



كلية المستقبل الجامعة
قسم هندسة تقنيات البناء والانشاءات

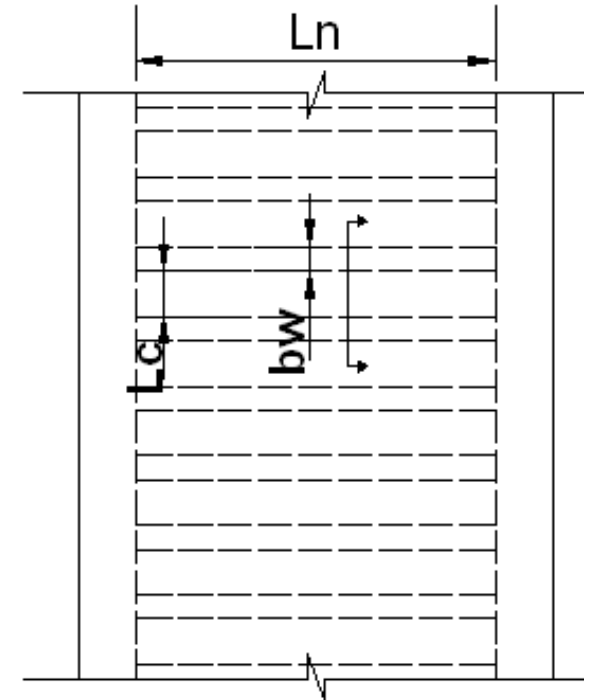
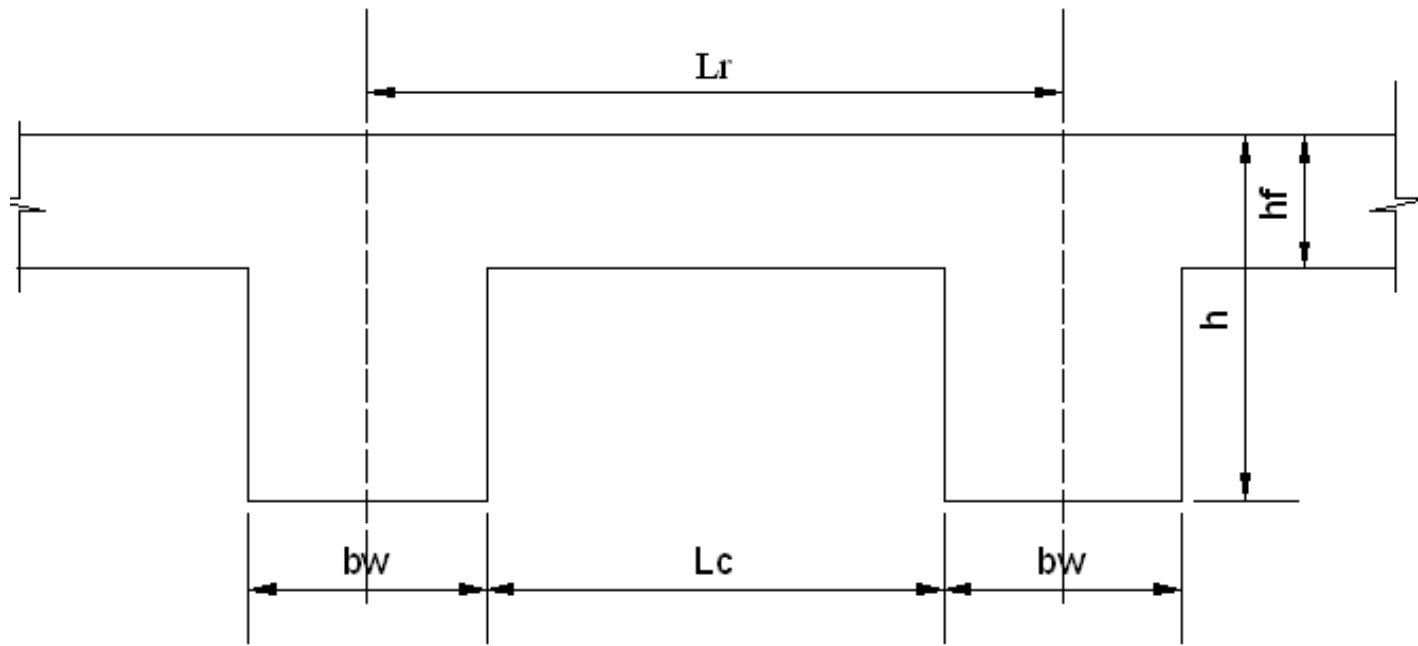


