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2nd TASK: TWO-WAY SLAB SUPPORTED ON 4 SIDES

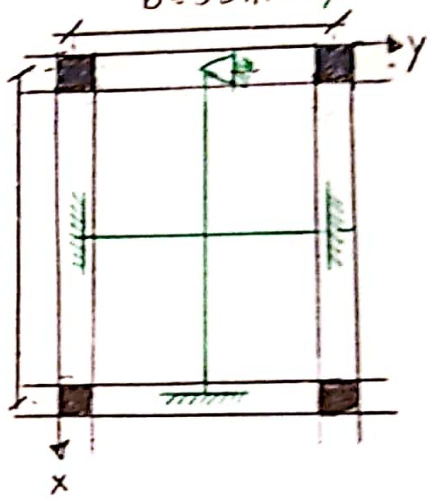
- DATA -

Scheme B
Member P2
$b = 5'5 m$
$a = 5'6 m$
$h_s = 180 mm$

Loads: $(g - g_c)_{floor,k} = 1'1 \ KN/m^2$
$q_{floor,k} = 2'9 \ KN/m^2$

Material: C 25/30
B500

Weight of the concrete = $25 \ KN/m^3$



- LOADS -

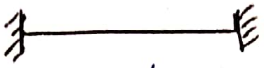
PERMANENT	K-VALUE [KN/m²]	γ	d-value [KN/m²]
self-weight $25 \frac{KN}{m^3} \cdot 0'18 \ m$	4'5	1'35	6'075
$(g - g_c)_{floor,k}$	1'1	1'35	1'485
VARIABLE			
$q_{floor,k}$	2'9	1'5	4'35
	8'5 KN/m²		11'91 KN/m²

- LINEAR ANALYSIS -

- $$f_{d,x} = \frac{f_d \cdot \frac{K_y}{K_x} \cdot \left(\frac{L_y}{L_x}\right)^4}{1 + \frac{K_y}{K_x} \cdot \left(\frac{L_y}{L_x}\right)^4}$$

- $$f_{d,y} = f_d - f_{d,x}$$

where K:



$K_y = \frac{1}{384}$

$K_x = \frac{2}{384}$

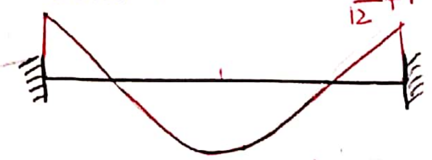
So: $$f_{dx} = \frac{11'91 \cdot \frac{1/384}{2/384} \cdot \left(\frac{5'5}{5'6}\right)^4}{1 + \frac{1/384}{2/384} \cdot \left(\frac{5'5}{5'6}\right)^4} = 3'78 \ KN/m^2$$

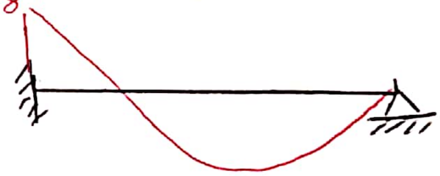
$$f_{d,y} = 11'91 - 3'78 = 8'13 \ KN$$

Therefore, the linear bending moments in the slab:

$\frac{1}{12} f l^2 = 20'5 \ KN$

$\frac{1}{8} f l^2 = 14'8 \ KN$



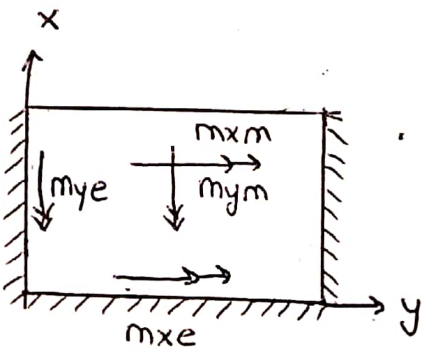


$\frac{1}{24} f l^2 = 10'25 \ KN$

$\frac{9}{128} f l^2 = 8'3 \ KN$

- $\frac{1}{12} \cdot f_{d,y} \cdot l_y^2 = \frac{1}{12} \cdot 8'13 \cdot 5'5^2 = 20'5 \ KN$
- $\frac{1}{8} f_{d,x} \cdot l_x^2 = \frac{1}{8} \cdot 3'78 \cdot 5'6^2 = 14'8 \ KN$
- $\frac{1}{24} \cdot 8'13 \cdot 5'5^2 = 10'25 \ KN$
- $\frac{9}{128} \cdot 3'78 \cdot 5'6^2 = 8'3 \ KN$

