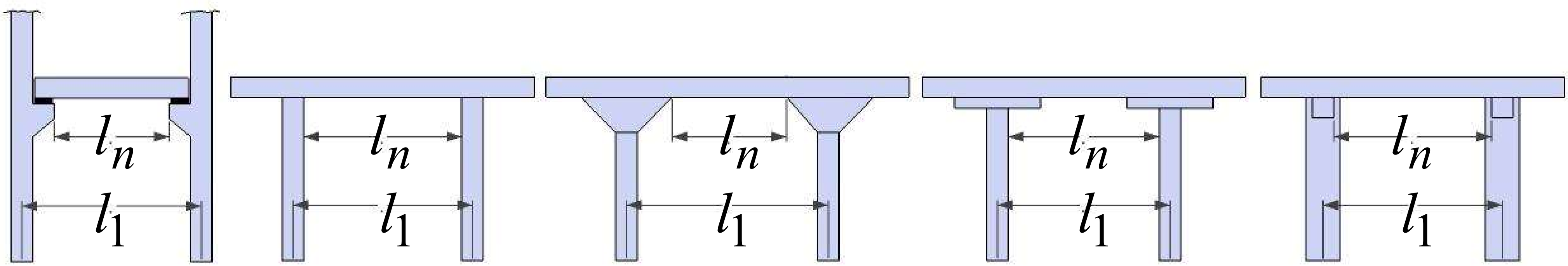
Minimum Slab thickness for Deflection Control of Two-Way Slabs (ACI 8.3)

Definition of l_n :

l_n is the length of clear span in the long direction, measured face-to-face of supports in slabs without beams and face-to-face of beams or other support in other cases.



Where l_1 :length of span in direction of analysis measured center-to-center of supports, mm.

Note : $l_n \geq 0.65 l_1$

A-Slabs without Interior Beams:

Slabs without Interior Beams are flat plates and flat slabs with or without edge beams. The minimum thickness must not be less than provided by Table (8.3.1.1)

Table 8.3.1.1—Minimum thickness of nonprestressed two-way slabs without interior beams (mm)[1]

f_y, MPa[2]	Without drop panels[3] $\geq 125mm$			With drop panels[3] $\geq 100mm$		
	Exterior panels		Interior panels	Exterior panels		Interior panels
	Without edge beams	With edge beams[4]		Without edge beams	With edge beams[4]	
280	$\ell_n/33$	$\ell_n/36$	$\ell_n/36$	$\ell_n/36$	$\ell_n/40$	$\ell_n/40$
420	$\ell_n/30$	$\ell_n/33$	$\ell_n/33$	$\ell_n/33$	$\ell_n/36$	$\ell_n/36$
520	$\ell_n/28$	$\ell_n/31$	$\ell_n/31$	$\ell_n/31$	$\ell_n/34$	$\ell_n/34$

[1] ℓ_n is the clear span in the long direction, measured face-to-face of supports (mm).

[2] For f_y between the values given in the table, minimum thickness shall be calculated by linear interpolation.

[3] Drop panels as given in 8.2.4.

[4] Slabs with beams between columns along exterior edges. Exterior panels shall be considered to be without edge beams if α_f is less than 0.8. The value of α_f for the edge beam shall be calculated in accordance with 8.10.2.7.

For fy between the values given in the Table (8.3.1.1), linear interpolation by the equation below can be used to find the minimum thickness of slab

$$h_{min} = \left[\frac{\Delta h}{\Delta f_y} \left(f_y - f_{y1} \right) + h_1 \right] \times l_n$$

Where: f_{y1} is the lower value of f_y

and h_1 is the lower value of h

B- Slab with Beams:

- Compute (α_m) for each panel where (α_m) is the average value of (α_f) for all beams on edges of a panel.

- find $\beta = \frac{\text{clear span in long direction}}{\text{clear span in short direction}}$

Three Cases of α_m:

a) $\alpha_m \leq 0.2$ Use table (T 8.3.1.1)

b) $0.2 < \alpha_m \leq 2$ $$h = \frac{l_n(0.8 + f_y/1400)}{36 + 5\beta(\alpha_m - 0.2)} \geq 125mm$$ Use (T 8.3.1.2)

c) $\alpha_m > 2$ Use $$h = \frac{l_n(0.8 + f_y/1400)}{36 + 9\beta} \geq 90mm$$ (T 8.3.1.2)

Note: At discontinuous edge, if α_f of the edge beam < 0.8 then increase (h) by at least (10%) in the panel with the discontinuous edge.

