Lecture-02 (After Mid Term) ; Page-01:

Book: CH # 13 14-05-2020

SLAB: It is basically a horizontal two dimensional structural member which can resist both horizontal and gravity loads.

→ It is designed for bending, shear and torsion at the corners.

→ Minimum thickness of slab in residential construction is 4 inches. However, 5" to 6" is recommended if the concrete will receive occasional heavy loads.

Types: Two types of Slab:

1- One Way SLAB

→ If the ratio of length to width of one slab Panel is larger than '2', it will be treated as one way slab

→ $\frac{L}{W} > 2$

→ Load is transferred in one direction

→ It has supports on the two opposite sides.

2- Two Way SLAB.

→ If the ratio of length to width of one slab Panel is less than or, equal to '2', it is Known as Two-Way Slab.

→ $\frac{L}{W} \leq 2$.

→ Load is transferred in both directions

→ It has supports on all four sides.

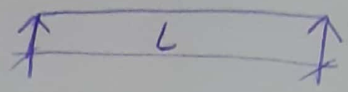
Types of Reinforcement in SLAB: Two-Types

1- Main Reinforcement

2- Distributed/Shrinkage/Temperature/Minimum Reinforcement.

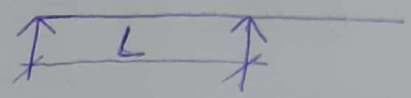
Minimum thickness of different types of SLAB:

1- Simply Supported SLAB: $t_{min} = \frac{L}{20}$



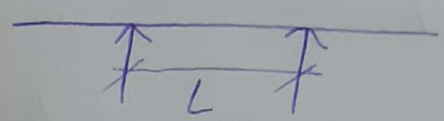
2- One Side Overhanging Slab:

$t_{min} = \frac{L}{24}$

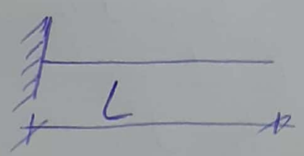


3- Both Side Overhanging SLAB:

$t_{min} = \frac{L}{28}$



4- Cantilever SLAB: $t_{min} = \frac{L}{10}$



Note: Above four formulas are applicable only if the value of f_y = 60 ksi or, 60000 Psi

If Other than Grade-60 steel is used, then the following factor will be multiplied with each formula mentioned above for minimum thickness of slab.

$$\text{Factor} = \left(0.4 + \frac{f_y}{100}\right)$$

Here, the value of 'f_y' will always be in ksi

Minimum Area of Steel Required for different Grades:

1- $As_{min} = 0.002 * b * t$ → (For Grade 40 & 50 steel)

2- $As_{min} = 0.0018 * b * t$ → (For Grade 60 steel)

Spacing Requirements:

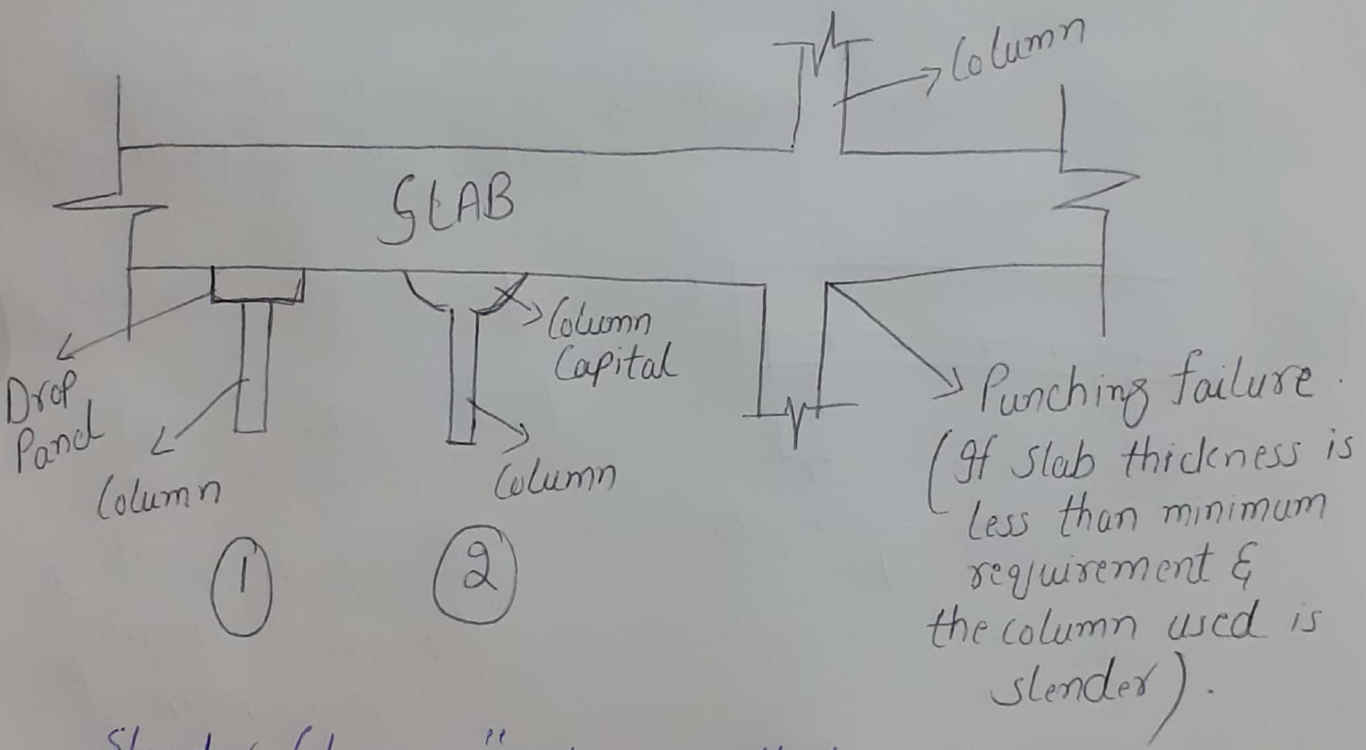
1- Spacing for Main Steel $\ngtr$ 3*t or, 18".

