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by massey, C., Proc. ASCE, Vol. 89, EM3, June
1963, Reprint No. 226 (63-13)

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Welded Continuous Frames and Their Components

DISCUSSION OF THE PAPER

**"Lateral Bracing Force of Steel I-Beams" by
Campbell Massey, ASCE Proceedings Paper
No. 3364, EM6, Vol. 88, December, 1962.**

by

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LATERAL BRACING FORCE OF STEEL I BEAMS^a

Discussion by M. G. Lay & T. V. Galambos

M. G. LAY¹⁶ and T. V. GALAMBOS¹⁷, M.ASCE. - It is noted that Massey has found the force required to hold one point of an I beam fixed against deflections out of the plane in which the beam is being loaded. There is no reason why this force should be synonymous with the bracing condition required to ensure the adequate structural performance of that beam. For instance; tests reported elsewhere¹⁸ have shown that I beams may deliver adequate rotation capacity under conditions in which the braced points deflect laterally 7/8" in a 13 foot span. As the author did not present load-deflection curves for his tests it would be appreciated if such curves could be given in the closure to this discussion. Plots of moment versus vertical and horizontal deflection would allow the significance of Mr. Massey's tests to be more fully realized.

It also needs to be pointed out that the author's post-elastic analysis represents a highly idealized situation. A complete analysis would also consider the following effects:-

^a December 1962, by Campbell Massey (Proc. Paper 3364)

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¹⁸"Experiments on Braced Wide Flange Beams" by A. T. Ferrara, G. C. Lee and T. V. Galambos, Fritz Engrg. Lab. Report 205H.6, March, 1963.

- 1) Residual Stresses
- 2) Biaxial bending and twisting during the loading sequence
- 3) The variation of deformations and stiffness functions
along the beam

The neglect of residual stresses is valid for a theory applicable to heat-treated specimens such as the author tested. However, it has been shown^{10,19} that residual stresses will exert a significant influence on the lateral buckling behavior of commercial beams and thus the author is not correct in using his results to draw conclusions about such members.

The stress distribution used in Fig. 2 is applicable in cases of in-plane bending and problems treating the point of lateral bifurcation (or buckling). The author's case is an initial deflection problem and therefore buckling will be precluded. Twisting and lateral deflections will occur from the commencement of loading and the assumption of Fig. 2 will progressively worsen as the loading increases.

The above points are not intended to indicate that Massey's analysis will necessarily lead to incorrect results, but rather to point out that more careful studies are required before some of his

¹⁹"Inelastic Lateral Buckling of Beam-Columns" by Y. Fukumoto, Ph.D. Dissertation, Lehigh University, 1963

conclusions can be accepted. A case in point is the author's conclusion on the magnitude of the required bracing force. This force is normally taken as:

$$F_b \leq 0.02 F_f$$

where $F_f = (\text{area of compression flange}) \times (\text{yield stress})$

Massey suggests that this value of 0.02 may be too low for beams proportioned according to Ref. 13 or Ref. 20. The maximum value of F_b/F_f from the author's tests is 0.0039, so these do not directly support his conclusions. The theoretical results presented in Figs. 3 and 4 do appear to indicate large bracing forces for very short beams (in this regard it is noted that the theory assumes no strain-hardening).

Massey suggests that a beam designed according to Ref. 13 would fall into this category of very short beams. It appears here that the author has incorrectly interpreted the bracing recommendations of Refs. 13 and 20. In the former it is recommended that the unbraced length be $45r_y$, not the full span as interpreted by Massey. Using the correct length, it is seen that the author's tests are for unbraced lengths of $120r_y$, $100r_y$, $60r_y$ and $40r_y$, not for $240r_y$, $200r_y$, $120r_y$ and $80r_y$ as was stated. Since it was a $40r_y$ test which gave $F_b/F_f = 0.0039$ it is seen that the tests actually contradict the author's conclusion. Furthermore, when

the theoretical results are viewed in this light, see Figs. 3 and 4, the maximum span recommended by Ref. 13 would be $2 \times 45r_y = 90r_y$, not $45r_y$. From Fig. 4 the value of F_b would be 13 lb. whereas $F_f = 1/2" \times 1/8" \times 31,500 = 1,980$ lb. Hence $F_b/F_f = 0.0065$. As this latter value is still very much less than the 0.0200 recommended, the writers see little cause for the concern expressed by the author.