Table 8.3.1.2—Minimum thickness of nonprestressed two-way slabs with beams spanning between supports on all sides

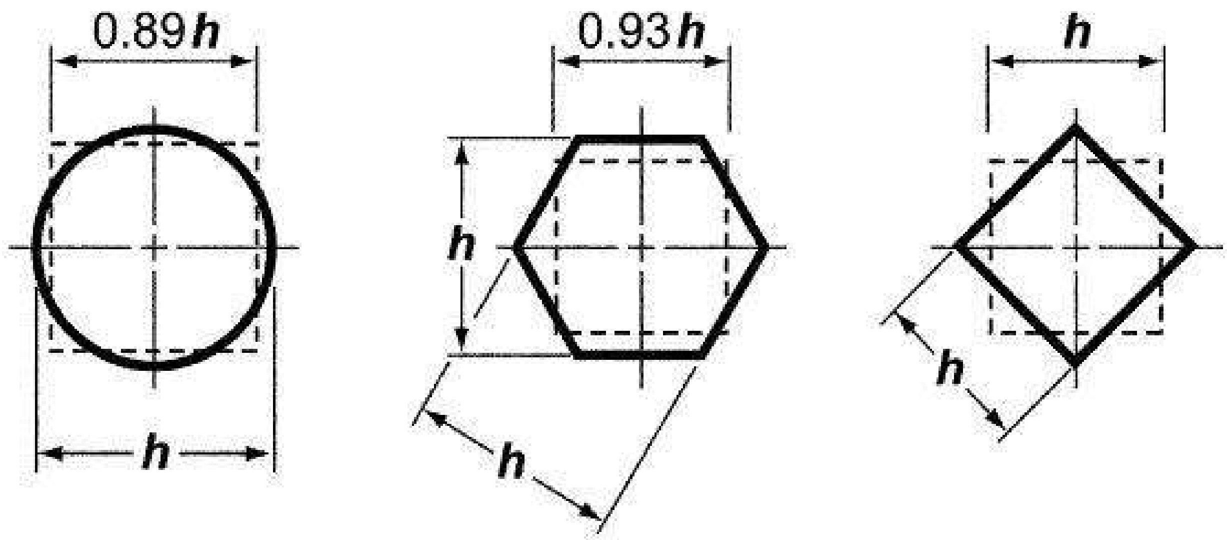
α_{fm}[1]	Minimum h, mm		
$\alpha_{fm} \leq 0.2$	8.3.1.1 applies		(a)
$0.2 < \alpha_{fm} \leq 2.0$	Greater of:	$\dfrac{\ell_n\left(0.8+\dfrac{f_y}{1400}\right)}{36+5\beta\left(\alpha_{fm}-0.2\right)}$	(b)[2],[3]
		125	(c)
$\alpha_{fm} > 2.0$	Greater of:	$\dfrac{\ell_n\left(0.8+\dfrac{f_y}{1400}\right)}{36+9\beta}$	(d)[2],[3]
		90	(e)

[1] α_{fm} is the average value of α_f for all beams on edges of a panel and α_f shall be calculated in accordance with 8.10.2.7.

[2] ℓ_n is the clear span in the long direction, measured face-to-face of beams (mm).

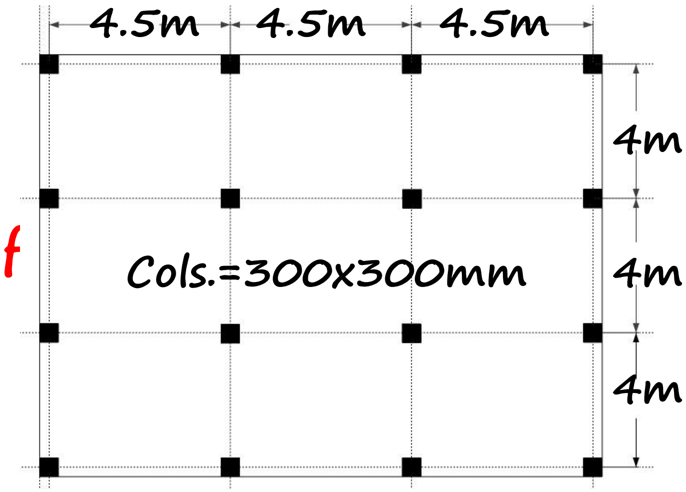
[3] β is the ratio of clear spans in long to short directions of slab.

