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: \( A_s \geq \frac{6\sqrt{f_c'}}{f_y} (b_w d) \)
  \( A_s = \frac{3\sqrt{f_c'}}{f_y} (b_f d) \)
- effective width (interior)
  - \( \frac{L}{4} \)
  - \( b_w + 16t \)
  - center-to-center of beams

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![Diagram of T-beams and slabs](image_url)
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**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

\[
a = \beta_1 c \\
0.85f'c
\]

**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

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**One-Way**

- **Joists**
  - standard stems
  - 2.5” to 4.5” slab
  - ~30” widths
  - reusable forms

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Compression Reinforcement

• analysis
  – \( A_s \) & \( A_s' \)
  – \( T = C_c + C_s \)
  – \( T = A_s f_y \)
  – \( C_s = A_s' (f'_s - 0.85 f''_c) \)
  – \( C_c = 0.85 f'_c b a \) 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

![Diagram of One-Way Slabs]

<table>
<thead>
<tr>
<th>Bar size (in.)</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
<th>16</th>
<th>17</th>
<th>18</th>
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<td>0.15</td>
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<td>0.34</td>
<td>0.33</td>
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<td>0.31</td>
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</tbody>
</table>

Precast

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

![Diagram of Precast Slabs]

<table>
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<tr>
<th>Load (psi)</th>
<th>Span (ft)</th>
<th>2 in. Normal Weight Topping</th>
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<tr>
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<td>1.30</td>
</tr>
<tr>
<td>60</td>
<td>8</td>
<td>1.40</td>
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</tbody>
</table>

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