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SEMESTER	6th
SUBJECT	PRCD
TECHNOLOGY	Civil

(Q) No1

Given that

$f_y = 60000$ Psi , $w = 10''$

$f'_c = 4000$ Psi , $h = 20''$

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

$d' = 2.5''$

STEP #01:-

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

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

$$\rho_{max} = 0.0181$$

Step 02 :-

Area of steel

$$\rho_{max} = \frac{AST}{b \times d}$$

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

$= 0.0181 \times 10 \times 17$

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

⇒ STEP 3:-

Design factored Moment :-

$M_{u2} = \phi \times A_{st} \times f_y \times \left(d - \frac{a}{2}\right)$

$a = A_{st} \times f_y$

$= 0.85 f'_c b$

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

$M_{u2} = 0.90 \times 3.08 \times 60 \times \left(17 - \frac{5.4}{2}\right)$

$M_{u2} = 2378.38 \text{ k}''$

Now,

Moments of the given load.

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

$= \frac{10}{12} \times \frac{20}{12} \times 150$

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Now total factored load = 1.2 D.L + 1.6 L.L

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

$= 5461.996$ lb/ft

$= 5.46$ k/ft

ultimate factored moment $= \frac{WL^2}{8}$

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

$= 2653.56$ k"

Thus $2378.38 < 2653.56$

It should be doubly designed beam

Step 04:-

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

$= 2653.56 - 2378.38$

$M_{u1} = 275.18$ k"

Step 05

$$M_{u1} = \phi \times A_s' \times f_y \times (d - d')$$

$$A_s' = \frac{M_{u1}}{\phi \times f_y \times (d - d')}$$

$$= \frac{275.18}{0.90 \times 60 (17 - 2.5)}$$

$$= 0.35 in^2$$

Step 06:-

$$A_s = A_{s1} + A_s'$$

$$= 3.08 + 0.35$$

$$= 3.43 in^2$$

This lies in the tension zone of steel

Step 07:-

Selection of Bars

For tensile steel, let's take # 8 having an area of 0.785 in^2

No of bars = $\frac{As}{Ab} = \frac{3.43}{0.785} = 4.36 \approx 5$ bars

for compression steel ; let's Take #6 having an area of 0.442 in^2

No of bars = $\frac{As'}{Ab} = \frac{0.35}{0.442} = 0.79 \approx 1$ bar

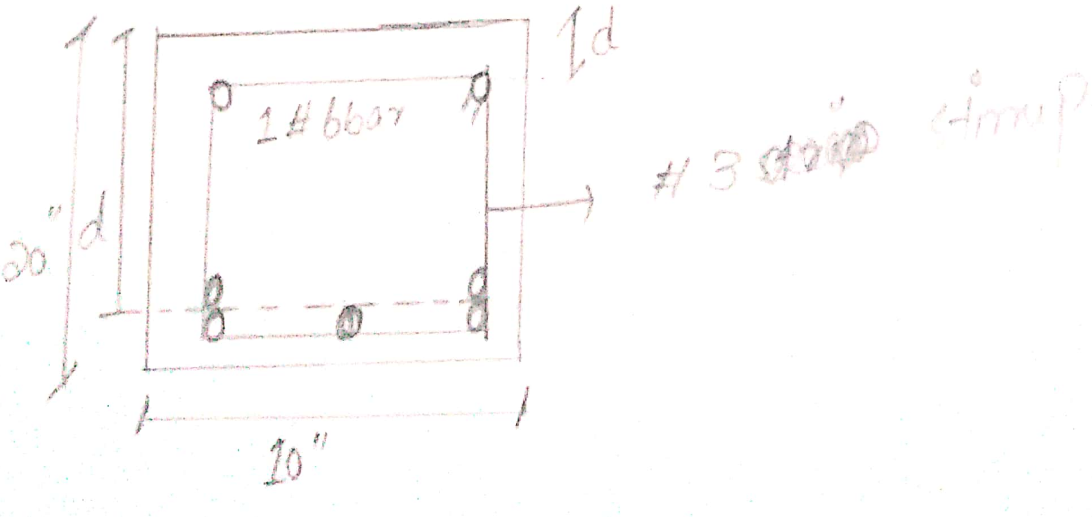
step 08:-

Beam Minimum width

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

$= 12.75'' > 10''$

It should be in multiple layers



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

$d = 16.625''$

$d' = 1.5 + \frac{3}{8} + \frac{1}{8}\left(\frac{6}{8}\right) = 2.25''$

Step 09:-

Design Moment

$Md = \phi \times \left[As' \times fy \times (d - d') + (As - As') \times fy \times \left(d - \frac{a}{2}\right)\right]$

$a = \frac{(As - As') \times fy}{0.85 fc \times b} = \frac{(5 \times 0.785 - 1 \times 0.44) \times 60}{0.85 \times 4 \times 10}$

$a = 6.15''$

$= 0.90 \times \left[1 \times 0.44 \times 60 \times (16.625 - 2.25) + (5 \times 0.785 - 1 \times 0.44) \times 60 \times \left(16.625 - \frac{6.15}{2}\right)\right]$

$Md = 2891.5245$

$Md = 2891.5245 > 2653.56\ K''$

Design is OK.

