One-Way Solid Slabs

Slabs

- They are structural elements with a small thickness comparable to their dimensions in the other two directions.
- Used for floors, roofs and bridge decks.
- Maybe supported by edge beams or walls, or they maybe supported directly by columns; flat slab.
One-Way & Two-Way Slabs

- If the load is transferred in one direction; it is a one-way slab.

- When the load is transferred in two directions; then it is a two-way slab.

- Only a strip with 1m width is considered for the design.

Definition of One-Way slabs

- Slabs supported only by two opposite edges

- Slabs supported at four edges with a rectangularity ratio; \( r > 2 \)

\[
r = \frac{m_b}{m_a}
\]

- \( m_a \) & \( m_b \) = 1 for simple span
- = .87 for spans continuous from one end only
- = .76 for spans continuous from both ends

When the slab is supported by walls or \( LL > 5kN/m^2 \); \( m_a = m_b = 1 \)
Effective Span

\[ L = \min \left\{ \max \left( \frac{L_n + t_e}{1.05xL_n}, \frac{C.L. - C.L.(L_{cl})}{L_n} \right) \right\} \]

For cantilevers

\[ L = \min \left\{ \frac{L_n + t_e}{edge - C.L.(L_{cl})} \right\} \]

Minimum Thickness

- **Egyptian Code E203 – 2010; table (4-10) page 4-51 & page 6-4:**

<table>
<thead>
<tr>
<th>Support condition</th>
<th>Simply supported</th>
<th>Continuous one end</th>
<th>Continuous both ends</th>
<th>cantilever</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear span ((L_n/t_e))</td>
<td>25</td>
<td>30</td>
<td>36</td>
<td>10</td>
</tr>
<tr>
<td>Effective span ((L/t_e))</td>
<td>30</td>
<td>35</td>
<td>40</td>
<td>10</td>
</tr>
</tbody>
</table>

- For spans less than 10m or cantilevers less than 2m long.
- St. 400/600; for other grades divide values by \( \frac{0.4 + \frac{f_s}{650}}{f_s} \)
- \( t_s \geq 80\text{mm} \) for static loads & \( t_s \geq 120\text{mm} \) for dynamic loads
Design Steps

- **Loading:**
  - **Dead loads:**
    - Own weight = $\gamma_c t_s$
      \[\gamma_c = 25 \text{kN/m}^3\]
    - Flooring
      Consider weight of tiles, sand and mortar $\approx 2 \text{kN/m}^2$
  - **Live Loads:**
    - Code specifies LL value according to the building usage.

Design Steps

- **Cases of Loading:**
  - When spans do not allow for using code coefficients, cases of loading should be utilized to get the bending moment envelope
    - $W_{\text{max}} = 1.4 \text{ D.L.} + 1.6 \text{ L.L.}$
    - $W_{\text{min}} = 0.9 \text{ D.L.}$

For maximum bending moment in Span 2

For maximum bending moment at support B
Calculate Bending Moment

- Two spans
  - When $LL \leq DL$, and the difference between spans is not more than 20%; then the bending moment could be calculated as following.

  - $W = w_u$ for limit state design method.
  - $w = w$ for allowable stresses design method.

- More than two spans
  - Spans differences are not more than 20%
  - $LL \leq DL$
Design of Reinforcement

- \( d = t_s - 20\text{mm} \)
- \( A_{s\text{min}} = \frac{0.6}{f_y} bd \geq \begin{cases} 0.25 \times b x d \; \text{mild steel} \; f_y = 240 & 280 N/mm^2 \\ 0.15 \times b x d \; \text{high grade} \; f_y = 360 & 400 N/mm^2 \end{cases} \)
- Design for section at support
- Design for section at mid-span
  - \( R_i = \frac{M_s}{f_w bd^2} \)
  - Get \( \omega \) from curves
  - \( A_s = \omega \frac{f_w bd}{f_y} \)

Reinforcement

- 1/3 reinforcement should be straight.
- Distribution reinforcement \( \approx 20\% \) of main reinforcement.
- Bent-up reinforcement @ \( l_w/5 \) and extend to \( l_w/4 \) in the next span.
- Maximum spacing of rebars \( \leq 200\text{mm} \).
Reinforcement

- Min. bar diameter is 6mm for straight rebars & 8mm for bent-up rebars.

- For $ts \geq 160\text{mm}$; use top reinforcement mesh with $As \approx 20\%$ main $As$ & minimum $5\phi 8/\text{m}^2$ for mild steel ($5\phi 6/\text{m}^2$ for high tensile).

One-Way Solid Slabs Example
Example

- **Materials**
  - $F_{cu} = 25N/mm^2$
  - St. 360/520

- **Loading**
  - Flooring 2kN/m²
  - L.L. 2kN/m²

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Using Design Aids (cont’d)

![Design Chart for Sections Subjected to Simple Bending](image-url)