CENTER FOR TRANSPORTATION INFRASTRUCTURE SYSTEMS
THE UNIVERSITY OF TEXAS AT EL PASO

Project Summary Report 0-4129-S
Project 0-4129: Development of an Objective Field Test to Determine Tack Coat Adequacy
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PROJECT SUMMARY REPORT

A Field Test to Determine Tack Coat Adequacy

To improve performance of flexible pavements, it is quite common to place an overlay on top of the existing surface layer. A bonding agent commonly known as "tack coat" is placed on top of the old layer, before placement of overlay, to ensure proper bonding between the two layers. A good tack coat provides necessary bonding between the two layers to make sure that they act as a monolithic system to withstand the traffic and environmental loads. In recent years, Texas Department of Transportation (TxDOT) has experienced an increase in the number of premature pavement failures, and these failures have been attributed to debonding between the two layers. One of the reasons for debonding could be attributed to the inferior quality of tack coat. The debonding reduces bearing capacity of the pavement. Insufficient bonding may also cause concentration of tensile stresses at the bottom of the wearing course. The concentration of stresses and/or reduced bearing capacity leads to premature failure of overlay layer.

Various laboratory tests are available; however, no reliable field test is available that can quantify the quality of applied tack coat. Currently, TxDOT uses a boot heel test. The procedure suggests that an inspector stand on the applied tack coat area-if his/her boot sticks to the tack coat, it is good; otherwise it is not. This field test is subjective and does not ensure that a good quality tack is applied. Hence, a test set-up is needed to determine the bonding characteristics of the tack coat before paving. Developing such a test was the objective of this research.

What We Did …

We performed a literature review and identified various equipment that can be used for evaluation of tack coat adequacy. The following types of equipment were identified:

- Koch Material Company Shear Device
- ATAKER™ Shear and Tension Device
- UTEP Torque Device
- Elcometer106 Mechanical Adhesion Tester
- Road and Transport Authority of New South Wales Device

Only the first three devices were evaluated in the parking lot using three tack coat types. The evaluation was performed at two different temperatures, three different set times, and three dilution levels. On the basis of parking lot evaluation, ATAKER™ Shear and UTEP Torque devices were selected for field evaluation.

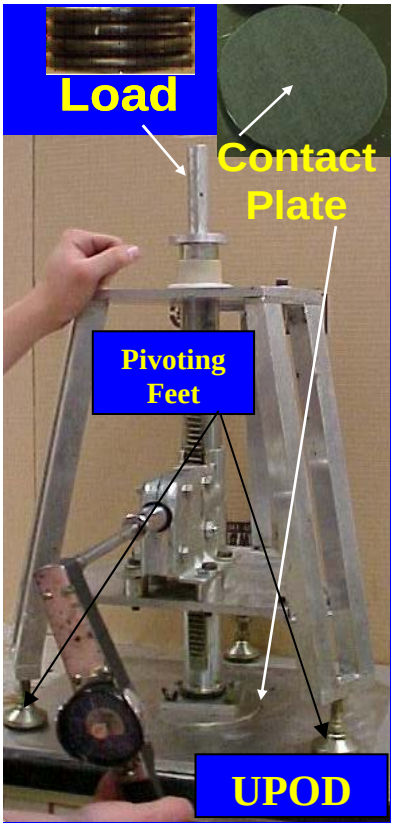
However, the field evaluation of devices identified several deficiencies. One of the deficiencies was mode of testing. The identified devices measure shear

strength by applying shearing forces. The shearing mode of testing takes into account friction offered by the tested surface.

Although the failure occurs due to shearing forces, the tests can also be performed in tension (pull-off) mode to identify the quality of the tack coat. The main advantage of this system is that the surface effect is minimal.

To measure quality of the tack coat, a UTEP Pull-off Device (UPOD) was developed. The instrument weighs about 23 lbs and can be easily leveled with the help of pivoting feet. It has a weight key on the top, which provides stability during placement of loads. A 3/8th in. nut fits a 3/8th in. drive torque wrench, which is used to pull the plate up or down from the tack-coated surface. A 6-150 in.-lb torque wrench is used for measuring pull-off torque and is converted into pull-off strength.

The device consists of a 5 in. diameter aluminum contact plate. To make sure that the device conforms to the uneven surface, 5 in.^{2} 3M double-sided tape is attached to the aluminum contact plate and 5 in.^{2} moisture bearing foam is placed over the tape. The advantage of the moisture bearing foam is that it can be easily peeled off the double-sided tape and three to four tests can be performed before the adhesive layer (double-sided tape) needs replacement.



The UPOD test procedure is simple. After the tack coat is applied on the pavement, it is allowed to set for a specified period of time. After waiting for the set time, the UPOD is placed on the tack-coated surface. The torque wrench is rotated clockwise until the contact plate is firmly set on the tack-coated pavement. The load is placed on the weight key (at the top of the device) for ten minutes prior to testing. The load is then removed and the torque wrench is rotated in a counter-clockwise direction to detach the contact plate from the tack-coated pavement. The torque (T) required to detach the contact plate from the tack coated pavement is recorded in in.-lb. The torque (T) is then converted to the strength using a calibration factor.

