ELEMENTS OF ARCHITECTURAL STRUCTURES:
FORM, BEHAVIOR, AND DESIGN
ARCH 614
DR. ANNE NICHOLS
SPRING 2019

lecture
twenty four

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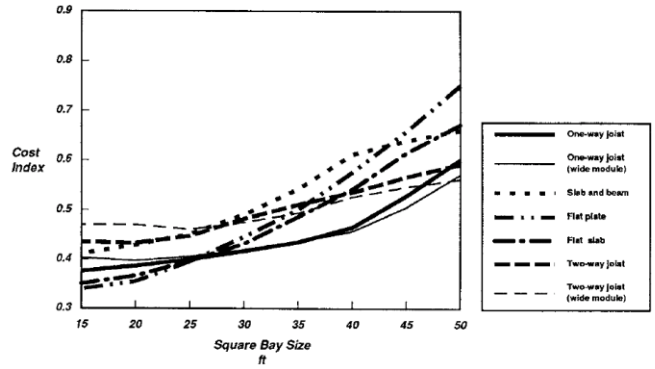
concrete construction: flat spanning systems

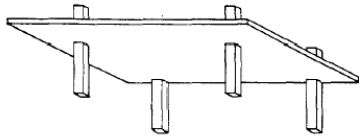
Reinforced Concrete Design

- *economical & common*
- *resist lateral loads*

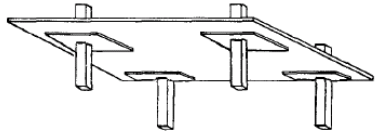


Reinforced Concrete Design

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

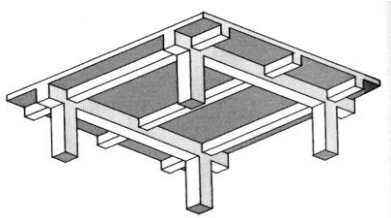


- *flat slab*
  - *same as plate*
  - *2 ¼”–8” drop panels*



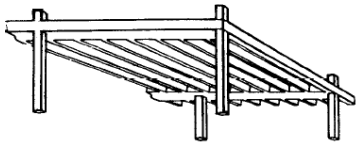
Reinforced Concrete Design

- *beam supported*
  - *slab depth ~ L/20*
  - *8”–60” deep*



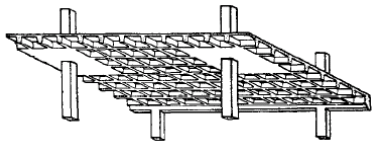
The Architect’s Studio Companion

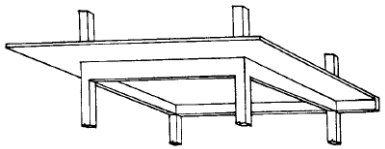
- *one-way joists*
  - *3”–5” slab*
  - *8”–20” stems*
  - *5”-7” webs*



Reinforced Concrete Design

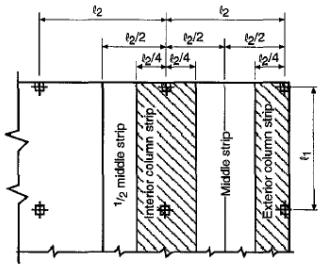
- *two-way joist*
  - *"waffle slab"*
  - *3"-5" slab*
  - *8"-24" stems*
  - *6"-8" webs*
- *beam supported slab*
  - *5"-10" slabs*
  - *taller story heights*



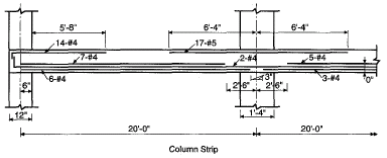


Reinforced Concrete Design

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



(a) Column strip for $\ell_2 \le \ell_1$



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 $\le$ 3*
  - *ℓ_n is clear span (+M) or average of adjacent clear spans (-M)*

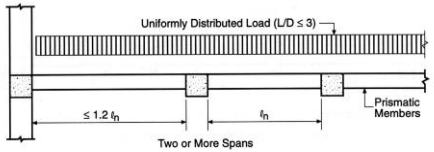


Figure 2-2 Conditions for Analysis by Coefficients (ACI 8.3.3)

