URE 13.17
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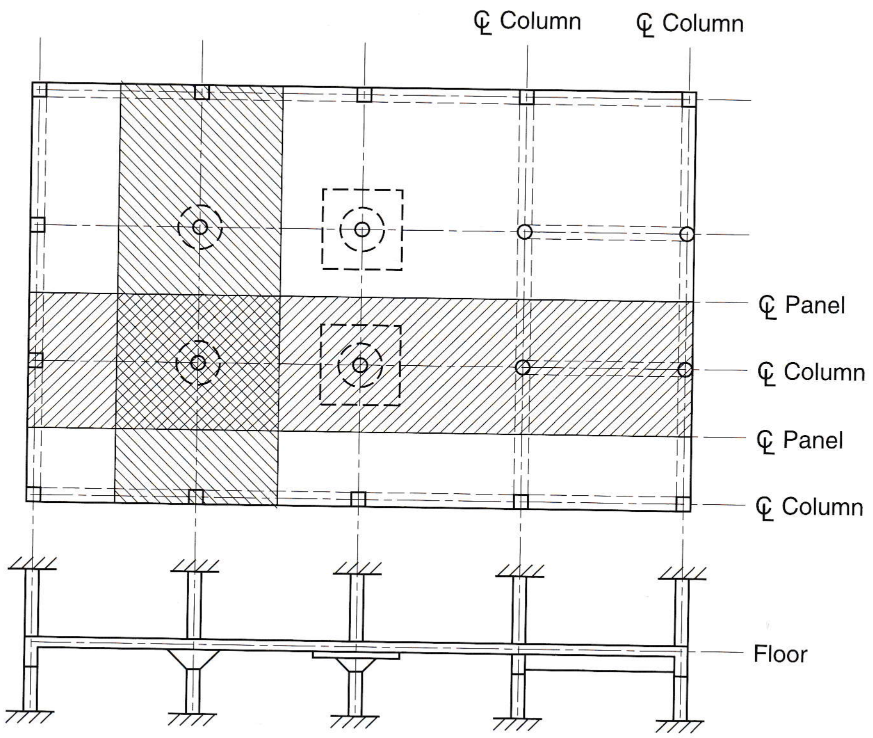
valent frame analysis.



For the beam strips, the first change from the midspan moment of inertia normally occurs at the edge of drop panels, if they are used. The next occurs at the edge of the column or column capital. While the stiffness of the slab strip could be considered infinite within the bounds of the column or capital, at locations close to the panel centerlines (at each edge of the slab strip), the stiffness is much less. According to ACI Code 13.7.3, from the center of the column to the face of the column or capital, the moment of inertia of the slab is taken equal to the value at the face of the column or capital, divided by the quantity $(1 - c_2/l_2)^2$, where c_2 and l_2 are the size of the column or capital and the panel width, respectively, both measured transverse to the direction in which moments are being determined.

Accounting for these changes in moments of inertia results in a member, for analysis, in which the moment of inertia varies in a stepwise manner. The stiffness factors, carryover factors, and uniform-load fixed-end moment factors needed for moment distribution analysis (see Chapter 12) are given in Table A.13*a* of Appendix A for a slab without drop panels and in Table A.13*b* for a slab with drop panels with a depth equal to 1.25 times the slab depth and a total length equal to one-third the span length.

c. The Equivalent Column

In the equivalent frame method of analysis, the columns are considered to be attached to the continuous slab beam by torsional members that are transverse to the direction of the span for which moments are being found; the torsional member extends to the panel centerlines bounding each side of the slab beam under study. Torsional deformation of these transverse supporting members reduces the effective flexural stiffness provided by

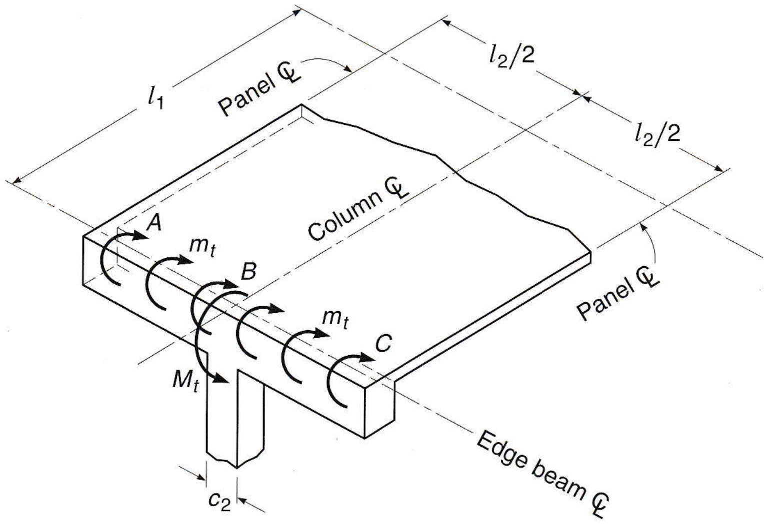


FIGURE 13.18
Torsion at a transverse supporting member illustrating the basis of the equivalent column.

the actual column at the support. This effect is accounted for in the analysis by use of what is termed an *equivalent column* having stiffness less than that of the actual column.

The action of a column and the transverse torsional member is easily explained with reference to Fig. 13.18, which shows, for illustration, the column and transverse beam at the exterior support of a continuous slab-beam strip. From Fig. 13.18, it is clear that the rotational restraint provided at the end of the slab spanning in the direction l_1 is influenced not only by the flexural stiffness of the column but also by the torsional stiffness of the edge beam AC. With distributed torque m_t applied by the slab and resisting torque M_t provided by the column, the edge-beam sections at A and C will rotate to a greater degree than the section at B, owing to torsional deformation of the edge beam. To allow for this effect, the actual column and beam are replaced by an equivalent column, so defined that the total flexibility (inverse of stiffness) of the equivalent column is the sum of the flexibilities of the actual column and beam. Thus

$$\frac{1}{K_{ec}} = \frac{1}{\Sigma K_c} + \frac{1}{K_t} \tag{13.9}$$

where K_{ec} = flexural stiffness of equivalent column
K_c = flexural stiffness of actual column
K_t = torsional stiffness of edge beam

all expressed in terms of moment per unit rotation. In computing K_c, the moment of inertia of the actual column is assumed to be infinite from the top of the slab to the bottom of the slab beam, and I_g is based on the gross concrete section elsewhere along the length. Stiffness factors for such a case are given in Table A.13c.

The effective cross section of the transverse torsional member, which may or may not include a beam web projecting below the slab, as shown in Fig. 13.18, is the same as defined earlier in Section 13.6c. The torsional constant C is calculated by Eq. (13.6) based on the effective cross section so determined. The torsional stiffness K_t can then be calculated by the expression

$$K_t = \sum \frac{9E_{cs}C}{l_2(1 - c_2/l_2)^3} \tag{13.10}$$