GAS TECHNOLOGY INSTITUTE
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Laboratory Testing of Utilibond Grout Used in Pavement Core Reinstatement

December 2003

TESTING PROGRAM SUMMARY

Title: Laboratory Testing of Utilibond Grout Used in Pavement Core Reinstatement

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Period: July 2003

Objective: A laboratory-testing program was carried out in order to evaluate the mix properties, mixing time, and interface shear strength of the Utilibond grout all at a one-hour curing time and constant temperature. The grout is used for intact pavement-core replacement during keyhole operations.

Approach: Laboratory tests were performed on six 4-inch diameter asphalt cores with an average height of 5 inches. The cores were drilled from aged asphalt slabs obtained from streets in the Chicago area. Figure 1 shows the drilled cores from the asphalt samples. The cores were then reinstated using the Utilibond grout.

The grout was mixed in controlled lab temperature of about 75°F. Grout samples of about 6 to 8 lb were mixed at a water content ratio of 0.1 and mixed for duration of 90 seconds (Figure 2). Two different setting times were evaluated in this test program. Two of the reinstated cores were left to set for one hour before loading. For the remaining four reinstated cores, the grout was left to set for a half hour before loading.

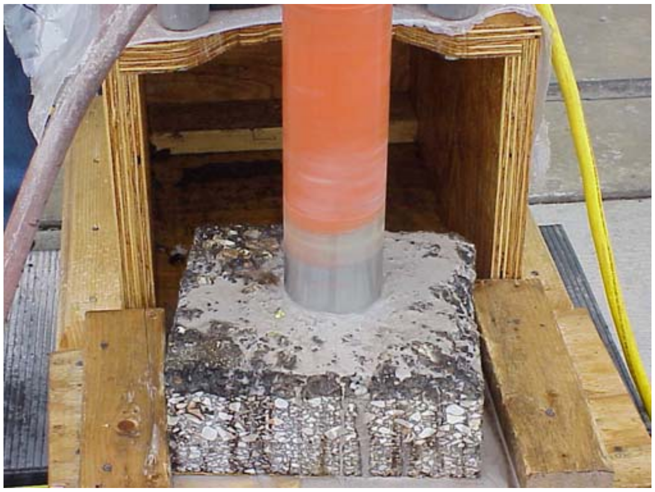

Figure 1. Drilling the 4-inch core in the asphalt specimen

Figure 2. Mixing the grout in the lab

Shear tests were performed by applying a vertical load to the grouted cores. The shear resistance at the grout interface and the displacement of the core were measured during load application. A gap in the base plate was left beneath the core and grouted area to allow for a free displacement of the core. Figure 3 shows a schematic of the shear test. The tests were performed using the MTS compression-testing machine at GTI's ASTM Lab. Figure 4 shows the application of the load on the grouted core.

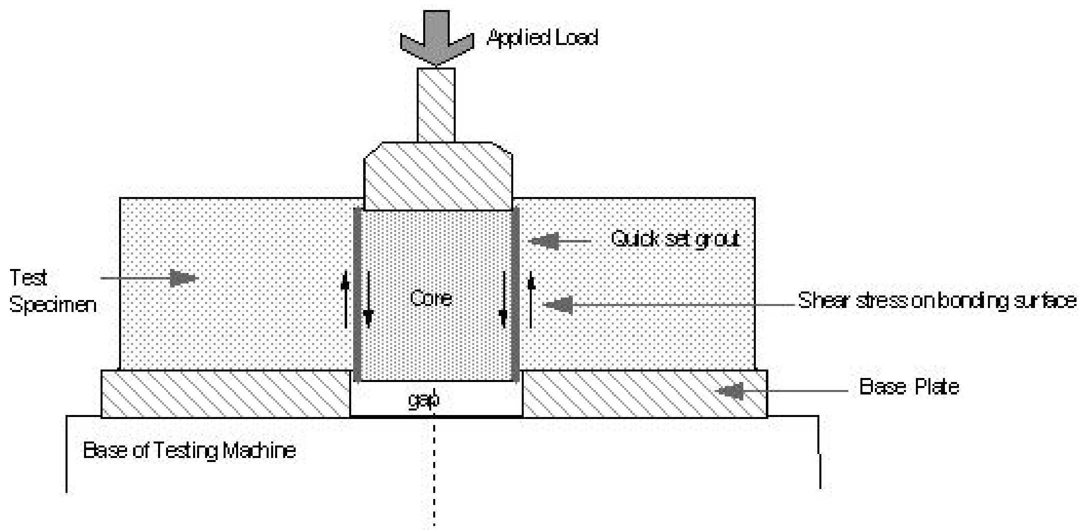

Figure 3. Schematic of the shear testing on the grouted core

Figure 4. Lab test to evaluate the 30 & 60-minute shear strength of the grout

B. GROUT SELECTION CRITERIA

The selection of the appropriate grout for use in intact core replacement depends on many criteria:

- The grout should provide the shear strength required to transfer the traffic load from the core to the adjacent pavement structure.
- The grout should reach its target strength at an adequate setting time to allow fast opening to traffic.
- The consistency should be of medium viscosity such that it allows flow of grout through the core sides and, it prevents settlement of the core under its own weight.
- The grout should be readily available in the market.

