

$$W_u = 1.4DL + 1.7LL$$

DL..

$$\text{Concrete slabs} = 24 \times 60 = 3.84 \text{ KN/m}^2$$

$$\text{Concrete tiles} = 20 \times 0.04 = 0.8 \text{ kn/m}^2$$

$$\text{Soil} = 18 \times 0.15 = 2.7 \text{ kn/m}^2$$

$$\text{Sand} = 16.5 \times 0.03 = 0.5 \text{ kn/m}^2$$

$$DL = 7.84 \text{ kn/m}^2$$

$$LL = 2 \text{ kn/m}^2$$

$$W_u = 1.4 \times 7.84 + 1.7 \times 2$$

$$= 10.976 + 3.4 = 14.38 \text{ kn/m}^2$$

$$\text{Thick of slab} = 160 \text{ mm}$$

Design slab(1)

Lb

$$\frac{L_b}{L_a} = 7/6 = 1.167 < 2$$

La

| m | M ^{DL} | M ^{LL} | W |
|----------|-----------------|-----------------|---------|
| Ca=0.072 | Ca=0.028 | Ca=0.032 | Wa=0.72 |
| Cb=0.013 | Cb=0.013 | Cb=0.02 | Wb=0.21 |

Design as two way slab

Short direction

$$M_a^- = c_a \cdot w_u \cdot L_a^2$$

$$= 0.072 \times 14.38 \times (6)^2$$

$$= 37 \text{ kn.m}$$

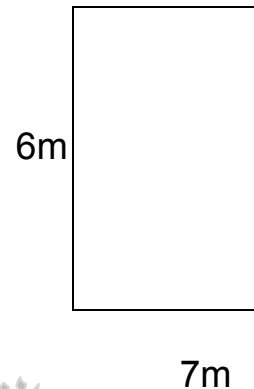
$$M_a^+ = (c_a \cdot DL \cdot w_u \cdot DL + c_a \cdot LL \cdot w_u \cdot LL) \cdot (L_a)^2$$

$$= (0.028 \times 10.976 + 0.032 \times 3.4) \cdot (6)^2$$

$$= 15 \text{ kn.m}$$

Moment in column strip = $\frac{2}{3} \cdot M$ middle

$$M^- = 0.67 \times 37 = 25 \text{ KN.M}$$



$$M^+ = .67 * 15 = 10 \text{KN.M}$$

Long direction

$$M_b^- = 0.021 * 14.38 * (7)^2 = 14.8 \text{kn.m}$$

$$M_b^+ = (0.013 * 10.796 + 0.02 * 3.4) * (7)^2 = 10.32 \text{kn.m}$$

$$M^- \text{ at discontinuous end} = 1/3 * M^+$$

$$= .33 * 10.32 = 3.44 \text{Kn.m}$$

Moment in column strip = $2/3 * M$ middle

$$= 0.67 * 14.8 = 9.86 \text{kn.m}$$

| | | |
|-------|--------|-------|
| -9.86 | -14.8 | -9.86 |
| +6.88 | +10.32 | +6.88 |
| -2.3 | -3.44 | -2.3 |

Long direction

| | | |
|-----|-----|-----|
| -25 | +10 | -25 |
| -37 | +15 | -37 |
| -25 | +10 | -25 |

short direction

Short direction

$$d_a = 160 - 20 - 12/2 = 134 \text{mm}$$

$$\text{Max moment} = 37 \text{kn.m}$$

$$P = 5.78 * 10^{-3} \quad f_c = 25 \text{mpa}$$

$$b = 1000 \text{mm} \quad d = 134 \text{mm}$$

$$\rho_{min} = \frac{1.4}{420} = .033$$

$$\rho_{max} = .75 * \rho_b = 0.02$$

$$\rho_{min} < \rho < \rho_{max}$$

$$A_s = 5.78 * 10^{-3} * 1000 * 134$$

$$A_s = 774.52 \text{mm}^2$$

$$S = \text{MIN} \left(\frac{113}{774.52} * 1000, 2 * 160, 500 \right)$$

$$= \text{MIN}(150, 320, 500)$$

$$S = 150 \text{mm}$$

$$\text{no of bars} = \frac{A_s}{A_B} = \frac{750.4}{113} = 7 \text{bar@each}(1\text{m})$$

Short direction
max moment=14.8KN.M

$$\rho = 0.003$$

$$\rho_{min} < \rho < \rho_{max}$$

$$AS=3.3*10^{-3}*1000*122=403MM^2$$

Middle strip space

$$S = MIN \left(\frac{113}{403} * 1000, 2 * 160, 500 \right)$$

$$S=MIN(280,320,500)$$

$$S=280MM$$

$$\text{No of bars}=403/113=4\text{bars @each}(1m)$$

When $f_c=50\text{mpa}$

$$\rho = 0.00267$$

$$\rho = \rho_{MIN} = 0.033$$

$$AS=3.3*10^{-3}*1000*122$$

$$=403\text{mm}^2$$

$$S=\min(113/403*1000, 2*160, 500)$$

$$=\min(280,320,500)$$

$$S=280\text{mm}$$

$$\text{No of bars}=403/113=4 \text{ bars@ each}(1m)$$

CHECK SHEAR

$$W=w_u*La*L_b$$

$$=14.38*6*7$$

$$W=604$$

$$W_a=W* w_a$$

$$=604*0.79=477$$

$$W_b=W*w_b$$

$$W_b = 604 * 0.21$$

$$W_b = 127$$

$$V_a = W_a / 2L_b = 477 / 14$$

$$V_a = 34 \text{ kn}$$

$$V_b = W_b / 2L_a = 127 / 12 = 11 \text{ kn}$$

$$V_a > V_b$$

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$$\frac{(V_a - w_u * w_a * d_a)}{\phi} = \frac{34 - 14.38 * 0.79 * 0.134}{0.85}$$
$$= 38.2 \text{ kn}$$

$$V_c = 0.17 * \sqrt{f_c} * b * d_{ave}$$

$$f_c = 25 \text{ mpa}$$

$$V_c = 108.8 \text{ kn more than } 38.2 \text{ kn} \dots \text{ok}$$

$$f_c' = 50 \text{ mpa}$$

$$V_c = 154 \text{ kn more than } 38.2 \text{ kn} \dots \text{ok}$$

DESIGN SLAB(2)

$$L_b / L_a = 7.25 / 6 = 1.3$$

Design two way slab

$$M = L_a / L_b = 6 / 7.25 = 0.75$$

Short direction

$$M_a^- = c_a * w_u * l_a^2$$

$$= 0.078 * 14.38 * (6)^2 = 40.38 \text{ kn.m}$$

$$M_a^+ = [c_a, DL * w_u, DL + c_a, LL * w_u, LL] * (l_a)^2$$

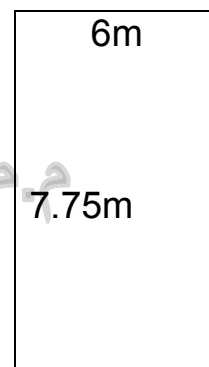
$$= 0.031 * 10.796 + 0.046 * 3.4 * (6)^2 = 17.88 \text{ kn.m}$$

Moment in column strip = 2/3 * M middle

$$M^- = 2/3 * 40.38 = 26.92 \text{ kn.m}$$

$$M^+ = 2/3 * 17.88 = 11.92 \text{ kn.m}$$

| | M ⁻ | M ⁺ DL | M ⁺ LL | W load |
|--|----------------|-------------------|-------------------|---------|
| | Ca=0.073 | Ca=0.031 | Ca=0.046 | Wa=0.86 |
| | Cb=0.014 | Cb=0.007 | Cb=0.013 | Wb=0.14 |



Long direction

$$M_b^- = c_b \cdot w_u \cdot L_b^2$$

$$= 0.014 \cdot 14.38 \cdot (7.75)^2 = 12 \text{ kn.m}$$

$$M_b^+ = [0.007 \cdot 10.976 + 0.013 \cdot 3.4] \cdot (7.75)^2 = 7.27 \text{ kn.m}$$

$$M^- \text{ at discontinuous end} = 1/3 \cdot M^+$$

$$= 1/3 \cdot 2.27 [2.42 \text{ kn.m}]$$

$$M \text{ in column strip} = 2/3 \cdot M \text{ middle}$$

$$= 0.67 \cdot 2.42 = 1.61 \text{ kn.m}$$

$$M^- = 0.67 \cdot 12 = 8 \text{ kn.m}$$

$$M^+ = 0.67 \cdot 7.27 = 4.85 \text{ kn.m}$$

short direction

$$d_a = 160 - 20 - 12/2 = 134 \text{ mm}$$

$$\text{max moment} = 40.38 \text{ kn.m}$$

$$\rho = 0.00635$$

$$\rho_{min} = .0033$$

$$\rho_{max} = 0.02$$

$$\rho_{min} < \rho < \rho_{max}$$

$$A_s = 0.00635 \cdot 1000 \cdot 134$$

$$A_s = 851 \text{ mm}^2$$

$$S = \min[113/851 \cdot 1000, 2 \cdot 160, 500]$$

$$S = 130 \text{ mm}$$

$$\text{No of bars} = 851/113 = 8 \text{ bars@ each(1m)}$$

$$F_c' = 50 \text{ mpa}$$

$$\text{Max moment} = 40.38 \text{ kn.m}$$

| | | |
|-------|-------|-------|
| -1.16 | -2.42 | -1.16 |
| +4.85 | +7.27 | +4.85 |
| -8 | -12 | -8 |

Long direction

| | | |
|--------|--------|--------|
| -26.92 | +11.92 | -26.92 |
| -40.38 | +17.88 | -40.38 |
| -26.92 | +11.92 | -26.92 |

$$\rho = 0.00613$$

$$\rho_{min} = 0.0033$$

$$\rho_{max} = 0.04$$

$$\rho_{min} < \rho < \rho_{max}$$

$$A_s = \rho * b * d$$

$$A_s = 0.00613 * 1000 * 134$$

$$A_s = 821.42 \text{mm}^2$$

$$S = \min[113 * 821.42 * 1000, 2 * 160,500]$$

$$S = 130 \text{mm}$$

$$\text{No of bars} = 821.42 / 113 = 8 \text{ bars@ each (1m)}$$

Long direction

$$d_b = 122 \text{mm}$$

$$\text{max moment} = 12 \text{kn.m}$$

$$f_c' = 25 \text{mpa}$$

$$\rho = 0.00218$$

$$\rho_{min} > \rho$$

$$\rho_{min} = \rho$$

$$A_s = \rho * b * d$$

$$A_s = 0.0033 * 1000 * 122$$

$$A_s = 403 \text{mm}^2$$

$$S = [113 / 403 * 1000, 2 * 160,500]$$

$$S = 280 \text{mm}$$

$$\text{No of bars} = 403 / 113 = 4 \text{ bars@ each (1m)}$$

$$f_c' = 50 \text{mpa}$$

$$\rho = 0.0022$$

$$\rho_{min} = \rho$$

$$A_s = \rho * b * d$$

$$A_s = 0.0033 \times 1000 \times 122$$

$$A_s = 403 \text{ mm}^2$$

$$S = [113 / 403 \times 1000, 2 \times 160, 500]$$

$$S = 280 \text{ mm}$$

$$\text{No of bars} = 403 / 113 = 4 \text{ bars @ each (1m)}$$

CHECK SHEAR

$$W = w_u \times L_a \times L_b$$

$$W = 14.38 \times 6 \times 7.75$$

$$W = 668$$

$$W_a = W \times w_a = 668 \times 0.86 = 574$$

$$W_b = W \times w_b = 668 \times 0.14 = 94$$

$$V_a = W_a / 2L_b = 574 / 2 \times 7.75 = 37$$

$$V_b = W_b / 2L_a = 94 / 12 = 7.83$$

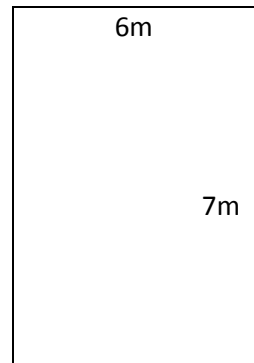
$$V_A > V_B$$

$$\frac{V_a - w_u \times w_a \times d_a}{\phi} = \frac{37 - 14.38 \times 0.86 \times 0.134}{0.85} = 42 \text{ kn}$$

$$V_c = 0.17 \times \sqrt{f_c'} \times b \times d = 108.8 \text{ kn} > 42 \text{ kn} \dots \text{ok}$$

$$f_c' = 50 \text{ mpa}$$

$$v_c = 154 \text{ kn} > 42 \text{ kn}$$



DESIGN SLAB(3)

$$L_b / L_a = 7 / 6 = 1.167$$

Design two way slab

$$M = L_a / L_b = 6 / 7 = 0.85$$

| M ⁻ | M ^{+DL} | M ^{+LL} | W Load |
|----------------------|----------------------|----------------------|--------------------|
| Ca=0.065 Cb=0.034 | Ca=0.036 Cb=0.019 | Ca=0.043 Cb=0.023 | Wa=0.66 Wb=0.34 |

Short direction

$$M_a^- = c_a * w_u * L_a^2 = 0.065 * 14.38 * (6)^2 = 33.65 \text{ kn.m}$$

$$M_a^+ = [0.036 * 10.976 + 0.043 * 3.4] * (6)^2 = 19.48 \text{ kn.m}$$

$$M^- \text{ at discontinuous end} = 1/3 * M^+ \\ = 1/3 * 19.48 = 6.5 \text{ kn.m}$$