ACI (8.10.1.3): circular or regular polygon shaped support shall be treated as square support with the same area



Example (1)

Flat plate , t=140mm, fy=350MPa, check slab thickness for deflection control.



Sol.

Flat plate without edge beams,

use table 8.3.1.1 Linear interpolation for f

$$h_{\min} = \left[\frac{\Delta h}{\Delta f_y} \left(f_y - f_{y1} \right) + h_1 \right] \times l_n$$

$$h_{\min} = \left[\frac{\frac{1}{30} - \frac{1}{33}}{420 - 280} (350 - 280) + \frac{1}{33} \right] \times (4500 - 300) = 133.63 > 125mm$$

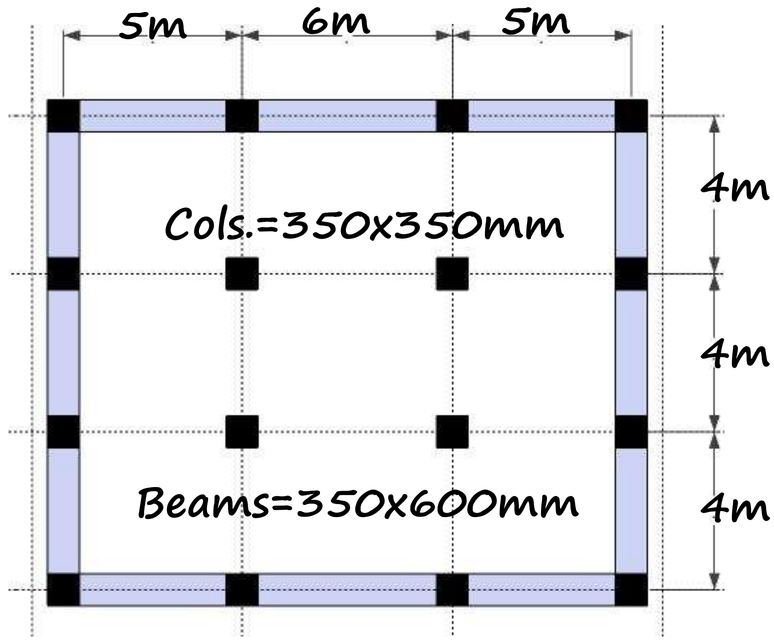
t=140mm>h_{min} O.K

Example (2)

Flat plate with edge beams ,fy=280 MPa, f'c=25 MPa check slab thickness for deflection control.

Sol.

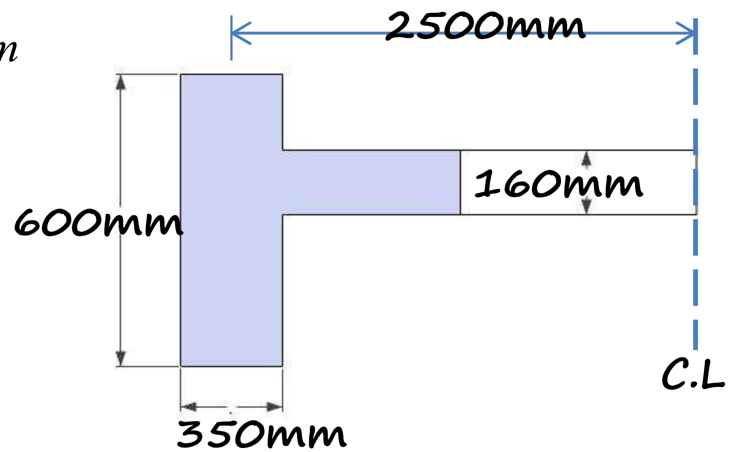
Check α_f for edge beam



$$I_b = \frac{350\times600^3}{12}\times1.5 = 9.45\times10^9\,mm^4$$

$$I_s = \frac{\left(2500+\frac{350}{2}\right)\times160^3}{12} = 9.13\times10^8\,mm^4$$

$$\alpha_f = \frac{9.45\times10^9}{9.13\times10^8} = 10.35 > 0.8$$ Slab with edge beam



