

**ELEMENTS OF ARCHITECTURAL STRUCTURES:
FORM, BEHAVIOR, AND DESIGN**

ARCH 614

DR. ANNE NICHOLS

SPRING 2013

lecture
twenty four

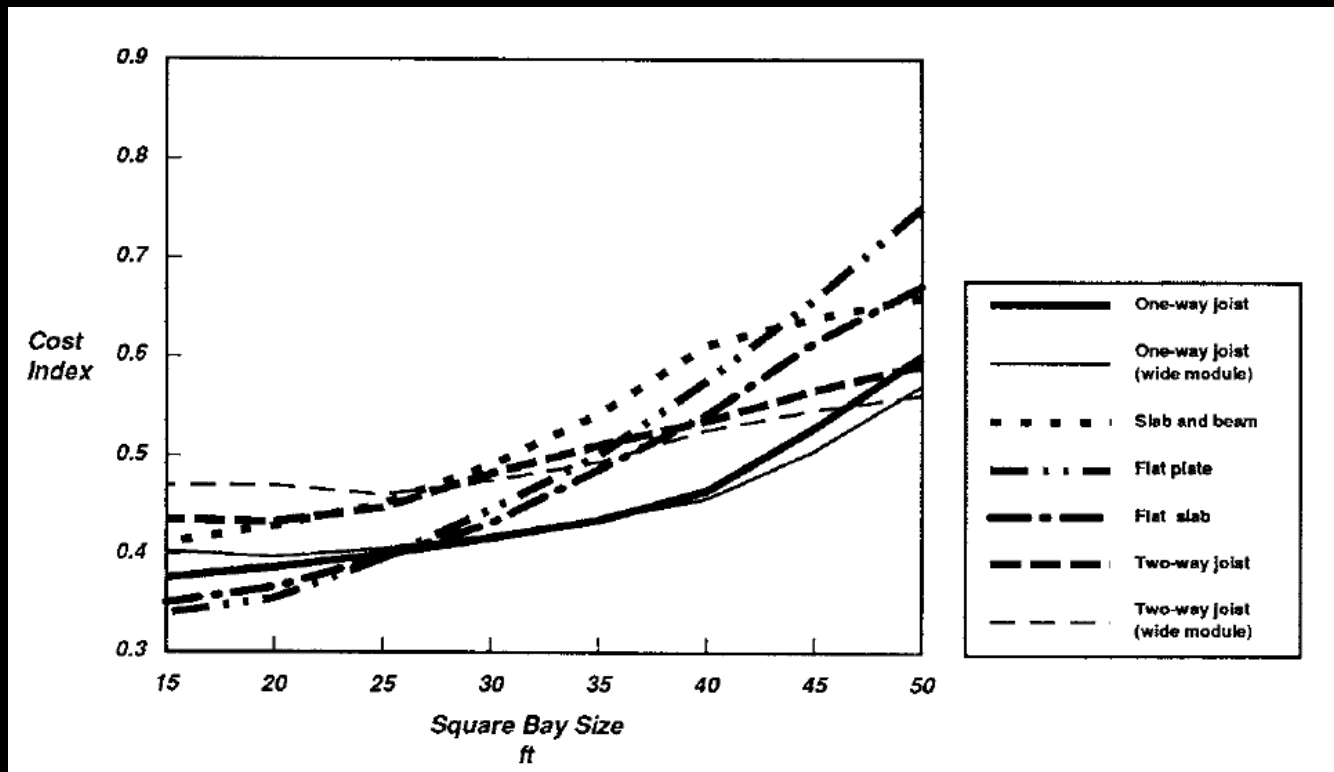


<http://nisee.berkeley.edu/godden>

**concrete construction:
flat spanning systems**

Reinforced Concrete Design

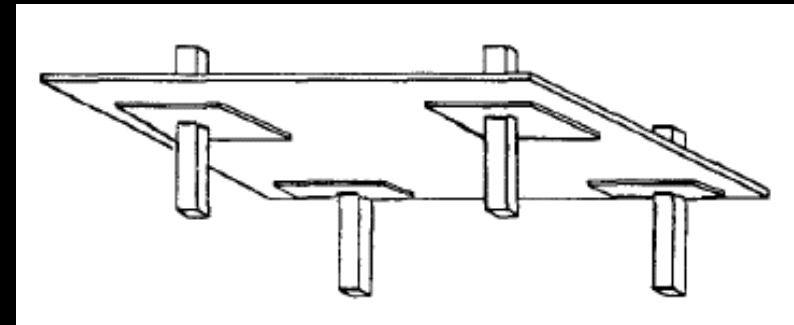
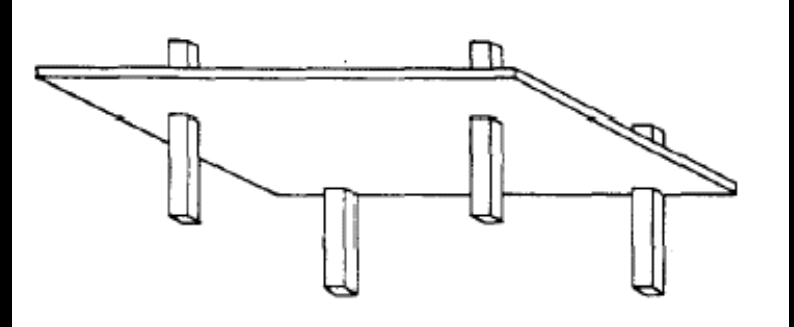
- economical & common
