FLEXIBLE PAVEMENTS OF OHIO

An association for the development, improvement and advancement of quality asphalt pavement construction.

6205 Emerald Parkway, Suite B, Dublin, Ohio 43016
888-4HOTMIX, 614-791-3600, 614-791-4800 (Fax)
info@flexiblepavements.org
www.flexiblepavements.org

Technical Bulletin: Proper Tack Coat Application (19Sept2012)

General

Research published in 2012 (Reference A) has confirmed that the proper application of tack coat material is a key component of a quality asphalt paving project. Tack coat promotes bond to underlying layers, facilitating achievement of maximum strength of the pavement structure. It prevents delamination and sliding type failures and ensures long-term performance and lasting ride quality to the highway user. This technical bulletin examines the necessary procedures for ensuring proper tack coat application.

As in the placement of Hot Mix Asphalt, uniformity is a very important consideration when placing tack coat materials. Since the purpose of tack coat is to promote bond between an existing pavement surface and an overlay, it is very important that the tack coat be applied in a uniform manner, with full coverage of the surface and pick-up by haul vehicle tires minimized. Attention to detail is necessary for all aspects of tack coat application: the surface condition of the existing pavement, the consistency and temperature of the bituminous liquid, and the capability of the placement equipment.

Figure 1 –Uniform tack-coat application (photo courtesy of the Ohio Department of Transportation)

A good tack coat application will exhibit a uniform layer of bituminous material at the desired rate (gallons per square yard). Streaking and puddling, the two extremes of any tack coat application, are considered unacceptable.

The application of tack coat on vertical surfaces must also be uniform, just as application on horizontal surfaces. Here, tack coat promotes bond and mitigates cracking and subsequent deterioration at construction joints. ODOT specifications, 401.17, require that the entire face of a cold longitudinal joint be sealed with either PG binder or rubberized asphalt emulsion, 702.13, overlapping the edges of the joint 1/2 inch prior to placing the adjacent mat.

Equipment

Proper functioning equipment will help ensure that the tack coat application meets the desired uniformity and rate requirements. The distributor must be calibrated to ensure the placement of the required application rate. If there is any question as to the distributor's capability to uniformly place the required application rate, its calibration should be verified using the method in ASTM D 2995.

Tack distributors must be capable of maintaining temperature of the bituminous material to ensure the material will adequately flow. A spraying temperature between 75° F and 130° F is suggested for slow setting asphalt emulsions such as SS-1h. Excessive heating should be avoided. This may cause the emulsion to break[1] while still in the distributor.

Distributors must have the capability to develop pressure sufficient to force the bituminous material through the spray bar nozzles, creating a fan shape as the material leaves the nozzle. For slow setting emulsified asphalt tack coat materials,

[1] The term, “break,” is used to describe the initiation of the process whereby water, introduced during emulsification, separates from the asphalt cement and begins to evaporate.

dilution will facilitate this operation by reducing the material's viscosity. An adjustment to the rate of application must be made, however, to ensure sufficient bituminous material is deposited on the pavement surface.

The elevation of the distributor spray bar should be set at a height sufficient to allow the fan of bituminous material to fully develop. A fully developed fan will provide overlap of the material placed by the adjacent nozzles. This double lap, or in some cases triple lap, ensures the desired uniform application with approximately full coverage of the pavement surface.

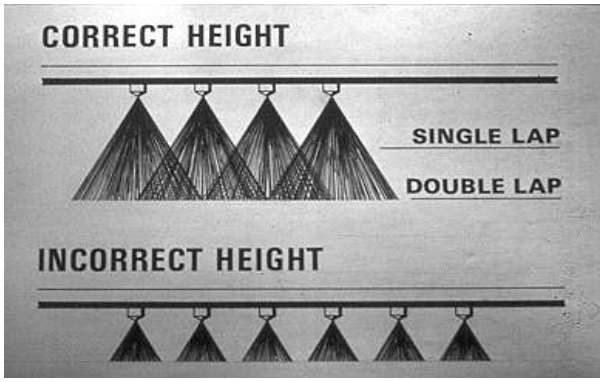

Figure 2 – Spray bar height to obtain desired coverage (Figure courtesy of the Asphalt Institute, Pavement Maintenance with Asphalt)

As tack coat material is placed, the reduction in its quantity will cause the distributor to lighten. Consequently, the spray bar will tend to rise. Should this occur it would result in a non-uniform layer of bituminous material across the pavement width. As such, the distributor should be equipped to maintain the spray bar at a constant height.

