concrete construction: 
T-beams & slabs

T sections
- two areas of compression in moment possible
- one-way joists
- effective flange width

Systems
- beams separate from slab
- beams integral with slab
  - close spaced
- continuous beams
- no beams

T sections
- negative bending: min $A_s$, larger of:
  $A_s = \frac{6\sqrt{f_c}}{f_y} (b_w d) \quad A_s = \frac{3\sqrt{f_c}}{f_y} (b_f d)$
- effective width (interior)
  - $L/4$
  - $b_w + 16t$
  - center-to-center of beams
**T sections**

- usual analysis steps
- 1. assume no compression in web
- 2. design like a rectangular beam
- 3. needs reinforcement in slab too
- 4. also analyze for negative moment, if any

**One-Way**

- Joists
  - wide pans
  - 5’, 6’ up
  - light loads & long spans
  - one-leg stirrups

- Compression Reinforcement
  - doubly reinforced
  - negative bending
  - two compression forces
  - bigger $M_n$
  - control deflection
  - increase ductility
  - needs ties because of buckling
Compression Reinforcement

- **analysis**
  - \( A_s \) & \( A_s' \)
  - \( T = C_c + C_s \)
  - \( T = A_s f_y \)
  - \( C_s = A_s' (f'_{s} - 0.85f''_{c}) \)
  - \( C_c = 0.85f''_{c} ba \) with \( a = \beta_1 c \)
  - \( f_s' \) not known, so solve for \( c \) (n.a.)
  - \( f_s' \) < \( f_y \)?
  - \( M_n = T(d-a/2)+C_s(d-d') \)

Slabs

- **one way behavior – like beams**
- **two way behavior – more complex**

Slab Design

- **one unit wide “strip”**
- **with uniform loads**
  - like “wide” beams
  - moment / unit width
  - uniform curvature
- **with point loads**
  - resisted by stiffness of adjacent strips
  - more curvature in middle

Slab Design

- **min thickness by code**
- **reinforcement**
  - bars, welded wire mesh
  - cover
  - minimum by steel grade
    - 40-50:
      \[ \rho = \frac{A_s}{bt} = 0.002 \]
    - 60:
      \[ \rho = \frac{A_s}{bt} = 0.0018 \]
One-Way Slabs

- $A_s$ tables
- max spacing
  - $\leq 3(t)$ and 18”
  - $\leq 5(t)$ and 18” – temp & shrinkage steel
- no room for stirrups

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<th>10</th>
<th>11</th>
<th>12</th>
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Precast

- prestressed
  - PCI Design Handbook
  - double T’s
  - hollow core
  - L’s
- topping
- load tables