Optimization of Tack Coat Applications in Asphalt Pavements

Louisiana Develops Evaluation Tools and Pilot-Tests Guidance

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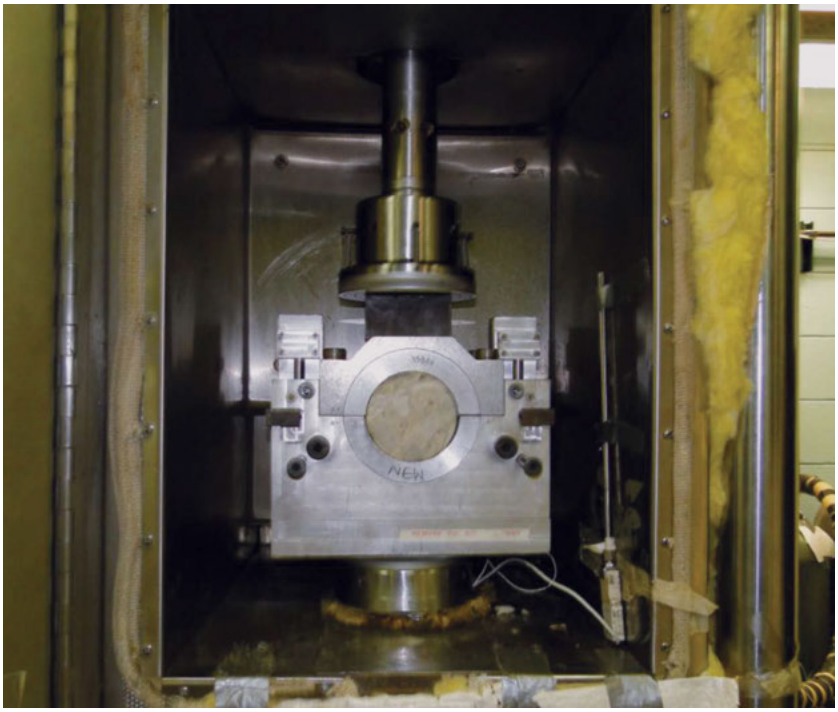
Tack coat is a light application of asphalt—usually asphalt emulsion diluted with water—onto a relatively nonabsorptive pavement surface. The tack coat provides an adequate bond between the surface and the newly placed pavement (*1*). Bonding at the interface of pavement layers ensures that the layers behave as a single system in withstanding traffic and environmental stresses. Practitioners have favored emulsified tack coats instead of cutback asphalts because emulsified tack coats provide additional benefits, such as reduced energy consumption, fewer environmental impacts, and increased personnel safety.

Problem

The selection of the optimum tack coat material and the determination of an application rate appropriate to the condition of the pavement surface are critical for developing the bond strength between pavement layers. Generally, the tack coat does not cover the entire surface; moreover, an excessive application of tack coat may promote shear slippage at the interface.

For the most part, experience, convenience, or empirical judgment have guided the selection of tack coats. Quality control and quality assurance testing of the tack coat construction process is rare. Research was needed, therefore, to develop procedures for

The Louisiana Tack Coat Quality Tester, developed to evaluate the quality of the bond strength of tack coat in the field.



The Louisiana Interlayer Shear Strength Tester, developed to characterize the interface shear strength of cylindrical specimens in the laboratory.

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selecting tack coats and evaluating their quality in field applications.

Solution

Research Scope

For National Cooperative Highway Research Program (NCHRP) Project 9-40, Optimization of Tack Coat for Hot-Mix Asphalt (HMA) Placement, investigators assessed many plausible factors affecting the characteristics of the interface bond between newly placed pavement and the surface covered (2). The research results identified the optimal application methods, including the types of equipment, the procedures for calibration, and the rates for tack coat application. The findings led to proposed revisions to the American Association of State Highway and Transportation Officials' (AASHTO's) methods and practices related to tack coats.

During the NCHRP project, the research team developed the Louisiana Tack Coat Quality Tester (LTCQT) to evaluate the quality of the bond strength of tack coat in the field with an acceptable repeatability, described by a coefficient of variation (CV) of 11 percent. The Louisiana Interlayer Shear Strength Tester (LISST) also was developed during the NCHRP project to characterize the interface shear strength of cylindrical specimens in the laboratory. The LISST was designed to fit into any universal testing machine and to achieve an acceptable repeatability with a CV of less than 15 percent.

The research team also constructed full-scale test overlays with different tack coat application rates between a new HMA overlay over four surfaces: old HMA, new HMA, milled HMA, and grooved portland cement concrete (PCC). Three application rates were used for each of five types of tack coat materials: slow setting (SS-1h), SS-1, cationic rapid setting (CRS-1), nontracking tack coat, and Performance Grade 64-22. The quality of the tack coat application was evaluated with the LTCQT, and specimens were cored from the test pavements to measure the interface shear strength on the LISST.

Results and Findings

The NCHRP project investigated the effects of emulsified tack coat types, surface types, and application rates. The effects of conditions such as the dustiness of the pavement surface and the wetness of the tacked surface—for example, from a rainfall—also were investigated. The analysis led to the following conclusions:

◆ Among the emulsified tack coats, the nontracking tack coat exhibited the highest interface shear strength, and the CRS-1 emulsion the lowest.

