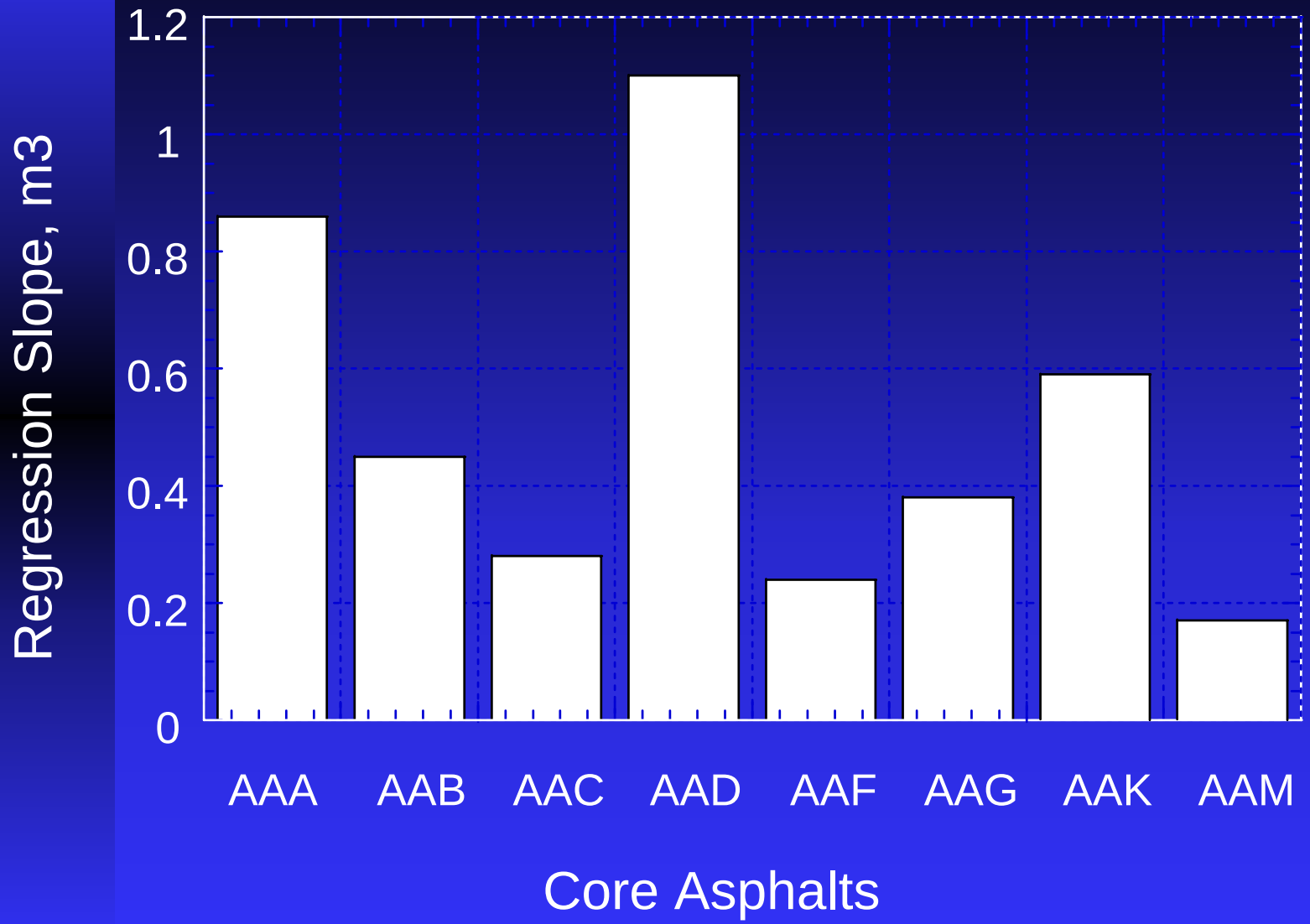
Effect of Soak Time on AAM-1 Asphalts and Maltenes