Moment in column strip = $2/3 * M$ middle

$$M^- = 2/3 * 6.5 = 4.33 \text{ kn.m}$$

$$M^- = 2/3 * 33.65 = 22.43 \text{ kn.m}$$

$$M^+ = 2/3 * 19.48 \text{ kn.m}$$

Long direction

$$M_b^- = 0.034 * 14.38 * (7)^2 = 24 \text{ kn.m}$$

$$M_b^+ = [0.019 * 10.976 + 0.023 * 3.4] * (7)^2 = 14 \text{ kn.m}$$

$$M^- \text{ at discontinuous end} = 1/3 * M^+ \\ = 1/3 * 14 = 4.67 \text{ kn.m}$$

Moment in column strip = $2/3 * M$ middle

$$M^- = 2/3 * 4.67 = 3 \text{ kn.m}$$

$$M^- = 2/3 * 24 = 16 \text{ kn.m}$$

$$M^+ = 2/3 * 14 = 9.33 \text{ kn.m}$$

short direction

$$d_a = 134 \text{ mm}$$

$$\text{max moment} = 33.65 \text{ kn.m}$$

$$f_c = 25 \text{ mpa}$$

$$\rho = 0.00523$$

$$\rho_{min} < \rho < \rho_{max}$$

$$A_s = \rho * b * d$$

| | | |
|-------|-------|-------|
| -16 | -24 | -16 |
| +9.33 | +14 | +9.33 |
| -3 | -4.67 | -3 |

| | | |
|--------|--------|-------|
| -22.43 | +9.65 | -4.33 |
| -33.65 | +19.48 | -6.5 |
| -22.43 | +9.65 | -4.33 |

$$A_s = 0.00523 \cdot 1000 \cdot 134 = 700$$

$$S = \min[113/700 \cdot 1000, 2 \cdot 160, 500]$$

$$S = 160 \text{ mm}$$

$$\text{No of bars} = 700/113 = 7 \text{ bars @ each (1m)}$$

$$f_c' = 50 \text{ mpa}$$

$$mu = 33.65 \text{ kn.m}$$

$$\rho = 0.0051$$

$$\rho_{min} < \rho < \rho_{max}$$

$$A_s = \rho \cdot b \cdot d$$

$$A_s = 0.0051 \cdot 1000 \cdot 134$$

$$A_s = 683.4 \text{ mm}^2$$

$$S = [1000 \cdot 113/683.4, 2 \cdot 160, 500]$$

$$S = 160 \text{ mm}$$

$$\text{No of bars} = 683.4/113 = 7 \text{ bars @ each (1m)}$$

Long direction

$$d_b = 122 \text{ mm}$$

$$\text{max moment} = 24 \text{ kn.m}$$

$$\rho = 0.0045$$

$$\rho_{min} < \rho < \rho_{max}$$

$$A_s = \rho \cdot b \cdot d$$

$$A_s = 0.0045 \cdot 1000 \cdot 122$$

$$A_s = 549 \text{ mm}^2$$

$$S = [113/549 \cdot 1000, 2 \cdot 160, 500]$$

$$S = 200 \text{ mm}$$

$$\text{No of bars} = 549/113 = 5 \text{ bars @ each (1m)}$$

$$f_c' = 50 \text{ mpa}$$

$$mu = 24 \text{ kn.m}$$

$$\rho = 0.00436$$

$$\rho_{min} < \rho < \rho_{max}$$

$$A_s = \rho * b * d$$

$$A_s = 0.00436 * 1000 * 122$$

$$A_s = 532 \text{ mm}^2$$

$$S = [113 / 532 * 1000, 2 * 160 * 500]$$

$$S = 210 \text{ mm}$$

$$\text{No of bars} = 532 / 113 = 5 \text{ bars @ each (1m)}$$

CHECK SHEAR

$$W = w_u * L_a * L_b$$

$$W = 14.38 * 6 * 7 = 604$$

$$W_a = W * w_a$$

$$W_a = 604 * 0.66 = 398.84$$

$$W_b = W * w_b$$

$$W_b = 604 * 0.34 = 205.36$$

$$V_a = 398.84 / 2 * 7 = 28$$

$$V_b = 205.36 / 2 * 6 = 17$$

$$V_a > V_b$$

$$\frac{V_a - w_u * w_a * d}{\phi} = \frac{28 - 14.38 * 0.66 * 0.134}{0.85} = 31 \text{ kn}$$

$$V_c = 0.17 \sqrt{25} * 1000 * 128 = 108.8 > 31 \text{ kn}$$

$$f_c' = 50 \text{ mpa}$$

$$V_c = 154 \text{ kn} > 31 \text{ kn} \quad \dots \dots \text{ok}$$

DESIGN SLAB(4)

$$L_b/L_a=5.15/4=1.28$$

Design two way slab

$$M=La/L_b=4/5.15=0.75$$

Short direction

$$M_a^- = 0.088 * 14.38 * (4)^2$$

$$M_a^- = 20.24 \text{ kn.m}$$

$$M_a^+ = [0.048 * 10.976 + 0.055 * 3.4] * (4)^2$$

$$M_a^+ = 11.42 \text{ kn.m}$$

Long direction

$$M_b^- = 0.024 * 14.38 * (5.15)^2$$

$$M_b^- = 9.15 \text{ kn.m}$$

$$M_b^+ = [0.012 * 10.976 + 0.016 * 3.4] * (5.15)^2$$

$$M_b^+ = 5 \text{ KN.M}$$

Short direction

$$d_a = 134 \text{ mm}$$

$$\text{Max moment} = 20.24 \text{ kn.m}$$

$$f_c = 25 \text{ MPa}$$

$$\rho = 0.0031$$

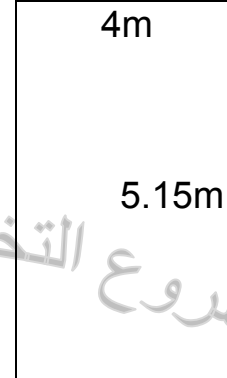
$$\rho = \rho_{min}$$

$$\rho = .0033$$

$$A_s = \rho * b * d$$

$$A_s = .0033 * 1000 * 134$$

$$A_s = 442.2 \text{ mm}^2$$



مشروع التخرج لنيل درجة البكالوريوس
اعداد
سبأ عمران
مروة فائق

محمد عبد خلهن

سجى عدنان
نسور كمال

اشراف

م.م. علي عبد سلطان

| M ⁻ | M ⁺ DL | M ⁺ LL | W load |
|----------------------|----------------------|----------------------|--------------------|
| Ca=0.088 Cb=0.024 | Ca=0.048 Cb=0.012 | Ca=0.055 Cb=0.016 | Wa=0.88 Wb=0.12 |

$$S=[113/442.2*1000,2*160,500]$$

$$S=250\text{mm}$$

$$\text{No of bars}=442.2/113=4 \text{ bars@ each}(1\text{m})$$

$$FC^{\prime} = 50\text{mpa}$$

$$\rho = 0.0031$$

$$\rho_{min} > \rho$$

$$AS = \rho * b * d$$

$$AS=0.0033*1000*134$$

$$AS=442.2\text{mm}^2$$

$$S=[113/442.2*1000,2*160,500]$$

$$S=250\text{mm}$$

$$\text{No of bars}=442.2/113=4 \text{ bars@ each}(1\text{m})$$

Long direction

$$db=122\text{mm}$$

$$\text{max moment}=5\text{kn.m}$$

$$FC^{\prime} = 25\text{mpa}$$

$$\rho = 0.00896$$

$$\rho_{min} > \rho$$

$$AS = \rho * b * d$$

$$AS=.0033*1000*122$$

$$AS=403\text{mm}^2$$

$$S=[113/403*1000,2/160,500]$$

$$S=280\text{mm}$$

$$\text{No of bars}=403/113=4\text{bars@each}(1\text{m})$$

CHECK SHEAR

$$W=w_u \cdot L_a \cdot L_b$$

$$W=14.38 \cdot 4 \cdot 5.15$$

$$W=296$$

$$W_a=W \cdot w_a=296 \cdot 0.88=260$$

$$W_b=W \cdot w_b=296 \cdot 0.12=36$$

$$V_a=W_a/2L_b=260/2 \cdot 5.15=25 \text{ kn}$$

$$V_b=W_b/2L_a=36/2 \cdot 4=4.5 \text{ kn}$$

$$V_a > V_b$$

$$\frac{V_a - w_u \cdot w_a \cdot d}{\phi} = \frac{25 - 14.38 \cdot 0.88 \cdot 0.134}{0.85} = 27.42 \text{ kn}$$

$$V_c = 0.17 \cdot \sqrt{f_c'} \cdot b \cdot d$$

$$f_c' = 25 \text{ mpa}$$

$$V_c = 108.8 \text{ kn} > 27.42 \text{ kn} \dots \dots \dots \text{ok}$$

$$f_c' = 50 \text{ mpa}$$

$$V_c = 154 \text{ kn} > 27.42 \text{ kn} \dots \dots \dots \text{ok}$$

DESIGN SLAB(5)

$$L_b/L_a=4/3.25=1.2$$

Design two way slab

$$M=3.25/4=0.8$$

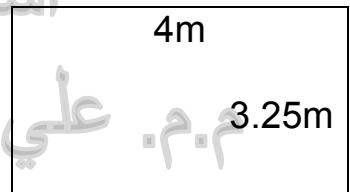
Short direction

$$M_a^- = 0.065 \cdot 14.38 \cdot (3.25)^2$$

$$M_a^- = 9.87 \text{ kn.m}$$

$$M_a^+ = [0.026 \cdot 10.976 + 0.041 \cdot 3.4] \cdot (3.25)^2$$

$$M_a^+ = 4.5 \text{ kn.m}$$



| M ⁻ | M ⁺ DL | M ⁺ LL | W load |
|----------------------|----------------------|----------------------|--------------------|
| Ca=0.026 Cb=0.011 | Ca=0.026 Cb=0.014 | Ca=0.041 Cb=0.017 | Wa=0.71 Wb=0.29 |

Long direction

$$M_b^- = 0.026 * 14.38 * (4)^2$$

$$M_b^+ = [0.011 * 10.976 + 0.017 * 3.4] * (4)^2$$

$$M_b^+ = 2.9 \text{ kn.m}$$

| | | |
|-------|-------|-------|
| -6.58 | -9.87 | -6.58 |
| +0.75 | +4.5 | +0.75 |
| -6.58 | -9.87 | -6.58 |

Short direction

SHORT DIRECTION

$$d_a = 134 \text{ mm}$$

$$\text{max moment} = 9.87 \text{ kn.m}$$

$$f_c = 25 \text{ mpa}$$

$$\rho = 0.00147$$

$$\rho_{min} > \rho$$

$$A_s = \rho_{min} * b * d$$

$$A_s = 0.0033 * 1000 * 134$$

$$A_s = 442.2 \text{ mm}^2$$

$$S = [113 / 442.2 * 1000, 2 * 160, 500]$$

$$S = 250 \text{ mm}$$

$$\text{No of bars} = 442.2 / 113 = 4 \text{ bars @ each (1m)}$$

$$f_c = 50 \text{ mpa}$$

$$mu = 9.87 \text{ kn.m}$$

$$\rho = 0.00146$$

$$\rho_{min} > \rho$$

$$A_s = \rho * b * d$$

$$A_s = 0.0033 * 1000 * 134$$

$$A_s = 442.2 \text{ mm}^2$$

$$S = \min[113 / 442.2 * 1000, 2 * 160, 500]$$

| | | |
|-------|-------|-------|
| -4.13 | +1.93 | -4.13 |
| -6.2 | +2.9 | -6.2 |
| -4.13 | +1.93 | -4.13 |

Long direction

$$S=250\text{mm}$$

$$\text{No of bars} = 442.2/113 = 4 \text{ bars @ each}(1\text{m})$$

LONG DIRECTION

$$d_b = 122\text{mm}$$

$$\text{max moment} = 6.2\text{kn.m}$$

$$f_c = 25\text{mpa}$$

$$\rho = 0.0011$$

$$\rho_{min} > \rho$$

$$AS = \rho * b * d$$

$$AS = 0.0033 * 1000 * 122$$

$$AS = 403\text{mm}^2$$

$$S = \min[1000 * 113 / 403, 2 * 160, 500]$$

$$S = 280\text{mm}$$

$$\text{No of bars} = 403/113 = 4 \text{ bars @ each}(1\text{m})$$

$$f_c = 50\text{mpa}$$

$$mu = 6.2\text{kn.m}$$

$$\rho = 0.0011$$

$$\rho_{min} > \rho$$

$$As = \rho * b * d$$

$$AS = 0.0033 * 1000 * 122$$

$$AS = 403\text{mm}^2$$

$$S = \min[1000 * 113 / 403, 2 * 160, 500]$$

$$S = 280\text{mm}$$

$$\text{No of bars} = 403/113 = 4 \text{ bars @ each}(1\text{m})$$

CHECK SHEAR

$$W = w_u * L_a * L_b$$

$$W = 14.38 * 3.25 * 4$$

$$W = 187$$

$$W_a = W * w_a$$

$$W_a = 187 * 0.71 = 133$$

$$W_b = W * w_b$$

$$W_b = 187 * 0.29 = 54$$

$$V_a = W_a / 2L_b$$

$$V_a = 133 / 2 * 4 = 17$$

$$V_b = W_b / 2L_a$$

$$V_b = 54 / 2 * 3.25 = 8.3$$

$$V_a > V_b$$

$$\frac{V_a - w_u * w_a * d}{\phi} = \frac{17 - 14.38 * 0.71 * 0.134}{0.85}$$
$$= 18.4kn$$

