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Study Investigating the Influence of Warm-Mix Asphalt Additives on Rutting and Fatigue Performance of Nano-Modified Asphalt Binders

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Abstract

The current study investigates the synergized effect of a nanomaterial and two warm mix additives asphalt (WMA) additives on different properties of asphalt binders. The study used an optimal percentage of 2% for nano-Al_2O_3; two WMA additives were used in different concentrations. The results revealed that the addition of WMA additives increased the softening point of nano-Al_2O_3 modified asphalt binder. Penetration and ductility results showed a decrease after the introduction of WMA additives. The viscosity of nano-Al_2O_3 modified asphalt binders showed a reduction after the introduction of WMA additives. Rutting evaluation was done by using the superpave rutting parameter and multiple stress creep and recovery (MSCR) test. The fatigue performance of the asphalt binders was measured using the superpave fatigue parameter and linear amplitude sweep (LAS) test. Results showed that the introduction of WMA additives improved the rutting and fatigue performance of nano-Al_2O_3 modified asphalt binders. The introduction of WMA additives enhanced the aging performance of the nano-Al_2O_3 modified asphalt binders.

Keywords

infrastructure, materials, binders, asphalt binder aging, asphalt binder modifiers, binder specifications, fatigue cracking, high-temperature binder testing, multiple stress creep recovery (MSCR), performance tests, physical properties, rheological properties, rheology, rutting, specifications

Nanomaterials are defined as functional structures with at least one characteristic measurement in nanometres. In recent years, the field of nanotechnology has seen major leaps: it has found applications in the field of physics, electronics, and chemistry. Most recently the application of nanotechnology has also emerged in the field of engineering. Nanomaterials have exhibited appealing characteristics and these novel characteristics are attributed to the size of the nanomaterials. The potential of nanomaterials to react with other materials at the molecular level makes this a very interesting field of study. Improvement in the characterization techniques has helped to better understand the role of nanomaterials in material sciences (*1*, *2*).

The field of pavement engineering is also embracing nanotechnology. Studies have shown that nanomaterials like carbon nanotubes, nanosilica, nanoclay, carbon nanofiber, and nano aluminum trioxide can efficiently modify the desired properties of the asphalt binders. The nano-modified binders exhibit higher resistance against fatigue, rutting, and aging. Nanomaterials have higher compatibility with asphalt binders and are therefore stable at higher temperatures (*3*, *4*).

The investigations into the use of nano-Al_2O_3 for asphalt binder modification have shown that the introduction of nano-Al_2O_3 improves the rutting and fatigue performance of the asphalt binders and asphalt mixes. Nano-Al_2O_3 enhances the compatibility between the asphalt binder and additives like polymers and natural

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