CENTER FOR TRANSPORTATION RESEARCH

PROJECT SUMMARY

Texas Department of Transportation

5-6652-01: Shear Behavior of Spliced Post-Tensioned Girders with Ungrouted Tendons

Background

Spliced post-tensioned girder implementation incorporates various post-tensioning systems in continuous prestressed precast members. In these systems, the post-tensioning ducts are typically injected with grout, as a means for corrosion protection. However, once the post-tensioning ducts are grouted, it is difficult to inspect the status of tendons and the quality of grout. This motivated some bridge designers to use commercially available flexible fillers in lieu of a cementitious grout to fill the post-tensioning ducts, referred to as ungrouted ducts.

The spliced girder research program conducted as part of TxDOT Project 0-6652 investigated the implications of spliced girder technology and resulted in updating the AASHTO LRFD Bridge Design Specification's (AASHTO LRFD) General Procedure for shear design, which was originally developed based on the results of small-scale panel tests. However, TxDOT Project 0-6652 evaluated large-scale post-tensioned members with grouted ducts only. Thus, the AASHTO LRFD general shear design provisions are currently based on an incomplete database of specimens and could result in potentially poorly designed spliced girders with the ungrouted ducts. Thus, large-scale testing was necessary to investigate the response of ungrouted post-tensioning systems.

What the Researchers Did

The focus of TxDOT Project 5-6652-01 was the assessment of strength and serviceability of shear-critical post-tensioned girders incorporating grouted or ungrouted ducts. A comprehensive experimental program was undertaken to address limited knowledge with respect to the performance of post-tensioning systems containing ungrouted ducts. The program involved the design, fabrication, and structural testing of large-scale specimens, as shown in Figure 1, incorporating the following main variables: three different duct layouts

Figure 1. 5-6652-01 Structural Test

(straight, parabolic, and hybrid) and grouted and ungrouted duct condition. Six Tx62 I-girder

Research Performed by:
Center for Transportation Research

Research Supervisor:
Dr. Oguzhan Bayrak, CTR

Researchers:
Sangyoung Han
Dr. Jarrod Zaborac
Zachary D. Webb
Dr. Jongkwon Choi
Dr. Anca C. Ferche

Project Completed:
05-31-2022

test specimens were fabricated and twelve shear tests were conducted, one at each end of the specimens. The knowledge and insight gained from the structural testing, along with the analytical study, led to the development of shear design recommendations for implementation into AASHTO LRFD.

What They Found

The current AASHTO LRFD provisions for the shear design of post-tensioned concrete members account for a reduction in the shear capacity due to the presence of ducts in the web region, varying based on the condition of the ducts. The current shear design procedure was not found to be in agreement with the observed failure mechanism of the test specimens. The structural tests resulted in similar failure modes, initiated by localized web crushing, regardless of the duct condition and tendon profile. This led to the following proposed modifications:

- The gross web width (b_w) should be used in the calculation of the concrete component to the shear strength capacity for the V_{n1} equation of §5.7.3.3-1 (AASHTO, 2020).

- When calculating the concrete contribution to the shear strength capacity in the V_{n2} equation of §5.7.3.3-2, the effective web width (b_v) should be reduced by the diameter of the duct (AASHTO, 2020).

- Based on the changes proposed for the effective web width correction factor (k), the proposed value of 2.0 for the duct diameter correction factor (δ) ensures similar structural conservativeness for both grouted and ungrouted ducts.

What This Means

The findings from testing large-scale specimens offered valuable insight into the behavior and governing failure mechanisms particular to post-tensioned concrete members containing grouted or ungrouted ducts. This enabled the development of realistic shear strength reduction factors to be incorporated into AASHTO LRFD. This study's meticulous analysis of large-scale test data and the in-depth review of shear models shed light on the underlying shear resisting mechanism of post-tensioned concrete members, leading to the proposed modifications for the upcoming edition of AASHTO LRFD.

For More Information

Project Manager:
Joanne Steele, RTI (512) 416-4657

Research Supervisor:
Dr. Oguzhan Bayrak, CTR (512) 965-2875

Technical reports when published are available at **https://library.ctr.utexas.edu.**

Research and Technology Implementation Division
Texas Department of Transportation
125 E. 11th Street
Austin, TX 78701-2483

www.txdot.gov
Keyword: Research