Discussion

Mill Building Design Procedure

Paper by JOHN F. BAKOTA
(4th Quarter 1977)

Discussion by **Anand B. Gogate**

The discusser concurs with Mr. Bakota's observation regarding the lack of systematic information on the design of mill buildings in text books. One of the main reasons for this situation is that Consulting Engineers, who have the expertise in this field, do not have the time to write textbooks. This discussion is aimed to add a few remarks based on the discusser's experience of about two decades of Consulting Engineering.

A "must" in the list of references on the design of mill buildings is the pioneering book written by the late Milo S. Ketchum[1] in 1903. This book was the very bible of steel building design about sixty years ago. During the discusser's employment with one of the major steel fabricating firms in 1966, this old book proved to be very valuable; it provided more information on the design of mill buildings than any modern text book then available.

A reasonable argument is given in Ketchum's book as to why a mill building constituting a single span roof truss with knee braces, and supported on hinged base columns, can be treated as a frame for lateral load resistance. This method has been used ever since by designers with no regrets. Even a recent paper by Zweig[2] has recommended full frame action in design of buildings with bottom chord extension of roof trusses into supporting columns.

SPACING OF EXPANSION JOINTS AND THERMAL STRESSES

The effect of thermal stresses becomes pronounced when thermal expansion is restrained. Expansion joints, when detailed and spaced adequately, minimize thermal expansion restraints. Consequently, there is less need to account for the negligible thermal stresses. Indeed this is very fortunate, since an accurate stress distribution in any three-dimensional enclosure subjected to temperature gradients is extremely complex. From the design standpoint, therefore, the discusser would like to recommend the upper limit on the spacing of expansion joints as 200 ft. With this limitation, the thermal stresses can be safely ignored.

On the other hand, expansion joints are expensive and are a potential source of roof leakage, which must be considered. Incidentally, the location of true expansion joints also affects the design of wind bracing, and the discusser has found on many projects that this fact was not fully realized in the location and proportioning of the wall bracing and diaphragm bracing in the roof system.

SIDESWAY AND COLUMN STABILITY

In regard to effective length of framed columns and the benefits derived by rotating the axes of adjacent columns the discusser would like to refer to the papers by Yura[3] and Zweig[2] and the discussion of Yura's paper by Gogate.[4] These papers conclude that for a safe lower bound the total buckling load of a rigid frame with an infinitely stiff horizontal member (a roof truss with bottom chord extensions very nearly fulfills this requirement)[2] equals approximately the sum of the buckling loads of each frame column. In other words, two columns tied at the top with bottom chord extensions of the roof truss would act together in such a way that an overload of one column (less than the Euler Load) can be justified on the basis of a smaller load on the other column. Yura's[3] inelastic G concept and an iterative procedure to obtain a modified K-factor for such columns is also a major contribution towards economical design of column grids where loads (like crane loads) create an excess load at one or two adjacent columns at a given time only.

Finally the discusser hopes that other Consultants will share their knowledge through papers such as Mr. Bakota's in the coming years.

Anand B. Gogate is Senior Structural Engineer, Elgar Brown Consulting Engineers, Worthington, Ohio.

REFERENCES

1. *Ketchum, Milo S.* General Specification for Steel Frame Mill Buildings 1903, (*Retitled "Steel Mill Buildings" in 1932 and published by McGraw-Hill Co.*)

2. *Zweig, Alfred* Discussion of "Column Stability Under Elastic Supports" by T. R. Higgins *AISC Engineering Journal, Vol. 2, No. 3, July 1965, pp. 105–106.*
3. *Yura, Joseph A.* The Effective Length of Columns in Unbraced Frames *AISC Engineering Journal, Vol. 8, No. 2, April 1971, pp. 37–42.*
4. *Gogate, Anand B.* Discussion of "The Effective Length of Columns in Unbraced Frames" by Yura *AISC Engineering Journal, Vol. 8, No. 3, July 1971, pp. 110–111.*