

The Fatigue Limit States, Part 1



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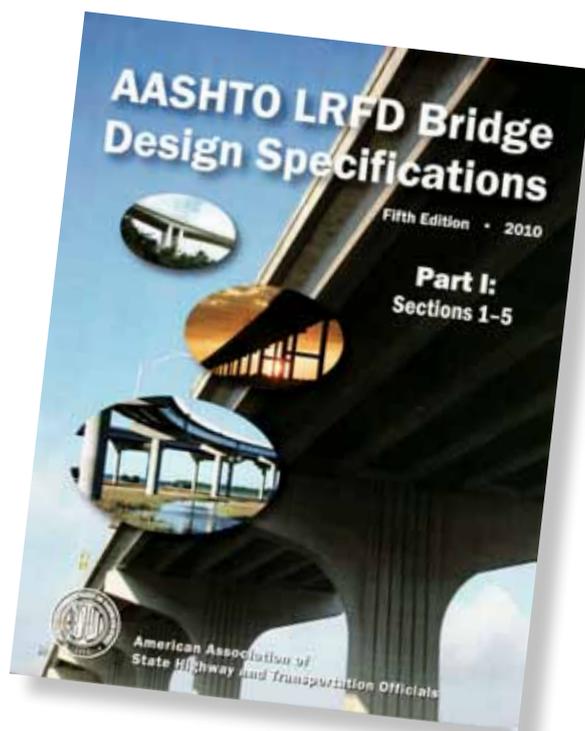
A recent interim revision to Section 3 of the *AASHTO LRFD Bridge Design Specifications* introduced a second fatigue limit-state load combination. This article discusses the intent of the two fatigue limit states.

The new fatigue limit state is Fatigue I, where the factor on live load is 1.5. Fatigue II is the pre-existing fatigue limit state where the factor on live load remains at 0.75. The concept of two fatigue limit states was introduced so designers would better understand fatigue design. It does not change fatigue designs or the proportions of bridge members.

Fatigue damage does not accumulate significantly due to a relatively small number of heavy trucks but more due to the vast number of trucks of more typical weight. Thus, the fatigue limit-state factor on live load included in the *LRFD Specifications* since the first edition was less than one, specifically 0.75. Further, this load factor is not applied to the HL-93 vehicle and lane superposition, but only to the design truck with a fixed rear-axle spacing of 30 ft. The factored stress range from this load factor and truck represents the most typical truck. This factored stress range is used to design bridge details to exhibit a finite fatigue life based upon the average daily truck traffic (ADTT). This pre-existing fatigue load factor has been assigned to the new Fatigue II limit-state load combination. The live-load factor of 0.75 was derived

as the root-mean-cube of the stress ranges experienced by a bridge detail.

Many bridge details exhibit a fatigue threshold such that if all applied stress ranges are kept below this threshold value of stress range, the detail will not crack but will theoretically exhibit



infinite fatigue life. The new Fatigue I limit-state load combination is intended to represent infinite-life fatigue design. The Fatigue I load factor on live load of 1.5 represents the stress range due to the heaviest truck that needs to be considered for fatigue. It is not the absolute heaviest truck. The live-load load factor of 1.5 was derived as the 1 in 10,000 greatest stress range experienced by a bridge detail.

The addition of a second fatigue limit-

state load combination is not a revelation on fatigue design, but merely a re-writing of the existing fatigue provisions, for both concrete and steel, to explicitly acknowledge infinite-life fatigue design. Previous to the interim revision of adding Fatigue I, the factor of two represented by the Fatigue I load factor divided by the Fatigue II load factor was implicitly included in the fatigue-resistance provisions where appropriate. Thus, fatigue design has not changed, but infinite-life design has become explicit with the designer now knowing when designing for infinite or finite life using the Fatigue I and Fatigue II limit states, respectively.

With the load side of the fatigue limit-state functions discussed above, a future article will investigate the resistance side of the fatigue limit-state functions specifically for concrete bridges.

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.