Effect of Polymer Modifiers on Stone Matrix Asphalt Rutting

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Abstract

The purpose of this study is to evaluate performance of control and modified stone matrix asphalt mixtures. Conventional and four modified mixtures were studied on SMA performance. Ethylene vinyl acetate (EVA), Elvaloy, styrene-butadiene rubber (SBR), and Lucobit were used as modifiers. SMA mixtures containing 60/70 penetration grade unmodified bitumen and polymer modified bitumen were plant prepared with one source of aggregate. For this study specimens were made and designed by Marshall method which is the most common design method in Iran. Dynamic creep and indirect tensile strength tests were used for evaluation of performance of control and modified mixtures. Elvaloy-modified mixture has resulted to highest value of ITS and flow number. It was also observed that Elvaloy-modified mixture had the most resistance in view of rutting.

Keywords: Stone matrix asphalt, Modified bitumen, Indirect tensile strength, Rutting resistance.

1. INTRODUCTION

Stone matrix asphalt (SMA) is hot mixture asphalt consisting of a coarse aggregate skeleton and a high binder content mortar. SMA was developed in Germany during the mid-1960s and it has been used in Europe for more than 20 years to provide better rutting resistance and to resist studied tire wear [1]. Because of its success in Europe, some states, through the cooperation of the Federal Highway Administration, constructed SMA pavements in the United States in 1991 [2]. Since that time the use of SMA in the US has increased significantly.

According to the SMA Technical Working Group, SMA is a gap graded aggregate-asphalt hot mixture that maximizes the asphalt cement content and coarse aggregate fraction. This provides a stable stone-on-stone skeleton that is held together by a rich mixture of asphalt cement, filler, and establishing additive. The original purpose of SMA was to provide a mixture that offered maximum resistance to studded tyre wear. SMA has also shown high resistance to plastic deformation under heavy traffic loads with high tyre pressures, as well as good low temperature properties [3, 4].

A study conducted in Ontario, Canada, by the Ministry of Transportation on SMA pavement slabs trafficked with a wheel-tracking machine gave less rut depths in comparison to that occurring in a dense friction coarse [5]. The main concept of having a gap gradation of 100% crushed aggregates is to increase pavements stability through interlock and stone-to-stone contact. This mixture is designed to have 3–4% air voids, and relatively high asphalt content due to the high amount of voids in the mineral aggregate. The mixture contains high filler content (10% passing the 0.075-mm sieve), and typically contains a polymer in the asphalt cement, or fiber (cellulose or mineral) in the mixture to prevent drainage of the asphalt cement. This mixture has a surface appearance similar to that of an open graded friction course, however it has low in-place air voids similar to that of a dense graded HMA.

The addition of polymers, chains of repeated small molecules, to asphalt has been shown to improve performance. Pavement with polymer modification exhibits greater resistance to rutting and thermal cracking, and decreased fatigue damage, stripping and temperature susceptibility. Polymer modified binders have been used with success at locations of high stress, such as intersections of busy streets, airports, vehicle weigh stations, and race tracks. Polymers that have been used to modify asphalt include styrene-butadiene-styrene (SBS), styrene-butadiene-rubber (SBR), Elvaloy, rubber, ethylene vinyl acetate (EVA), polyethylene,