Discussion

The Effective Length of Columns in Unbraced Frames

Paper presented by JOSEPH A. YURA (April 1971 issue)

Discussion by **Anand B. Gogate**

The writer would like to thank Professor Yura for writing a useful paper from the structural designer's standpoint. The paper focuses attention on one of the areas of the AISC Specification that has not been adequately articulated even in the Commentary on the Specification. The inelastic "G" concept and the equivalent axial load concept are indeed ingenious and extremely simple to apply. The author has also brought to attention two very important features of column instability in a structural system, viz.,

1. Sidesway mode of buckling has to be associated with all the story columns collectively. If all the columns are loaded to their full capacity; and if the effective slenderness ratio falls in the elastic range; then and only then, the basic assumptions of the AISC alignment chart are fulfilled.

2. If the effective slenderness ratio of a compression member is less than C_c, the alignment chart gives conservative values for K. For columns with slenderness ratios under 100, the K values from the AISC chart are ultra-conservative. The alignment chart is invalid for compression members having a slenderness ratio smaller than C_c since the chart is evolved for elastic buckling, whereas the actual column instability would fall in the inelastic range.

The author's paper makes one aware of the great importance of basic assumptions in code provisions; and the benefits that a designer can derive by obtaining familiarity with them.

Papers, like the present one and the one authored by Dr. Higgins (Reference No. 7 in the original paper) do a great service to the average structural designer who does not enjoy the personal participation in and the associate familiarity with research and, particularly, the basis f the AISC code provisions.

Activating the unused capacity of adjoining colum to augment the deficiency in capacity of a particul column can result in optimum use of all the colun sections. It must, however, be borne in mind that tl structural system tying the column extremities mu possess the requisite shear-diaphragm action to brii about this load sharing.

One practical example where the author's meth can really pay rich dividends is in the design of cra columns.

The author has already made reference to the val able contribution of Dr. Adel H. Salem (Reference N 6). The writer would like to add a few more significa excerpts from the same paper. Figures 1 and 2 drama cally show the insensitivity of the sum of the criti column loads to their ratio for fixed base and hing base frames. The effect of the relative stiffness of t girder to the column on the total column capacities c also be noted. For most practical cases (excluding fla pole type structures), the ratio of K_2 to K_1 will be u ward of 1.5.

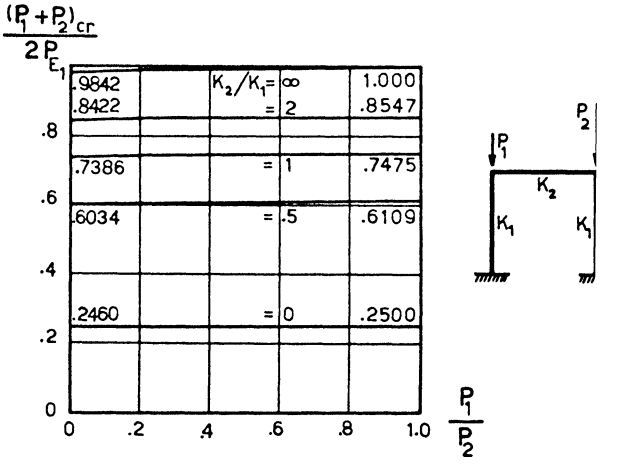

Fig. 1. Elastic critical sum of loading versus axial load ratio f fixed base portal frame. P_E = Euler-Load

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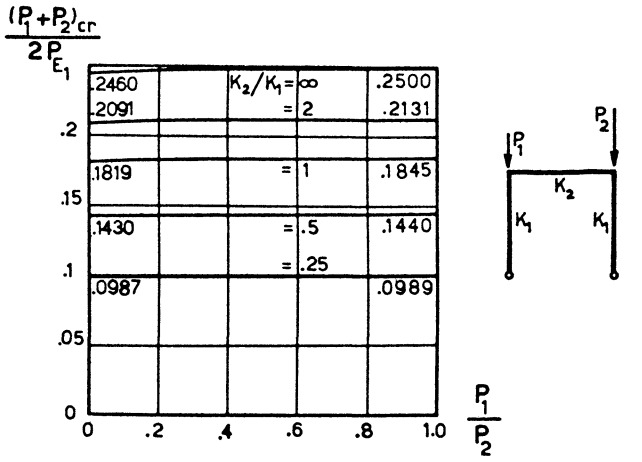

Fig. 2. Elastic critical sum of loading versus axial load ratio for a hinged base portal frame

In the same paper Dr. Salem has elaborated on the "Theory of Multiples" for the elastic buckling of multi-bay frames, which can be stated as follows:

The sway buckling load of a multi-bay frame is equal to that of a single bay frame when the following two conditions are satisfied:

1. When it is possible to split a multi-bay frame into a number of identical single bay frames, each of which has the same column stiffness and the same column loads.

2. When each of the two components of pure-shear sway, and no-shear sway at the "split" columns are the same.

Figures 3 and 4 explain the theory of multiples and its domain of validity quite well.

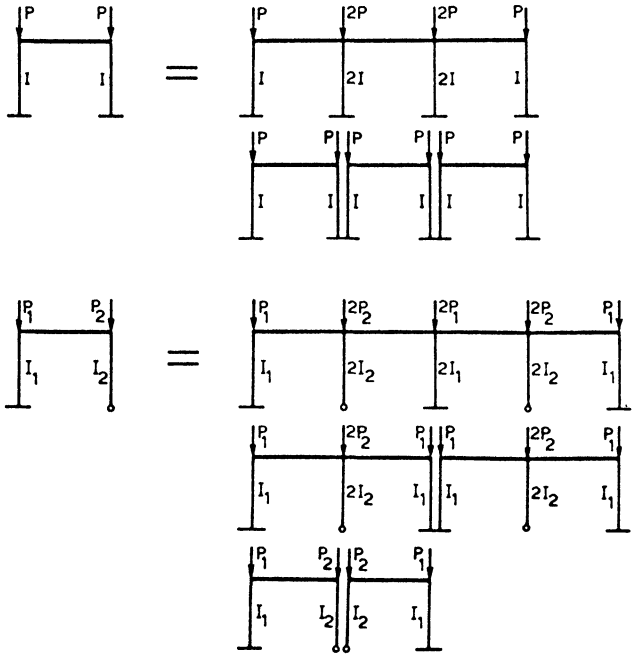

Fig. 3. Examples of frames where the theory of multiples can be applied

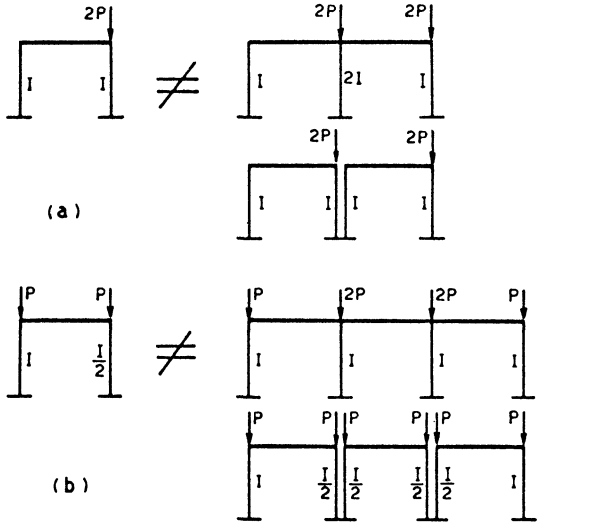

Fig. 4. Examples of frames where the theory of multiples can be applied