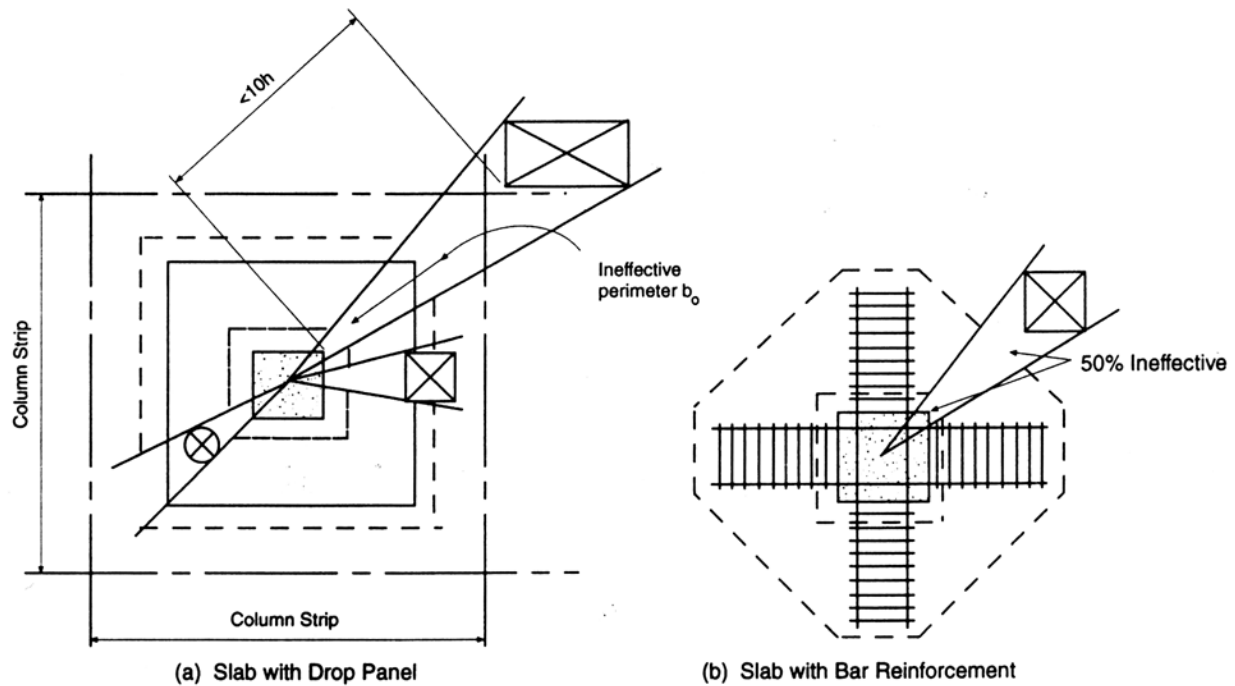


**Openings in Concrete Slab Systems**  
from Notes on ACI 318-99, Portland Cement Association, 1999

### 11.12.5 Openings in Slabs

The effect of openings (vertical holes through slabs) on the shear strength of slabs must be investigated when the openings are within the column strip areas of slabs or within middle strip areas when the openings are closer than 10 times the slab thickness ( $10h$ ) from a column. A reduction in shear strength is made by considering as ineffective that portion of the critical section  $b_o$  which is enclosed by straight lines projecting from the column centroid to the edges of the opening. Ineffective portions of critical sections  $b_o$  are illustrated in Fig. 18-10. For slabs with shear reinforcement, the ineffective portion of the perimeter  $b_o$  is one-half of that without shear reinforcement. The one-half factor is interpreted to apply equally to shearhead reinforcement and bar or wire reinforcement.



