

POST-TENSIONING GROUT BLEED, DUCT, AND ANCHORAGE PROTECTION TEST

PROBLEM STATEMENT

Due to substantial problems with product quality, the Florida Department of Transportation (FDOT) is revising all specifications concerning post-tensioning corrosion protection. New products for grouting post-tensioning ducts have recently become available, but they must be thoroughly tested before general application. Standard tests are available to evaluate several of these new products to ensure that they will perform as expected under conditions as near as possible to field grouting conditions. These tests can also be modified to study expanded applications for these grouts. The results from this testing program will help to establish the limits of product applicability, and it will facilitate the completion of the work required to produce the new specifications.

OBJECTIVES

Quality and process control problems have led FDOT to require the use of bagged grouts rather than grouts formulated on the work site. However, FDOT also needs to study the use of grouts for vertical applications, in addition to horizontal applications. Researchers sought to determine the best test method for vertical applications of grout, to investigate different duct designs, and to determine the relationship between wick-induced bleed tests and the Schupack pressure bleed test.

This research project focused upon three parts of the post-tensioning system: cementitious grout, internal duct, and pour-back material. Four prepackaged grouts, Euclid Euco Cable Grout PTX, Master Builders Masterflow GS 1205, Five Star Special grout 400, and Sika Cable Grout, were selected for testing. The following tests were conducted at the FDOT Structures Research Center in Tallahassee on June 28, 2002:

- *Wick-Induced Bleed Test:* Vertical PVC pipes up to 25-ft in length, containing single or bundled strand configurations were erected in the structures laboratory. Grout from each of the manufacturers was mixed and injected into the vertical pipes. Following injection, the grouted pipes were visually inspected, marked, and periodically recorded for bleed at the top and along the length of the grout column. Schupack pressure bleed tests were conducted on the grout used in the injection of the vertical pipes. Fresh and hardened properties of the grout were also determined.
- *Inclined Bleed Test:* Two inclined bleed test setups were constructed and injected. Researchers used one of the prepackaged grouts and a plain grout composed of water and cement.
- *Horizontal Corrugated Ducts:* Three horizontal plastic ducts with different rib styles were also injected to determine the influence of the corrugations and longitudinal ribs on the completeness of grouting.

Supplemental testing was also conducted at the University of Florida:

- *Epoxy Pour-Back Test:* A full-scale mock-up of a combined multiple anchorage pour-back was constructed and subjected to temperature variations.
- Schupack pressure bleed tests were conducted to examine the effects of temperature and mixing time on bleeding.

FINDINGS AND CONCLUSIONS

First, the vertical test proved to be more effective for studying vertical grouting applications. Second, the post-tensioned duct with longitudinal rib channels was ultimately selected for use, but needs to be studied further. Third, relationships between wick-induced bleed tests and the Schupack pressure bleed test could only be determined on a product specific basis—no generally applicable findings were obtained. The following provides further information regarding the test results.

Wick-Induced and Schupack Pressure Bleed Tests

- The relative bleed water quantity increased with the height of the duct and the number of strands.
- The wicking action of strand bundles promoted bleeding more than increased height with a single strand.
- The Schupack pressure bleed test was performed on four grouts at various increased temperatures. The bleed quantity increased in all but the Master Builders grout, which showed a decrease in bleed for both increasing and decreasing temperatures. This finding supports the upper limit on grout temperature, which was added to the FDOT specifications after the test.
- The Schupack pressure bleed test indicated that increased mixing times resulted in decreased bleed in both the Sika and Euclid Grouts. Varying mixing time did not significantly affect the Master Builders grout, but it did cause an increase in bleed in the Five Star grout.
- A correlation between the Schupack test and the wick-induced test was developed.

Duct Tests

- Air was trapped in all three corrugation configurations tested in the duct test.
- The grout front was thought to be advancing too slowly to adequately evaluate the extent of grouting.

Inclined Test

- The bleed was found to be difficult to measure in the inclined test and did not appear to be any harsher than in the vertical wick-induced tests.

Epoxy Pour-Back

- No cracking was noted on the specimen following thermal cycling.
- Impact-echo results indicated no change in the bond between the epoxy grout and concrete.

Schupack Pressure Test

- Recommend that the test procedure require the insertion of a wire to break the surface tension and remove trapped air.
- Recommend that the longer times and/or higher pressures be considered for the test method. The test method used in these tests included two pressures (50/100psi) for a total of 10 minutes.

BENEFITS

Problems with the corrosion of post-tensioning tendons due to inadequate or improper grouting materials and techniques have been extremely costly to the State; millions of dollars have been spent on repair work to prevent or address tendon failure. These problems have been a direct result of the lack of attention to the materials and methods used in grout injection. Post-tensioned bridges, in many cases, are monumental structures that are expected to have very long service lives. This research has provided valuable information on the mixing, injection, and bleed performance of newly available prepackaged grouting materials. It has also provided input to improve the grouting specifications used by the State. Furthermore, the findings will be presented at a workshop on post-tensioned bridges (July 2003) that will address design, construction, specification of materials, load rating, and inspection.

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