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Effects of Rejuvenators on High-RAP Mixtures Based on Laboratory Tests of Asphalt Concrete Mixtures and Fine Aggregate Matrix Mixtures

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RESEARCH MOTIVATION

✓ Although the linear viscoelastic stiffness, fracture characteristics, and permanent deformation behavior of AC mixtures can be determined through experiments, it is generally time-consuming and expensive to reach statistically repeatable results. Thus, it is attractive to pursue alternative methods that are cheaper, faster, and repeatable in order to efficiently evaluate and predict asphalt mixtures' core mechanical characteristics (such as stiffness, fatigue, and plastic deformation).

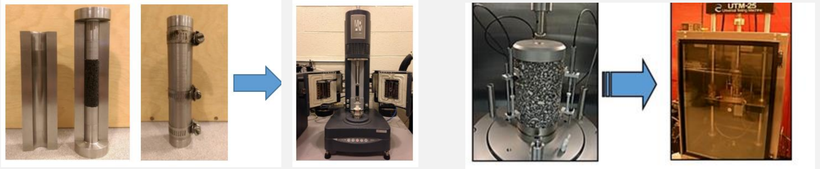
OBJECTIVE

✓ To explore a linkage in the performance characteristics between AC mixture and its corresponding fine aggregate matrix (FAM) phase. As an example, mixtures with three different rejuvenators were examined.

MIXTURES

Mixture ID	Compositions	Rejuvenator Addition
C	virgin aggregates (35%) + RAP (65%) + virgin binder (PG 64-34)	N/A
CR1	virgin aggregates (35%) + RAP (65%) + virgin binder (PG 64-34) + Rejuvenator 1 (petroleum-tech based)	9.0% of RAP binder was added to virgin binder
CR2	virgin aggregates (35%) + RAP (65%) + virgin binder (PG 64-34) + Rejuvenator 2 (green-tech based)	0.65% of RAP material was added to total batch
CR3	virgin aggregates (35%) + RAP (65%) + virgin binder (PG 64-34) + Rejuvenator 3 (agriculture-tech based)	5.0% of virgin binder was added to virgin binder

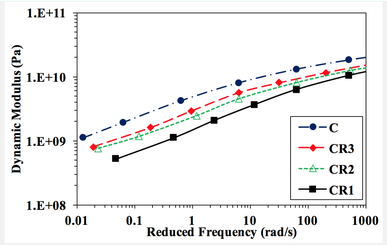
RESEARCH METHOD



FAM Testing

AC Testing

RESULTS – Dynamic Modulus (Stiffness)



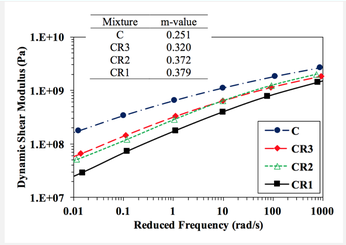
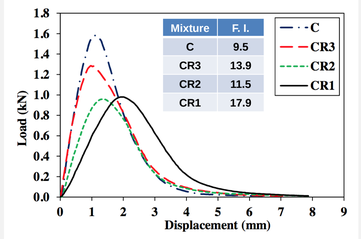


Fig. 1. Dynamic modulus test results of AC (left) and FAM (right).

RESULTS – Fatigue Performance



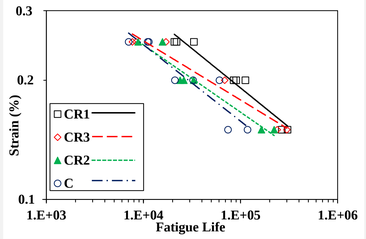
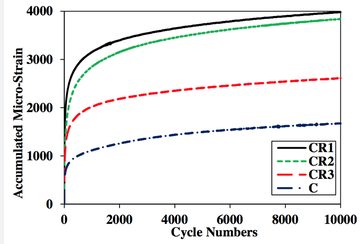


Fig. 2. Semicircular bending (SCB) tests results of AC (left) and fatigue life of FAM (right).

RESULTS – Permanent Deformation (Creep)



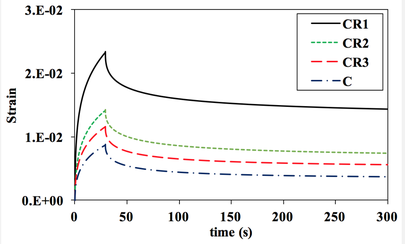


Fig. 3. Dynamic creep test results of AC (right) and creep-recovery test results of FAM.

RESULTS – Rank Order Comparison

Property/Performance	AC	FAM	Remarks
Viscoelastic Stiffness	CR1 < CR2, CR3 < C	CR1 < CR2, CR3 < C	ductile to stiff
Cracking Resistance	C < CR2 < CR3 < CR1	C < CR2 < CR3 < CR1	more resistant
Permanent Deformation	CR1, CR2 < CR3 < C	CR1 < CR2, CR3 < C	more resistant

CONCLUSION

- Rejuvenators made high-RAP mixtures softer and more compliant (ductile), which decreased viscoelastic stiffness and improved the fatigue resistance of high-RAP mixtures (65% RAP).
- Experimental results for the two length scales generally showed strong agreement, which indicates a close linkage between the AC and FAM.
- FAM scale tests seem to be good alternative for predicting AC mixture behavior by providing key information and thereby act as an efficient tool for screening materials.
- FAM testing showed material-specific behavior and is expected to significantly reduce the time and costs of testing the entire AC mixtures, due to its smaller geometry and much more homogeneous nature.

ACKNOELEDGMENTS

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