- resist lateral loads



Reinforced Concrete Design

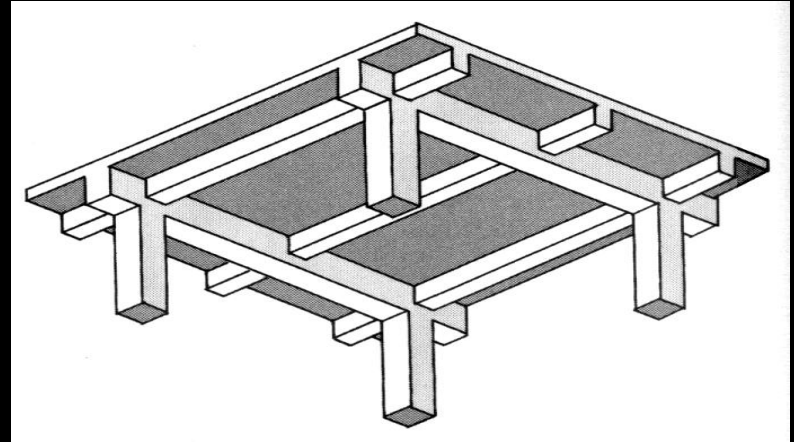
- *flat plate*
 - 5”-10” thick
 - simple formwork
 - lower story heights

- *flat slab*
 - same as plate
 - 2 ¼”–8” drop panels

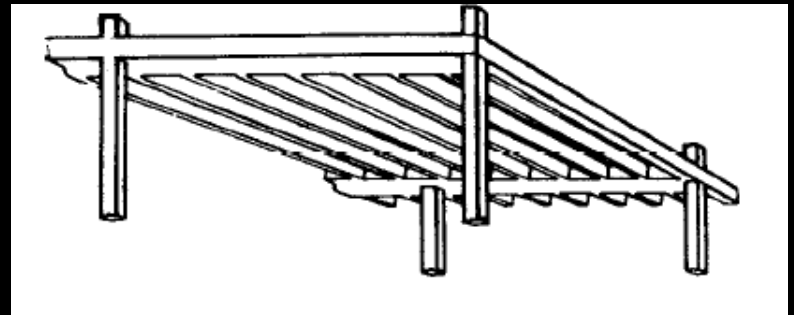


Reinforced Concrete Design

- *beam supported*
 - slab depth $\sim L/20$
 - 8"–60" deep
- *one-way joists*
 - 3"–5" slab
 - 8"–20" stems
 - 5"-7" webs

