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Reference Guide for Tack Coats, Spray Paver Membranes, and Underseals

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REFERENCE GUIDE FOR TACK COATS, SPRAY PAVER MEMBRANES, AND UNDERSEALS

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DISCLAIMER

This research was performed in cooperation with the Texas Department of Transportation (TxDOT) and the Federal Highway Administration (FHWA). The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official view or policies of the FHWA or TxDOT. This report does not constitute a standard, specification, or regulation. This report is not intended for construction, bidding, or permit purposes. The researcher in charge of the project was Bryan Wilson, P.E. (Texas, #126948).

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Overlay Bonding and Sealing

OVERVIEW

The bond quality between pavement layers significantly impacts pavement life. Poor overlay bonding may lead to delamination, slippage cracking, and premature fatigue cracking, reflection cracking, and rutting. There are several options to prepare the surface prior to an asphalt overlay. Choosing the right treatment depends on the existing surface condition and the type of overlay construction. This document gives guidance on when each option may be used and some information on bond strength testing and performance.

BOND AND SEAL TREATMENTS

Traditional Tack Coat

The most common materials used for a tack coat are the asphalt emulsions CSS-1H and SS-1H. Other possible materials include polymer-modified (pm)-emulsion, neat asphalt (AC 5, AC 10), pm-asphalt, and cutbacks. A traditional tack coat (FIGURE 1) uses an application between 0.04 and 0.10 gal/sy (0.02 to 0.05 residual). Construction tips for applying tack coat are given in https://ftp.dot.state.tx.us/pub/txdot-info/cst/tips/ tack_coat.pdf.

FIGURE 1 – Traditional Tack Coat.

Emulsified Trackless Tack Coat

Emulsified trackless tack resists tracking under traffic after the material has cured (FIGURE 2). The material can be an emulsified hard-pen asphalt or a pm-emulsion and must be on the Texas Department of Transportation's (TxDOT's) approved Material Producer List (MPL). The hard-pen base tacks have better tracking-resistance performance, especially in higher temperatures. Emulsified trackless tacks are applied between 0.04 and 0.10 gal/sy, (0.02 to 0.05 residual). These tacks typically have superior bond performance than traditional tack.

FIGURE 2 – Emulsion Trackless Tack Coat.

Hot-Applied Trackless Tack Coat

Hot-applied trackless tack is hard-pen or heavily polymer modified binder that is very stiff at ambient temperatures (FIGURE 3). Within seconds of application, the tack is hard and resists tracking under traffic. Materials for use must be on TxDOT's MPL. These materials have the best tracking resistance and the best bond strength among all the bonding options. Typical application rates are 0.10 to 0.20 gal/sy.

FIGURE 3 – Hot-Applied Trackless Tack Coat.

Spray Paver Underseal Membrane

A spray paver is a specially designed asphalt paver with a tack tank and spray bar attached (FIGURE 4). The tack is sprayed immediately before being overlaid. Any emulsion or asphalt can be used, but the typical application uses a pm-emulsion. Application rates for emulsion are considerably higher at 0.20 to 0.30 gal/sy (0.10 to 0.15 residual). Applications at lower rates are not feasible due to higher travel speeds required of the paver. Spray paver membranes seal off moisture and provide stress relief against reflective cracking. Initial bond strengths can be much lower than for other treatments.

FIGURE 4 – Spray Paver Membrane Underseal.

Traditional Underseal

An underseal is a one-course surface treatment with a loose application of aggregate (FIGURE 5). The binder is any seal coat asphalt, pm-asphalt, pm-emulsion, or rubber-modified asphalt. The rock is a uniform Grade 3 or Grade 4 and may be precoated. The binder rate is 0.25 to 0.40 gal/sy, and a typical rock spread rate is 1 cy/sy. Underseals do a very good job sealing against moisture. They have low shear bond strength, but their flexibility is very good at resisting reflection cracking.

FIGURE 5 – Traditional Underseal.

APPLICATION SCENARIOS

New HMA

The best-case scenario for good bonding is overlaying on new hot-mix asphalt (HMA). This will occur in new construction or when paving in multiple lifts. Asphalt from the intermediate lift is still present on the surface and will bond with the asphalt in the overlay mix. While a good bond can be achieved without tack under ideal conditions, the cost of tack is inconsequential to the overall project and using a light tack application is still recommended.

Aged Surface, Good Condition

This surface should have minimal low-severity cracking, no bleeding, and has typical aggregate wear. A higher rate is required for courser surface textures and higher aggregate porosity. The heavy application from a spray paver may be excessive for tight surfaces.

TABLE 1 – Recommended Bond and Seal Treatment Applications.

