EQUIVALENT FRAME METHOD DESIGN FACTORS FOR MOMENT DISTRIBUTION

To calculate the factored moments using the moment distribution procedure we need to determine moment distribution factors and fixed-end moments for the equivalent frame members (columns and slab-beam members). Stiffness factors k, carry over factors COF, and fixed-end moment factors (FEM) for the slab-beams and column members are commonly determined using the design aids tables in ***Appendix 20A of PCA Notes on ACI 318-11***.

The PCA Notes provides tables to obtain the design factors for the equivalent frame method as developed by Corley and Jirsa (1970) and further developed by Misic and Simmonds (1970) and Simmonds and Misic (1971).

ACI 318-71 changed the usual assumptions of uniform prismatic members stiffness and carryover factors and fixed-end moments so that it cannot be applied to the column elements and slab-beam elements. Instead it specified that the moment of inertia of the slab-beam from the centre of the column to the column face shall be assumed equal to the moment of inertia of the slab-beam at the column face divided by the quantity $(1-c_2/l_2)^2$. Also, to compute the column stiffness, the moment of inertia shall be assumed to be infinite from the top to the bottom of slab-beam at the joint.

Having determined the moment of inertia properties of all sections of each element, any structural analysis method such as moment area and conjugate beam can be used for the determination of the stiffness factor, carry-over factor, and fixed-end moment factors. Misic and Simmonds (1970) and Simmonds and Misic (1971) used the Column Analogy method to calculate these factors. This process is tedious and not practical due to the precense of non-prismatic members in floor systems to account for the column, column capitals, drop panels and in some cases beams. Therefore, a predetermine and tabulated values for these factors is desirable and two simplifications were proposed to ease the process of generating the design aids tables:

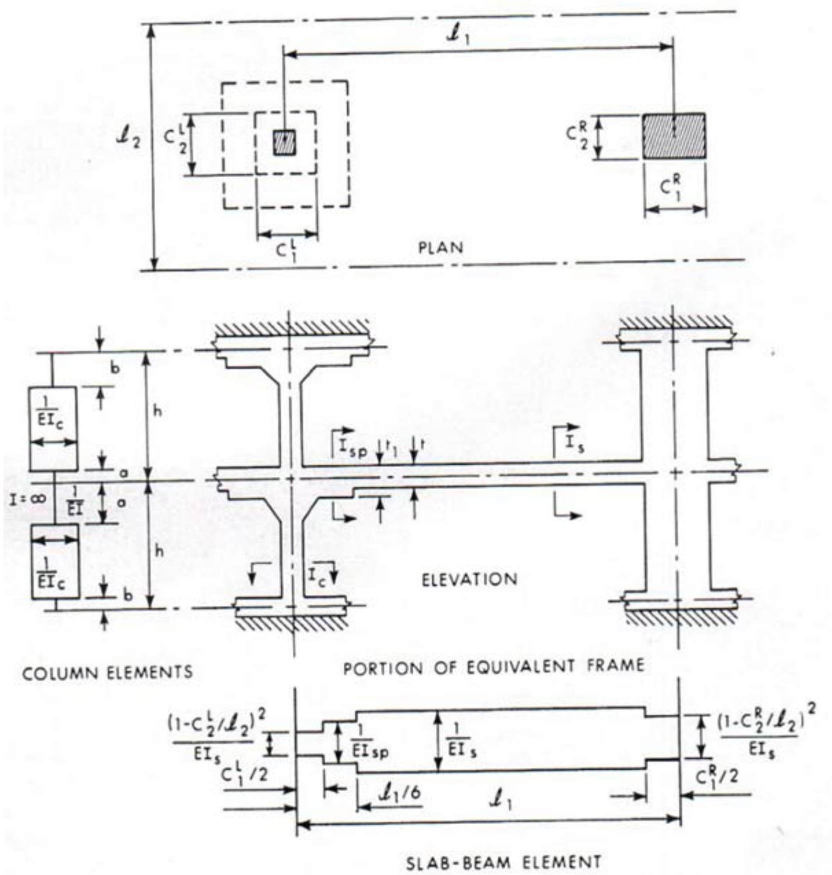
1. Assuming c_1/l_1 is equal to c_2/l_2 at each end (reducing the variables to the c_1/l_1 ratio at each end).
2. Assuming that c_1/l_1 and c_2/l_2 at far end are equal to the respective ratio at the near end (reducing the unknowns to c_1/l_1 and c_2/l_2 at the near end).

The second assumption showed more accurate results when compared with the exact values, and was used to develop the first part of the PCA notes tables to obtain the design constants. Tables were extended later to cover two other cases (when c_1/l_1 and c_2/l_2 at the near end equal to half c_1/l_1 and c_2/l_2 at the far end, and when c_1/l_1 and c_2/l_2 at the near end equal to double c_1/l_1 and c_2/l_2 at the far end).

Conclusions

The designer is required to take into account the non-prismatic nature of equivalent frames and to account for the variation in the moment of inertia along the axis of the slab-beam between supports.

With the increasing use of computers for two-way slab analysis by the Equivalent Frame Method, programs such as spSlab take into account the combination of the exact geometry of column elements, torsional members, and slab-beams to complete the structural analysis and determine the design moments without the need for design aids.



Portion of equivalent frame and element stiffness diagrams

References

Corley, N. G., and Jirsa, J. O., "Equivalent Frame Analysis for Slab Design," *ACI Journal*, Proceedings V. 67, No. 11, Nov. 1970, pp. 875-884.

Misic, J., "Comparative Study of Slab-Beam Systems," MS thesis, University of Alberta, Edmonton, July 1970.

ACI Committee 318, "building Code Requirements for Reinforced Concrete (ACI 318-71)," American Concrete Institute, Detroit, 1971.

Simmonds, S. H., and Misic, J., "Design Factors for the Equivalent Frame Method," *ACI Journal*, Proceedings V. 68, No. 11, Nov. 1971, pp. 825-831.