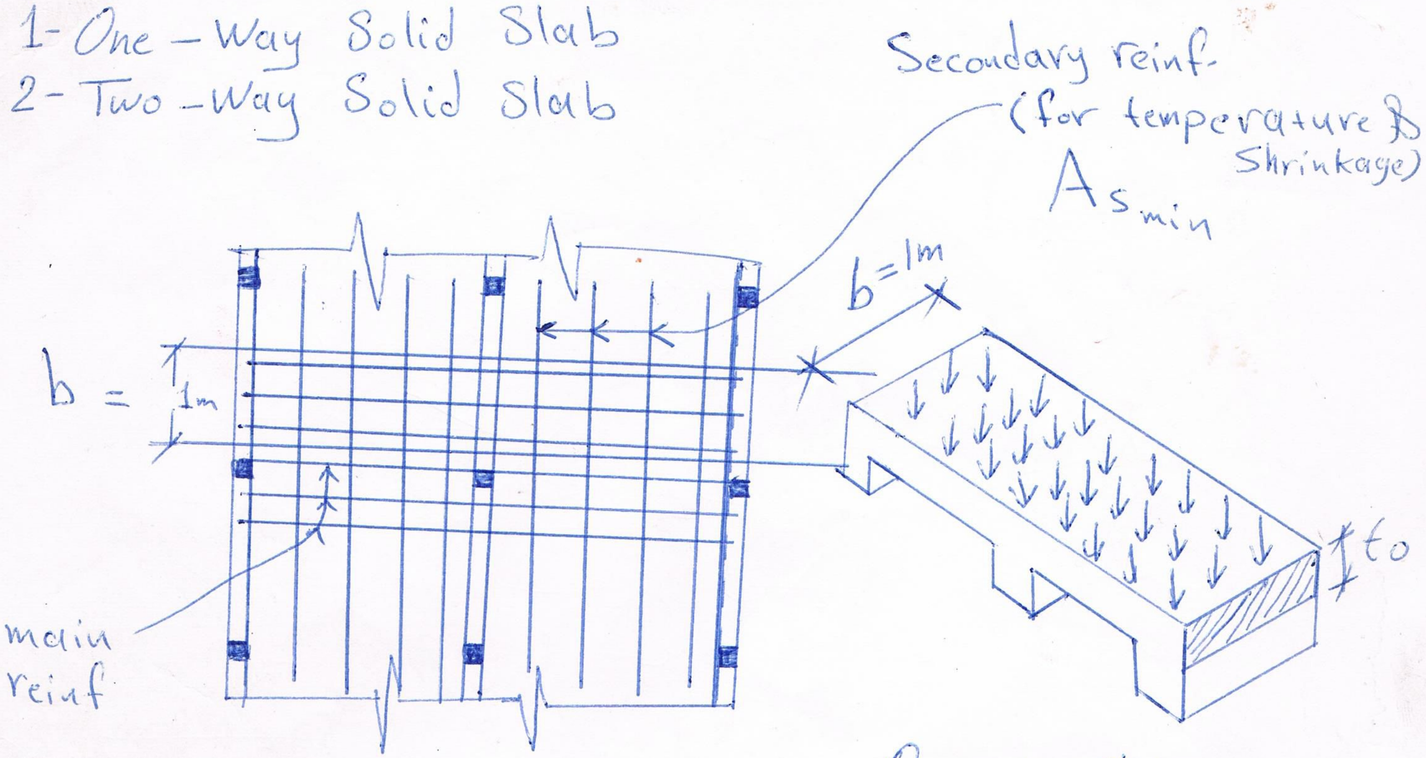
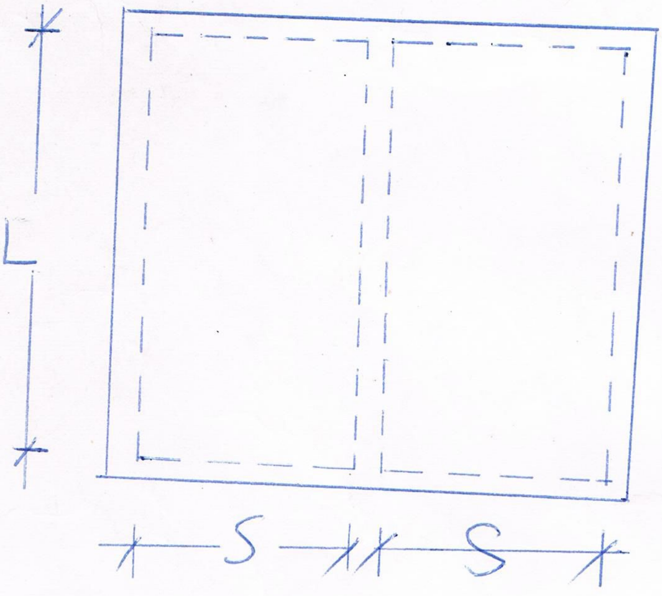
Reinforced Concrete Slabs

