ID # 7829

Name # Malak Miraj Qadir

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Section # A

Instructors Name# Engr Fawad Khan

Subject # PRCD 1

Paper # Mid Term.

Question-01

Sol:-

Given data:-

Width (b) = 10'

Live load (L.L) = 2.47 Kips/ft

Dead load (D.L) = 1.05 Kips/ft

Span = 18'

f'_c = 4000 Psi = 4 ksi

f_y = 60000 Psi = 60 ksi

Height (h) = 20".

Sol:-

Step#1:-

Effective depth (d) = h-3

= 20-3

= 17"

→ Effective Cover (d') = 2.5"

Reinforcement Ratio:-

$$\rho_{max} = 0.85 \times \beta \times \frac{F'_c}{F_y} \times \left(\frac{\varepsilon_u}{\varepsilon_u + \varepsilon_y}\right)$$

Putting all the values.

$$= 0.85 \times 0.85 \times \frac{4}{60} \times \left(\frac{0.003}{0.003+0.005}\right)$$

$$\boxed{\rho_{max} = 0.0180}$$

Step#02:-

Now finding area of steel.

$$\rho_{max} = \frac{Ast}{b \times d}.$$

$$\Rightarrow Ast = \rho_{max} \times (b \times d)$$

~~Ast =~~ Putting all the values.

$$Ast = 0.0180 \times (10 \times 17)$$

$$Ast = 3.06 in^2.$$

⇒ ## Step#3:-

Using by formula of design Moment,

$$M_{U_2} = \phi \times Ast \times fy \times (d - a/2)$$

Now we also know that

$$a = \frac{Ast \times fy}{0.85 \times f'c \times b} \rightarrow$$

Putting all the values.

$$a = \frac{(3.06 \times 60}{0.85 \times 4 \times 10}$$

$a = 5.4''$.

$Mu_2 = 0.90 \times 3.06 \times 60 \times (17 - 5.4/2)$

$\Rightarrow 2362.93$ kip-inch

Moment because of given loads:-

Beam Self weight $= \frac{10}{12} \times \frac{20}{12} \times 150$

$= 208.33$ lb/ft.

Total Factored Load $= 1.2(1050 + 208.33) + 1.6(2470)$

$= 5461.99$ lb/ft

$= 5.46$ kips/ft

Ultimate Factored Moment:- $\frac{wL^2}{8}$

$= \frac{5.46 \times (18)^2}{8} \times 12$

$Mu = 2653.56$

Now,

$Mu_2 < Mu$

$2362.92 < 2653.56$

This as known as Doubly Reinforcement Required.

→ Step#04:-

$M_{u_1} = 2653.56 - 2362.92$

$= 290.64$ kip-inch.

→ Step#05:-

Now steel area in Compression zone will be,

$M_{u_1} = \phi \times A'st \times f_y \times (d-d')$

$$A'st = \frac{M_{u_1}}{\phi \times f_y \times (d-d')}$$

$$= \frac{290.64}{0.90 \times 60 \times (17-2.5)}$$

$= 0.37$ in².

⇒ Step#06:-

$As = Ast + A'st$

Putting all the know values

$As = 3.06 + 0.37$

$= 3.43$ in²

⇒ Step#07:-

we tak #8 bars, (dia = 8/8 = 1")

Area = 0.785 in².

Now No of bars = $\frac{Ast}{\text{Area of 1 bar}}$

Putting all the values.

$= \frac{3.43}{0.785} = 4.36 \simeq 5$ bars

So 5 #8 bars

(∵ #, For tensile zone)

⇒ Compression Steel :-

Use #6 bars,

dia (6/8) = 0.75"

Area = 0.44 in^2

No. of bars = $\frac{Ast'}{\text{Area of 1 bar}} = \frac{0.37}{0.44}$

= 0.84 ≃ 1 bars

So 1 #6 bars in → Compression zone.

⇒ Step #08:-

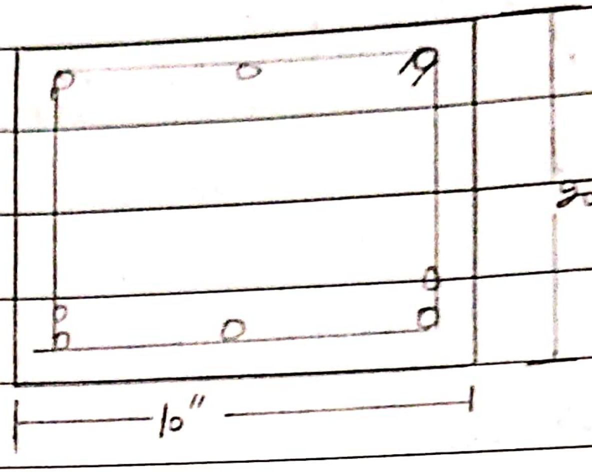
Beam Minimum width.

