WESTERN RESEARCH INSTITUTE

"Providing solutions to highway building materials problems"

CHEMICAL ASPECTS OF MOISTURE DAMAGE

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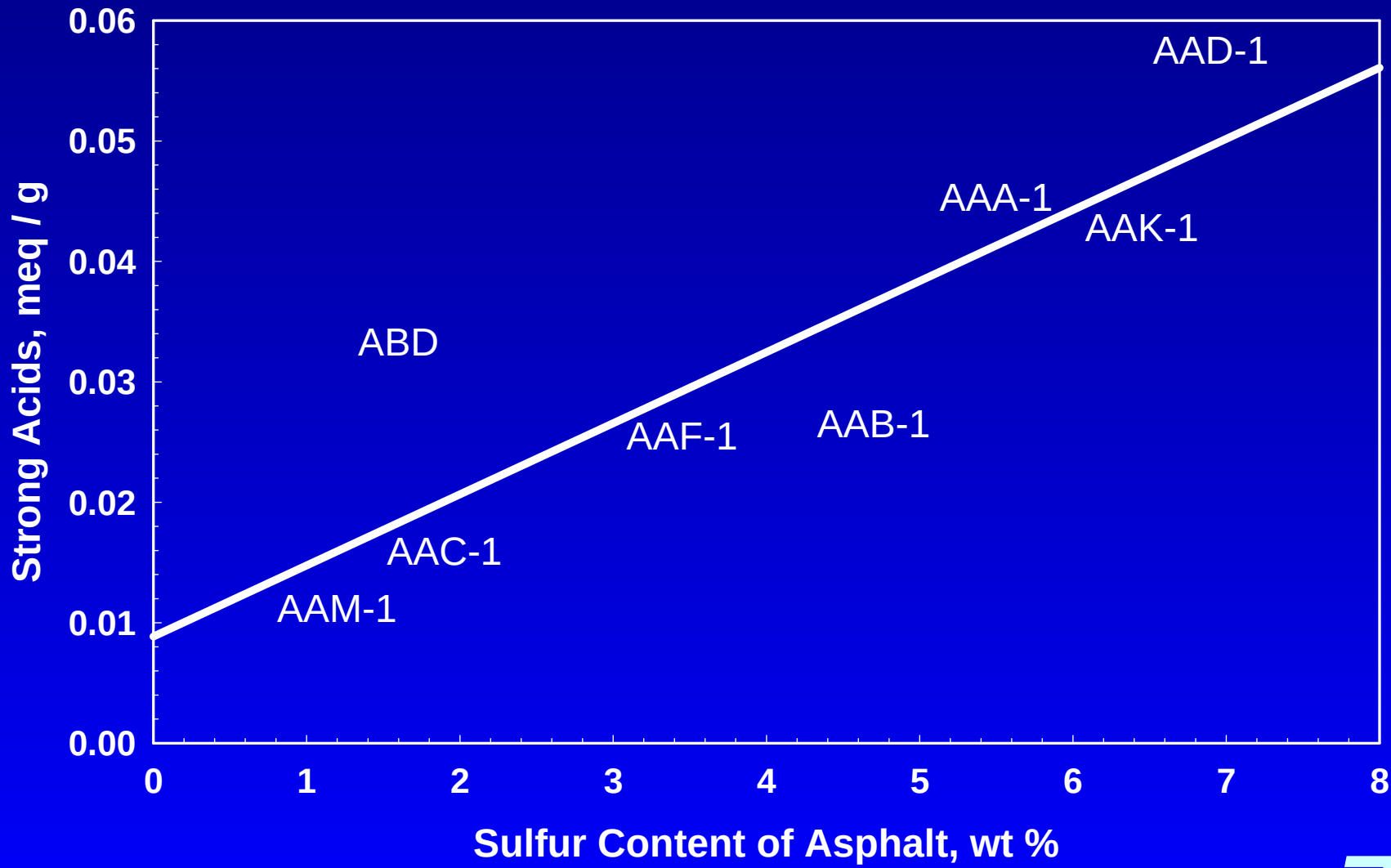
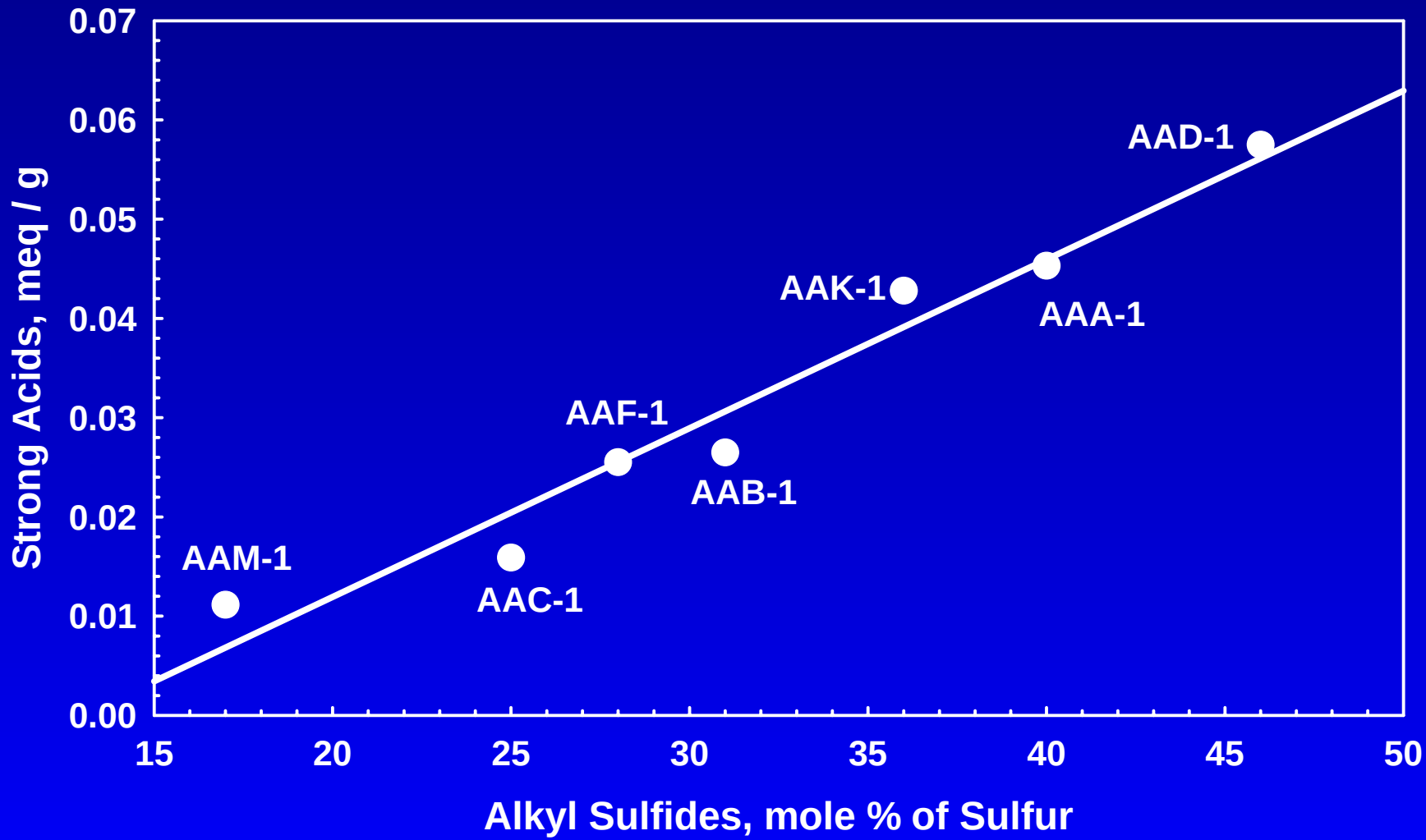
Formation of Emulsions