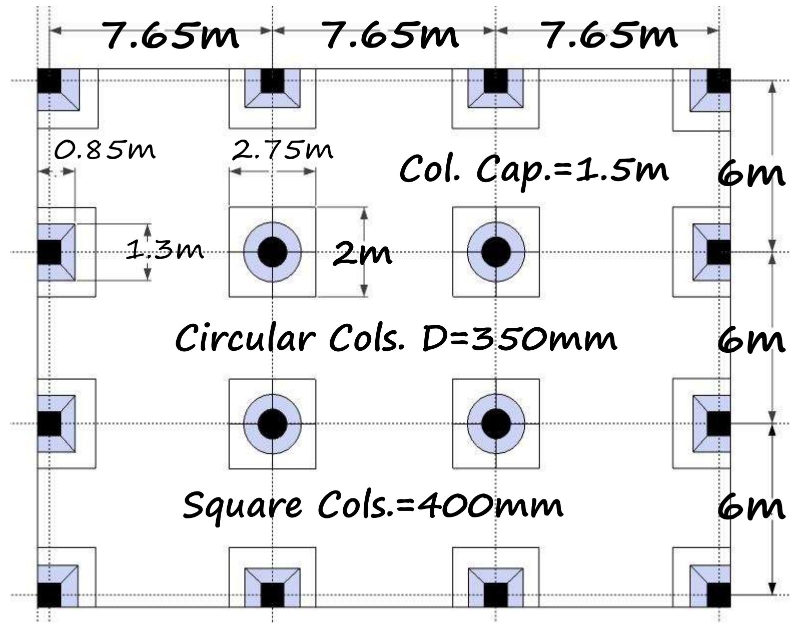
1. Exterior panels: $h = \frac{l_n}{36} = \frac{6000-350}{36} = 157mm > 125mm$

2. Interior panel: $h = \frac{l_n}{36} = \frac{6000-350}{36} = 157mm > 125mm$

Use h=160mm

Example (3)

Flat slab , t=190mm, t_{drop}=75mm, f'c=25 MPa, fy=350MPa, check slab thickness for deflection control.



Sol.

Check drop panel:

$$\frac{2.75}{2}=1.375m$$

$$\frac{l_1}{6}=\frac{7.65}{6}=1.275m$$

$1.375>1.275$ **O.K**

$$\frac{2}{2}=1,\frac{6}{6}=1\geq\frac{l}{6}$$ **O.K**

$$t_{drop}=75mm$$

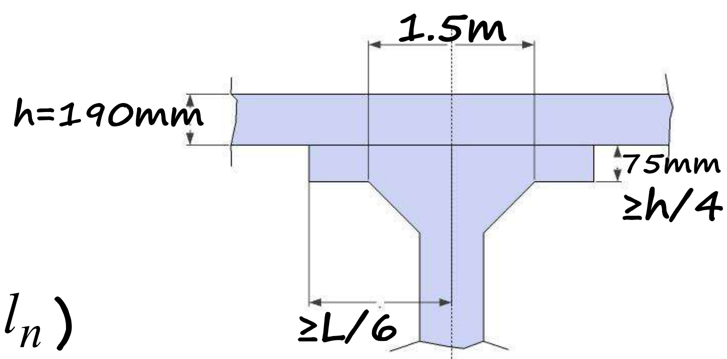
$$\frac{190}{4}=47.5mm$$

$75>47.5$ **O.K**

Interior panel:

$$l_n=\left(7650-\frac{0.89\times1500\times2}{2}\right)=6315mm>0.65l_1=0.65\times7650=4972.5$$

$$h_{\min}=\left[\frac{\frac{1}{36}-\frac{1}{40}}{420-280}(350-280)+\frac{1}{40}\right]\times6315=166.67>100mm$$



Exterior panel: (without edge beams)