2- Spacing for distribution Steel $\ngtr$ 5*t or, 18".

Flat Slab and Flat Plate:

Flat Slab → When slab is directly resting on columns

Flat Plate → When slab comes in contact with beams.

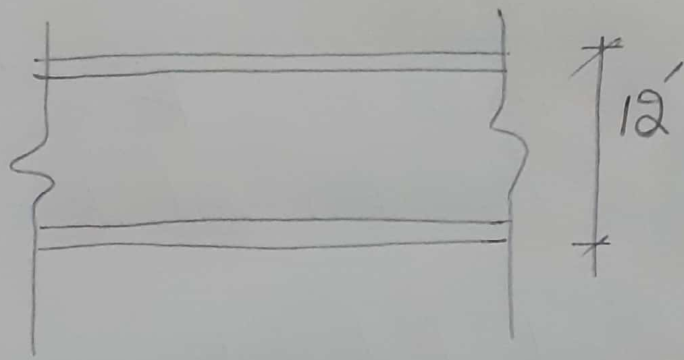


Slender Column: "When Length to width ratio of column is greater than 12".

Design Problem: Design a 12 ft. simply supported slab to carry a uniform D.L of 120 Psf (excluding self weight) and a uniform L.L of 100 Psf.

Use f'_c = 3ksi and f_y = 60 ksi.

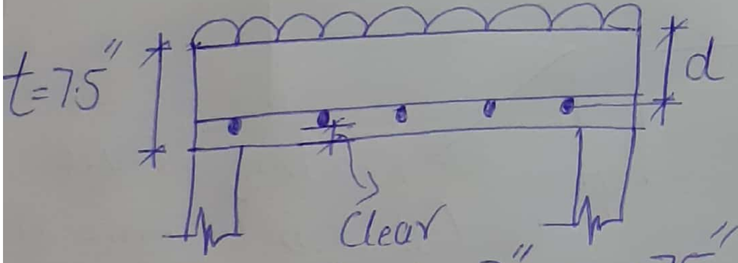
Solution:



Step-01: Minimum thickness.

$$t_{min} = \frac{L}{20} = \frac{12}{20} * 12 = 7.2 \approx 7.5''$$

Step-02: Effective Depth: (Distance from top of slab to the center of Main bars)



$$d = t - \text{Clear Cover} - \frac{1}{2}(d_{M.B})$$

$$d = 7.5 - 0.75 - \frac{1}{2}\left(\frac{4}{8}\right)$$

Let Say we are using #4 bar for Main Reinforcement.

$$d = 6.5''$$

Step-03: Self wt. of Slab $= \frac{t}{12} \times \gamma_{Concrete}$

$$= \frac{7.5}{12} \times 150 = 93.75 \text{ Psf}$$

Step-04: Total factored load:

$$W_u = 1.2 * D.L + 1.6 * L.L$$

$$W_u = 1.2 * (120 + 93.75) + 1.6 * (100) = 416.5 \text{ Psf} = 0.4165 \text{ Ksf}$$

