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Investigation of fatigue and thermal cracking behavior of rejuvenated reclaimed asphalt pavement binders and mixtures

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Abstract

Bio-based rejuvenators are being under extensive study to enhance the properties of aged binders. Industry professionals and state transportation agencies are wary about incorporating high amounts of reclaimed asphalt pavement (RAP) into new mixtures owing to their high stiffness and low creep rate. In this work, a soybean-derived rejuvenator is used to rejuvenate an extracted stiff RAP binder. The rejuvenator is initially added to a PG58-28 binder using a 12% dosage. The modified PG58-28 is then blended with an extracted RAP binder at a ratio of 1:5. The critical high and low temperatures of the rejuvenated RAP binder are significantly lowered as revealed by the Dynamic Shear Rheometer (DSR) and the Bending Beam Rheometer (BBR) testing. A study of the BBR master curves shows significant improvement in the creep compliance of the rejuvenated RAP binder indicating the ability of the binder to dissipate thermal fatigue loading. The fatigue cracking of the rejuvenated RAP binder is considerably enhanced as suggested by both the fatigue and Glover-Rowe parameters. Disk compact tension (DCT) specimens made of 100% RAP mixed with the modified PG58-28 showed higher fracture energy compared to specimens made of 100% RAP and the neat PG58-28, when tested at -6^{o}C . To simulate full blending conditions, additional mixtures were prepared using extracted RAP binder blended with the neat PG58-28 and the modified PG58-28, and subsequently mixed with the recovered bare aggregates. These mixtures simulating full blending conditions showed higher increase in fracture energy.

1. Introduction

Reclaimed asphalt pavements (RAP) material is obtained from full-depth reclamation or milling of existing pavements [1]. The asphalt binder in the RAP is excessively aged due to many years of in-service thermal and ultraviolet oxidation. The aged RAP binder exhibits high stiffness and increased susceptibility to low temperature cracking. Unaged binders possess a significant ability to undergo stress relaxation which largely contributes to their thermal cracking and fatigue resistance. As a result of the oxidation process, aged RAP binders suffer from reduced stress relaxation ability in addition to high stiffness [2]. In terms of performance grade (PG), aging of binders typically causes an increase in both the critical high and low temperatures. The PG system was introduced to provide a means to classify binders where a binder designated as a