- PLASTIC ANALYSIS -



- $\frac{l_y}{l_x} \rightarrow \beta$

$\frac{5'6}{5'5} = 1'02$

l_x is the shorter span, in this case:

$l_x = 5'5 \ m$
$l_y = 5'6 \ m$

So, interpolating, I obtained from the table:

$\beta_{xe} = -0'041$

$\beta_{xm} = 0'0312$

$\beta_{ye} = -0'0296$

$\beta_{ym} = 0'0224$

The bending moments:

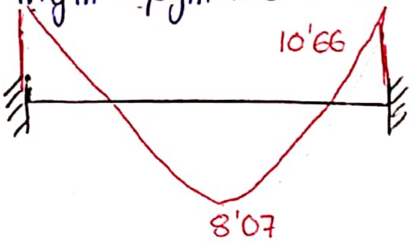
$$M_0 = f_d \cdot l_x^2 = 11'91 \cdot 5'5^2 = 360'27 \text{ KN}$$

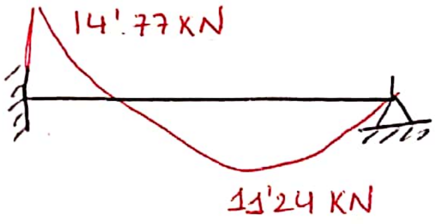
$$M_{xe} = \beta_{xe} \cdot M_0 = -0'041 \cdot 360'27 = -14'77 \text{ KN}$$

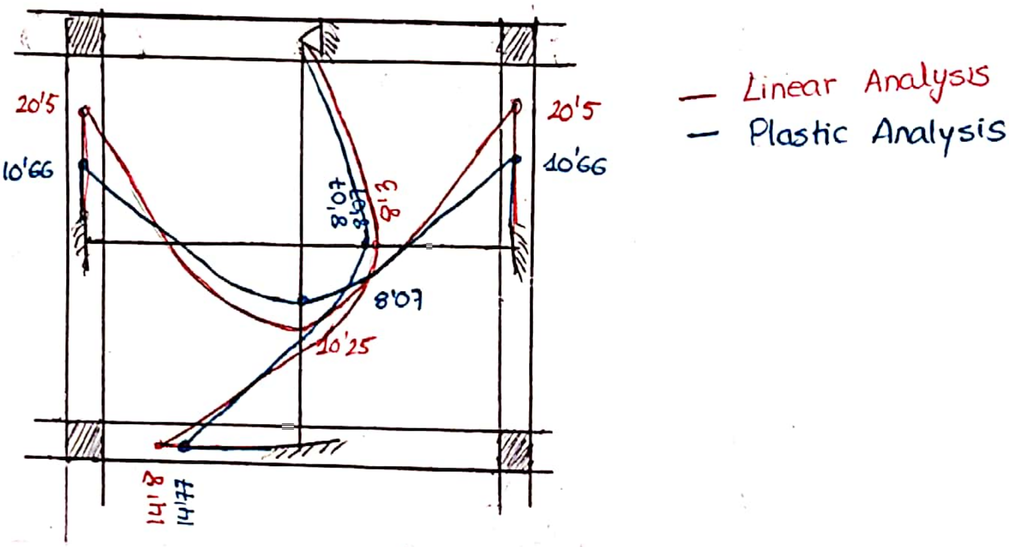
$$M_{xm} = \beta_{xm} \cdot M_0 = 0'0312 \cdot 360'27 = 11'24 \text{ KN}$$

$$M_{ye} = \beta_{ye} \cdot M_0 = -0'0296 \cdot 360'27 = -10'66 \text{ KN}$$

$$M_{ym} = \beta_{ym} \cdot M_0 = 0'0224 \cdot 360'27 = 8'07 \text{ KN}$$







– CHECK OF h_s –

$$a_{s,rqd} = \frac{M_{Ed,max}}{0'9 \cdot d \cdot f_{yd}} \quad \text{where } d = h_s - \frac{\phi}{2} - c$$

assuming rebars $\phi 10$ mm and a cover depth $c = 20$ mm (from frame structure)

$$d = 180 - \frac{10}{2} - 20 = 155 \text{ mm}$$

$$\rightarrow a_{s,rqd} = \frac{14'77}{0'9 \cdot 0'155 \cdot 434'78 e^{-3}} = 243'5 \text{ mm}^2$$

