

## technotes

“tech notes” are a product of the State Materials Laboratory to share design and construction technology gained from projects done through WSDOT. This issue is from the Pavements Branch discussing the use of tack coat.

### Issues Related to Tack Coat

The use of emulsified asphalts as a tack coat for hot mix asphalt (HMA) paving has predominately been ignored as to the importance it plays in the pavement structure. The lack of tack coat can lead to premature failure in the form of debonding, mat slippage, and potentially fatigue cracking, which leads to reduced pavement life.

Tack coats are diluted emulsified asphalt materials placed on an existing pavement surface prior to a hot-mix asphalt overlay. Tack coat needs to be applied to any adjacent surface (i.e. curbs, gutters, structures, or existing pavement). A quality tack coat provides the necessary bond between the underlying/adjacent layers and the new pavement surface. The bond ensures that the entire pavement structure will act together. Deficiencies such as debonding, mat slippage, and top-down cracking can occur with a poor bond between layers. Progression of these deficiencies advances into other distresses that can greatly reduce the life of the pavement surface. The fundamental aspects of tack coat success include: surface preparation and application, along with the proper setup and function of the equipment.

According to WSDOT Standard Specification 5-04.3(5)A, the entire surface of the pavement shall be thoroughly cleaned of dust, soil, pavement grindings, and other foreign matter (Image 1). A proper bond cannot be achieved if the surface is not thoroughly cleaned. The tack coat will bond to the excess debris left behind and not to the existing surface. Effective tack coat applications bond the existing surface to the overlay so the entire pavement structure can act as one. Unfortunately, even a uniform tack coat application is of no value if the surface is not prepared correctly.

Surface preparation is the first step in applying a proper application of tack coat. The emulsion needs to be placed on a clean, dry surface. The bond is first created by the absorption of the emulsion into the existing surface, second by the emulsion curing and breaking, and third by placing the hot-mix layer over the broken emulsion. If the surface is not clean, the emulsion absorbs into the debris left on the roadway instead of the existing surface. When the paving equipment is allowed onto the tack coat, “pick up” can occur (Images 2 and 3). Pick up is the term used to describe when the tires of the paving and delivery equipment pick up the tack coat. If the existing surface is not thoroughly cleaned, absorption into the



Image 1. Brooming operation



Image 2. Delivery vehicle tracking



Image 3. Material transfer device tracking



Image 4. Application on oxidized asphalt

surface does not occur (the excess fines on the roadway absorb the emulsion). In this case, the emulsion does not bond to the existing surface and when delivery or placement equipment is driven over the tack coat, the tack sticks to the equipment's tires instead of the roadway. Of course, tire pick up typically occurs in each of the wheelpaths, which is the most critical location for the new surface to bond to the existing surface.

This problem happens more often with a milled surface because of the large amount of debris created during the milling process. Brooming the surface typically does not adequately remove the debris. A broom and vacuum system may be necessary to completely clean the roadway prior to the application of the tack coat.

Within Washington State, the use of CSS-1 (Cationic Slow Set), STE-1 (Special Tack Emulsion), or CSS-1H is predominately used for tack coat applications. The difference between CSS-1 and CSS-1H is that the CSS-1H residue has a lower penetration value (i.e. a stiffer asphalt). This results in less penetration into the existing surface.

Various states have residual emulsion rates that vary from 0.03 to 0.15 gal/sy. WSDOT Standard Specifications call for 0.02 to 0.08 gal/sy of retained asphalt, which equates to an application rate of 0.05 to 0.11 gal/sy. Application rates need to be adjusted according to the existing pavement condition, surface type, and dilution rate.

Recently, a technical paper from Flexible Pavements of Ohio<sup>1</sup> has published application rates for various pavement types (Table 1). The residual rates vary from 0.03 to 0.08 gal/sy for different pavement types.



Image 5. Excessive tack (unbroken)

Image 4 shows an oxidized asphalt surface with a residual asphalt amount of 0.04 gal/sy, which is at the low end of the recommended application rate. In contrast, Image 5 illustrates the application of too much tack. The residual application rate was 0.05 gal/sy but was applied four times, which equates to a residual application rate of 0.20 gal/sy. This much tack is not necessary and the cure time will be excessively long.

1 Flexible Pavements of Ohio, Technical Bulletin: *Proper Tack Coat Application* (21May01)

Table 1. Tack coat application rates.

