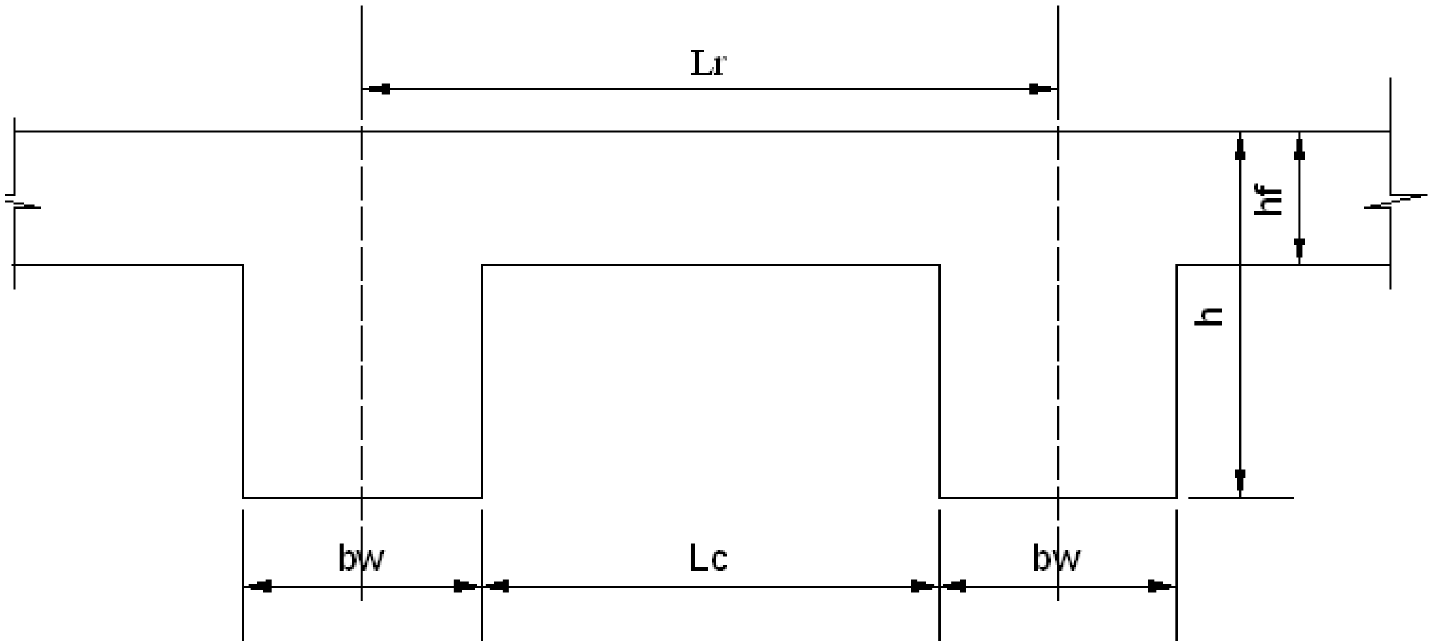
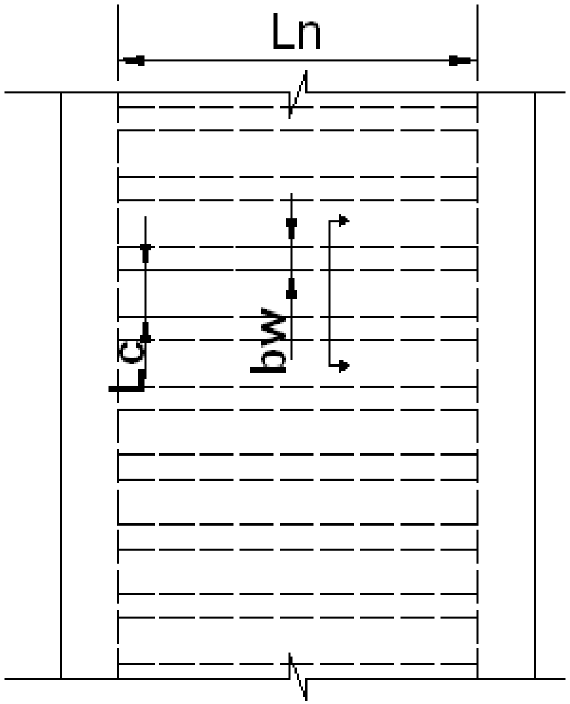
One Way Ribbed Slab (joist construction):-





