Haris Ali Shah

7530

Submitted to :- Engr Fawad Khan

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Q1 Answer to Q 1

Data

height = 20"

width = 10"

D.L , L.L = 1.05 k/ft , 2.47 kip/ft

Total span = 18 ft

f'_c = 4 ksi , f_y = 60 ksi

Sol

Let d = h - 3
d = 20 - 3 = 17"

Assume d' = 2.5"

Step 1

Checking the capacity of given beam as Simply Reinforcement beam

$$\rho_w = 0.85 \times \beta \times \frac{f_c'}{f_y}\left[\frac{\varepsilon_u}{\varepsilon_u + \varepsilon_y}\right]$$

Date:

$$\rho_{max} = 0.85 \times 0.85 \times \frac{4}{60} \left[\frac{0.003}{0.003+0.005}\right]$$

$\rho_{max} = 0.0181$ → Reinforcement ratio

Step 2

Finding Area of Steel

$$A_{st} = \rho_{max} \times b \times d$$

$$A_{st} = 0.0181 \times 10 \times 17$$

$$A_{st} = 3.077 \text{ in}^2$$

Step 3

Finding design moment

$$M_{u_2} = \phi \times A_{st} \times f_y \times (d - a/2)$$

$$a = \frac{A_{st} \times f_y}{0.85 \times f_c' \times b} = \frac{3.077 \times 60}{0.85 \times 4 \times 10} = 5.43''$$

Now

$$M_{u_2} = 0.90 \times 3.077 \times 60 (17 - 5.43/2)$$

$$M_{u_2} = 2373.567 \text{ kip-inch}$$

Now moment due to given loads

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

$= 208.33\ lb/ft$

Total fractured load $=(1.2)(D.L) + (1.6)(L.L)$

$=(1.2)(1050+208.33) + 1.6(2470)$

$= 5.46\ kips/ft$

Ultimate fractured moment $= \frac{WL^2}{8} = \frac{5.46 \times 18^2 \times 12}{8}$

$M_u = 2653.56\ kp\ in$

As

$M_{u2} < M_u$

~~[illegible]~~

$2373.5k < 2653.56$

Now we provide Doubly Reinforcement

Step 4

$M_{u1} = M_u - M_{u2}$

$M_{u1} = 2653.56 - 2373.57$

$M_{u1} = 2.8\ kp/in$

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Step 5

Compression zone Steel Area

$$A'st = \frac{Mu_1}{\Phi \times f_y (d-d')} = \frac{280}{\Phi \times 60(17-2.5)} = 0.36\, in^2$$