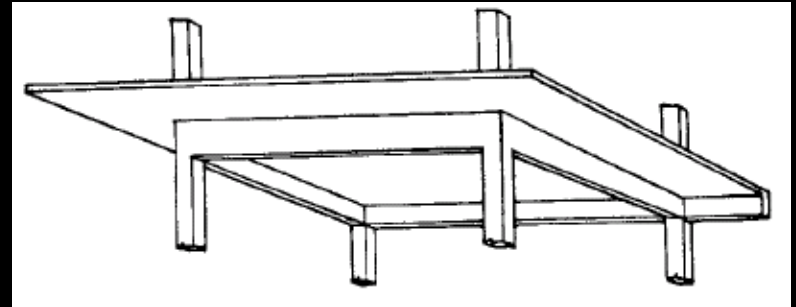
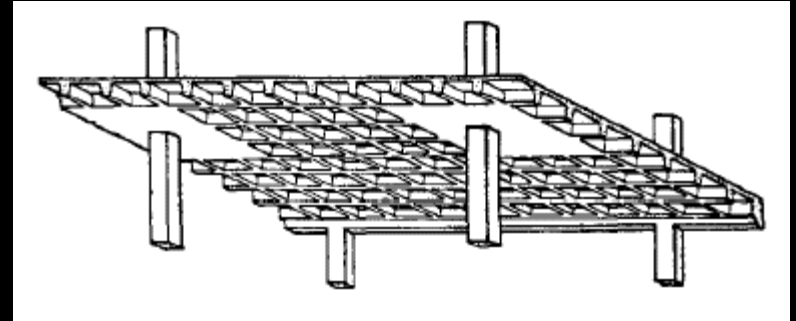


The Architect's Studio Companion



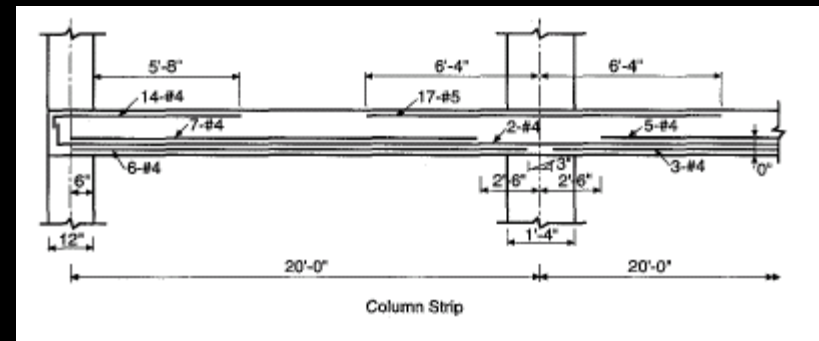
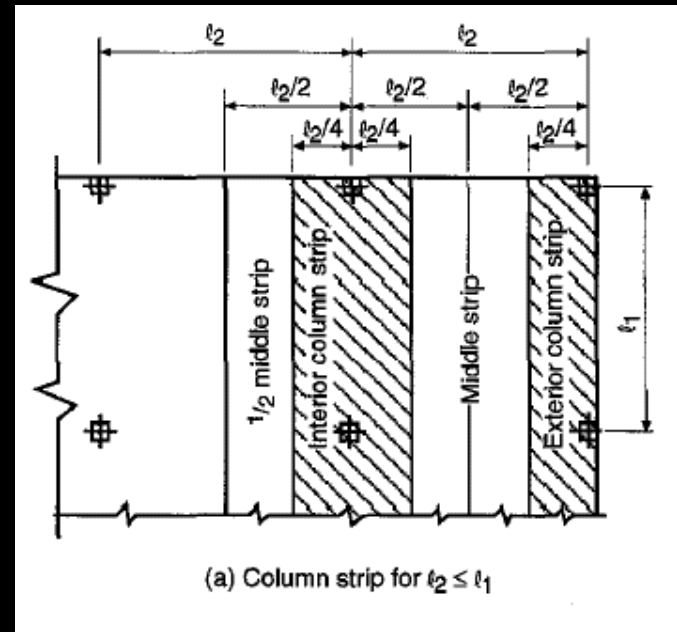
Reinforced Concrete Design

