COMPATIBILITY OF RAP AND VIRGIN BINDER

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Asphalt Research Consortium

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Introduction

- Early in the 20th Century, it became apparent that asphalt performance varied
  - Derived from different crude sources
  - Even asphalts of the same grade
- Classification methods developed
  - Composition based
  - Rheology based
- Crude oil methods adapted

Introduction

- Asphalt behaved as a colloidal system (Traxler)
- Asphaltenes dispersed in maltene solvent
- Asphalts classified as sol or gel
  - Sol asphalts are more compatible
    - Lower asphaltene content
  - Gel asphalts are less compatible
    - Higher asphaltene content
- Many asphalts are intermediate

Methods for Estimation of Compatibility

- Asphaltene dispersibility index
- Asphaltene filtering rate
- Asphaltene compatibility index (Branthaver)
- Relative viscosity (v. asphalt/ v. maltenes)
- Ratios of fractions (Corbett, Rostler, Schweyer, Traxler)
- Heithaus parameters
  - p_a – peptizability of the asphaltenes
  - p_o – peptizability of the maltenes
  - P – state of peptization

Composition and Compatibility

Heithaus Test

- Solution of asphalt in toluene titrated with heptane;
  - Must match
    - Solvent power of petrolenes
    - Dispersibility of asphaltenes

Altgelt and Harle

- "Thickening power" of asphaltenes related to degree of association
- Degree of association of asphaltenes controlled by solvent power of petrolenes

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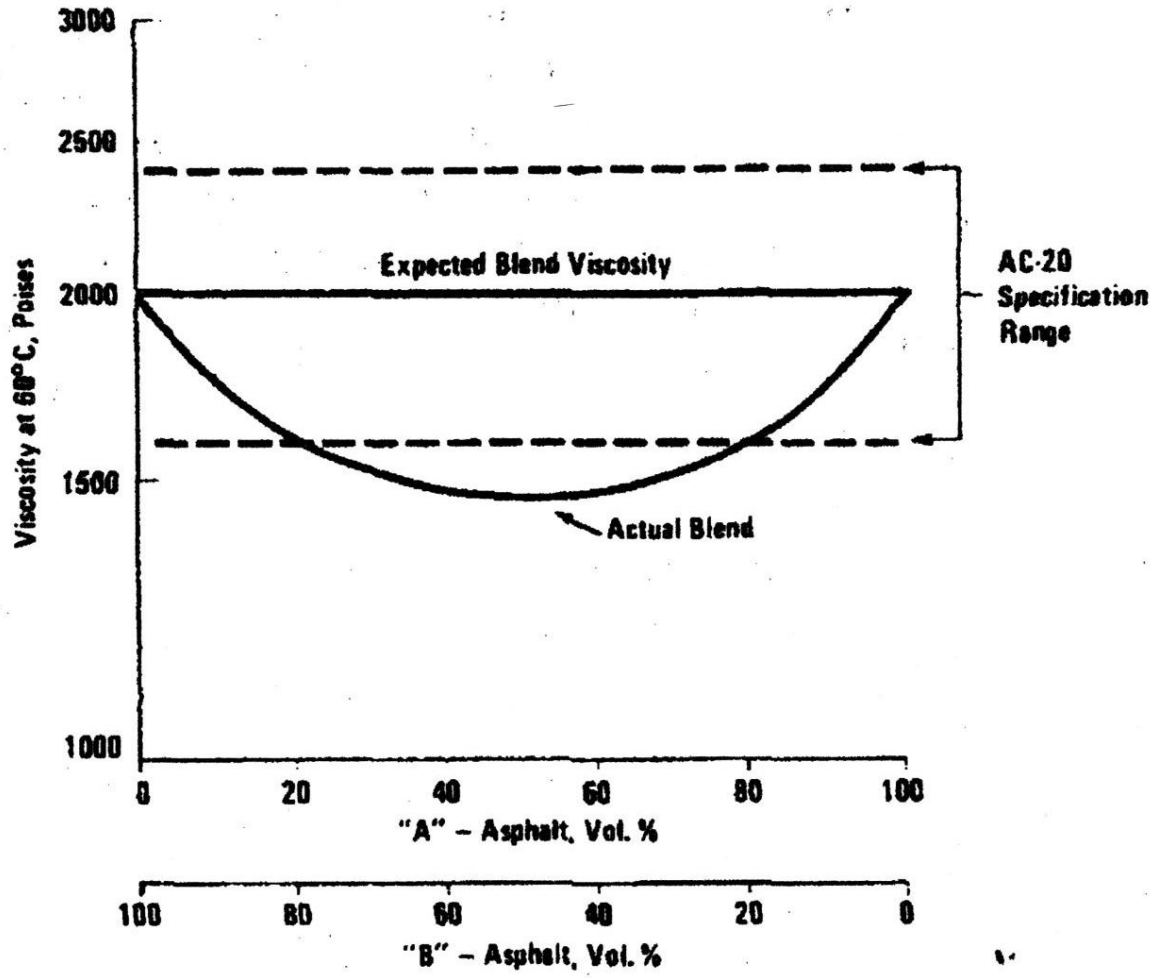
Effect of Compatibility on Blending



Reference: W. J. Kari. "Effects of Construction Practices on the Asphalt Properties in the Mix", *Proc. Canadian Tech. Asphalt Assn.*, vol. XXVII (1982), pp. 321-334. (cited in AAPT, Anderson, Petersen and Christensen, v. 55 (1986), pp. 250-268.