$\Phi = 0.90$

Step 6

$Ast = Ast + A'st$

$Ast = 3.077 + 0.36$

$Ast = 3.44\, in^2$

Step 7

For tensile zone

using #8 bar

$Area = 0.785\, in^2$

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

$$= \frac{3.44}{0.785} = 4.38 \text{ say 5 bars}$$

For Compression zone

use # 6 bar

dia = $6/8 = 0.75"$

Area = $0.44\, in^2$

No. of bars $= \frac{A'_{st}}{\text{Area of bar}} = \frac{0.36}{0.44} = 0.86$

$0.86 \simeq 1$

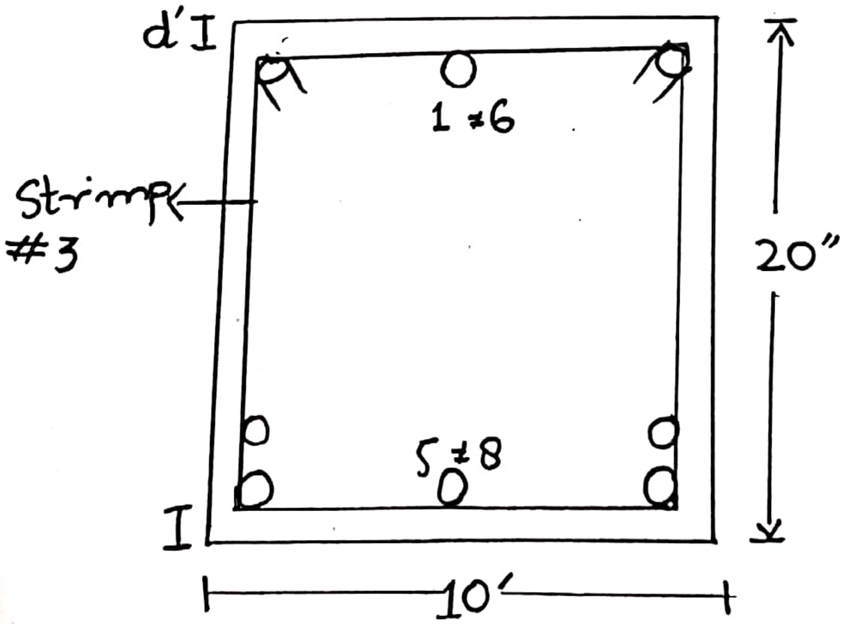
So 1 #6 bar in compression zone

Step 8

$b_{min} = 2(1.5) + 2(3/8) + 5(8/8) + 4(8/8)$

$= 12.75'' > 10''$

So in multiple layers



⇒ Effective depth, $d = 20 - 1.5 - 3/8 - 8/8 - 1/2(8/8)$

$d = 16.62''$

⇒ Effective cover, $d' = 1.5 + 3/8 + 1/2(6/8)$

$d' = 2.25''$

Step 9

Given design moment

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

$$a = \frac{(A_{st} - A'_{st}) \times f_y}{0.85 - f_c' \times b} = \frac{(5 \times 0.785 - 1 \times 0.44)}{0.85 \times 4 \times 10} = 6.15''$$

So

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

$M_d = 2890.46$ kip-in

$M_d = 2890.46$ kip-in > 2653.56 kip-in

Q2 (a) Define Bond --- & why

Bond Stress :-

The stress which is acting on the outer surface of steel to the surrounding concrete is called bond stress.

⇒ This stress help in keeping bond b/w reinforcement & concrete together. Bond stress resists any force that tries to pull out the rods from concrete.

Development length :-

" The length of the bar required for transferring the stress into the concrete".

why we provide development length.

① To develop a safe bond b/w the bar surface & concrete so that no failure due to shippage of bar occur dueing the ultimate loading condition

Q2
(b) In what condition doubly Reinforcement beam can be used

A2 (b) 1- Beams required with steel in compression zone & tension zone are called doubly Reinforced beam.

⇒ Condition for using Doubly Reinforced:-

we used the ~~dub~~ doubly Reinforced beam on that condition when the Restrictions occur in the size of beam.

Q2
(C) Difference b/w T beam Analysis & Rectangular Analysis

A2 (C) Both of them are T beam but according to Analysis they are quite different from each other

→ In T-beam Analysis All members that are slab & beam act as single member like = h/hp

→ In case of Rectangular beam Analysis Slab has been placed on the beam so there is no connection b/w slab & beam

Q2 (d) Effect of strength reduction factor on Flexural strength.

A2 (d) In the design of flexural strength the strength reduction factor decreases from tention control section to compression controlled section to increase safety with decreasing ductility that show to determine the reduction factor for flexural strength of reinforcement concrete.

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Q2 Briefly describe --- & why?
(e)

A2 Designing Method:-
(e)

There are two types of designing meth

① ASD Method
② USD method

ASD Method:- is also known as working stress design method. It is used on the principle that stress developed in the structueal member should not exceed a certain limit briction of elastic limit.