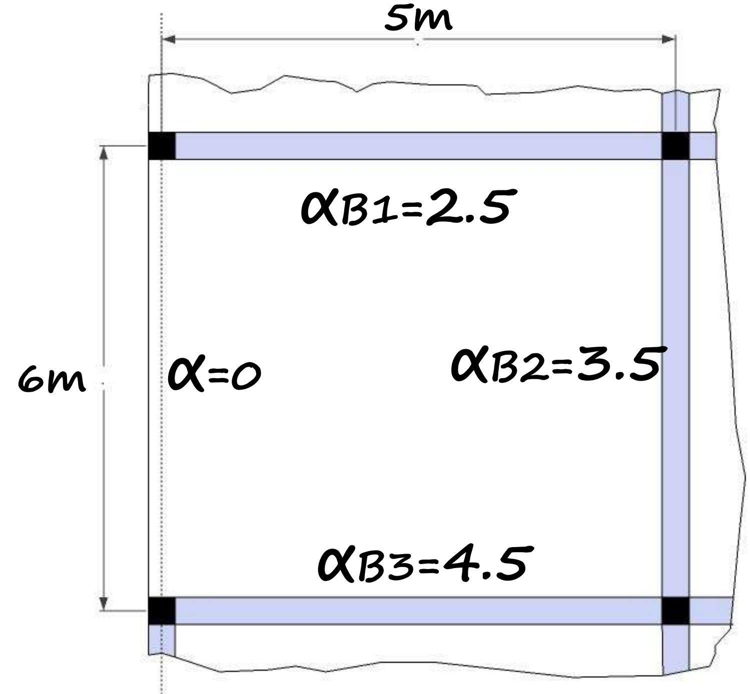
$$l_n=\left[7650-\frac{1300}{2}-(850-200)\right]=6350mm>0.65l_1$$ **(larger l_n)**

$$h_{\min}=\left[\frac{\frac{1}{33}-\frac{1}{36}}{420-280}(350-280)+\frac{1}{36}\right]\times6350=184.4>100mm$$

t=190mm>hmin O.K

Example (4)

Find the slab thickness for the panel shown, fy=350MPa, Col.=300x300mm.



Sol.

$$\alpha_m = \frac{2.5+3.5+4.5+0}{4} = 2.625$$

$$\alpha_m = 2.625 > 2$$

$$h_{min} = \frac{l_n(0.8+f_y/1400)}{36+9\beta}$$ (T 8.3.1.2)

$$\beta = \frac{6-0.3}{5-0.3} = 1.212$$

$$\alpha_{edge} = 0 < 0.8$$

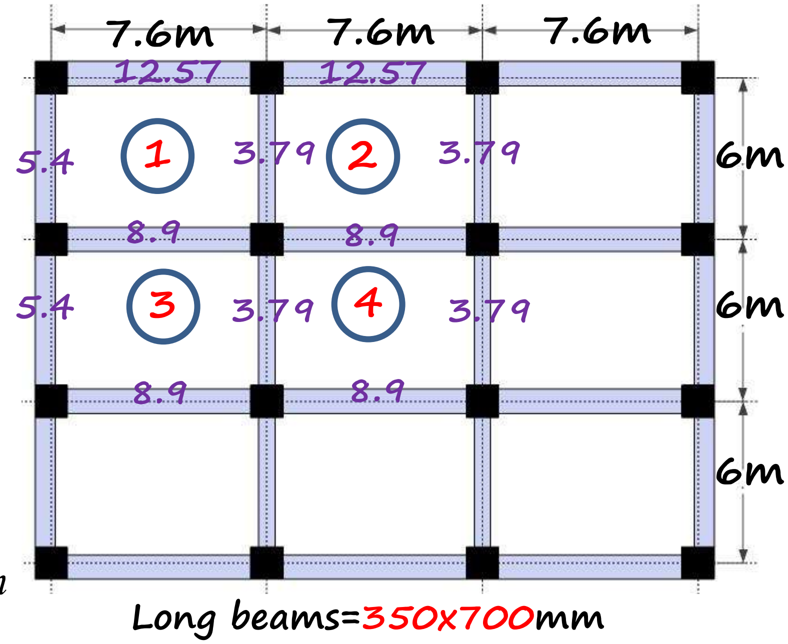
Increase slab thickness by 10% at least

$$\therefore h_{min} = 1.1 \times \frac{5700(0.8+350/1400)}{36+9\times 1.212} = 140.35mm > 90mm$$

Use h=150mm

Example (5)

check the slab thickness for deflection control if slab thickness =165mm and the values of flexural stiffness (αf) as shown on the beams in the figure., fy=420MPa, Cols.=375x375mm



Sol.

