TRBAM-21-00116: Extended Aging Performance Of High RAP Mixtures and The Role of Softening Oils

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Introduction

- The 2018 NAPA's nationwide survey on recycled asphalt mixtures found 77% of state asphalt paving associations felt "there was room to increase the use of RAP materials";
- Softening oils are used to offset the effects of oxidative aging of recycled binder, thereby allowing higher contents of RAP to be used;
- While the state agencies and contractors have risen a concern of pavement performance of high RAP mixtures due to limited understanding of long-term service of the high RAP mixtures that utilizes the softening oils.

Objectives

- To investigate the rutting resistance and cracking resistance of 30%RAP and 50%RAP mixtures with three types of softening oils at various aging levels;
- To compare the effects of pre-blending softening oils into asphalt binder and spraying softening oils on the RAP prior to the mixing.

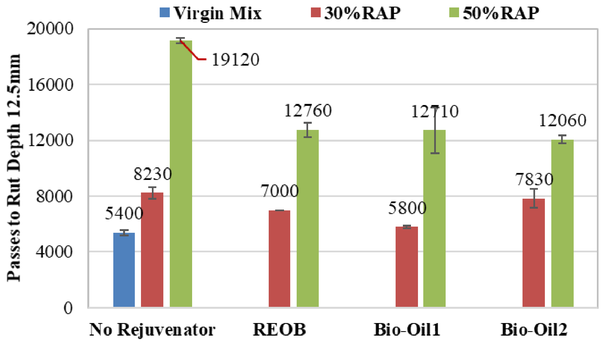
Materials

Factor	Level	Explanation		
Mixture type	3	Virgin Mix	30%JMF RAP	50%JMF RAP
Virgin binder	1	PG 58-28S		
Percent binder replacement	2	NA	27.0%	45.0%
Total AC,%	1	5.50		
Recycling agent type	3	NA	REOB; Bio-Oil#1; Bio-Oil#2	
Recycling agent dose	2	NA	REOB-5.0%; Bio-Oils-3.0%	REOB-10.0%; Bio-Oils-5.0%
Aging condition	3	Short-Term Oven Aging (STOA: 4 h at 135 °C); Long-Term Oven Aging (LTOA: 8 h at 135 °C and 16 h at 135 °C)		

Methods

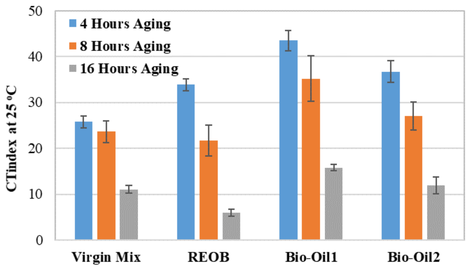
Temperature range	Selected testing method	Sample aging condition	Response parameter
High temp.	Hamburg Wheel-Track Test (HWTT) AASHTO T 324	STOA	Passes to rut depth 12.5 mm; creep slope
Intermediate temp.	Indirect Tensile Cracking Test (IDEAL-CT) ASTM D 8225	STOA; LTOA-8h; LTOA-16h	CTindex; Fracture Energy; Post-Peak Slope
Low temp.	Modified IDEAL-CT (0.5 mm/min at 0 °C)	STOA; LTOA-8h; LTOA-16h	CTindex

Rutting Resistance

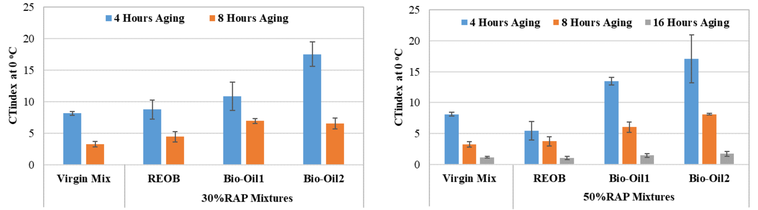


Cracking Resistance of High RAP Mixtures

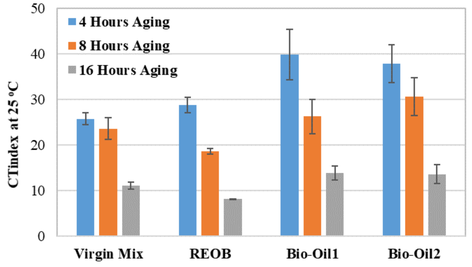
CTindex @25°C of 30%RAP Mixtures



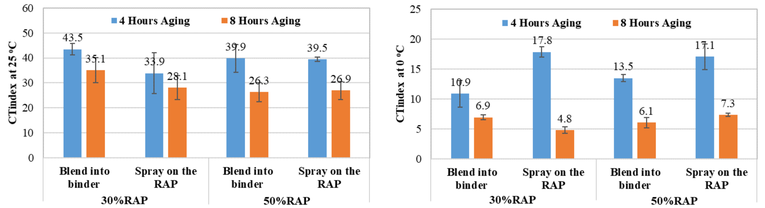
CTindex @0°C of 30%RAP and 50%RAP Mixtures



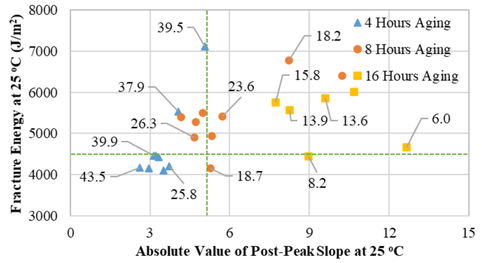
CTindex @25°C of 50%RAP Mixtures



Comparison between Two Oil Applying Methods



Fracture Energy VS. Post-Peak Slope



Main Findings

- Using proper dose of softening oils in high RAP mixtures are not expected to increase rutting relative to the virgin mixture.
- The addition of softening oils produced the CTindex at 25 °C similar and at times higher than an equivalent virgin mixture for the three levels of mixture aging.
- A minimum value of Fracture Energy and a maximum of absolute value of the Post-Peak Slope could be more effective as performance criteria for cracking and aging resistance.
- The addition of softening oils increased the CTindex at 0 °C of all RAP mixtures after the STOA and LTOA conditioning.
- The practical significance of the oil applying method resulted in marginal differences in the CTindex. Pre-blending of the softening oils in the binder is preferred.