CENTER FOR TRANSPORTATION RESEARCH

PROJECT SUMMARY

Texas Department of Transportation

0-6652: Spliced Texas Girder Bridges

Background

Spliced girder technology continues to attract attention due to its versatility over traditional prestressed concrete highway bridge construction. By joining multiple precast concrete girders using post-tensioning, spliced girder technology effectively extends the application of low-cost precast construction to uncharacteristic span lengths. Although various connection methods have been devised over the years, the cast-in-place (CIP) splice region has emerged as the preferred connection between precast I-girder segments. Relatively limited data are available in the literature, however, for large-scale shear tests of post-tensioned I-girders, and only a few studies have examined the behavior of the CIP splice regions of spliced girder bridges.

The goal of this project was to develop a better understanding of spliced girder behavior. To accomplish this task, the project was divided into two phases. The Phase I research was aimed at evaluating the effect of post-tensioning ducts contained in the thin webs of spliced I-girders. Phase II examined the behavior of the CIP splice regions of spliced I-girders.

What the Researchers Did

For the Phase I experimental program, 11 shear tests were performed on large-scale I-girder specimens. The behavioral characteristics of the test specimens at service-level shear forces and at their ultimate shear strengths were evaluated in regard to five primary experimental variables:

- The presence of a post-tensioning duct.
- Post-tensioning duct material (plastic versus steel).
- Web width.
- Duct diameter.
- The transverse reinforcement ratio.

Before starting the Phase II experimental program, an industry survey was conducted to identify the best practices that have been successfully implemented in the construction of the splice regions of existing bridges. Splice region details were then selected for inclusion within large-scale post-tensioned spliced I-girder test specimens. Two tests were conducted to study splice region behavior and evaluate the performance of the chosen details. The Phase II specimens each consisted of two precast girder segments joined at a CIP splice region. Three post-tensioning tendons extending the full length of the specimens provided continuity.

What They Found

One of the most significant findings from the Phase I experimental program was that no differences were observed in the ultimate or service-level shear behavior of girders containing

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grouted plastic ducts when compared to those containing grouted steel ducts. Furthermore, an analysis of the Phase I tests along with those available within the literature led to the development of proposed modifications to shear design expressions in the American Association of State Highway and Transportation Officials (AASHTO) load and resistance factor design (LRFD) specifications.[1] The resulting design procedure is based on a mechanical model consistent with the strength behavior of the test specimens and therefore better accounts for the presence of post-tensioning ducts in the webs of bridge girders.

The Phase II specimens exhibited shear-compression failures as expected. The failures were characterized by concrete crushing in the vicinity of the top post-tensioning duct. The girders acted essentially as monolithic members in shear at failure. The web crushing extended across much of the test span and was not localized within the splice regions (see Figure 1). Furthermore, the experimental shear capacities of the specimens were greater than calculated strengths based on AASHTO LRFD[1] expressions and the proposed design procedure of the Phase I program. Lastly, recommended splice region details were selected based on the flexural and shear performance of the test specimens while also minimizing potential constructability issues.

Figure 1. Phase II Spliced Girder Specimen after Failure.

What This Means

The tests conducted as part of the spliced girder research efforts led to a significantly greater understanding of spliced I-girder behavior. The Phase I program included the first full-scale shear tests on girders containing plastic post-tensioning ducts. Moreover, the Phase II tests were the first in which a shear failure mechanism was developed in post-tensioned spliced girders containing in-span CIP splice regions. With a more in-depth understanding of spliced girder behavior and the application of the proposed design procedure, engineers are more equipped to design spliced girder bridges while confidently ensuring their strength and serviceability. The splice region recommendations have the potential to lead to more uniform design standards that simplify the design and construction of spliced I-girders. The research findings are presented with the hope that their implementation will result in the tools needed for the precast concrete girder industry to better reach its full potential by offering a low-cost alternative for moderate bridge spans.

[1] *AASHTO LRFD Bridge Design Specifications*, 7th ed., 2014. American Association of State Highway and Transportation Officials, Washington, D.C.

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