

Asphalt Emulsion Bond Coats

Optimize UTBO, Thinlay Performance

BY TOM KUENNEN

Asphalt emulsion bond or “tack” coats—done with the right material, application rate and full-width of paving—are essential to long-term performance of any bituminous overlay.

But because of the thin depth of wearing course placed, they’re absolutely essential to—and play a special role in—performance of ultra-thin bonded asphalt overlays (UTBOs) and thin asphalt overlays (*Thinlays*) used for pavement preservation.

A bond coat adheres one layer of asphalt to another layer of pavement, whether bituminous or portland cement concrete. The same way that fragile, thin veneers of wood are glued to each other to form a robust sheet of plywood, research shows layers of

pavement perform better when thoroughly bonded to each other.

Whether for thin or conventional hot-, warm- or cold-mix asphalt overlays, asphalt emulsions are ideal for bonding the layer, compared to straight or “neat” liquid asphalt, or cutback asphalt.

“The most widely used tack coat material in the world is emulsified asphalt,” according to 2012’s NCHRP Report 712, *Optimization of Tack Coat for HMA Placement*. A survey in the report indicated that approximately 92 percent of tack coat applications worldwide utilized asphalt emulsions.

Why does the world prefer asphalt emulsions for bond coats? Straight or “neat” liquid asphalt must be kept heated to stay

liquefied, and that poses burn hazards and other safety problems as the distributor moves around on the site. And use of volatile cutback asphalt poses air pollution problems, resulting in curtailed use from coast to coast.

Asphalt emulsion, also called emulsified asphalt, is a nonflammable liquid substance produced by combining water, liquid asphalt and emulsifier and blending them in a powerful colloid mill, and storing prior to use.

Because oil and water don’t mix, the emulsifier—an engineered surfactant (detergent) or surface-active agent—maintains the microscopic asphalt droplets in a stable suspension, keeping them from recombining. The amount



IMAGE CREDIT: ROADTEC INC.

For ultrathin bonded overlay, asphalt emulsion bond coat from paver-mounted tank is placed on existing pavement directly in front of asphalt paver screed for hot-on-hot paving

and type of surfactant used, along with other variables, controls properties of the emulsion critical to performance in the field application.

For example, emulsifiers affect the “break” time following placement on a road, in which the water evaporates, leaving the residual asphalt behind. Asphalt emulsions partially are categorized as rapid setting (RS), medium setting (MS), slow setting (SS) and quick setting (QS) emulsions.

EMULSIONS FOR THIN BONDED OVERLAYS

Ultrathin bonded overlays (UTBOs) also called ultrathin bonded wearing courses (UTBWCs), ultrathin bonded asphalt surfaces (UBASs), and ultrathin asphalt concrete surfacings (UTACSs)—are constituted of a heavy application of polymer modified asphalt emulsion, followed by an ultrathin (0.5 to 1.0-in.), polymer modified, gap-graded hot mix asphalt layer, both applied by the same machine.

An ultrathin bonded overlay is a high-performance wearing course for preventive maintenance or new construction, and is used over both asphalt and concrete pavements. The emulsion application rate is 0.13 to 0.30 gal. per sq. yd., according to the *Preservation Toolbox* developed by FP² Inc.

Ultrathin bonded overlays need polymer modification. Today, the most common types of emulsions used for conventional paving bond coats include slow-setting grades of emulsion such as SS-1, SS-1h, CSS-1, and CSS-1h and the rapid-setting grades of emulsion such as RS-1, RS-2 and CRS-1 or CRS-1h. However, these emulsions are not polymer modified, as is generally required for ultrathins. For them, a common modified emulsion used is a (C)RS-2H PM.

California DOT (Caltrans) defines its bonded wearing courses “a gap- or open-graded, ultra-thin hot-mix asphalt mixture applied over a thick polymer modified asphalt emulsion membrane,” to quote the agency. “The emulsion membrane seals the existing surface and produces high binder content at the interface of the existing roadway surface and the gap- or open-graded mix, all in one pass.”

In addition to enhancing friction, such gap-graded and open-graded mixes



Spray bars on paver of Las Vegas Paving Corp. place asphalt emulsion bond coat in advance of ultrathin bonded overlay

IMAGE CREDIT: WIRTGEN AMERICA INC.

provide an open surface texture to allow rain water to flow through the surface, reducing tire spray, eliminating ponding, and suppressing noise at the tire/pavement interface. They represent one version of a porous asphalt pavement.

Such bonded wearing courses are primarily used in high-traffic areas as a surface treatment over hot mix asphalt or portland cement concrete pavements. They are placed over structurally sound pavements as a maintenance treatment but may also be used in new construction and rehabilitation projects as the final wearing course.

In a bonded wearing course like those specified by Caltrans, the polymer modified asphalt emulsion membrane seals the existing pavement while bonding the gap-graded or open-graded mix to the surface. The thicker nature of the “membrane” allows it to “wick” upwards into

the mix, filling voids in the aggregate and creating an interlayer of high cohesion that does not delaminate or bleed, if applied correctly.

