Tire jack

Using GTR elevates performance in asphalt pavements

Asphalt mixtures are commonly comprised of various ratios of aggregate, asphalt binder and air.

While this is usually the case for standard dense-graded Superpave mix designs, specialty mixtures such as open-graded friction courses (OGFCs) and stone-matrix asphalt (SMA) mixes typically contain some type of fiber.

Fibers are used to either increase the toughness or fracture resistance of asphalt mixtures (though this is rarely applied in practice), or to stabilize the asphalt binder in order to prevent binder drain-down while the asphalt mixes are hot. When binder drain-down occurs, it results in small flushed areas of the pavement with excess asphalt (sometimes called "fat spots"). The rest of the mix is lean, which results in premature raveling and cracking. The use of fibers in OGFC became common after the introduction of SMA to the U.S.

Fibers add stability to the asphalt film, covering the aggregate by increasing the film thickness by as much as 30% to 40% compared to conventional OGFC or SMA mixtures. Prior to the use of fibers, OGFC mixes were typically produced at cooler temperatures (240-260°F) and had lower binder contents. Today, OGFC and SMA mixtures also contain polymer-modified binders to improve mixture durability.

Success made of rubber

The two types of fibers commonly used in OFGC and SMA mixes are mineral and cellulose, with cellulose fibers more commonly used. For example, the Georgia Department of Transportation (GDOT) uses 0.4% by weight of mix for mineral fibers and 0.3% for cellulose fibers. Fiber clumping and control can be an issue during mixture production; however, using cellulose fibers has been shown to reduce this issue because they are pelletized and more easily metered. The cost of fibers is around $0.25 per pound and adds about $1.50 per ton to the cost of an asphalt mix. Additional costs at the plant include the purchase of a separate fiber hopper and feeding system. This system fluffs and blows the fibers at a specified rate into the drums or mixing chambers at drum and batch plants, respectively.

Over the past several decades, other fiber types and additives also have been evaluated on their ability to provide drain-down resistance. Current research is gauging the possible use of waste carpet fibers in these mixtures; however, it is not currently common practice. Mineral fibers are added at batch plants

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through a weigh hopper and feeding system that introduces the fibers at a prescribed rate in either the drum or the mixing chamber. Other fiber types have included waste carpet fibers, waste cotton fibers, paper mill sludge, polyester fibers and aramid fibers. Additional additives evaluated for drain-down resistance include ground tire rubber (GTR) and some chemical warm-mix asphalt additives.

Studies in the U.S. and abroad have shown that GTR can be effectively used for drain-down resistance and as a binder modifier to eliminate the need for fibers and/or polymer-modified binders in both SMA and OGFCs. It has been well understood since the 1990s that GTR can be used to modify asphalt binders to improve their rutting and cracking performance. A recent NCAT study (Report 13-11) examined how using different GTR-modified binders affected the performance of OGFCs in comparison to an OGFC that used a polymer-modified binder and fibers. The study showed that using 10% GTR by weight of the binder eliminated the need for fibers in the drain-down test. Additionally, the GTR-modified OGFC maintained commonly accepted lab test criteria for durability, moisture damage and rutting. Essentially, GTR-modification increases the viscosity of the binder and allows for slightly higher total binder contents, increasing the film thickness of the binder on the aggregate needed for specialty mixture performance. Thus, the increased binder viscosity prevents drain-down while the increased film thickness ensures mixture durability.

The right replacement

While laboratory tests have shown that GTR is a viable replacement for both fibers and polymer-modified asphalt, there have been few documented field studies where fibers were eliminated from the mixtures. Two case study OGFCs were constructed as part of the 2012 NCAT Pavement Test Track, which used GTR-modified binders and no fibers. Section S1 was sponsored by the Virginia Department of Transportation, and Section E9b was an OGFC sponsored by the Alabama Department of Transportation. At the time of construction, both of the mixtures met standard drain-down requirements. After approximately 8 million equivalent single axle loads (ESALs), both test sections have shown excellent rutting and durability performance. No cracking or raveling are evident in either test section to date.

A few highway agencies and researchers have recently begun assessing the possibility of using RAS as a substitute for fibers in specialty mixtures. Like GTR, RAS binder has a high viscosity that can reduce drain-down potential. Additionally, RAS commonly has a fiber content between 2% and 3%. When released from the asphalt mastic, the RAS fibers can prevent drain-down.

The Illinois Tollway, the city of Chicago and Illinois DOT have used 5% post-consumer RAS in SMA mixtures without added fibers on multiple projects such as I-80 and the Jane Addams Memorial Tollway. On both of these roadways, PG 70-28 binder was used in conjunction with 5% post-consumer RAS. The Illinois DOT designed these experimental projects to determine if RAS could be used in lieu of fibers on SMA mixtures. Testing during construction showed no signs of drain-down and the projects have performed well through some extremely harsh weather. A couple of the projects were part of the National Pooled Fund Study on RAS.

Similarly, a test section was built on the NCAT Test Track in 2012 with an SMA surface layer containing 5% post-consumer RAS and no added fiber. Under the severe loading conditions on the track, the SMA with PC-RAS has outperformed a dense-graded Superpave mix with 20% RAP.

The Tennessee DOT also constructed an OGFC on the pavement test track that contained only 3% RAS and no additional fibers. At the time of construction, the mixture barely failed the drain-down test; however, the DOT elected to keep the mixture in place. To date, no cracking, raveling or flushing has been witnessed in this test section.

In summary, lab experiments and field trials have shown GTR and RAS as possible substitutes for fibers in open and gap-graded specialty asphalt mixtures. Further evaluation of the long-term performance of such mixtures continues. As the paving community shows an increasing interest in the triple bottom line of sustainability, the use of these recycled materials to enhance the performance of certain asphalt mixes appears to be a positive step forward. **R&B**

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