Ways to prevent the disease COVID-19

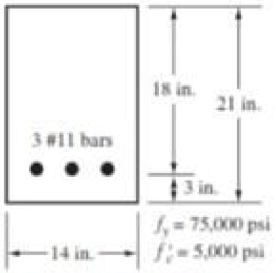
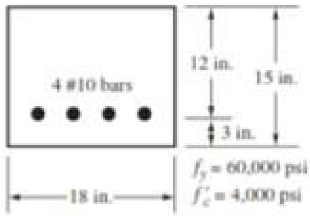
1. Wash Your Hands For 20sec.
2. Cover Nose & Mouth When Sneezing.
3. Use hand sanitizer if soap and water are not available.
4. Avoid Crowded Places (Social Distancing)
5. Avoid Contact With Sick People
6. Stay At home
7. Don't visit outside unnecessarily

Subject: Advanced Design of Reinforced concrete structures

Instructor: Engr. Fawad Ahmad **Total Marks:** 30

Note:

1. Attempt all questions. **R** is your class id.
2. ACI tables and values used in design must be referred while solving your design problem.
3. Use correct class Id R.

Q.NO (01)		**(10)**
A	Determine the values of €t, Ø and ØMn for the sections shown below:   Also dissuss the strength analysis. Does the reinforcement is done according to design standard or not. Defend your design analysis.	5
B	Design a doubly reinforced beam for M_D= = **[First three Digits of R]** ft-K and M_L=410 ft-K, if fc'=4000 psi and fy= 6000psi. Appropriate diagram is must in design. Assume the maximum permissible beam dimensions other than done in notes or Text book.	5

Q.NO (02)		**(10)**
A	Design a short square column for the following conditions: Pu = **[First three Digits of R]** k, Mu = **[First two Digits of R]** ft-k, fc' = 4000 psi, and fy = 60,000 psi. Place the bars uniformly around all four faces of the column. Appropriate diagram is must in design.	10

Q.NO (03)		**(10)**
A	Design a square column footing for a 16 inch square tied interior column that supports a dead load PD= **[First three Digits of R]**K and live load of PL= 160K. The column is reinforced with #8 bars the base of the footing is 5feet below, the soil weight is 100 lf/ft3, fy= 60,00 psi and fc'=3000psi and qa= **[First four Digits of R]**psf. Development length for main bars is also to be done in footing design. Appropriate diagram is must in design.	10

**************************** **Best of Luck- Stay Safe**********************************

Name :- Shahzeb

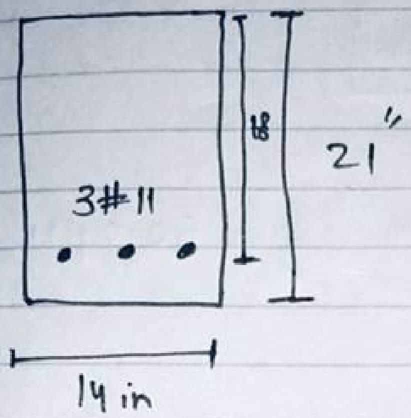
ID :- 15629

Subject :- Advanced Design of Reinforced concrete structure -

Instructor :- Engr - Fawad Ahmed -

IQRA National University Peshawar -

Q#(1)
Determine the Value of ε_t, ϕ and ϕM_n for the Section.



Given data.

$f_y = 75{,}000\,psi$

$f_c' = 5{,}000\,psi$

$A_s = 4.68$ (table A-4)

Sol:

We know that

$$\varepsilon_t = \frac{d-c}{c}(0.003)$$

$$c = \frac{a}{\beta_1}$$

for this we have to find a and β_1

$$a = \frac{A_s f_y}{0.85 f_c' b}$$

$$a = \frac{(4.88)(75)}{0.85 \times 5 \times 14}$$

$$\boxed{a = 5.899 \text{ in}}$$

$\beta_1 = 0.80$ for $f_c' = 5000$ psi

Now

$$c = \frac{a}{\beta_1}$$

$$c = \frac{5.899}{0.80}$$

$$\boxed{c = 7.37 \text{ in}}$$

$$\varepsilon_t = \left(\frac{d-c}{c}\right)(0.003)$$

$$\varepsilon_t = \left(\frac{18 - 7.37}{7.37}\right)(0.003)$$

$$\varepsilon_t = 0.00432$$

$0.0042 < \varepsilon_t < 0.005$

transition zone.