Step-05: Ultimate Moment:

$$M_u = \frac{W_u * l^2}{8} = \frac{0.4165 * (12)^2}{8} * 12 = 89.96\,K''.$$

Step-06: Area of Steel for Main Bars by Trial and Repeat Method:

Trial # 01: Let $a = 0.2 * t = 0.2 * 7.5 = 1.5''$

$$A_s = \frac{M_u}{\phi * f_y * \left(d - \frac{a}{2}\right)} = \frac{89.96}{0.90 * 60 * \left(6.5 - \frac{1.5}{2}\right)} = 0.29\ in^2/ft$$

Trial # 02:

$$a = \frac{A_s * f_y}{0.85 * f'_c * b} = \frac{0.29 * 60}{0.85 * 3 * 12} = 0.57''.$$

$$A_s = \frac{M_u}{\phi * f_y * \left(d - \frac{a}{2}\right)} = \frac{89.96}{0.90 * 60 * \left(6.5 - \frac{0.57}{2}\right)} = 0.27\ in^2/ft$$

Trial # 03:

$$a = 0.53''.$$

$$A_s = 0.27\ in^2/ft.$$

Step-07: Area of Steel for distribution Reinforcement:

$$A_{s_{min}} = 0.0018 * b * t = 0.0018 * 12 * 7.5 = 0.162\ in^2/ft.$$

Step # 08: Spacing for Main Bars:

$$S = \frac{A_b * 12}{A_s} = \frac{0.2}{0.27} \times 12 = 8.89'' \approx 8\tfrac{1}{2}'' \text{ c/c}$$

Step # 09: Spacing for Distribution Bars:

Let try #4 bar for distribution steel also.

$$S = \frac{A_b}{A_s} * 12$$

$$S = \frac{0.2}{0.162} * 12 = 14.81 \approx 14'' \text{ c/c}.$$

Step-10: Final Summary:

$f'_c = 3\text{ksi}$, $f_y = 60\text{ ksi}$, $t = 7\tfrac{1}{2}''$

Main-Steel = #4 at $8\tfrac{1}{2}''$ c/c

Distribution-Steel = #4 at $14''$ c/c.

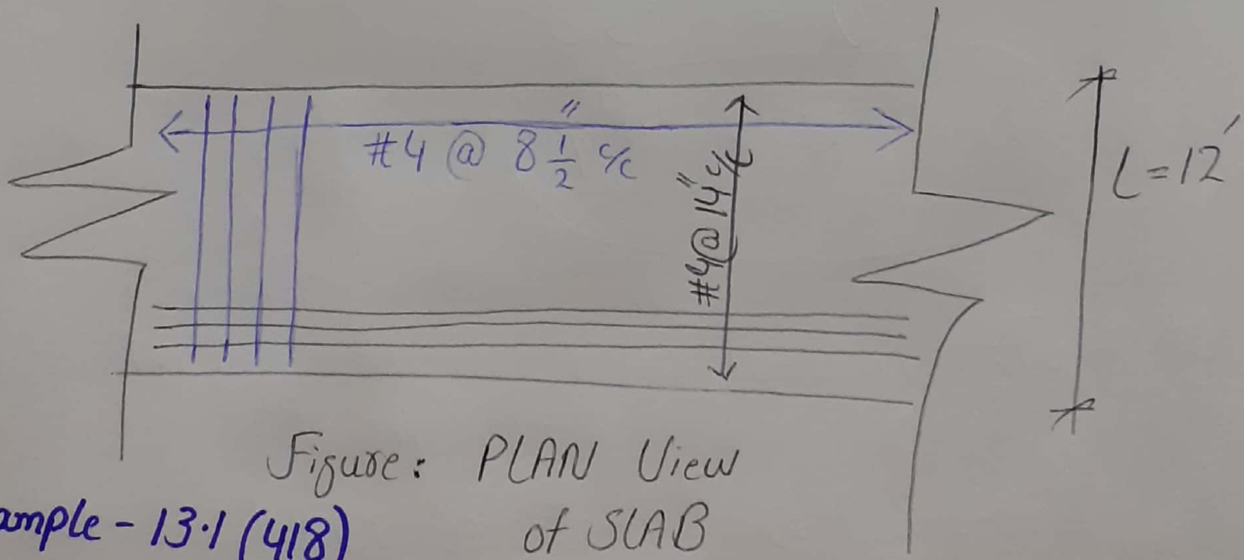


Figure: PLAN View of SLAB

Example - 13.1 (418)

Pb - 13.1 & 13.2 (Page-479)