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High temperature properties of rubberized binders containing warm asphalt additives

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Abstract

Several studies have been conducted evaluating the properties of warm mix asphalt (WMA), and it is observed that warm asphalt additives work in different ways to either reduce the viscosity of the binder or to allow better workability of the mix at lower temperatures. In terms of rubberized asphalt mixtures, they are compacted at a higher temperature than conventional mixtures, based on the field experience. If the technologies of warm mix asphalt are incorporated, it is expected to reduce the mixing and compaction temperatures of rubberized asphalt mixtures to those of conventional mixtures. This paper presents the high temperature properties of rubberized binders containing warm asphalt additives. Rubberized binders were produced at 10% by binder weight using five binder sources, and the binders with the additives were produced using two (i.e. Aspha-min® and Sasobit®) of the available processes and artificially short-term aged through the rolling thin film oven (RTFO) method. Tests were conducted on the binders using the rotational viscometer and the Dynamic Shear Rheometer. The results indicated that the viscosity properties of rubberized binders can be changed significantly through the use of warm asphalt additives. Also, the addition of the additives was found to improve rutting resistance of the rubberized binders.

Keywords: Warm asphalt additive; Crumb rubber modifier: Viscosity; Rutting resistance

1. Introduction

1.1. Background

Previous studies have indicated that rubberized binders can produce asphalt pavements that exhibit decreased traffic noise, reduced maintenance costs and resistance to rutting and cracking [18,14,6,20]. Because of these advantages, there is an increasing interest in utilizing rubberized binders in hot mix asphalt (HMA) pavements in some states in the Unites States and other countries [2,24,20].

The warm mix asphalt (WMA) refers to technologies that allow reducing the mixing and compaction temperatures significantly for unmodified binders by reducing the viscosity of the binders [8]. Reduced mix production and paving temperatures would decrease the energy required to make HMA, reduce emissions and odors from plants, and improve the working conditions at the plant and paving site [9]. In terms of rubberized asphalt mixtures, they should be compacted at a higher temperature than conventional mixtures, based on the field experience [1]. If the technologies of warm mix asphalt are incorporated, it is predicted to observe a reduction in the mixing and compaction temperatures of rubberized asphalt mixtures compared to those of conventional mixtures. The properties of the binders need to be investigated further prior to utilizing the rubberized mixtures containing warm asphalt additives. However, the effect of warm asphalt additives on rubberized binders is not studied in detail yet.

Among several warm asphalt additives, this study concentrated on two additives, Aspha-min® and Sasobit®. The Aspha-min® is hydro thermally crystallized as a very

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fine powder. It contains about 21% crystalline water by weight [3]. Sasobit® is long chain aliphatic hydrocarbon obtained from coal gasification. After crystallization, Sasobit® forms a lattice structure in the binder which is the basis of the structural stability of the binder containing Sasobit® [19].

1.2. Research objectives and scope

The main objective of this research was to investigate the high temperature properties of rubberized warm asphalt binders through selected Superpave binder tests. The rubberized binders were produced in the laboratory incorporating one crumb rubber modifier (CRM) source (ambient) and one CRM percentage (10% by weight of asphalt binder) into five base binders. The rubberized warm asphalt binders were manufactured with two different warm asphalt additives, Aspha-min® and Sasobit®, and artificially short-term aged using rolling thin film oven (RTFO) procedure. The viscosity and rutting properties for the binders in the original state, and the rutting properties after RTFO aging process were evaluated. Fig. 1 shows a flow chart of the experimental design used in this study.

2. Materials and test program

2.1. Materials

2.1.1. Asphalt binders

Five PG 64-22 asphalt binders designated as A, B, C, D, and E from different crude sources were used in this study. Binder A was a mixture of several sources that could not be identified by the supplier, binder B was from a Venezuelan crude source, binder C was from a Texas, binder D was

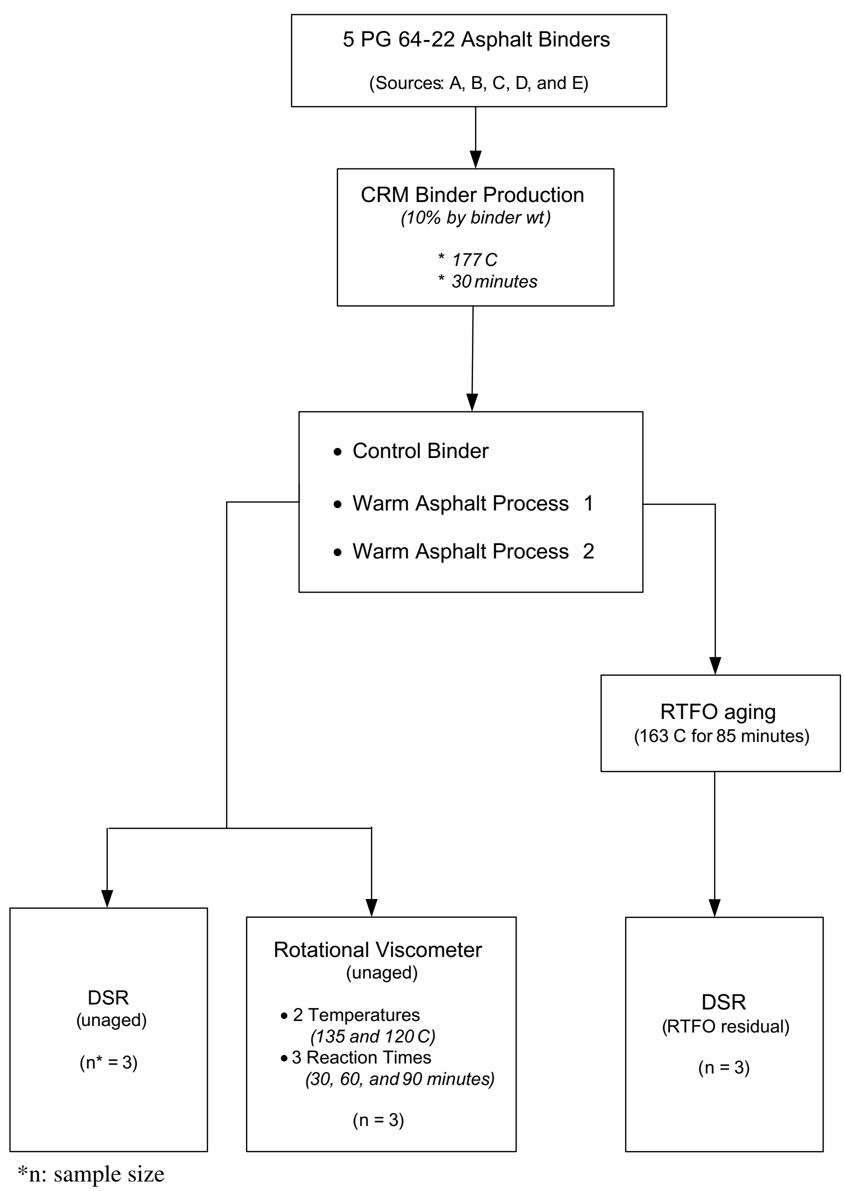

Fig. 1. Flow chart of experimental design procedures.