هنا المعادلة اكتب $c = 0.17 * \sqrt{f_c} * b * d$

$$f_c = 25mpa$$

$$V_c = 108.8kn > 18.4kn \dots\dots ok$$

$$f_c = 50mpa$$

$$V_c = 154kn > 18.4kn \dots\dots ok$$

DESIGN SLAB(6)

$$L_b/L_a = 5.15/1.75 = 2.9 > 2$$

Design one way slab

$$d = t - \text{cover} - 12/2$$

$$d = 160 - 20 - 6 = 134 \text{ mm}$$

thickness of slab = 160 mm

$$m_u = w_u * \frac{l_n^2}{10} = 14.38 * \frac{(1.75)^2}{10} = 4.4 \text{ kn.m}$$

$$m_u = w_u * \frac{l_n^2}{11} = 14.38 * \frac{(1.75)^2}{11} = 4 \text{ kn.m}$$

$$m_u = w_u * \frac{l_n^2}{16} = 14.38 * \frac{(1.75)^2}{16} = 2.75 \text{ kn}$$

$$\text{max momen} = 4.4 \text{ kn.m}$$

$$f_c' = 25 \text{ mpa}$$

$$\rho = .00065$$

$$\rho_{min} > \rho$$

$$A_s = \rho_{min} * b * d$$

$$A_s = 0.0033 * 1000 * 134$$

$$A_s = 442.2 \text{ mm}^2$$

$$S = \min[1000 * 113 / 442.2, 2 * 160, 500]$$

$$S = 250 \text{ mm}$$

Spacing for shrinkage and temperature

$$S = \min[1000 * 113 / 288.5, 2 * 160, 500]$$

$$S = 460 \text{ mm}$$

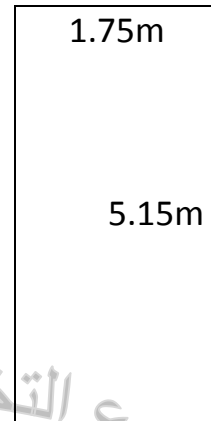
No of bars = $442.2 / 113 = 4$ bars @ each (1m)

$$f_c' = 50 \text{ mpa}$$

$$\rho = 0.00065$$

$$\rho_{min} > \rho$$

$$A_s = \rho * b * d$$



$$A_s = 0.0033 \cdot 1000 \cdot 134$$

$$A_s = 442.2 \text{ mm}^2$$

$$S_{\text{main}} = 250 \text{ mm}$$

$$S_{\text{shrinkage}} = 460 \text{ mm}$$

No of bars = 4 bars @ each (1m)

DESIGN SLAB (7)

$$L_b/L_a = 6/3.25 = 1.8$$

Design two way slab

$$M = 3.25/6 = 0.55$$

Short direction

$$M_a^- = 0.084 \cdot 14.38 \cdot (3.25)^2$$

$$M_a^- = 12.75 \text{ kn.m}$$

$$M_a^+ = [0.035 \cdot 10.976 + 0.062 \cdot 3.4] \cdot (3.25)^2$$

$$M_a^+ = 6.3 \text{ kn.m}$$

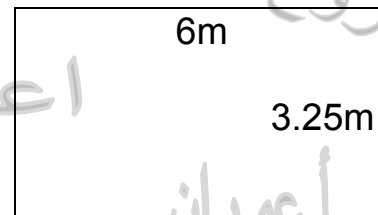
Long direction

$$M_b^- = 0.007 \cdot 14.38 \cdot (6)^2$$

$$M_b^- = 3.6 \text{ kn.m}$$

$$M_b^+ = [0.003 \cdot 10.976 + 0.006 \cdot 3.4] \cdot (6)^2$$

$$M_b^+ = 1.92 \text{ kn.m}$$



| M^- | $M^+ \text{ DL}$ | $M^+ \text{ LL}$ | W load |
|--------------------------------|--------------------------------|--------------------------------|------------------------------|
| $C_a = 0.084$ $C_b = 0.007$ | $C_a = 0.035$ $C_b = 0.003$ | $C_a = 0.062$ $C_b = 0.006$ | $W_a = 0.92$ $W_b = 0.08$ |

SHORT DIRECTION

$$d_a = 134 \text{ mm}$$

$$\text{max moment} = 12.76 \text{ kn.m}$$

$$f_c' = 25 \text{ mpa}$$

$$\rho = 0.00192$$

$$\rho_{min} > \rho$$

$$A_s = \rho * b * d$$

$$A_s = 0.003 * 1000 * 134$$

$$A_s = 442.2 \text{ mm}^2$$

$$S = \min[1000 * 113 / 442.2, 2 * 160, 500]$$

$$S = 250 \text{ mm}$$

$$\text{No of bars} = 442.2 / 113 = 4 \text{ bars @ each (1m)}$$

$$f_c' = 50 \text{ mpa}$$

$$mu = 12.76 \text{ kn.m}$$

$$\rho = 0.00189$$

$$\rho_{min} > \rho$$

$$A_s = \rho * b * d$$

$$A_s = 0.0033 * 1000 * 134$$

$$A_s = 442.2 \text{ mm}^2$$

$$S = \min[1000 * 113 / 442.2, 2 * 160, 500]$$

$$S = 250 \text{ mm}$$

$$\text{No of bars} = 442.2 / 113 = 4 \text{ bars @ each (1m)}$$

LONG DIRECTION

$$d_b = 122 \text{ mm}$$

$$\text{max moment} = 3.6 \text{ kn.m}$$

| | | |
|------|-------|------|
| -2.4 | +1.28 | -2.4 |
| -3.6 | +1.92 | -3.6 |
| -2.4 | +1.28 | -2.4 |

Long direction

| | | |
|------|--------|------|
| -8.5 | -12.76 | -8.5 |
| +4.2 | +6.3 | +4.2 |
| -8.5 | -12.76 | -8.5 |

Short direction

$$f_c' = 25 \text{ mpa}$$

$$\rho = 0.000644$$

$$\rho_{min} > \rho$$

$$AS = \rho * b * d$$

$$AS = 0.003 * 1000 * 122$$

$$AS = 403 \text{ mm}^2$$

$$S = \min[1000 * 113 / 403, 2 * 160, 500]$$

$$S = 280 \text{ mm}$$

$$\text{No of bars} = 403 / 113 = 4 \text{ bars @ each (1m)}$$

$$f_c' = 50 \text{ mpa}$$

$$\mu = 3.6 \text{ kn.m}$$

$$\rho = 0.00064$$

$$\rho_{min} > \rho$$

$$AS = \rho_{min} * b * d$$

$$AS = 0.003 * 1000 * 122$$

$$AS = 403 \text{ mm}^2$$

$$S = \min[1000 * 113 / 403, 2 * 160, 500]$$

$$S = 280 \text{ mm}$$

$$\text{No of bars} = 403 / 113 = 4 \text{ bars @ each (1m)}$$

CHECK SHEAR

$$W = w_u * L_a * L_b$$

$$W = 14.38 * 6 * 3.25$$

$$W = 280 \text{ mm}$$

$$W_a = W * w_a$$

$$W_a = 280 * 0.91 = 255$$

$$W_b = W * w_b$$

$$W_b = 280 * 0.08 = 22$$

$$V_a = W_a / 2L_b = 255 / 2 * 6 = 21.3$$

$$V_b = W_b / 2L_a = 22 / 2 * 3.25 = 3.4$$

$$V_a > V_b$$

$$\frac{V_a - w_u * w_a * d}{\phi} = \frac{21.3 - 14.38 * 0.92 * 0.134}{0.085} = 23 \text{kn}$$

$$V_c = 0.17 * \sqrt{f_c'} * b * d$$

$$f_c' = 25 \text{mpa}$$

$$V_c = 108.8 \text{kn} > 23 \text{kn} \dots\dots, \text{ok}$$

$$f_c' = 50 \text{mpa}$$

$$V_c = 154 \text{kn} > 23 \text{kn} \dots\dots \text{ok}$$

مشروع التخرج لنيل درجة البكالوريوس
اعداد
سبأ عمران
مروة فائق
محمد عبد خلهن
سجى عدنان
نور كمال

اشراف

م.م. علي عبد سلطان

| Slab no | direct | Mu Kn.m | ρ | ρ | AS | AS | S | S |
|---------|--------|------------|--------|---------|--------|--------|--------|--------|
| | | | Fc`=25 | Fc`=50 | Fc`=25 | Fc`=50 | Fc`=25 | Fc`=50 |
| S1 | Short | 38.88 | 0.0061 | 0.006 | 817 | 804 | 130 | 140 |
| | Long | 15.4 | 0.0033 | 0.003 | 403 | 403 | 280 | 280 |
| S2 | Short | 42.12 | 0.0066 | 0.0064 | 884.4 | 858 | 120 | 130 |
| | Long | 8.76 | 0.0016 | 0.0016 | 403 | 403 | 280 | 280 |
| S3 | Short | 10.29 | 0.0015 | 0.0015 | 442.2 | 442.2 | 250 | 250 |
| | Long | 6.48 | 0.0012 | 0.0012 | 403 | 403 | 280 | 280 |
| S4 | Short | 35.64 | 0.0056 | 0.0054 | 750.4 | 724 | 150 | 150 |
| | Long | 16.66 | 0.0031 | 0.0033 | 403 | 403 | 280 | 280 |
| S5 | Short | 21.12 | 0.0032 | 0.0032 | 442.2 | 442.2 | 250 | 250 |
| | Long | 5.5 | 0.0098 | 0.0098 | 403 | 403 | 280 | 280 |
| S6 | Short | 4.6 | 0.0068 | 0.007 | 442.2 | 442.2 | 250 | 250 |
| | Long | | | | | | | |
| S7 | Short | 13.3 | 0.002 | 0.00197 | 442.2 | 442.2 | 250 | 250 |
| | Long | 3.78 | 0.0064 | 0.00674 | 403 | 403 | 280 | 280 |

For ground plan

اشراف

م.م. علي عبد سلطان

| Slab no | direct | Mu Kn.m | ρ | ρ | AS Mm ² | AS Mm ² | S mm | S mm |
|---------|---------------|--------------|------------------|------------------|-----------------------|-----------------------|------------|------------|
| | | | Fc`=25 | Fc`=25 | Fc`=25 | Fc`=50 | Fc`=25 | Fc`=50 |
| S1 | Short Long | 37 14.8 | 0.0057 0.0033 | 0.0056 0.0026 | 774.5 403 | 750.4 403 | 140 250 | 150 280 |
| S2 | Short Long | 46.38 12 | 0.0063 0.0021 | 0.0061 0.0022 | 851 403 | 821.42 403 | 130 260 | 130 280 |
| S3 | Short Long | 9.87 6.2 | 0.0015 | 0.0015 | 442.2 | 442.2 | 250 | 250 |
| S4 | Short Long | 33.65 24 | 0.0052 0.0045 | 0.0051 0.0045 | 683.4 532 | 683.4 532 | 160 200 | 160 280 |
| S5 | Short Long | 20.24 5 | 0.0031 0.0089 | 0.0031 0.0011 | 442.2 403 | 442.2 403 | 250 280 | 250 280 |
| S6 | Short Long | 4.4 | 0.0065 | 0.0065 | 442.2 | 442.2 | 250 | 250 |
| S7 | Short Long | 12.76 3.6 | 0.0019 0.0064 | 0.0019 0.0064 | 442.2 403 | 442.2 403 | 250 280 | 250 280 |

For first plane

م.م. علي عبد سلطان

DESIGN OF COLUMN

$$W_u = 14.38 \text{ kn.m}$$

$$\text{Weight of stem} = (0.35 - 0.16) * 0.25 * 25 * 1.4 = 1.67 \text{ kn/m}$$

$$\text{Partition} = 1.5 * 0.25 * 20 * 1.4 = 10.5 \text{ kn/m}$$

$$\text{Dimension of column} = 400 \text{ mm} * 400 \text{ mm}$$

$$\text{Weight of column} = 0.4 * 0.4 * 3.5 * 25 * 1.4 = 19.6 \text{ kn/m}$$

$$d' = 40 + 10 + 25/2 = 62.5 \text{ mm}$$

DESIGN COL(1)

$$F_c = 25 \text{ mpa}$$

$$P_u = 14.38(2.27 * 2.85) + (1.67 * 2.85) + (1.67 * 2.27) + 19.6 + 10.5$$

$$P_u = 131.6 \text{ kn}$$

Moment from both side.....biaxial

$$w_u(x) = \frac{14.38 * 4.25}{3} + 1.67 + 10.5$$

$$W_u(x) = 32.54 \text{ kn/m}$$

$$w_u(y) = \frac{14.38 * 4.25}{3} * \frac{(3 - 0.78)}{2} + 1.67 + 10.5$$

$$W_u(y) = 36.4 \text{ kn/m}$$

$$m_u x = \frac{36.4(5.4 - 0.4)}{16} = 59.17 \text{ kn.m}$$

$$m_u y = \frac{32.54(4.25 - 0.4)}{13} = 31.73 \text{ kn.m}$$

$$\frac{m_u y}{m_u x} = \frac{31.73}{59.14} = 0.54 < \frac{b}{h} = 1$$

$$M_u \text{ eq} = 59.17 + 31.73(0.4/0.4) * (1 - 0.65)/0.65$$

$$M_u \text{ eq} = 76.25 \text{ kn.m}$$

$$\gamma = \frac{400 - 2 * 62.5}{400} = 0.7$$

$$kn = \frac{131.6}{0.7 * 25 * 0.4 * 0.4 * 1000} = 0.05$$

$$Rn = \frac{76.25}{0.7 * 25 * 0.4 * 0.4 * 0.4 * 1000} = 0.068$$

From chart..... $\rho_g = \rho_{min} = 0.01$

$$AS = \rho_g * b * h$$

$$AS = 0.01 * 400 * 400$$

$$AS = 1600 \text{mm}^2$$

$$Ab = 490 \text{mm}^2$$

$$\text{no of bars} = \frac{1600}{490} = 3.2$$

use 4 θ 25

$$F_c = 50 \text{mpa}$$

Dimension of column = 300mm * 300mm

Weight of column = 11.025kn/m

Weight of stem = 1.67kn/m

Partition = 10.5kn/m

$P_u = 123.11 \text{kn}$

$M_u = 76.25 \text{kn.m}$

$$Rn = \frac{76.25}{0.7 * 50 * 0.3 * 0.3 * 0.3 * 1000} = 0.08$$

$$kn = \frac{123.1}{0.7 * 50 * 0.3 * 0.3 * 1000} = 0.04$$

$\rho_g = 0.011$

$$A_s = 0.011 * 300 * 300 = 990 \text{mm}^2$$

$$\text{No of bars} = 990 / 490 = 2.02$$

use 3 θ 25

DESIGN COL(2)