- *two-way joist*
 - “waffle slab”
 - 3”-5” slab
 - 8”-24” stems
 - 6”-8” webs
- *beam supported slab*
 - 5”-10” slabs
 - taller story heights



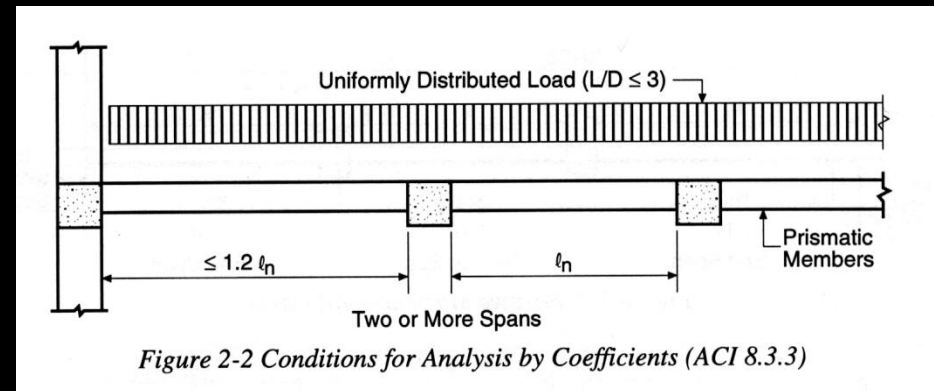
Reinforced Concrete Design

- *simplified frame analysis*
 - strips, like continuous beams
- *moments require flexural reinforcement*
 - top & bottom
 - both directions of slab
 - continuous, bent or discontinuous



Reinforced Concrete Design

- *one-way slabs (wide beam design)*
 - *approximate analysis for moment & shear coefficients*
 - *two or more spans*
 - *~ same lengths*
 - *w_u from combos*
 - *uniform loads with $L/D \leq 3$*
 - *l_n is clear span (+M) or average of adjacent clear spans (-M)*