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Effects of Crossblending

Mix #	Components of Mixture	Neat: Vis., Pa•s 25°C, 1 r/s	Neat: Tan ∂ 25°C, 1 r/s	Neat: R. S. Visc. 25°C, 1 r/s
I (A)	AAD Maltenes (79%) AAD Asphaltenes (21%)	49,011	3.2	705
VII (B)	AAG Maltenes (94%) AAG Asphaltenes (6%)	389,100	6.3	64
	Cross Blends			
V (C)	AAG Maltenes (79%) AAD Asphaltenes (21%)	4,970,900	1.5	287 (?)*
III (A) (C)	AAD Maltenes (79%) AAG Asphaltenes (21%)	62, 908	3.7	906
II (D)	AAD Maltenes (94%) AAG Asphaltenes (6%)	1,023	>10	35
VI (B) (D)	AAG Maltenes (94%) AAD Asphaltenes (6%)	337,190	6.0	54

Data from: "Fundamental Properties of Asphalts and Modified Asphalts", Vol. 1: Interpretive Report FHWA-RD-99-212, Oct. 2001.

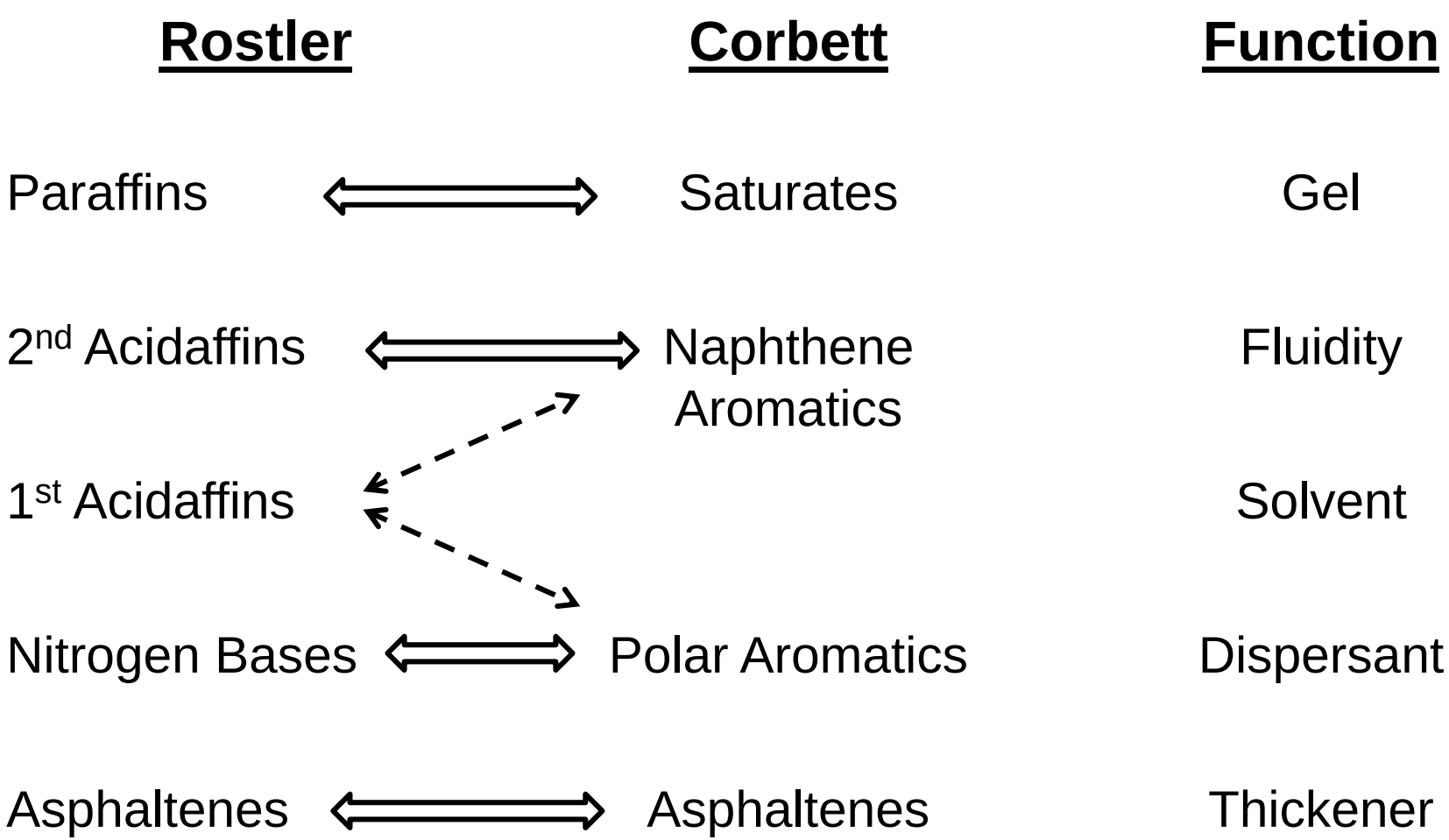
(JCP, 09/08)

*Value is suspect. Reduced specific viscosity at 60°C is reported as 393.

Asphalt Characterization

- **Methods developed to separate asphalt components (maltenes)**
- **Rostler Method**
- **Corbett-Swarbrick method —> ASTM D4124**
- **Clay-gel**
- **Size-exclusion chromatography (GPC) (whole asphalt)**
- **Ion-exchange chromatography (whole asphalt)**

Composition Fraction Comparison



What is Compatibility?

Operational Definition of Compatibility

- Mixing of two or more similar materials gives expected results

Incompatibility

- Mixing of two or more similar materials gives unexpected results
  - Softer than expected
  - Stiffer than expected

Aging

What happens when asphalts age?

