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Determination of Resistance to Creep Permanent Deformation of Hot Mix Asphalts Prepared with Various Additives

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Abstract

In this study, the resistance of hot mix asphalts containing different additives to the creep permanent deformation was investigated by the dynamic creep test. Four different additives were used in the study. Styrene-butadiene-styrene (SBS), American Gilsonite (AG), and Iranian Gilsonite (IG) were used for modifying the bitumen. Additionally, the same mixtures were prepared by using 2% hydrated lime as filler. The samples were subjected to dynamic creep test at 50°C under 500 kPa stress level. As a result of the tests performed, it has been determined that all of the additives used in the study improve the resistance to the creep permanent deformation. It has also been determined that the use of bitumen additives is more effective than the use of lime. Furthermore, it has been determined that the most effective additive is IG while the least effective additive is SBS, and hydrated lime use is more effective compared to the mixtures prepared with a neat binder.

Keywords: Creep Permanent Deformation; Hot Mix Asphalt; Modification; Styrene-Butadiene-Styrene; American Gilsonite; Iranian Gilsonite; Hydrated Lime.

1. Introduction

Hot mix asphalt (HMA), is a type of highway flexible pavement material, formed by mixing of aggregate and bitumen at certain ratios and compacting the resulting mixture at a certain temperature [1]. Hot mix asphalts consist of solid (aggregate), liquid (bitumen) and gas (air void) phases. The behavior of asphalt mixtures depends on the loading rate, temperature, aging of the binder, and air void content of the mixture [2]. Depending on the traffic loads and climatic stresses, various deteriorations occur in hot mix asphalts [3].

Rutting, which is one of the most common types of deterioration, is defined as the increased deformation in each layer of pavement under constant traffic load [4]. The most significant layer in terms of permanent deformation is the pavement layer, which is directly exposed to the traffic load [5]. Permanent deformations can occur during various periods of the pavement's service life. Mainly, there are three occurring mechanisms of permanent deformation (Figure 1). The first is the consolidation permanent deformation that occurs in the first years of the pavement's service life. Such deformations generally result from the consolidations, which occur due to lack of sufficient compaction during the construction of the asphalt layers. The second type of permanent deformation is called creep permanent deformation. It was determined that the permanent deformations observed on site are generally creep permanent deformations. The creep permanent deformation of asphalt layer is caused by a combination of consolidation (volume change) and shear deformation (no volume change) resulting from the dynamic pressure of traffic loads. The shear deformation of properly constructed (compacted) pavements – caused primarily by large shear stresses in the upper portions of asphalt layer(s)

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