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Subject :- PRC Design-I

Qno(1)

Given Data:-

Width (b) = 10", Height = 20"

Live load = 2.47 kips/ft, Dead load = 1.05 kips/ft

span = 18', F'c = 4000 psi = 4 ksi, Fy = 60,000 psi = 60 ksi

Solution:-

Step 1:-

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

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

$$\rho_{max} = 0.018$$

Step 2:-

Area of steel

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

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

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

$$A_{ST} = 3.07 \, in^2$$

Step 3:-

Design Factor Moment

$Mu_2 = \phi \times A_{ST} \times f_y \times \left(d - \frac{a}{2}\right)$

$a = \frac{A_{ST} \times F_y}{0.85 f_c' b}$

$= \frac{3.08 \times 60}{0.85 \times 4 \times 10}$ $a = 5.4''$

$Mu_2 = 0.90 \times 3.08 \times 60 \times \left(17 - \frac{5.4}{2}\right)$

$Mu_2 = 2378.3 \; k''$

Step 4:-

$Mu_1 = Mu - Mu_2$

$Mu_1 = 2653.6 - 2378.3$

$Mu_1 = 275.2 k''$

Step 5:-

$Mu_1 = \phi \times As' \times f_y \times (d - d')$

$As' = \frac{Mu_1}{\phi \times f_y \times (d - d')}$

$= \frac{275.2}{0.90 \times 60 (17 - 2.5)}$

$As' = 0.35 in^2$

Scanned with CamScanner

Step 6:-

$A_s = A_{s1} + A\bar{s}$

$= 3.08 + 0.35$

$= 3.43 \, in^2$

This lies in tension zone of steel

Now,

Moment of given load

Beam self weight $= b \times \gamma_c \times t$

$= \frac{10}{12} \times 150 \times \frac{120}{12}$

$= 2083 \, lb/ft$

Total Factored load $= 1.2 D.L + 1.6 L.L$

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

$= 5.5 \, k/ft$

Ultimate Factored moment $= \frac{wL^2}{8}$

$M_u = \frac{5.5(18)^2 \times 12}{8}$

$= 2653.6 \, k''$

∴ $2378.3 < 2653.6$

∴ doubly designed beam

Step 7:- Bars Selection

→ For tensile steel, lets take #8 area of $0.785 in^2$

$$\text{No. of bars} = \frac{A_s}{A_b} = \frac{3.43}{0.785} = 4.36 \approx 5 \text{ bars}$$

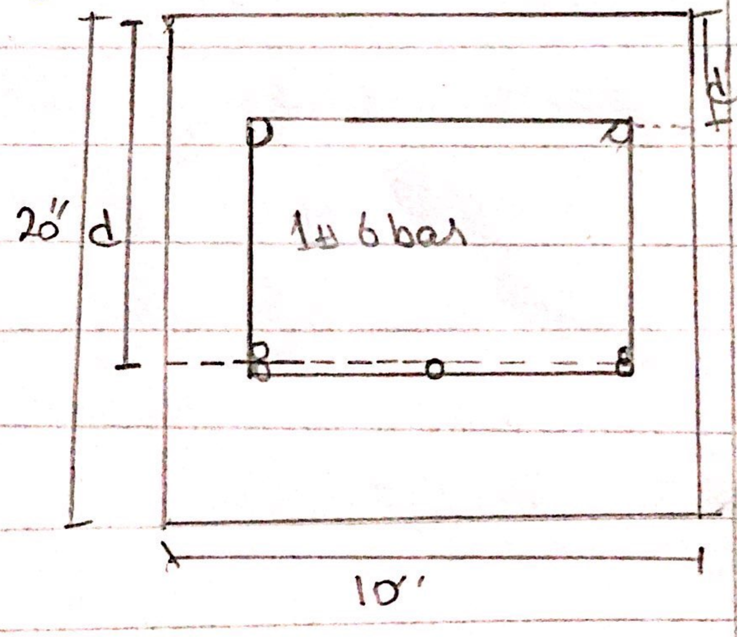
For compression steel let take #6 area of $0.442 in^2$

$$\text{No. of bars} = \frac{A_s'}{A_b} = \frac{0.35}{0.442} = 0.79 \text{ bars} \approx 1 \text{ bar.}$$

Step 8:- Beam Minimum Widht

$$b_{min} = (2 \times 1.5) + 2\left(\frac{3}{8}\right) + \left(5 \times \frac{8}{8}\right) + \left(4 \times \frac{8}{8}\right) = 12.75'' > 10''$$

Multipals layers



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

$$d = 16.62''$$

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

$$= 2.25''$$

Step 9:-

Design Moment

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

$$a = \frac{(As - As') \times Fy}{0.85 fc \times b}$$

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

$a = 6.15''$

$$= 0.90 \times \left[1 \times 0.44 \times 60 \times (16.62 - 2.25) + (5 \times 0.785 - 1 \times 0.44) \times 60 \times \left(16.25 - \frac{6.15}{2}\right) \right]$$

$Md = 2891.52$

$Md = 2891.52 > 2653.56 k''$

Design is ok..