- Saturates – little oxidation/ little change
- Aromatics – some oxidation/ small change
  - Oxidation products move to Resins
- Resins – considerable oxidation
  - Oxidation products move to Asphaltenes
- Asphaltenes – increase
  - Molecular associations increase

- Asphalt aging decreases with pavement depth

RAP and Virgin Binder

- Virgin and RAP asphalts mix --- Degree?
- Age of RAP affects blending
  - Some components more “available”
- Adsorption effects of RAP aggregate
- Solubility “Power” of virgin asphalt
- Is compatibility of virgin and RAP an issue?
  - Depends
  - Compatibility depends on solubility
  - Combined binder rheology will be a function of compatibility

RAP Compatibility Work

- **Lab blends of virgin and RAP @ 0,15 & 50%**
  - **2 asphalts of different composition**
  - **4 RAP; MB, SC, IA, & CA**
  - **Rheology**
  - **Heithaus parameters**
  - **Separation methods, etc.**
- **Evaluation of NCSPC plant-mix samples**

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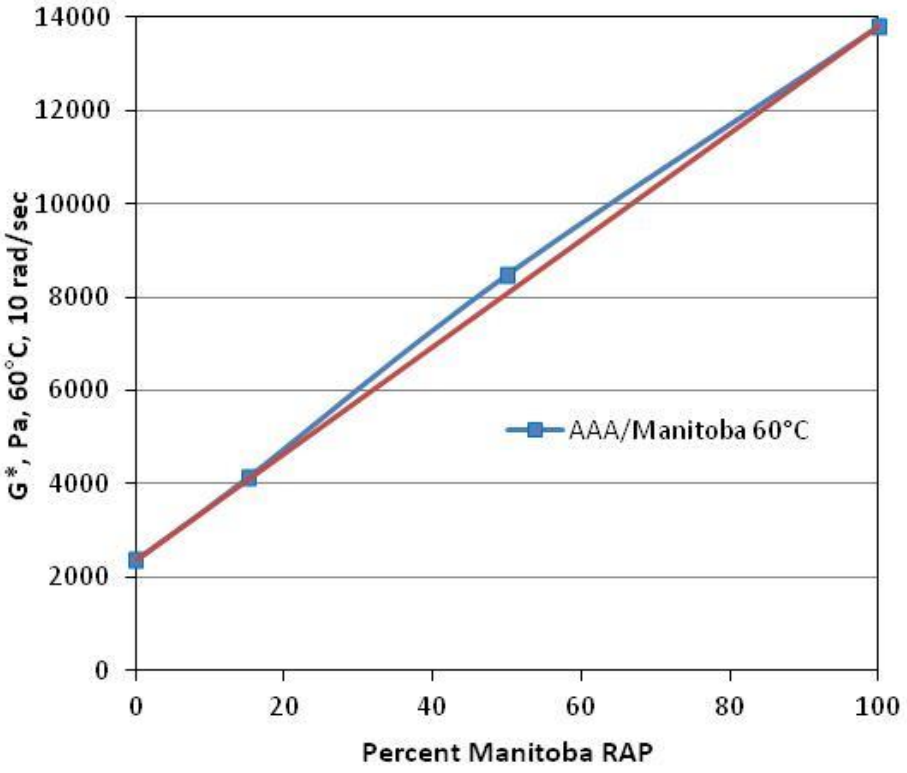
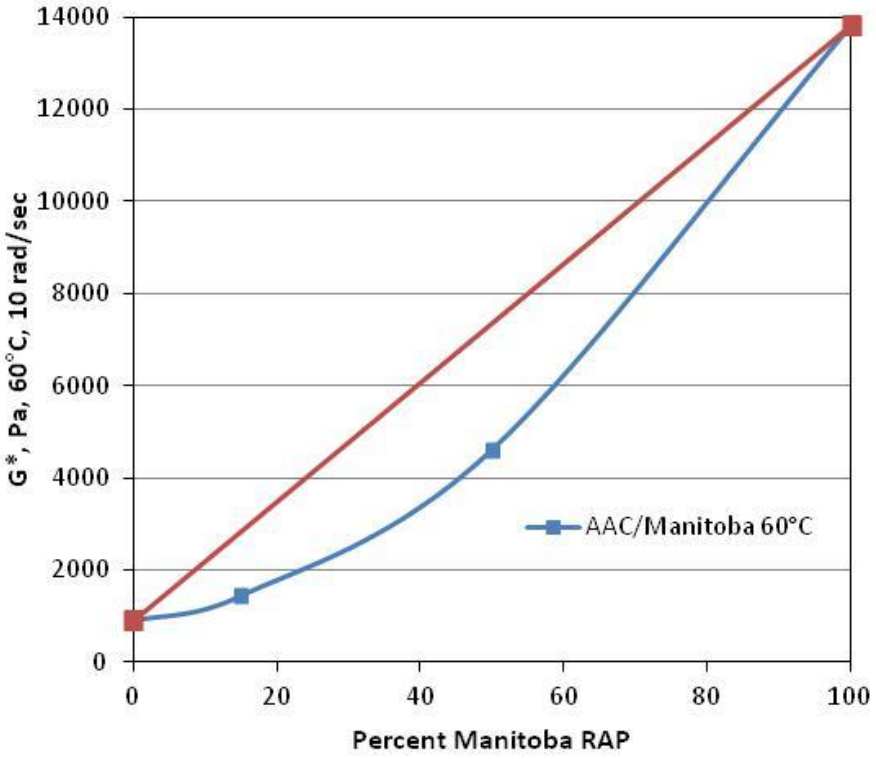
Virgin Asphalt RAP Blends