$b_{min} = 2(1.5) + 2\left(\frac{3}{8}\right) + 5\left(\frac{8}{8}\right) + 4\left(\frac{8}{8}\right)$

= 12.75 > 10"

↓

in multiple layers.



→ Effective depth (d) =

$$20 - 1.5 - \frac{3}{8} - \frac{8}{8} - \frac{1}{2}\left(\frac{8}{8}\right)$$

$d = 16.62"$

→ Effective Cover (d') =

$$\Rightarrow 1.5 + \frac{3}{8} + \frac{1}{2}\left(\frac{6}{8}\right)$$

$\Rightarrow 2.25"$

→ Step#09:-

Design Moment is given by,

$$M_d = \phi \times [A_{st}' \times f_y \times (d - d') + (A_{st} - A_{st}') \times f_y \times (d - a/2)]$$

$$a = \frac{(A_{st} - A_{st}') \times f_y}{0.85 \times f'_c \times b}$$

$$= \frac{(5 \times 0.785 - 1 \times 0.44) \times 60}{0.85 \times 4 \times 10}$$

$= 6.15''$

$Md = 0.90 \times [((1 \times 0.44) \times 60 \times (16.62 - 2.25) + (5 \times 0.785 - 1 \times 0.44) \times 60 \times (16.62 - \frac{6.15}{2})]$

$Md = 2890.46$

$Md = 2890.46 > 2653.56$

This is required design

Q.No#03

Given data:-

$f'c = 4000$ psi

$fy = 60,000$ psi

$S.S = 225\ lb/ft^2$

Dead load (D.L) = $50\ lb/ft^2$

Effective depth = $28'' - 3''$

$= 25''$

Total depth (h) = $28''$

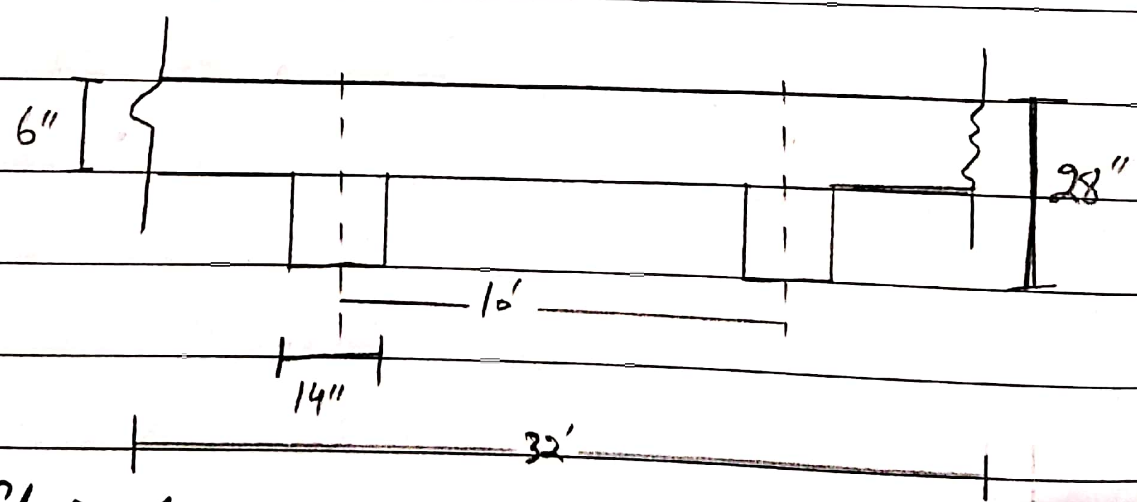
web width = $14''$

Slab thickness = $6''$

C/c distance = $10'$

Span = $32'$

Sol:-



Step#1:-

$M_u = W_u \times L^2/8$

1- Self weight beam Per feet.

$wt = b \times t \times \gamma_c$

$= \frac{14}{12} \times \frac{28}{12} \times 150$

$= 408.33$ lb/ft

Total Factored Load:-

$= 1.2(50 + 408.33) + 1.6(225)$

$= 909.99$ lb/ft.

$= 0.909$ kip/ft.

Find Moment:-

We already know to find out the Moment.

$\frac{WL^2}{8} = \frac{0.909 \times (32)^2 \times 12}{8}$

$= 1396.23$ kip-inch.

⇒ Effective breadth:-

how to find effective breadth

1) $16(hf) + bw$

$= 16(6) + 14 = 110''$

2) c/c distance $= 10(12) = 120''$

3) Span/4 $= \frac{32}{4} \times 12 = 96''$.

So effective breadth (be) = 96".

Step# 03:-

(Rectangular or T-Beam).

Trial#1:-

let $a = h_f = 6"$

$$A_{st} = \frac{M_u}{\phi \times f_y \times (d - a/2)}$$

$$= \frac{1396.23}{0.90 \times 60 (25 - 6/2)}$$

• $A_{st} = 1.17 \, in^2$.