◆ All tack coat materials showed the highest interface shear strength at a residual application rate of 0.155 gallon per square yard (gsy). This may indicate that under actual field conditions, optimum application rates are greater than what is commonly predicted from laboratory-based experiments. Higher application rates may increase interface shear strength, but excessive tack coat may migrate into the new asphalt mat during compaction, decreasing the air void content of the mix.

◆ The differences between clean and dusty conditions were statistically significant, but the differences between dry and wet conditions were not. These results indicated that a small amount of water can be flashed away by the heat from the HMA mat, so that the effects on the quality of the tack coat may be inconsequential. Nevertheless, only a small amount of water was used to simulate rainy conditions; therefore the recommendation specifies a dry and clean surface, to avoid any negative effects from water on the bonding at the interface.

◆ The roughness of the surface directly affected the shear strength at the interface. The milled HMA

TABLE 1 Recommended Tack Coat Residual Application Rate

Surface Type	Residual Application Rate (gsy)
New HMA	0.035
Old HMA	0.055
Milled HMA	0.055
Portland cement concrete	0.045

surface provided the greatest interface shear strength, followed by the grooved PCC, the old HMA, and the new HMA surfaces.

◆ Table 1 (page 44) presents the recommended residual application rates of tack coat for different surface types. A 50 percent coverage reduced the interface shear strength by 50 to 70 percent. Moreover, increases in the tack application rate tended to decrease the interface shear strength in laboratory-prepared specimens, but to increase the interface shear strength in the field.

◆ According to a finite element analysis of results from the LISST, 40 pounds per square inch is the minimum laboratory-measured interface shear strength that provides acceptable performance.

Application and Implementation

AASHTO is considering adoption of two test procedures for tack coats; the procedures determine the interlayer shear strength of the asphalt pavement layers and evaluate the tack coat quality in the field with the LTCQT or in the laboratory with the LISST. Many state DOTs are considering adjustments to the required tack coat materials and application rates for different surface types.

Louisiana DOTD was the first agency to implement the recommended tack coat application rates. Six pilot projects in the state evaluated the new specifications, including the recommended application rates. Florida DOT is using the LISST in conflict resolution and forensic cases and in the approvals for new tack coat materials based on field tests.

To support the implementation of the LISST test method by state DOTs, NCHRP initiated a follow-up project to evaluate the device in field projects. The objective is to validate the LISST test method in the field and to recommend application rates. Field projects will be selected and sampled with the LISST device, and pavement performance will be monitored—for example, rutting, slippage, roughness, and more.

Benefits

Calculations with the AASHTOWare Pavement Mechanistic–Empirical Design software suggested possible cost savings from the changes in state specifications. A simulation was performed with data from a rehabilitated pavement section of US-190 in West Baton Rouge Parish, Louisiana, and the performance was evaluated for major pavement distresses. The simulation explored three cases for the effects of tack coat application rates:

◆ Fully bonded, with adequate voids in total mix (VTM);

◆ No bonding, with optimum VTM; and

◆ Fully bonded, with high VTM.

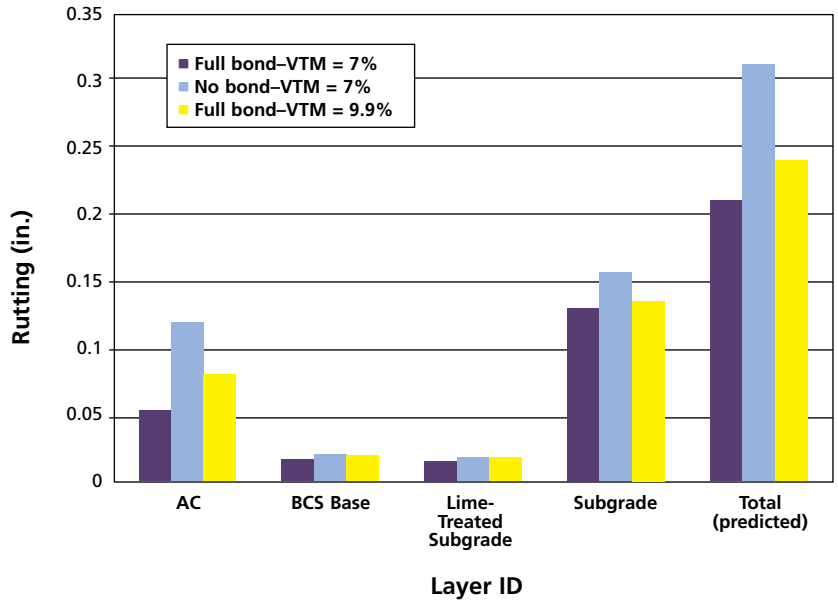

FIGURE 1 Predicted rutting performance for different pavement analysis cases (AC = asphalt concrete; BCS = blended calcium sulfate).

As shown in Figure 1 (above), the unbonded case exhibited the highest level of rutting, both in the asphalt layer and in the total pavement layers, and the fully bonded case with adequate VTM after construction exhibited the lowest level of rutting. These results demonstrate the need for applying the tack coat to the interface at the recommended rate.

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Suggestions for Research Pays Off topics are welcome. Contact G. P. Jayaprakash, Transportation Research Board, Keck 488, 500 Fifth Street, NW, Washington, DC 20001 (202-334-2956; gjayaprakash@nas.edu).