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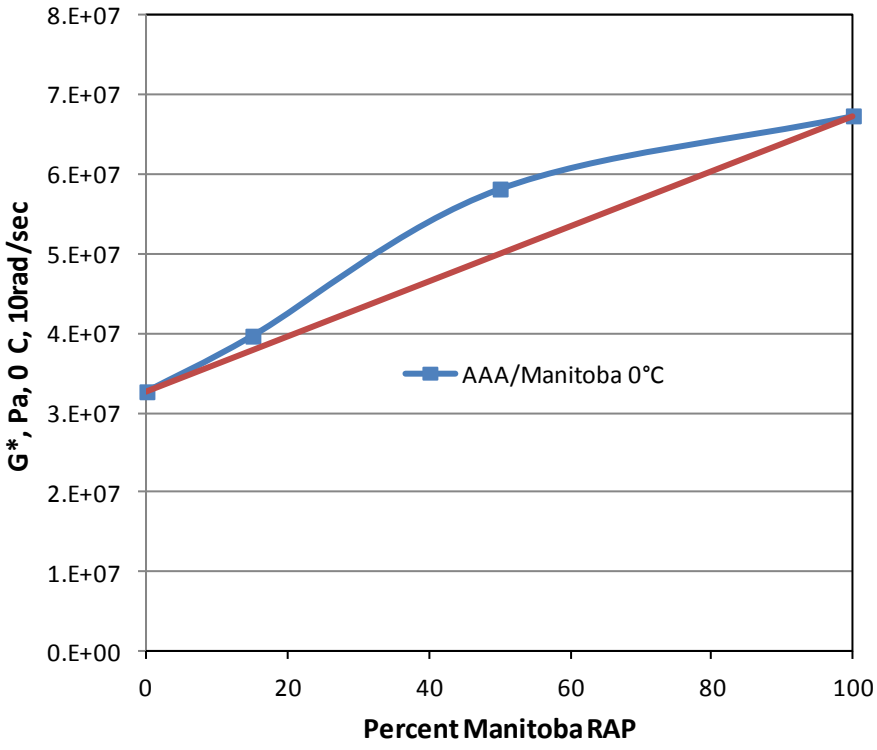

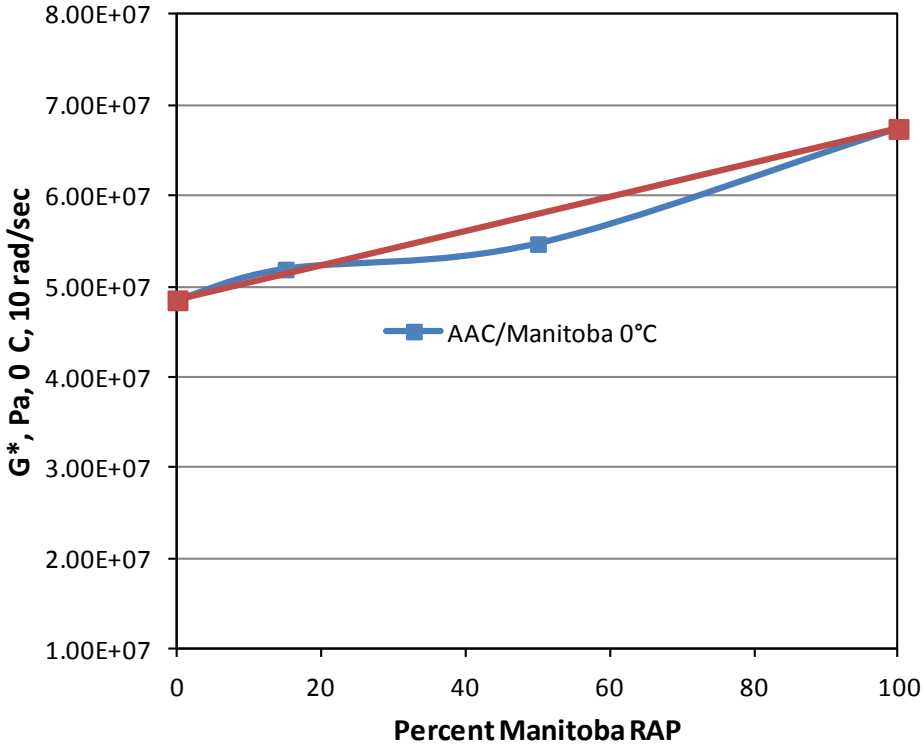

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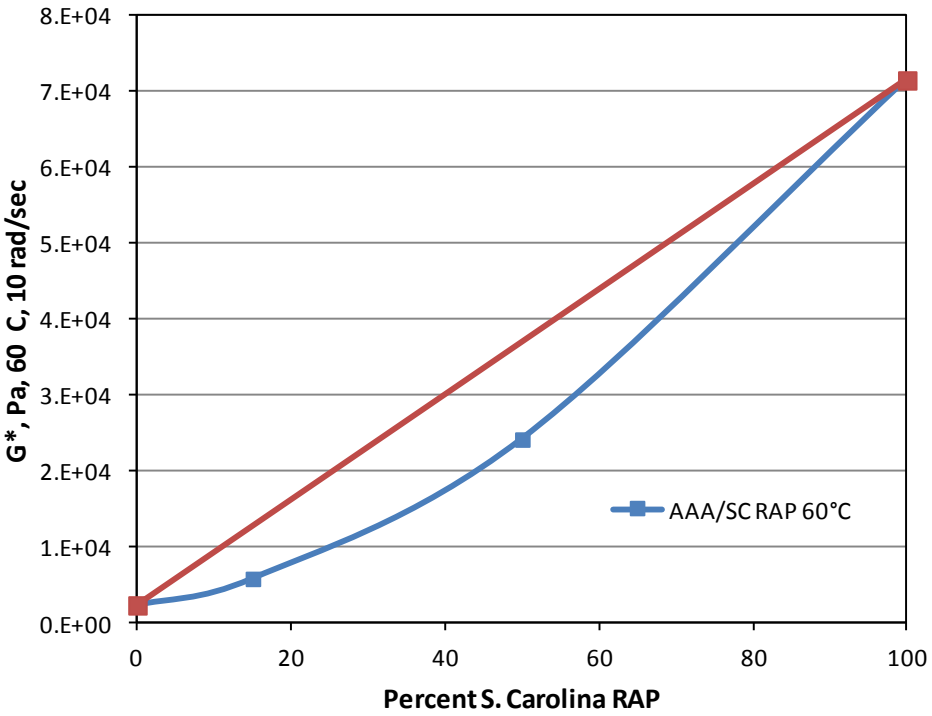