*Figure 18-10 Effect of Slab Openings on Shear Strength*

## 13.4 OPENINGS IN SLAB SYSTEMS

Openings of any size are permitted in slab systems without beams if special analysis indicates that both strength and serviceability of the slab system, considering the effects of the opening, are satisfied. Without special analysis, openings up to a certain size are permitted as illustrated in Fig. 18-11. The size of openings located within intersecting middle strip areas is unlimited. Within the area of the slab common to intersecting column

strips, size of openings is the most restrictive, due to their effect on slab shear strength or load transfer near slab-column connections. See discussion on effect of slab openings on shear strength (11.12.5) and Fig. 18-10. Without special analysis, size of openings within intersecting column strips is limited to one-sixteenth of the slab span length in either direction ( $1/8 (\ell/2) = \ell/16$ ). Within the slab area common to one column and one middle strip, opening size is limited to one-eighth the span length in either direction ( $1/4 (\ell/2) = \ell/8$ ).

The total amount of reinforcement required for the panel without openings, in both directions, must be maintained; reinforcement interrupted by any opening must be replaced, one-half on each side of the opening.

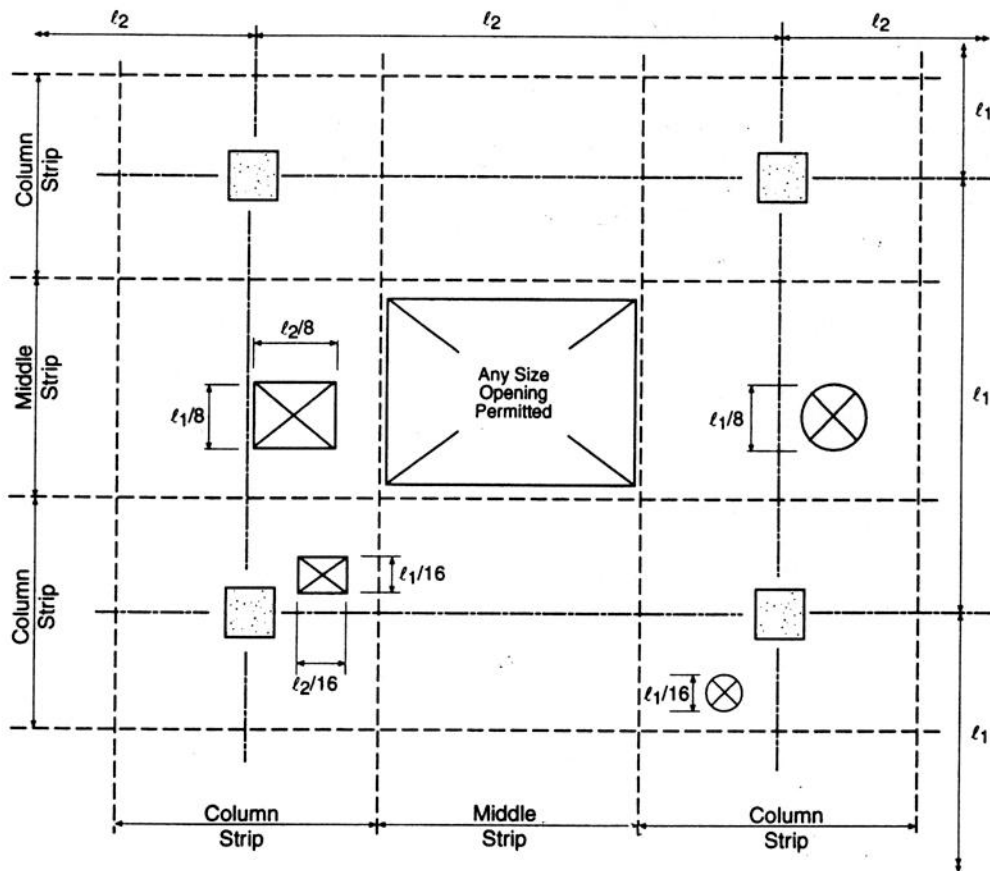


Figure 18-11 Openings in Slab Systems without Beams