- The amount of material produced and the stability of emulsions formed by asphalts in contact with water are directly related to the severity of aging.
- In fact, an asphalt (AAF-1) subjected to only RTFO aging produced an emulsion.
- The emulsions are composed of strong acids and other surfactants, etc.

SULFUR CONTENT OF ASPHALT VS. STRONG ACIDS PRODUCED DURING PAV AGING



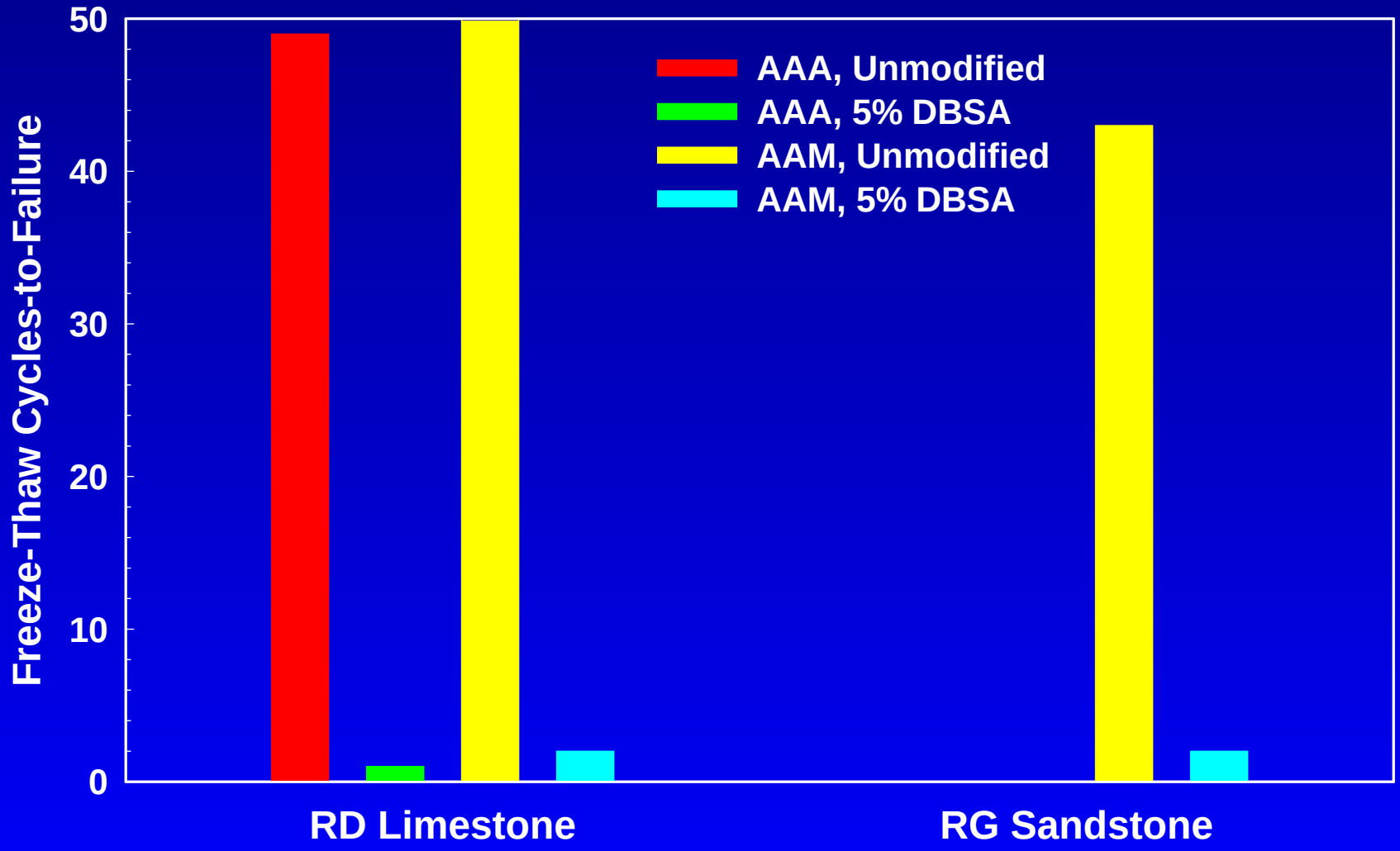
ALKYL SULFIDE CONTENT OF ASPHALT VS. STRONG ACIDS PRODUCED DURING PAV AGING



AQUEOUS EXTRACTION OF ASPHALT SOLUTIONS UNMODIFIED OR MODIFIED WITH 5% p-DBSA

Asphalt	pH	Material Recovered, %
AAA	4.9 – 6.3	0.02
AAA modified	2.3 – 2.6	1.44
AAM	4.9 – 6.4	0.05
AAM modified	2.4 – 3.4	1.23

PERFORMANCE OF SEVERAL MIXES MODIFIED WITH p-DODECYLBENZENE SULFONIC ACID



Conclusions

- The oxidative aging of asphalt produces polar compounds, such as sulfonic acids, surfactants, etc.

