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SEC B

PRCD

Qno # 1

Given data

live load = 2.47 kips/ft

dead load = 1.05 kips/ft

Span (L) = 18 ft

Width = 10 inh

Depth = 20 inh

F_y = 6000 psi

f_c = 4000 psi

$d = h - 3 = 20 - 3 = 17''$

$d' = 2.5''$

Step # 01

$$\rho_{max} = 0.85 \times B \times \frac{f'_c}{f_y} \times \left[\frac{\varepsilon_u}{\varepsilon_u + \varepsilon_y}\right]$$

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

$$\boxed{\rho_{max} = 0.0181}$$

Step # 02 Beam Self weight

$$= B \times t \times \gamma_c$$

$$= \frac{10}{12} \times \frac{20}{12} \times 150 \; lb/ft^3$$

$$\boxed{BSW = 208.3 \; lb/ft}$$

Step# 03

Area of Steel

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

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

$$= 0.0181 \times 10 \times 17$$

$$\boxed{A_{st} = 3.077 \text{ inh}^2}$$

Step # 04

Design factored ~~load~~ Moment.

$$M_{U_2} = \phi \times A_{st} \times f_y \left(d - \frac{a}{2}\right)$$

$$a = \frac{A_{st} \times f_y}{0.85 f'_c \times b} = \frac{3.08 \times 60}{0.85 \times 4 \times 10}$$

$$= 5.4''$$

$$M_{U_2} = 0.90 \times 3.08 \times 60 \times \left(17 - \frac{5.4}{2}\right)$$

$$\boxed{M_{U_2} = 2378.38 \text{ K}''}$$

Now total factored load

$= 1.2\,(DL) + 1.6\,(L.L)$

$= 1.2\,(1050 + 208.3) + 1.6\,(2470)$

$= 5461.9$ lb/ft

$$TFL = 5.46\ k/ft$$

Ultimate factored moment $= \dfrac{wL^2}{8}$

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

$$M_U = 2653.56\ k''$$

Now

$$M_{U_1} = M_U - M_{U_2}$$

$$M_{U_1} = 2653.56 - 2378.3$$

$$M_{U_1} = 275.18\ k''$$

Step # 05

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

$$= \frac{275.18}{0.9 \times 60 \, (17-2.5)}$$

$$\boxed{A_s' = 0.35 \text{ in}^2}$$

$$A_s = A_{st} + A_s'$$

$$= 3.08 + 0.35$$

$$= 3.43 \text{ inh}^2$$ (Tension zone of skel) occurs in

Step # 06

For tensile Steel let's take

8

No of bar $= \frac{Ast}{Ab} = \frac{3.43}{0.785} = 4.3 \approx 5$ bars

For Comppression let take #6, having area $= 0.44 inh^2$

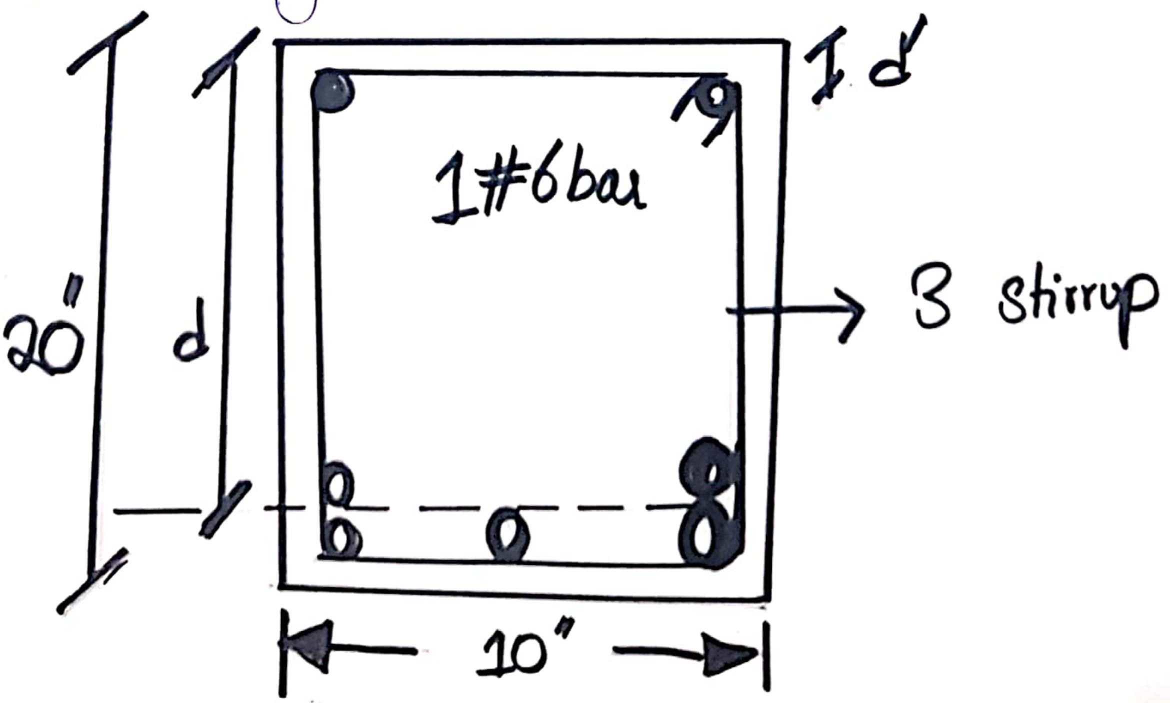
No of bars $= \frac{As'}{Ab} = \frac{0.35}{0.44} = 0.7 \approx 1$ bar