Existing Pavement Condition	Application Rate (gallons/sy)*		
	Residual	Undiluted	Diluted (1:1)
New Asphalt	.03 to .04	.05 to .07	.10 to .13
Oxidized Asphalt	.04 to .06	.07 to .10	.13 to .20
Milled Surface (asphalt)	.06 to .08	.10 to .13	.20 to .27
Milled Surface (PCCP)	.06 to .08	.10 to .13	.20 to .27
Portland Cement Concrete	.04 to .06	.07 to .10	.13 to .20
Vertical Face	**	**	**

\* Rates shown are for slow setting asphalt emulsions (SS1, SS1H) containing approximately 60% bituminous material.  
 \*\* Longitudinal construction joints should be treated using a rate that will thoroughly coat the vertical face without running.

Besides the possibility of creating a slip plane, excessive tack can result in a much slower break time. Allowing the tack to cure is another vital component in the life of a pavement. Paving over uncured tack can cause a slip plane. Typically, a slip plane is noticeable during rolling operations in the form of checking or micro-cracking. Flushing can also be caused by paving over unbroken tack. Migration of the tack into the overlay will cause an over-asphalted mix. A tack coat that has begun to break will turn from brown (Image 5, the surface is slick) to black (the surface becomes sticky).

Research from a recent report (Eighth International Conference on Asphalt Pavements<sup>2</sup>) has shown that the strength of the wearing course increases as the time for the tack to break increases. For instance, a 24-hour cure time has a higher bonding capability than a one-hour cure time. Time and traffic constraints do not allow long cure times, but the time allowed for the breaking of tack needs to be maximized.

The distributor equipment is essential to proper application. It must function properly to ensure the desired rate and uniformity. Distributors have to be capable of maintaining proper temperature, pressure, and spray bar height to apply the correct emulsion rate.

According to WSDOT Standard Specification 5-02.3(3), the emulsion temperature for application can range from 70 to 140°F. Because CSS-1H and STE-1 are more viscous materials, they will probably require a higher temperature than CSS-1. Temperatures for CSS-1 are typically around 135°F but can vary depending on the manufacturer and dilution rate. The manufacturer should be able to recommend the best temperature for their emulsion. The emulsion needs to be kept at the proper temperature because it can cause problems within the tank and nozzles, or with the application rate.

The pressure, along with the speed of the truck, need to be properly adjusted according to the application rate, type of emulsion, and the type of spray bar nozzles. The opening of the spray bar nozzles, also called snivies, need to be the proper size to create the needed pressure. If too small of a nozzle opening is used (i.e. too much pressure), the result can be spray back or misting. The result is a surface that has a spider web coating of tack (Image 7).

Not only is nozzle selection important, but also the angle of the nozzle with respect to the spray bar axis. There should be a 15 to 30 degree angle to each of the nozzles and all nozzles should be set at the same angle to maximize overlap and minimize interference.

Spray bar height is also important to the application process. The height will depend on the speed of the truck, the snivy configuration,

<sup>2</sup> Hachiya, Y; Sato, K (1997) *Effect of Tack Coat on Binding Characteristics at Interface Between Asphalt Concrete Layers*.



Image 6. Proper overlap and spray bar height



Image 7. Small nozzle opening



Image 8. Uneven distribution



Image 9. Proper coverage on a milled surface



Image 10. Broke and un-broke tack coverage on a un-milled surface

and the pressure used to apply the emulsion. The spray bar height will also have to be adjusted throughout the day depending on the amount of emulsion in the tank. Once the proper type of snivy and configuration are chosen for the type of emulsion to be used, the pressure, truck speed, and spray bar height can be determined according to the needed application rate. The proper choice for these factors should produce double or triple coverage.

Image 9 shows a correct tack coat application. There is a uniform coverage with no excess tack, which will allow the emulsion to cure in the minimum amount of time and perform well over the intended period of time.

The fundamental aspects of tack coat success include:

- Thoroughly clean roadway surface of foreign matter according to WSDOT Standard Specification<sup>1</sup> 5-04.3(5)A to increase bonding capabilities and lessen pick up.
- Ensure that all equipment functions properly and is setup correctly (i.e. pressure, nozzle size and angle, spray bar height, and emulsion temperature).
- Choose the proper application rate for the emulsion being used and existing surface conditions.
- Allow the tack to break prior to paving to ensure the best possible bond between the layers.

The proper preparation of the existing surface and tack coat application will lead to longer performance of HMA overlays.

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