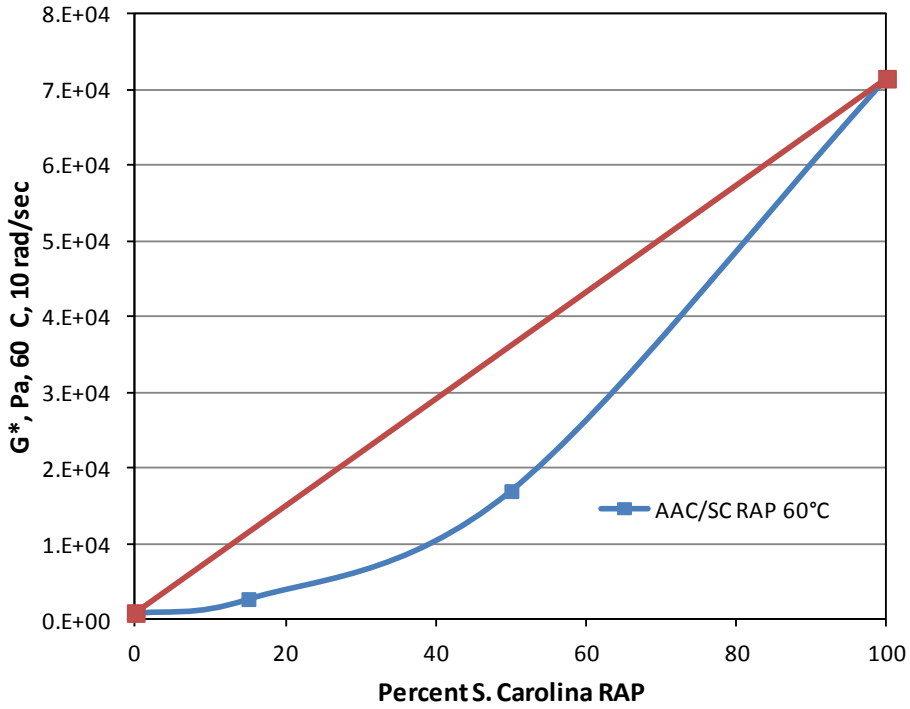

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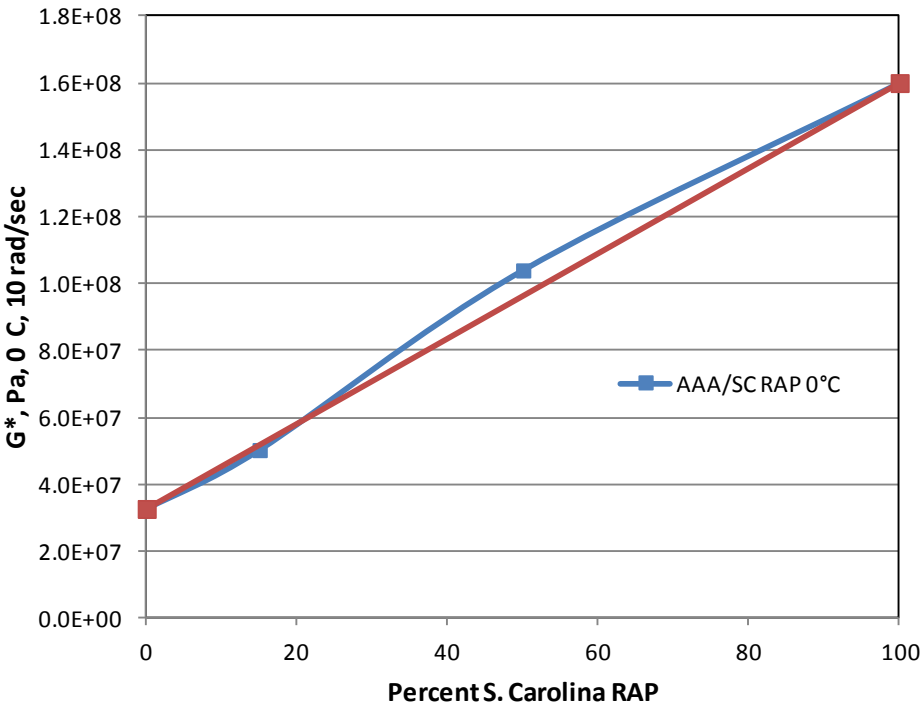