Step #7

$$b_{min} = (2\times1.5) + 2\left(\frac{3}{8}\right) + \left(5\times\frac{8}{8}\right) + \left(4\times\frac{8}{8}\right)$$

$$= 12.75'' > 10''$$

Multiple layer's required



$$d = 20 - 1.5 - \frac{3}{8} - \frac{8}{8} - \frac{1}{2}\left[\frac{8}{8}\right]$$

$$d = 16.625''$$

$$d' = 1.5 + \frac{3}{8} + \frac{1}{2}\left[\frac{6}{8}\right] = 2.25''$$

Step # 8

Design Moment

$$M_d = \phi \times \left[A_s' \times f_y \times (d - d') + (A_s - A_s') \times f_y \times \left(d - \frac{a}{2}\right)\right]$$

$$a = \frac{(A_s - A_s')\, f_y}{0.85 f_c \times b} = \frac{(5 \times 0.785 - 1 \times 0.44)\, 60}{0.85 \times 4 \times 10}$$

$$a = 6.15''$$

$$= 0.90\left[1 \times 0.44 \times 60 \times (16.625 - 2.25) + (5 \times 0.785 - 1 \times 0.44) \times 60 \times \left(16.625 - \frac{6.1}{2}\right)\right]$$

$$M_d = 2891.52$$

$$M_d = 2891.52\,K'' > 2653.56\,K''$$

Design is OK

Qno # 2 (Part - a)

Bond Stress

It can be defined as, The pulling out of steel bar from Concrete is resisted by gripping action of concrete is known as bond stress.

Development length

"The necessary length between the point of maximum stress in a bar and the end of bar"

For #11 or smaller bar's the development length must not be less than the value obtained from the

(b)

⇒ The following are the reason's due to such conditions doubly reinforcement must be used

1) Where depth is restricted.
2) when load applied is more and depth is restricted than we apply doubly reinforced beam.

(c)

Both beams have 'T' shape but their analysis and design is quiet different from one another. In case of "T" beams, slab and beams are connected with one another and act as one member. In case of rectangular beams, slab has been placed on the beam so there is no connection between slab and beam

(d)

The effects of strength reduction factor on flexural strength is briefly explained by ACI (440.2R-08) 2008, two distinct modes of failure govern the behaviour of the members externally strengthened with FRP, and thus affect the calculations of equations. The first mode is initiated by the crushing concrete ($\varepsilon_c = 0.003$). It also state that the effects on flexural strength due to strength reduction factor also relies on the member design parameters.

(e)

There are two types of design methods

1) Ultimate Strength Design Method. (USDM)
2) Allowable Stress Design Method. (ASDM)

USDM → Due to this method we can find thickness of beam and depth of the beam.

ASDM → In this method we only count service load.
– In this method actual loads are considered means (Live load + dead load)

★ ASDM is more preferable because it consider's actual load.