- Sulfonic acids and surfactants appear to promote moisture damage.

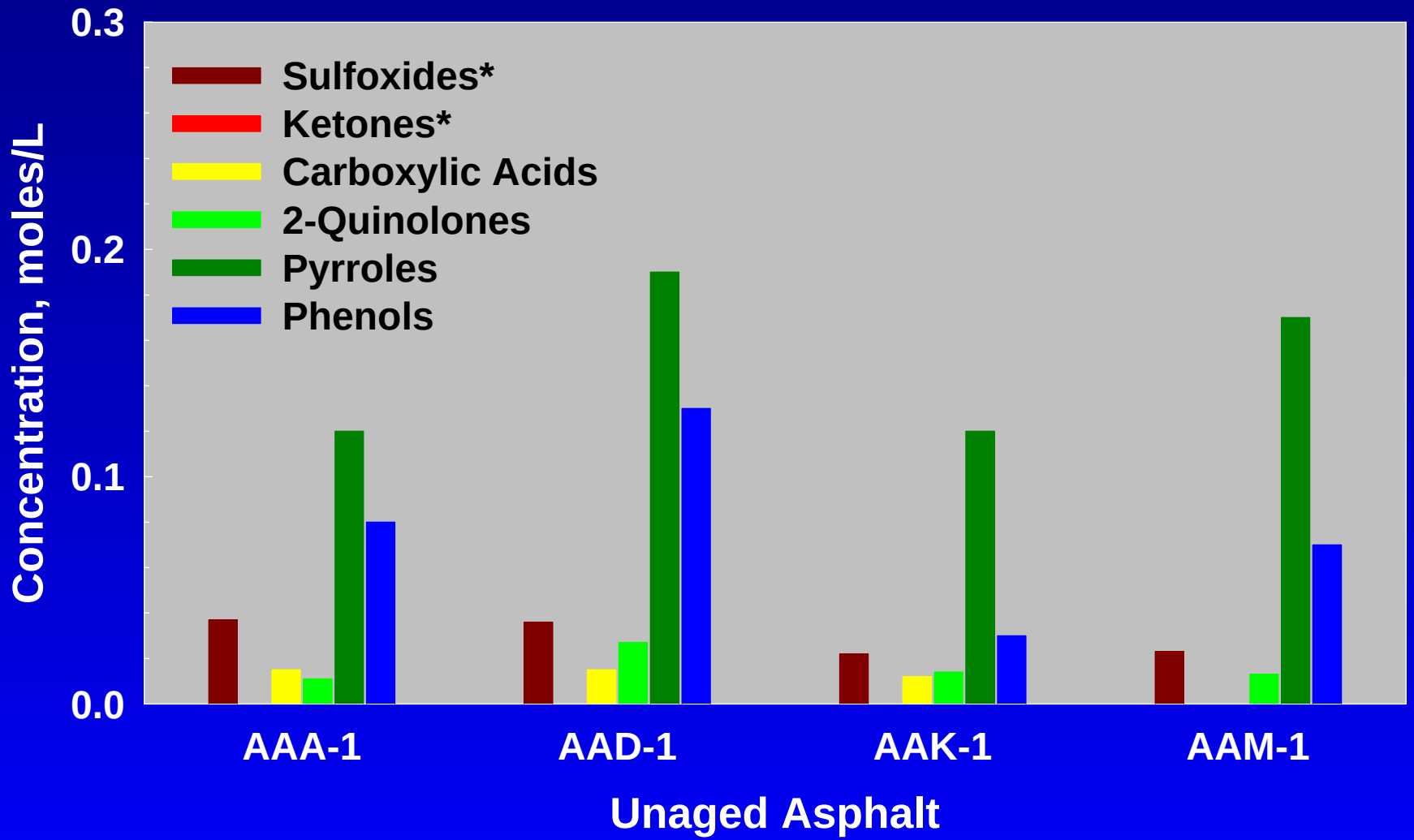
Implication

- It may be the properties of the aged asphalt and the aggregate that determine whether an asphalt pavement is prone to moisture damage.