ONE WAY RIBBED SLAB

المرحلة الثالثة

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One Way Ribbed Slab (joist construction):-



Total depth h

to be calculated from table 9.5.a (ACI code) based on deflection consideration:-

$$h \geq \frac{L}{16} \text{ simply supported}$$

$$h \geq \frac{L}{18.5} \text{ one end continuous}$$

$$h \geq \frac{L}{21} \text{ two end continuous}$$

$$h \geq \frac{L}{8} \text{ cantilever}$$

ACI code limitation (ACI code 8.11)

$$b_w \geq 100\text{mm}$$

$$h \leq 3.5b_w$$

$$L_c \leq 750 \text{ mm} \quad 8.11.3$$

$$hf \geq \max. \left(\frac{L_c}{12}, 50\text{mm} \right)$$

Note:-Section dimension may be obtained from manufactures catalogues

ACI 8.11.4:-joist construction not meeting these limitation shall be designed as slabs and beams

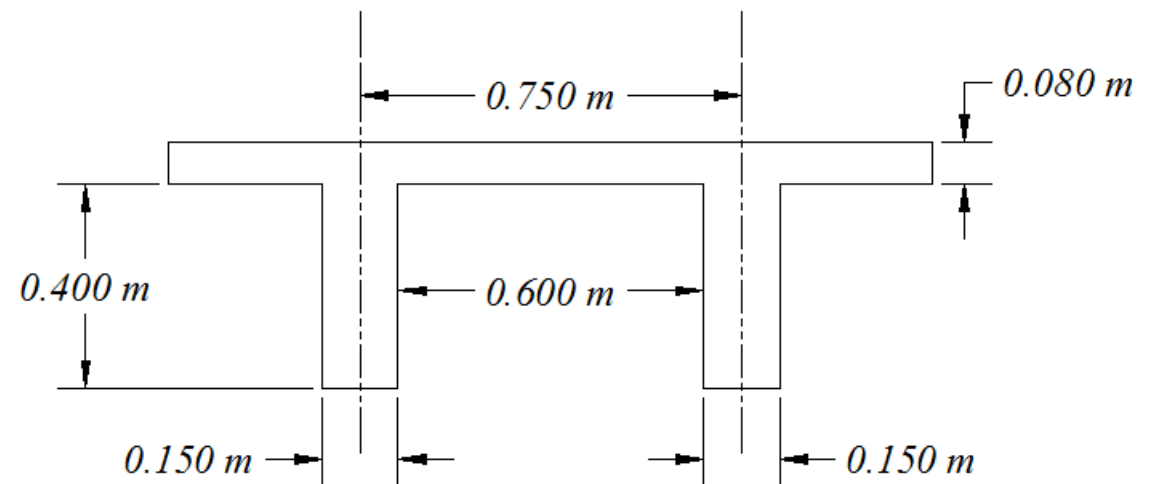
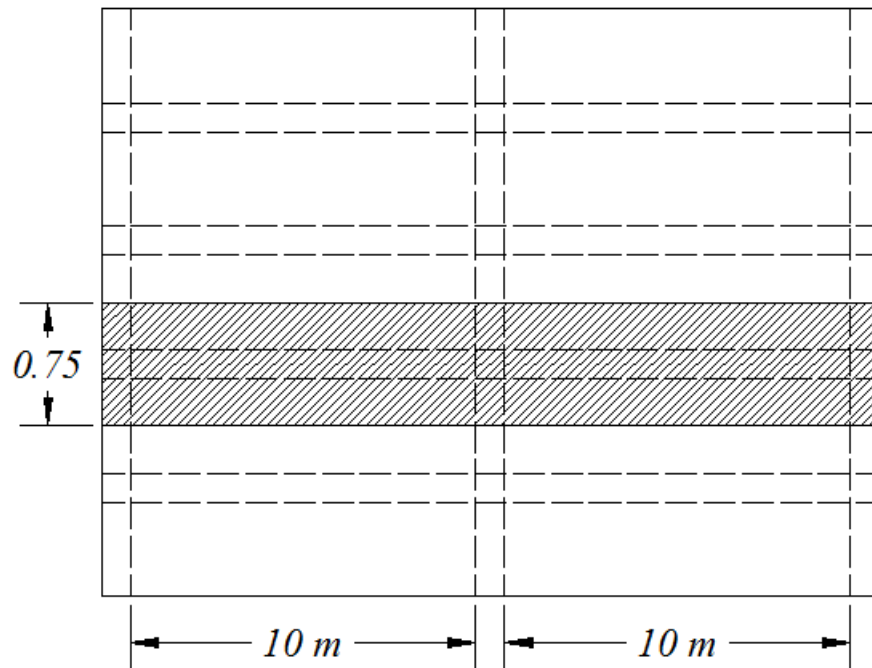
Stiffeners(bridging ribs) shall be used as follow:

