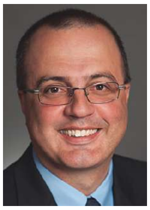

AASHTO LRFD Bridge Design Specifications: Stability of Pretensioned Concrete Girders

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Over the past 10 to 15 years, the design and fabrication of prestressed concrete girders have benefited from the availability of high-performance materials, new technologies, and advanced methods for structural design. More specifically, the advent of concrete materials technology, widespread availability of high-performance/high-strength concrete, the development and popularization of self-consolidating concrete, and the introduction of 0.6-in.-diameter strands with the potential for 300-ksi and 0.7-in.-diameter strands have created new opportunities within the prestressed concrete industry. Coupled with these advances in materials, the industry has moved forward to accept more sophisticated methods of design that allow for better optimization by removing unnecessary levels of design conservatism. As a result of these advancements, many states have developed better-optimized prestressed concrete bridge girders. In at least three states—Washington, Nebraska, and Florida—record-breaking spans have been designed and constructed.

With girder lengths in excess of 200 ft, the stability of slender pretensioned concrete girders has recently become a serious concern, which necessitates additional considerations in bridge design, fabrication, handling, transportation, erection, and construction. To address this concern, the Washington State Department of Transportation (WSDOT) has been requiring designers to evaluate stability of girders during both handling and transportation. (For more on the WSDOT views on this issue, see "Designing Precast, Prestressed Concrete Bridge Girders for Lateral Stability: An Owner's Perspective" in the Winter 2018 issue of *ASPIRE*®.) Additionally, on the national level, the American Association of State Highway and Transportation Officials (AASHTO) Committee on Bridges and Structures took on this issue by adopting revisions to several articles in the *AASHTO LRFD Bridge Design Specifications* 8th edition at the committee's June 2018 meeting in Burlington, Vt.

First, Article 5.5.4.3 and its commentary have been revised to highlight the importance of considering girder stability. The specifications have been revised as follows: "Buckling and stability of precast members during handling, transportation, and erection shall be investigated." Commentary for this article provides the necessary background, stating that "Stability during handling, transportation, and erection can govern the design of precast, prestressed girders. Precast members should be designed such that safe storage, handling, and erection can be accomplished by the contractor. This consideration does not make the designer responsible for the contractor's means and methods for construction, as discussed in 2.5.3."

Second, Article 5.9.4.5 has been developed and added to the specifications. This article addresses the use of temporary top strands. This specification states, "Temporary top strands may be used to control tensile stresses in precast, prestressed girders during handling and transportation. These strands may be pretensioned or post-tensioned prior to lifting the girder from the casting bed or post-tensioned prior to transportation of the girder. Detensioning of temporary strands shall be shown in the construction sequence and typically occurs after the girders are securely braced and before construction of intermediate concrete diaphragms, if applicable." Additional useful details about providing, tensioning, and detensioning temporary strands are also presented. Further, the effects of temporary strands on camber calculations and prestress losses are also acknowledged.

The commentary for the article provides a detailed discussion about how the use of temporary top strands improves the stability of girders by

Erecting a long-span pretensioned concrete girders. Photo: Concrete Technology Corporation.

altering stresses and reducing initial camber and camber growth. The beneficial effects of moving the lifting points away from the girder ends are also discussed.

Third, the commentary for Article 5.12.3.2.1 has also been revised to read: "*AASHTO LRFD Bridge Construction Specifications* places the responsibility on the Contractor to provide adequate devices and methods for the safe storage, handling, erection, and temporary bracing of precast members. However, these preservice conditions may govern and should be considered in the design, as discussed in 2.5.3." The last sentence in this commentary is provided to draw the attention of all responsible parties—the designer, the beam fabricator, and the contractor—to the fact that better-optimized girders require careful consideration from their conception to their use in service.

The three important revisions summarized previously are intended to draw our attention to consequences using the better-optimized girders and higher-performance materials of the 21st century to economically construct longer-span bridges, which allow the prestressed concrete industry to compete for new span ranges. However, with that stated, and as I say in my classes frequently, we do not get something for nothing in structural engineering. Better-optimized sections and higher-performance materials require better engineering and additional care during beam fabrication, storage, and transportation. Furthermore, girder erection, bracing (temporary or permanent), and superstructure construction all require considerations that were either less significant or not significant at all in the recent past. Advancing the state of practice in precast concrete bridge construction requires close coordination among all interested/responsible parties. In my view, the assignment of a particular responsibility, such as girder stability considerations, to a particular party carries a secondary level of importance. What is most important is that girder stability gets considered in the process of design, fabrication, handling, storage, transportation, erection, and construction.

As we aspire to move the profession forward, we must do so with care. The revisions to the AASHTO LRFD specifications discussed in this column are all aimed at accomplishing this goal. Additionally, Seguirant and colleagues[1] provide a useful example illustrating stability considerations. PCI has published a detailed procedure for evaluating the lateral stability of a girder during production, storage, transportation, erection, and construction.[2] PCI is also developing eLearning modules on lateral stability and a spreadsheet that implements the procedures in reference 2.

References

1. Seguirant, S.J., R. Brice, and B. Khaleghi. 2009. "Design Optimization for Fabrication of Pretensioned Concrete Bridge Girders: An Example Problem." *PCI Journal* 54(4): 73-111.
2. Precast/Prestressed Concrete Institute (PCI). 2016. *Recommended Practice for Lateral Stability of Precast, Prestressed Concrete Bridge Girders*. Publication CB-02-16-E. Chicago, IL: PCI.