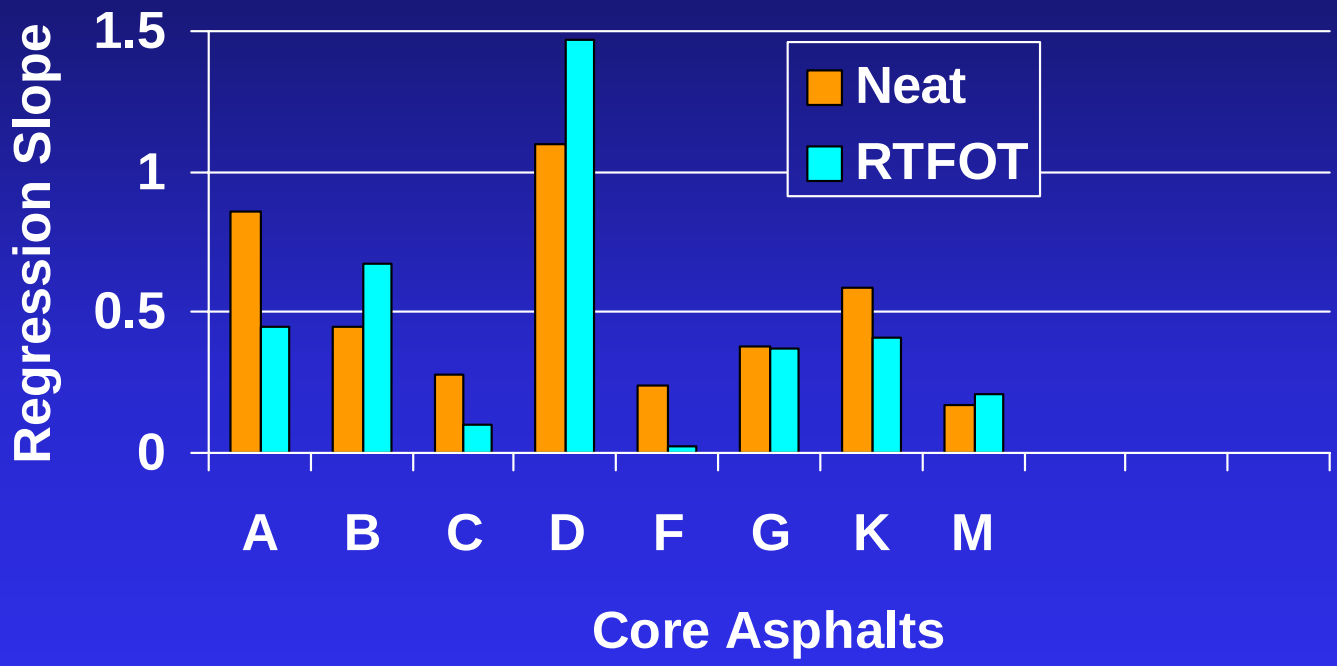


Effect of Soak Time on Pull-off Strength of Maltenes

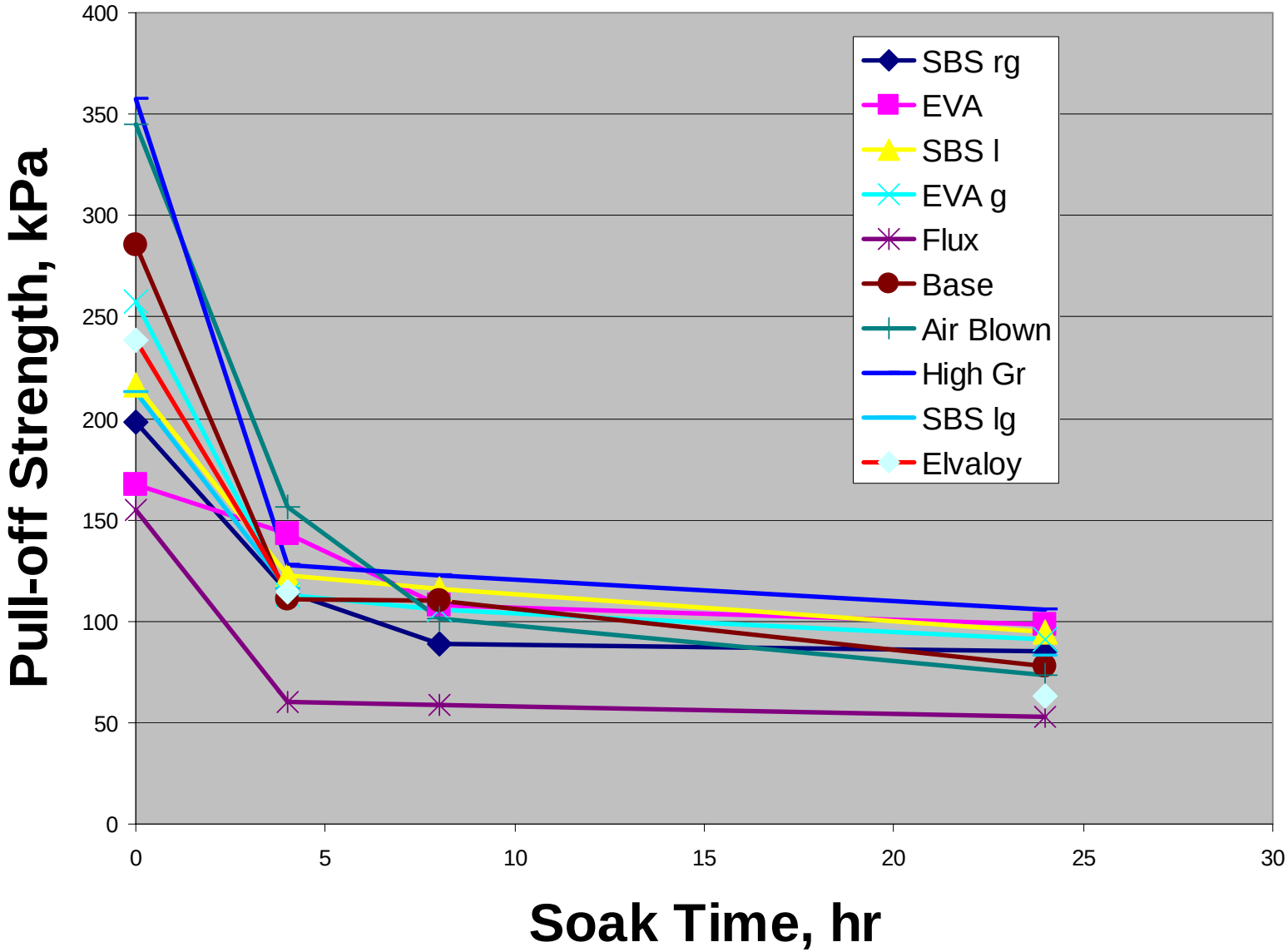
Regression Slopes for Unaged SHRP Core Asphalts