Total depth h

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

$$h \geq \frac{L}{16} \text{ simpLy suported}$$

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

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

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

ACI code limitation (ACI code 8.11)

$b_w \geq 100mm$

$h \leq 3.5b_w$

$L_c \leq 750\ mm$ 8.11.3

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

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

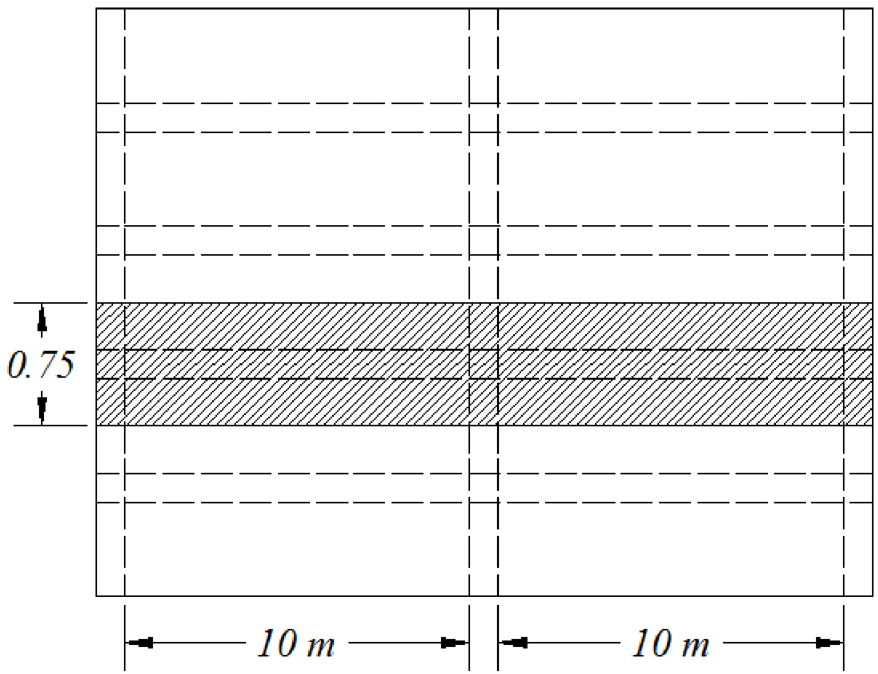
Stiffeners(bridging ribs) shall be used as follow:

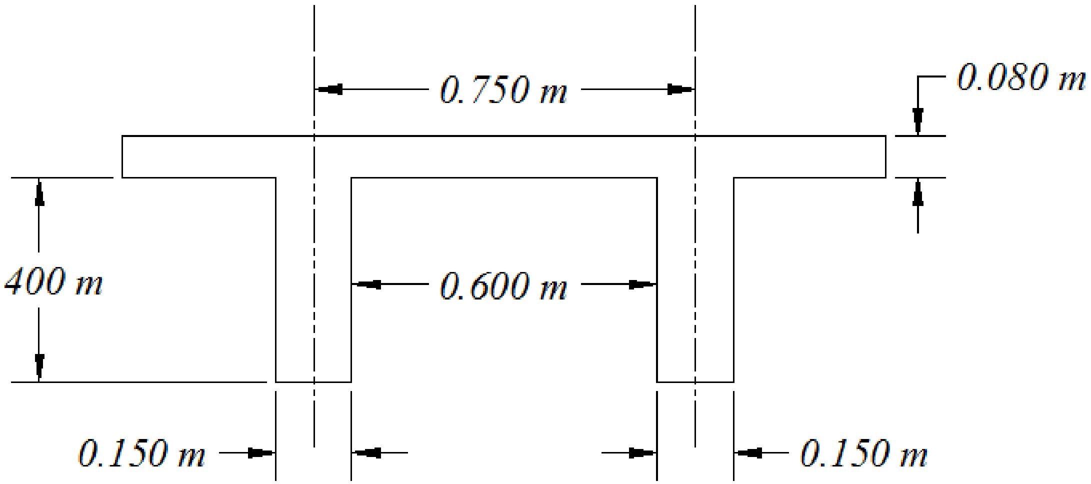
- $L_n \leq 7.3$ m one stiffeners at $\frac{L_n}{2}$
- $L_n > 7.3$ m two stiffeners at $\frac{L_n}{3}, \frac{2L_n}{3}$

