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A study investigating the influence of nano Al_2O_3 on the performance of SBS modified asphalt binder

Faheem Sadiq Bhat [a,*], Mohammad Shafi Mir [b]

[a] National Institute of Technology, Srinagar J&K 190006, India
[b] Dept. of Civil Engineering, National Institute of Technology, Srinagar J&K India

HIGHLIGHTS

- SBS and nano Al_2O_3 is proposed as composite asphalt modifier.
- Enhanced asphalt performance at high and intermediate temperatures.
- Improved performance in in a wide range of time-temperature domains.
- Al_2O_3/SBS nanocomposite improved the anti-aging performance of asphalt binder.
- Nano Al_2O_3 improves the storage stability of the SBS modified asphalt.

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ABSTRACT

The present study investigates the effect of using nano Al_2O_3 as a modifier for SBS modified asphalt binders. The effects of varying concentrations (1%, 2%, 3%, 4% and 5%) of nano Al_2O_3 on SBS modified asphalt binder were evaluated by utilizing various physical tests like penetration, softening point, elastic recovery, and penetration index test. Rheological investigations were carried out by performing frequency sweep tests. Rutting and fatigue performance of the modified asphalt binders was evaluated by using the Superpave rutting parameter, multiple stress creep and recovery test, Superpave fatigue parameter, and linear amplitude sweep tests. Furthermore, the storage stability of the modified asphalt binders was evaluated and the separation index was calculated. The aging resistance was evaluated by using the aging index based on the Superpave rutting parameter. Results showed that the addition of nano Al_2O_3 has a positive effect on the rutting and fatigue performance of SBS modified asphalt binders. Storage stability of the SBS modified asphalt binders improved significantly after the addition of nano Al_2O_3, and the aging resistance of the asphalt binders also improved.

1. Introduction

Asphalt binder is a vital component in asphalt mixes, it makes about 4–8% of the weight of the asphalt mixes. Asphalt binder acts as a binding agent and holds the aggregates together in the mixes. The characteristics of the asphalt mixes are dependent on the properties of the asphalt binder; therefore it becomes imperative to use asphalt binders that are capable of resisting various kinds of distresses associated with flexible pavements.

Asphalt binder is a specialty product obtained during the refinement of petroleum. In the unmodified state, asphalt binders are incapable of withstanding high stresses and varying environmental conditions. The high stresses and increased number of axles combined with varying environmental conditions cause diverse kinds of distresses in the pavements. therefore there is a continuous search to find modifiers that will accentuate the performance of the asphalt binders. The plentitude of the problems associated with pavements have been addressed by using polymer modifiers, two broad types of polymers that are being used in asphalt binder modification are elastomers and plastomers [1–10]. Other kinds of modifiers include Crumb rubber, chemical modifiers, fibers, and most recently nanomaterials [11–16].

Nanocomposites are a new type of novel materials that are receiving a lot of attention [17,18]. Nanocomposite encompasses the novel properties of nanomaterials and polymers to form modifiers with unique properties. Nanocomposites have found application in various fields like aerospace engineering; in which heavier materials of different parts are being replaced by polymer composites. Polymer composites are lightweight, have higher specific

* Corresponding author.
E-mail address: faheem_35phd17@nitsri.ac.in (F. Sadiq Bhat).

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