A PUBLICATION OF FP² INC.

Pavement Preservation journal

SUMMER 2012

ASPHALT RUBBER SURFACINGS

National Pavement Preservation Conference

Ground Tire Rubber Challenges Polymer Modifiers in Asphalt

By Doug Carlson

The road to universal acceptance of granulated tire rubber as an alternative to conventional polymer modifiers is long, and has been paved with doubts created by premature failures from technologies of the 1990s that were not well understood, or required too many challenges to implement.

But two more decades of research and development have dramatically changed the landscape by generating materials and process advancements that definitively position rubberized asphalt as a viable alternative to polymer modified asphalt in terms of performance and cost.

Simultaneously, significant price fluctuations of polymers tied to crude oil prices during the past 10 years have made granulated tire rubber (GTR) a sustainable alternative for modifying asphalt.

Recycled tire rubber has remained at a stable, lower price for several years. And along with cost-savings, GTR mixes have proven to provide greater performance and durability.

Asphalt rubber (AR) is defined by the American Society for Testing and Materials (ASTM) Standard D6114 as "a blend of paving grade asphalt cement, ground recycled tire (that is, vulcanized) rubber and other additives, as needed, for use as binder in pavement construction. The rubber should be blended and interacted in the hot asphalt cement sufficiently to cause swelling of the rubber particles prior to use."

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Asphalt rubber binder is field blended (at a hot mix plant) and requires mobile mixing equipment to produce. The typical rubber content for asphalt rubber ranges from 18 to 22 percent. Granulated tire rubber used in asphalt rubber is in the 10-to-16 mesh range for maximum particle size. This binder is best suited for very thin overlays and heavy duty surface treatments to prevent cracking.

Pavement condition before AR/PMAR (asphalt-rubber/polymer modified asphalt-rubber) three-layer cape seal in Watsonville, Calif.

PHOTO CREDITS: Liberty Tire Recycling

AR/PMAR three-layer cape seal after six years of performance, spring 2009, same location.

New technologies have emerged that allow GTR to be used as the primary modifier in performance graded (PG) asphalt. These binders are manufactured with 8 to 12 percent rubber content and may include a small amount of virgin polymer or other additives. The rubber particles have a 30 minus maximum size, but are small enough to fit into PG tests. They can be made onsite or delivered by an asphalt supplier. Mechanical or chemical suspension is needed for the binders that retain GTR particles. These binders can directly replace polymer modified materials in dense graded mixes and chip seals.

For pavement preservation applications, the use of AR or switching polymer modifiers with GTR in a binder can be used in thin surface courses such as stone matrix asphalt mixes, open-graded friction courses, spray-applied chip seals and multi-layer systems.

IN THE MIX ...

As the technology evolves, road engineers and mix producers are continuing to discover the benefits of using rubberized asphalt. Applications using warm-mix, thin overlays, and placement over concrete have advanced the use of GTR across North America.

Rubber can be used with warm mix. The industry is moving toward warm mix as the latest advancement in asphalt production. Several recent reports and case studies describe success using warm mix with rubber. Warm mix makes using rubber easier to place and compact, which is why the process is now standard in Massachusetts on every project using rubber.

Rubber saves money for mix producers. When a mix producer makes its own modified binder (usually a PG 76-22) on site with rubber, the raw materials cost can drop as much as 15 percent. New processes whereby rubber suppliers coordinate manufacturing logistics, testing and quality control help the binder fit right into Superpave (dense graded) mixes. Mix producers in Louisiana, such as Diamond B, have pioneered the replacement of polymers with rubber in the LA DOT PG 82-22 rubber modified binder specification following the SBS shortage in 2008.

Rubber enables the use of more recycled asphalt pavement (RAP). Emerging technologies researched by Louay N. Mohammad and Samuel B. Cooper Jr. at the Department of Civil Engineering, and Louisiana Transportation Research Center at Louisiana State University, show that rubber mixes with up to 40 percent of RAP can perform as well as regular mixes with only 25 percent RAP.

Rubber can be placed thinner. Higher rubber dosage binders create a significant engineering benefit through the use of more asphalt. Although these mixes may cost more per ton, they are placed in thinner layers and resist cracking much better than conventional

asphalt that is twice as thick. With conventional asphalt, one way to prevent cracking is to place a thicker layer. The crack has farther to go through the mix, and so it takes longer to get to the surface. Rubber is a crack-resistant material and allows mixes to be placed much thinner with better durability. The Caltrans *Reduced Thickness Design Guide* is used extensively by cities and counties to place thinner overlays with AR materials to save money.

... AND ON THE STREET

GTR is also making major strides in spray applications. Tougher membranes can be placed with AR chip seals to solve severe cracking problems, and can be used in conjunction with a slurry seal, providing several more years of service before an overlay is needed. The City of Watsonville, Calif. has advanced the use of multilayered systems to save streets from total reconstruction.

New technologies with rubberized asphalt binders are effectively replacing polymer modified binders and can enhance chip retention in cold weather conditions. There are approximately 15 state departments of transportation in the U.S. that have at least one rubberized asphalt project in the works each year, including Alaska, Arizona, California, Florida, Georgia, Louisiana, Massachusetts, Missouri, Nebraska, Nevada, New Jersey, New Mexico, Rhode Island, South Carolina and Texas.

To the north, Saskatchewan has a robust rubberized asphalt program, and Ontario is beginning one.

Although asphalt rubber technology has improved by leaps and bounds in recent years, examples of cost savings from reduced cracking and maintenance are well documented by the Arizona DOT and demonstrate why ADOT has used rubberized friction courses as the standard pavement surface since the 1980s.

And though rubberized asphalt was first developed for southern climates, implementation in northern California, Canadian provinces, Massachusetts, New Jersey and Sweden has proven advanced cold weather performance.

Ongoing research, proven results on highways across the nation, and market conditions have produced an undeniable truth: Granulated tire rubber is a smart, viable alternative for the paving industry and departments of transportation. It is an important consideration as all of these stakeholders contemplate how to preserve America's aging superhighways and make them durable for the foreseeable future.

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