



RESEARCH SERVICES

OFFICE OF POLICY ANALYSIS,
RESEARCH & INNOVATION

TECHNICAL SUMMARY

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\$123,195



To visually inspect grout and post-tensioning strands within a duct, researchers inserted a borescope, which consists of a small camera lens mounted at the end of a flexible tube.

Identifying Grouting Problems on Post-Tensioned Bridges

What Was the Need?

To strengthen concrete after it has hardened, engineers have sometimes used a method called post-tensioning, which involves running steel strands through a hollow plastic or metal duct within a concrete beam. Tension is then applied to these strands with a hydraulic jack, compressing the concrete beam and creating internal stresses that resist external traffic loads. Post-tensioning improves the durability of concrete and virtually eliminates cracking. It also allows the use of fewer and smaller beams and other elements when building structures such as bridges, reducing construction costs and environmental impacts.

However, the steel strands used in post-tensioning are susceptible to corrosion from contact with air, water and chlorides in deicing chemicals. To protect these strands, engineers use grout, a thick emulsion of water, cement and sand that hardens over time. Grout is used to fill in the gaps between the strands and the duct through which they run. Nevertheless, these voids, which leave strands vulnerable to corrosion, may remain if the duct is improperly filled or if water bleeds out of the grout mixture before it has fully hardened.

During the late 1990s and early 2000s, problems were found in grouted post-tensioned ducts in Florida bridges. As a consequence, in 2003 state transportation agencies significantly improved their grouting methods and began using a grouting material not susceptible to bleeding. However, in bridges built before 2003, voids around grouted strands are fairly common, leading to widely varying levels of deterioration depending on climate, construction practices and structure type.

What Was Our Goal?

The objective of this project was to conduct inspections of post-tensioned bridges built in Minnesota before 2003 and update current bridge inspection procedures so that potential problems in these bridges can be detected and remedied.

What Did We Do?

Researchers began by reviewing the plans and inspection reports for 40 of these post-tensioned bridges. Based on this information, they identified for further inspection 10 bridges most likely to have grouting-related corrosion problems. These bridges were chosen from across the different bridge construction types so that the sample would effectively represent Minnesota's post-tensioned bridge inventory.

Researchers visually inspected these bridges, focusing on signs of distress related to post-tensioning. These inspections consisted of an exterior examination from ground level, from the bridge deck or from a snoop truck—a vehicle equipped with a crane that allows access to the underside of bridges.

Researchers then chose three bridges for a more invasive inspection. Because the corrosion of post-tensioning strands typically provides few external visual indications of problems, traditional nondestructive inspection methods are not reliable for inspecting these bridges. Consequently, ducts were inspected using ground-penetrating radar to map their location and shape. Based on these maps, researchers drilled holes into the

This project improved public safety by identifying grouting and corrosion problems in some post-tensioned bridges in Minnesota, and by developing inspection procedures so that these problems can be routinely identified and addressed.

“This project is helping MnDOT ensure the safety of the traveling public by establishing bridge inspection procedures that take into account problems with grouting on some bridges built before 2003.”

—Paul Kivisto,
Metro Region Bridge
Engineer, MnDOT Bridge
Office

“The problem with post-tensioned bridges is that the warning signs are not easy to see because they are hidden inside the concrete. This project developed a way of identifying signs for these bridges so we can be confident of their safety.”

—Andrea Schokker,
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A borescope inserted into a duct reveals a large void, with post-tensioning strands covered only by a thin layer of grout. Ideally the grout would completely fill the duct, protecting strands from corrosion.

structure and used a borescope to visually inspect the duct interiors, including the grout and post-tensioning strands. After inspection, the holes were sealed with epoxy. When visual signs indicated a potential problem such as moisture, rust staining and cracking, a section of concrete was removed to expose a length of the duct for further inspection of grout and strand condition, and to take samples for chloride testing.

What Did We Learn?

Researchers summarized the characteristics of all 40 post-tensioned bridges built prior to 2003 in Minnesota. Each bridge summary includes an aerial view photograph, design drawings, inspection notes applicable to the post-tensioning system condition and a discussion of the bridge's characteristics.

Researchers also documented the results for the 10 bridges chosen for visual inspections and three chosen for invasive inspections, and made recommendations for follow-up inspections. In general, the inspected bridges were in good overall condition. Invasive testing showed that one of the three bridges showed no strand corrosion or grouting problems, one had major corrosion problems related to construction issues but appeared to have good grout, and one had significant problems with grouting and the beginning of corrosion. Researchers recommend a full investigation of the third bridge to identify and remedy the grouting problems and protect it from future corrosion.

Using these results, researchers developed a general inspection plan for post-tensioned bridges in Minnesota and a concise guide for MnDOT bridge inspection staff.

What's Next?

MnDOT has adopted the new bridge inspection procedures developed in this project and has started a follow-up implementation project as of summer 2012 to conduct a more detailed investigation of grouting in post-tensioned bridges.

This Technical Summary pertains to Report 2012-09, “Development of Best Practices for Inspection of PT Bridges in Minnesota,” published April 2012. The full report can be accessed at <http://www.dot.state.mn.us/research/documents/201209.pdf>.