

Discussion

Yield Line Analysis of Column Webs with Welded Beam Connections

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THE CONCERN of the author for an analytical approach to the problem of column (or beam) web adequacy is very welcome. However, the assumptions made do not necessarily lead to the critical yield line. Assumption 3 and the selection of $6t$ (for the distance above and below the beam flange affected by the rotation) yield a different beam end moment M for a given thickness of column web than the writer's approach. The writer's analysis of this problem is similar to that in "Yield Line Analysis of a Web Connection in Direct Tension" by the writer (AISC Engineering Journal, 2nd Quarter, 1974).

Assumption 3 is not made, and the lengths of lines ④ and ⑤ and their angles of rotation are calculated. The distance $6t$ is treated as a variable e (since the yield pattern does not depend on the thickness of the web, but on the geometry of the connected parts). The resulting moment equation varies with respect to e .

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$$M = \frac{F_y t^2 d}{2} [(2a + b)/e + 2e/a + (ba + d^2 + 2a^2)/da] \quad (1)$$

Taking the first derivative of Eq. (1) with respect to e , equating to zero, and solving for e yields the particular e which causes the critical M (the second derivative yields a positive quantity, thus M is minimum for e).

$$e = \sqrt{(2a + b)a/2} \quad (2)$$

Substituting Eq. (2) into Eq. (1) yields the equation for the critical moment M_{cr} .

$$M_{cr} = \frac{F_y t^2 d}{2} [2\sqrt{(4a + 2b)/a} + (2a + b)/d + d/a] \quad (3)$$

Using the author's example with $M = 3520$ kip-in., a web of 0.80 in. is required and the selected column is adequate. The e which gives the yield line shape can be calculated from Eq. (2) and is 3.25 in., which is less than the author's assumed $6t = 5.04$ in. However, the assumptions made by the writer do not much affect the use of the author's graphs when they are compared to graphs which could be made from these equations.

If the assumption is made that $2a + b = T$, as the author has done, then Eqs. (2) and (3) can be written as follows:

$$e = \sqrt{Ta/2} \quad (2a)$$

$$M_{cr} = \frac{F_y t^2 d}{2} [2\sqrt{2T/a} + T/d + d/a] \quad (3a)$$