To assure a uniform coating of material on the pavement, **ALL** spray bar nozzles should be open and set at the same angle. The angle is measured from the axis of the spray bar and is typically 15° to 30°.

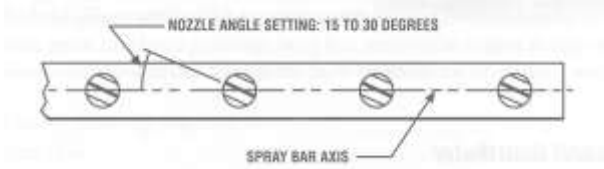

Figure 3 – Proper Nozzle Angle Setting (Figure courtesy of the Asphalt Institute, A Basic Asphalt Emulsion Manual)

Lack of a uniform angle will result in some areas of the pavement having thicker coverage, and possible interference between nozzles.

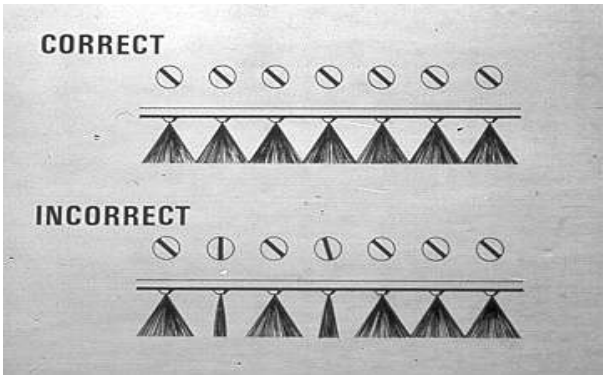

Figure 4 – Spray bar nozzle adjustment (figure courtesy of the Asphalt Institute, Pavement Maintenance with Asphalt)

Application

Tack coat material should be placed on clean, dry pavement. Where cold and/or damp weather conditions exist, an adjustment to the type of material used may be necessary. Emulsified tack coat materials may be applied to cool and/or damp pavement, however, the length of time needed for the set[2] to occur may increase. Guidance on the types of tack coat materials can be found in the Asphalt Institute's publication number MS-19, A Basic Asphalt Emulsion Manual.

The pavement surface receiving tack coat material should be free of any substance that might inhibit bond. The tack coat operation is never a substitute for cleaning a pavement prior to overlay. A dirty or overly dusty surface will inhibit the ability of the tack coat to bond, resulting in a potential slippage plane between the existing surface and the asphalt overlay. Slippage cracking, or tearing, and delamination are distresses typically seen when cleanliness is lacking.

Application rate should vary depending on the condition of the pavement being overlayed. The objective is to apply a sufficient quantity of tack coat, resulting in a thin, uniform coating of asphalt covering the entire pavement surface. Matching the application rate with the condition of the existing surface is key to success.

Pavements having a fine surface texture require less tack coat material than those with coarse textures. This is due to the lesser amount of exposed surface area. Conversely, milled surfaces will typically require amounts of tack coat

[2] The "set" occurs when the water, introduced during emulsification, has completely evaporated from the asphalt emulsion, leaving a black, thin film of asphalt cement on the pavement surface.

Figure 5 – Non-uniform tack-coat application (photo courtesy of the Ohio Department of Transportation)

material similar to that of existing weathered surfaces.

In some instances it is desirable to dilute slow-setting emulsified asphalt tack coat materials. This is done to facilitate obtaining uniform coverage without placing too much asphalt on the surface. However, ODOT specifications require the engineer's approval for dilution and have a minimum viscosity specification for the diluted emulsion. Dilution will increase the break and set times. Only slow setting emulsion should be diluted in the field – and then only carefully, by adding water to the emulsion instead of the opposite. Adding the emulsion to water may cause the tack to break. The dilution rate should not exceed 1:1.

