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Dr. Mark Hartzman
Mechanical Engineering Branch
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Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Dr. Hartzman,

This is a reply to your letter concerning the interpretation of the AISC Specification interaction equations in Sec. 1.6. Following are my comments on your interpretation. First, however, some general observations:

a) A structural specification is a minimum standard, adherence to which will very likely result in a safe design. Factors of safety, or load and resistance factors, are provided to render the probability of failure acceptably negligible.

b) The AISC interaction equations, recommended for use in all situations where a member is subject to axial compression and flexure, are an extreme simplification of a rather complex problem area in structural mechanics. The interaction equations work quite well for doubly symmetric wide-flange shapes under major axis flexure (see e.g., Chap. 11 in "Structural Steel Design" 2nd ed., editor L. Tall, Ronald Press, 1974), but they are rather conservative for minor axis flexure and biaxial bending of wide-flange shapes (see Fig. 8.9, "Guide to Stability Design Criteria for Metal Structures", 3rd ed., editor B.G. Johnston, Wiley, 1976). They also work well for singly symmetric shapes (double angles and tees) bent about the plane of symmetry and not subject to lateral-torsional buckling. For single-angles I know that the interaction equation is conservative. However, in cases of various unsymmetric shapes with thin elements there is interaction between local buckling, lateral-torsional buckling and in-plane buckling, and so it is difficult to make general statements.

c) It is my understanding that in cases where I feel that the Specification provisions do not satisfactorily cover the problem under consideration, I can perform a more detailed rational analysis based on my knowledge or on published material. Unfortunately this is not stated explicitly as a general statement in the AISC Specifications, although

it is stated in the context of several sections (see e.g. Sec. 1.5.1.4). I personally would thus not use the criteria of Sec. 1.6 for angles and tees under biaxial flexure but use more exact analyses. However, this is a private and personal choice.

Now to reply to your comments.

1) Equations 1.6-1a and 1.6-2 are definitely referenced to flexure about the principal axes.

2) The interaction equations are based on the premise that if only one of the load effects act, the resulting solution is correct. Thus, when all load effects act, it is not necessary that the critical stress combinations occur at the same point in the cross section. Your interpretation of this point is thus correct.

3) Due to the same premise as in Point 2 above, the maximum moments need not occur at the same point along the length of the member, and so your interpretation is again correct.

4) Again, your interpretation is correct, based on the same premise as in Point 2 above.

Basically, it is my opinion that your interpretation of the use of the interaction equations is correct in the sense of the intended meaning of Sec. 1.6 of the AISC Specification. It is also my opinion that this literal interpretation of the AISC interaction rules as applied to angles and tees results in conservative design.

Sincerely yours,

Ted Galambos

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Professor in Civil
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