$$F_c' = 25 \text{mpa}$$

$$P_u = 14.38(3.125 * 2.85) + 1.67 * 2.85 + 1.67 * 3.125 + 19.6 + 10.5$$

$$P_u = 168.6 \text{kn}$$

$$w_{u y} = \frac{14.38 * 4.25}{3} + 1.67 + 10.5 = 32.54 \frac{\text{kn}}{\text{m}}$$

$$w_{u x} = \frac{14.38 * 5.4}{3} * \frac{3 - 0.78}{2} + 1.67 + \frac{14.38 * 2}{2} = 47 \frac{\text{kn}}{\text{m}}$$

$$m_{u x} = \frac{47(5.1)}{10} = 123.3 \text{kn.m}$$

$$m_{u y} = \frac{32.54(4.25 - 0.4)}{10} = 50.8 \text{kn.m}$$

$$m_{u eq} = 123.3 + 50.8 \left(\frac{0.4}{0.4} \right) * \frac{1 - 0.65}{0.65} = 149.65 \text{kn.m}$$

$$\gamma = 0.7$$

$$k_n = \frac{168.6}{0.7 * 25 * 0.4 * 0.4 * 1000} = 0.06$$

$$R_n = \frac{149.65}{0.7 * 25 * 0.4 * 0.4 * 0.4 * 1000} = 0.134$$

$$\rho_g = 0.018 \dots \dots \dots \rho_{min} < \rho < \rho_{max}$$

$$A_s = 0.018 * 400 * 400 = 2880 \text{mm}^2$$

$$\text{No of bars} = 2880 / 490 = 5.8$$

use 6 θ 25

$$F_c' = 50 \text{mpa}$$

$$P_u = 160.6 \text{kn}$$

$$M_u = 149.65 \text{ kn.m}$$

$$K_n = 0.05$$

$$R_n = 0.16$$

$$\gamma = 0.6$$

$$\rho_g = 0.028 \dots \dots \rho_{min} < \rho < \rho_{max}$$

$$A_s = 0.028 * 300 * 300 = 2520 \text{ mm}^2$$

$$\text{No of bars} = 2520 / 490 = 5.14$$

use 6 θ 25

DESIGN COL(3)

$$F_c' = 25 \text{ mpa}$$

$$P_u = 14.38(4.125 * 3.78) + 1.67 * 3.78 + 1.67 * 4.125 + 19.6$$

$$P_u = 257 \text{ kn}$$

$$w_u x = \frac{14.38 * 6.25}{3} * \frac{(3 - 0.86)}{2} + 1.67 = \frac{49.85 \text{ kn}}{m}$$

$$w_u y = (14.38 * \frac{6.250}{3} + 1.67) = \frac{31.63 \text{ kn}}{m}$$

$$m_u x = \frac{49.85(7.5 - 0.4)}{10} = 258.4 \text{ kn.m}$$

$$m_u y = \frac{31.63(6.25 - 0.4)}{10} = 111.97 \text{ kn.m}$$

$$\frac{m_u y}{m_u x} = \frac{111.97}{258.4} = 0.45 < \frac{b}{h}$$

$$m_u eq = 258.4 + \frac{111.97 \left(\frac{0.4}{0.4}\right) (1 - 0.65)}{0.65} = 318.7 \text{ kn.m}$$

$$k_n = \frac{257}{0.7 * 25 * 0.4 * 0.4 * 1000} = 0.1$$

$$R_n = \frac{318.7}{0.7 * 25 * 0.4 * 0.4 * 0.4 * 1000} = 0.28$$

$$\rho_g = 0.044 \dots \dots \rho_{min} < \rho < \rho_{max}$$

$$AS=0.044*400*400=7040\text{mm}^2$$

$$\text{No of bars}=7040/490=13.36$$

use 14 θ 25

$$F_c' = 50\text{mpa}$$

$$P_u = 248.43\text{kn}$$

$$M_u \text{ eq} = 318.7\text{kn.m}$$

$$\gamma = 0.6$$

$$k_n = \frac{248.43}{0.7 * 50 * .03 * .03 * 1000} = 0.08$$

$$R_n = \frac{318.7}{0.7 * 50 * 0.3 * 0.3 * 0.3 * 1000} = 0.33$$

From chart

$$\rho_g = 0.062 \dots \dots \rho_{min} < \rho < \rho_{max}$$

$$AS=0.062*300*300=5580\text{mm}^2$$

$$\text{No of bars}=5580/490=11.38$$

use 12 θ 25

DESIGN COL (4)

$$F_c' = 25\text{mpa}$$

$$P_u = 14.38(3.8*3.3) + 1.67*3.3 + 1.67*3.8 + 19.6$$

$$P_u = 211.8\text{kn}$$

$$w_u x = \frac{14.38 * 6.25}{3} * \frac{3 - 0.86}{2} + 1.67 = 33.8 \text{ kn/m}$$

$$w_u y = \frac{14.38 * 6.25}{3} + 1.67 = 31.63 \frac{\text{kn}}{\text{m}}$$

$$m_u x = \frac{33.8 * 6.85}{16} = 163.3\text{kn.m}$$

$$31.63 * 5.85$$

$$\frac{\mu_y}{\mu_x} = \frac{111.9}{163.3} = 0.68 < \frac{b}{h}$$

$$\mu_{eq} = 163.3 + 111.9 \left(\frac{0.4}{0.4} \right) * \frac{1 - 0.65}{0.65}$$
$$= 223.56 \text{ kn.m}$$

$$\gamma = 0.7$$

$$k_n = \frac{211.8}{0.7 * 25 * 0.4 * 0.4 * 1000} = 0.08$$

$$R_n = \frac{223.56}{0.7 * 25 * 0.4 * 0.4 * 0.4 * 1000} = 0.2$$

$$\rho_g = 0.032 \dots \dots \rho_{min} < \rho < \rho_{max}$$

$$A_s = 0.032 * 400 * 400 = 5120 \text{ mm}^2$$

$$\text{no of bars} = \frac{5120}{490} = 10.4$$

use 11 θ 25

$$f_c = 50 \text{ mpa}$$

$$P_u = 203.2 \text{ kn}$$

$$M_u = 223.56 \text{ kn.m}$$

$$\gamma = 0.6$$

$$k_n = \frac{203.2}{0.7 * 50 * 0.3 * 0.3 * 1000} = 0.06$$

$$R_n = \frac{223.56}{0.7 * 50 * 0.3 * 0.3 * 0.3 * 1000} = 0.24$$

$$\rho_g = 0.045 \dots \dots \rho_{min} < \rho_{max}$$

$$A_s = 0.045 * 300 * 300 = 4050 \text{ mm}^2$$

$$\text{no of bars} = \frac{4050}{490} = 8.26$$

use 9 ̸ 25

DESIGN COL(5)

Fc`=25mpa

Pu=14.38(5.5*6.25)+1.67*5.5+1.67*6.25+19.6

Pu=533.5kn

$$wu_x = 2 \left[\frac{14.38 * 6.25}{3} * \frac{3 - 0.86}{2} \right] + 1.67 = \frac{69.27kn}{m}$$

$$wu_x = 2 \left[\frac{14.38 * 3.5}{3} \right] + 1.67 = \frac{35.22kn}{m}$$

$$mu_x = \frac{69.27 * 6.85}{10} - \frac{35.22 * 3.1}{10} = 298.53kn.m$$

mu_y = 0

γ = 0.7

$$kn = \frac{533.5}{0.7 * 25 * 0.4 * 0.4 * 1000} = 0.19$$

$$Rn = \frac{298.53}{0.7 * 25 * 0.4 * 0.4 * 0.4 * 1000} = 0.26$$

ρg = 0.037 ... ρmin < ρ < ρmax

$$AS = 0.037 * 400 * 400 = 5920mm$$

$$no\ of\ bars = \frac{5920}{490} = 11.9 \quad use\ 12\ \theta\ 25$$

Fc`=50mpa

Pu=525kn

Mu=298.53kn.m

$$kn = \frac{525}{0.7 * 50 * 0.3 * 0.3 * 1000} = 0.16$$

$$Rn = \frac{298.53}{0.7 * 50 * .3 * .3 * .3 * 1000} = 0.3$$

$$\rho g = 0.054$$

$$AS = 0.054 * 300 * 300 = 4860mm$$

$$no\ of\ bars = \frac{4860}{490} = 9.9$$

use 10 θ 25

DESIGN COL (6)

$$P_u = 14.38(6.25 * 3.8) + 1.67 * 6.25 + 1.67 * 3.8 + 19.6 + 10.5$$

$$P_u = 107.78kn$$

$$w_u x = 2 \left[\frac{14.38 * 6.25}{3} * \frac{3 - 0.86}{2} \right] + 1.67 + 10.5 = \frac{79.78kn}{m}$$

$$w_u y = \frac{14.38 * 6.25}{3} + 1.67 + 10.5 = \frac{42.13kn}{m}$$

$$m_u x = \frac{79.78 * 6.85}{16} = 333.96kn.m$$

$$m_u y = \frac{42.13 * 5.85}{10} = 144.2kn.m$$

$$\frac{m_u y}{m_u x} = \frac{144.2}{323.96} = 0.005 < \frac{b}{h}$$

$$m_u eq = 323.96 + 144.2 \left(\frac{0.4}{0.4} \right) * \frac{1 - 0.65}{0.65} = 401.6kn.m$$

$$\gamma = 0.7$$

$$k_n = \frac{107.78}{0.7 * 25 * 0.4 * 0.4 * 1000} = 0.04$$

$$R_n = \frac{401.6}{0.7 * 25 * .4 * .4 * .4 * 1000} = 0.35$$

$$\rho g = 0.062 \dots \dots \rho_{min} < \rho < \rho_{max}$$

$$AS = 0.062 * 400 * 400 = 9920mm$$

$$\text{no of bars} = \frac{9920}{490} = 19.2$$

use 20 θ 25

$$F_c' = 50 \text{ mpa}$$

$$P_u = 99.2 \text{ kn}$$

$$M_u \text{ eq} = 401.6 \text{ kn.m}$$

$$\gamma = 0.6$$

$$k_n = \frac{99.2}{0.7 * 50 * 0.3 * 0.3 * 1000} = 0.03$$

$$R_n = \frac{401.6}{0.7 * 50 * 0.3 * 0.3 * 0.3 * 1000} = 0.42$$

$$\rho = \rho_{max} = 0.08$$

$$A_s = 0.08 * 300 * 300 = 7200 \text{ mm}^2$$

$$\text{no of bars} = \frac{7200}{490} = 14.69$$

use 15 θ 25

DESIGN COL(7)

$$P_u = 14.38(5.375 * 6.25) + 1.67 * 5.375 + 1.67 * 6.25 + 19.6 \text{ م.م.}$$

$$P_u = 522 \text{ kn}$$

$$w_u x = 2 \left[\frac{14.38 * 3.5}{3} \right] + 1.67 = 35.22 \text{ kn/m}$$

$$w_u x = \left[\frac{14.38 * 6.25}{3} * \frac{3 - 0.86}{2} \right] + 1.67 = 35.52 \frac{\text{kn}}{\text{m}}$$

$$m_u x = \frac{35.5 * 6.85}{10} - \frac{35.22 * 3.1}{10} = 135.4 \text{ kn.m}$$

$$w_u y = \frac{14.38 * 6.25}{3} = 29.95 \text{ kn/m}$$

$$mu y = \frac{29.95 * 5.85}{10} = 106kn.m$$

$$\frac{mu y}{mu x} = \frac{106}{135.4} = 0.78 < \frac{b}{h}$$

$$mu eq = 135.4 + \frac{106 \left(\frac{0.4}{0.4}\right) (1 - 0.65)}{0.65} = 192.47kn.m$$

$$\gamma = 0.7$$

$$kn = \frac{522}{0.7 * 25 * 0.4 * 0.4 * 1000} = 0.19$$

$$Rn = \frac{192.47}{0.7 * 25 * 0.4 * 0.4 * 0.4 * 1000} = 0.18$$

$$\rho g = 0.021 \dots \dots \rho min < \rho < \rho max$$

$$As = 0.021 * 400 * 400 = 3360mm^2$$

$$no\ of\ bars = \frac{3360}{490} = 6.8$$

use 7 θ 25

$$Fc' = 50mpa$$

$$Pu = 513.4kn$$

$$Mu eq = 206.8kn.m$$

$$\gamma = 0.6$$

$$kn = 0.16$$

$$Rn = 0.2$$

$$\rho g = 0.031 \dots \dots \rho min < \rho < \rho max$$

$$AS = 0.031 * 300 * 300 = 2790mm^2$$

$$No\ of\ bars = 2790/490 = 5.6$$

use 6 θ 25

DESIGN COL(8)

