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Rheological properties of asphalt binder containing Hydrated lime

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Abstract

Sustainable development addresses concerns about limited natural resources and impacts of human beings on environment. In this regard, construction of durable pavements that can withstand both traffic and climate effects is essentially required. Moisture damage is the most premature distress that affects asphalt pavement life and performance. Hydrated lime (HL) is the most commonly used anti-stripping agent that decreases deteriorating effects of water on asphalt mixtures. The main objective of this study is to characterize the properties of HL-modified mastic through superpave asphalt tests and compare them by the base binder. A PG 64-22 asphalt binder from Tehran refinery (Pasargad) was used as the base binder. The concentrations of HL tested were 20, 30 and 40 percent of the base binder weight. The viscosity properties for the binders in the original state, rutting resistance, fatigue cracking properties, and the low temperature crack resistance were evaluated. Superpave binder tests showed that hydrated lime strongly improves high-temperature rheology, but it deteriorates the low temperature performance slightly.
Keywords: Hydrated lime, Binder rheology, Superpave, Asphalt binder

1. INTRODUCTION

The asphalt industry has always incorporated new technologies into the design, construction and maintenance of pavements in order to optimize the use of available resources. In other words, the goal of these technologies is to produce asphalt mixtures withstanding imposed traffic and thermal loading and the deteriorating effects of water while considering environmental issues [1,2].

Many of premature distresses that affect the asphalt pavement performance are related to the moisture damage [1,3]. For instance, Stripping occurs when the bond between the asphalt binder and the aggregate breaks down due to the presence of moisture, and the binder separates from the aggregate [1]. Cohesion (asphalt mastic bond) and adhesion (binder-aggregate bond) within asphalt mixtures have a key role in the moisture susceptibility of asphalt pavements [1,3,4]. Hydrated lime (HL) is the most commonly used anti-stripping agent [3]. This treatment can decrease moisture susceptibility via three main mechanisms:

I. Hydrated lime reacts with the asphalt binder. Highly polar molecules (carboxylic acid and 2-quinolene groups) in the asphalt react with Lime to form insoluble salts. Conversion of those polar molecules to insoluble salts prior to mixing process should prevent adsorption of water-sensitive free acids to form water-soluble soaps that promote stripping. [1,3,4,5]
II. HL reacts with aggregates and facilitates strong bonding between asphalt basic nitrogen groups and the aggregate surface [1,3,4,5]
III. When aggregates are coated with clays, hydrated lime can react pozzolanically to remove those deleterious materials that would otherwise damage the mixture [1,3,4,5].

Although the ability of hydrated lime as an anti-stripping additive has been widely accepted, recent studies states that lime also generates other important benefits for asphalt mixtures [4,5]. The behavior of fillers in different binder types is not easy to predict due to the complex nature of the interactions between the two materials [2,5,6]. The mastic formed from filler and binder can be considered the “true binder” of the mixture and thus the properties of the mastic, and hence the properties of filler are important in an asphalt mixture [5,7,8,9].