



0-4562: Corrosion Resistance of Grouted Post-Tensioning Systems

Background

The increased popularity of post-tensioned bridge construction in the United States has led to concerns about corrosion and its impact on the life cycle of these bridges. Although the vast majority of post-tensioned bridges in the United States have performed satisfactorily, corrosion problems on a small number of bridges have raised concerns about the durability of these types of structures. Problems in coastal and deicing regions of the United States have highlighted the importance of controlling corrosion, including the use of new materials and construction methods. New materials have been produced by commercial manufacturers and are being used in post-tensioning systems. New construction methods have also been developed and include procedures recommended by the Post-Tensioning Institute (PTI).

One major problem that agencies face today is the difficulty of providing sufficient monitoring and inspection techniques for bonded post-tensioned structures. Condition surveys are often limited to visual inspections for signs of cracking, spalling, and surface rust staining. This limited technique can often overlook the deterioration of prestressing steel and can fail to detect the potential for very severe and sudden collapses.

What the Researchers Did

This project began in 2003 and was conducted at the Ferguson Structural Engineering Laboratory at The University of Texas at Austin under sponsorship of the Texas Department of Transportation (TxDOT) and the Federal Highway Administration. A new set of specimens was required for exposure to highly aggressive environments to test the new products.

Using the recommendations from previous Center for Transportation Research (CTR) research, the research team designed and developed new specimens. To establish the corrosion resistance of the post-tensioning strands to be used in the new specimens, the researchers performed preliminary companion tests. These strands were then used in combinations with different duct, coupler, and anchorage types and were subjected to highly aggressive exposure for either 4 or 6 years. The specimens were monitored continuously and eventually autopsied to evaluate the final corrosion resistance of each strand, duct, coupler, and anchorage combination.

What They Found

Monitoring techniques used throughout the exposure period provided a significant amount of data but ultimately did not correlate quantitatively to the final autopsies. Rather, the monitoring indicated only the

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corrosion trends that occurred. A different method for data collection was attempted in order to obtain results on special tendon types, but ultimately this method was abandoned for the original procedure.

Final autopsies noted only mild discoloration and limited corrosion at locations where the most susceptible strand type had limited cover from grout. Good grouting procedures and a limit on initial grout chloride content can prevent this corrosion. In highly aggressive exposures on critical bridges, the use of plastic duct with either epoxy-coated, stainless steel, or stainless-clad strands should be used. The substantial cost increase for stainless steel as compared to epoxy-coated or stainless-clad strands is justifiable only if the other two strands cannot meet tensile capacity demands or if significant concern arises that the epoxy coating and stainless cladding will be damaged during the construction process.

These conclusions are based on very aggressive exposure and are useful in selecting the level of resistance that will be required in future bridge fabrication or design. Additionally, the reports contain detailed recommendations for future practice based on both specimen analysis and the PTI documents. TxDOT’s major goal is reducing lifetime maintenance costs and increasing service life of the more durable components used in construction (although these components may result in marginally higher construction costs). Lifetime costs on a sample structure were computed by assuming that a decrease in corrosion rate corresponds to a proportional decrease in maintenance cost.

What This Means

The compact specimen designed for the project was successful and should be used in future research. Continued development of better grout mixes is extremely important because high chloride content in prepackaged grout proved to be a variable that was unaccounted for. Ensure that grout chloride content specifications are followed so that chlorides are not introduced to the tendon through the grout itself. Conducting nondestructive monitoring was difficult, and new and existing nondestructive monitoring methods for post-tensioned structures should be refined and developed.

The recommendations included are based on design flaws or repeated corrosion issues that were noticed and documented in the autopsies but that are not mentioned explicitly in the specifications. Recommendations include a requirement to always use a full cover with plastic ducts as well as epoxy-coated non-prestressed reinforcement for crack control. Another reoccurring concern was poor grouting application. Grout voids provide an easy avenue for chloride travel in a tendon, so minimizing grout voids should remain a priority. The older PTI specifications did not contain recommendations for pressure testing and have since been updated. The new specification rightly mandates that grouting continue until constant pressure is observed across grout vents and duct openings. This project’s findings reiterate the importance of this procedure and highlight the issues that arise when this procedure is not followed.

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