$F_c = 25 \text{ mpa}$

$$P_u = 14.38(3.325 \times 3.825) + 1.67 \times 3.325 + 1.67 \times 3.825 + 19.6 + 10.5$$

$$P_u = 225 \text{ kn}$$

$$w_{u x} = \frac{14.38 \times 6.25}{3} \times \frac{3 - .86}{2} + 1.67 + 10.5 = 46.03 \frac{\text{kn}}{\text{m}}$$

$$w_{u y} = \frac{14.38 \times 6.25}{3} + 1.67 + 10.5 = 42.13 \frac{\text{kn}}{\text{m}}$$

$$m_{u x} = \frac{46.03 \times 6.85}{16} = 134.9 \text{ kn.m}$$

$$m_{u y} = \frac{42.13 \times 5.85}{16} = 90.12 \text{ kn.m}$$

$$\frac{m_{u y}}{m_{u x}} = \frac{90.12}{134.9} = 0.67 < \frac{b}{h}$$

$$m_{u eq} = 134.9 + \frac{90.12 \left(\frac{0.4}{0.4} \right) (1 - 0.65)}{0.65} = 183.43 \text{ kn.m}$$

$$\gamma = 0.7$$

$$k_n = 0.08$$

$$R_n = 0.164$$

$$\rho_g = 0.025 \dots \dots \rho_{min} < \rho < \rho_{max}$$

$$A_s = 0.025 \times 400 \times 400 = 4000 \text{ mm}^2$$

$$\text{no of bars} = \frac{4000}{490} = 8.16$$

use 9 θ 25

$$F_c' = 50 \text{ mpa}$$

$$P_u = 216.4 \text{ kn}$$

$$M_u \text{ eq} = 188.36 \text{ kn.m}$$

$$K_n = 0.07$$

$$R_n = 0.2$$

$$\gamma = 0.6$$

$$\rho_g = 0.036 \dots \rho_{\min} < \rho < \rho_{\max}$$

$$A_s = 0.036 * 300 * 300 = 3240 \text{ mm}^2 \text{ اعداد}$$

$$\text{no of bars} = \frac{3240}{490} = 6.6 \dots \text{use 7 bars}$$

DESIGN COL (9)

$$F_c' = 25 \text{ mpa}$$

$$P_u = 14.38(5.25 * 3.8) + 1.67 * 3.8 + 1.675 * 2.5 + 19.6 + 10.5$$

$$P_u = 332 \text{ kn}$$

$$w_u x = \left[\frac{14.38 * 6.25}{3} * \frac{3 - 0.86}{2} \right] + \left[\frac{14.38 * 4.25}{3} * \frac{3 - 0.8}{2} \right] + 1.67$$

$$w_u x = 59.56 \frac{\text{kn}}{\text{m}}$$

$$w_u y = \frac{14.38 * 6.25}{3} + 1.67 + 10.5 = 42.13 \frac{\text{kn}}{\text{m}}$$

$$m_u x = \frac{59.56 * 6.85}{16} = 279.5 \text{ kn.m}$$

$$m_u y = (42.13 * \frac{5.850}{16}) = 180.3 \text{ kn.m}$$

$$\frac{180.3}{279.5} = 0.65 < \frac{b}{h}$$

$$M_u eq = 352.35 \text{ kn.m}$$

$$\gamma = 0.7$$

$$k_n = 0.12$$

$$R_n = 0.31$$

$$\rho_g = 0.051 \dots \dots \rho_{min} < \rho < \rho_{max}$$

$$A_s = 0.051 * 400 * 400 = 8160 \text{ mm}^2$$

$$\text{no of bars} = \frac{8160}{490} = 14.6$$

use 15 θ 25

$$F_c' = 50 \text{ mpa}$$

$$P_u = 323.4 \text{ kn}$$

$$M_u eq = 385.3 \text{ kn.m}$$

$$K_n = 0.1$$

$$R_n = 0.4$$

$$\gamma = 0.6$$

$$\rho_g = \rho_{max} = 0.08$$

$$A_s = 0.08 * 300 * 300 = 7200 \text{ mm}^2$$

$$\text{no of bars} = \frac{7200}{490} = 13.06$$

use 14 θ 25

DESIGN COL (10)

$$F_c' = 25 \text{ mpa}$$

$$P_u = 14.38(5.25 * 5.4) + 1.67 * 5.25 + 1.67 * 5.4 + 19.6$$

$$P_u = 443.2 \text{ kn}$$

$$w_u x = \left[\frac{14.38 * 4.25}{3} * \frac{3 - 0.8}{2} \right] + \left[\frac{14.38 * 6.25}{2} * \frac{3 - 0.86}{2} \right] + 1.67$$

$$= 59.57 \frac{kn}{m}$$

$$w_u x = 2 \left[\frac{14.38 * 3.5}{3} \right] + 1.67 = 35.22 \frac{kn}{m}$$

$$m_u x = \frac{59.57 * 6.85}{10} - \frac{35.22 * 3.1}{10} = 245.86 kn.m$$

$$w_u y = \frac{14.38 * 4.25}{3} + 1.67 = 22 \frac{kn}{m}$$

$$w_u y = \frac{14.38 * 6.25}{3} + 1.67 = 31.63 \frac{kn}{m}$$

$$m_u y = \frac{31.63 * 5.85}{10} - \frac{22 * 3.85}{10} = 75.6 kn.m$$

$$\frac{75.6}{245.86} = 0.3 < \frac{b}{h}$$

$$m_u eq = 245.86 + \frac{75.6 \left(\frac{0.4}{0.4} \right) (1 - 0.65)}{0.65} = 286.56 kn.m$$

$$\gamma = 0.7$$

$$k_n = 0.16$$

$$R_n = 0.26$$

$$\rho_g = 0.036 \dots \dots \rho_{min} < \rho < \rho_{max}$$

$$A_s = 0.036 * 400 * 400 = 5760 mm^2$$

$$no \ of \ bars = \frac{5760}{490} = 11.7$$

use 12 θ 25

$$F_c' = 50 \text{ mpa}$$

$$P_u = 434.6 \text{ kn}$$

$$M_u \text{ eq} = 297.36 \text{ kn.m}$$

$$K_n = 0.14$$

$$R_n = 0.3$$

$$\gamma = 0.6$$

$$\rho_g = 0.053 \dots \dots \rho_{\min} < \rho < \rho_{\max}$$

$$A_s = 0.053 * 300 * 300 = 4770 \text{ m}^2$$

$$\text{no of bars} = \frac{4770}{490} = 9.7$$

use 10 θ 25

DESIGN COL (11)

$$F_c' = 25 \text{ mpa}$$

$$P_u = 14.38(5.25 * 5.75) + 1.67 * 5.25 + 1.67 * 5.75 + 19.6$$

$$P_u = 472 \text{ kn}$$

$$w_u x = \frac{14.38 * 0.75}{3} + \left[\frac{14.38 * 6.25}{3} * \frac{3 - 0.86}{2} \right] + 1.67 = 39.125 \frac{\text{kn}}{\text{m}}$$

$$w_u x = \frac{2(14.38 * 3.5)}{3} = 33.55 \frac{\text{kn}}{\text{m}}$$

$$m_u x = \frac{39.125 * 7.6}{10} - \frac{33.55 * 3.1}{10} = 193.75 \text{ kn.m}$$

$$w_u y = \left[\frac{14.38 * 3.5}{3} * \frac{3 - 0.86}{2} \right] + \left[\frac{14.38 * 6.25}{3} \right] + 1.67 = 54.16 \frac{\text{kn}}{\text{m}}$$

$$w_u y = \left[\frac{14.38 * 0.75}{3} * \frac{3 - 0.18}{2} \right] + \left[\frac{14.38 * 3.5}{3} * \frac{3 - 0.8}{2} \right] + 1.67 = 23.67 \frac{\text{kn}}{\text{m}}$$

$$\mu_y = \frac{54.16 * 5.85}{10} - \frac{26.67 * 3.85}{10}$$
$$= 145.8 \text{kn.m}$$

$$\frac{\mu_y}{\mu_x} = \frac{145.8}{193.75} = 0.75 < \frac{b}{h}$$

$$\mu_{eq} = 193.75 + \frac{145.8 \left(\frac{0.4}{0.4} \right) (1 - 0.65)}{0.65}$$
$$= 266.65 \text{kn.m}$$

$$k_n = 0.16$$

$$R_n = 0.23$$

$$\rho_g = .03$$

$$A_s = 0.031 * 400 * 400 = 4960 \text{mm}^2$$

$$\text{no of bars} = \frac{4960}{490} = 9.79$$

$$f_c = 50 \text{mpa}$$

$$P_u = 463.42 \text{kn}$$

$$M_u = 275.33 \text{kn}$$

$$K_n = 0.15$$

$$R_n = 0.29$$

$$\rho_g = 0.051$$

$$A_s = 0.051 * 300 * 300 = 4590 \text{mm}^2$$

$$\text{no of bars} = \frac{4590}{490} = 9.63$$

use 10 θ 25

DESIGN COL(12)

$F_c' = 25 \text{ mpa}$

$P_u = 14.38(4 \times 5.25) + 1.67 \times 4 + 1.67 \times 5.25 + 19.6$

$P_u = 337 \text{ kn}$

$$w_{u y} = \left[\frac{14.38 \times 2.75}{3} * \frac{3 - 0.64}{2} \right] + 1.67 = 18.68 \frac{\text{kn}}{\text{m}}$$

$$w_{u y} = \left[\frac{14.38 \times 6.25}{3} \right] + 1.67 = 31.63 \frac{\text{kn}}{\text{m}}$$

$$m_{u y} = \frac{31.63 \times 5.85}{10} - \frac{18.68 \times 3.85}{10} = 80.56 \text{ kn.m}$$

$$w_{u x} = \left[\frac{14.38 \times 2.75}{3} + \frac{14.38 \times 6.25}{3} * \frac{3 - 0.78}{2} \right] + 1.67$$
$$= 47.3 \frac{\text{kn}}{\text{m}}$$

$$m_{u x} = \frac{47.3 \times 7.6}{16} = 170.753 \text{ kn.m}$$

$$\frac{80.56}{170.753} = 0.47 < \frac{b}{h}$$

$$m_{u eq} = 214.13 \text{ kn.m}$$

$$k_n = 0.12$$

$$R_n = 0.2$$

$$\rho_g = 0.028$$

$$A_s = 0.028 \times 400 \times 400 = 4480 \text{ mm}$$

$$\text{no of bars} = \frac{4480}{490} = 9.12$$

use 10 θ 25

$F_c' = 50 \text{ mpa}$

$$P_u = 328.4 \text{ kn}$$

$$M_u \text{ eq} = 221.32 \text{ kn.m}$$

$$K_n = 0.1$$

$$R_n = 0.23$$

$$\gamma = 0.6$$

$$\rho_g = 0.029 \dots \dots \rho_{\min} < \rho < \rho_{\max}$$

$$A_s = 0.029 * 300 * 300 = 2160$$

$$\text{no of bars} = \frac{2160}{490} = 5.3$$

use 6 θ 25

مشروع التخرج لنيل دبلوم الهندسة المعمارية
اعداد
سبأ عمران
مروة فائق

محمد عبد خلهن
سجى عدنان
نور كمال

اشراف
م.م. علي عبد سلطان

DESIGN COL(1)

$W_u = 15 \text{ kn/m}$

Partition = $3.5 * 0.25 * 20 * 1.4 = 24.5 \text{ kn/m}$

Weight of stem = 1.67 kn/m

Dimension of column = $(450 \text{ mm} * 450 \text{ mm})$

Weight of column = $(0.45 * 0.45 * 3.5 * 25 * 1.4) = 23.8 \text{ kn/m}$

$F_c = 25 \text{ mpa}$

$P_u = 131.6 + (15 * 2.27 * 2.85) + (1.67 * 2.27) + (1.67 * 2.85) + 23.8 + 24.5$

$P_u = 285.5 \text{ kn}$

$$w_{u x} = \left[\frac{15 * 4.25}{3} * \frac{3 - 0.78}{2} \right] + 1.67 + 24.5 = 51.46 \text{ kn/m}$$

$$w_{u y} = \left[\frac{15 * 4.25}{3} \right] + 1.67 + 24.5 = 47.42 \frac{\text{kn}}{\text{m}}$$

$$m_{u x} = \frac{51.46 * 4.25}{16} = 160.8 \text{ kn.m}$$

$$m_{u y} = \frac{47.42 * 3.8}{16} = 70.29 \text{ kn.m}$$

$$\frac{m_{u y}}{m_{u x}} = \frac{70.29}{160.8} = 0.43 < \frac{b}{h} =$$

$$m_{u eq} = 160.8 + \frac{70.29 \left(\frac{0.45}{0.45} \right) (1 - 0.65)}{0.65} = 195.95 \text{ kn.m}$$

$$k_n = \frac{285.5}{0.7 * 25 * 0.45 * 0.45 * 1000} = 0.08$$

$$R_n = \frac{195.95}{0.7 * 0.45 * 0.45 * 0.45 * 25 * 1000} = 0.12$$

$$\gamma = 0.7$$

$$\rho_g = 0.015 \dots \dots \rho_{min} < \rho < \rho_{max}$$

$$A_s = 0.015 * 450 * 450 = 3038 \text{ mm}^2$$

$$\text{No of bars} = 3038/490 = 6.45$$

use 7 θ 25

$$F_c' = 50 \text{ mpa}$$

$$\text{Dimension of column} = 400 * 400 \text{ mm}$$

$$P_u = 281.3 \text{ kn}$$

$$M_u \text{ eq} = 195.95 \text{ kn.m}$$

$$K_n = 0.05$$

$$R_n = 0.09$$

$$\gamma = 0.7$$

$$\rho_g = \rho_{min} = 0.01$$

$$A_s = 0.01 * 400 * 400 = 1600 \text{ mm}^2$$

$$\text{no of bars} = \frac{1600}{490} = 3.2$$

use 4 θ 25

DESIGN COL(2)