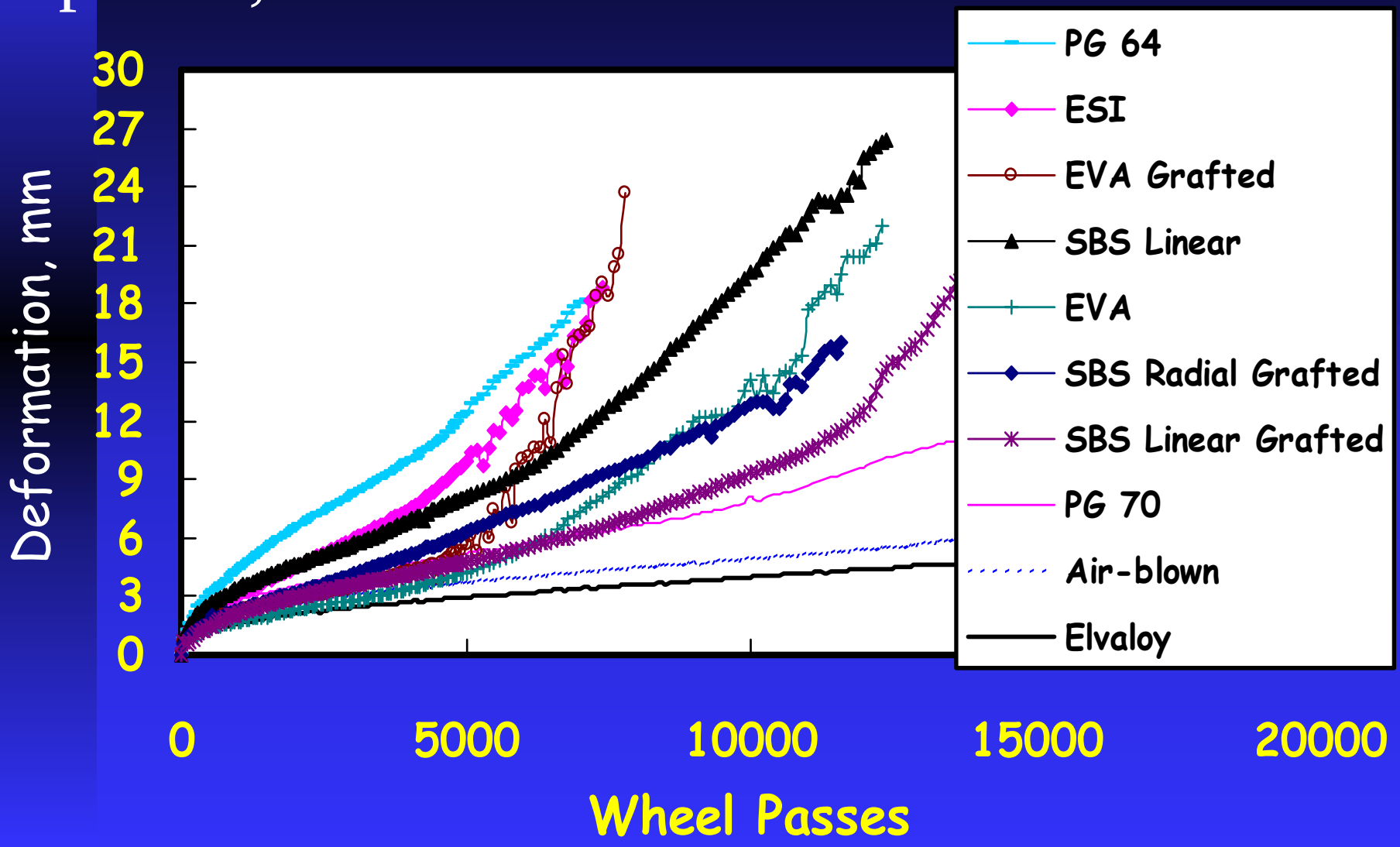
Regression Slope for Core Asphalts



Pneumatic Adhesion Test



Deformation vs. Hamburg WTD wheel passes, 58 ºC.



Findings

- Stiffer binders offer greater resistance to moisture susceptibility.
- Oxidation tends to improve this resistance.
- But stiffening attributed to excessive aging in the field may be detrimental. Pull-off test may not be able to identify this mode of distress.

Findings

- Asphalts containing stiffer / more viscous maltenes are less moisture sensitive.
- Mode of modification can significantly affect the cohesive and adhesive strength of the binder.