Example

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

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





Solution:

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

$$= 480\text{mm}$$

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

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

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

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

Section dimensions are satisfied the ACI code limitation

Dead load calculations

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

$$\text{Slab weight} = \big((0.75 * 0.08) + (0.15 * 0.4)\big) * 24.5 * \frac{1}{0.75}$$

$$= 3.92\,\frac{\text{kN}}{\text{m}^2}$$

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

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

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

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

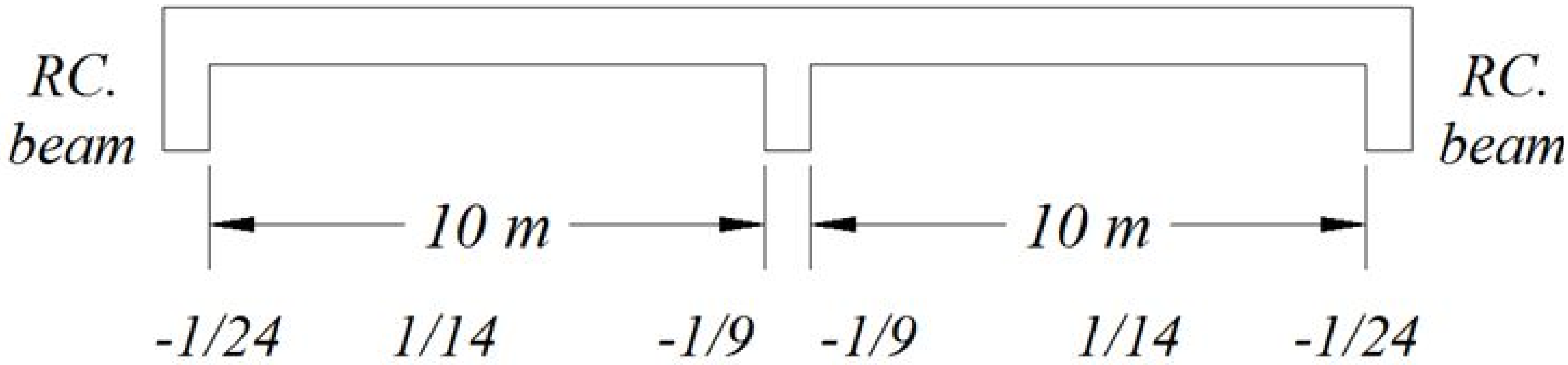
$$W_u = 1.6\ W_L + 1.2W_d = 1.6 * 3 + 1.2 * 6.08 = 12.096\ \frac{kN}{m^2}$$

W_u uniformly distributed load per m^2

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

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

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.	$M = \overline{W_u} * L_n^2 * coff.$	$R = \frac{Mu}{\emptyset fc' bd^2}$	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 $\omega < \omega_{max}$		

assume $\emptyset = 0.9$ to be checked later

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

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

$$\text{for } M^{+} \text{ (rec. or T} - \text{sec)}$$

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

$\therefore a < hf$ (Rectangular section with L_r width)→use $R = \frac{Mu}{\emptyset fc' bd^2}$