$$F_c' = 25 \text{ mpa}$$

$$P_u = 168.6 + (15 * 2.85 * 3.125) + (1.67 * 2.85) + (1.67 * 3.125) + 23.8 + 24.5$$

$$P_u = 360.47 \text{ kn}$$

$$w_u x = \left[\frac{15 * 4.25}{3} * \frac{3 - 0.78}{2} \right] + \frac{15 * 2}{2} + 1.67 + 24.5 = 66.446 \frac{\text{kn}}{\text{m}}$$

$$w_u y = \left[\left(15 * \frac{4.250}{3} \right) \right] + 1.67 + 24.5 = 47.42 \frac{\text{kn}}{\text{m}}$$

$$m_u x = \frac{66.46 * 5}{16} = 207.68 \text{ kn.m}$$

$$m_u y = \frac{47.42 * 3.8}{10} = 70.29 \text{ kn.m}$$

$$\frac{70.29}{207.68} = 0.338 < \frac{b}{h} = 1$$

$$\mu_{eq} = 207.68 + \frac{70.29 \left(\frac{0.45}{0.45}\right) (1 - 0.65)}{0.65}$$

$$= 242.8 \text{ kn.m}$$

$$\gamma = 0.7$$

$$k_n = 0.1$$

$$R_n = 0.15$$

$$\rho_g = 0.02 \dots \dots \rho_{min} < \rho < \rho_{max}$$

$$A_s = 0.02 * 450 * 450 = 4050 \text{ mm}^2$$

$$\text{no of bars} = \frac{4050}{490} = 8.2$$

use 9 θ 25

$$F_c' = 50 \text{ mpa}$$

$$P_u = 356.27 \text{ kn}$$

$$\mu_{eq} = 242.8 \text{ kn.m}$$

$$K_n = 0.06$$

$$R_n = 0.08$$

$$\rho_g = 0.012 \dots \dots \rho_{min} < \rho < \rho_{max}$$

$$A_s = 0.012 * 400 * 400 = 1920 \text{ mm}^2$$

$$\text{no of bar} = \frac{1920}{490} = 3.9$$

use 4 θ 25

DESIGN COL(3)

$$F_c' = 25 \text{ mpa}$$

$$P_u = 257 + (15 * 4.125 * 3.78) + 1.67 * 4.125 + 1.67 * 3.787 + 23.8 + 24.5$$

$$P_u = 552.38 \text{ kn}$$

$$w_u x = \left[\frac{15 * 6.25}{3} * \frac{3 - 0.86}{2} \right] + 1.67 + 24.5 = 76.48 \frac{kn}{m}$$

$$w_u y = \left[\frac{15 * 6.25}{3} \right] + 1.67 + 24.5 = 57.42 \frac{kn}{m}$$

$$m_u x = \frac{(76.48 * 6.8)}{10} = 353.6 kn.m$$

$$m_u y = \frac{57.42 * 5.8}{10} = 193.16 kn.m$$

$$\frac{193.16}{353.6} = 0.55 < \frac{b}{h} = 1$$

$$m_u eq = 353.6 + \frac{193.16 \left(\frac{0.45}{0.45} \right) (1 - 0.65)}{0.65} = 455.97 kn.m$$

$$K_n = 0.15$$

$$R_n = 0.28$$

$$\gamma = 0.7$$

$$\rho_g = 0.042 \dots \dots \rho_{min} < \rho < \rho_{max}$$

$$A_s = 0.042 * 450 * 450 = 8505 mm^2$$

$$no \ of \ bars = \frac{8505}{490} = 17.3$$

$$F_c' = 50 mpa$$

$$P_u = 5480.18 kn$$

$$M_u eq = 457.11 kn.m$$

$$K_n = 0.09$$

$$R_n = 0.02$$

$$\gamma = 0.7$$

$$\rho_g = 0.031 \dots \dots \rho_{min} < \rho < \rho_{max}$$

$$A_s = 0.031 * 400 * 400 = 4960 \text{mm}^2$$

$$\text{no of bars} = \frac{4960}{490} = 10.12$$

use 11 θ 25

DESIGN COL(4)

$$F_c = 25 \text{mpa}$$

$$P_u = 211.8 + (15 * 3.8 * 3.5) + 1.67 * 3.8 + 1.67 * 3.5 + 23.8 + 24.5$$

$$P_u = 460 \text{kn}$$

$$w_{u x} = \left[\frac{15 * 6.25}{3} * \frac{3 - .86}{2} \right] + 1.67 + 24.5 = 61.49 \frac{\text{kn}}{\text{m}}$$

$$w_{u y} = \left[\frac{15 * 6.25}{3} \right] + 1.67 + 24.5 = 57.42 \frac{\text{kn}}{\text{m}}$$

$$m_{u x} = \frac{61.49 * 6.8}{16} = 177.7 \text{kn.m}$$

$$m_{u y} = \frac{57.42 * 5.8}{16} = 120.72 \text{kn.m}$$

$$\frac{120.72}{177.7} = 0.68 < \frac{b}{h} = 1$$

$$m_{u eq} = 177.7 + \frac{120.72 \left(\frac{0.45}{0.45} \right) (1 - 0.65)}{0.65} = 253.06 \text{kn.m}$$

$$K_n = 0.13$$

$$R_n = 0.16$$

$$\rho_g = 0.021 \dots \dots \rho_{min} < \rho < \rho_{min}$$

$$A_s = 0.021 * 450 * 450 = 4252 \text{mm}^2$$

$$\text{no of bars} = \frac{4252}{490} = 8.6$$

use 9 θ 25

$F_c = 50 \text{mpa}$

$P_u = 455.08 \text{kn}$

$M_u \text{ eq} = 245.42 \text{kn.m}$

$K_n = 0.08$

$R_n = 0.1$

$\rho_g = 0.012$

$$A_s = 0.012 * 400 * 400 = 1920 \text{mm}^2$$

$$\text{no of bars} = \frac{1920}{490} = 3.9$$

use 4 θ 25

DESIGN COL(5)

$F_c = 25 \text{mpa}$

$$P_u = 533.5 + (15 * 5.5 * 6.25) + 1.67 * 6.25 + 1.67 * 5.5 + 23.8 + 24.5$$

$P_u = 1117 \text{kn}$

$$w_u x = 2 \left[\frac{15 * 6.25}{3} * \frac{3 - 0.86}{2} \right] + 1.67 + 24.5 = 96.8 \frac{\text{kn}}{\text{m}}$$

$$w_u x = 2 \left[\frac{15 * 3.5}{3} \right] + 1.67 + 24.5 = 61.8 \frac{\text{kn}}{\text{m}}$$

$$m_u x = \frac{96.8 * 6.8}{10} - \frac{61.17 * 2.8}{10} = 424.2 \text{kn.m}$$

$m_u y = 0$

$K_n = 0.3$

$R_n = 0.4$

$$\rho_g = 0.045$$

$$A_s = 0.045 * 450 * 450 = 9112 \text{mm}^2$$

$$\text{no of bars} = \frac{9112}{490} = 18.6$$

use 19 θ 25

$$F_c' = 50 \text{mpa}$$

$$P_u = 1112.8 \text{kn}$$

$$M_u \text{ eq} = 429.18 \text{kn.m}$$

$$K_n = 0.19$$

$$R_n = 0.2$$

$$\rho_g = 0.025$$

$$A_s = 0.025 * 400 * 400 = 4000 \text{mm}^2$$

$$\text{no of bars} = \frac{4000}{490} = 9.16$$

use 10 θ 25

DESIGN COL(6)

$$F_c' = 25 \text{mpa}$$

$$P_u = 107.8 + (15 * 6.25 * 3.8) + 1.67 * 3.8 + 1.67 * 6.25 + 23.8 + 24.5$$

$$P_u = 529.11 \text{kn}$$

$$w_u x = \left[\frac{15 * 6.25}{3} * \frac{3 - 0.86}{2} \right] + 1.67 + 24.5 = \frac{96.7 \text{kn}}{m}$$

$$w_u y = \frac{15 * 6.25}{3} + 1.67 + 24.5 = 57.42 \frac{\text{kn}}{m}$$

$$m_u x = \frac{96.7 * 6.8}{16} = 279.5 \text{kn.m}$$

$$m_u y = \frac{57.42 * 5.8}{10} = 193.16 \text{kn.m}$$

$$\frac{193.16}{279.5} = 0.69 < \frac{b}{h} = 1$$

$$mu_{eq} = 279.5 + \frac{193.16 \left(\frac{0.45}{0.45} \right) (1 - 0.65)}{0.65} = 376 \text{ kn.m}$$

$$K_n = 0.15$$

$$R_n = 0.23$$

$$\rho_g = 0.032$$

$$A_s = 0.032 * 450 * 450 = 6480 \text{ mm}^2 \quad \text{اعداد}$$

$$\text{no of bars} = \frac{6480}{490} = 13.2$$

$$F_c' = 50 \text{ mpa}$$

$$P_u = 524.9 \text{ kn}$$

$$M_u \text{ eq} = 387.75 \text{ kn.m}$$

$$K_n = 0.09$$

$$R_n = 0.17$$

$$\rho_g = 0.024 \dots \dots \rho_{min} < \rho < \rho_{max}$$

$$A_s = 0.024 * 400 * 400 = 3840 \text{ mm}^2$$

$$\text{no of bars} = \frac{3840}{490} = 7.8$$

use 8 @ 25

DESIGN COL(7)

$$F_c' = 25 \text{ mpa}$$

$$P_u = 522 + (15 * 5.375 * 6.25) + 1.67 * 6.25 + 1.67 * 35.375 + 23.8 + 24.5$$

$$P_u = 1093.4 \text{ kn}$$

$$w_u x = \frac{2(15 * 3.5)}{3} + 1.67 + 24.5 = 61.17 \frac{kn}{m}$$

$$w_u x = \frac{(15 * 6.25)}{3} * \frac{3 - 0.86}{2} + 1.67 + 24.5 = 61.48 \frac{kn}{m}$$

$$m_u x = \frac{61.48 * 6.8}{10} - \frac{61.17 * 3.05}{10} = 227.4 kn.m$$

$$w_u y = \frac{15 * 6.25}{3} + 1.67 + 24.5 = 57.42 kn/m$$

$$m_u y = \frac{57.42 * 5.8}{10} = 193.16 kn.m$$

$$\frac{m_u y}{m_u x} = \frac{193.16}{227.4} = 0.85 < \frac{b}{h} = 1$$

$$k_n = 0.3$$

$$R_n = 0.2$$

$$\gamma = 0.7$$

$$\rho_g = 0.02$$

$$A_s = 0.02 * 450 * 450 = 4050 mm^2$$

$$no \ of \ bars = \frac{4050}{490} = 8.26$$

$$use \ 9 \ \theta \ 25$$

$$F_c = 50 \text{ mpa}$$

$$P_u = 1089 \text{ kn}$$

$$M_u \ eq = 333.85 \text{ kn.m}$$

$$K_n = 0.19$$

$$R_n = 0.15$$

$$P_g = 0.015 \dots \rho_{min} < \rho < \rho_{max}$$

$$AS=0.015*400*400=2400\text{mm}^2$$

$$\text{No of bars}=2400/490=4.8$$

use 5 θ 25

DESIGN COL(8)

$$F_c'=25\text{mpa}$$

$$P_u=225+(15*3.325*3.325)+1.67*3.325+1.67*3.325+23.8+24.5$$

$$P_u=476\text{kn}$$

$$w_u x = \left[\frac{15 * 6.25}{3} * \frac{3 - 0.86}{2} \right] + 1.67 + 24.5 = 61.5 \frac{\text{kn}}{\text{m}}$$

$$w_u y = \frac{15 * 6.25}{3} + 1.67 + 24.5 = 57.42 \frac{\text{kn}}{\text{m}}$$

$$m_u x = \frac{61.5 * 6.8}{16} = 177.7 \text{kn.m}$$

$$m_u y = \frac{57.42 * 5.8}{16} = 120.72 \text{kn.m}$$

$$\frac{m_u y}{m_u x} = \frac{120.72}{177.7} = 0.68 < \frac{b}{h} = 1$$

$$m_u eq = 177.7 + 120.72 \left(\frac{0.45}{0.45} \right) \left(1 - \frac{0.650}{0.65} \right) = 238.06 \text{kn.m}$$

$$K_n=0.13$$

$$R_n=0.15$$

$$\rho_g = 0.019$$

$$AS=0.019*450*450=3847.5\text{mm}^2$$

$$\text{no of bars} = \frac{3847.5}{490} = 7.85$$

use 8 θ 25

$$F_c' = 50 \text{ mpa}$$

$$P_u = 471.8 \text{ kn}$$

$$M_u \text{ eq} = 245.45 \text{ kn.m}$$

$$K_n = 0.08$$

$$R_n = 0.1$$

$$\rho_g = 0.012$$

$$A_s = 0.012 * 400 * 400 = 1920 \text{ mm}^2$$

$$\text{no of bars} = \frac{1920}{490} = 3.9$$

use 4 θ 25

DESIGN COL (9)

