

The article “Enduring Strength” in the September 2003 issue of Civil Engineering raises questions about the long-term durability of post-tensioning tendons in segmental concrete bridges. The article discusses corrosion discovered in external tendons of two span-by-span segmental bridges in Florida that required replacement of 12 of the total of approximately 4500 external tendons in this type of bridge in Florida (0.26 percent). Although the extent of the observed corrosion problems was limited, these incidents served as a catalyst for many agencies to look for constructive responses to the question, “How can these sinews be better protected?” In this context, concerted investigations directed towards improving corrosion protection of post-tensioning tendons have been made in recent years by the Florida Department of Transportation, the Federal Highway Administration, the American Segmental Bridge Institute (ASBI), and the Post-Tensioning Institute, as well as many other State Departments of Transportation, and research agencies. These investigations have identified improvements in post-tensioning materials, design details, and construction procedures necessary to avoid recurrence of the problems discussed in the referenced article. Comprehensive inspection of segmental and other post-tensioned bridges in other States made at the request of the Federal Highway Administration did not disclose any significant corrosion problems, although deficiencies in grouting (voids) were observed.

Some specific responses to items in the referenced article are as follows:

- An NCHRP Research Report 20-7/Task 92, “Durability of Precast Segmental Bridges”, June 1998, by R.W. Poston (one of the authors of “Enduring Strength”) and J.P. Wouters discusses (among other issues) the Ynys-y-Gwas Bridge in the United Kingdom, and the Interstate 195 Bridge over the Seekonk River in Rhode Island which are also discussed in the “Enduring Strength” article. In regard to the Ynys-y-Gwas Bridge, and other segmental bridges in the U.K., this NCHRP report states that “the problems with segmental bridges in the U.K. have been specifically with thin mortar joints and poor design and construction practices”. In reference to the Interstate 195 Bridge in Rhode Island, the NCHRP report states, “Despite the high incidence of voided tendons, no significant corrosion of the prestressing steel had occurred in some 30 years”. This report concludes, “The durability performance of precast segmental bridges has been excellent in the United States to date”.
- There has been no restriction on construction of segmental bridges with external tendons in the United Kingdom since the U.K. Department of Transportation ban was lifted in 1996. The global investigation of post-tensioned bridges in the U.K. found very limited corrosion or durability problems.
- While the durability performance of segmental bridges to date in the U.S. has generally been excellent, durability of post-tensioning tendons in segmental bridges now being built does not “rely on the same corrosion protection system used on bridges where problems have been encountered”. The following are only a few of the specific changes implemented by the Florida Department of Transportation and other State and Federal Agencies:

1. Prepackaged, pre-qualified, anti-bleed thixotropic grouts are used which are mixed with high-energy mixers. The anti-bleed characteristics of these grouts virtually eliminates problems related to voids in grouts due to bleed water.
2. All post-tensioning anchorages are inspected for bleed water voids 24-48 hours after grouting. Post-tensioning anchorage details have been modified to facilitate inspections of grouting at anchorages.
3. The problems with duct splitting were resolved by introduction of new American State Highway and Transportation Officials (AASHTO) specifications for high density polyethylene duct in the late 1990's.
4. Corrosion protection details of post-tensioned anchorages have been revised to ensure that deck runoff or wind-blown salt water will not gain access to the anchorage.
5. The ASBI initiated a "Grouting Certification Training Program" in 2001 to train and certify engineers and construction personnel in proper techniques for mixing and placing grout, as well as protection of post-tensioning anchorages. To date, 604 personnel have participated in this training.
6. The Florida Department of Transportation has concluded numerous comprehensive Post-Tensioning Durability Workshops. These workshops deployed a five-part strategy to improve the durability of Florida's post-tensioned bridges. The most recent event in Orlando, Florida on July 24 – 25, 2003 was attended by more that 300 engineers and construction personnel.
7. AASHTO adopted comprehensive new grouting specifications in 2001.

Notwithstanding the corrosion problems noted in the referenced article, National Bridge Inventory data shows conclusively that the overall durability performance of segmental concrete bridges, and pre-stressed concrete bridges in general, is outstanding. The changes in materials, grouting technology, construction procedures, and anchorage protection details implemented by the Florida Department of Transportation, and most States and Agencies that use post-tensioned construction, are considered to provide a more durable and robust system that represents a new standard for corrosion protection of post-tensioning tendons. This new corrosion protection standard provides added assurance that segmental concrete bridges will provide the 100 year minimum service life endorsed by the Board of Directors of the American Segmental Bridge Institute in 1999.

William N. Nickas  
State Structures Design Engineer  
Florida Department of Transportation

Andrea Schokker  
Henderson Professor of Civil Engineering  
The Pennsylvania State University

Clifford L. Freyermuth  
Manager, American Segmental Bridge Institute