PAVEMENT TECHNOLOGY ADVISORY
- POLYMER-MODIFIED HOT MIX ASPHALT -
PTA-D5

WHAT IS POLYMER-MODIFIED HOT MIX ASPHALT?

Asphalt cement is the "glue" that holds a hot mix asphalt (HMA) pavement together. It is a viscoelastic material, meaning that it displays both viscous (fluid-like) and elastic (solid-like) characteristics. These characteristics are largely temperature dependent, as asphalt cement behaves more like a solid at low temperatures, and more like a liquid at high temperatures.

Either behavior extreme can have a negative effect on HMA pavement performance. Cracking can occur if the asphalt cement is too stiff, and rutting or other deformation can occur if it is too fluid. An ideal temperature range exists for each asphalt cement, in which it displays the right combination of viscous and elastic properties for good pavement performance, as illustrated in Figure 1.

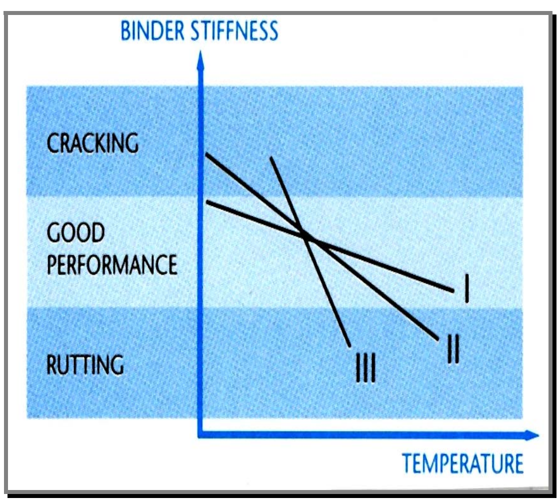

Figure 1: Ideal Temperature Ranges for Good HMA Pavement Performance

Polymers can be added, which modify the natural viscoelastic behavior of the asphalt cement; thus, affecting the ideal temperature range. There are two main classes of polymers used for this purpose: *elastomers*, which enhance strength at high temperatures, as well as elasticity at low temperatures; and *plastomers*, which enhance strength but not elasticity. Three types of elastomeric copolymer modifiers are currently approved for use in Illinois: styrene-butadiene diblock (SB), styrene-butadiene triblock (SBS); and styrene-butadiene rubber (SBR). Plastomer-modified asphalt cements are not allowed in Illinois.

As an example of how polymer-modifiers can be useful, consider the three binder materials (I, II, and III) in Figure 1: [The term "asphalt cement" refers to an unmodified material, while the term "binder" includes both modified and unmodified materials (see *PTA-D4*).] Binder III has a narrow ideal temperature range that would be suitable for use in a moderate climate with consistent year-round temperatures, but not suitable for a climate featuring extreme seasonal temperature variations. In order for Binder III to perform well in such a climate, polymer-modifiers could be added that would change its behavior to be more like that of Binder I or Binder II. Both of those materials display wider ideal temperature ranges that are better suited for highly variable temperatures. With all else being equal, an HMA pavement containing Binder I would be expected to perform the best under those conditions.

OTHER POTENTIAL BENEFITS

In addition to improving pavement performance at locations with extreme hot-cold temperature variations, there are other potential benefits of using polymer-modified binders in HMA construction. Polymer-modified binders typically are more viscous (thicker) than unmodified binders, and tend to show improved adhesive bonding to aggregate particles (stickier). These properties result in a thicker binder coating on the aggregate particles that does a better job of holding the particles together. Thicker binder coatings usually take longer to become brittle from oxidation, so the durability of the pavement can be improved. The better adhesion helps to minimize drain-down at the time of construction, and also helps to reduce the tendency of the pavement to ravel once it has aged.

Areas which experience frequent heavy truck traffic and/or slow-moving truck traffic may benefit from the use of polymer-modified HMA mixtures. The higher viscosity and improved adhesion provided by the polymers help resist rutting under extremely heavy loads, while increased elasticity improves the fatigue resistance from repeated cycles of heavy truck loading over the lifetime of the pavement.

USAGE IN ILLINOIS

Polymer-modified binders have been used in Illinois in 1992. These materials are now commonly prescribed for conventional dense-graded HMA mixtures, as well as special HMA mixtures, such as open-graded friction course (OGFC) and stone-matrix asphalt (SMA) mixtures. While the benefits described in the previous section have been observed at individual locations, research is ongoing to quantify the long-term pavement performance benefits of using polymer-modified HMA mixtures, specifically in terms of pavement life extension.

SPECIAL CONSIDERATIONS

Polymers may add to the cost of the binder, but the cost of the binder is only a fraction of the total HMA mixture cost, so the impact on the overall project cost is typically quite small. However, the greater the ideal temperature range offered by the binder, the more expensive the product; therefore, use of the most expensive grades in Illinois is limited to areas of extreme truck traffic, where the benefits of improved resistance to rutting and fatigue cracking outweigh the additional cost. Selection of the appropriate binder for the application can be confirmed with the District Materials Engineer.

Because polymer-modified binders are more viscous, pumping times may be slower and performance of some asphalt metering systems may be affected. Dense-graded polymer-modified HMA mixtures often require higher mixing temperatures - typically 300 to 350°F (149 to 177°C). Mix production rates may be reduced if the polymer-modified binder is not delivered or stored at high enough temperatures.

Polymer-modified binders may not be mixed or stored with other binders, as this may change the behavior of the material. Since different polymer-modified binders display different behaviors, the supplier should be contacted for individualized assistance and advice. Pre-production meetings with the supplier and the contractor are a good way of learning what to expect from the polymer-modified HMA mixture during production and laydown.

If you have any questions, please contact:

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