$$P_u = 332 + (15 * 5.75 * 3.8) + 1.67 * 3.8 + 1.67 * 5.25 + 23.8 + 24.5$$

$$P_u = 694.6 \text{ kn}$$

$$w_u x = \left[\frac{15 * 6.25}{3} * \frac{3 - 0.86}{2} \right] + 1.67 + 24.5 = 86.48 \frac{\text{kn}}{\text{m}}$$

$$w_u y = \left[\frac{15 * 6.25}{3} \right] * 1.67 + 24.5 = 57.42 \frac{\text{kn}}{\text{m}}$$

$$m_u y = \frac{57.42 * 5.8}{16} = 120.72 \text{ kn.m}$$

$$m_u x = \frac{86.48 * 6.8}{16} = 249.93 \text{ kn.m}$$

$$\frac{120.72}{249.93} = 0.48 < \frac{b}{h} = 1$$

$$m_u \text{ eq} = 249.9 + \frac{120.72 \left(\frac{0.45}{0.45} \right) (1 - 0.65)}{0.65} = 310.29 \text{ kn.m}$$

$$k_n = 0.2$$

$$R_n = 0.19$$

$$\rho_g = 0.022 \dots \dots \rho_{min} < \rho_g < \rho_{max}$$

$$AS = 0.022 * 450 * 450 = 4455 \text{mm}^2$$

$$\text{no of bars} = \frac{4455}{490} = 9.09$$

use 10 θ 25

$$F_c = 50 \text{mpa}$$

$$P_u = 690.4 \text{kn}$$

$$M_u \text{ eq} = 318.69 \text{kn.m}$$

$$K_n = 0.12$$

$$R_n = 0.14$$

$$\rho_g = 0.018 \dots \dots \rho_{min} < \rho_g < \rho_{max}$$

$$AS = 0.018 * 400 * 400 = 2880 \text{mm}^2$$

$$\text{no of bars} = \frac{2880}{490} = 5.8$$

use 6 θ 25

DESIGN COL(10)

$$P_u = 934.5 \text{kn}$$

$$w_u x = 2 \left[\frac{15 * 3.5}{3} \right] + 1.67 + 24.5 = 61.17 \frac{\text{kn}}{\text{m}}$$

$$w_u x = \left[\frac{15 * 4.25}{3} * \frac{3 - .45}{2} \right] + \left[\frac{15 * 6.25}{3} * \frac{3 - 0.86}{2} \right] + 1.67 + 24.5$$

$$w_u x = 86.5 \text{kn.m}$$

$$m_u x = \left[\frac{86.5 * 6.8}{10} - \frac{61.17 * 3.05}{10} \right] = 343 \text{kn.m}$$

$$w_u y = \left[\frac{15 * 6.25}{3} \right] + 1.67 + 24.5 = 57.42 \frac{kn}{m}$$

$$w_u y = \left[\frac{15 * 4.25}{3} \right] + 1.67 + 24.5 = 47.42 \frac{kn}{m}$$

$$m_u y = \frac{57.42 * 5.8}{10} - \frac{47.42 * 3.8}{10} = 124.68 kn.m$$

$$\frac{m_u y}{m_u x} = \frac{124.68}{343} = 0.36 < \frac{b}{h} = 1$$

$$m_u eq = 343 + 124.68 \left(\frac{0.45}{0.45} \right) \left(1 - \frac{0.650}{0.65} \right) = 405.34 kn.m$$

$$k_n = 0.26$$

$$R_n = 0.25$$

$$\rho_g = 0.032 \dots \dots \rho_{min} < \rho_g < \rho_{max}$$

$$A_s = 0.032 * 450 * 450 = 6480 mm^2$$

$$no \ of \ bars = \frac{6480}{490} = 13.2$$

use 14 θ 25

$$f_c' = 50 mpa$$

$$P_u = 930.3 kn$$

$$m_u eq = 416.16 kn.m$$

$$k_n = 0.16$$

$$R_n = 0.18$$

$$\rho_g = 0.022$$

$$A_s = 0.022 * 400 * 400 = 3520 mm^2$$

$$no \ of \ bars = \frac{3520}{490} = 7.15$$

use 8 θ 25

DESIGN COL(11)

$F_c = 25 \text{ mpa}$

$P_u = 472 + (15 * 5.75 * 5.25) + 1.67 * 5.75 + 1.67 * 5.25 + 23.8 + 24.5$

$P_u = 998 \text{ kn}$

$$w_{u x} = \left[\frac{15 * 0.75}{3} + \frac{15 * 6.25}{3} * \frac{3 - 0.86}{2} \right] + 1.67 + 24.5 = 65.22 \frac{\text{kn}}{\text{m}}$$

$$w_{u x} = 2 \left[\frac{15 * 3.5}{3} \right] + 1.67 + 24.5 = 61.17 \frac{\text{kn}}{\text{m}}$$

$$m_{u x} = \frac{65.22 * 7.55}{10} - \frac{61.17 * 2.8}{10} = 314.8 \text{ kn.m}$$

$$w_{u y} = \left[\frac{15 * 3.5}{3} * \frac{3 - 0.56}{2} + \frac{15 * 6.25}{3} \right] + 1.67 + 24.5 = 80.92 \frac{\text{kn}}{\text{m}}$$

$$w_{u y} = \left[\frac{15 * 0.75}{3} * \frac{3 - 0.18}{2} + \frac{15 * 3.5}{3} * \frac{3 - 0.8}{2} \right] + 1.67 + 24.5$$
$$= 52.38 \frac{\text{kn}}{\text{m}}$$

$$m_{u y} = \frac{80.92 * 5.8}{10} - \frac{52.38 * 3.8}{10} = 196.56 \text{ kn.m}$$

$$\frac{m_{u y}}{m_{u x}} = \frac{196.56}{314.8} = 0.62 < \frac{b}{h} = 1 \dots \dots \mu_{eq} = 413 \text{ kn.m}$$

$k_n = 0.28$

$R_n = 0.26$

$\rho_g = 0.028 \dots \dots \rho_{min} < \rho_g < \rho_{max}$

$A_s = 0.028 * 450 * 450 = 5670 \text{ mm}^2$

$$\text{no of bars} = \frac{5670}{490} = 11.57$$

use 12 θ 25

$$F_c' = 50 \text{ mpa}$$

$$P_u = 982.8 \text{ kn}$$

$$M_u \text{ eq} = 422.15 \text{ kn.m}$$

$$K_n = 0.17$$

$$R_n = 0.18$$

$$\rho_g = .022$$

$$A_s = 0.022 * 400 * 400 = 3520 \text{ mm}^2$$

$$\text{no of bars} = \frac{3520}{490} = 7.1$$

use 8 θ 25

DESIGN COL(12)

$$F_c' = 25 \text{ mpa}$$

$$P_u = 337 + (15 * 5.25 * 4) + 1.67 * 5.25 + 1.67 * 4 + 24.5 + 23.8$$

$$P_u = 715.7 \text{ kn}$$

$$w_u x = \left[\frac{15 * 2.75}{3} + \frac{15 * 6.25}{3} * \frac{3 - 0.86}{2} \right] + 1.67 + 24.5 = 75.22 \frac{\text{kn}}{\text{m}}$$

$$m_u x = \frac{75.22 * 7.55}{16} = 267.98 \text{ kn.m}$$

$$w_u y = \left[\frac{15 * 2.75}{3} * \frac{3 - 0.64}{2} \right] + 1.67 + 24.5 = 43.9 \frac{\text{kn}}{\text{m}}$$

$$w_u y = \frac{15 * 6.25}{3} + 1.67 + 24.5 = 57.42 \frac{\text{kn}}{\text{m}}$$

$$m_u y = \frac{57.42 * 5.8}{10} - \frac{43.9 * 3.8}{10} = 129.77 \text{ kn.m}$$

$$\frac{m_u y}{m_u x} = \frac{129.77}{267.98} = 0.48 < \frac{b}{h} = 1$$

$$m_{ueq} = 267.98 + \frac{129.77 \left(\frac{0.45}{0.45} \right) (1 - 0.65)}{0.65} = 332.86 \text{ kn.m}$$

$$K_n=0.2$$

$$R_n=0.2$$

$$\rho_g = 0.024$$

$$A_s=0.024*450*450=4860\text{mm}^2$$

$$\text{no of bars} = \frac{4860}{490} = 9.9$$

use 10 θ 25

$$F_c'=50\text{mpa}$$

$$P_u=711.5\text{kn}$$

$$M_u \text{ eq}=342\text{kn.m}$$

$$K_n=0.13$$

$$R_n=.015$$

$$\rho_g = 0.018$$

$$A_s=0.018*400*400=2880\text{mm}^2$$

$$\text{no of bars} = \frac{2880}{490} = 5.8$$

use 6 θ 25

مشروع التخرج لنيل درجة البكالوريوس

اعداد

سبأ عمران
مروة فائق

محمد عبد خلهن

سجى عدنان
نور كمال

اشراف

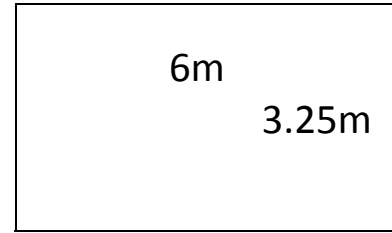
م.م. علي عبد سلطان

DESIGN SLAB(7)

$$L_a/L_b=6/3.25=1.8$$

Design as two way slab

$$M=0.55$$



| m^- | $M^+ DL$ | $M^+ LL$ | W Load |
|--------------------------|--------------------------|--------------------------|------------------------|
| $Ca=0.089$ $Cb=0.007$ | $Ca=0.035$ $Cb=0.003$ | $Ca=0.062$ $Cb=0.006$ | $Wa=0.92$ $Wb=0.08$ |

Short direction

$$Ma^- = 0.084 \cdot 15 \cdot (3.25)^2$$

$$Ma^- = 13.3 \text{ kn.m}$$

$$Ma^+ = [0.035 \cdot 8.2 + 0.062 \cdot 6.8] \cdot (3.25)^2$$

$$Ma^+ = 7.5 \text{ kn.m}$$

Long direction

$$Mb^- = 0.007 \cdot 15 \cdot (6)^2 = 3.78 \text{ kn.m}$$

$$Mb^+ = [0.003 \cdot 8.2 + 0.006 \cdot 6.8] \cdot (6)^2 = 2.35 \text{ kn.m}$$

Short direction

$$f_c = 25 \text{ mpa}$$

$$d_a = 160 - 20 - 12/2 = 134 \text{ mm}$$

$$\text{max moment} = 13.3 \text{ kn.m}$$

$$\rho = 0.002$$

$$\rho_{min} = 0.0033$$

$$\rho_{max} = 0.02$$

$$\rho = \rho_{min} = 0.0033$$

$$A_s = 0.0033 * 1000 * 134$$

$$A_s = 442.2 \text{ mm}^2$$

Long direction

$$d_b = 122 \text{ mm}$$

$$\text{max moment} = 3.78 \text{ kn.m}$$

$$f_c' = 25 \text{ mpa}$$

$$\rho = 0.00068$$

$$\rho = \rho_{min} = 0.0033$$

$$A_s = 0.0033 * 1000 * 122$$

$$A_s = 403 \text{ mm}$$

$$S = \min \left[1000 * \frac{113}{403}, 2 * 160, 500 \right]$$

$$S = 280 \text{ mm}$$

$$\text{no of bars} = \frac{A_s}{A_b} = \frac{403}{113} = 4 \text{ bars @ each (1m)}$$

$$F_c' = 50 \text{ mpa}$$

$$\rho = 0.00674$$

$$\rho = \rho_{min}$$

$$A_s = 0.0033 * 1000 * 122 = 403 \text{ mm}$$

$$S = \min \left[1000 * \frac{113}{403}, 320, 500 \right]$$

$$S = 280 \text{ mm}$$

$$\text{no of bars} = \frac{403}{113} = 4 \text{ bars @ each (1m)}$$

Check shear

$$W = w_u \cdot L_a \cdot L_b$$

$$W = 15 \cdot 6 \cdot 3.25 = 293$$

$$W_a = W \cdot w_a = 293 \cdot 0.92 = 270$$

$$W_b = W \cdot w_b = 293 \cdot 0.08 = 23$$

$$V_a = 23$$

$$V_b = 4$$

$$V_a > v_b$$

$$\frac{23 - 15 \cdot 0.92 \cdot 0.134}{0.85} = 25kn$$

$$V_c = 0.17 \cdot \sqrt{f_c'} \cdot b \cdot d$$

$$f_c' = 25mpa \dots\dots V_c = 108.8 > 25kn \dots\dots ok$$

$$f_c' = 50mpa \dots\dots V_c = 154 > 25kn \dots\dots ok$$

اشراف

م.م. علي عبد سلطان

DESIGN SLAB(6)

