10th International Congress on Civil Engineering, 5-7 May 2015
University of Tabriz, Tabriz, Iran

Modeling of the stiffness modulus of stone matrix asphalt containing recycled tire rubber

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Abstract

Nowadays, the re-use of recycled waste materials in asphalt concrete as modifier additives have large economic and environmental benefits. Stone matrix asphalt (SMA) is a conventional type of asphalt concrete and adding Recycled Tire Rubber (RTR) can improve dynamic properties such as the stiffness modulus (SM). The objective of this study is to evaluate the effect of RTR on the stiffness modulus of SMA. In addition, a model has been presented to describe the stiffness modulus of SMA mixture containing RTR. The results of this research showed an improvement in the stiffness modulus of SMA mixtures containing RTR in comparison with the conventional hot mixed asphalt (HMA) concrete.
Keywords: Asphalt concrete, Stone Matrix Asphalt (SMA), Stiffness modulus, Hot Mixed Asphalt (HMA) concrete.

1. INTRODUCTION

Providing a surface having resistance to repeated loads is a challenge facing all the road agencies. Pavements under repeated loads has to be checked and repaired continuously leading to high rehabilitation and maintenance costs. The use of new asphalt concrete mixtures like stone matrix asphalt (SMA) is a common solution to improve the asphalt pavement performance and prevent damages of repeated loads resulting in a high economic benefit in highway investment projects[1].

Stone matrix asphalt (SMA) is a type of hot mixed asphalt (HMA) concrete with gap-graded aggregate (mainly coarse aggregate) consisting of asphalt cement (typically 5.5–7%), filler (typically 8–12%), and stabilizing additive. The increasing of stone to stone contact of aggregate is the main advantage of gap gradation leading to high rut resistance and high durability. Other advantage of SMA are high skid resistance, improved resistance to reflective cracking, better drainage condition and reduced noise pollution. The Additives are used to prevent binder drainage that is the main problem of SMA mixtures due to the high amount of binder. Fibres and Polymers are two common types of additives. Preventing binder drainage, fibres such as polyester fibre, mineral fibre and cellulose fibre can relatively change the viscoelasticity of mixture; improves dynamic modulus, tensile strength and moisture susceptibility, creep compliance, rutting resistance and fatigue life; while significantly lowers the amount of drain-down of asphalt mixtures. On the other hand, decreasing the binder drain-down, polymers (such as styrene–butadiene–styrene (SBS), ethylene–vinyl–acetate (EVA), polyethylene or polypropylene) also enhance the mechanical properties of asphalt mixtures [2].

By adding virgin materials to asphalt mixture, the construction cost of highway increases. Consequently, using waste materials such as Polyethylene Terephthalate (PET), tire, carpet, and polyester fibres has been popular recently resulting in reducing environmental pollution. Many research have been done to determine the effect of these additives on the SMA mixture. E. Ahmadinia et al [3] have shown that after the addition of PET, the stiffness modulus (SM) increases until it reaches the maximum level, after which it starts to decrease. The SM values of mixtures containing PET were generally greater than the conventional mix (0% PET) and the achieved results indicate that the maximum value of MR was obtained by adding 6% PET, which showed that the SM had increased by 16% compared to the conventional mix. The research of T. Baghaee Moghaddam et al [4] has indicated that in the same stress levels stiffness of mixtures increases initially with addition of PET followed by a decreasing trend and test results indicate that PET reinforced asphalt mixtures have considerably higher fatigue lives in comparison with control mixtures (the mixture without PET). According to the research of E. Ahmadinia et al [5], after adding PET, the stability value increased until it reached the maximum level,