Qno #3

Given data

c/c distance = 10'

Slab thickness = 32'

Web Width = 14"

Total depth = 28"

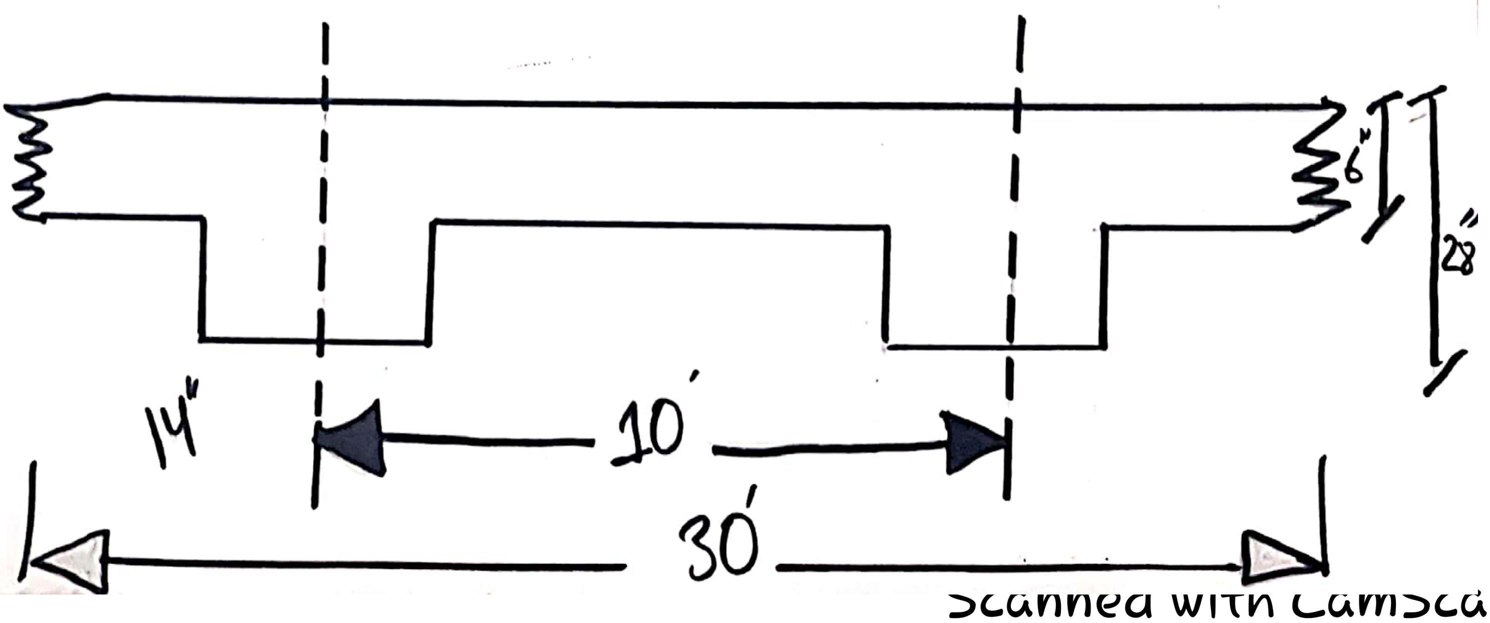
D.L = 50 lb/ft

S.S = 225 lb/ft

f_y = 60,000 psI

f_s = 40,000 psI

Effective depth = 28" - 3" = 25"



(UFM)

$$M_u = \frac{W_u \times L^2}{8}$$

(Step#1)

So, beam self weight per feet

$$W_t = b \times t \times \gamma_c$$

$$W_t = \frac{14 ft}{12} \times \frac{28 ft}{12} \times 150 lb/ft^3$$

$$W_t = 408.33 \ lb/ft$$

Now total factored load

$$= 1.2(50 + 40.833) + 1.6(225)$$

$$TFL = 909.9 \ lb/ft \text{ or } 0.909 \ Kp/ft$$

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

$$M_d = 1396.2 \ kp \cdot inh$$

Effective breadth

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

$c/c \text{ distance} = 10 \times 12 = 120''$

$\text{span}/4 = \frac{32}{4} \times 12 = 96''$

So $\boxed{b_e = 96''}$

Step # 2

Rectangular or T beam analysis is required?

Trail : 1

$$A_{st} = \frac{M_u}{\phi \times f_y \times (d - a/2)} = \frac{1396.23}{0.9 \times 60\left[25 - \frac{6}{2}\right]}$$

$$\boxed{A_{st} = 1.17 \text{ in}^2}$$

Trail : 2

$$a = \frac{A_{st} \times f_y}{0.85\, f_c \times b_e}$$

$$a = \frac{1.175 \times 60}{0.85 \times 4 \times 96} = 0.22'' < 6''$$

Thus Rectangular beam analysis is required.

$$A_{st} = \frac{M_u}{\phi \times f_y \times [d - a/2]} = \frac{1396.244}{0.90 \times 60 \left(25 - \frac{0.2}{2}\right)}$$

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

Trail : 3

$$a = \frac{1.04 \times 60}{0.85 \times 4 \times 96} = 0.19''$$

$$A_{st} = \frac{1396.244}{0.90 \times 60 \left(25 - \frac{0.19}{2}\right)} \boxed{= 1.04 \text{ in}^2}$$