1- One-Way Solid Slab
2- Two-Way Solid Slab



One way slab

Plan (Top View)



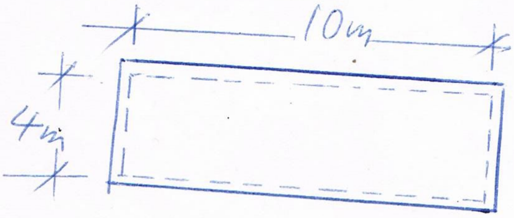
If $\frac{L}{S} > 2$ One-way slab

$\frac{L}{S} \leq 2$ Two-way slab

$m = \frac{S}{L} < 0.5$ One-way

≥ 0.5 Two-way

E.x.

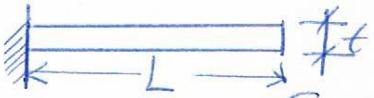


Since $\frac{10}{4} = 2.5 > 2 \therefore$ one way

Slab Thickness

Minumum thickness of one way slab for deflection Control

$t_{min} = \frac{L}{10}$

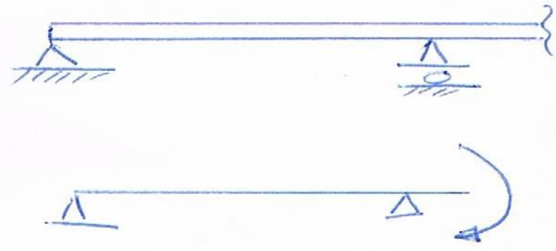


Cantilever Slab

$t_{min} = \frac{L}{20}$

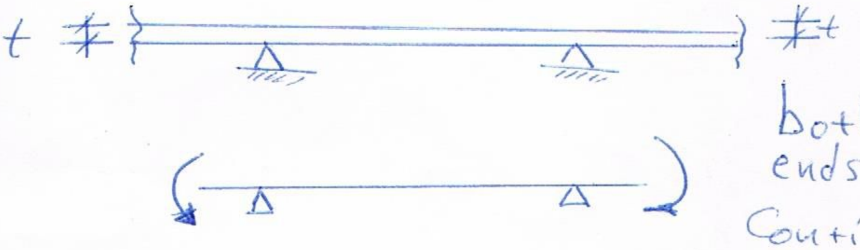
Simply Supported

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



one-end Continous

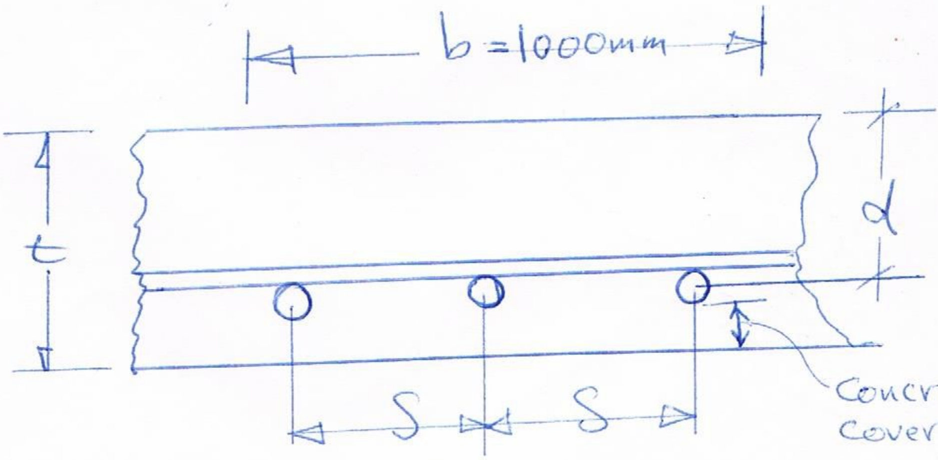
$t_{min} = \frac{L}{28}$



both ends Continous

$d = t - 20 - \frac{d_b}{2}$

$d_b = 10_{mm}, 12_{mm}, 16_{mm}$



Concrete cover = 20mm.

