DISCUSSION

Flexible Moment Connections for Unbraced Frames Subjected to Lateral Forces—A Return to Simplicity

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Discussion by David Nethercot

While a discussion of the history of the flexible moment connections (in all its guises) approach to the design of steel frame structures might be an interesting topic over "brandy and cigars," it is its role as part of the portfolio of design tools available today and its likely use in the future that is, I believe, the aspect of the paper deserving of further consideration. The general concept has, of course, been around for almost a century. Nowadays we might concern ourselves less with the niceties of the terminology and definitions—in reality all practical forms of steel beam to column connections have:

- Some degree of rotational stiffness.
- An ability to transmit some level of moment.
- Rotation limits beyond which they start to shed load.

By grouping sets of characteristics within which certain approximate approaches yield results sufficiently close to those obtained from a rigorous treatment, we are able to use these simpler approaches when appropriate, for example, to compare several initial options on an approximate basis, and to devise an input for a more detailed investigation (all computer-based analyses require the input of numerical values of the frame properties that have to be devised somehow).

It is a feature not just of this particular structural topic but of all engineering that mathematical treatments are a simplified representation of reality and that, in many cases, they will only be valid within certain limits. This is, of course, true for design rules given in codes of practice and all approaches to structural analysis, no matter how sophisticated.

A valuable aspect of the paper is, therefore, its highlighting of the interactions between: response under lateral and gravity loads, the structural characteristics of members and connections, and the need to consider drift as well as strength in design. Any young engineer brought up on an unrelenting diet of matrix stiffness analysis, rigid joints, linear behavior and substitution into interaction equations will gain much from the careful explanation of incremental loading, growth of deformation, and the changing pattern of internal forces as the relative stiffness of the different structural components (including the connections) changes.

In the United Kingdom, the so-called wind moment method (WMM) is presented a little differently since practices and priorities differ from those on the western side of the Atlantic. The fundamentals of behavior are, of course, identical; for example; so far as I know gravity acts downward in the United States. The United Kingdom tends to regard the method as most useful for buildings up to about 10 stories; this covers a very large fraction. Since extensive use is made of composite construction, the method's application has been extended into this area (Hensman and Way, 2001).

I suspect that the authors would like to feel that their paper is the "last word on the topic." They might like to reflect that, to the best of my knowledge, all the American work presumes fixed-base columns. These do, of course, have some inherent lateral stiffness, even in the absence of any tying together by beams. However, nominally pinned bases would generally (at least in the United Kingdom) be regarded as a more economic arrangement. Calculations for the drift of frames designed on a WMM [or partially restrained (PR)] approach assuming the replacement of fixed bases by pins frequently yield lateral deflections well outside acceptable drift limits (Hensman and Nethercot, 2001). One solution is to assess the likely degree of rotational restraint available from nominal pin bases and to include this when determining lateral deflections. Frequently, the result is that the design may be shown to be satisfactory. This point does, however, indicate that the approach is only a representation of reality and that as with all methods of structural design it must be used in an intelligent fashion.

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REFERENCES

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