AASHTO LRFD: *Shear Resistance, Part 1*

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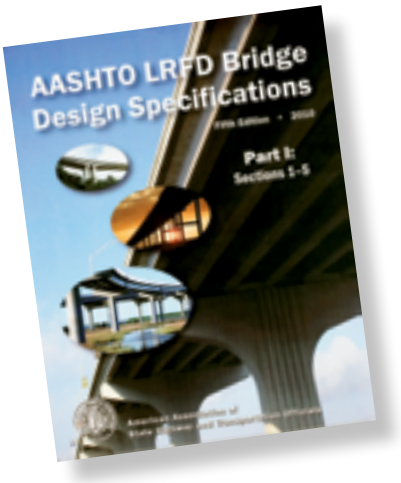

The AASHTO *LRFD Bridge Design Specifications* currently includes the following six different procedures to estimate the shear resistance of concrete members:.

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 through d are based upon the sectional design model. Procedure e is only applicable to segmental concrete box girders. Procedure f does not use the sectional method.

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. Sectional models assume that shear distribution remains uniform and that the plane sections remain plane after loading. This assumption is true where the conventional methods of strength of materials are applicable. The sectional model is appropriate for the design of typical bridge girders, slabs, and other regions of components where the assumptions of traditional engineering beam theory are valid. Near supports, near the points of application of concentrated loads, at abrupt changes in cross section, and for deep beams where the distance between the centers of applied load and the supporting reactions is less than about twice the member depth, sectional models are not appropriate and the strut-and-tie model must be used.

Only Procedures a, c, and f of the six current procedures listed previously for estimating shear resistance were included in the first edition of the *LRFD Specifications* published in 1994. At that time, the basic sectional model of Article 5.8.3.4.2 was the procedure that is now Appendix B5 (Procedure c). It is based upon the modified compression field theory (MCFT), which is a comprehensive behavioral model for the response of diagonally cracked concrete subject to in-plane shear and normal stresses. The shear resistance in the MCFT model is a function of the calculated longitudinal strain at the mid-depth of the member, ε_x, the shear stress, v_u, and the concrete compressive strength, f_c'. Shear design was iterative and required entering these values into the tables for the determination of β, a factor indicating ability of diagonally cracked concrete to transmit tension and shear and θ, the angle of inclination of diagonal compressive stresses. These two variables were then used in the calculation of shear resistance.

A simplification of this general MCFT procedure was also included in the first edition (Procedure a). This simplification for certain nonprestressed sections specifies that β be taken as 2.0 and θ as 45 degrees resulting in shear resistances essentially identical to those traditionally used for these sections.

Finally, the strut-and-tie model (Procedure f) was introduced in the first edition as a third procedure to estimate shear resistance where the sectional models are not appropriate.

Over the years, the number of shear-resistance procedures has grown as bridge engineers and owners reacted to the newness of the MCFT and the strut-and-tie models, and the complication of the iterative nature of the MCFT as presented in the first edition of the *LRFD Specifications*. In the next article, I will explore what the three added shear-resistance procedures (Procedures b, d, and e) represent and why they are in the *LRFD Specifications*.

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.*