New Specifications for Grouting

by Theodore L. Neff, Post-Tensioning Institute

Proper grouting is essential to ensure the performance and durability of post-tensioned (PT) concrete structures. Cementitious grout provides an alkaline environment that passivates the steel and serves as a physical barrier that helps keep water, oxygen, and corrosion-causing contaminants (such as chloride) away from the prestressing steel. Thus, the grout is providing corrosion protection. In bonded, post-tensioning applications, the grout also bonds the steel and duct to the surrounding concrete so that the structural element performs integrally as a unit.

Prior to 2001, most grouts used in PT construction were a simple mixture of cement and water. Generally these grouts performed satisfactorily. However starting in the 1990s, corrosion problems were observed on several projects in Florida and around the world. These durability issues were primarily attributed to a combination of the use of high-bleed grouts and improper workmanship.

In 2001, the Post-Tensioning Institute (PTI) released *Specifications for Grouting of Post-Tensioned Structures*, which introduced many new requirements to minimize bleed water and improve grouting practices. This led to widespread use of engineered, low-bleed grout materials that were prepackaged by manufacturers. While these prepackaged grouts have been effective in minimizing the formation of voids due to bleeding, new problems related to high chloride content and segregation have recently been reported.

PTI's 3rd edition of the *Specifications for Grouting of Post-Tensioned Structures* is intended to address concerns related to high-chloride content and segregation as well as strengthen the provisions to minimize bleed water and to ensure proper construction.

Control of Chlorides

Previously, the specification limited the chloride content in new grout to 0.08% by weight of cement. However for prepackaged grouts, chloride was only tested during the initial qualification testing. In the latest version, chloride must be tested more frequently: first during the qualification testing, then once per 40,000 lb of grout, with a minimum of at least once per project. In addition, the manufacturer must certify the chloride content of all constituents.

Grout Segregation or Instability

Grout segregation was observed in Europe in early 1990s. In response, research by The Technical Department for Transport, Roads and Bridges Engineering and Road Safety (SETRA), a department within the French Ministry of Transport and Infrastructure, found the inclined tube test (see sidebar for more information) and a modified wick-induced-bleed test to be very effective in checking the stability of grouts under conditions representative of field conditions. The tests were adopted as part of the French specification in 1996 and have subsequently been incorporated into European standards for grouting. The new edition of the PTI grout specification also includes these tests to identify grouts that are susceptible to bleed and segregation.

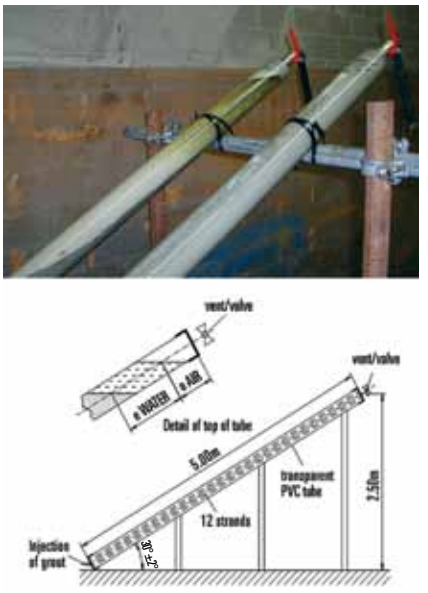

Photo (above) and schematic (below) of Inclined Tube Test set-up. Note: the difference in bleed between the high-bleed grout on the left and the low-bleed grout on the right. Graphic: VSL.

High pumping rates and pressures also were determined to contribute to the segregation of grout. Pumping rate must be slow enough to avoid air entrapment and segregation; and is required by the specification to be between 5 and 15 m per minute (16 and 49 ft per minute). Pumping pressures are listed in the PTI specification, and the new specification also eliminates the procedure of holding pressure for one minute after grouting.

Construction Quality

Several revisions have been made to the PTI specification to improve quality of grouting operations. Of particular significance, flushing of ducts is no longer permitted whether to clean the ducts prior to grouting or to remove grout in the event of a problem.

Inclined Tube Test

The inclusion of the inclined tube test is a key improvement in the qualification testing of post-tensioning grouts.

Advantages of this test are that it:

- includes the effects of both pressure and the strand, and
- is sized to be representative of a real environment in a duct.

The test was studied and validated by the French agency SETRA, and found to be a good indicator of a grout's susceptibility to bleeding and segregation.

The test is based on a standard procedure set forth in Euronorm EN 445—"*Grout for prestressing tendons—Test methods.*" Set-up includes two clear tubes that are 5 m (16 ft) in length and 80 mm (3.1 in.) in diameter. Each contains 12 prestressing strands and is inclined 30 degrees to the horizontal. (See figure.)

Grout is injected into both tubes. When filled, the outlets are closed; after 30 minutes, the valves of the second specimen are reopened and the pump re-started until grout flows out the outlet again.

Air, water, and segregation that accumulate at the top are recorded after 30 min., and 1, 3, and 24 hr.

Because worker training and ability greatly affects grouting quality, this version of the specification requires that the work be performed and supervised by qualified personnel. The specification recommends that grouting operators, supervisors, and inspectors be certified under American Segmental Bridge Institute's Grouting and PTI's Bonded PT certification programs.

Summary

These are only a few of the enhancements that have been included in the third edition of the PTI *Specifications for Grouting of Post-Tensioned Structures*. For more information, contact PTI or visit www.post-tensioning.org.

Theodore L. Neff is the executive director of the Post-Tensioning Institute.