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The Effects of Nano Bentonite and Fatty Arbocel on Improving the Behavior of Warm Mixture Asphalt against Moisture Damage and Rutting

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Abstract

The use of warm mix asphalt (WMA) technology has increased dramatically in recent years to protect the environment and reduce energy consumption. Despite numerous advantages, WMAs are less commonly used as a result of their lower performance in comparison to HMAs. One of the main reasons for the low performance of WMAs is their high moisture sensitivity. In recent decades, bitumen modifiers have been used to improve the performance of asphalt mixtures. One of the additives that has recently been used to modify the characteristics of bitumen, is bentonite. The grade of asphalt cement used in this study is PG 64 -22 and the Bitumen is modified with 1, 3, 5 and 7% nano bentonite. Also, 0.3% fatty Arbocel has been used for the preparation of WMA. Indirect tensile strength (ITS) test and Nicholson stripping test are used to determine moisture sensitivity and dynamic creep test and LCPC are also used to evaluate the rutting potential. The results indicate that, increasing the percentage of nano bentonite and applying 0.3% of fatty Arbocel improves the resistance of mixture against moisture damage. Also it was found that increasing the mixture hardness decreases the permanent displacement and rutting potential of WMAs. So, it is suggested that the consumption of these additives increases WMA's lifetime and decreases its maintenance cost.

Keywords: Warm Mix Asphalt; Dynamic Creep Modules; Rutting; ITS.

1. Introduction

Possible failures in WMAs are divided into four major groups: 1. Permanent deformation or rutting, 2. Fatigue or load associated cracking, 3. Low temperature or thermal cracking, 4. Moisture damages. WMA is an emerging technology, In line with concerns about global warming and energy consumption in asphalt industry. In WMA production, the mixing and compaction temperature are reduced from 10 to 38 $^{\circ}$C compared to the HMA (Hot mix asphalt) that is produced and compacted at temperatures of 145 to 150 $^{\circ}$C [1]. Production of temperature reduction results in reduced fuel consumption and manufacturing costs. It also reduces the amount of greenhouse gas emissions in asphalt production process [2]. Modified bitumen is one solution for improving the pavement performance [3]. Clay modified bitumen had been used since 100 years ago. As soon as the clay particle-page reaches inside the bitumen, it creates similar rebar properties inside reinforced concrete which improve bitumen performance against cracking and deformation in high temperatures [4]. Research shows that adding clay to bitumen increases bitumen softening point and decreases its elasticity which increases the resistance of hot mix asphalt against thermal cracking [5]. Adding nano

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