- $L_n \leq 7.3 \text{ m}$ one stiffeners at $\frac{L_n}{2}$
- $L_n > 7.3 \text{ m}$ two stiffeners at $\frac{L_n}{3}, \frac{2L_n}{3}$

Example

Design the two panel slab system as one way ribbed (joist) slab.

$$W_{L.L} = 3 \frac{\text{kN}}{\text{m}^2}, \frac{S}{c} = \frac{350}{30} \text{ MPa}, L_c = 600 \text{ mm}, b_w = 150 \text{ mm}, hf = 80 \text{ mm}$$



Solution:

$$\text{both end continuous } h_{\min} = \frac{L_n}{21} = \frac{10 * 1000}{21} = 476\text{mm}$$
$$= 480\text{mm}$$

$$b_w = 150\text{mm} > 100 \text{ mm o.k}$$

$$h = 480 \text{ mm} \leq 3.5 b_w = 3.5 * 150 = 525\text{mm o.k}$$

$$L_c = 600 < 750 \text{ mm o.k}$$

$$hf = 80 > \max. \left(\frac{L_c}{12} = \frac{600}{12} = 50 \text{ mm}, 50\text{mm} \right) \text{ o.k}$$

Section dimensions are satisfied the ACI code limitation

Dead load calculations

$$\text{Slab weight} = [(Lr * hf) + bw(h - hf)] * \gamma_c * \frac{1}{Lr}$$

$$\begin{aligned}\text{Slab weight} &= ((0.75 * 0.08) + (0.15 * 0.4)) * 24.5 * \frac{1}{0.75} \\ &= 3.92 \frac{\text{kN}}{\text{m}^2}\end{aligned}$$

$$\text{Plastering} = 0.48 \frac{\text{kN}}{\text{m}^2}$$

$$\text{Tiling with mortar} = 0.04 * 24.5 = 0.98 \frac{\text{kN}}{\text{m}^2}$$

$$\text{Minor partitions} = 0.7 \frac{\text{kN}}{\text{m}^2}$$

$$\Sigma W_{D.L} = 6.08 \frac{\text{kN}}{\text{m}^2}$$

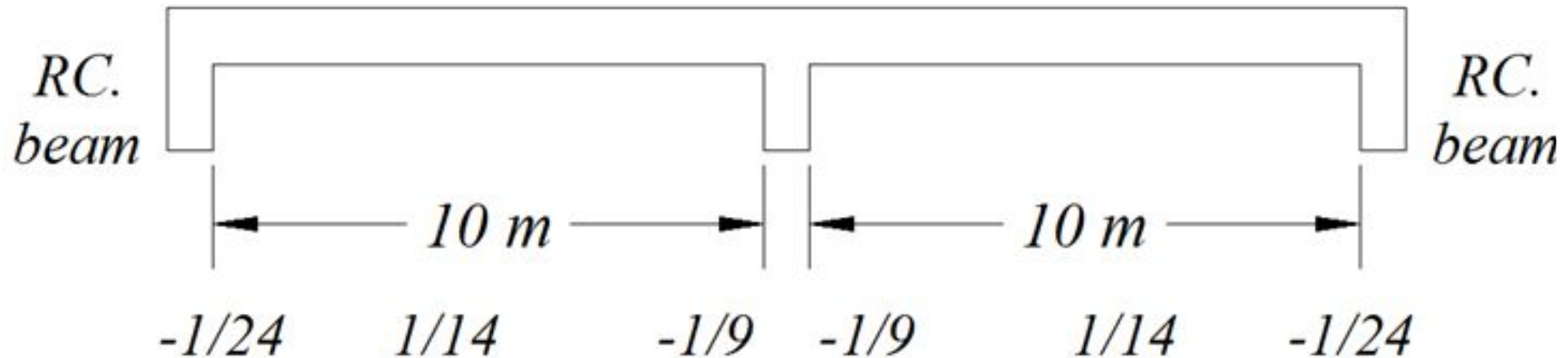
$$W_u = 1.6 W_L + 1.2 W_d = 1.6 * 3 + 1.2 * 6.08 = 12.096 \frac{\text{kN}}{\text{m}^2}$$