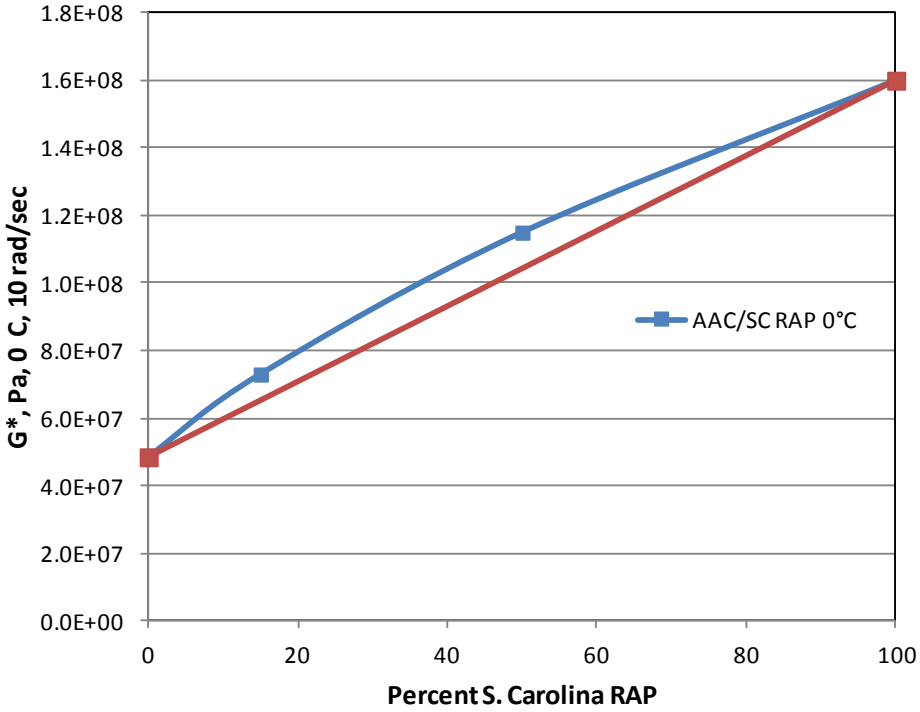

NCSC Plant Mix Study

- **5 contractors produced 6 RAP mixes**
  - **PG 64-22 with 0, 15, 25, and 40% RAP**
  - **PG 58-28 with 25 and 40% RAP**
- **Mix Testing**
  - **Dynamic modulus and Low Temp IDT**
- **Binder extracted and graded**
- **Samples of binder sent to WRI for compatibility (4 of 5)**

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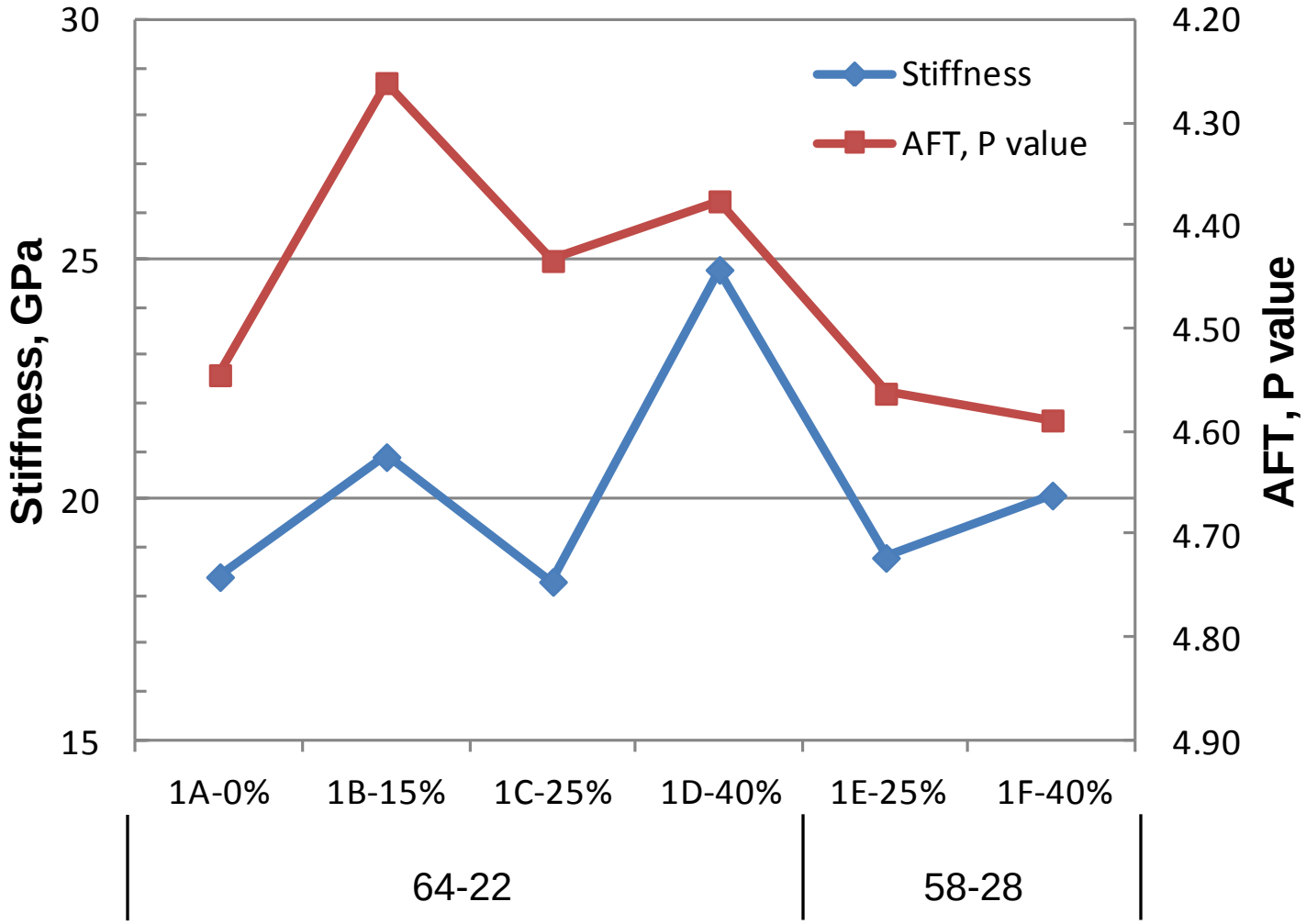
Mix Properties vs. Compatibility



Stiffness data from: *Investigation of Low and High Temperature Properties of Plant-Produced RAP Mixtures Phase II,* McDaniel and Huber

