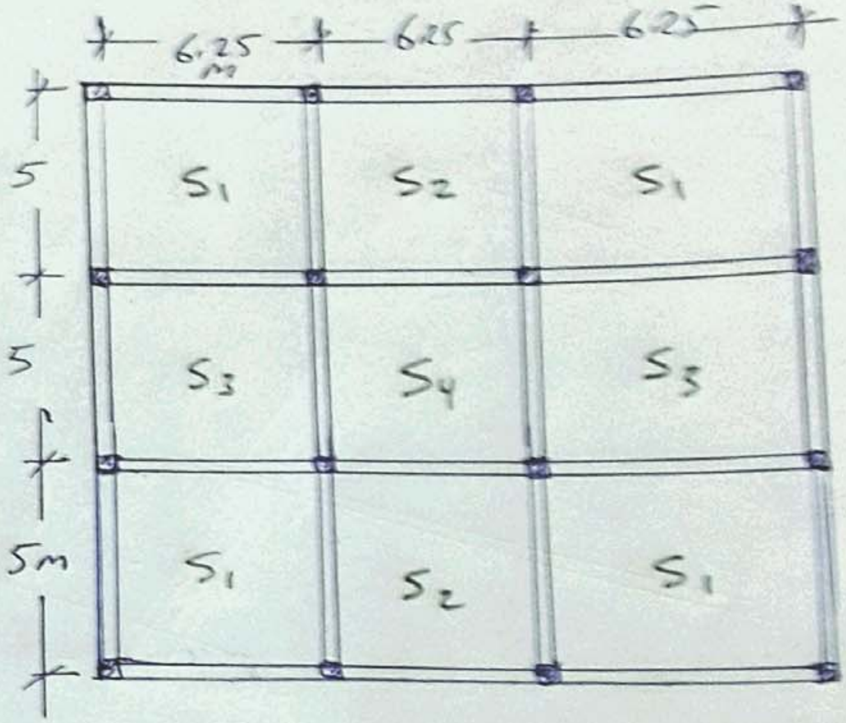
Two way slab

Ex: Design the slab (S1) shown in Figure below, LL = 5 kN/m²,
finishing of floor = 1 kN/m², $f_y = 420$ MPa, $f'_c = 25$ MPa.



Solution :-

- Check type of slab

$L_a = 5.0$ m

$L_b = 6.25$ m

$$\frac{L_b}{L_a} = \frac{6.25}{5} = 1.25 < 2.0$$

∴ Two way slab

- Slab thickness

$$h = \frac{\text{perimeter}}{170}$$

$$= \frac{(6.25+5)*2}{170} = 0.132 \text{ m}$$

use $h = 150$ mm

$$m = \frac{L_a}{L_b} = \frac{5.0}{6.25} = 0.8$$

- Loads calculations :-

Self wt. $= \gamma_{concrete} * h$

$= 24 * 0.15 = 3.6$ kN/m²

Dead load (DL) $= 3.6 + 1.0 = 4.6$ kN/m²

$W_u = 1.4\,DL + 1.7\,LL$

$= 1.4 * 4.6 + 1.7 * 5 = 15.0$ kN/m²

- Moment calculations :-

(1) Negative bending moment (-ve B.M.)

- $M_a = C_a \cdot w_u \cdot (L_a)^2$
- $M_b = C_b \cdot w_u \cdot (L_b)^2$

} C_a & C_b found from tables [Table(1)] & Case(4)

$M_a = 0.071 * 15 * (5)^2 = 26.6$ KN.m /m

$M_b = 0.029 * 15 * (6.25)^2 = 17.0$ KN.m/m

$d = h - (\text{cover} + \text{bar. dia.})$
$= 150 - (20 + 10) = 120$ mm.

(2) Positive bending moment (+ve B.M.)

- For Dead load;

$W_{DL} = 1.4 \cdot DL = 1.4 * 4.6 = 6.44$ KN/m^2

$C_a = 0.039$
$C_b = 0.016$
} From table 2 & case(4)

+ $M_{a_{DL}} = C_a \, W_{DL} (L_a)^2$
+ $M_{b_{DL}} = C_b \, W_{DL} (L_b)^2$

$M_{a_{DL}} = 0.039 * 6.44 * (5)^2 = 6.3$ KN.m/m

$M_{b_{DL}} = 0.016 * 6.44 * (6.25)^2 = 4.0$ KN.m/m

– For Live load ;

$W_{LL} = 1.7 . LL = 1.7 * 5 = 8.5 \ kN/m^2$

$C_a = 0.048$
$C_b = 0.02$ } From table 3 & case (4)

$+M_{a_{LL}} = C_a . W_{LL} . (L_a)^2$

$+M_{b_{LL}} = C_b . W_{LL} . (L_b)^2$

$M_{a_{LL}} = 0.048 * 8.5 * (5)^2 = 10.2 \ kN.m/m$

$M_{b_{LL}} = 0.02 * 8.5 * (6.25)^2 = 6.64 \ kN.m/m$

* Total Positive B.M

$M_{total} = M_{DL} + M_{LL}$

$\therefore \ M_a = M_{aDL} + M_{aLL} = 6.3 + 10.2 = 16.5 \ kN.m/m$

$M_b = M_{bDL} + M_{bLL} = 4.0 + 6.64 = 10.64 \ kN.m/m$

– Reinforcement calculations

$$C = \frac{F_y}{0.85 * f'_c} = \frac{420}{0.85 * 25} = 19.76$$

$$R_u = \frac{M_u}{\phi . b . d^2}$$

$$\rho = \frac{1}{\text{[redacted]}}\left(1 - \sqrt{1 - \frac{2CR_u}{F_y}}\right)$$

$$A_s = \rho . b . d$$

Detail	$^{-}M_a$	$^{-}M_b$	$^{+}M_a$	$^{+}M_b$
M_u (kN.m)	26.6	17.0	16.5	10.64
$R_u = \frac{M_u}{\phi . b . d^2}$	2.05	1.31	1.27	0.82
$\rho = \frac{1}{c}\left(1 - \sqrt{1 - \frac{2cR_u}{f_y}}\right)$	0.0052	0.0032	0.003	0.002
$A_s = \rho . b . d$	624	384	360	240 < As_{min}
If we use (ϕ12) bars				
$S = \frac{A_b}{A_s} * 1000$ (mm)	181	294	313	470 > 3h=450
use ϕ12 @	180	290	300	400

*Note $As_{min} = \rho_{min} * b * h$

$= 0.0018 * 1000 * 150$

$= 270\ mm^2/M$

$\therefore$ for $^{+}M_b$; $S = \frac{A_b}{A_s} * 1000 = \frac{113}{270} * 1000$

$= 418$ mm

use ϕ12 @ 400 mm c/c