Reinforced Concrete Design

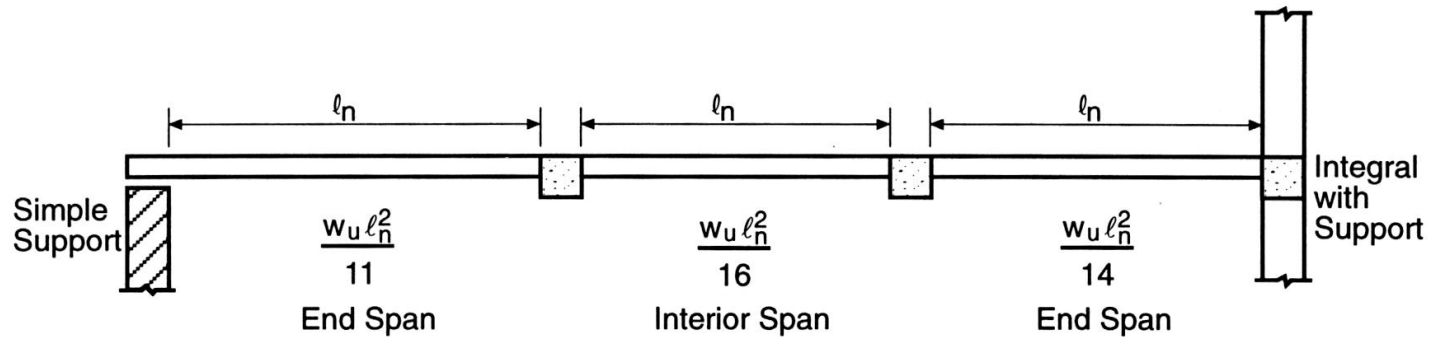


Figure 2-3 Positive Moments—All Cases