The amount of shear strength required for transferring the vertical load to the adjacent pavement can be estimated by applying a half-axle wheel load of 9 Kips on the top of the core as shown in Figure 5. This value represents the maximum load on the pavement under the standard 'Equivalent Single Axle Load ESAL' of 18 Kips. It should be noted that this amount of load results in a conservative estimation of shear strength as the surrounding pavement usually carries a portion of the wheel load when dual tires run on cores of 18-inch diameter and smaller.

The portion of the wheel load, which is transferred by the grout to the adjacent pavement, depends mainly on the thickness of the core. In thin cores, most of the load is carried out by the base soil under the core. In thicker cores, the load is primarily carried out by shear stress along the kerf of the core (grout line). Figure 5 shows a schematic of the load carrying mechanism in the cores. The maximum shear strength carried out at the interface (τ_{max}) can be calculated from the following equation:

$$\tau_{max} = (\alpha \times 9{,}000 \text{ lbs}) / (\pi D H) \qquad \text{(in psi)}$$

Where 'α' is the percentage of wheel load carried by shear stress along the kerf of the core, 'D' is the diameter of the core in inches, and 'H' is the height of the core in inches.

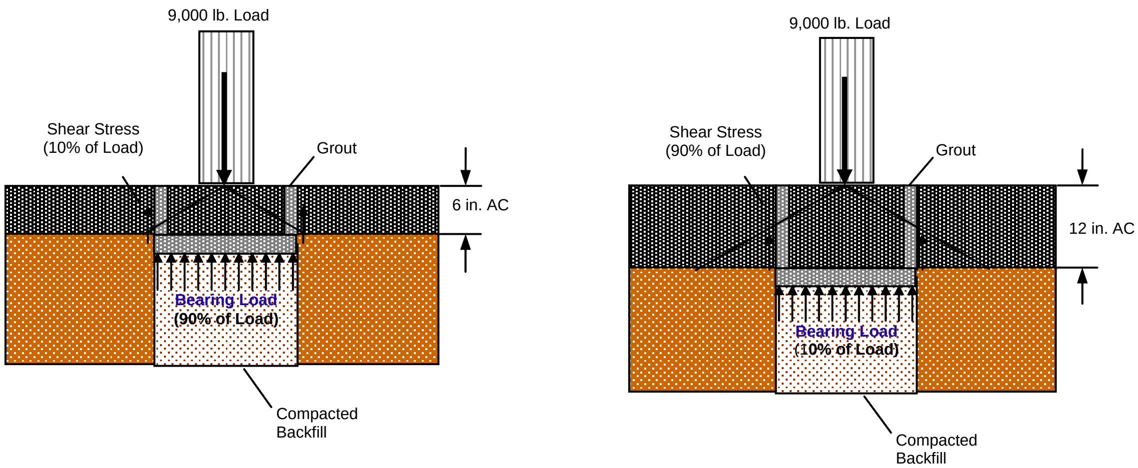

Figure 5 – Differences in shear load carried by the grout in different asphalt thickness

If a conservative approach is taken the entire load would be carried by the grout and 'α' would be 100%. Using this conservative approach an 18-inch diameter core 6 inches thick would have a $\tau_{max,6"}$=26.5 psi and a 12 in. thick core a $\tau_{max,12"}$=13.2 psi.

These values yield an average shear strength (τ_{max}) value of **20 psi** for cores that averaging 8 inches thick. Equating this stress to the test samples (4 in. diameter and 5 in. height) the critical load the test cores and grout would need to support would be 1.26 kips, which would achieve the 20 psi stress.

Figure 6 – Utilitbond Grout

RESULTS

Table 1 shows the testing parameters and the results of shear strength.

Table 1 . Laboratory testing program

Test	Water Ratio (Grout: water)	Mixing Time (sec)	Mixing Temp. (^{O}F)	Set Time (Minutes)	Max Shear Strength (psi)
1	1:0.1	90	72	60	60.09
2	1:0.1	90	73	60	76.19
3	1:0.1	90	77	30	17.1
4	1:0.1	90	78	30	25.44
5	1:0.1	90	75	30	18.97
6	1:0.1	90	70	30	20.72

Summary

Based on the passing criteria values using a ninety second mixing time and setting time of at least 30 minutes the Utilibond grout strength would be acceptable. A more conservative approach would be to allow the grout to cure for 45 minutes based on the borderline passing values of the 30 minute cure times.