Q no (2) (A)

Bond Stress:-

Bond stress is the result of the bonding between the concrete surface and reinforcement steel.

The stress which is on the outer interface of steel to the concrete is called bond stress.

Development Length:-

The length of the bar required for transfering the stress into concrete.

In simple words

"The amount of reinforcement (bar) length needed to be embedded or projected into the column to establish the desired bond strength between the concrete and steel.

(B)

In which condition double reinforced beam can be used:-

- When moment to be carried by the beam is more then the balanced moment
- When the cross section of beam is fixed
- When there is torsion on the beam

- DRB is provided to increase the moment of resistance of a beam having limited dimensions.
- For safty reasons we provide doubly reinforced beam to counter wind force and seismic forces.

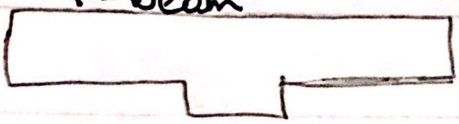
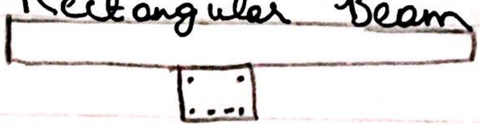
Advantages :-

→ More moment of resistance over single re, section

→ the depth of beam can be reduced to have archi. view and strength can be increased by rein. in compreson zone.

(C)

Differentiate b/w T-beam and rectangular beam analysis

T-Beam	Rectangular Beam
	
· Flexural capacity of T-beam varies based on the sign of moment	· Flexular capacity depends on location of rienforcement to yield
· Design depends on the location of moment	· Simple design
· Beams and slab connected with eachother, act as one member	· slab is placed on beam so that there is no connection b/w slab and beam.

(D)

Q Write short note on effect of strength ----

Ans The design of Flexural RC members strengthend with externally bonded Fiber-reinforced polymer (FRP) systems assign an additional partial strength reduction Factor to the contribution of FRP. The tension controlled sections are desirable for their ductile behaviour for giving sufficent warning to failure. Depending on the structure compression controlled section have less ductility thus they acts simultaneosly to hold together.

(e)

Describe methods, which one of them can be used for design of different member and why?

There are three methods :-

- Working stress Method
- ultimate load Method
- Limit state method

· Working Stress Method:-

The method basically assumes that the structure material behaves as a linear elastic manner, and that adequate safety can be ensured by suitably restricting the stresses in the material induced by the expected "working loads".

Ultimate load Method:-

The ultimate load method makes it possible for different types of loads to be assigned different load Factors under combined loading conditions, thereby overcoming the related short coming of working stress methode.

Limit state Method:-

The philosophy of the limit state method of design represents a definite advancement over the traditional design philosophies.

Qno 3:-

Given data:-

Span = 32' , C/C distance = 10' , h_f = 6"

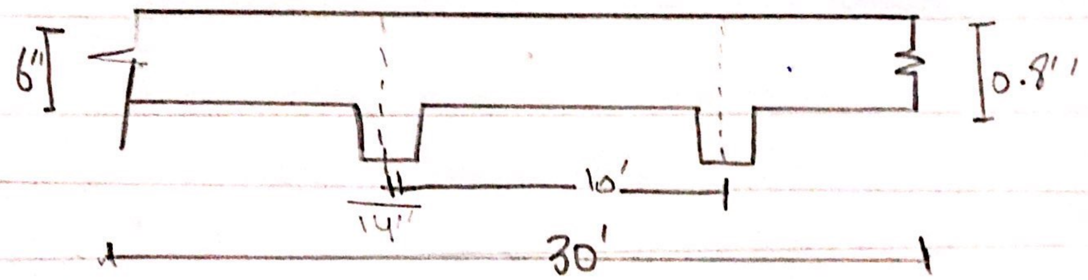
h = 28" , b_w = 14"

d = effective depth = h-3 = 28-3 = 25"