USD Method:- is also known as load factor method for the structueal subjected to large external load the ultimate strength is determine by the welestic Analysis

⇒ USD method is best for designing different stucture method because
⇒ the ultimate strength of mateeial considered we will get much stander ~~the~~ Section for

coloum Eg bcam compare to
other material.

m

Q3

A concrete --- Draw sketch

A3 Given Data

Length = 32′

Slab thickness = h_f = 6″

web width = b_w = 14″

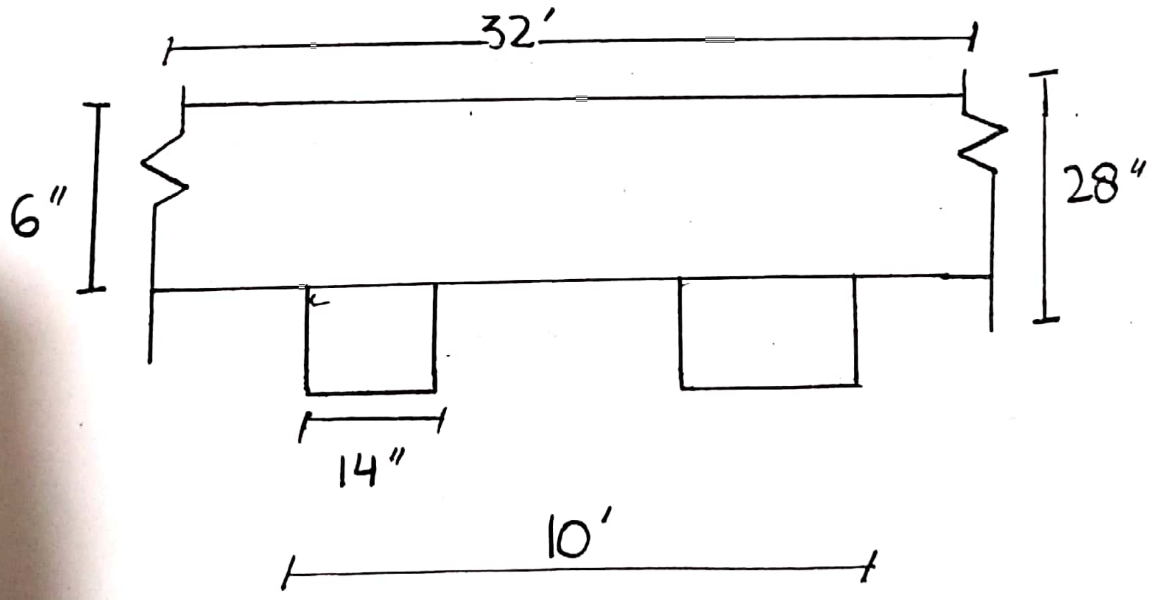
depth, h = 28″

L.L , D.L = 225 lb/ft², 50 lb/ft²

f_c' = 4 ksi

f_y = 60 ksi

c/c distance = 10′



Step 1

To find self weight of beam

$w_t = b \times h \times \gamma_c$

$= \frac{14}{12} \times \frac{28}{12} \times 150 \text{ lb/ft}^2$

$w_t = 408.33 \text{ lb/ft}$

Total fractured load.

$W_u = 1.2 (D.L) + 1.6 (L.L)$

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

$W_u = 0.91 \text{ kip/ft}$

Step 2

Ultimate factored moment

$M_u = \frac{W_u \times l^2}{8} = \frac{0.91 \times (32)^2 \times 12}{8}$

$M_u = 1397.76 \text{ kip-in}$

Step 3

Effective width (b_e)

① $16 \times h_f + b_w$

$16 \times 6 + 14 \Rightarrow 110'$

② c/c distance $= 10 \times 12 = 120'$

③ span/4 $= 32/4 = 8' = 8 \times 12 = 96''$

$b_e = 96''$

Step 4

checking which type of Analysis is required

Trial 1

let $a = h_f = 6''$

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

$$A_{st} = \frac{1397.66}{0.9 \times 60 (25 - 6/2)}$$

$A_{st} = 1.77 \ in^2$

Trial 2

$$a = \frac{A_{st} \times f_y}{0.85 \times f_c \times b_e} = \frac{1.77 \times 60}{0.85 \times 4 \times 96} = 0.216'' < h_f = 6''$$

so design by Rectangular beam

$$A_{st} = \frac{1397.76}{0.90 \times 60 \times (25 - \frac{0.216}{2})} = 1.04 in^2$$