Q no 2

Part (A):-

Bond stress:-

The bonding between the concrete surface and the reinforced steel is known as bonding stress. The acting stress that acts parralel between the interface of the rebar and the concrete as a result of Adhesion, Mechanical interlock and fritional forces between the steel and concrete is called bond stress.

Development length:-

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 (or any other type of material)

Part (B)

When there are Architechural Restrictions the need of doubly Reinforced beam is required hence we use the doubly reinforced beam.

Part (C):-

T. beam Analysis	Rectangular Beam Analysis
The analysis slab and beam are connected together and act as one in T-beam analysis	The analysis slab is placed on the beam hence there is no connection among them in Rectangular beam.
② The resistance of T-beam is higher for positive moment because the flange section would be in compression But for Negative moments it yeilds the same strength as an equivalent beam without the flange	② The Rectangular beam section only depends on the location of reinforcement to yeild the flexural capacity.

Part (D)

The flexural strength of reinforced concrete (RC) beams strengthened with a carbon fiber reinforced polymer plate which fails by intermediate crack debonding is evaluated

The effect is due to higher debonding resistance in the first case, where the comparison of the strength Reduction factor with Experimental Data and factor proposed for That

Part (E)

Design Methods:-

It is a procedure, technique aids, or tool for designing they offer a number al different kinds of activities that a designer might use with in an overall design process.

- Tree Methods of structural design ① working stres, ② limit state iii ultimate load method.

⇒ limit state method is used mostly Because it provide strength and serviceability

Q.NO 3

Given DATA:..

C/C distance = 10'

Span = 32'

h_f = 6"

web width = 14"

Total depth (h) = 28"

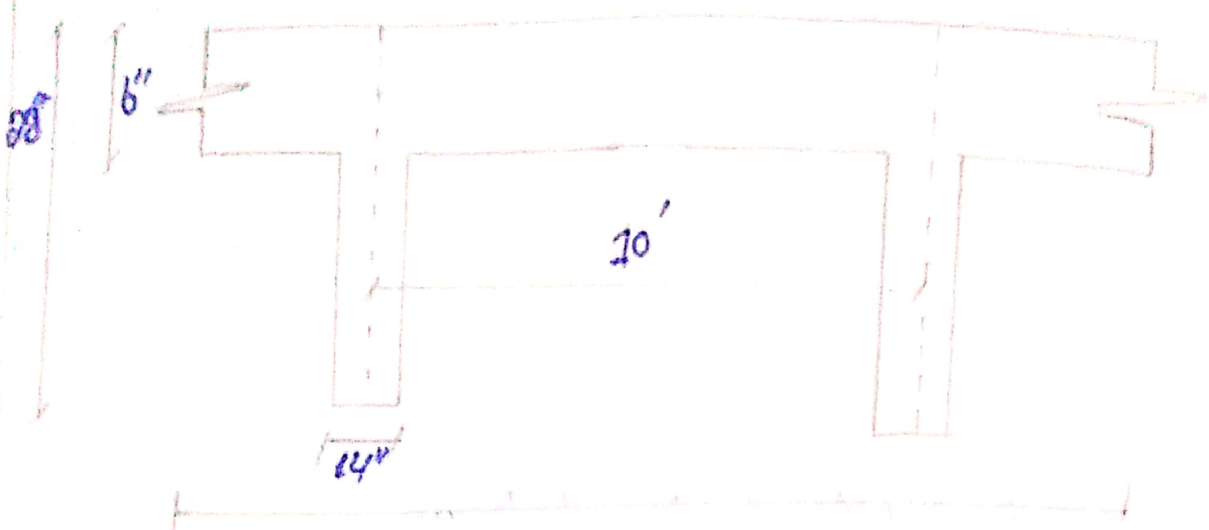
Effective depth = h - 3 = 28 - 3 = 25"

