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Improving Fatigue Performance of Bitumen by Binary Modification

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Abstract

This study was conducted to evaluate rheological, damage and performance properties of Binary Modified (BM) Asphalts. The research investigated the effectiveness of a specific processing with or without polymer to improve fatigue properties. BM includes a refining process in which an oxidation technique is used to adjust molecular structure of asphalts combined with a limited polymer concentration to achieve better performance. The changes in workability of binders due to modification were evaluated using rotational viscosity at various temperatures. Also, the performance under cyclic loading was evaluated using a Dynamic Shear Rheomter following a protocol recently developed at various stress and temperature levels. The results show that significant improvements in fatigue can be achieved with the binary modification with minimal effect on workability. The process appears to be adjustable to achieve various levels of improvements.

Keywords: Asphalt, Binary Modification, Rhelogical Properties, Fatigue

1. INTRODUCTION

Over the past decade, many research studies have been conducted to explore the effect of various modifications on resistance to rutting in pavement. Enhancement in rutting resistance raises concern that the stiff asphalts may be more susceptible to fatigue cracking in the long term especially if the asphalt binder ages (stiffens) due to oxidation. Fatigue resistance of asphalt is typically defined as their ability to respond to repeated traffic loading under the climate condition without significant cracking. Similar to other materials, fatigue cracks begin in asphalt pavement as micro-cracks that propagate under repeated loads, eventually leading to macro-cracks that are visible on the pavement surface.

Binder testing and evaluation of binder fatigue has advanced significantly in recent years. A new binder fatigue test and a new repeated creep test have been introduced to estimate binder contribution to resistance of fatigue as well as rutting of asphalt mixtures. These new binder tests could help estimate the effect of modification technique on performance of asphalts [1-6]. Specific binder tests and parameters were conducted in this research to achieve a better understanding and predictive capability for fatigue resistance of asphalt at intermediate pavement temperatures. The parameters under consideration can account for traffic volume and speed for better performance evaluation of asphalt.

Numerous asphalt modification techniques are being used to improve temperature susceptibility of asphalts in order to provide a wide range of application temperature [1, 2]. Some modifiers improve the low temperature properties, some modifiers improve high temperature properties, and some other can achieve both [2-8]. Modification of asphalts can be done using the following three major technologies:

- Modification with additives
- Modification without additives (also called process modification)
- Hybrid modification

The first 2 types have been used widely. A good and common example for the first type (with additives) is polymer modifiers. Examples of the second type are modification with oxidation and chemical modification. There are advantages and disadvantages for each type of modification depending on application conditions and required level of modification. One of the main advantages of using polymer is the significant improvement in damage resistance and durability of paving asphalts [8-10]. Some of the main disadvantages of using additives in general are compatibility, cost, and phase separation.

In the modification without additives, oxidation and other refining processes are used to change the molecular structure of asphalts to induce certain characteristics. The low cost of refining modification, relative to polymer and other modifiers, makes it alternative very important and competitive. These processes