$$\phi = 0.65(\varepsilon_t - 0.002)\frac{250}{3}$$

$$\phi = 0.65(0.00432 - 0.002)\left(\frac{250}{3}\right)$$

$$\phi = 0.836$$

$\phi M_n = ?$

$$\rho = \frac{A_s}{bd} = \frac{4.68}{14 \times 18} = 0.0185 >$$

$$\rho_{max} = 0.0028$$
$$\rho_{min} = 0.0194$$

ok

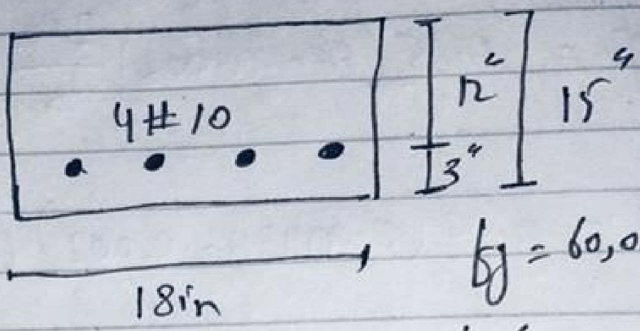
$$M_n = A_s f_y\left(d - \frac{a}{2}\right) = 4.68 \times 75\left(18 - \frac{5.89}{2}\right)$$

$$M_n = 5282.72 \text{ in-k}$$

$$M_n = 440.2 \text{ ft-k.}$$

$$\phi M_n = 0.836 \times 440.2$$

$$\boxed{\phi M_n = 368.028}$$



$f_y = 60{,}000$ psi

$f_c' = 4000$ psi

find

$\varepsilon_t = ?$

$\phi = ?$

$\phi M_n = ?$

Sol:

$A_s = 5.06$ (table)

$$\varepsilon_t = \left(\frac{d - c}{c}\right)(0.003)$$

$$c = a/\beta_1$$

$$a = \frac{A_s f_y}{0.85 f_c' b}$$

$$a = \frac{5.06 \times 60}{0.85 \times 4 \times 18}$$

$a = 4.96 in$

$B_1 = 0.85$

$$C = a/B_1 = \frac{4.96 in}{0.85} = 5.835$$

$$\varepsilon t = \left(\frac{12 - 5.835}{5.835}\right)(0.003)$$

$\varepsilon t = 0.003 < 0.004.$

Section is Not ductile and can not be Used As per ACI Code -

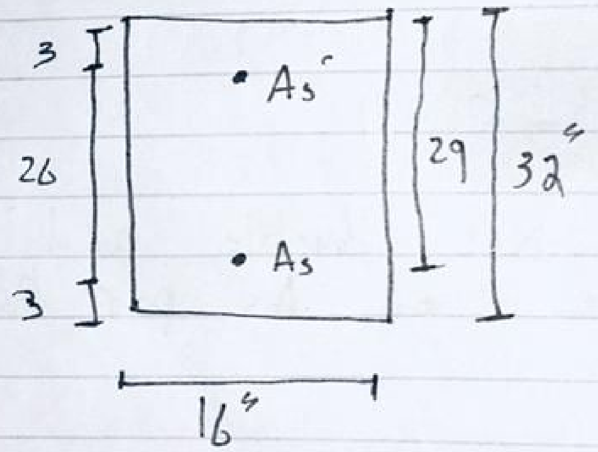
—— x —— x —— x —— x —— x ——

Q#(1) part(B)

Design a doubly reinforced beam for $M_D = 156$ ft-k and $M_L = 418$ ft-k
$f_c' = 4000$ psi and $f_y = 60{,}000$ psi

Sol:

Assuming the Maximum dimension for the beam is -



① factored Load :-

$$M_u = 1.2 M_D + 1.6 M_L$$

$$M_u = 1.2(156) + 1.6(418)$$

$$M_u = 843.6 \text{ ft-k}$$

② Nominal Moment (M_n)

$$M_n = \frac{M_u}{\phi}$$

$$M_n = \frac{843.2}{0.90}$$

$$\boxed{M_n = 936.88}$$

Now

$\because \rho_{max} = 0.0018$ (table A-7)

$$A_s = \rho_{max}\, b\, d$$

$$A_{s1} = 0.018 \times 16 \times 29$$

$$A_{s1} = 8.352\ in^2$$

for

$\rho_{max} = 0.0181$ $\quad \frac{M_u}{\phi b d^2} = 912$ (table = A-13)