In lieu of dilution, alterations to equipment or operational methods, such as reducing nozzle opening size or increasing pressure, can provide the desired fan shape without placing excessive amounts of tack coat.

Excessive tack coat is detrimental. In these instances the tack coat acts as a lubricant, creating a slippage plane. Additionally, using too much material can cause it to be drawn into an overlay, negatively affecting mix properties and even creating potential for bleeding in thin overlays. ODOT specifications require the actual rate to be within plus or minus 10% of the required rate.

When using diluted emulsified asphalt tack coat material, an adjustment to the application rate will be necessary to ensure the desired residual asphalt is achieved. Failure to do so will result in too thin of a coating of bituminous material and inadequate bonding between the layers.

Typical application rates for various pavement conditions are provided in Table 1.

Table 1 – Typical Application Rates

Existing Pavement Condition	Application Rate * (gallons/sy)		
	Residual	Undiluted	Diluted (1:1)
New Asphalt	.03 to .04	.05 to .06	.10 to .12
Oxidized Asphalt	.05 to .06	.08 to .09	.15 to .18
Milled Surface (asphalt)	.05 to .06	.08 to .09	.15 to .18
Milled Surface (PCC)	.04 to .05	.06 to .08	.12 to .15
Portland Cement Concrete	.04 to .05	.06 to .08	.12 to .15
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 off.

Rates listed are in accordance with the recommendations from NCHRP Research project 09-40 (Reference A)

Allowing the emulsified asphalt tack coat material to set prior to placing the asphalt overlay will enhance opportunity for bond to occur. Whenever practicable, equipment should stay off the tack coat until the set has occurred.

During the break, dispersed droplets of asphalt cement in the emulsified asphalt begin to coalesce. This starts when the emulsified asphalt comes in contact with the pavement surface, and is complete after all moisture has evaporated. A change in the color of the emulsified asphalt tack coat material, from brown to black, is a visual indicator of when the emulsion has broken. The ability of the tack coat to bond is best once the material has set.

Tracking

Tracking, the pick-up of bituminous material by vehicle tires, can occur as a result of the tack coat operation. The critical consequence of tracking is

the removal of the needed tack coat from the pavement surface, which may prevent adequate bond. Areas where the tack coat has been excessively picked up must be corrected by reapplying tack coat material to the areas where the tack has been lost. Care must be exercised to avoid over-tacking areas already sufficiently tacked.

An undesirable consequence of tracking is the depositing of bituminous material on adjacent pavement and at intersections. Though aesthetically not pleasing, the effect on adjacent pavement is typically minimal, and wears off in a short time period. Intersections, on the other hand, can receive deposits of material significant enough to distort the pavement surface and hinder a driver's ability to navigate. As such, steps should be taken to eliminate the occurrence of tracking.

The magnitude of tracking is largely dependent upon two issues. They are: the type of bituminous material being used, and whether sufficient time has been allotted to allow emulsified asphalt tack coat materials to set prior to haul vehicles having access.

Tack coat material having enhanced elastomeric properties (rubberized tack) has a high propensity to adhere to vehicle tires. Because of the tenacity of rubberized tack material, it is more readily carried off the project site than conventional tack coat material. Exacerbating this is the failure of allowing emulsified asphalt tack coat materials to set. Haul vehicle tires will pick up material that has not had sufficient time to set. During transport, the tack coat material will gather on the haul vehicle tires, from which deposits will be made on the road surface. Intersections experience the greatest distress due to the haul vehicle being at rest, allowing the greatest amount of material to be deposited on the road surface.

In order to reduce tracking, the emulsified asphalt tack coat material must have sufficient time to set prior to exposure to haul vehicles. To accomplish this, the delivery of material must be balanced with the speed of the paving operation, the length needed for access by haul vehicles, all in consideration of weather conditions.

