

ROAD SCIENCE

by Tom Kuennen, Contributing Editor

Modifiers a Must in a World of High-Performance Asphalt



Enhanced durability and the defeat of rutting, such as this on a Los Angeles street, are the main goals of asphalt modification

Photo courtesy of Tom Kuennen

The universe of modifiers has expanded far beyond polymer modifiers of yesterday; phosphoric and polyphosphoric acids get look.

More and more, modifiers are a must in producing the high-performing, durable asphalts — such as the performance graded (PG) binders used with Superpave — that can be predicted to behave in a certain way throughout time.

Asphalt modifiers are used principally to optimize durability and rut resistance in hot-mix asphalt (HMA). It is the menace of rutting and age-related ills that most actively motivates the use of asphalt modifiers in hot mix asphalt.

The more familiar polymer modifiers mix with the liquid binder to help it perform bet-

ter. Mineral modifiers perform physically to enhance adhesion of binder to aggregate, or keep liquid asphalt binder from draining from an aggregate structure, as with stone matrix asphalt.

But in the new millennium, a new breed of modifiers is going beyond making asphalt perform better, to making it easier to place by reducing the heat or energy required to produce the mix. These waxy or water-yielding modifiers make low-energy asphalt mixes — such as warm mix asphalt (WMA) and cold mixes — possible. The use of low-energy asphalt mixes offers significant environmental benefits the asphalt industry may need if it going to survive the environmental onslaught now building on the horizon.

At the same time use of conventional polymer modifiers is being

expanded to make more durable and versatile surface treatments, including chip seals, fog seals, an microsurfacing, with new research on the way from the pavement preservation community.

And a new bunch of modifiers, including phosphoric acid and polyphosphoric acid, are getting a close look by researchers in an effort to determine whether they do more good than harm in asphalt mixes.

Polymer modifiers in asphalt

Why modify?

“Improvement in resistance to rutting, thermal cracking, fatigue damage, stripping, and temperature susceptibility have led polymer modified binders to be substituted for asphalt in virtually all paving and maintenance applications, including hot-mix,

warm-mix/cold lay, cold mix, chip seals, hot and cold crackfilling, patching, recycling, and slurry seal,” says Stylink polymer modified asphalt technology provider Sem Materials L.P. “They are used wherever extra performance and durability are desired. In many cases they are selected to reduce life cycle costs.”

Polymer modified binders have allowed the use of techniques previously not practicable such as microsurfacing and use of asphalt emulsion chip seals on high-volume roads, according to Sem. And specifiers are finding that many of the Superpave binder grades require polymer modification to concurrently meet the requirements for high temperature resistance to rutting, and low temperature resistance to thermal cracking.

Asphalt cement properties are highly temperature-sensitive. As temperature of the asphalt cement increases, its stiffness decreases, increasing the propensity for permanent deformation under load. The high temperature susceptibility of asphalt cement may be reduced through the addition of polymer modifiers such as natural latex, synthetic latex, block copolymers, reclaimed rubber (tires), polypropylene, polyethylene, and ethyl-vinyl-acetate (EVA). The addition of modifiers substantially improves rutting resistance by improving the high temperature stiffness characteristics of the asphalt cement, thereby reducing shear deformation.

The term polymer refers to a very large molecule made by chemically reacting many (poly) smaller molecules (monomers) to one another in long chains or clusters. Polymer modifiers for asphalt can be either elastomeric or plastomeric.

Specific binder and mix properties can be engineered by choosing the right polymer for a given application, and making sure it's compatible with the asphalt. In general, elastomers give a more resilient, flexible pavement, while plastomers result in mixes with higher stabilities and stiffness values.

Elastomers include copolymers

of styrene and butadiene (such as, styrene butadiene diblock, styrene butadiene triblock or radial, styrene isoprene, and styrene ethylbutylene. Other elastomers include styrene butadiene rubber (SBR) latex, polychloroprene latex, polyisoprene, and crumb rubber modifier. Plastomers include EVA, polyethylene, and various compounds based on polypropylene.

In addition to polymer modifiers, other additives such as liquid anti-stripping agents or hydrated lime are used to enhance the bond between the asphalt cement and the aggregate particles to prevent moisture damage, also known as “stripping.” Loss of asphalt cement due to stripping allows aggregates to shift under traffic loading, leading to severe rutting. Use of anti-strips can reduce rutting by reducing the loss of asphalt cement through moisture damage.

Better performing pavements

The Superpave binder specification uses various tests performed at multiple temperatures to characterize the binder, said John D'Angelo, P.E., asphalt team leader, FHWA Office of Pavement Technology.

Polymer modification has become an essential part of Superpave mix designs, even though its binder specification doesn't adequately determine the performance characteristics of modified binders. As a result, many state Departments of Transportation (DOTs) are including additional tests to the Superpave binder specification to make sure a desired modifier is included in the binder. These Superpave “plus” tests do not relate directly to performance, but only relate to the presence of a particular modifier in the binder, D'Angelo said. For example, for additional (“plus”) tests for Superpave, a number of states have specified elastic recovery testing to assure that some type of SBS material in the binder purchased.

“Essentially the PG system was designed to describe asphalt binder in a similar manner that the motor oil industry developed

a half-century ago, a 10W40 asphalt,” says engineering consultant Dale Decker, P.E., D.S. Decker LLC, and former vice president, research and technology, National Asphalt Pavement Association, in the July 2008 issue of the National Asphalt Pavement Association's (NAPA) publication, “Focus on HMA” (hot-mix asphalt technology).

“Unfortunately, the PG (performance-graded) system does not adequately describe asphalt binders that are modified,” Decker said. “In the meantime, users are resorting to descriptive tests to adequately specify the desired modified asphalt. This PG+ approach uses the existing PG requirements, but adds some type of physical test to determine the presence of a modifier in the asphalt binder.”

D'Angelo called said Superpave's omission of modifier specs a “gap” in the system. “The full application of modified systems and performance-related specifications based on the actual material properties is a gap which we are trying to close,” he told *Better Roads*. “We want to make Superpave ‘blind’ to polymer modification.”

Despite all this, D'Angelo says modifiers can be a positive for boosting the qualities of liquid asphalt. “There is no question that polymer modification can improve the performance properties of an asphalt binder,” he says. “At the Federal Highway Administration's (FHWA) Accelerated Load Facility, polymer modified asphalts far exceeded their expected performance.”

For example, polymer modified asphalts are essential to a successful race track pavement, said Brian Prowell, P.E., principal engineer at Auburn, Ala.-based Advanced Materials Services LLC. AMS designs race track mixes and also serves as quality assurance/quality control manager for projects. In June at Lime Rock Park near Lakeville, Conn., AMS was performing QA testing on the mix and density, as well as developing specifications and overseeing the work.

There the mix was highly poly