$$M_{u1} = 912 \times \phi b d^2$$

$$M_{u1} = 912 \times 0.90 \times 16 (29)^2$$

$$M_{u1} = 920.3\ ft\text{-}k.$$

$$M_{n_1} = \frac{M_{u_1}}{\phi}$$

$$M_{n_1} = \frac{920.3}{0.90}$$

$$M_{n_1} = 1022.65 \text{ ft-K}$$

$$M_{n2} = M_n - M_{n_1}$$

$$M_{n2} = 936.8 - 1022.65$$

$$M_{n2} = -85.8$$

I am taking this value positive
it because of M_D = is less -

$$\boxed{M_{n2} = 85.8 \text{ ft-K}}$$

As' Required.

$$A_s' = \frac{M_{n2}}{f_y(d-d')}$$

$$A_s' = \frac{85.8 \times 12}{60(29-3)}$$

$0.66 in^2$.

f_y 3#5 $\boxed{A_s' = 0.91 in^2}$

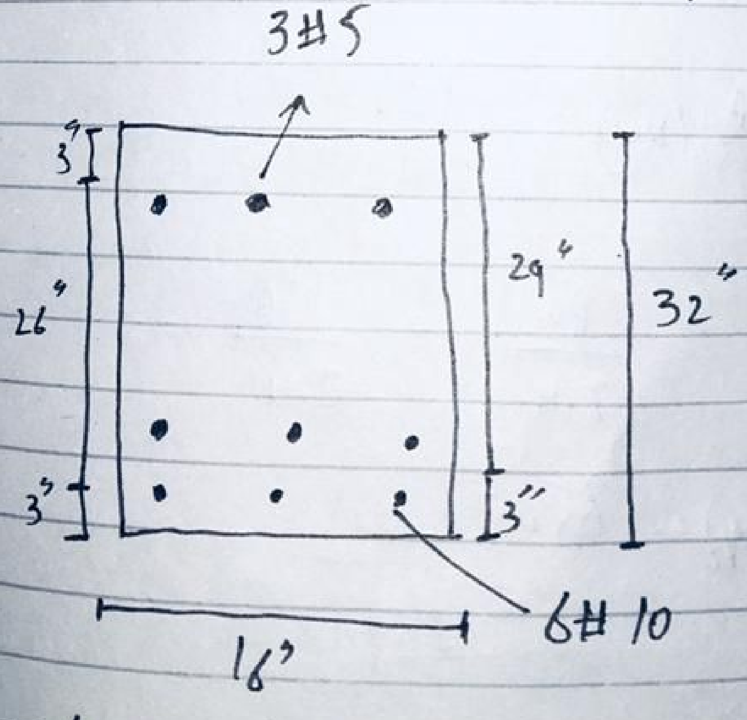
$$A_s' f_c' = A_{s2} f_y$$

$$A_{s2} = \frac{A_s' f_s'}{f_y}$$

$$A_{s2} = \frac{0.91 \times 60}{60} = \boxed{0.91 in^2}$$

$A_s = A_s + A_{s2}$
$A_s = 8.35 + 0.9 in$
$A_s = 7.515$

f_y
6#10
$A_s = 7.59$.



x — x — x — x

Q #(2)

→ Design a short squar column for the following condition -

$P_u = 156\,k$
$M_u = 15\,f\text{-}k$
$f_c' = 4000\,psi$
$f_y = 60{,}000\,psi$

place the bar uniformly around all fore face of the column -

Sol:-

Assuming the column will have compression stress about

$0.6 f_c' = 2400\,psi$

$= 2.4\,ksi$.

Now

$$A_g(Req) = \frac{P_u}{2.4}$$

$$= \frac{P_u}{2.4} = \frac{156}{2.4}$$

$A_g(Req) = 65\,in^2$

So we try

9 x 9 in column -

$A_g = 81\ in^2$

$$e = \frac{M_u}{P_u} = \frac{15 \times 12}{156}$$

$$= 1.15\ in$$

$$P_n = \frac{P_u}{\phi} = \frac{156}{0.65}$$

$$P_n = 240\ k$$

$$K_n = \frac{P_n}{f_c' \times A_g}$$

$$= \frac{240}{4 \times 81}$$

$K_n = 0.74$

$$R_n = \frac{P_n \times e}{f_c' \times A_g \times h}$$

$$R_n = \frac{240 \times 1.15}{4 \times 81 \times 9}$$

$R_n = 0.946$

$$\gamma = \frac{9 - 2.5 - 2.5}{9}$$

$$\gamma = \frac{4}{9}$$

$\gamma = 0.44$ (Not in the table)