S = Spacing between bars

Concrete Cover	
20 mm	slab
40 mm	beam, column
75 mm	foundation

Check the effective depth according to shear requirements

* The design shear strength (ϕV_c) must be equal or greater than design shear force at critical section, if not, the (h) must be greater.

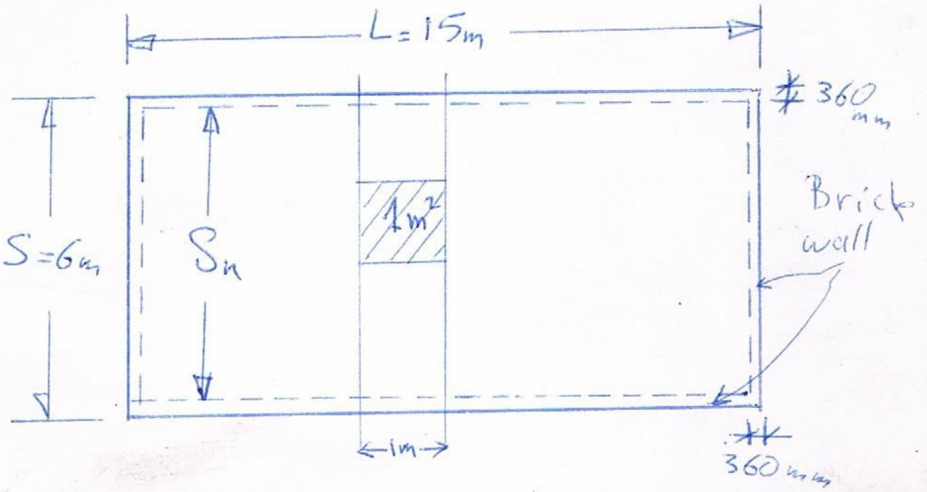
The slab is simplly supported, $f_y = 300$ MPa, $f'_c = 20$ MPa.

Ex. Design the slab (Roof) showing in the Fig. below:-

$W_L = 1.5$ kN/m², Tiles = 1.0 kN/m², Earth filling = 2 kN/m²

assuming the average thickness of earth filling = 100 mm

Solution:-



$* \ \frac{L}{S} = \frac{(15 - 2*0.36)}{(6 - 2*0.36)}$

$= 2.70 > 2$

∴ The slab is one way slab.

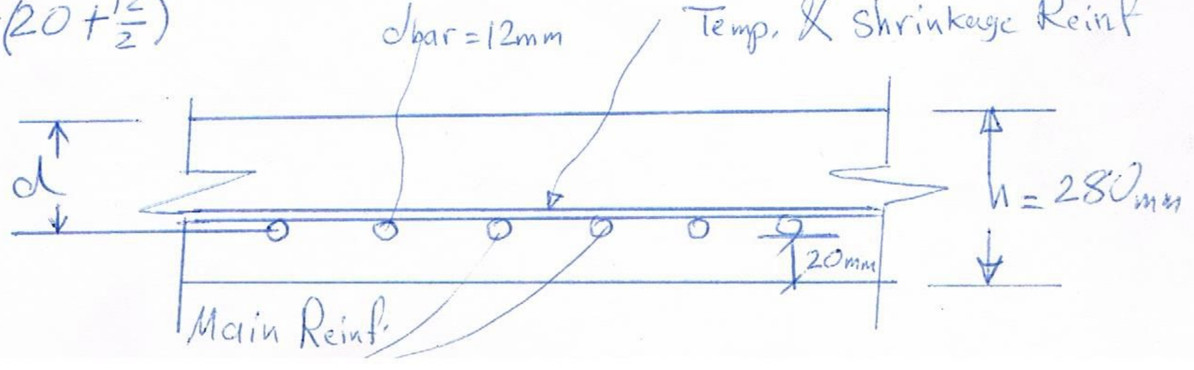
$* \ h = \frac{6 - 2*0.36}{20} * 1000 = 264 \text{ mm}$ use $h = 280$ mm

$* \ W_D = W_{tiles} + W_{earth} + W_{self} = 1 + 2 + 24 \times 1 \times 1 \times 0.28 = 9.72 \text{ kN/m}^2$

$W_u = 1.6 * 1.5 + 1.2(9.72) \simeq 14.1 \text{ kN/m}^2$

$d = 280 - (20 + \frac{12}{2})$

$d = 254$ mm



* Checking for shear

$V_{us} = \frac{14.1 * 5.28}{2} = 37.22\ kN$

$V_{ud} = V_{us} - W_u d = 37.22 - 14.1 * 0.254 = 33.643\ kN$

$\phi V_c = 0.75 * \frac{1}{6}\sqrt{f'_c} * b * d = 0.75 * \frac{1}{6}\sqrt{20} * 1000 * 254 * 10^{-3}$

$\phi V_c = 142\ kN > V_{ud} = 33.64\ kN$

∴ The thickness is adiquate for shear.

