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Letter to the editor, International Journal Mechanical Science, June 1963

M. G. Lay

Welded Continuous Frames and Their Components

LETTER TO THE EDITOR,
INTERNATIONAL JOURNAL OF MECHANICAL SCIENCES

Discussion of Paper: "The Effect of Restraint upon the Collapse Loads of Mild Steel Trusses" by B. G. Neal and D. S. Mansell.
Int. Jour. Mech. Sci., 5, p. 87-97, February 1963.

by

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LETTER TO THE EDITOR:

Discussion of Paper by B. G. Neal
and D. S. Mansell, Vol. 5, Feb. 1963

by

M. G. Lay*

The writer wishes to comment on the authors' statement that the strut curves used in their analysis are derived from "the exact differential equation

$$\frac{d^2y}{dx^2} + f \quad (y) = 0 \qquad (13)"$$

This equation is not exact in the mathematical sense, hence it is of interest to consider whether it is exact in the sense that its assumptions conform to reality. Eq. (13) assumes that the curvature of a strut is expressed by y" rather than by the more exact expression

$$y''/\left[1 + \left(\frac{dy}{dx}\right)^2\right]^{3/2}$$

This assumption is normally of sufficient accuracy, however, the authors' Fig. 4 would indicate that large regions of the two charts shown are outside the range of small deflection theory. For instance, in Fig. 4a, the line $m_{12} = 0$ represents a strut under axial load with a moment m_{21} applied at one end and a pin at the other. After reaching an extreme value at $m_{21} = 0.025$, the strut end rotations then reverse and m_{21} reaches another extreme of about -0.40. It would appear that very large curvatures would be required for a strut under constant axial load to have its end moment change sign and increase to about sixteen times its original value.

A second assumption made by the authors is that the moment-curvature relationships are single valued. Again, this is a reasonable assumption within a range such as $-0.025 < m_{21} < +0.025$ for

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$m_{12} = 0$ in Fig. 4a. In the portion of the charts outside of this range, any real strut will have been subjected to considerable elastic unloading of the yielded regions and the moment-curvature relationship will not be single valued. In addition the strains will be such as to cause deleterious local effects in many cross-sections[D1].

It is apparent, from the portions of the paper following Fig. 4, that the technique of finding equilibrium points from curve intersections (Fig. 7) actually does limit the authors' use of the charts to almost the same regions as the writer suggests above. This can be seen from the fact that the steepness of the curve of Eq. (9) is limited by considerations of initial elastic instability.

It is worth noting that similar strut curves to those used by the authors have been employed in recent years to analyze frameworks in which bending moments have been of a more predominant nature[D2]. However the authors' major point - that stiffening a joint connection can reduce the strength of a structure - is a well made and novel contribution.

References:

D1 Galambos, T. V. and Lay, M. G. "End-Moment End-Rotation Characteristics of Beam-Columns", Fritz Engineering Laboratory Report No. 205A.35, Lehigh University, 1962.

D2 Ojalvo, M. and Levi, V. "Columns in Planar Continuous Structures" Proc. ASCE, 89 (ST1), February 1963, p. 1.