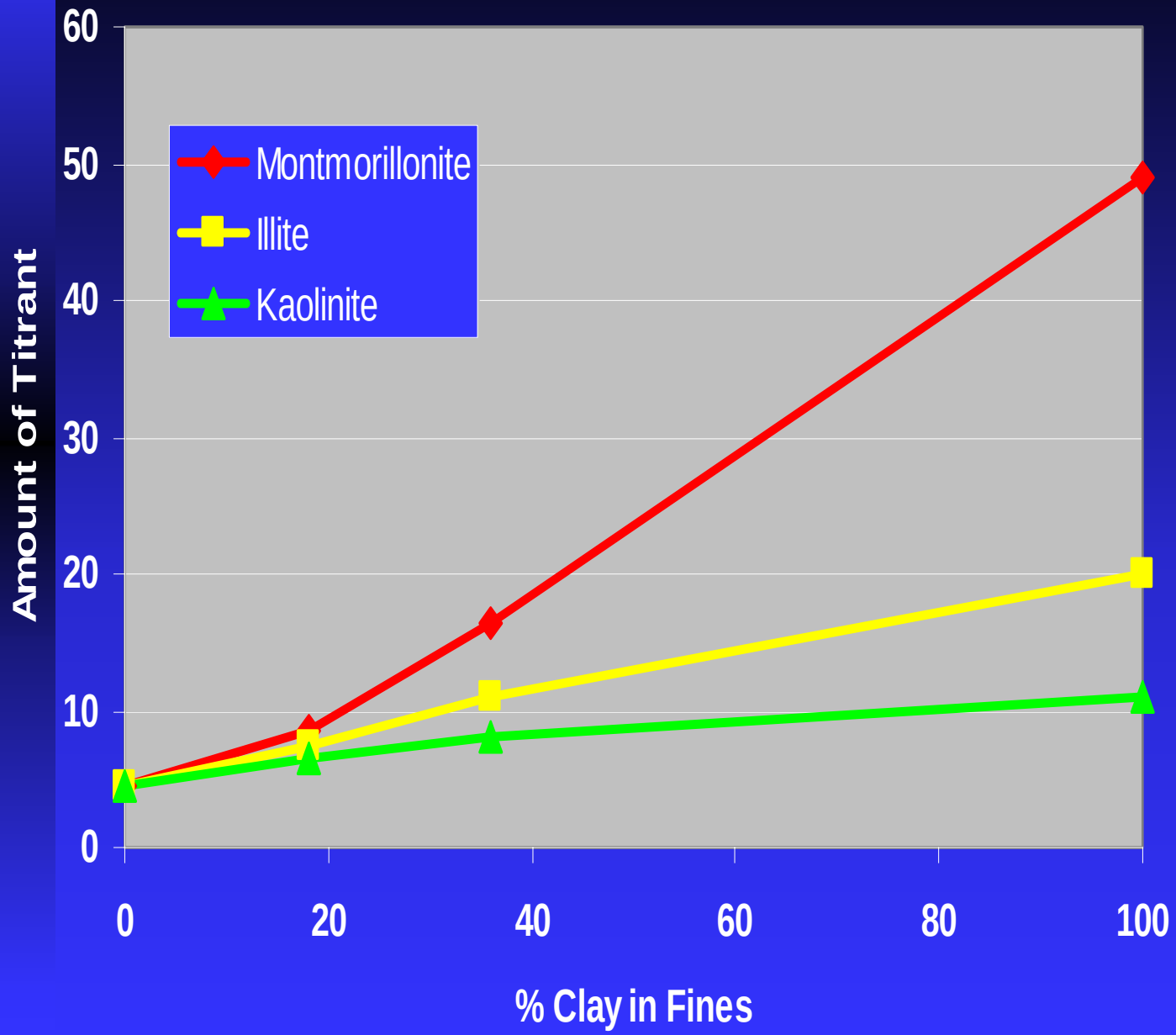
Ongoing Studies

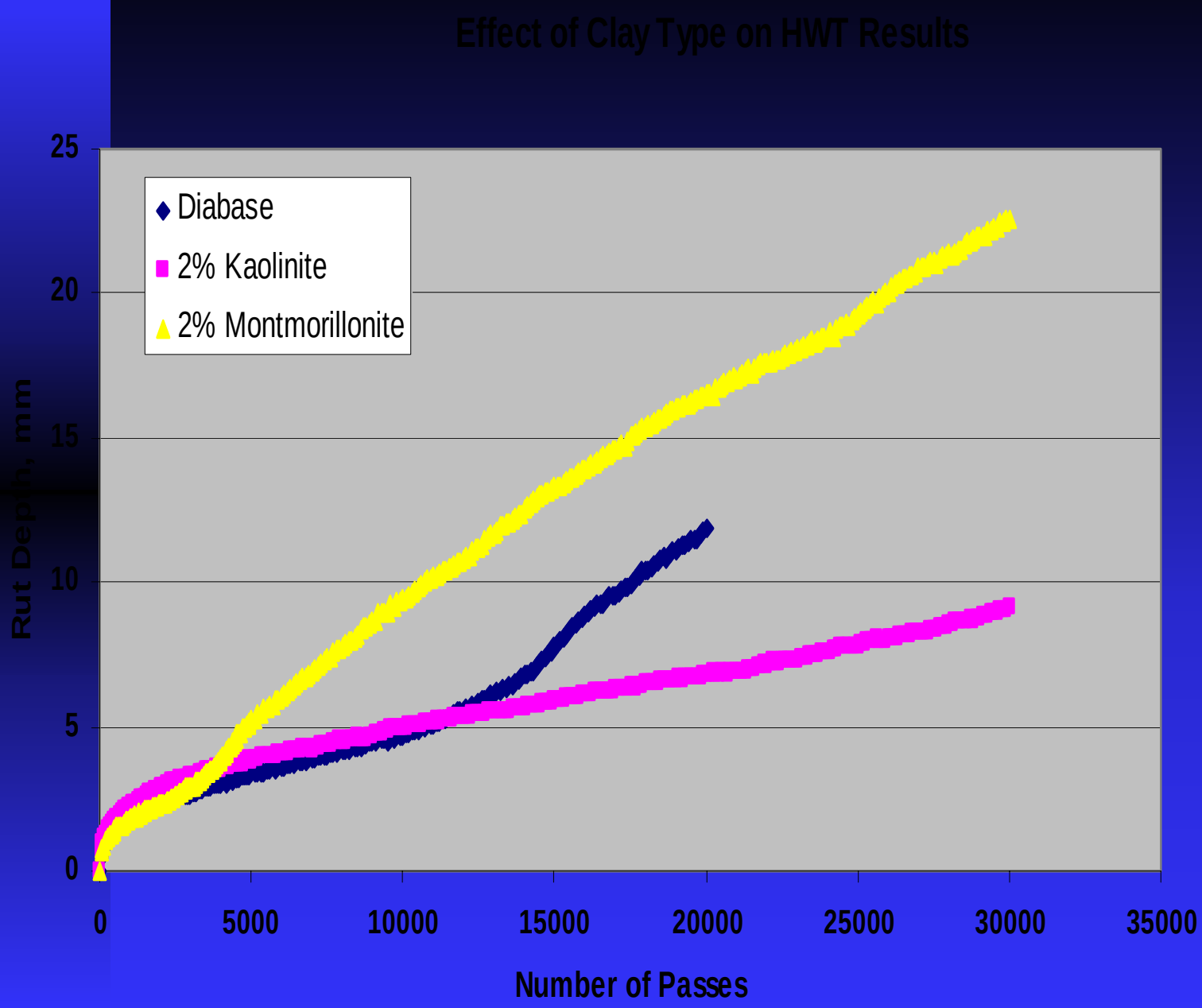
- Mastic Testing with Pull-Off Tester
  - 6% and 31% loadings of –200 mesh agg.
- Evaluation of Clays
- Evaluation of Lime Useage