* Bending Moment :-

$M_{u_{max}} = \frac{W_u\, S_n^2}{8} = \frac{14.1 * (5.28)^2}{8} = 49.14\ kN.m$

$\rho_{max} = 0.0206$

$M_u = \phi \rho f_y b d^2 \left(1 - \frac{0.59 \rho f_y}{f'_c}\right)$

$49.14 * 10^6 = 0.9 * 300 * \rho * 1000 * 254^2 \left(1 - \frac{0.59 * \rho * 300}{20}\right)$

$49.14 * 10^6 = 1.742 * 10^{10} \rho - 1.542 * 10^{11} \rho^2$

$\rho^2 - 0.113\rho + 0.00031 = 0$

$\rho = \frac{-0.113 \pm \sqrt{0.113^2 - 4 \times 1 \times 0.00031}}{2}$

$\rho = 0.0028 < \rho_{max} = 0.0206$

$A_{s_{min}} = 0.002\ bh = 0.002 * 1000 * 280 = 560\ mm^2/m$

$A_s = \rho b d = 0.0028 * 1000 * 254 = 711.2\ mm^2/m > A_{s_{min}}$

$\rho_t = 0.018 > \rho \quad \therefore \phi = 0.9$ ok

$A_{s\,bar} = \frac{\pi}{4} \times 12^2 = 113\ mm^2$, $S_{max} \leq \begin{cases} 450\ mm \checkmark \\ 3h = 3 \times 280 = 840\ mm \end{cases}$

$S = \frac{1000}{712/113} = 158.7\ mm\ c/c$ Use $S = 150\ mm\ c/c < 450\ mm$

A_s for Temperature & shrinkage

$A_s = A_{s\,min} = 560\ mm^2/m$

$S = \frac{1000}{560/113} = 201.8$ $S_{max} \leq \begin{cases} 5h = 1400\ mm \\ 450\ mm \checkmark \end{cases}$

$\therefore$ Use $S = 200\ mm\ c/c$

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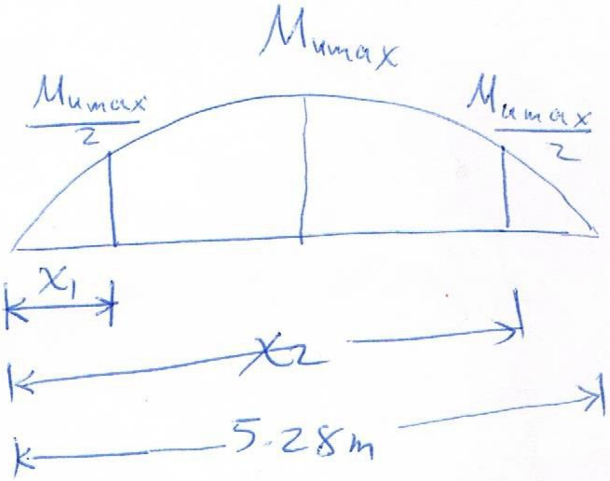
The B.M. value in any Point at distance $= x$

is $M_x = \frac{w s_n}{2} * X - \frac{w x^2}{2}$



$\left(\frac{49.14}{2}\right) = \frac{14.1 * 5.28}{2} * X - \frac{14.1 X^2}{2}$

$24.57 = 37.224 X - 7.05 X^2$

$X^2 - 5.28 X + 3.485 = 0$

$x = \frac{5.28 \pm \sqrt{5.28^2 - 4 \times 1 \times 3.85}}{2}$

$x_1 = \frac{1.748}{2} = 0.874\ m$, $x_2 = \frac{8.812}{2} = 4.41\ m$

نقاط العزم الحقيقية .

$$x_{1_{Real}} = X_1 - \frac{d}{2} = 0.874 - \frac{0.254}{2} = 0.747\,m$$

$$x_{2_{Real}} = X_2 + \frac{d}{2} = 4.41 + \frac{0.254}{2} = 4.537\,m$$