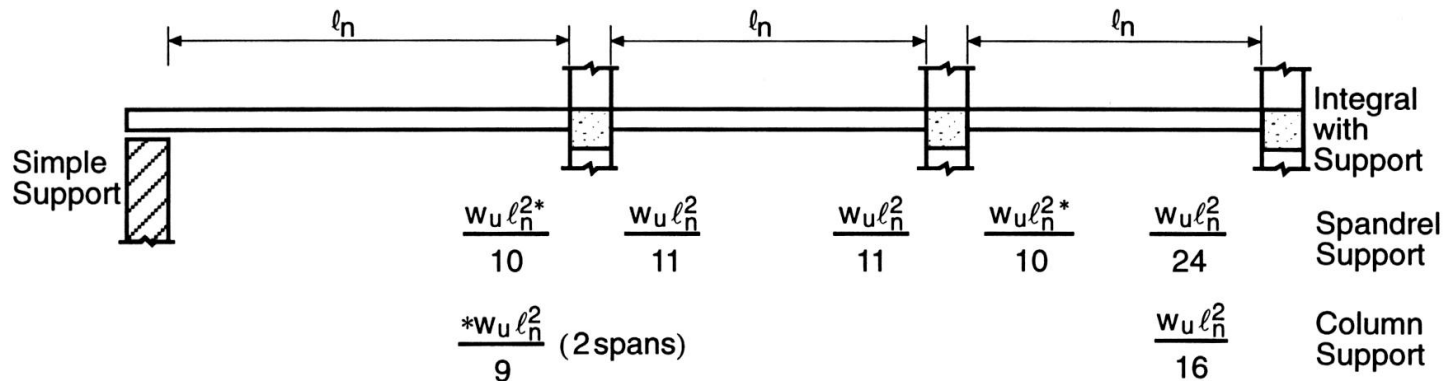
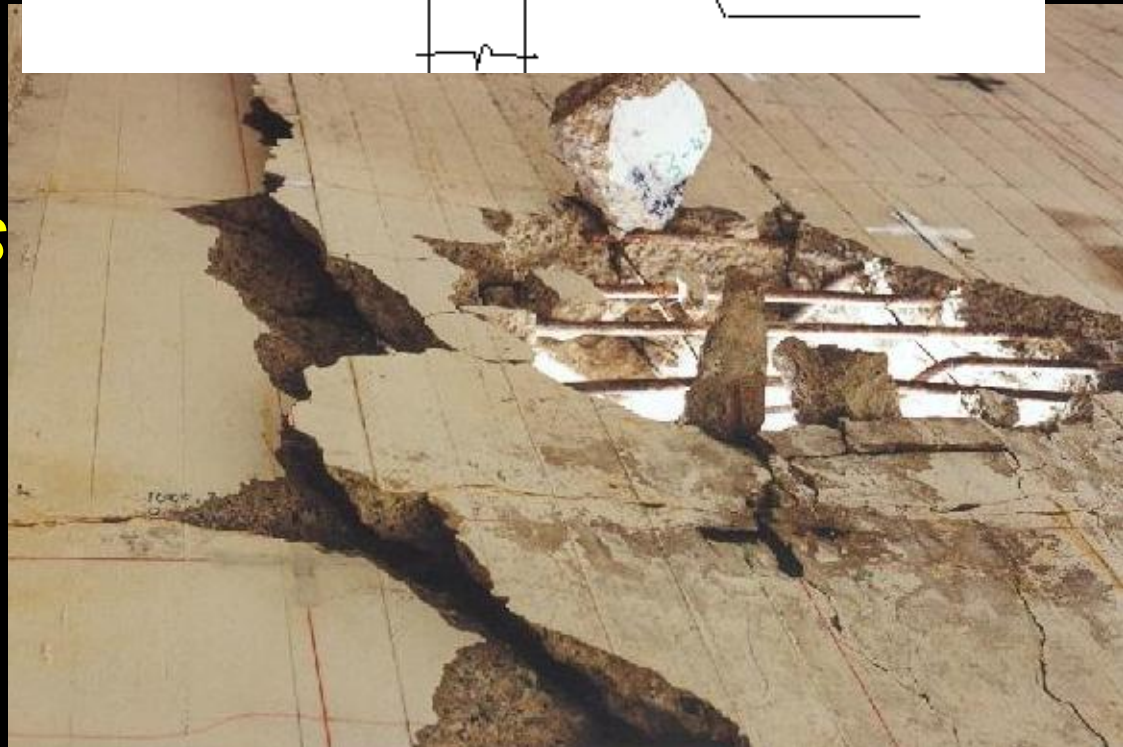
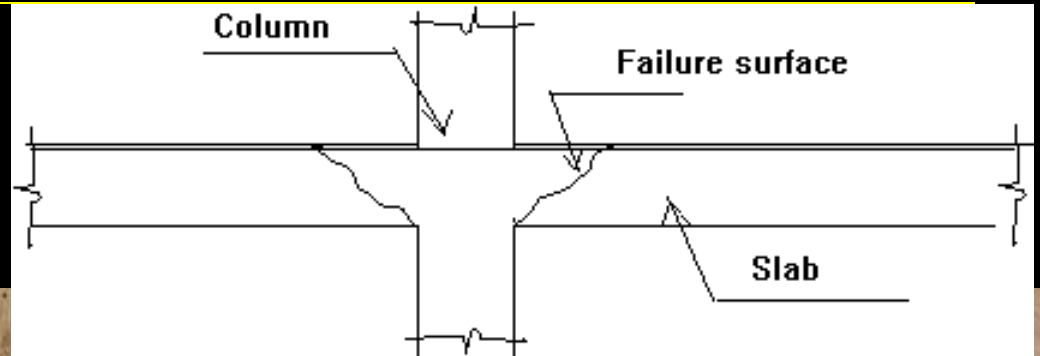