D.L = 50 lb/ft^2 , L.L = 225 lb/ft^2

f_y' = 60,000psi , f_c' = 4000psi
= 60ksi = 4ksi

Solution:-



Step # 1

$$M_u = \frac{WL^2}{8}$$

→ self weight of the beam

$W_t = b \times t \times rc$

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

= 408.33 lb/ft

→ Total factored load

= 1.2 D.L + 1.6 L.L

= 1.2(50+408.33)+1.6(225) = 909.99 lb/ft

= 0.909 k/ft

$M_u = \frac{0.909 \times (32^2)}{8}$ = 116.352 ×12 = 1396.224 kft

Step 2:- Determine the effective width "be"

→ $16 \times h_f + b_w = 16 \times 6 + 14 = 110''$

→ C/C distance $= 10 \times 12 = 120''$

→ Span/4 $= \frac{32}{4} \times 12 = 96''$

Select the least value of be i.e 96

Step 3:- Checking whether Rectangular or T.Beam req.

Trail:-1 let $a = h_f = 6''$

$$A_{ST} = \frac{M_u}{\phi \times f_y \times (d - a/2)} = \frac{1399.244}{0.90 \times 60 \times (25 - 6/2)}$$

$A_{ST} = 1.175 \, m^2$

Trail:2

$$a = \frac{A_{ST} \times f_y}{0.85 f_c \times b_e} = \frac{1.175 \times 60}{0.85 \times 4 \times 96} = 0.22'' < 6''$$

Thus Reactangular beam analysis Required

$$A_{ST} = \frac{M_u}{\phi \times f_y \times (d - a/2)} = \frac{1396.244}{0.90 \times 60 \times (25 - \frac{0.2}{2})}$$

$= 1.04 \, m^2$

Trail 1-3

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

$$A_{ST} = \frac{1396.244}{0.90 \times 60 \times (25 - 0.19/2)} = 1.04 \, m^2$$

Same area.

Step 4:- Checking ρ_{max} and ρ_{min}

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

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

$$\rho_{max} = 0.018$$

$$\rho_{min} = \frac{200}{fy} = \frac{200}{60000} = 0.003$$

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

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

$$0.003 < 0.002 < 0.018$$

ρ is less then ρ_{min} Thus,

$$\rho = \frac{AsT}{b \times d}, \quad AsT = \rho_{min} \times b \times d$$

$$= 0.003 \times 14 \times 25$$

$$= 1.05 \text{ in}^2$$

Step 5:- Selection No of bars.

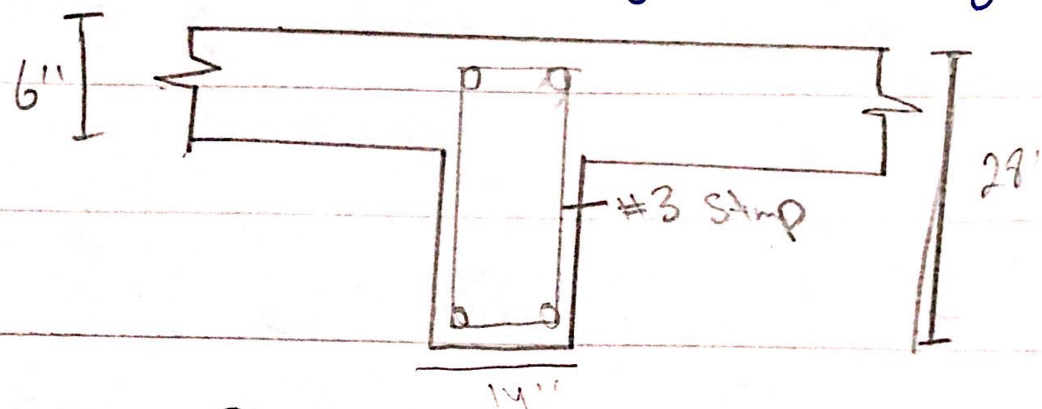
let's use #10 bar area of 1.27 in²

No. of bars = $\frac{A_{ST}}{1.27} = \frac{1.05}{1.27} \approx 2$ bars

Step 6:- Checking minimum width

$b_{min} = (2\times1.5)\times(2\times3/8) + 2(10/8) + 1(10/8)$

$= 7.5'' < 14''$ good in one layer



Step 7:- Design Moment

$M_d = \phi \times f_y \times A_{ST} \times \left(d - \frac{a}{2}\right)$

$A_{ST} = 1.27\times2 = 2.54\,in^2$

$a = \frac{A_{ST}\times f_y}{0.85 F'c \times b_e} = \frac{2.54\times60}{0.85\times4\times96} = 0.467''$

$M_d = 0.90\times60\times2.54\times\left(25 - \frac{0.467}{2}\right) = 3396.97$

$\Rightarrow 3396.97 > 1396.244$

Design is OK