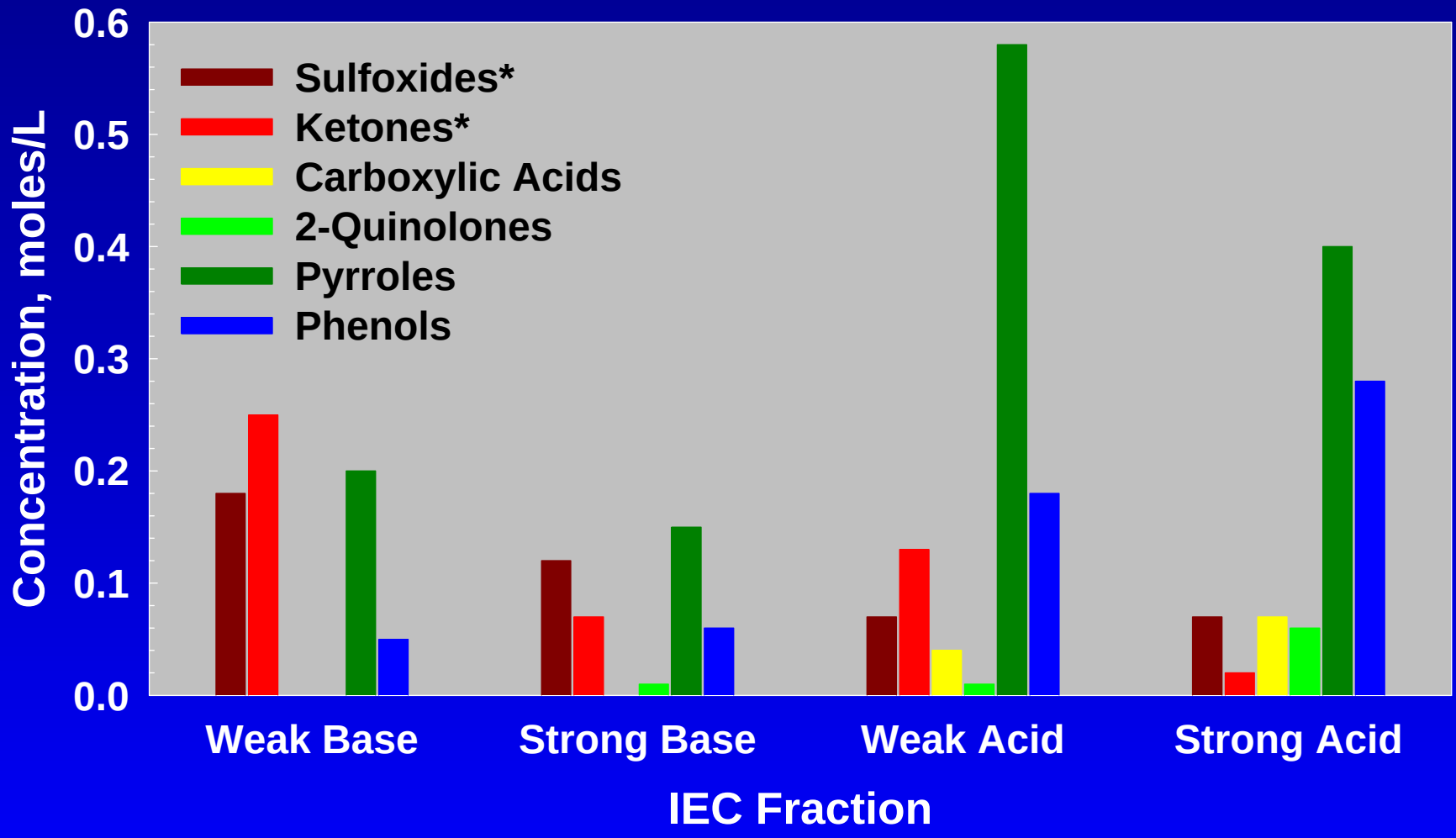
THANK YOU

QUESTIONS ??