So let Assume the ($\gamma = 0.7$)

Now by the intersection diagram take the ρ value with the help of Rn and Kn value - which is

$\boxed{\rho = 0.012}$ - table intersection from diagram

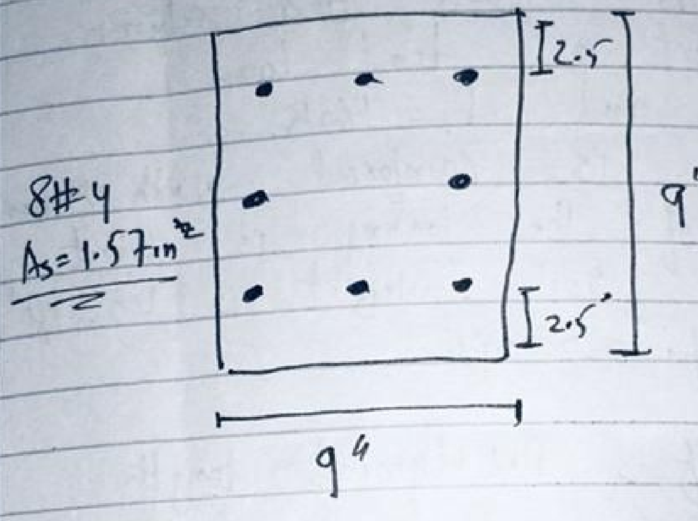
$A_s = \rho b h$

$A_s = 0.012 \times 9 \times 9$.

$\boxed{A_s = 0.972 \, in^2}$

USC 8#4

As = 1.57 in²



— x — x — x — x —

Q#(3)

→ Design a square column footing for a 16in square tied column that support a dead load $P_D = 156k$ and $P_L = 160K$. The column is reinforced with 8 bar. The base of the footing is 5 feet below, the soil weight is $100 lb/ft^3$

$f_y = 60{,}000$, $f_c' = 3000 psi$

$q_a = 1562 psf$. Development length. Appropiate diagram is must.

Sol)

Given data.

$P_D = 156K$

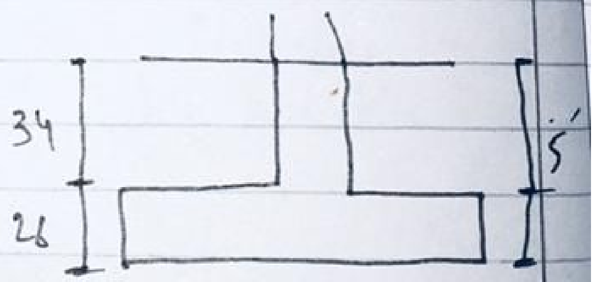
$P_L = 160K$

$\gamma_s = 100 lb/ft^3$

$f_y = 60{,}000 psi$

$f_c' = 3000 psi$

$q_a = 1562 psf$ (~~3000~~)



Assumed data:

$\gamma_c = 150 lb/ft^3$

$h_c = 26''$ $d = 22.5$

$h_s = 34$.

Sol:-

① effective Soil pressure -

$$q_e = q_a - h_c \times \gamma_c - H_s' \times \gamma_s$$

$$q_e = 1562 - \left(\frac{26}{12} \times 150\right) - \left(\frac{34}{12} \times 100\right)$$

$$q_e = 1562 - 325 - 283.3$$

$$q_e = 953.7$$

$$q_e = 0.953 \text{ ksf}$$

② Area of footing - $= \dfrac{P_D + P_L}{q_e}$

$$= \frac{156 + 160}{0.953}$$

$$= 331.34$$

use

18' x 18' footing

Area = 324'

③ Ultimate bearing capacity -

$$q_u = \frac{1.2 P_D + 1.6 P_L}{\text{Area of footing}}$$

$$q_u = \frac{1.2(156) + 1.6(160)}{324}$$

$$\boxed{q_u = 1.36 \text{ ksf}}$$

(4) Depth required for two way or punching shear.

The depth required for to two-way shear is the largest value obtain from the following.

