# Discussion

## Analysis and Design of Framed Columns Under Minor Axis Bending

Paper presented by T. KANCHANALAI AND LE-WU LU
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Discussion by **D. A. Nethercot**

The writer was interested to read of this investigation dealing specifically with the behaviour of beam-columns bent about the minor axis, since he has also been concerned with certain aspects of this problem in the context of the revision of codes of practice in the U.K.

Results for the two cases of Figs. 2 and 3 have previously been obtained by Young,[23] who used them as part of the basis for his own critical length design approach for in-plane failure of beam-columns.[24] Figures 19 and 20 show the author's results to be in reasonable agreement with this alternative solution. The differences between the two sets of results are greatest for columns subjected to small end moments. The authors do not state whether the effects of initial curvature were included in their analysis and it seems likely that this, together with differences in the cross-sectional shape and the assumed pattern of residual stresses, could well be responsible, since such factors would be expected to become increasingly significant as the column approaches the pure axial load case. Young also considered five different sections in minor-axis bending; examination of the scatter in his results (admittedly made somewhat difficult due to the novel form of plot adopted) naturally raises the question of how representative are the results of Figs. 2 through 4, when viewed in the context of the complete range of possible sections.

Although the authors use their own results for the $M_o = 0$ case to construct Fig. 5, they then base the development of their new interaction approach on axial strengths calculated using the SSRC Basic Column Formula. As indicated in Figs. 19 and 20, the two approaches do not yield identical results. The writer's experience[25,26] suggests that changes in the axial strength portion of an interaction equation can produce surprisingly large differences in the predictions of that interaction formula over its whole range of application. As an example of this, a change from the variant of the ECCS maximum strength column curves proposed in the new U.K. Draft Steelwork Code[27] to the SSRC Basic Column Curve when used with the well-known SSRC interaction formula[28] caused the mean value of (predicted load)/(test load) for the 24 tests reported by Mason, Fisher and Winter[29] to change from 1.152 to 1.016. When an ultimate load version of the simple linear formula of BS.449 was used, the corresponding values became 1.046 and 0.876. In view of the possible change from the SSRC Basic Column Formula to a set of maximum strength column curves, have the authors considered how the accuracy of their interaction formulas [Eqs. (10) and (11)] would be affected, and whether any modifications would be necessary?

In the writer's study,[25] it was also found that while (for the nonsway case) it was probably necessary to retain the effect of the amplification factor for minor-axis bending, for practical purposes this effect could be approximated without much loss in accuracy, with the result that evaluation of the interaction formula was simplified. In view of the authors' comments later in the paper, where they go on to consider the effects of sway (last paragraph on p. 37) it

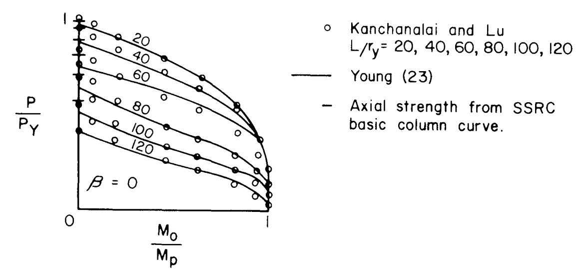


*Fig. 19. Comparison of ultimate strength results for columns subjected to one end moment*

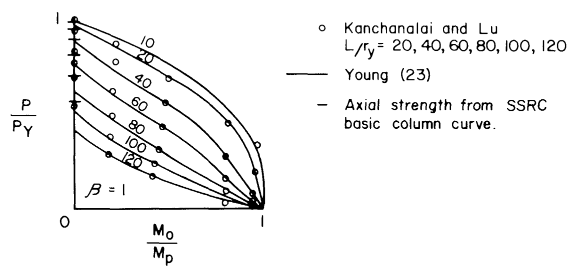


*Fig. 20. Comparison of ultimate strength results for columns subjected to equal end moments*

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would be of interest to know whether the possibility of simplifying the expressions for $B_1$ by means of some approximation for $P_e$ had been considered. It should be noted, however, that this point is also affected by the presence or otherwise of the effects of initial curvature in the interaction formula. The importance of the amplification term was found to be greatly reduced in the type of expression used in the U.K.,[27] as well as by ECCS,[30] over the SSRC interaction equation.

It would have been of interest to see a somewhat more detailed comparison of the authors' interaction formula with the test data of Johnston and Cheney. For the full set of 28 tests (the 10 tests at constant load eccentricity and variable slenderness are omitted from Table 1) the writer obtained a mean (test load)/(predicted load) of 1.088 using the SSRC interaction and Basic Column formulas. It is difficult to decide whether the comparison presented by the authors in Fig. 10 is superior. This is particularly true for the most stocky ($\lambda = 0.283$) columns for which the SSRC formula (because it can never become convex as required by Fig. 5) consistently underpredicts (but less so as the amount of bending is increased) and for which Fig. 10 suggests rather erratic predictions for the new method. Perhaps the authors can also indicate why the additional 10 tests were not used in their comparison?

**REFERENCES**


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