FUNCTIONAL GROUP CONCENTRATIONS IN SHRP ASPHALTS



FUNCTIONAL GROUP CONCENTRATIONS IN FRACTIONS ISOLATED FROM ASPHALTS



Plancher et al. 1977

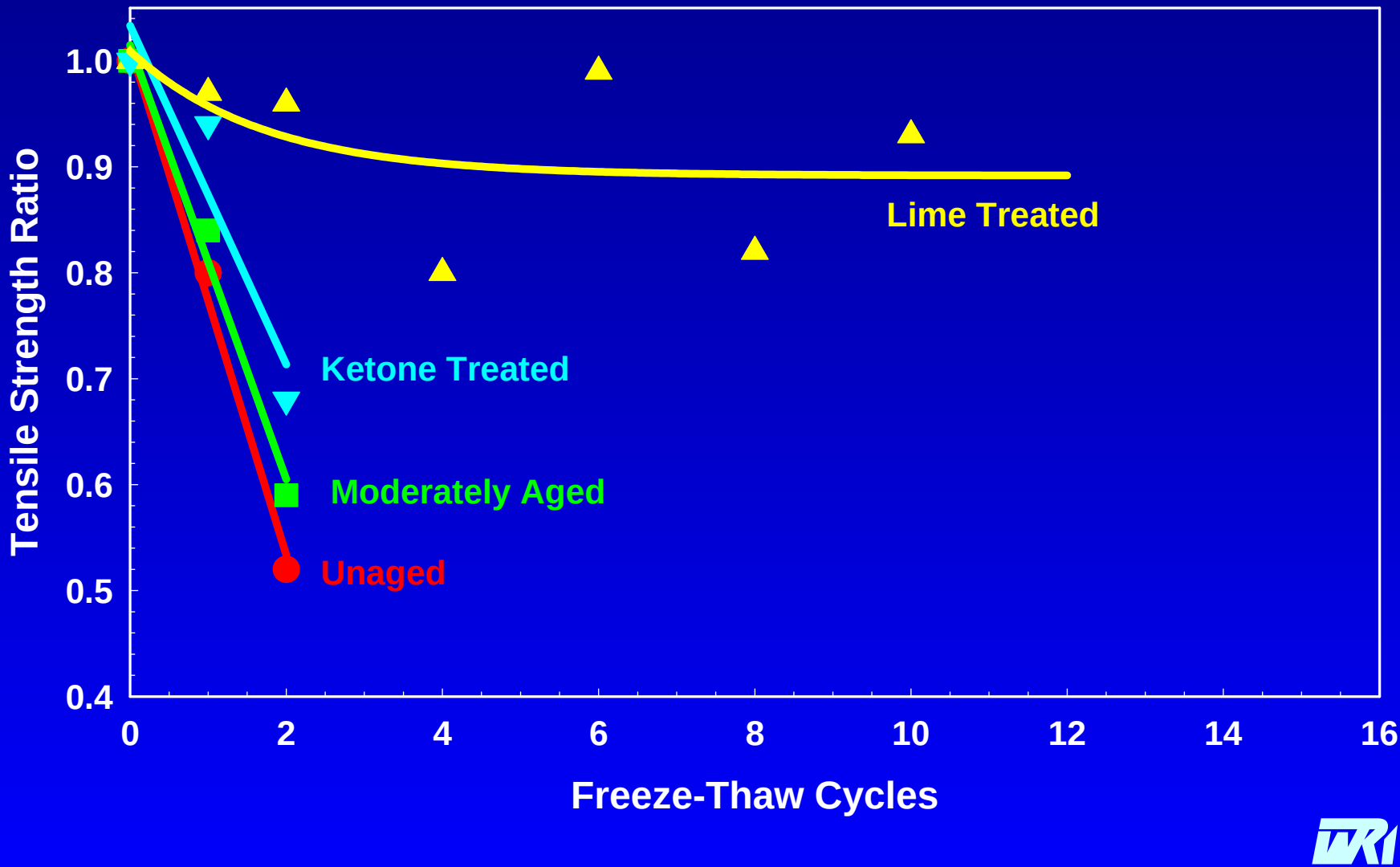
- **Functional group affinity for aggregate surface:**

  carboxylic acids > anhydrides > 2-quinolones > sulfoxides > nitrogen types > ketones

