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Project Summary Report 0-4391-S
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Project 0-4391: Develop Guidelines for Placing an Underseal

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PROJECT SUMMARY REPORT

Guidelines for the Use of Underseals as a Moisture Barrier: Summary Report

Placement of an asphalt seal coat between layers of asphalt mixtures is considered beneficial and necessary. Pavement designs may call for application of a seal prior to overlaying the pavement (commonly called an underseal) to provide an impervious membrane to stop the intrusion of surface or subsurface moisture. The designer may specify the seal to enhance bonding with subsequent layers. However, at the onset of this project, many engineers felt that premature cracking (Figure 1), rutting, stripping, and flushing or bleeding (Figure 2) have occurred on highway pavements because the underseal was installed. Microsurfacing has also been associated with premature failures.

Therefore, the Texas Department of Transportation (TxDOT) felt a need to understand the mechanisms that make a seal beneficial and when a seal may lead to a premature failure of the pavement layers above or below. The objective of this research project was to develop the criteria needed to determine when and where to place an underseal.

Figure 1. Premature Cracking Associated with Damaged Underseal.

What We Did...

Researchers reviewed the literature and found very little research on underseals as used in Texas. A great deal of information documented the movement of moisture through pavement structures.

Researchers also surveyed TxDOT districts to determine current practices regarding the use of underseals, district successes or failures, remedies, and new approaches that have been adopted as a result of successes or failures. Pavement failures associated with the use or lack of an underseal were identified and documented as to the cause associated with each failure.

Based on the results from the literature, district survey, and forensic documentation, researchers developed decision-making criteria, guidelines, and instructional materials. Subsequent project activities followed up with pavement evaluations and test sections aimed at supporting the criteria and guidelines.

Figure 2. Underseal Bleeding through the Asphalt Concrete Overlay.

What We Found...

The following conclusions were obtained from information in the literature regarding the movement of moisture through pavement structures:

- Experimental road tests show that when pavements contain large amounts of free water, the rates of deterioration range from 10 or 20 to hundreds or thousands of times greater than rates during times when they contain little or no free water. The effects of excess water in a pavement structure can overshadow many other pavement design factors such as stress and strain, deformation, volume change, and fatigue.
- When base materials that contain more than 5 to 10 percent fines (which are most of the flex base materials in Texas) become saturated, these bases will not drain freely due to capillary forces. If base materials are not designed to drain freely, they should be protected from the intrusion of surface water.
- In most cases, water that enters a pavement's structure comes through the pavement surface. In those few cases where groundwater seepage is entering the pavement structure, drainage provisions should be made to intercept this type of water.
- The infiltration of water through pavement surfaces depends on the overall permeability, which is affected by the mixture type, density, and degree of cracking for asphalt concrete pavements (ACP). For portland cement concrete (PCC) pavements, the overall permeability is affected by the condition of the cracks and/or joints. A Federal Highway Administration (FHWA) study of numerous pavement sections found that 33 to 50 percent of the precipitation water falling on an ACP and 50 to 67 percent falling on a PCC pavement could infiltrate through the pavement surface to the road base.

TxDOT districts were surveyed to determine the current practices and experiences with the use of underseals. A summary of these findings is listed below:

- One hundred percent of TxDOT districts surveyed consider that the primary function of an underseal is to serve as a moisture barrier to prevent the intrusion of surface water into underlying layers. Another function that is considered important is that the underseal enhances the bond with the subsequent pavement layer. A few districts mentioned that they believed there is a secondary benefit associated with delayed reflection cracking and preventing the movement of subsurface moisture into the surface layer.
- Underseals are used on all types of surfaces: existing hot-mix asphalt concrete (HMAC), PCC, and aggregate bases. The most common use is to apply an underseal to seal off cracks in an existing pavement (PCC or ACP) prior to overlay. However, several districts (about one-third of those surveyed) routinely use an underseal any time a hot-mix overlay is placed.

- The most common type of binder used for seal coats applied as underseal is AC-20-5TR, and the most common aggregate grade is Grade 4. Some districts select binder based on specific criteria (such as weather and traffic). Both lightweight and natural aggregates are used for underseal construction.
- Testing and evaluation performed by some districts prior to underseal and overlay include coring (and visual evaluation of cores for signs of stripping), falling weight deflectometer (FWD), ground penetrating radar (GPR), ride quality, checking Pavement Management Information System (PMIS) scores, and performing visual evaluation to determine if milling is required.
- Dense-graded types C and D mixes are the most common surfaces applied over underseals.

Findings from the results of forensic investigations are summarized below:

- The main problems or failures experienced with underseals include: asphalt binder from the underseal bleeds through to the surface of the overlay; underseals (on aggregate bases) sometimes get damaged by traffic or construction operations prior to overlay, allowing water to leak into the base; and the underseal traps moisture in a moisture-susceptible layer, causing it to fail.
- Excessive binder application rates for underseals can cause the binder to bleed through to the surface of the HMAC overlay. This is true for both very high-viscosity asphalt binders, such as asphalt rubber, as well as low-viscosity binders. There is some evidence to suggest that low-viscosity binders (even when applied at appropriate application rates) have a propensity for bleeding.
- Poor construction and quality control practices on the underseal can reflect through to the performance of the HMAC overlay.
- Underseals can be very effective in protecting base materials from the intrusion of surface water. This is evidenced from failures that occurred in areas where the underseal was damaged prior to overlay. This has been a problem in regions of the state with low rainfall as well as high rainfall rates. The need for an underseal may be more a function of the moisture susceptibility of the base material than the region in which it is used.
- Base materials should be adequately cured prior to prime and surface treatment. This helps to ensure a good bond of the surface treatment and prevent highway traffic or construction traffic from damaging the surface treatment prior to overlay. Any damaged areas should be repaired. Even small and isolated areas associated with a damaged underseal have led to failure of the underlying base and HMAC overlay.
- While speculation occurs that underseals trap moisture in underlying layers and may eventually lead to pavement failures, researchers could find no evidence to document that assumption. On the other hand, there is evidence to show that any moisture-susceptible ACP layer that is overlayed (even without an underseal) has the potential to strip.
- Concern has also been expressed that when a seal is placed under an HMAC overlay, water penetrates the HMAC and collects on top of the underseal where it remains until evaporation. There is a fear that the action of traffic in these conditions will accelerate damage to the mix. For pavements on which GPR data were collected one day after a heavy rain, even pavements for which this situation was shown to exist, performance was very good.
- Because of the permeability associated with most asphalt concrete pavements or their longitudinal construction joints, rainfall will penetrate through most overlays. Without an underseal, this water will proceed to the underlying layers.
- GPR data collected one day after a heavy rainfall showed that moisture seems to be penetrating the underseal on some pavements. This could be due to cracking in the underlying layer, damage that occurred to the underseal prior to overlay.

The Researchers Recommend...

Researchers recommend the use of the decision-making criteria, guidelines, and instructional materials that were developed during this project and are presented in Report 0-4391-1.

For More Details...

The research is documented in:

Report 0-4391-1, *Guidelines for the Use of Underseals as a Moisture Barrier*

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