AASHTO LRFD: *Shear Resistance, Part 2*

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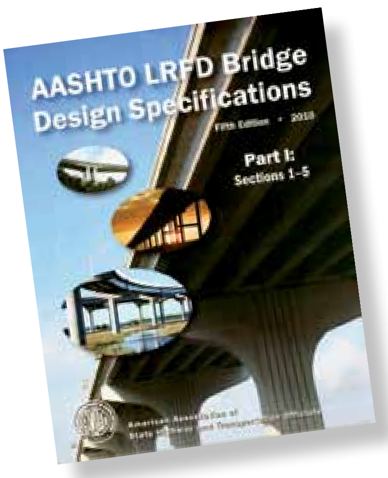

The AASHTO *LRFD Bridge Design Specifications* currently includes the following six different procedures to estimate the shear resistance of concrete members:

a. Article 5.8.3.4.1—Simplified Procedure for Nonprestressed Sections
b. Article 5.8.3.4.2—General Procedure
c. Article 5.8.3.4.2 reference to Appendix B5—General Procedure for Shear Design with Tables
d. Article 5.8.3.4.3—Simplified Procedure for Prestressed and Nonprestressed Sections
e. Article 5.8.6—Shear and Torsion for Segmental Box Girder Bridges
f. Article 5.6.3—Strut-and-Tie Model

Procedures a, c, and f of the six procedures were discussed in the Winter 2013 issue of *ASPIRE*™. These procedures were included in the first edition of the *LRFD Specifications* published in 1994. Procedures b, d, and e were added over the years since the original edition of the *LRFD Specifications* and are reviewed herein.

Procedure b is the current basic sectional model in the *LRFD Specifications*. It represents a refinement of the iterative modified compression field theory (MCFT) of Procedure c. In Procedure b, a factor indicating ability of diagonally cracked concrete to transmit tension and shear, β, and the angle of inclination of diagonal compressive stresses, θ, are directly calculated. In the author's opinion, Procedure b is the preferred procedure to estimate shear resistance when a sectional model is appropriate. Again, sectional models are based upon the assumption that the reinforcement required at a particular section depends only on the separated values of the factored section force effects (moment, axial load, shear, and torsion) and does not consider the specific details of how the force effects are introduced into the member. Procedure c in Appendix B5 remains only so that software written using the previous tabularized values of β and θ, while perhaps yielding slightly different solutions, remains code compliant and can be used to load rate bridges designed with the table values.

The newness of the MCFT and its perceived complication due to its iterative nature, as presented in the first edition of the *LRFD Specifications*, led to a National Cooperative Highway Research Program (NCHRP) project to find a simpler estimate of shear resistance. This NCHRP project resulted in Procedure d. Procedure d is more in line with that of the American Concrete Institute's (ACI's) approach, wherein the nominal shear resistance provided by the concrete is taken as the lesser of the resistance associated with the two types of inclined cracking: flexure-shear cracking and web-shear cracking for which the associated resistances are V_{ci} and V_{cw}, respectively. This procedure was developed concurrently with Procedure b, the refined MCFT with direct calculation of β and θ. Procedure d appears less accurate for bridges than Procedure b. In the author's opinion, the simplicity of Procedure d is no longer needed as Procedure b is just as simple.

Finally, Procedure e was brought into the *LRFD Specifications* from the AASHTO *Guide Specifications for Design and Construction of Segmental Concrete Bridges* because of the segmental-bridge community's reaction to the newness of MCFT and their inexperience with MCFT. Slowly, the segmental-bridge community is warming to Procedure b for segmental bridges as well.

The AASHTO Technical Committee T-10, Concrete Design, is beginning an effort to reorganize and reassess the concrete design provisions of Section 5 of the *LRFD Specifications*. Most likely, these six variations in estimating shear resistance of concrete members will ultimately be consolidated.

Six Procedures to Estimate Shear Resistance

- Article 5.8.3.4.1—Simplified Procedure for Nonprestressed Sections
- Article 5.8.3.4.2—General Procedure
- Article 5.8.3.4.2 reference to Appendix B5—General Procedure for Shear Design with Tables
- Article 5.8.3.4.3—Simplified Procedure for Prestressed and Nonprestressed Sections
- Article 5.8.6—Shear and Torsion for Segmental Box Girder Bridges
- Article 5.6.3—Strut-and-Tie Model

EDITOR'S NOTE

If you would like to have a specific provision of the AASHTO LRFD Bridge Design Specifications *explained in this series of articles, please contact us a www.aspirebridge.org.*