PTI Journal *Technical Paper*

TESTING / EVALUATION AND GROUT REMEDIATION OF POST-TENSIONING TENDONS FOR BRIDGES

By

S. NOUR

Authorized reprint from: July 2006 issue of the PTI Journal

TESTING/EVALUATION AND GROUT REMEDIATION OF POST-TENSIONING TENDONS FOR BRIDGES

SAID I. NOUR
DYWIDAG-SYSTEMS INTERNATIONAL, USA INC.

PROBLEM

The durability of bonded post-tensioned structures depends on the success of the grouting operation. The hardened cement grout provides bond between the concrete and tendon as well as the long-term corrosion protection for the prestressing steel. In recent years the problems in grouting have resulted in the failure of a number of post-tensioned bridges in Europe. This resulted in a ban on post-tensioned bridges in U.K. Problems have also been observed in bridges in the United States.

SOLUTION

These recent corrosion problems have increased the need for reliable methods to determine the presence of grout voids and restore the corrosion protection required in post-tensioning tendons. The following four step procedure has been found to be efficient in re-grouting the voids in post-tensioning tendons:

1. **Non-Destructive Testing (NDT) and Evaluation of Post-Tensioning Tendons with Voids**

   The tendon paths of internal post tensioning tendons are determined using Ground Penetrating Radar devices. This technique can be used successfully and is relatively fast in locating metal ducts and mild reinforcement embedded in concrete. Plastic ducts can also be located by an experienced operator by looking for the characteristics of the bundled strands inside the duct rather than the duct itself, Fig. 1. The Impact-echo technique is then used to scan the concrete surface along the tendon paths to detect sections of the duct with voids.

2. **Limited Invasive Inspection of Post-Tensioning Tendons**

   Limited invasive inspection is used to verify the results obtained from the NDT investigation. Minimizing the drilling required to re-grout the tendons and eliminating any chance of damaging the strand wires enhance the efficiency of the grout remediation process in post-tensioned structures. In general, this is achieved by drilling one hole per continuous void using a special drill, which shuts itself off when the drill bit comes in contact with metal. The two-fold advantage of such a technique is to avoid damaging the reinforcement in a congested area where the radar is

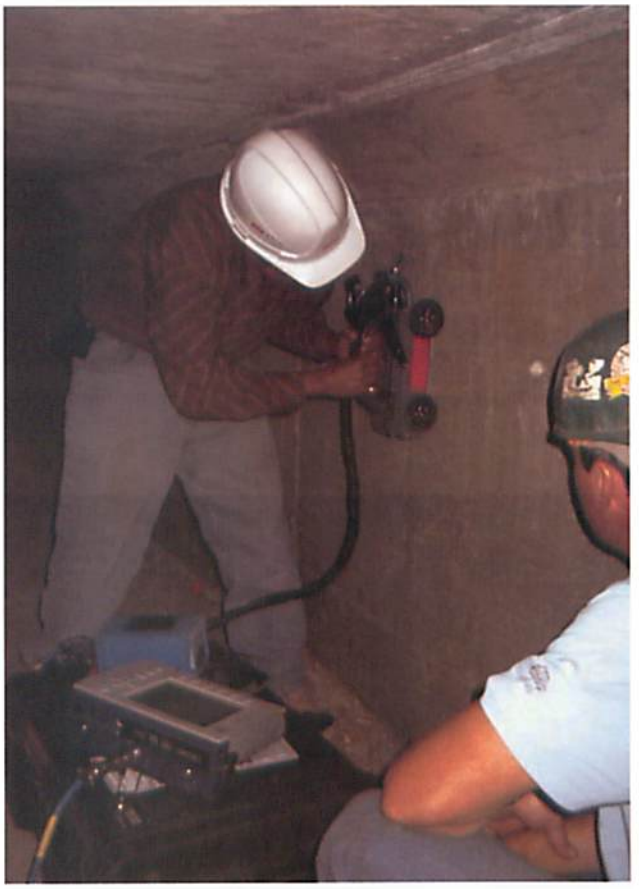

Fig. 1 – NDT: Tendon Location with Ground Penetrating Radar

Fig. 2 – Special Drill with Automatic Shut-off Capabilities When in Contact with Metal; Dial Graduates Sensitivity of Instrument

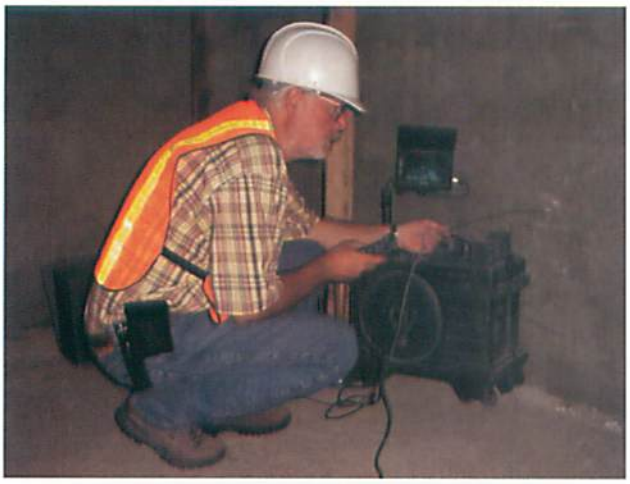

Fig. 3 – Videoscope Inspection of Post-Tensioning Tendon

Fig. 4 – Measurement of Void Volume with Volumeter Capable of Compensating for Leaks

not able to differentiate closely-spaced mild reinforcement and to avoid damaging the strand wires inside the tendon, Fig. 2.

3. **Visual Inspection and Void Volume Measurement of Tendon Voids**

   The same small hole drilled for the limited invasive inspection of the tendon can be used to insert a flexible cable of a video scope to examine the extent of the void and steel corrosion. Still pictures or video clips or both can be recorded along with an audio report of the findings, Fig. 3. However, assessment of the void size with the video scope alone is not enough, as small gaps or "bottlenecks" may be missed by the video scope. Therefore, measuring the void volume with a device capable of compensating for leaks is highly desirable to quantify the void size, Fig. 4.

4. **Vacuum Grouting of Post-Tensioning Tendons with Voids**

   The final step of the grout remediation procedure is to completely fill the voids with grout. The more efficient method to do this is by using, whenever possible (an acceptable level of vacuum needs to be developed inside the void), the vacuum grouting technique. Vacuum grouting requires only one port to fill the void with grout, as the negative pressure created by the vacuum inside the void will allow the grout to completely fill the void. In cases where an acceptable level of vacuum is difficult to reach, a combination of vacuum with positive pressure grouting can be used (i.e., vacuum assisted grouting). A flow meter can be used to measure the amount of injected grout. Comparing the void volume measured versus the actual volume of grout injected will dictate if the task has been successfully completed or if there is a need for further grouting, Fig. 5.

Fig. 5 – Vacuum Grouting Operation