Check ρ_{max} and ρ_{min}

$$\rho_{max} = 0.85 \times \beta \times \frac{f'_c}{f_y} \times \left(\frac{\varepsilon_u}{\varepsilon_u + \varepsilon_t}\right)$$

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

$$\boxed{\rho_{max} = 0.018}$$

$$\rho_{min} = \frac{200}{f_y} = \frac{200}{60{,}000} = 0.003$$

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

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

$$0.003 < 0.002 < 0.018$$

As ρ is less than ρ_{min}

$$A_{st} = 0.003 \times 14 \times 25 = 1.05\ inh^2$$

Soory sir

Step # 3

No and Selection of Bar

let use #8 bar, then

dia $= \left(\frac{8}{8}\right) = 1''$ Area $= 0.785$

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

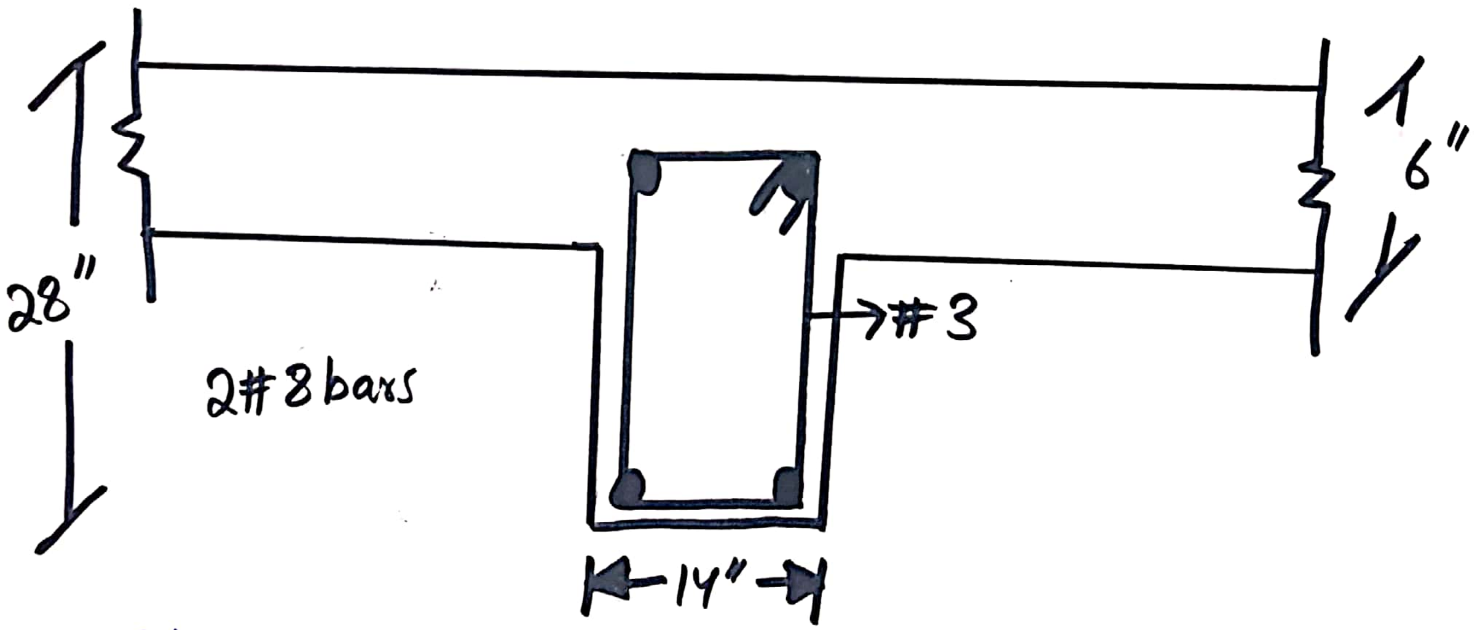
So we use 2#8 bars

Minimum width Step #

$$b_{min} = 2(1.5) + 2\left(\tfrac{3}{8}\right) + 2\left(\tfrac{8}{8}\right) + 1\left(\tfrac{8}{8}\right)$$

$$= 6.75'' < 14''$$

Good in One layer.



Step # Design Moment

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

Area of Steel = Area of one X No of bar

$= 0.785 \times 2 = 1.57 \text{ inh}^2$

$a = \frac{1.57 \times 60}{0.85 \times 4 \times 96} = 0.2''$

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

$= 2111.02$ kp-inh

As, $2111.02 > 1396.23$

Design is OK.

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