Effect of Clays

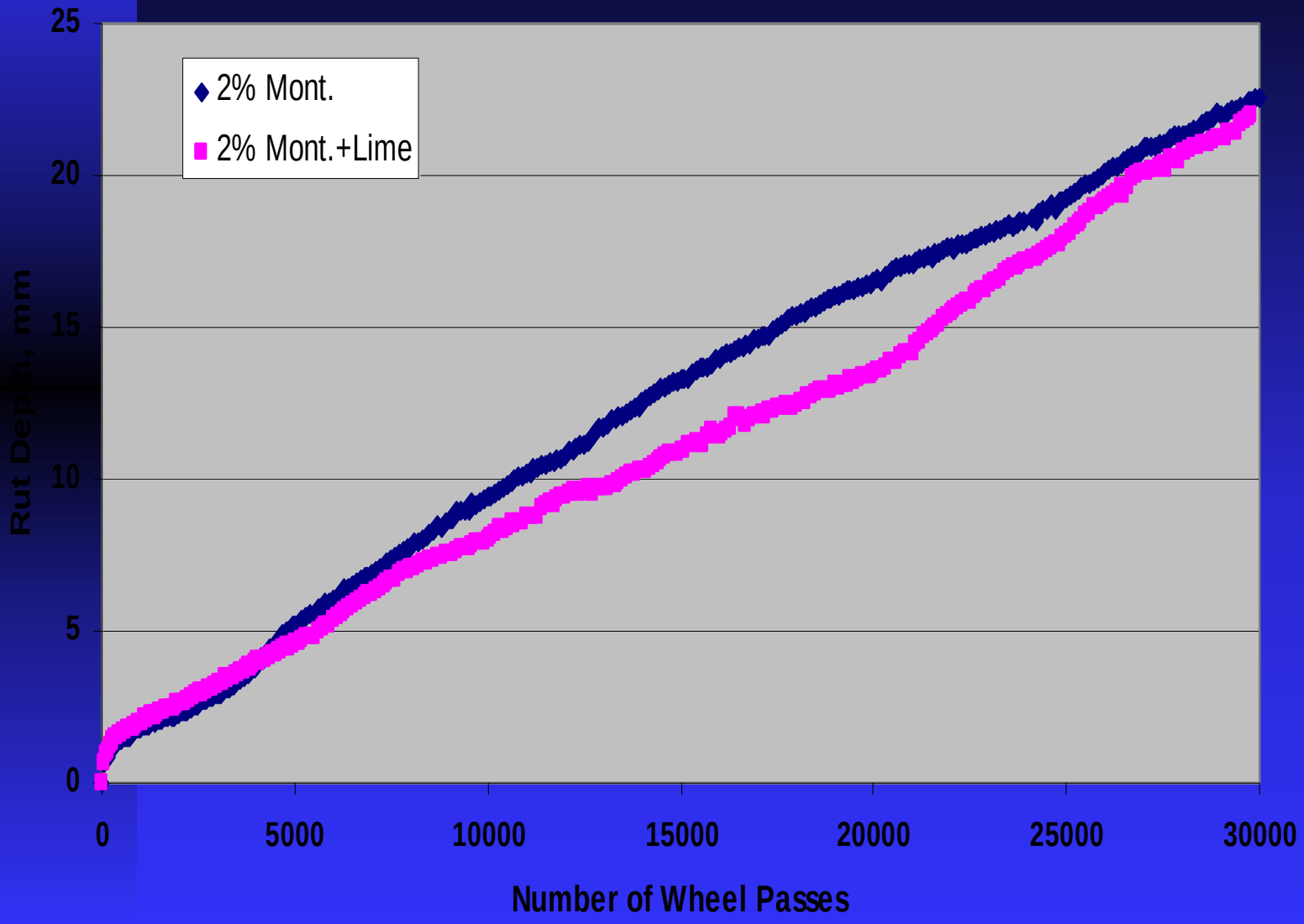
- Key Findings
  - Not all clays are alike
  - Mixes containing montmorillonites are not likely to be corrected by antistrips
  - Hamburg validated the Pull-Off Test results of clay mastics
- Recommendation
  - Use Methylene Blue Test!!!!!!!!

