Achieving Optimum Rutting Resistance of Bitumen Using Oxidation and Polymers - A Laboratory Study

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Abstract

This study was designed to investigate the changes in rheological and rutting resistance of selected bitumen binders due to a special modification process called Binary Modified (BM). BM includes a specific refining process in which an oxidation technique is used to adjust molecular structure of asphalts combined with a limited polymer concentration to enhance resistance to rutting, fatigue, aging, and low temperature cracking. This paper includes a comprehensive set of testing data showing the improvement in rutting properties. The results show the promise of combining the specific oxidation technique with polymer addition to optimize cost and rutting performance under varying loading and temperature conditions.

Keywords: Asphalt, Binary Modification, Rhelogical Properties, Rutting

1. INTRODUCTION

There is an increasing interest in using modified asphalts to address deterioration of roads due to severe climate and traffic conditions. Rutting is one of the most damaging distresses in pavements because it commonly requires removing and replacing asphalt mixtures. Numerous modification techniques are being used to improve resistance to permanent deformation as well as other distresses [1, 2]. Modifiers vary in their effects on bitumen properties and it is known that some improve the low temperature properties, some improve the high temperature properties, and some other can achieve both [2-9].

Modification of paving bitumens has been achieved by one of the following techniques:

- Modification with additives such as polymers and oils
- Modification without additives (also called process modification), such as oxidation or acid addition
- Hybrid modification, which is a combination of the first two.

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 [7-11]. Some of the main disadvantages of using additives in general are compatibility, cost, and phase separation. In fact, many modifications with additives have shown significant improvement in asphalt properties and thus improved pavement performance [1-3]. However, the use of the additives, like polymer modifiers, has added cost and created production and construction concerns. For example, polymer modified asphalts need special mixing, agitation, storage facilities, and compaction methods.

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 the refining modification alternative very important and competitive. These processes are considered favorable compared to polymer modification due to more stability of modification, less reaction time, and homogeneity of the modified asphalt. Also it can eliminate special handling requirements during storage and production. It is also known that cost is generally lower than that for polymer or other modification techniques.

Thermal oxidation is not a new technique; In fact the majority of asphalt refineries utilize one form or another of "air-blowing" to increase stiffness. It is generally done in what is called a "blowing still" in which temperature is elevated and air is injected in hot asphalt to promote an oxidation reaction [6, 8, 10]. The reaction is an exothermic one that causes polymerization, which is generally realized as formation of esters, and dehydrogenation, which results in formation of cyclic hydrocarbons with water as a side product.