D.L = 50 lb ft²

S.S = 225 lb/ft²

f_y = 60,000 psi = 60 ksi

f_c' = 4000 = 4 ksi



Step 1

$$M_U = \frac{w_U \times L^2}{8}$$

Beam self weight per unit feet

$$w_t = b \times t \times \gamma$$

$$= \frac{14}{12} \times \frac{28}{12} \times 150 = 408.33 \text{ lb/ft}$$

total factored load:-

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

$$= 909.99 \text{ lb/ft} = 0.909 \text{ kip/ft}$$

Moment:-

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

$$= 1396.23 \text{ kip/inch}$$

Effective Breadth:-

(1) $16(h_f) + b_w = 16(6) + 14 = 110''$

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

(3) span/4 $= \frac{32}{4} \times 12 = 96''$

So $b_e = 96''$

Step (3) Rectangular or T-Beam

Trial (1) Let $a = A_f = 6''$

$$A_{st} = \frac{M_u}{\phi \times f_y \times (d - a/2)} = \frac{1396.23}{0.90 \times 60 \times (25-3)}$$

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

Trial (2)

$$a = \frac{A_{st} \times f_y}{0.85 \times f'_c \times b} = \frac{1.175 \times 60}{0.85 \times 4 \times 96}$$

$= 0.2'' < 6''$

So Rectangular Beam Design

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

$= 1.03 \text{ in}^2$

trial ③

$$a = \frac{1.03 \times 60}{0.85 \times 4 \times 96} = 0.18$$

$$A_{st} = \frac{1896.23}{0.90 \times 60 (25 - 0.18/2)}$$

$$= 1.037 \text{ in}^2$$

step ④ Check ρ_{max} and ρ_{min}

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

$$\rho_{max} = 0.018$$

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

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

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

$$0.003 < 0.0029 < 0.018$$

As "ρ" is less than ρ_{min}

So,

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

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

Step 5 No. of Bar selection

let use #8 bar, then

dia = 8/8 = 1" , Area = 0.785 in²

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

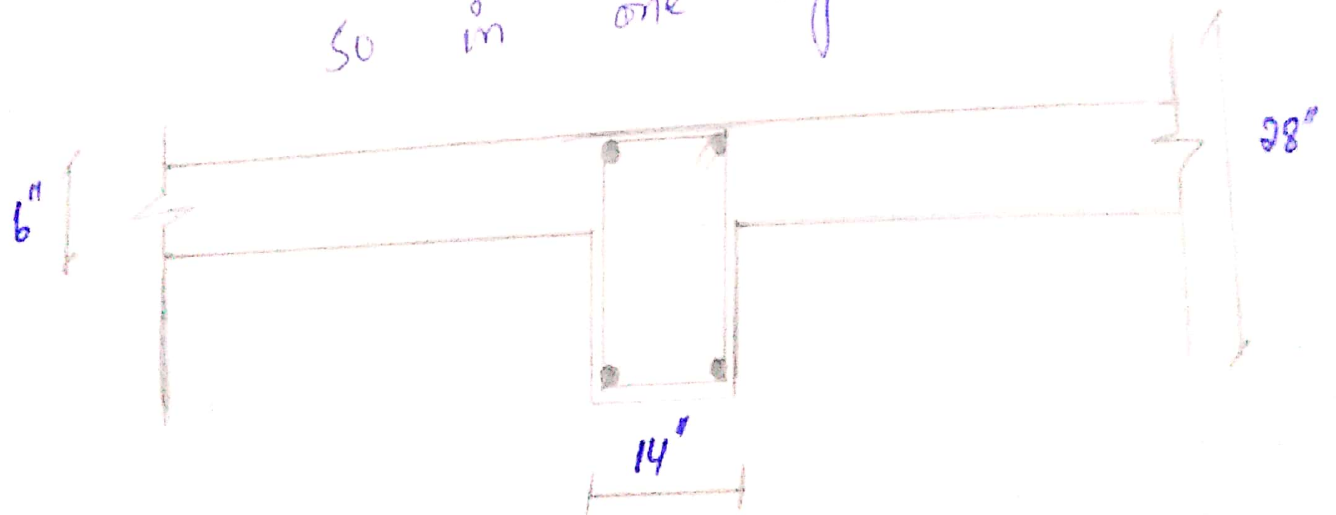
so we use 2 #8 bars

Step #6 Minimum width

bmin = 2(1.5) + 2(3/8) + 2(8/8) + 1(8/8)

= 6.75" < 14

So in one layer



Step ⑦ Design ~~method~~ Moment

Md = ϕ × fy × Ast × (d − a/2)

Area of steel = Area of 1 bar × No. of b

$= 0.785 \times 2$

$= 1.57 \text{ in}^2$

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

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

$= 2111.02$ kip-inch

As, $2111.02 > 1396.23$

Design is ok

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