Figure 2-4 Negative Moments—Beams and Slabs

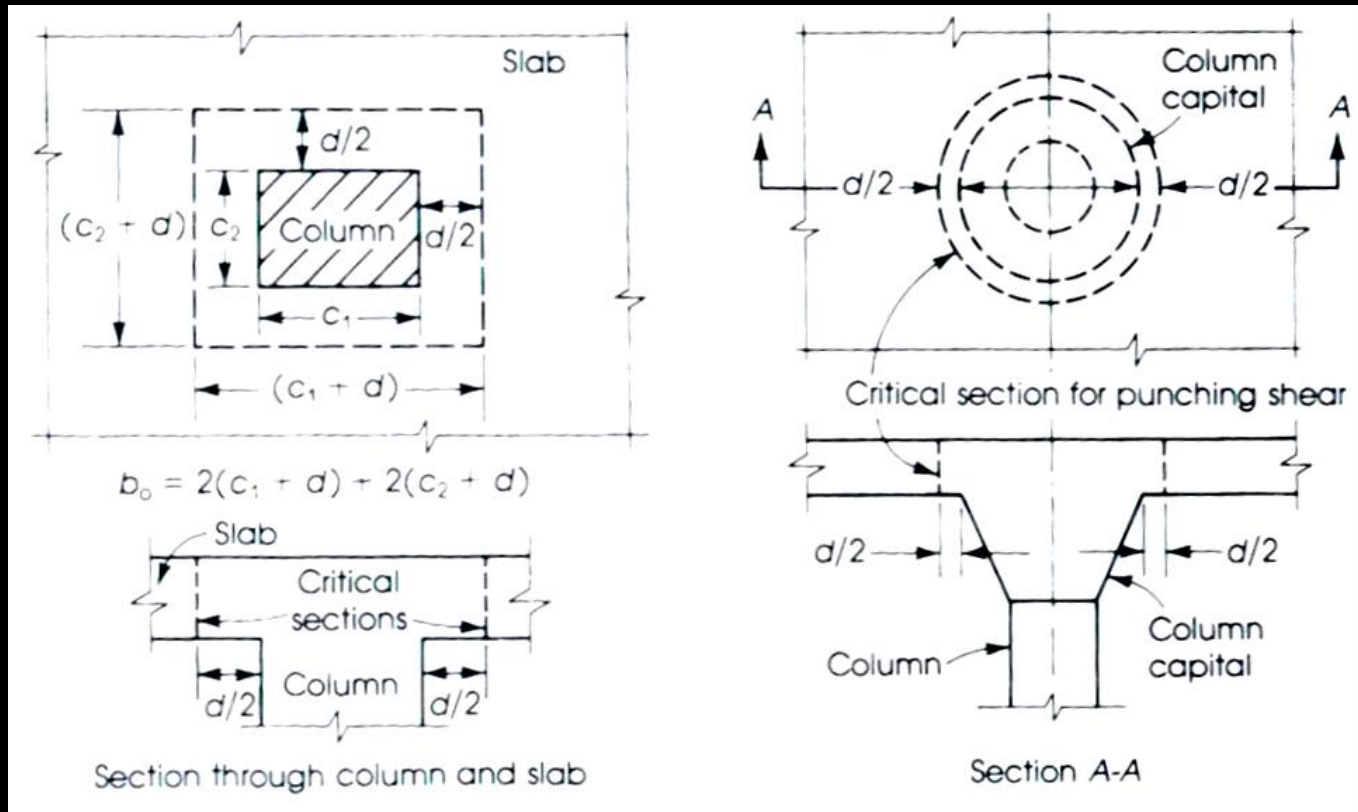
Shear in Concrete

- *at columns*
- *want to avoid stirrups*
- *can use shear studs or heads*



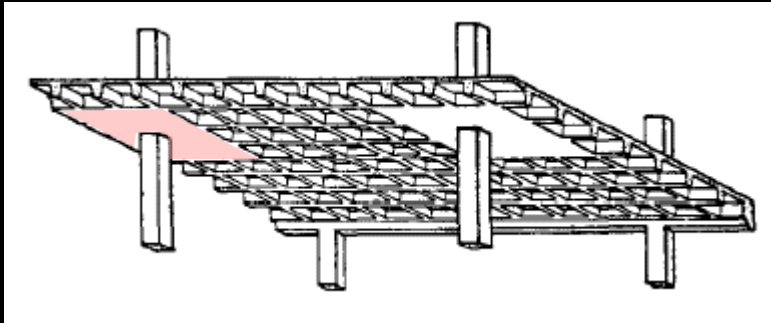
Shear in Concrete

- critical section at $d/2$ from
 - column face, column capital or drop panel



Shear in Concrete

- *at columns with waffle slabs*



Openings in Slabs

- careful placement of holes
- shear strength reduced
- bending & deflection can increase