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

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

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

0.004 for negative moment

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

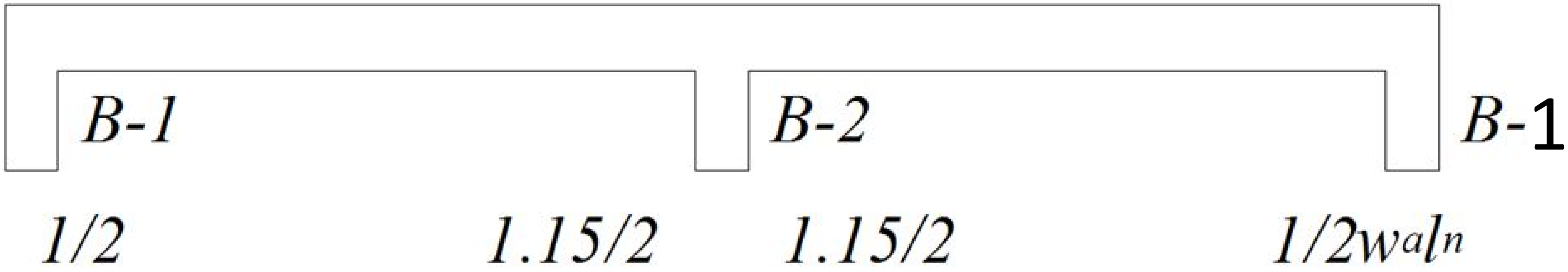
<u>checking Ø(redaction factor)</u>

$$\rho_t = 0.85 * \beta_1 * \frac{fc'}{fy} * \frac{\varepsilon_{cu}}{\varepsilon_{cu} + 0.005} = 0.85 * 0.83 * \frac{30}{350} * \frac{3}{8}$$

$$= 0.0227$$

$\text{all } \rho < \rho_t \rightarrow \ \emptyset = 0.9 \text{ o.k}$

Checking slab for shear



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

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

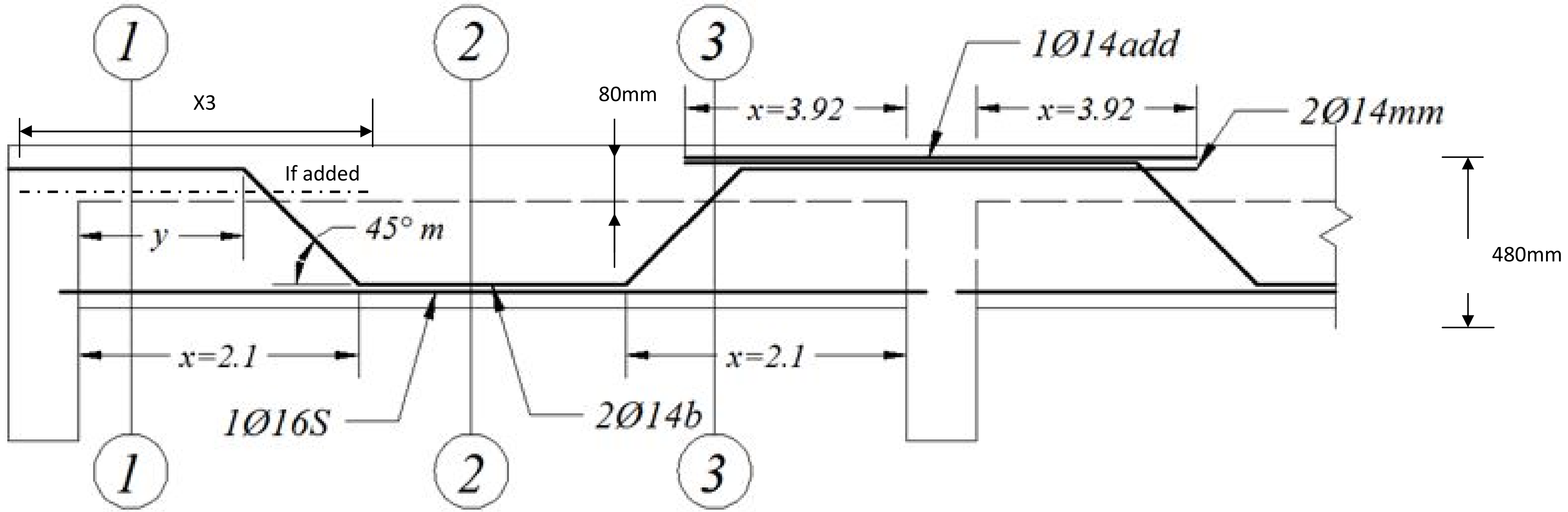
$$V_c = 0.17\sqrt{fc'} * b_w * d * \underbrace{1.1}_{\text{ACI } 8.11.8}$$