Construction Scenario		Recommended Bond and Seal Treatments and Residual Asphalt Rates, gal/sy					Comments
		Traditional Tack Coat	Trackless Tack Coat		Spray Paver Membrane Underseal	Traditional Underseal	
			Emulsion	Hot-Applied			
Surface Type	New HMA	0.02–0.03	0.02–0.03	-	-	-	
	Aged HMA, Good Condition	0.03–0.05	0.03–0.07	0.10–0.20	0.10–0.15	-	
	Aged HMA, Moderate Cracking	-	-	-	0.12–0.15	0.25–0.40	
	Aged HMA, Bleeding	0.02–0.05	0.02–0.07	-	-	-	Reduce rate in wheel paths.
	Aged HMA, Severe Polishing	-	0.03–0.07	0.10–0.20	-	-	Gravel surfaces are hardest to bond to.
	Milled HMA	-	0.04–0.07	0.10–0.20	0.10–0.15	-	
	Aged Concrete	-	-	0.10–0.20	0.12–0.15	0.25–0.40	Rubber-modified asphalt.
Overlay Type	Thin Overlay	-	0.02–0.07	0.10–0.20	0.10–0.15*	0.25–0.40*	*Low initial shear strength. Limit use near stop-go traffic.
	Permeable Friction Course	-	0.04–0.07	0.10–0.20	0.10–0.15		
	Seal Coat	None					
	Slurry Seal/Microsurfacing	None					

Aged Surface, Moderate Cracking Distress

Moderately cracked pavements should be sealed to limit moisture infiltration and reduce reflection cracking. Both spray paver membranes and underseals will provide a good seal. By comparison, stiff treatments like trackless tack can increase the rate of reflection cracking. If cracking is severe and limited to the surface, it may be more appropriate to mill and inlay, perform full-depth repairs, or rehabilitate.

Another tack application is not needed over the underseal.

Aged Surface, Bleeding

Bleeding presents a particular challenge. The surface already has excess asphalt, so additional asphalt may migrate through the new overlay and present new bleeding problems. However, the surface outside the wheel paths would often benefit from tack. The contractor should adjust the nozzle size and configuration to reduce the rate in the wheel paths.

Milled Surface

A milled surface can provide a strong bond, but only if the surface is free of milling dust. Because of this difficulty, it is recommended to use a moderate to high rate application with a trackless tack or spray paver on milled surfaces. On a related note, scabbing milled surfaces can result in very poor bond strength where the bond fails at the old weak plane. This situation cannot be corrected with any kind of treatment.

Thin Overlays

Thin lifts <1.25 inches require better bonding. A trackless tack is recommended to minimize tracking and also provide a stronger bond. A spray paver membrane or underseal can also be used, though the low initial shear strength of these treatments may limit placement in heavy stop-and-go traffic areas.

Permeable Friction Course

A thicker application of tack will improve the bond for PFC. Therefore, an ideal treatment for PFC is a spray paver membrane underseal. The ideal equipment for PFC is a spray paver.

ADDITIONAL CONSIDERATION

Milling

Milling of the existing surface is a way to remove a deteriorated surface and improve roughness. Milling can also provide a good surface to bond to because it exposes cut aggregate faces and provides some texture as well. However, major problems can arise if the milling dust is not properly swept away. The tack coat and overlay will stick to the dust instead of the existing layer.

Scabbing can also cause bond problems (FIGURE 6). Scabbing occurs when milling partially exposes an old HMA surface. This old interface was poorly bonded and will be a weak point in the new overlay. The milling depth needs to either increase or decrease.

FIGURE 6 – Scabbing.

Spray Uniformity

Tack uniformity is just as important as tack rate to achieve a good bond. The pattern across the spray bar should be uniform with double or triple fan coverage. To achieve this, nozzles should be properly cleaned and aligned to about 30°. The distributor pump must provide

adequate pressure, and the material must be at the recommended temperature (FIGURE 7).

FIGURE 7 – Proper and Improper Application.

Tack Tracking

Traffic driving over the tack coat should be avoided as much as possible. Tracking can contaminate or even remove tack from the wheel paths (FIGURE 8). If most of the tack stays on the road after traffic, then bonding may be okay, and the only issue is messy equipment and adjacent roads and driveways. If the tack is actually picking up, then an alternative material (trackless tack) or method (spray paver or windowing in an adjacent lane) should be considered.

FIGURE 8 – Tack Tracking.

Bond Testing and Performance

The TxDOT Shear Bond Strength Test (Tex-249-F) is used to test bond quality for informational purposes on tracking resistant asphalt interlayer (TRAIL) products (FIGURE 9). The recommended minimum bond strength is 40–50 psi, depending on the application.

FIGURE 9 – Bond Shear Strength Tester.

Bond strength is influenced by several factors:

- Tack material type.
- Existing surface condition.
- Overlay type.
- Compaction temperature.
- Time after construction.

All these factors should be considered when evaluating the bond strength results. Higher bond strength is achieved with stiffer tacks at optimized rates (not too low, not too high), cleaner unpolished surfaces, dense overlay mixtures, and higher compaction temperatures. Also, bond strength tends to increase substantially within the first month, even in the first week, especially for emulsions.

A good bond will eliminate delamination and slippage. It will reduce early fatigue cracking and rutting. However, a stiff bond may also accelerate reflection cracking, which is why a more flexible treatment like an underseal or spray paver membrane is recommended for distressed pavement. The shear bond strength from Tex 249-F may be much lower, but this is not an indication of poor performance.