CENTER FOR TRANSPORTATION RESEARCH

PROJECT SUMMARY

Texas Department of Transportation

0-6854: Engineering the Properties of Asphalt Mixtures Using Carbon Nanotubes

Background

Recent advances in nanotechnology have allowed for development of novel materials that can be tailored to deliver improvements in both high- and low-temperature properties of the modified composite. Several existing studies have shown an improvement in the high-temperature properties of asphalt binders due to the addition of nanomaterials. However, there is an increasing demand in the asphalt industry to identify cost effective methods to improve the intermediate and low temperature properties of asphalt binders and concomitant mixtures. The main objectives of this study were to evaluate a number of different nanomaterials in terms of their ability to (i) disperse effectively in the asphalt binder at a nanometer length scale (as opposed to forming micrometer sized or larger agglomerates), (ii) provide beneficial effects in terms of high-, intermediate-, and low-temperature properties (or at least benefits in a certain temperature range without compromising the properties in other ranges), and (iii) provide a cost-effective solution to modify asphalt binders.

What the Researchers Did

Initially the study was focused on the use of carbon nanotubes. However, owing to the cost of these nanomaterials and based on a review of the literature, the study was expanded to include other nanomaterials; i.e., nanosilica, nanoclay, nanoalumina, and nanoglass. In an effort to improve dispersion, nanosilica was also surface functionalized using two different agents. Several techniques were used to evaluate the mixing conditions required to fully disperse these nanomaterials as well as assess the extent of dispersion of these nanomaterials. In addition, the influence of these nano-scale materials on the performance related properties of asphalt binder were evaluated. A subset of nanomaterials was then used to evaluate the performance of asphalt mortars and mixtures.

What They Found

Direct observations using microscopy techniques and mechanical tests, complemented by indirect observations in reference solvents show that in most cases, nanomaterials do not disperse as nanometer sized particles but rather form agglomerates that are several micrometers in size. Under such circumstances, the benefits of using nanomaterials are rather limited. Amongst the nanomaterials used in this study, nanoglass was the only material that had maximum dispersion approaching a nanometer length scale, was cost-effective, and demonstrated improvement in

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mechanical properties as observed using the binder, mortar, and mixture tests.

What This Means

Based on the nanomaterials incorporated in this study, there is at least one low-cost candidate (nanoglass) that can potentially be used to improve the properties of asphalt binders. It is recommended that this nanomaterial be evaluated with a larger variety of asphalt binders and potentially in test sections with appropriate controls. Since nanotechnology is an evolving field, this research also presented a simple method to screen nanomaterials that can be dispersed in asphalt binders and have potential benefits.

For More Information

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