To evaluate the repeatability of the UPOD, the following parameters were selected:

- six tack coat types (CSS-1h, CSS-1, SS-1h, SS-1, RC-250, and PG64-22) ,
- two application rates: 0.04 and 0.1 gal/yd^2,
- two test times : 7 AM and 4 PM,
- two set times: 20 and 30 minutes, and
- three load levels: 20, 30, and 40 lbs.

Various tests in the parking lot were performed. The test results indicated that the device is repeatable and the observed coefficient of variation is typically less than 15 percent. A typical example is shown in the table below for CSS-1h emulsion tested at 4 PM.

Res. App. Rate gal/yd^2	Set Time, min	Load, lb	Avg. Strength, psi	COV, %
0.04 Ambient Temp. 64.1°F	20	20	0.18	10.83
		30	0.22	7.69
		40	0.22	8.66
	30	20	0.21	9.12
		30	0.28	6.93
		40	0.31	6.19
0.1 Ambient Temp. 64.1°F	20	20	0.22	8.66
		30	0.35	5.59
		40	0.42	9.12
	30	20	0.32	5.97
		30	0.37	9.09
		40	0.51	7.53

The test results suggested that the field tests be performed after 30 minutes set time and that 40 lbs of load be used to obtain better repeatability.

Based on parking lot test results, a series of tests were performed in the laboratory to identify the relationship between strength, set time, and test temperature. In the laboratory, the following parameters were evaluated:

- four tack coat types: CSS-1h, CSS-1, SS-1h, and PG64-22,
- 0.04 gal/yd^2 application rate,
- three temperatures: 140, 93, and 50 °F, and
- three set times: 30, 45, and 60 minutes.

What We Found …

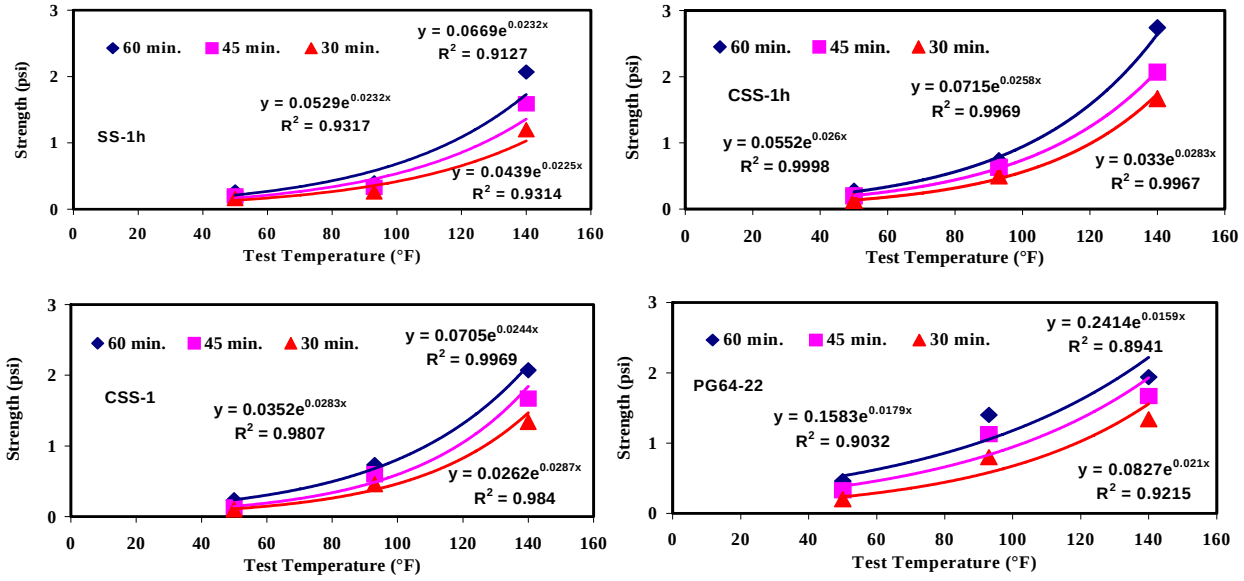
The laboratory test results indicated that strength is nonlinearly dependent on the test temperatures and set time. In addition, the relationships are tack coat type dependent.

Field evaluations were performed based on the proposed test procedure at one site within the El Paso District. The site was located at Joe Battle on I-10 Eastbound (detour section). On this site, CSS-1h tack coat type was used with 90% dilution with water. The results of the evaluation are shown in the table to the right. The tests results indicate that the measured strength is similar to the estimated strength. For example, the measured shear strength at 30 minutes of set time was 0.20 psi while estimated strength was 0.18 psi. Overall, for all of the set times, the measured strength was slightly higher than the estimated strength, indicating that the tack coat quality is adequate.

Set Time, min	Measured Strength, psi	Estimated Strength, psi
20	0.13	0.12
30	0.20	0.18
40	0.27	0.25
50	0.33	0.31
60	0.37	0.37

The Researchers Recommend …

Based on the test results, the developed UPOD device can be reliably used in the field to identify the quality of the tack coat. The device is ready for the field implementation/evaluation. However, the effect of wind velocity, pavement temperature, and relative humidity has not been evaluated and might impact the strength gained in the field. Therefore, these parameters need to be collected, during the field evaluation, to identify the impact of these parameters.



For More Details…

The research is documented in the following report:

- *4129-1: "Development of an Objective Field Test to Determine Tack Coat Adequacy"*

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