Trial 3

$$a = \frac{1.04 \times 60}{0.85 \times 4 \times 96} = 0.191 \ in$$

$A_{st} = 1.04 \ in^2$

Step 5

Finding ρ_{max} & ρ_{min}

$$\rho_{max} = 0.85 \times \beta \times \frac{f_c}{f_y} \times \left(\frac{\varepsilon_u}{\varepsilon_u + \varepsilon_y}\right)$$

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

$$\rho_{max} = 0.0181$$

Now

$$\rho_{min} = \frac{200}{f_y} = \frac{200}{60,000} = 0.0033$$

Now

$$\rho = \frac{A_{st}}{b_e \times d} = \frac{1.04}{14 \times 25}$$

$$\rho = 0.00297$$

So

$\rho_{min} < \rho < \rho_{max} \rightarrow$ Not ok

~~because~~

Here

$\rho_{min} < \rho$ not satisfied here

Now

$$\delta_{min} = \frac{A_{st}}{b \times d}$$

$$A_{st} = \delta_{min} \times b \times d$$

$$A_{st} = 0.0033 \times 14 \times 25$$

$$A_{st} = 1.155 \, in^2$$

Step 6

No. of bars $= \frac{A_{st}}{A_b} = \frac{1.155}{0.785}$

using #8

No. of bars $= 1.47 \simeq 2$

Take 2#8 bars as main bars

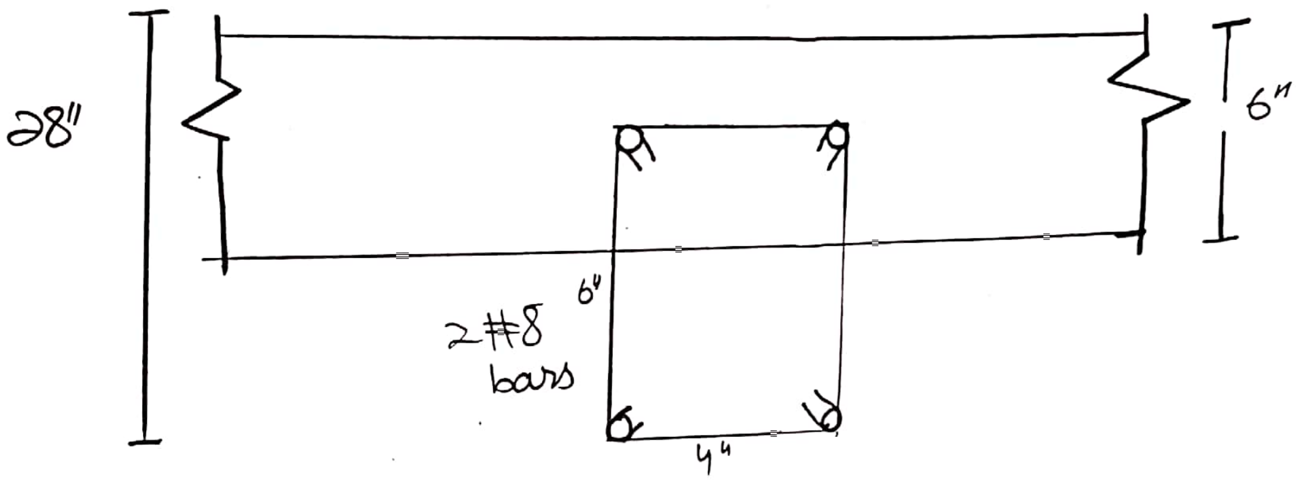
Step 7

$b_{min} = 2 \times c.c + 2 \times \text{stirup} + 2 \times m.b + 1 \times \text{spacing}$

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

$b_{min} = 6.75'' < 14''$

So the main bars are good in one layer.



Step 9

Design moment

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

$$M_d = 0.9 \times 60 \times (1.57)(25 - \frac{0.288}{2})$$

$$M_d = 2160$$

so

$$M_d > M_u$$

so design is ok!