So, the depth of the compressed zone:

$$x = \frac{1'2 \cdot a_{s,rqd} \cdot f_{yd}}{0'8 \cdot b \cdot f_{cd}} \quad \text{where } b = 1000 \text{ mm for slabs}$$

$M_{Ed,max}$ from the plastic analysis:

$M_{Ed,max} = 14'77$ KN

- for S500

$$f_{yd} = \frac{500}{1'15} = 434'78 \text{ MPa}$$

- for C25/30

$$f_{cd} = \frac{25}{1'5} = 16'67 \text{ MPa}$$

$$x = \frac{1'2 \cdot 243'5 \cdot 434'78}{0'8 \cdot 1000 \cdot 16'67} = 9'52 \text{ mm}$$

1. $a_{s,rqd} \geq a_{s,min}$

$$a_{s,min} = \max\left(0'26 \frac{f_{ctm}}{f_{yk}} \cdot b_s \cdot h_s \; ; \; 0'0013 \cdot b_s \cdot h_s\right)$$

$f_{ctm} = 2'6$ MPa for C25/30

$$a_{s,min} = \max\left(0'26 \frac{2'6}{500} \cdot 1000 \cdot 180 \; ; \; 0'0013 \cdot 1000 \cdot 180\right)$$

$$a_{s,min} = \max(243'36 \; ; \; 234)$$

$$a_{s,min} = 243'36 \text{ mm}^2$$

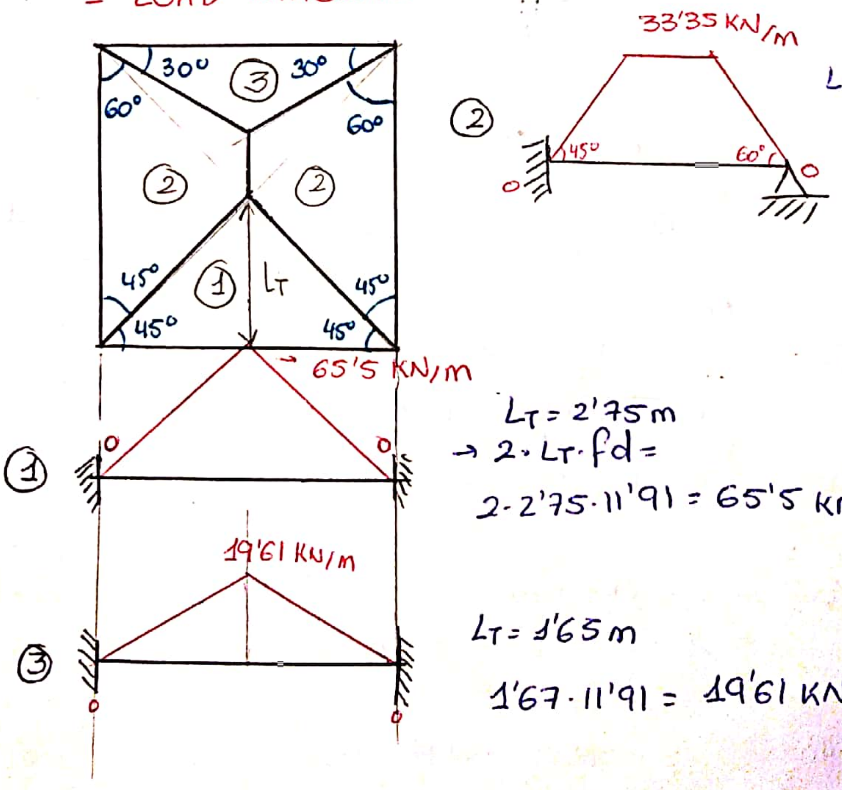
$$243'5 \text{ mm}^2 = a_{s,rqd} \geq a_{s,min} = 243'36 \text{ mm}^2 \checkmark$$

2. $\xi = \frac{x}{d} \leq 0'25$

$$\xi = \frac{9'52}{155} = 0'06 \leq 0'25 \checkmark$$

Therefore h_s is checked

– LOAD DIAGRAM –



$L_T = 2'8$ m

$2'8 \cdot 11'91 = 33'35$ KN/m

$L_T = 2'75$ m

$\to 2 \cdot L_T \cdot f_d =$

$2 \cdot 2'75 \cdot 11'91 = 65'5$ KN/m

$L_T = 1'65$ m

$1'67 \cdot 11'91 = 19'61$ KN