Methylene Blue Testing of Diabase Doped with Clay



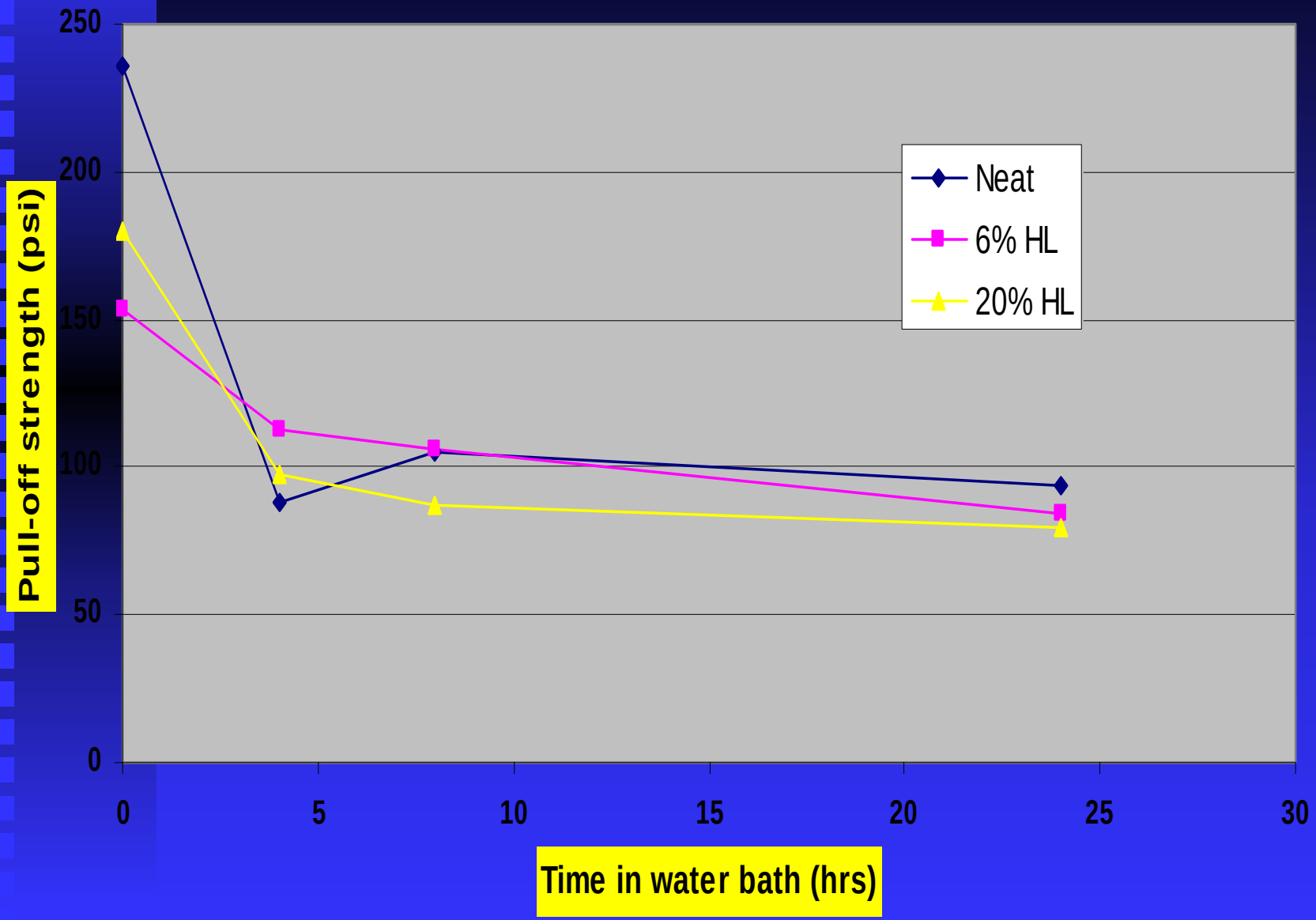

Effect of Clay Type on HWT Results
Diabase
2% Kaolinite
2% Montmorillonite
Rut Depth, mm
0
5
10
15
20
25
0
5000
10000
15000
20000
25000
30000
35000
Number of Passes