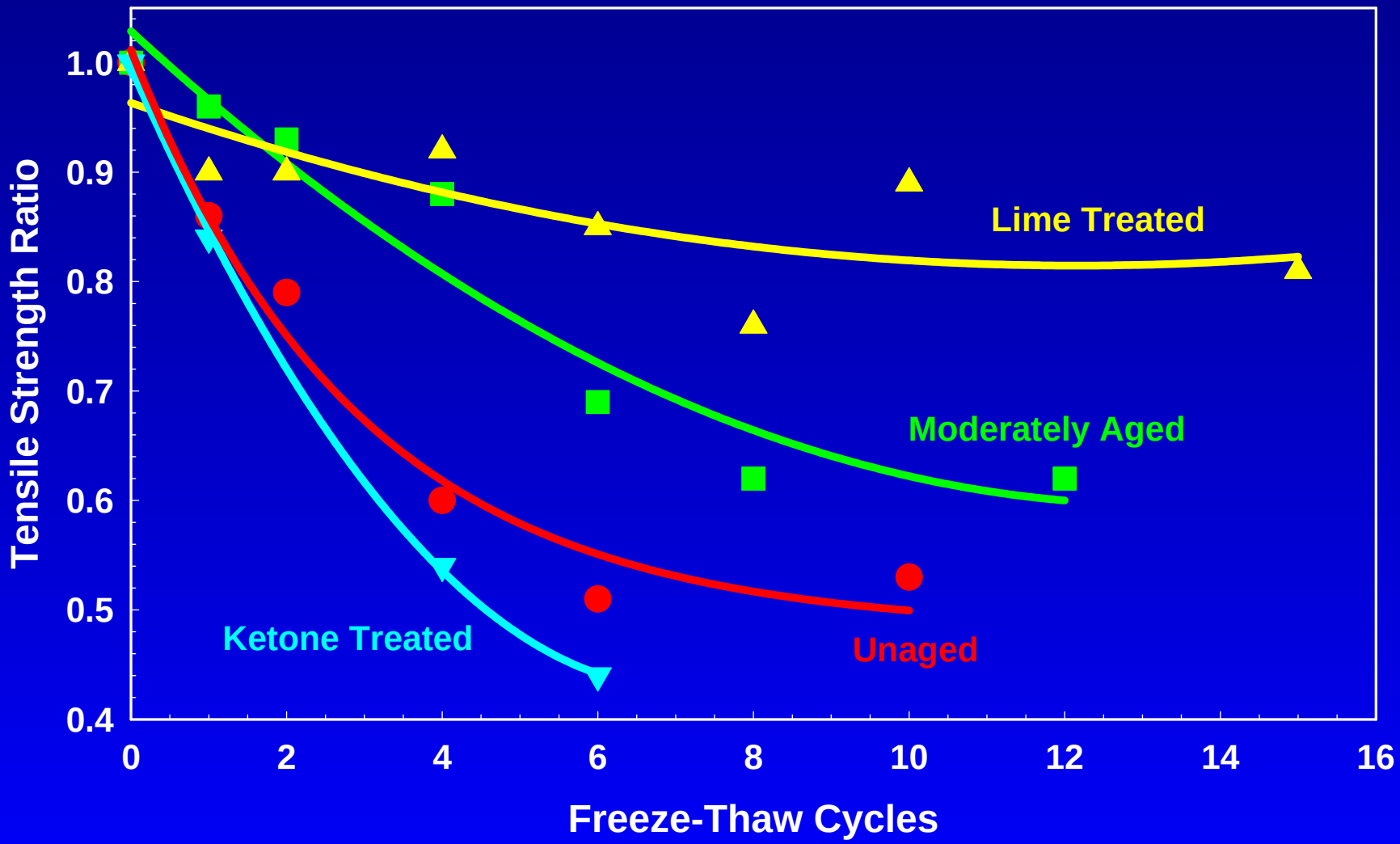
- **Functional groups retained after water treatment:**

  ketones > 2-quinolones > nitrogen types > sulfoxides > anhydrides > carboxylic acids