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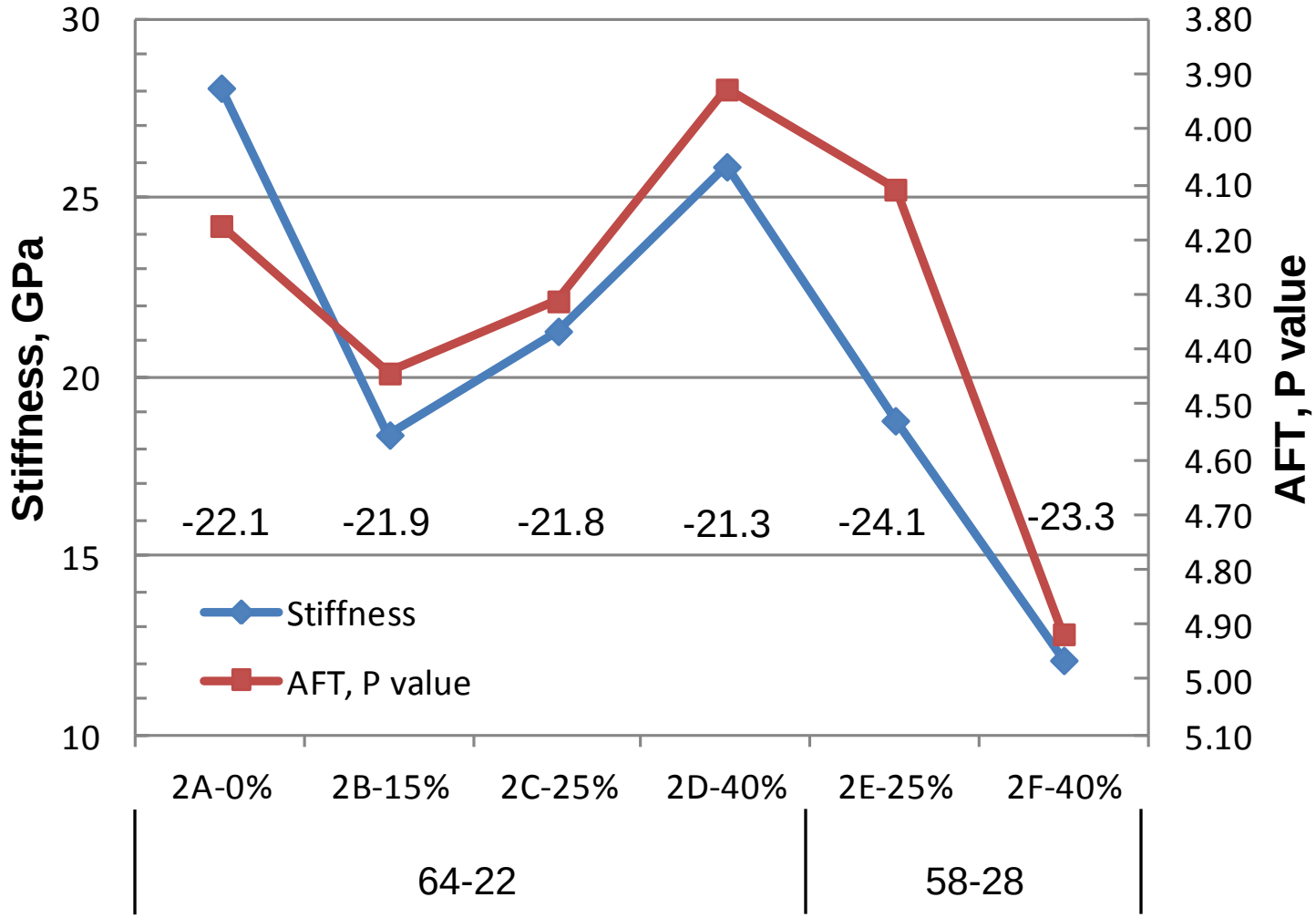

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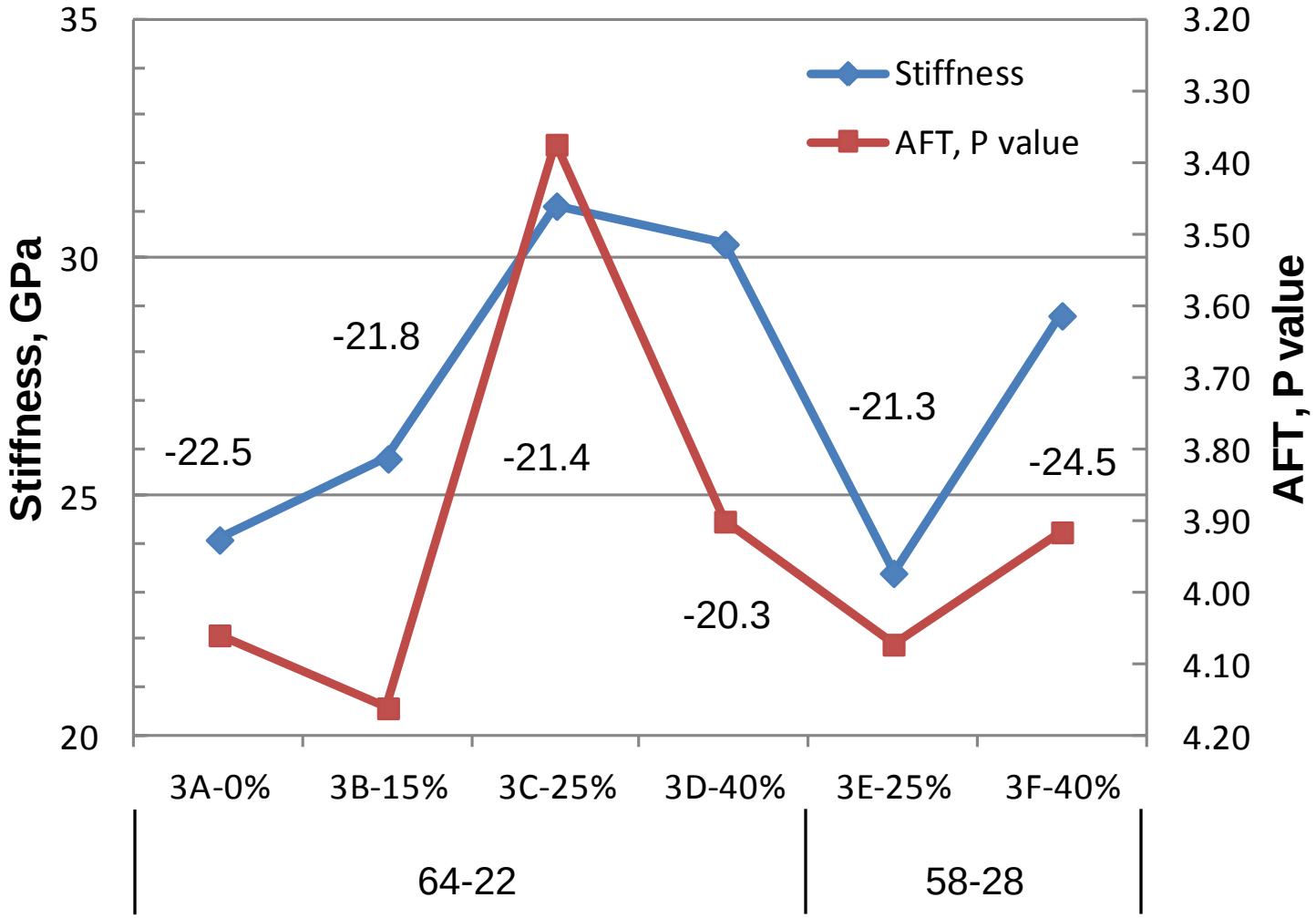

