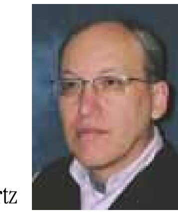
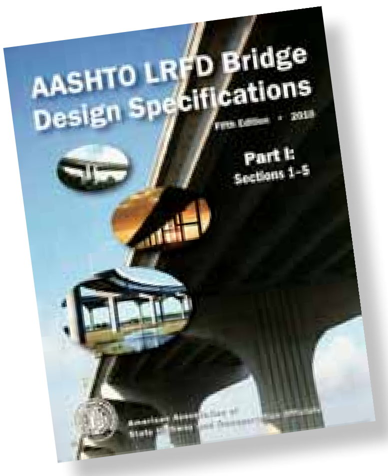
The Fatigue Limit States, Part 3



by Dr. Dennis R. Mertz



All the fatigue limit states for concrete structures defined in Article 5.5.3 of the *AASHTO LRFD Bridge Design Specifications* require the determination of the live-load stress range, Δf, due to the passage of the fatigue load as specified in Article 3.6.1.4. This fatigue load is the HL-93 design truck, identical to the HS20-44 truck of the AASHTO *Standard Specifications for Highway Bridges*, with a specified fixed rear axle spacing of 30 ft for the fatigue limit states. The use of the maximum rear axle spacing acknowledges that fatigue is governed by more typical force effects and not the maximum values of the strength limit states. The maximum rear-axle spacing spreads the load; thereby generating a lower moment and lower fatigue stresses. The dynamic load allowance (*IM*) associated with the fatigue limit states is 15%, a reduction from the 33% dynamic load allowance for the strength limit states, again acknowledging that fatigue is not governed by maximum force effects.

For simple span structures, the stress range is simply the live-load stress from the fatigue load for the critical truck location. For continuous structures, the stress range is the sum of the absolute values of the maximum live-load stress when the truck is on the span under consideration and the maximum live-load stresses when the truck is on all adjacent or more remote spans. In other words, it is the total excursion of stress due to the truck crossing the bridge.

The fatigue limit states for steel reinforcement of reinforced concrete components are checked when the steel reinforcement experiences significant tension. In regions of compressive stress due to unfactored permanent loads and prestress, fatigue is considered only if this compressive stress is less than the tensile portion of the stress range resulting from the Fatigue I load combination, discussed in *ASPIRE*,™ Summer 2011; in other words, 1.5 times the tensile portion of Δf. Fatigue of the reinforcement need not be checked for fully prestressed components designed to have extreme fiber tensile stress due to Service III Limit State within the specified tensile stress limit.

According to Article 5.5.3.1, the section properties for fatigue stress calculations are based on cracked sections where the sum of stresses, due to unfactored permanent loads and prestress, and the Fatigue I load combination is tensile and exceeds $0.095\sqrt{f_c'}$ ksi, a relatively conservative cracking stress limit (f_c' is in ksi). Otherwise, uncracked section properties can be used for fatigue stress calculations.

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 at www.aspirebridge.org.*