(1) $$d = \frac{V_{u2}}{\phi 4 \sqrt{f_c'}\, b_o}$$

$\alpha_s = 40$

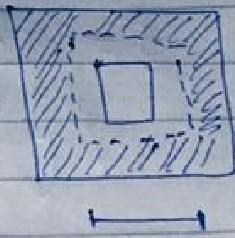
(2) $$d = \frac{V_{u2}}{\phi \left(\frac{\alpha_s d}{b_o} + 2\right) \sqrt{f_c'}\, b_o}$$

b_o = perimeter around the punching Area.

$b_o = 4(a+d)$

$b_o = 4(16+22.5)$

$b_o = 154$



$V_{u2} [A - (a+d)) * q_u$

$V_{u2} = 324 - \left(\frac{16+22.5}{12}\right) \times 1.367.$

$V_{u2} = (324 - 3.20) \times 1.367$

$V_{u2} = 438.53 \times 1000$

$V_{u2} = 438533$

① $d = \dfrac{V_{u2}}{\phi 4 \sqrt{f_c'}\ b_o}$

$= \dfrac{438533.6}{.75(4)\sqrt{3000} \times 154}$

$= 17.33 < 22.5$ /ok.

(2) $d = \dfrac{V_u^2}{\phi\left(\dfrac{\alpha_s d}{b_0} + 2\right)\sqrt{f_c}\, b_0}$

$= \dfrac{438533.6}{0.75\left(\dfrac{40 \times 22.5}{154} + 2\right)\sqrt{3000} \times 154}$

$= \dfrac{438533.6}{0.75(2.40)\sqrt{3000} \times 154}$

$= 12.75 > 22.5$ / ok.

(5) depth required for one way shear -

$V_{u1} = (18 \times 6.48) \times q_u$

$V_{u1} = 18 \times 6.48 \times 1.367$

$V_{u1} = 159.44$

$V_{u1} = 159446.8\ lb$

$\frac{l}{2} - \frac{a}{2} - d$

$\frac{18}{2} - \frac{1.3}{2} - 1.87$

$= 6.48$

$$d = \frac{159446.8}{0.75 \times 2 \times \sqrt{3000} \times (18 \times 12)}$$

$d = 8.98 < 22.5$ /ok.

Use hight = 26"

Moment-

$$M_u = 8.335 \times 18 \times 1.36 \times \frac{8.335}{2}$$

$M_u = 920.5$

Now

$$\frac{M_u}{\phi b d^2} = \frac{920.5 \times 1000 \times 12}{0.90 \times (18 \times 12)(22.5)^2}$$

$= 112.17$

Now from table (A.12)

$\rho = 0.0020$

Use grater value ① $\frac{200}{60,000} = 0.003$

② $\frac{3\sqrt{3000}}{60,000} = 0.002$

$\frac{L}{2} - \frac{a}{2}$

$\frac{18}{2} - \frac{16/12}{2}$

$\frac{18}{2} - \frac{1.33}{2}$

$= 9 - 0.66$

$= 8.335$

So

$\rho = 0.0033$.

Area of steel:-

$A_s = \rho b d$

$A_s = 0.003 \times (18 \times 12) \times 22.5$

$A_s = 16 in^2$

Use 8 # 14 (from table)

$A_s = 18 in^2$

→ Development length.

$\Psi_t = \Psi_e = \Psi_s = \lambda = 1$

$$\frac{l_d}{d_b} = \frac{3}{40} \frac{f_y}{\lambda \sqrt{f'_c}} \frac{\Psi_t \Psi_e \Psi_s}{c_b / d_b} \quad (1)$$

If $\frac{c_b}{d_b} > 2.5$

then we use 2.5

Ψ_t = Reinforcement location factor

Ψ_e = coating factor

Ψ_s = Reinforcement size factor

λ = Concrete Modification factor.

C_b = Side cover = 3.5
d_b = dia of bar = 1.69 (14 bar = 1.69)

$$\frac{C_b}{d_b} = \frac{3.5}{1.69} = 2$$

so use 2
using eq (1)

$$\frac{l_b}{d_b} = \frac{3}{40} \frac{60,000}{1\sqrt{3000}} \times \frac{1\times1\times1}{2}$$

$$\frac{l_b}{d_b} = 31.875$$

$$\frac{l_b}{d_b} \times \frac{A_s\,(Req)}{A_s\,(select)}$$

$$= 31.87 \times \frac{16 in^2}{18 in^2}$$

$$= 28.32$$

$$l_d = 28.32 \times d_b$$

$$l_d = 28.32 \times 1.69$$

$$\boxed{l_d = 47.87}$$