ROLE OF SPRAY PAVER

Ultrathin bonded overlays are placed with a dedicated spray paver. From an onboard tank, this specialized piece of equipment sprays the bond coat directly ahead of the screed placing the thin overlay.

Spray pavers combine the functions of a distributor truck, typically placing bond coat and high-performance polymer modified thin overlay in a single pass. In this case the bond or tack coat will be polymer modified as well, with application at rates of 0.08 to 0.20 gal. per sq. yd. residual, according to The Asphalt Institute.

As no bond coat is placed in front of the paver, traffic, road workers and pedestrians can move freely in front of the process



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without tracking bond or tack coat onto streets, sidewalks, parking lots and eventually into stores and offices.

Unrestricted traffic can often be returned to the fresh surface within one half hour, says spray jet paver manufacturer Roadtec Inc., adding these surface treatments are effective on high-level interstate highway pavements, as well as neighborhood streets.

Commercial spray pavers include the Roadtec SP-200e and the Vögele Super 1800-3i SprayJet. Like all spray pavers, the SP-200e sprays tack and applies hot mix asphalt seconds later. "Combining spraying and laydown produces a high-quality mat with a strong bond between layers," the manufacturer says. "A spray bar just in front of the paver's auger distributes the liquid through computer-controlled, self-cleaning valves. An onboard microprocessor precisely controls the rate of flow. Valves can also be controlled manually." The SP-200e is used for thin-lift applications, but it can serve as a conventional paver as well.

Because keeping forward movement is important to mat quality and contractor productivity, to cut down on refill stops, the SP-200e is equipped with a 2,100 gallon emulsion tank, the largest tank available on the market today, Roadtec says.

SPRAY PAVING IN NAPA

Via a polymer modified emulsion bond coat and ultrathin bonded wearing course, an SP-200 spray paver preserved the Silverado Trail, a scenic two-lane road that runs for

29 miles along the eastern edge of the Napa Valley in northern California.

In the city of Napa, a 10-year-old asphalt overlay on the road was showing signs of wear over a 2.9-mile section. There was minor cracking, some raveling, and a few areas required full-depth asphalt patching. But for the most part the road was in good shape; it was structurally sound.

To preserve the road and extend its life, and having good previous experience with the process, Caltrans placed an ultrathin bonded wearing course. Minimal milling was required.

On the Silverado Trail, the Construction Division of Telfer Oil, Martinez, Calif., used the spray paver to place a heavily polymer modified emulsion at a rate of 0.17 to 0.20 gallon per square yard. "The emulsion is similar to a PMCRS-2H emulsion, which is a standard chip sealing emulsion," said Karl Meyers, vice president and general manager of Telfer Pavement Technologies Construction Division, McClellan, Calif.

Immediately after the sprayed bond coat, the paver placed a 7/8-in.-deep of open-graded hot mix made with PG 64-16 liquid asphalt that was modified with crumb rubber. The target value for binder content was 8.5 percent, and the top-size aggregate in the mix was 3/8-inch. It also contained a small amount of sand.

Static compaction with two double-drum rollers followed the paver. "You have to run two rollers because you need to hit the temperature range on compaction, which is 180 to 280 degrees Fahrenheit," Meyers said. "That thin lift behind the screed is

cooling fast, and you want to release the road to traffic quickly. Plus, the paver is moving at 70 to 100 feet per minute, so you need to run two rollers behind."

The process has a number of advantages, Meyers said. "You are not getting any tack coat dragged around the city, you get an outstanding bond with the hot mix, you are forming a waterproof membrane, and you can release the road quickly to traffic," he said.

"The open-graded mixture really reduces the water splash in traffic," Meyers added. "Another advantage is that when the emulsion wicks up into the hot mix asphalt, it cools the pavement down right away. So even though our Silverado Trail project was done at night in high traffic, we were able to release intersections to the public in 15 minutes."

In addition to cost savings versus conventional mill-and-fill, the process saved the time and traffic disruption that mill-and-fill would have required.

UTACS IN LAS VEGAS

In the Far West, the similar ultrathin asphalt concrete surfacings (UTACS) are gap-graded wearing courses, bonded to the surface by a warm polymer modified asphalt emulsion, followed immediately by the hot, gap-graded, ultra-thin asphalt concrete friction layer.

In Nevada, using a Vögele Super 1800-2 SJ spray paver, Las Vegas Paving Corp. placed a 1 in.-deep UTACS, with almost 100 percent passing 1/2-in. with some fines. For this project, warm polymer modified asphalt emulsion was being sprayed directly ahead of the screed via spray bars on each side of a spray jet paver at a rate of 0.13 gal. per square yard.

"The emulsion is not unlike a prime or tack coat, but it provides much more coverage," said Clark Webster, general superintendent, Las Vegas Paving. "And no one can run on it. The spray paver places the coat behind the wheels but ahead of the material, so cars or our haul vehicles can't drive over it and pick up the sticky, polymer modified emulsion. It gives us the best of both worlds; we are able to use a polymer modified emulsion without having the mess of tires tracking it everywhere."

