Systems

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

T sections

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

T sections

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

- $T = C_C + C_s$
- $T = A_s f_y$
- $C_s = A_s' f_y$
- $M_n = T(d-a/2) + C_s(d-d')$

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**FLANGEforms**

FLANGEforms are available in standard 2–3 or 3–4 foot panels. These forms are among the most popular because of their flexibility to accommodate variation in width. They are especially effective for projects with many cross-sections and provide consistent quality. They are also available in 4 foot panels for projects requiring large panels. They are also offered for projects of standard size and for projects with varied finishes. FIns are available in a variety of finishes. FLANGEforms also offer an option for using concrete topping. They are especially effective for projects of smaller size and for projects with varied finishes. FIns are also offered for projects where the structure is not required to be a complete load bearing element. The forms can be ordered in widths or 5 inches or 3–5 inch thickness. The casting pitch provides flexibility to meet a wide range of finishes. FLANGEforms are also available in 4 foot panels for projects requiring large panels. They are also available in standard size and for projects with varied finishes. FLANGEforms are also offered for projects where the structure is not required to be a complete load bearing element. The forms can be ordered in widths for 5 inches or 3–5 inch thickness. The casting pitch provides flexibility to meet a wide range of finishes.
Compression Reinforcement

- needs ties because of buckling
- simplified method in text assumes
  - \( A_s' = 0.3A_s \)
  - \( M_n > M_u/\phi \)
  - \( f_s' = \frac{1}{2}f_y \)
  - \( a = 2d' \)
  - so
  \[
  A_s = \frac{M_u/\phi}{f_y(d - d')}
  \]

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

*not in note set

**Table 3-7 Areas of Bars per Foot Width of Slab—$A_s$ ($in.^2/ft$)**

<table>
<thead>
<tr>
<th>Bar size</th>
<th>6</th>
<th>7</th>
<th>8</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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<tbody>
<tr>
<td>A3</td>
<td>0.22</td>
<td>0.19</td>
<td>0.17</td>
<td>0.15</td>
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<td>0.12</td>
<td>0.11</td>
<td>0.10</td>
<td>0.10</td>
<td>0.09</td>
<td>0.08</td>
<td>0.08</td>
<td>0.07</td>
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<td>0.34</td>
<td>0.27</td>
<td>0.24</td>
<td>0.22</td>
<td>0.20</td>
<td>0.18</td>
<td>0.17</td>
<td>0.16</td>
<td>0.15</td>
<td>0.13</td>
<td>0.12</td>
<td>0.10</td>
</tr>
<tr>
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<td>0.41</td>
<td>0.37</td>
<td>0.34</td>
<td>0.31</td>
<td>0.28</td>
<td>0.25</td>
<td>0.23</td>
<td>0.22</td>
<td>0.21</td>
<td>0.19</td>
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<td>0.59</td>
<td>0.53</td>
<td>0.48</td>
<td>0.44</td>
<td>0.41</td>
<td>0.38</td>
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