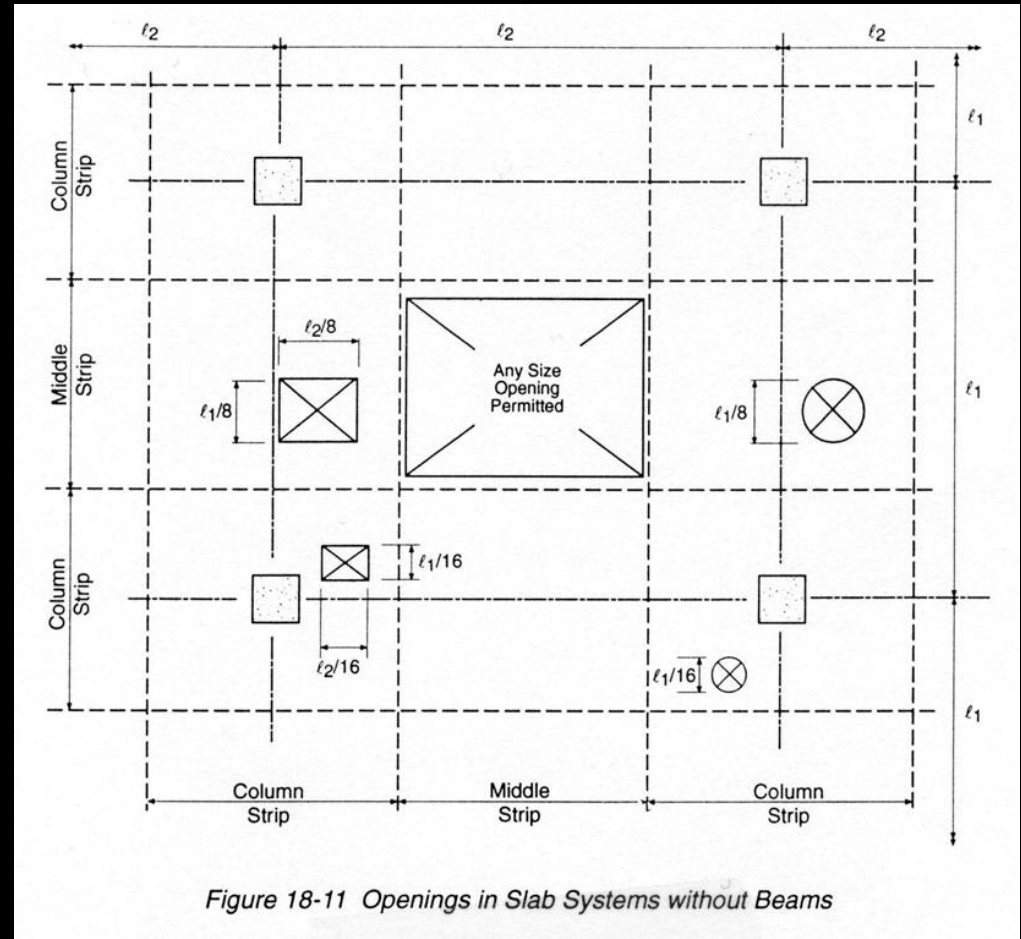
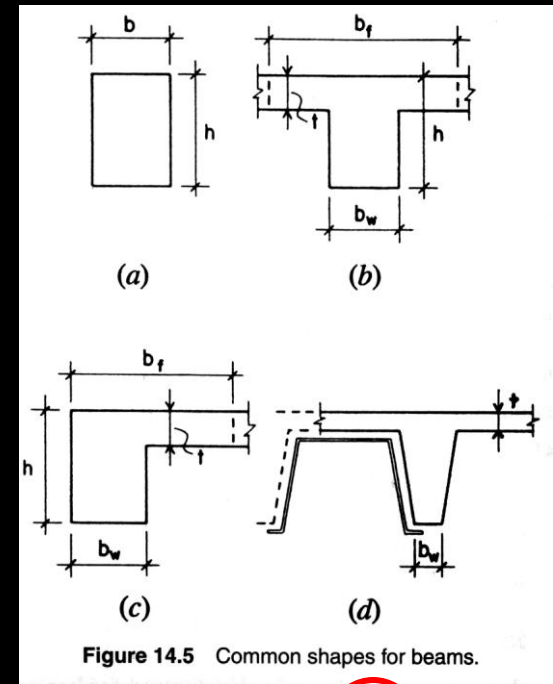


Figure 18-11 Openings in Slab Systems without Beams

General Beam Design

- f'_c & f_y needed
- usually size just b & h
 - even inches typical (forms)
 - similar joist to beam depth
 - $b:h$ of 1:1.5-1:2.5
 - b_w & b_f for T
 - to fit reinforcement + stirrups
- slab design, t
 - deflection control & shear



$$S = \frac{bh^2}{6}$$

General Beam Design (cont'd)

- *custom design:*
 - *longitudinal steel*
 - *shear reinforcement*
 - *detailing*

