A tack for the battle

A strong bond coat can combat against deterioration

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An emulsified asphalt "tack" or bond coat produces a strong adhesive bond that will prevent slippage between an existing pavement and a new overlay.

An asphalt emulsion for tack or bond coats—or surface treatments—is a homogeneous mixture of two insoluble substances, oil and water, in which particles of liquid asphalt (the dispersed phase) are surrounded by molecules of water (the continuous phase).

Asphalt emulsions are produced by dispersing tiny globules of asphalt cement into water treated with a small quantity of emulsifying agent. The dispersion takes place in a powerful blender, called a colloid mill, where spinning blades break or shear the liquid asphalt into suspended microscopic particles. The water, or soap solution, is immediately introduced to form the emulsion.

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

Preventing slippage

Many premature pavement failures can be attributed to the loss of bond between two layers of asphalt pavement.

The solution is a tack coat, more correctly called a bond coat. ASTM D8-13b—Standard Terminology Relating to Materials for Roads and Pavements—defines a tack coat as the application of a bituminous material to an existing, relatively non-absorptive pavement surface, to provide a thorough bond to hold a new surfacing.

"Tack coats are used to promote the bond between pavement layers," said Gregory Harder, P.E., regional engineer, the Asphalt Institute, at the October 2015 Pavement Preservation & Recycling Alliance conference in Niagara Falls, Ontario. "They prevent slippage between pavement layers, are vital for

the structural performance of the pavement, making all layers work together."

What if no bond coat is used, or is applied poorly? Slippage, shoving or rutting can occur, and corrugations may be evident. The problem may be more acute where traffic slows or stops, such as at streetlights or bus stops. Poor pavement performance such as early fatigue cracking—either bottom-up or top-down—may result in costly pavement repairs. "The most costly situation occurs when early fatigue cracking is seen, which may require the agency to remove and replace entire layers of pavement sooner than anticipated," Harder said.

Research at the National Center for Asphalt Technology underscores the benefit that bond coats provide to layered asphalt pavements. In the past 10 years, forensic investigations of a few test sections on the NCAT Test Track revealed bond failures that led to rapid structural deterioration of the pavements.

An engineering analysis of a pavement with and without one of the layers bonded will substantially increase the tensile stresses beneath the load, NCAT said in the spring of 2015. Cracking will initiate when a layer is unable to withstand the strains applied. Although tack coats are a small item in the overall cost of building and rehabilitating pavements, bonding of asphalt layers is critical to good performance.

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The preferred method

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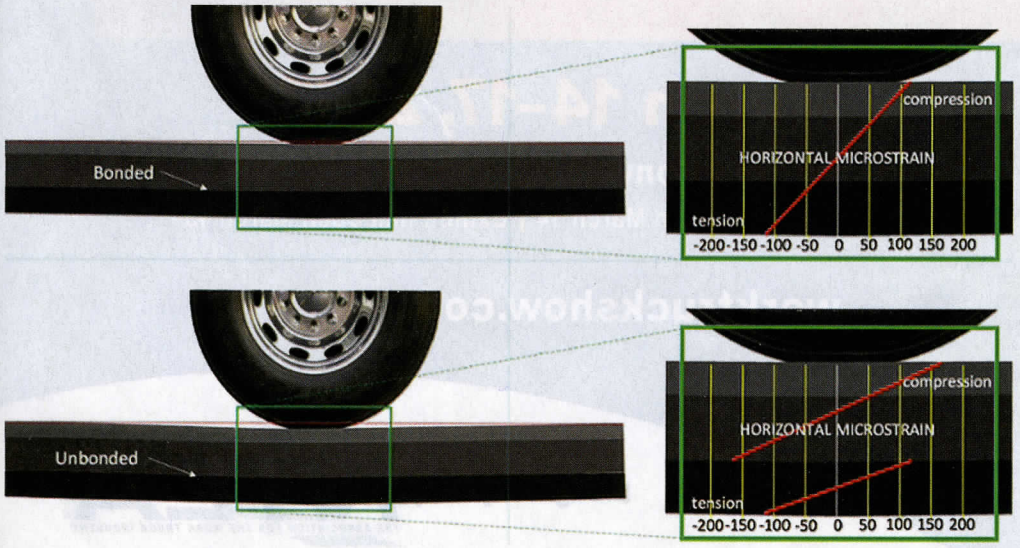
In a thorough, worldwide survey conducted for the recent NCHRP Report 712: Optimization of Tack Coat for HMA Placement, the authors found that 100% of the respondents—including 46 of the 50 states—allow the use of asphalt emulsions for bond coats. By comparison, only 27% and 20% of respondents allow paving grades and cutbacks, respectively. Worldwide, the survey found some 92% of bond coats are of asphalt emulsions.

That is because asphalt emulsions offer substantial benefits over the other two options. Compared to hot liquid asphalt, asphalt emulsions have greatly reduced viscosity, and are safe to use at lower temperatures. To maintain its fluid state, "neat" liquid asphalt has to be kept hot, typically over 300°F, which makes it dangerous to use in a dynamic road construction site with workers, drivers and pedestrians on the move.