Find αm for each panel

Panel (1):

$$\alpha_m = \frac{12.57+3.79+8.9+5.4}{4} = 7.66 > 2$$

$$\beta = \frac{7600-375+75+37.5}{6000-375+25+12.5} = \frac{7337.5}{5662.5} = 1.29$$

$$h_{\min} = \frac{l_n\left(0.8+f_y/1400\right)}{36+9\beta} = \frac{7337.5(0.8+420/1400)}{36+9\times1.29} = 169.5mm > 90mm$$

Panel (2):

$$\alpha_m = \frac{12.57+3.79\times2+8.9}{4} = 7.26 > 2$$

$$\beta = \frac{7600-300}{6000-375+25+12.5} = \frac{7300}{5662.5} = 1.28$$

$$h_{\min} = \frac{l_n\left(0.8+f_y/1400\right)}{36+9\beta} = \frac{7300(0.8+420/1400)}{36+9\times1.28} = 168.6mm > 90mm$$

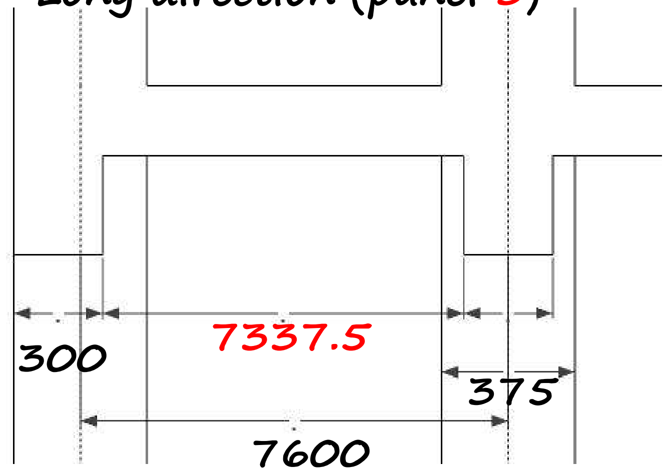
Panel (3):

$$\alpha_m = \frac{8.9\times2+3.79+5.4}{4} = 6.74 > 2$$

$$\beta = \frac{7600-375+75+37.5}{6000-350} = \frac{7337.5}{5650} = 1.298$$

$$h_{\min} = \frac{l_n(0.8+f_y/1400)}{36+9\beta} = \frac{7337.5(0.8+420/1400)}{36+9\times1.298} = 169.27mm > 90mm$$

Long direction (panel 3)



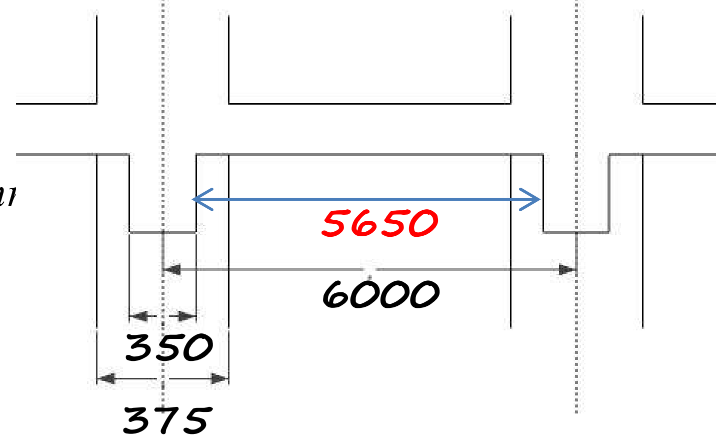
Panel (4):

$$\alpha_m = \frac{8.9\times2+3.79\times2}{4} = 6.34 > 2$$

$$\beta = \frac{7600-300}{6000-350} = \frac{7300}{5650} = 1.29$$

$$h_{\min} = \frac{l_n(0.8+f_y/1400)}{36+9\beta} = \frac{7300(0.8+420/1400)}{36+9\times1.29} = 168.66mm > 90m$$

Short direction (panel 4)



h_{min}=169.5 > 165 Not O.K