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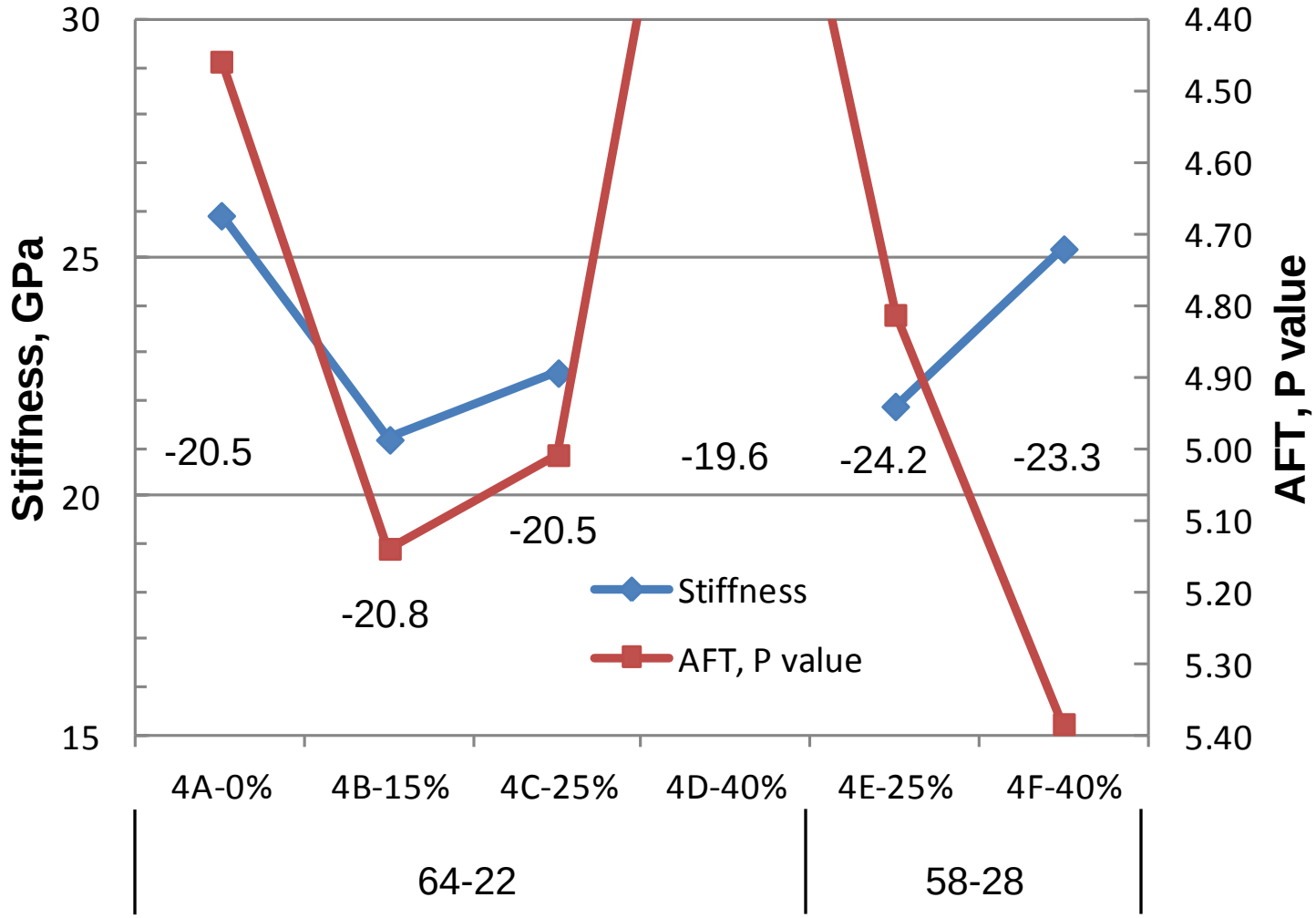

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Comments

- Lab binder blending study using rheology and compatibility will hopefully provide more insight
- Lab tests must correlate to plant mixing
- Goals of this are:
  - Better understanding of RAP/Virgin blending
  - Quick material evaluation method to determine the amount of RAP/RAS blending with new asphalt
- If oil prices rise, asphalt crude sources/blends are sure to change

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