Discussion

Allowable Loads on Beams without Lateral Support

Paper presented by JOHN MATAYA (January, 1967, issue)

Discussion by **JAMES K. GRANT**

MR. MATAYA has presented a new approach to an everyday design problem, but a serious error is inconspicuously hidden in Example 2 and has resulted in an unconservative beam selection.

The critical segment of the beam for lateral buckling consideration is from 2 to 3, not 3 to 4. The point of inflection within this segment may not be considered a point of lateral support unless a positive means of preventing torsional rotation is provided there.[1] Consequently, this segment must not be overlooked since its unsupported length is no less than that for 3 to 4.

The maximum moment within any given unsupported length of beam is the critical moment for lateral buckling, regardless of the configuration of the moment

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diagram. The effects of single and double curvature are reflected in Formula (4) of the AISC Specification by the bending coefficient C_b. The allowable stress of a laterally unsupported beam bent in double curvature will be higher than the same beam singly curved, unless, of course, Formula (5) indicates a greater value.

The required value of C in Example 2 should be:

$$C = \frac{12 \times 76.5 \times 9}{1{,}000} = 8.27$$

The minimum required section modulus is as correctly computed by the author:

$$S = 76.5 \times \frac{12}{22} = 41.7 \text{ in.}^3$$

Entering the tables with these values of C and S results in the selection of a 14W⊏34 as the most economical section.

Carrying the author's method one step further may, in some instances, indicate that more economy is possible. Since the section modulus computation is based on a maximum allowable stress of 22 ksi, which is the stress above which AISC Formulas (4) and (5) do not apply, the higher stress permitted for compact sections would never be taken advantage of. If the L_c value of the beam selected is greater than the actual unsupported length, L, and the section is compact, 24 ksi is allowed, indicating that the beam size may possibly be reduced.

To illustrate, suppose the beam of Example 1 were laterally braced at the third points, and the nominal depth had to be limited to 12 in.

$$M = 2 \times \frac{20^2}{8} = 100 \text{ ft-kips}$$

$$\text{Req'd. } S = 100 \times \frac{12}{22} = 54.5 \text{ in.}^3$$

$$\text{Req'd. } C = \frac{12 \times 100 \times 6.67}{1{,}000} = 8.0$$

Entering the tables with these values of S and C results in the selection of a 12W⊏45. However, the section is compact, and its L_c value of 8.7 ft is greater than the actual unbraced length of 6.67 ft, indicating a limiting stress of 24 ksi, or:

$$\text{Req'd. } S = 100 \times \frac{12}{24} = 50 \text{ in.}^3$$

Using $S = 50$ in.^{3} and $C = 8.0$ in the tables gives a 12W⊏40 as the most economical choice.

With due respect to the individuality of each designer, the writer would hesitate to recommend any single design method as being the quickest, but Mr.Mataya's method and the AISC curves for "Allowable Moments in Beams" are both fast routes to a design solution. The moment curves involve less work however.

Two minor errors, apparently typographical, were noticed in the paper. In Example 1, the 20 ft in the moment computation should be squared; and in Example 2, section 3, $f_{\text{actual}} = 19.7 < 20.7$ ksi. It should also be realized that the allowable stresses, as determined by Formulas (4) and (5) are slightly higher for the 14W⊏34 than for the 14W⊏30.

REFERENCE

1. *Milek, William A.* One Engineer's Opinion *AISC Engineering Journal, April, 1966.*