Trial #2:

$$a = \frac{A_{st} \times f_y}{0.85 \times f'_c \times b}$$

Putting all the known values.

$$a = \frac{1.17 \times 60}{0.85 \times 4 \times 96}$$

$= 0.2" < 6"$

So Rectangular beam are design.

$$A_{st} = \frac{1396.23}{0.90 \times 60 \times (25 - 0.2/2)}$$

$A_{st} = 1.03 \, in^2$

Trial #3:-

$$a = \frac{1.03 \times 60}{0.85 \times 4 \times 96}$$

$a = 0.18''$

$$A_{st} = \frac{1396.23}{0.90 \times 60(25 - 0.18/2)}$$

$A_{st} = 1.03\ in^2$

Step #4:-

Check ρ_{max} & ρ_{min}.

⇒ $\rho_{max} =$

$$0.85 \times 0.85 \times \frac{4}{60}\left(\frac{0.003}{0.003+0.005}\right)$$

$\rho_{max} = 0.018$

Now $\rho_{min} = \frac{200}{f_y} = \frac{200}{60{,}000}$

$= 0.003$

⇒ $\rho = \frac{A_{st}}{b \times d} = \frac{1.03}{14 \times 25} = 0.0029$

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

$0.003 < 0.002 < 0.018$

As

ρ is less than ρ_{min}

So,

$\rho = \frac{A_{st}}{b \times d} \Rightarrow A_{st} = \rho_{min} \times b \times d.$

Putting the values.

$A_{st} = 0.003 \times 14 \times 25$

$A_{st} = 1.05\ in^2$

Step # 5:-

No. and Choosen of Bar

let use #8 bar, then

dia $(8/8) = 1"$, Area $= 0.785\ in^2$.

No. of bars $= \frac{1.05}{0.785} = 1.3 \approx 2$

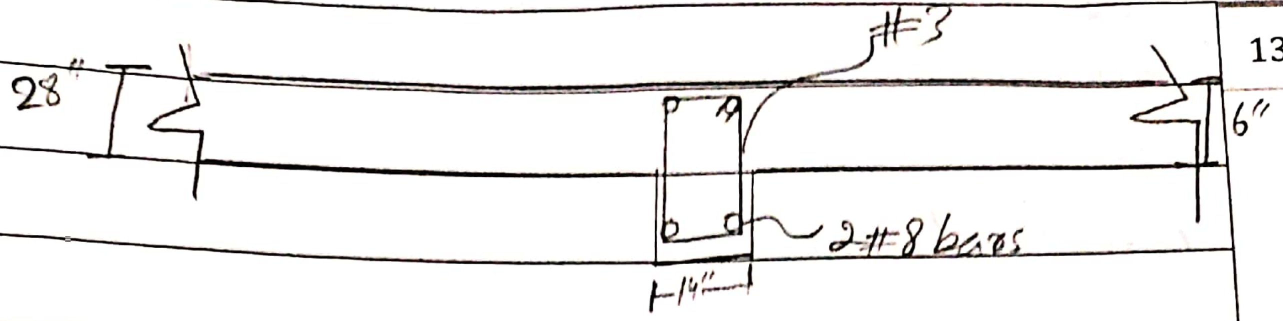
let we use 2#8 bars.

Step # 6:- Minimum width.

$b_{min} = 2(1.5) + 2(3/8) + 2(8/8) + 1(8/8)$

$= 6.75" < 14"$

Thats good in one layer.



Step #7:

Design Moment:

$M_d = \phi \times f_y \times A_{st} \times (d - a/2)$

Area of Steel = Area of 1 bar × no. of bars

Putting values

$= 0.785 \times 2$

$= 1.57\ in^2$

$a = \frac{1.57 \times 60}{0.85 \times 4 \times 96}$

$a = 0.2"$

$\Rightarrow M_d = 0.90 \times 60 \times 1.57 \times (25 - 0.2/2)$

$= 2111.02$ Kip-inch.

As, $2111.02 > 1396.23$

So This is the required design.

Q.No2 (a)

Ans:-

Bond Stress:-

The force of adhesion per unit area of contact between two bounded surfaces, between concrete and steel reinforcing bar.

Now bond stress is shear stress at the ~~difference~~ surface of reinforcing bar which prevent movement between bar and surrounding concrete.

Bond stress resist any force that tries to pull out rods from concrete.

Development length:-

The maximum length of a steel rod that is inserted inside concrete column, to ensure sufficient adhesion force between concrete and steel.

Development length creates a safe bond between bar surface and Concrete it also ensures during ultimate load conditions the reinforcement bar should not slaep through the complete it transfer stress from bar to column.

Ans: 02 (b)

Doubly reinforced concrete beams are used when asthetic of functional requirements dictate that the beam needs to be smaller then that which can be accomodated using a singly reinforced Concrete beam.

Ans:- 02(c)

Both beams have T shape but their analysis and design is quite different from one another. In ~~can~~ case of T beam, slab and beam are connected with one another