The placement of emulsion spray is automated, and the system regulates percentages of emulsion applied, making it easy



IMAGE CREDIT: ROADTEC INC.

On Silverado Trail in Napa, Calif., asphalt emulsion bond coat is sprayed by Roadtec SP 200 spray paver immediately in advance of screed placing asphalt rubber modified UTBWC

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on the crew, Webster said. "If the paver slows down, the application slows down," he said. "It's easy to use."

Once the emulsion is placed, and asphalt compacted, traffic can be allowed on the pavement within minutes. "You can let traffic on the UTACS very quickly, it's not a very 'tender' mix," he said.

UTBO ON HIGH-VOLUME HIGHWAY

A pavement preservation project utilizing an UTBO on U.S. 3 in Massachusetts would be considered significant based on its size alone, with nearly 1 million sq. yd. of mainline paving, and over 400,000 sq. yd. of preservation on the shoulders and breakdown lanes.

Completed in fall 2015, the project involved a section of U.S. 3 north and south from Burlington, Mass., to the New Hampshire state line at Tyngsborough, Mass. This 20.6-mile stretch of road is one of the main routes between Boston and New Hampshire, with average daily traffic counts of approximately 100,000 vpd. The route consists of six total travel lanes (three northbound and three southbound), as well as high-speed shoulders and breakdown lanes in each direction.

As part of the implementation of R26, MassDOT was selected as a lead adopter state, with U.S. 3 as a showcase project for SHRP2-R26, *Guidelines for the Preservation of High-Traffic-Volume Roads*.

The contract for the project, awarded to Brox Industries, Inc. of Dracut, Mass., involved a comprehensive scope of work, including significant pavement repairs and surface preparation, placement of several types of preservation treatments, replacement of pavement markings using multiple

methods, and traffic control and safety management throughout the entire project.

"The project also included a ride specification, making it the first ultrathin bonded overlay project in the region to include this requirement," said Ed Naras, pavement management engineer, MassDOT Highway Division, Boston.

The mainline paving of the highway was completed utilizing an UTBO which involved placement of a heavy application (0.18 to 0.25 gal. per sq. yd.) of polymer emulsion bond coat, immediately

followed by a 5/8 to 3/4-in. gap-graded hot mix overlay.

"This process seals the existing surface and provides a superior bond to the hot mix overlay," Naras said. On the U.S. 3 project, the road was split into three approximately even length sections that were each treated with a different type of UTBO. These included sections with a PG 64-28 binder (control section), PG 64V-28 binder (polymer modified section), and ASTM D6114 asphalt rubber binder (recycled material section).



IMAGE CREDIT: MASSDOT

On mainline lanes of U.S. 3 in Massachusetts, spray paver places asphalt emulsion bond coat and ultrathin bonded overlay in one pass

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One inch of stone matrix asphalt (SMA) Thinlay is placed in Bryan, Tex.; paver used *Pave-IR* system to detect uniformity of mat temperature, control of which critical for thin asphalt lifts

THINLAYS FOR PRESERVATION

A different type of thin overlay that utilizes asphalt emulsions is the *Thinlay*. Thinlays—as branded by the National Asphalt Pavement Association—constitute a suite of thin asphalt overlay mixes designed to be placed at thickness as thin as 5/8 of an inch, to 1.50 in.

This plant-mixed combination of asphalt cement and aggregate is placed via conventional paver over aging asphalt or concrete pavements as a pavement preservation treatment. The liquid asphalt binds the aggregates together in a strong but flexible pavement structure.


“When used appropriately, thin asphalt overlays are safe, reduce costs, and are sustainable through the incorporation of recycled materials,” NAPA says. “Construction is fast, with less impact on drivers, and there are additional environmental benefits, such as noise reduction. In addition, thin asphalt overlays provide a smooth driving surface, improving ride quality and reducing fuel consumption compared to rough pavements.”

Because there are hot mix plants and experienced HMA contractors almost everywhere, thin HMA overlays have become one of the most common pavement preservation treatments. Polymer modified asphalt may be used for improved performance, and reclaimed asphalt pavement (RAP) may be incorporated into the hot mix to lower cost and as a more environmentally friendly option.

For the Thinlay to succeed, quality bond coats are essential. “The tack coat is crucial to bonding the new overlay to the old pavement, especially on unmilled surfaces,”

according to information published by NAPA and available online. “Because the overlay is thin, the interface between the old and new pavement is in close proximity to the shear forces created by vehicles during braking and turning movements.”

Most specifications require a heavier-than-normal application of [bond] coat, and in the instance of California, the tack applicator is specified as being a part of the paver, said David Newcomb, then vice president—research and technology, NAPA, and now with TTI.

Some locations such as California require the use of polymer modified emulsions, while others such as Minnesota use non-modified emulsions. The application rate range varies according to individual states from as low as 0.04 to 0.08 gal. per sq. yd. for North Carolina, to as high as an average of 0.20 gal. per sq. yd. for California. Most states have a range closer to 0.10 to 0.15 gal. per sq. yd. he writes. 

Article provided by the Asphalt Emulsion Manufacturers Association

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