$$= 0.17 * \sqrt{30} * 0.15 * 0.455 * 10^3 * 1.1 = 70\text{kN}$$

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

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

Distribution of reinforcement :-



+Reinf=453 mm^2

$$2\phi 14\text{mm}(\text{bent}) + \left(\phi 16\text{mm sraight} > \frac{1}{4}\text{As}^+\right) \rightarrow \text{As}^+$$

$$= 509\text{mm}^2 > 453\ \text{mm}^2 \therefore \text{o.k}$$

-Reinf at interior support 758 mm^2

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

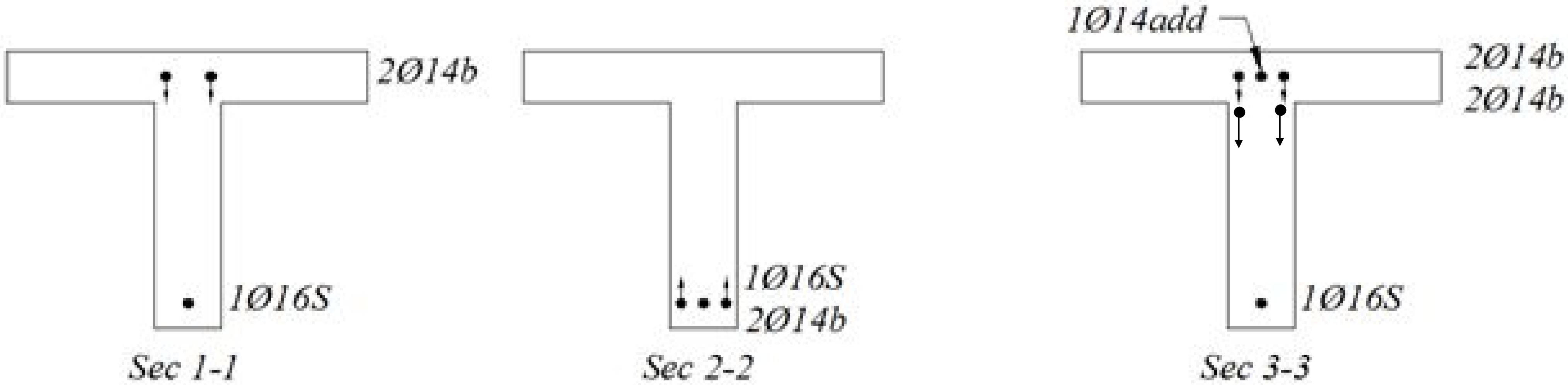
$$2\phi 14\text{ mm bent (right)} = 308\text{mm}^2$$

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

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

-Reinf at exterior support 273 mm^2

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



2Ø14b
1Ø16S
Sec 1-1
1Ø16S
2Ø14b
Sec 2-2
1Ø14add
2Ø14b
2Ø14b
1Ø16S
Sec 3-3

Cut off and bent point

$$+\textbf{Reinf \% bent up} = \frac{2\text{Ø}14 = 308}{2\text{Ø}14 + 1\text{Ø}16 = 509} = 0.6$$

$$= 60\% \ \ (\text{graph} + \frac{1}{14})$$

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

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

$$x_2 = 0.33 * 10$$

$$+ \max.\Big(d = 0.455,12\text{db}$$

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

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

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

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

$$= 1.67\text{m}$$

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

$$\text{if } y < x \text{ (use cut not bent)}$$

Temperature and shrinkage reinf. top slab

$As_{min.} = 0.002\ b*t$ for $f_y = 300$ MPa

$= 0.002*1000*80 = 160 mm^2/m$ width

use welded wire fabric Ø6@175mm