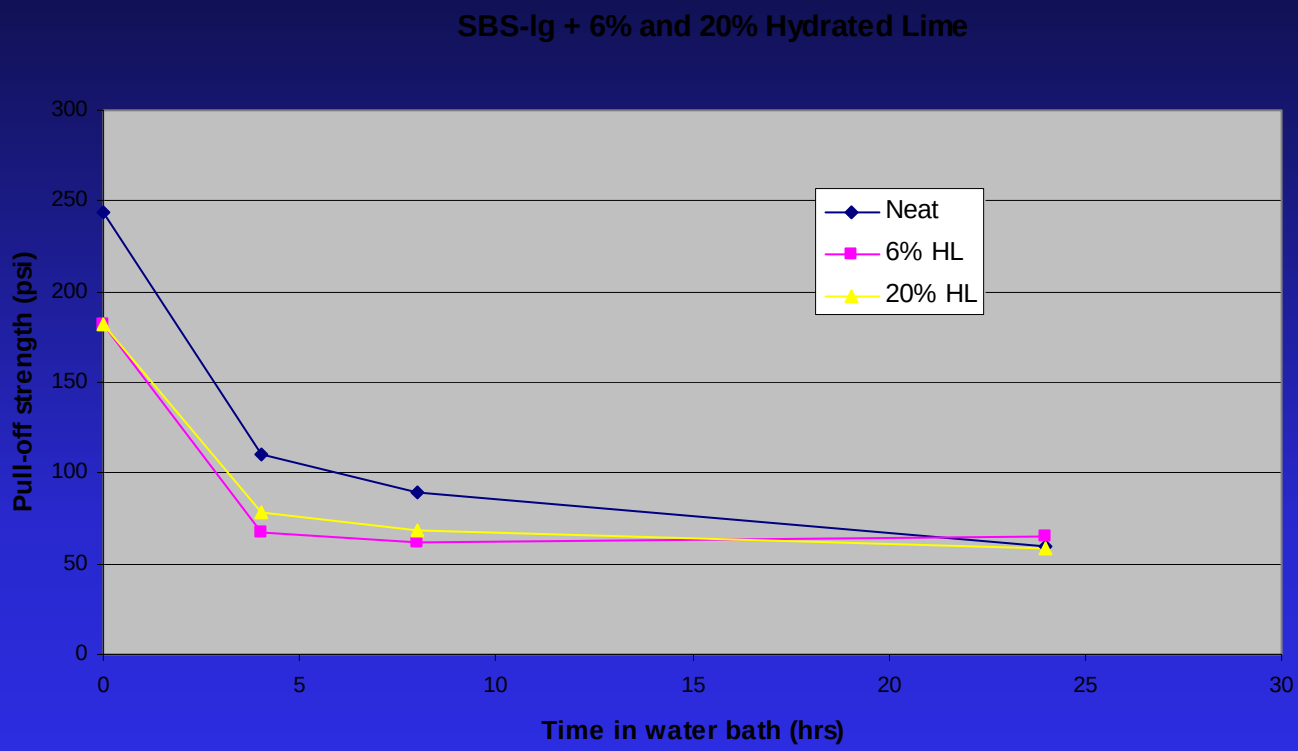
Effect of Lime on Mitigating Moisture Damage



Effect(s) Of Lime

Elvaloy + 6% and 20% Hydrated Lime (ALF)




SBS-lg + 6% and 20% Hydrated Lime
Pull-off strength (psi)
300
250
200
150
100
50
0
0
5
10
15
20
25
30
Time in water bath (hrs)
Neat
6% HL
20% HL

CONCLUSIONS

- Pneumatic Pull-Off Test is a quick, economical method for evaluating the moisture sensitivity of asphalt binders.
- Reproducibility of the test is quite good.
- Empirical model was developed that fits data for neat asphalts.
- High asphaltene asphalts are more sensitive to water than low asphaltene asphalts.

Pitfalls

- Interpretation of aging effects and stiff binder (PG 76+) results.
- Relating lab findings with field performance
- Results limited to set film thickness and testing rate

TENTATIVE MOISTURE SENSITIVITY TOOLS

PERFORMANCE	ISSUE	TEST	PARAMETER	When to Use
Raveling	Dissolution of Aggregate	Atomic Absorption	Na+, K+ Ion Concentration	Per Project
Stripping	Presence of Surfactants	Branthaver Separation Funnel Test	Presence of Emulsion	Binder Source
Rutting	Water Permeation	Pull-Off Test	Strength Ratio	Binder Source
Fatigue	Wet Oxidation	PAV	Rheological	Binder Source
Fatigue	Loss of Adhesion	?	Tackiness	Binder Source

Tentative Moisture Sensitivity Tools

PERFORMANCE	ISSUE	TEST	PARAMETER	When to Use
Stripping	Adhesion		Surface Energy	Binder-Aggregate Pairing
Stripping	Adhesion	Sonic Bath Loose Mix	Gravimetric	Binder-Aggregate Pairing
Stripping	Adhesion	Pull-Off Testing of Mastics	Strength Ratio	Binder-Aggregate Pairing
Moisture Damage	ALL	Sonic Bath Sections of Cores	Gravimetric	Test Gyratory Cores or Field Samples