W_u uniformly distributed load per m^2

\overline{W}_u = uniformly distributed load per rib = $W_u * L_r$

$$= 12.096 * 0.75 = 9.07 \frac{\text{kN}}{\text{m}}$$

Moment and shear coefficient are used in analysis:



$$M_u = \overline{W}_u * L_n^2 * \text{coff} = 9.07 * (10)^2 * \text{coff} = 907 * \text{coff}$$

$$d = t - 25\text{mm} = 480 - 25 = 455 \text{ mm}$$

B.M coff.	$\frac{M}{W_u * L_n^2}$ * coff.	$R = \frac{Mu}{\phi fc'bd^2}$	ω from table	$\rho = \omega * \frac{fc'}{fy}$	$As = \rho bd$ mm^2
-1/9	100.8	0.1202	0.130	0.0111	$\rho^- bwd = 758$
-1/24	37.8	0.0451	0.046	0.0039 → 0.004	$\rho^- bwd = 273$
+1/14	64.8	0.0154	0.0155	0.00133	$\rho^+ Lrd = 453$
			All ω $< \omega_{max}$		

assume $\phi = 0.9$ to be checked later

for M^- (rec. sec $b_w * h$)

$$R^- = \frac{M_u^-}{\phi fc' b_w d^2} = \frac{M_u^-}{0.9 * 30 * 10^3 * 0.15 * (0.455)^2} = \frac{M_u^-}{838}$$

for M^+ (rec. or T – sec)

$$M_u f = \phi 0.85 f_c' L_r h_f \left(d - \frac{h_f}{2} \right) = 0.9 * 0.85 * 30 * 10^3 * 0.75 * 0.08 * \left(0.455 - \frac{0.08}{2} \right) = 571 \text{ kN.m} > M_u^+ = 64.8 \text{ kN.m}$$

$\therefore a < h_f$ (Rectangular section with L_r width) \rightarrow use $R = \frac{M_u}{\phi f_c' b d^2}$

$$R^+ = \frac{M_u^+}{\phi f_c' L_r d^2} = \frac{64.8}{0.9 * 30 * 10^3 * 0.75 * (0.455)^2} = 0.0154$$

$$\omega_{\max} = 0.364 * \beta_1 = 0.364 * 0.85 = 0.309$$

$$\rho_{\min}^- = \max. \left(\frac{1.4}{f_y} = \frac{1.4}{350} = 0.004, \frac{\sqrt{f_c'}}{4f_y} = \frac{\sqrt{30}}{4 * 350} = 0.0039 \right) =$$

0.004 for negative moment

$$\rho_{\min}^+ = \max. \left(\frac{1.4}{f_y}, \frac{\sqrt{f_c'}}{4f_y} \right) * \frac{b_w}{b} = 0.004 * \frac{150}{750} = 0.0008 \text{ for}$$

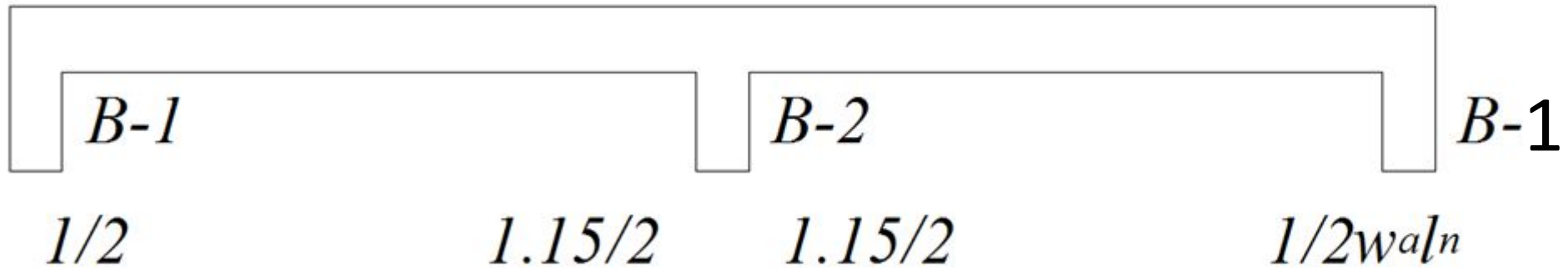
positive moment

checking ϕ (redaction factor)

$$\rho_t = 0.85 * \beta_1 * \frac{f_c'}{f_y} * \frac{\epsilon_{cu}}{\epsilon_{cu} + 0.005} = 0.85 * 0.83 * \frac{30}{350} * \frac{3}{8}$$
$$= 0.0227$$

all $\rho < \rho_t \rightarrow \phi = 0.9$ o.k

Checking slab for shear



$$\text{max shear force } V_u = 1.15 * \frac{W_u^-}{2} * L_n = 1.15 * \frac{9.07 * 10}{2} = 52.12 \text{ kN}$$