1.75m

$$\frac{L_a}{L_b} = \frac{5.15}{1.75} = 2.9 > 2$$

5.15m

design as one way slab

$$d = 160 - 20 - \frac{12}{2} = 134mm$$

$$m_u = \frac{w_u * l_n^2}{10} = \frac{15 * 1.75^2}{10} = 4.6kn.m$$

$$m_u = \frac{15 * 1.75^2}{11} = 4kn.m$$

$$m_u = \frac{15 * 1.75^2}{16} = 3kn.m$$

$$\text{max moment} = 4.6kn.m$$

$$f_c' = 25mpa$$

$$\rho = 0.00068$$

$$\rho = \rho_{min}$$

$$A_s = 0.0033 * 1000 * 134 = 442.2mm^2$$

$$A_{s \text{ min}} = 0.0018 * 1000 * 160 = 241.2mm^2$$

$$S = \min \left[1000 * \frac{113}{442.2}, 480, 500 \right]$$

$$S = 250mm$$

Spacing for shrinkage and temperature

$$S = \min \left[1000 * \frac{113}{241.2}, 800, 500 \right]$$

$$S = 460mm$$

$$\text{no of bars} = \frac{442.2}{113} = 4 @ \text{ each (1m)}$$

$$f_c = 50 \text{ mpa}$$

$$\rho = \rho_{\min} = 0.0033$$

$$AS = \rho * b * d$$

$$AS = 0.0033 * 1000 * 134$$

$$AS = 442.2 \text{ mm}$$

$$S = 250 \text{ mm}$$

$$S \text{ shrinkage and temp} = 460 \text{ mm}$$

$$\text{No of bars} = 4 @ \text{ each (1m)}$$

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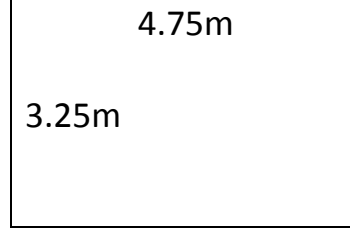
م.م. علي عبد سلطان

DESIGN SLAB()

$$L_b/L_a=4.75/3.25=1.46$$

Design as two way slab

$$M=0.7$$



| M ⁻ | M ^{+DL} | M ^{+DL} | W Load |
|----------------------|---------------------|----------------------|--------------------|
| ca=0.068 cb=0.029 | Ca=0.04 Cb=0.011 | Ca=0.054 Cb=0.014 | Wa=0.68 Wb=0.32 |

short direction

$$M_a^- = 0.068 * 15 * (3.25)^2 = 10.77 \text{ kn.m}$$

$$M_a^+ = [0.04 * 8.2 + 0.054 * 6.8] * (3.25)^2 = 7.3 \text{ kn.m}$$

Long direction

$$M_b^- = 0.029 * 15 * (4.75)^2 = 9.8 \text{ kn.m}$$

$$M_b^+ = [0.011 * 8.2 + 0.014 * 6.8] * (4.75)^2 = 4.2 \text{ kn.m}$$

Short direction

$$d_a = 134 \text{ mm}$$

$$\text{max moment} = 10.77 \text{ kn.m}$$

$$f_c = 25 \text{ mpa}$$

$$\rho = 0.0016$$

$$\rho = \rho_{min} = 0.0033$$

$$A_s = 0.0033 * 1000 * 134 = 442.2 \text{ mm}^2$$

$$S = \min \left[1000 * \frac{113}{442.2}, 320, 500 \right]$$

$$S = 250 \text{ mm}$$

No of bars=4 bars @ (1m)

Long direction

db=122mm

max moment=9.8kn.m

$$\rho = 0.0018$$

$$\rho = \rho_{min} = 0.0033$$

$$AS=0.0033*1000*122=403\text{mm}^2$$

$$S = \min \left[1000 * \frac{113}{403}, 320, 500 \right]$$

S=280mm

No of bars=4 bars @ (1m)

Fc`=50mpa

$$\rho = 0.00175$$

$$\rho = \rho_{min} = 0.0033$$

$$AS=0.0033*1000*122=403\text{mm}^2$$

$$S=\min[1000*113/403, 320, 500]$$

S=280mm

No of bars=4 bars @ (1m)

CHECK SHEAR

$$W=wu*La*Lb=15*4.75*3.25$$

$$W=232$$

$$Wa=232*0.68=158$$

$$Wb=232*0.32=72.24$$

$$v_a = 17$$

$$v_b = 11$$

$$v_a > v_b$$

$$\frac{v_a - W * w_a * d_a}{\theta} = \frac{17 - 15 * 0.68 * 0.134}{0.85}$$
$$= 18kn$$

$$F_c' = 25mpa$$

$$V_c = 108.8 > 18kn \dots \dots ok$$

$$F_c' = 50mpa$$

$$V_c = 154 > 18kn \dots \dots ok$$

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VOLUME OF CONCRETE SLABS

$$\text{Slab (1)}=6.25*7.25*0.16=7.25\text{m}^3$$

$$\text{Slab (2)}=6.25*8*0.16=8\text{m}^3$$

$$\text{Slab (3)}=6.25*7.25*0.16=7.25\text{m}^3$$

$$\text{Slab (4)}=5.4*4.25*0.16=3.672\text{m}^3$$

$$\text{Slab (5)}=4.25*3.5*0.16=2.38\text{m}^3$$

$$\text{Slab (6)}=2*5.4*0.16=1.728\text{m}^3$$

$$\text{Slab (7)}=3.5*6.25*0.16=3.5\text{m}^3$$

$$\text{Total volume of concrete for one story}=33.78\text{m}^3$$

$$\text{Total volume for two story}=67.56\text{m}^3$$

VOLUME OF BEAMS CONCRETE

$$f_c=25\text{mpa}$$

$$\text{Volume of beams}=0.35*0.25*243.6=21.315\text{m}^3$$

$$\text{Volume of beams for two story}=42.63\text{m}^3$$

$$f_c=50\text{mpa}$$

$$\text{Volume of beams}=0.3*0.2*243.6=14.616\text{m}^3$$

$$\text{Volume of beams for two story}=29.232\text{m}^3$$

VOLUME OF COLUMNS CONCRETE

Ground plan

$$F_c=25\text{mpa}$$

$$\text{Volume of columns}=0.45*0.45*3.5*32=22.68\text{m}^3$$

$$F_c=50\text{mpa}$$

$$\text{Volume of columns}=0.4*0.4*3.5*32=17.92\text{m}^3$$

First story

$$F_c=25\text{mpa}$$

$$\text{Volume of columns} = 0.4 \times 0.4 \times 3.5 \times 23 = 17.92 \text{m}^3$$

$$F_c = 50 \text{mpa}$$

$$\text{Volume of columns} = 0.3 \times 0.3 \times 3.5 \times 32 = 10.08 \text{m}^3$$

$$\text{Total volume at } f_c = 25 \text{mpa}$$

$$\text{Total volume} = 22.68 + 17.92 = 40.6 \text{m}^3$$

$$\text{Total volume at } f_c = 50 \text{mpa}$$

$$\text{Total volume} = 17.92 + 10.08 = 28 \text{m}^3$$

| Type of concrete | $F_c = 25 \text{mpa}$ | $F_c = 50 \text{mpa}$ |
|--------------------------|-----------------------|-----------------------|
| slabs | 67.56m^3 | 67.56m^3 |
| beams | 42.63m^3 | 29.232m^3 |
| columns | 40.6m^3 | 28m^3 |
| Total volume of concrete | 150.79m^3 | 124.792m^3 |

$$\text{Total cost} = 150.79 \times 450000 = 70000000 \text{dinar} \quad f_c = 25 \text{mpa}$$

$$\text{cost of stabilizer} = 80000 \text{dinar/m}^3$$

$$\text{amount of stabilizer} = 18 \text{ liter/m}^3$$

$$\text{Total cost} = 124.792 \times 45000 \times 18 \times 80000 = 80 \times 10^{10} \quad \dots f_c = 50 \text{mpa}$$

CALCULATION OF REINFORCEMENT AMOUNT

Ground plan

$F_c = 25 \text{mpa}$

Col 1 = $7 * 5.5 * 3.855 = 148.4 \text{kg}$

Col 2 = $9 * 5.5 * 3.855 = 190.822 \text{kg}$

Col 3 = $16 * 5.5 * 3.855 = 339.24 \text{kg}$

Col 4 = $9 * 5.5 * 3.855 = 190.822 \text{kg}$

Col 5 = $18 * 5.5 * 3.855 = 381.645 \text{kg}$

Col 6 = $15 * 5.5 * 3.855 = 318.375 \text{kg}$

Col 7 = $9 * 5.5 * 3.855 = 190.822 \text{kg}$

Col 8 = $8 * 5.5 * 3.855 = 169.62 \text{kg}$

Col 9 = $10 * 5.5 * 3.855 = 212 \text{kg}$

Col 10 = $14 * 5.5 * 3.855 = 296.835 \text{kg}$

Col 11 = $14 * 5.5 * 3.855 = 296.835 \text{kg}$

Col 12 = $10 * 5.5 * 3.855 = 212 \text{kg}$

Total of reinforcement amount = $2974.95 * 2 = 5949.9 \text{kg}$

Total of reinforcement amount = 6ton

$F_c = 50 \text{mpa}$

Col 1 = $4 * 5.5 * 3.855 = 84.81 \text{kg}$

Col 2 = $4 * 5.5 * 3.855 = 84.81 \text{kg}$

Col 3 = $11 * 5.5 * 3.855 = 233.2 \text{kg}$

Col 4 = $4 * 5.5 * 3.855 = 84.81 \text{kg}$

Col 5 = $10 * 5.5 * 3.855 = 212 \text{kg}$

Col 6 = $8 * 3.855 * 5.5 = 169.62 \text{kg}$

Col 7 = $5 * 3.855 * 5.5 = 106 \text{kg}$

$$\text{Col 8} = 4 * 5.5 * 3.855 = 84.81\text{kg}$$

$$\text{Col 9} = 6 * 3.855 * 5.5 = 127.2\text{kg}$$

$$\text{Col 10} = 8 * 5.5 * 3.855 = 169.62\text{kg}$$

$$\text{Col 11} = 8 * 3 * 5.5 * 3.855 = 169.62\text{kg}$$

$$\text{Col 12} = 6 * 5.5 * 3.855 = 127.2\text{kg}$$

$$\text{Total of reinforcement amount} = 1484.84 * 2 = 2969.68\text{kg}$$

$$\text{Total of reinforcement amount} = 3\text{ton}$$

First plan

$$F_c = 25\text{mpa}$$

$$\text{Col 1} = 4 * 5.5 * 3.855 = 84.81\text{kg}$$

$$\text{Col 2} = 6 * 5.5 * 3.855 = 127.2\text{kg}$$

$$\text{Col 3} = 14 * 5.5 * 3.855 = 296.8\text{kg}$$

$$\text{Col 4} = 11 * 5.5 * 3.855 = 233.22\text{kg}$$

$$\text{Col 5} = 12 * 5.5 * 3.855 = 254.43\text{kg}$$

$$\text{Col 6} = 20 * 5.5 * 3.855 = 508.86\text{kg}$$

$$\text{Col 7} = 7 * 5.5 * 3.855 = 148.4\text{kg}$$

$$\text{Col 8} = 9 * 5.5 * 3.855 = 190.8\text{kg}$$

$$\text{Col 9} = 15 * 5.5 * 3.855 = 318\text{kg}$$

$$\text{Col 10} = 12 * 5.5 * 3.855 = 254.43\text{kg}$$

$$\text{Col 11} = 10 * 5.5 * 3.855 = 212\text{kg}$$

$$\text{Col 12} = 10 * 5.5 * 3.855 = 212\text{kg}$$

$$\text{Total of reinforcement amount} = 2840.9 * 2 = 5721.1\text{kg}$$

$$\text{Total of reinforcement amount} = 5.75\text{ton}$$

$$F_c = 50\text{mpa}$$

$$\text{Col 1} = 3 * 5.5 * 3.855 = 63.6\text{kg}$$

$$\text{Col 2} = 6 * 5.5 * 3.855 = 127.2 \text{kg}$$

$$\text{Col 3} = 12 * 5.5 * 3.855 = 254.4 \text{kg}$$

$$\text{Col 4} = 9 * 5.5 * 3.855 = 190.82 \text{kg}$$

$$\text{Col 5} = 10 * 5.5 * 3.855 = 212 \text{kg}$$

$$\text{Col 6} = 15 * 5.5 * 3.855 = 318 \text{kg}$$

$$\text{Col 7} = 6 * 5.5 * 3.855 = 127.2 \text{kg}$$

$$\text{Col 8} = 7 * 5.5 * 3.855 = 148.4 \text{kg}$$

$$\text{Col 9} = 14 * 5.5 * 3.855 = 296.8 \text{kg}$$

$$\text{Col 10} = 10 * 5.5 * 3.855 = 212 \text{kg}$$

$$\text{Col 11} = 10 * 5.5 * 3.855 = 212 \text{kg}$$

$$\text{Col 12} = 6 * 5.5 * 3.855 = 127.2 \text{kg}$$

$$\text{Total of reinforcement amount} = 2235.62 * 2 = 4471.24 \text{kg}$$

$$\text{Total of reinforcement amount} = 4.5 \text{ton}$$

.TOTAL OF REINFORCEMENT AMOUNT FOR TWO STORY

$$\text{Total amount} = 6 + 5.75 = 11.75 = 12 \text{ton} \quad \dots \text{fc} = 25 \text{mpa}$$

$$\text{Total cost} = 12 * 850000 = 10200000 \text{ dinar} \quad \dots \text{fc} = 25 \text{mpa}$$

$$\text{Total amount} = 3 + 4.5 = 7.5 = 8 \text{ton} \quad \dots \text{fc} = 50 \text{mpa}$$

$$\text{Total cost} = 8 * 850000 = 6800000 \text{ dinar} \quad \dots \text{fc} = 50 \text{mpa}$$

$$\text{Total difference of reinforcement amount} = 12 - 8 = 4 \text{ton} \quad \text{م.م.}$$

$$\text{Difference of total cost} = 4 * 850000 = 3500000 \text{ dinar}$$

$$\text{Cost of building} = 10200000 + 70000000 = 80200000 \text{ dinar} \quad \dots \text{fc} = 25 \text{mpa}$$

$$\text{Cost of building} = 6800000 + 80 * 10^{10} = 800006800000 \text{ dinar} \quad \dots \text{fc} = 50 \text{mpa}$$