IMPACT OF FREEZE-THAW CYCLES ON THE TSR OF VARIOUS MIXTURES OF AAB-1 COATED ON GRANITE



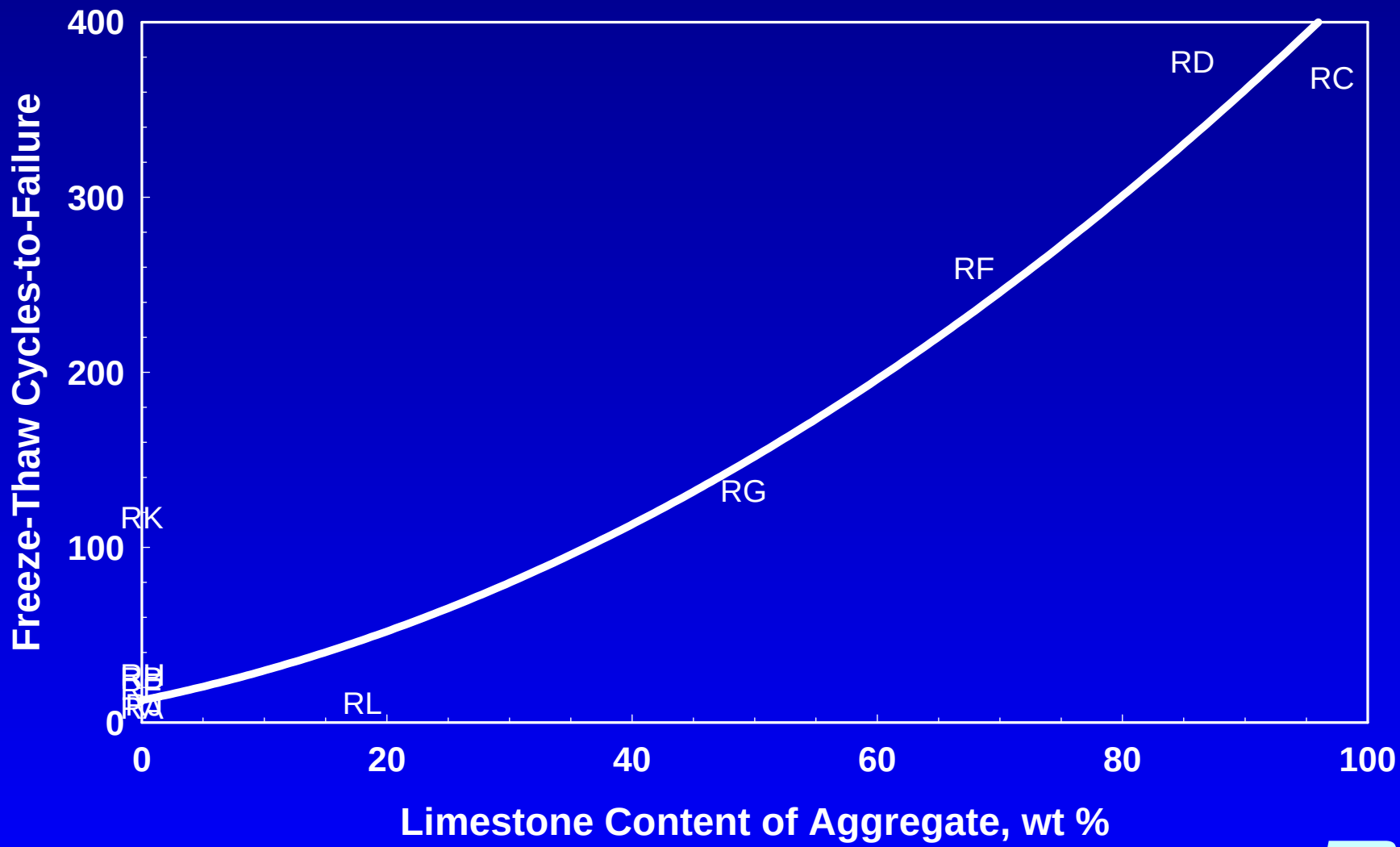
IMPACT OF FREEZE-THAW CYCLES ON THE TSR OF VARIOUS MIXTURES OF AAB-1 COATED ON LIMESTONE



MOISTURE SENSITIVITY OF VARIOUS ASPHALT-AGGREGATE COMBINATIONS, Freeze-Thaw Cycles-to-Failure

Asphalt	Aggregate					
	RJ	RC	RF	RB	RG	RK
AAA-1	1	33	49	3	6	4
AAC-1	2	>50	46	5	25	30
AAD-1	1	>50	19	2	25	10
AAF-1	1	>50	46	3	9	4
AAG-1	1	43	9	1	5	2
AAK-1	1	>50	13	3	11	5
AAM-1	2	>50	35	6	43	>50

PERFORMANCE OF BRIQUETS AS A FUNCTION OF THE LIMESTONE CONTENT OF THE AGGREGATE



PERFORMANCE AS A FUNCTION OF LIMESTONE (AGGREGATE) AND SULFUR (ASPHALT)