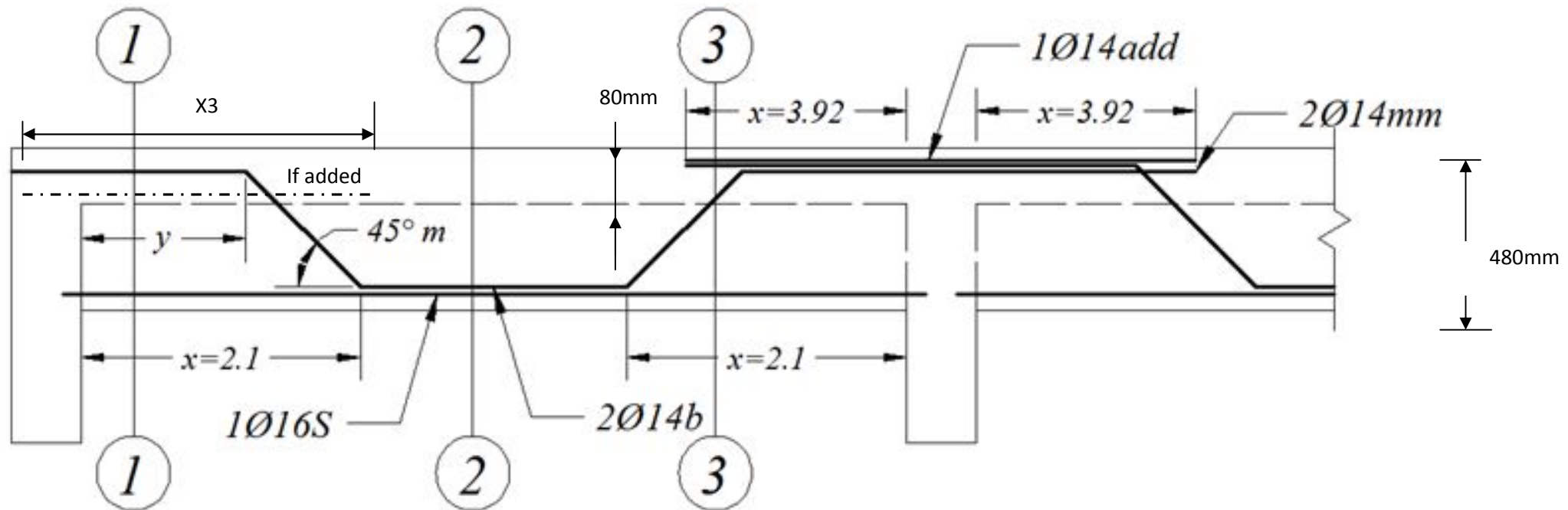
$$V_{ud} = V_u - \overline{W}_u * d = 52.12 - 9.07 * 0.455 = 48.02 \text{ kN}$$

$$V_c = 0.17 \sqrt{f_c'} * b_w * d * \underbrace{1.1}_{\text{ACI 8.11.8}} \\ = 0.17 * \sqrt{30} * 0.15 * 0.455 * 10^3 * 1.1 = 70 \text{ kN}$$

$$\frac{V_{ud}}{\phi} = \frac{48.02}{0.75} = 64 \text{ kN}$$

$$\frac{V_{ud}}{\phi} = 64 \text{ kN} < V_c = 70 \text{ kN} \rightarrow \text{o.k}$$

Distribution of reinforcement :-



+Reinf=453 mm²

$$2\emptyset 14\text{mm}(\text{bent}) + \left(\emptyset 16\text{mm sraight} > \frac{1}{4} A_s^+ \right) \rightarrow A_s^+ \\ = 509\text{mm}^2 > 453 \text{ mm}^2 \therefore \text{o.k}$$

