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Synergistic effect of SBS copolymers and aromatic oil on the characteristics of asphalt binders and mixtures containing reclaimed asphalt pavement

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ABSTRACT

Rejuvenators have been utilized to restore the physical and rheological properties of aged asphalt binders found in the reclaimed asphalt pavement (RAP). Also, the rejuvenators are utilized to enhance the cracking resistance of asphalt containing RAP. In addition, polymers have been efficiently applied to enhance the rutting performance of rejuvenated mixtures. The purpose of this study was to assess the influence of combining SBS copolymers and aromatic oil (AO) at the same time as a hybrid rejuvenator (HR) on the performance of high RAP asphalt binders and mixtures. HR is a mixture of 25% SBS and 75% AO. The properties of the rejuvenated binders were assessed by SARA (Saturates, Asphaltene, Resin, and Aromatics) fractions analysis, Fourier Transform Infrared Spectrum (FTIR), physical tests, high-temperature storage stability test, Dynamic Shear Rheometer (DSR) test, and Bending Beam Rheological (BBR) test. In addition, the mechanical behaviour of the rejuvenated mixtures was assessed using the Indirect Tensile Strength (ITS) test, moisture susceptibility test, resilient modulus test, and wheel tracking rutting test. The results showed that appropriate adjustment of the SARA fractions and SBS copolymer could improve the overall performance of mixtures and binders with high RAP content. However, it is asserted that a field investigation of this compound rejuvenator should be done to further analyze its influence on the long-term field behavior of high RAP mixtures.

1. Introduction

As transportation networks keep growing and expanding, more highways must be built, resulting in increased consumption of aggregates and asphalt binders. However, the excessive excavation of aggregates from mountains and rivers causes several environmental threats since they are neither renewable nor producible [1]. Furthermore, the scarcity of natural resources and the high price of asphalt binders and waste disposal at dumping sites motivate authorities to extract and recover existing pavement components known as reclaimed asphalt pavement (RAP) to be utilized as pavements materials [2]. As a result, the recycling of RAP materials in the construction of pavements has resulted in many environmental benefits as well as economic savings due to the reduced usage of raw asphalt binders and aggregates [3].

It has been observed that the addition of low dosages of aged binder (denoted as RAP in this study) i.e. below 15% has little or no influence on the characteristics of asphalt mixtures [4–6]. On the other side, it was found that utilizing a content of RAP higher than 25% in asphalt mixtures will cause early fatigue and low-temperature cracking [7–9]. Therefore, most agencies worldwide currently set the allowable RAP content in mix designs to be less than 40% [10]. According to literatures [11–13], a high RAP content can increase the stiffness of asphalt by 25 – 60%. Mogawer et al. [14] reported that the binder of an asphalt mixture containing 40% RAP was 49% stiffer than the binder of a virgin mixture. Likewise, Chen et al. [15] found that adding 30–50% of RAP to asphalt mixtures would make mixtures further brittle and susceptible to cracking at low-temperature. Zhang et al. [16] estimated the mechanical characteristics of asphalt mixtures containing 40% and 60% RAP. As a

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