GUIDELINES FOR USE OF MODIFIED BINDERS

PROBLEM STATEMENT

The current asphalt mix design procedure – Superpave Level 1 – essentially is a volumetric design procedure devoid of validated performance-based tests for asphalt mixtures. The current procedure assumes that the number of gyrations applied by a gyratory compactor resembles the traffic conditions to which the mixture will be subjected. The design asphalt content is selected to produce 4% air voids at the design number of gyrations for a particular level of traffic and environment. Mixtures produced with conventional asphalt binders, particularly those on high traffic volume facilities (i.e., high number of gyrations), may not have adequate resistance to cracking as a result of lower design asphalt content.

Consequently, adequate rutting and cracking performance may not always be attainable for high-traffic volume Superpave mixtures designed with conventional asphalt cement. Recent research, however, indicates that modifiers may be used to produce a mixture with desirable rutting resistance, as well as sufficient fracture resistance at lower in-service temperatures.

OBJECTIVES

This study was undertaken to consolidate and evaluate work that has been done in Florida in the area of modified asphalt mixtures. The objectives of the project included the following:

- Consolidate and document work that has been done in Florida in the area of modified asphalt mixtures. Develop a database to track laboratory, heavy vehicle simulator (HVS), and field test results, as well as all findings from this work.
- Summarize all issues identified by this work with regard to the advantages and disadvantages associated with the use of modifiers (e.g., production, placement, and cost).
- Analyze all of the data obtained to evaluate the relative performance of modified and non-modified mixtures subjected to similar conditions.
- Develop recommendations for the use of modified binders (for potential inclusion in the FDOT pavement design manual and general guidelines)..
- Evaluate the relative benefits of ground tire rubber modification in terms of both performance-related benefits and costs.

FINDINGS AND CONCLUSIONS

The primary findings of this work may be summarized as follows:

- Ground tire rubber (GTR) has been used in open and dense graded friction courses. The main benefit is that GTR can increase binder content while preventing draindown (which can lead to raveling); the increased binder content subsequently improves cracking resistance. For dense-graded mixtures (tested with 12% rubber), however, GTR creates problems with the aggregate structure: it prevents the aggregate structure from achieving maximum shear strength orientation.

- Field data for polymer-modified mixture-performance in Florida is mostly anecdotal. In most cases, observations indicate good rutting performance relative to prior history in existing locations. Experiments with the HVS and laboratory tests (i.e., APA, GTM, Servopac) showed that SBS-modified binder (PG 76-22) out-performed the control binder (PG 67-22) in rutting performance.
- Indirect Tension Test (Superpave IDT) results analyzed with the Hot Mix Asphalt (HMA) Fracture Mechanics model showed that the SBS modified mixtures could benefit cracking, mainly by reducing the rate of damage accumulation. SBS modifiers, however, do not have any effect on resilient modulus or the creep-energy of the material. A short loading time test, including complex modulus, is not able to capture the benefits of the modifier.
- The added cost of SBS-modified binder amounts to $100 per ton of liquid binder, or about $6 to $8 per ton of HMA (10 to 15% price increase in total cost). This may be reduced with continued use; case-by-case scenario results in higher costs because contractors need to use different storing tanks with agitators, purchase the binder in smaller quantities, etc.
- Based on the HMA Fracture Model analysis, for pavements with sufficient structure (i.e., HMA thickness not required for SN, or assuming SN obtained from base), SBS polymer modification reduces the required thickness. The result is a 5% to 30% reduction in initial cost depending on traffic level (in addition to potential for improved life-cycle cost).

BENEFITS

This study summarized the existing knowledge related to modified-binder performance, drawing from previously-completed projects in Florida as well as other documented work from around the country. The findings of this study will contribute to the development of new specifications for wider implementation of modified-binder technology. This study suggests that the performance enhancement benefits and cost-effectiveness of SBS-modified asphalts warrant their use.

Currently, FDOT requires the use of asphalt-rubber (ARB 12) or polymer-modified (SBS) binder for certain asphalt mixtures, viz., open graded friction-courses (OGFC). This study indicates that the use of polymer-modified binders would be beneficial (1) for use with pavements with sufficient structure, traffic level D or higher, and (2) at high volume, slow moving traffic intersections. However, the environmental benefits from the use of rubber in pavements cannot be overlooked. A project to investigate a hybrid binder (i.e., a combination of SBS polymer with rubber) is already under way.

This research project was conducted by Dr. Reynaldo Roque and Dr. Christos A. Drakos, of the University of Florida. For more information, contact Bruce Dietrich, Project Manager, at (850) 414-4371, bruce.dietrich@dot.state.fl.us