Preventing tracking by haul vehicles is particularly challenging during night work, where cooler weather and the lack of sunlight tend to increase the time needed for the set to occur and on traffic maintained maintenance projects, where sufficient time and space may not permit allowing the tack coat to set before paving. The NCHRP research suggests two alternatives for these situations. Trackless tack, a proprietary emulsion, can provide short set times and track free residual coating on the pavement. This material was also shown to provide a superior bond.

Based on experience in Europe and limited trials in the US, it is suggested that paving over the un-broken tack coat may prevent pick-up on haul vehicle tires without consequence to the paving. In Europe the use of "spray pavers' that apply the tack coat just ahead of the paving have been used effectively. The only problem with this equipment is verifying that the tack coat application is uniform.

Maintenance of Traffic Considerations

Ensuring the driving public is provided a safe driving surface is a primary consideration. For safety reasons, traffic should be kept off the tacked road surface at all times. When a tacked road surface is exposed to traffic, the potential exists for reduced skid resistance, especially during wet weather. To address this, good practice is to tack just far enough in front of the paving operation to provide reasonable access to the paver by haul vehicles and sufficient time for the tack coat material to set. It is prudent to use a sand cover to provide friction and prevent pick-up when the paving operation requires that the tacked road surface be open to traffic. A typical rate for applying sand cover aggregate is 4 to 8 lbs/sy.

The Effect of Texture on Bond

The NCHRP research indicates that the texture of the surface to be overlaid has a significant effect on the bond strength that is developed. Milled and tacked surfaces generally showed greater bond strengths than overlays placed on smooth surfaces. Thus, milling an existing asphalt or concrete surface can result in better bond and should be considered in high stress applications where bond will be critical.

In a similar manner, one could expect that a fine graded surface course placed over a coarse textured intermediate or base course would produce stronger bond. On new construction this is typically the case. For example a 12.5 mm surface course is placed on a 19 mm intermediate course. However, some maintenance, resurfacing projects consist of leveling and surface courses using the same fine graded material for both courses. For example, a Type 1 surface on a Type 1 leveling. For most applications this has not been

a problem. However, in a high stress application the bond that can be achieved between these similar materials may not be adequate to resist the shear stress applied by heavy loads stopping or starting on the pavement. Alternatives include placing the material as a single, thicker course over a milled surface or making the leveling a thicker, coarser graded material.

The Effect of Tack Material Type on Bond

The NCHRP research indicates that harder grades of residual asphalt and polymer modified materials provided higher bond strength than softer asphalt grades. The use of PG binder, SS1H, and trackless tack provided higher bond strengths in the tests. Ohio has specified a rubberized tack material for use on concrete or brick for many years. This material, 702.13, Rubberized Asphalt Emulsion, is produced by blending SBR rubber compound into a tack coat emulsion. It has been shown to provide a very strong bond, but is very difficult to haul and pave over.

Conclusions

- Uniformity is a major consideration in the proper application of tack coat material. A good tack coat application will exhibit a uniform layer of bituminous material adequate for the condition of the existing pavement.
- To ensure a uniform application of tack coat material, equipment must be capable of delivering the material at the required temperature and pressure. Dilution may facilitate uniform application by assisting the flow of material, however, a delay in the set time will result. Modification to equipment or operational methods such as reducing spraybar nozzle size or increasing pressure will help ensure uniform application. The spray bar and angle of the nozzles must be verified for proper height and alignment.
- Tack coat application should be made on clean, dry pavements at a rate reflecting the condition of the pavement being overlayed.
- Allowing the emulsified asphalt tack coat material to set prior to placing the asphalt overlay will enhance opportunity for bond to occur.
- To mitigate tracking, the emulsified asphalt tack coat material must set prior to access by haul vehicles.
- Maintenance of traffic should ensure that any road surface that has been tacked is covered prior to access by traffic, either by a Hot Mix Asphalt overlay or a cover aggregate.
- For high stress applications, ensure that sufficient pavement texture exists between courses, in addition to proper tack coat application, and use high strength tack coat materials to develop high bond strength between layers.
- For more information on the proper application of tack coat, consult the Training Manual included in NCHRP Report 712 (reference A)

References:

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6205 Emerald Parkway, Suite B
Dublin, Ohio 43016
888-4HOTMIX, 614-791-3600
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