Cutback asphalts keep the asphalt liquid by introducing solvents such as kerosene or diesel. Cutbacks have served the industry for decades, but have come under scrutiny, because as the solvents evaporate, leaving the residual asphalt behind, they introduce volatile organic compounds into the atmosphere, which promote smog formation and are discouraged by current environmental regulations.

Figure 1. Effects of bond coats on asphalt compression.



FAST FACTS FOR TACKS

Know the process and the terminology

Residual asphalt is the remaining asphalt after an emulsion has set typically 57% to 70%. The **bond or tack coat break** is the moment when water separates enough from the asphalt emulsion, showing a color change from brown to black. The **bond coat set** occurs when all the water has evaporated, leaving only the residual asphalt.

Know the requirements for success

There are four essential requirements for a successful bond coat application, according to the North Carolina Department of Transportation's (NCDOT) Tack Coat Best Practices Field Guide. The **existing pavement surface must be dry** and thoroughly cleaned. The **proper bond coat rate** must be applied. A **uniform coverage of emulsion** must be placed over the entire area to be paved. And the **bond coat must break** prior to trucks backing over the emulsion, or placement of a new asphalt layer.

Sweep first, then coat

Experts recommend that the existing surface be broomed or swept prior to placement. The surface should be clean and dry, although a little moisture (no standing water) is acceptable. A minimum ambient temperature of 35°F is recommended.

Watch for residual asphalt

The **application rate** of the bond coat asphalt emulsion alone does not determine the success of the bond; it is the **residual asphalt** that is left behind after the emulsion "breaks" and the water evaporates.

Check temperatures of the asphalt emulsion

While the most popular **"neat" liquid asphalt** used for tack or bond coats, PG 64-22, is placed at 350–400°F, **NCDOT-approved asphalt emulsions** are placed from 130–160°F.

Cover completely

The clean existing surface must be completely and uniformly covered with bond coat. A **triple overlap of nozzle spray** is best, but a double overlap also works. The triple overlap is more common and provides room for error. Whether triple or double lap, the goal in setting up the distributor bar is to achieve a **consistent application rate** across the full width of the pavement.

Don't over-tack

Streaks or "zebra" stripes should be avoided as they reduce bonding capability. Beware of over-tacking the pavement; this can lead to slippage of the overlay, or the **emulsions can flow off the road** and into the gutter or roadside ditch.

Align nozzle, reduce non-uniform bond coats

Nozzle alignment is particularly important when applying asphalt emulsion in the range of 0.025–0.05 gal per sq yd, according to the Colorado Asphalt Pavement Association. Nozzles must be installed at the **proper angle** for the equipment being used, and they should all be the **same size and type.** Distributor manufacturers will supply a wrench with the equipment that is intended specifically for this purpose.

Calibrate the truck before application

Ensure the intended application rate of the bond coat by calibrating the distributor truck before application, and then verify that rate was achieved by "strapping" the distributor as the project continues. ASTM D2995-14: Standard Practice for Estimating Application Rate and Residual Application Rate of Bituminous Distributors is the test standard that describes this process. **Calibration should address,** as a minimum, spray bar height, nozzle angle, spray bar pressure, thermometers and strapping stick.

Different types

Generally speaking, an emulsion will be constituted of 55–70% typical range of asphalt binder content per ASTM specifications, with the rest comprised of water and a very small amount of emulsifier, sometimes as low as 0.25% by weight. The emulsifier also partially controls the "break" time, following placement on a road, in which the water evaporates, leaving the residual asphalt behind.

A variety of asphalt emulsions are available for just about every tack coat application. These are designated by a simple code, which denotes their nominal attributes. For the very common tack coat emulsion—SS1h—the SS means slow setting, the 1 means it is a lower viscosity asphalt, and the h means it is a stiffer base asphalt. This denotation was developed by the Asphalt Institute, and in addition to slow setting, also includes rapid-setting (RS), medium-setting (MS) and quick-setting (QS) emulsions.

Asphalt emulsions for tack or bond coats will utilize the 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 and CRS-1.

Dilution of the bond coat is a very common issue for users and contractors in the field. The bond coat emulsion often may be diluted 50:50 with water. The principal reason is to make it easier to apply the material.

It is recommended that dilution not be done in the field. In the past, the emulsion has been diluted in the distributor truck itself, but it cannot be done there with the control that is afforded in the terminal, accurately metered into the emulsion and not compromising the quality of the product. Polymer-modified and value-added non-tracking emulsions often are not diluted. An emulsion manufacturer should be consulted for specific recommendations on storage, handling and application of these products.

For more information about bond or tack coats, or about asphalt emulsions, consult the Asphalt Emulsion Manufacturers Association at www.aema.org. R&B

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For more information about this topic, check out the Asphalt and Maintenance Channels at www.roadsbridges.com.