Reinforced Concrete Design

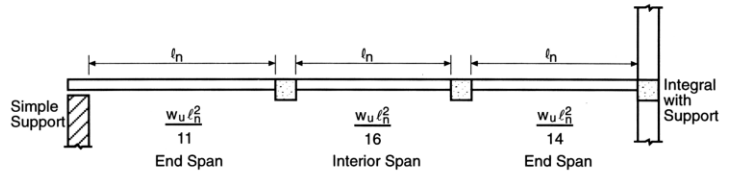


Figure 2-3 Positive Moments—All Cases

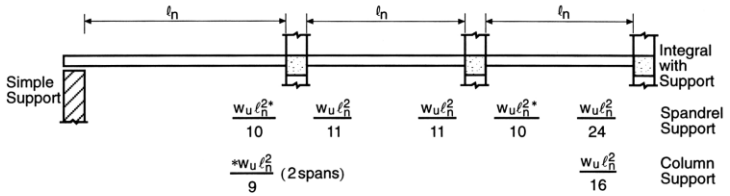
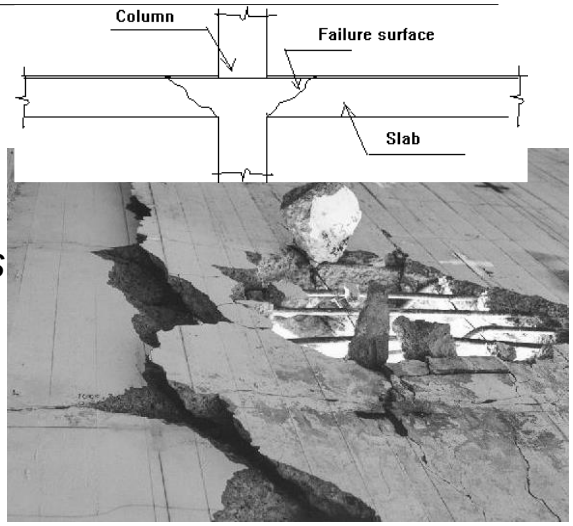


Figure 2-4 Negative Moments—Beams and Slabs

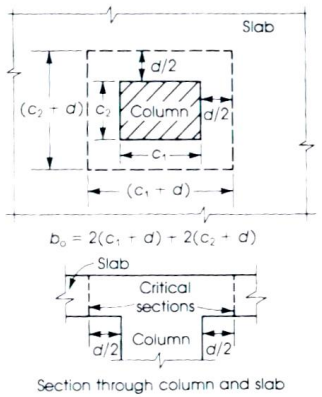
Shear in Concrete

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

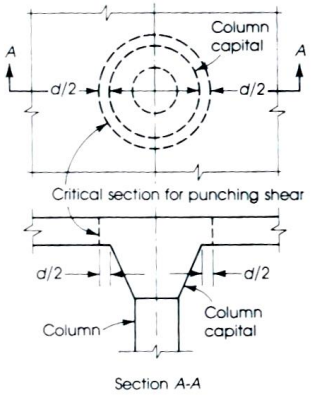


Shear in Concrete

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



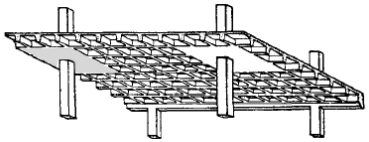
Section through column and slab



Section A-A

Shear in Concrete

- *at columns with waffle slabs*



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Openings in Slabs

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

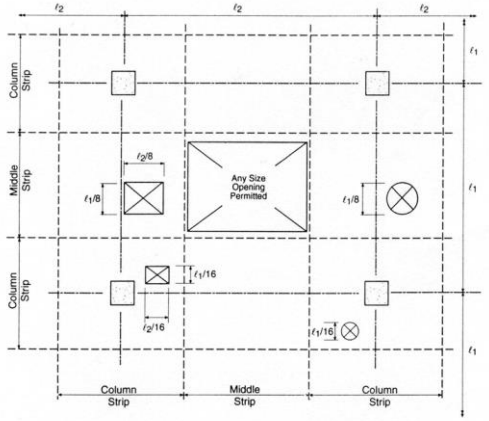

Figure 18-11 Openings in Slab Systems without Beams

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

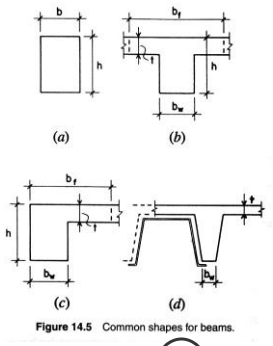

Figure 14.5 Common shapes for beams.

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

General Beam Design (cont'd)

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