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

• 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
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)

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
Shear in Concrete

- at columns with waffle slabs
Openings in Slabs

- careful placement of holes
- shear strength reduced
- bending & deflection can increase
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
  – $b_w$ & $b_t$ for $T$
  – to fit reinforcement + stirrups

• slab design, $t$
  – deflection control & shear

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

Figure 14.5  Common shapes for beams.
General Beam Design (cont’d)

• custom design:
  – longitudinal steel
  – shear reinforcement
  – detailing