-Reinf at interior support 758 mm²

$$2\emptyset 14\text{mm bent (left)} = 308\text{mm}^2$$

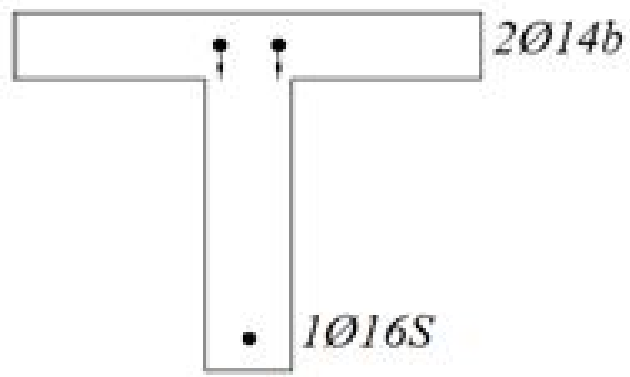
$$2\emptyset 14 \text{ mm bent (right)} = 308\text{mm}^2$$

$$1\emptyset 14 \text{ additional} = 154\text{mm}^2$$

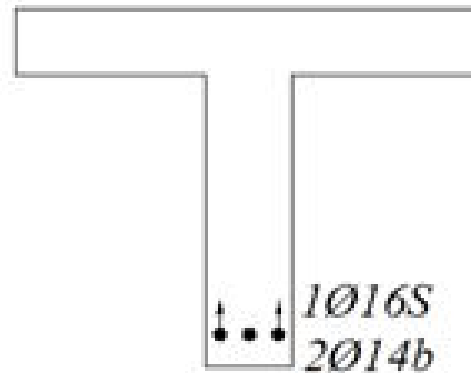
$$\Sigma A_s = 770\text{mm}^2 > 758\text{mm}^2 \therefore \text{o.k}$$

-Reinf at exterior support 273 mm²

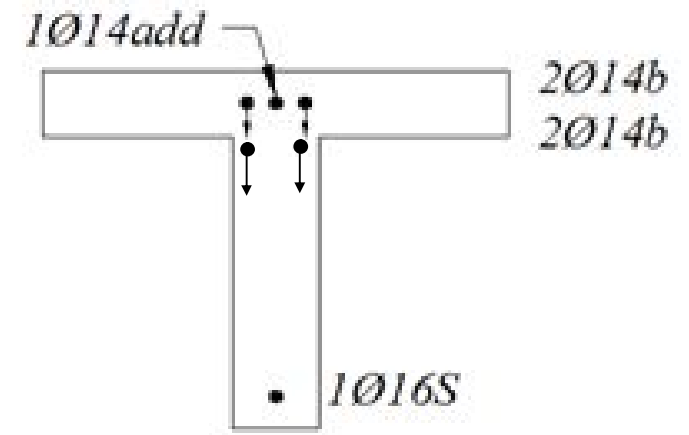
$$2\emptyset 14\text{mm bent} \rightarrow A_s^- = 308 \text{ mm}^2 > 273 \text{ mm}^2 \text{ o.k}$$



Sec 1-1



Sec 2-2



Sec 3-3

Cut off and bent point

$$\begin{aligned} \text{+Reinf \% bent up} &= \frac{2\emptyset 14 = 308}{2\emptyset 14 + 1\emptyset 16 = 509} = 0.6 \\ &= 60\% \left(\text{graph} + \frac{1}{14} \right) \end{aligned}$$

$$x_1 = 0.21 * L_n = 0.21 * 10 = 2.1\text{m}$$

$$\text{-Reinf (interier)\% cut off} = 100\% \text{ graph} \left(-\frac{1}{9} \right)$$

$$x_2 = 0.33 * 10$$

$$\text{+ max.} \left(d = 0.455, 12\text{db} \right)$$

$$= (12 * 0.014 = 0.168), \left(\frac{L_n}{16} = \frac{10}{16} = 0.625 \right) = 3.92\text{m}$$

–Reinf (exterior)% cut off = 100% grapg $\left(-\frac{1}{24}\right)$

$$x_3 = 0.092 * L_n + \max. \left(d, 12d_b, \frac{L_n}{16} \right) = 1.54\text{m}$$

$$y = x_1 - [(d - \text{cover})/\tan(45)] = 2.1 - \frac{(0.455 - 0.025)}{\tan 45}$$

$$= 1.67\text{m}$$

$y > x_3 \rightarrow \text{o.k}$

if $y < x$ (use cut not bent)

Temperature and shrinkage reinf. top slab

$$A_{S_{\min.}} = 0.002 b \cdot t \quad \text{for } f_y = 300 \text{ MPa}$$

$$= 0.002 * 1000 * 80 = 160 \text{ mm}^2/\text{m width}$$

use welded wire fabric $\emptyset 6 @ 175 \text{ mm}$

