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Section # B

Subject # PRCD

Semister # 6Th

Submitted To # FAWAD KHAN

Q1 A Rectangular beam that must carry a service load of 2.47 kips/ft and Calculate dead load of 1.05 kips/ft without selfweight on an 18-ft simple span is limited to 10 inches width and 20 inches total depth for Architectural Reasons. if fy = 60000 psi and f'c = 4000 psi. what steel Area must be provided? Draw sketch of your final design.

Sol:-

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

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

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

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

→ Step 02 :→

Area of steel.

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

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

$$= 0.081 \times 10 \times d7$$

$$Ast = 3.077 \ in^2$$

Step: 03: Design factored moment :→

$$Mu_2 = \phi \times Ast \times fy \times \left(d - \frac{a}{2}\right)$$

$$a = \frac{Ast \times fy}{0.85 fc\, b}$$

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

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

$$\boxed{Mu_2 = 2378.38 \ k'}$$

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

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

$= 5461.996$ lb/ft

$= 5.46$ K/ft

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

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

$= 2653.56$ K"

Thus $2378.38 < 2653.56$

It should be design double beam.

Step : 4 :->

$MU_1 = MU - MU_2$

$= 2653.56 - 2378.38$

$MU_1 = 275.18$ K"

Step :5 :→

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

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

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

$$= 0.35 \text{ in}^2$$

Step 06 :→

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

$$= 3.08 + 0.35$$

$$= 3.43 \text{ in}^2$$

lies on tension zone of steel.

Step 07 :

Selection of Bars

For tensile steel, lets take #6 having an area of $A = \frac{\pi D^2}{4} = \frac{3.14}{4} (6/8)^2 = 0.44 \text{ in}^2$

No of bars = $\frac{3.14 \text{ inch}^2}{0.44 \text{ inch}^2} = 7.795 \approx 8$

For compression steel ; lets take #6 bar having an area of 0.442 inch^2

No of bars $= \frac{A's}{Ab} = \frac{0.35}{0.442} = 0.79$

$\approx$ 1 bar.

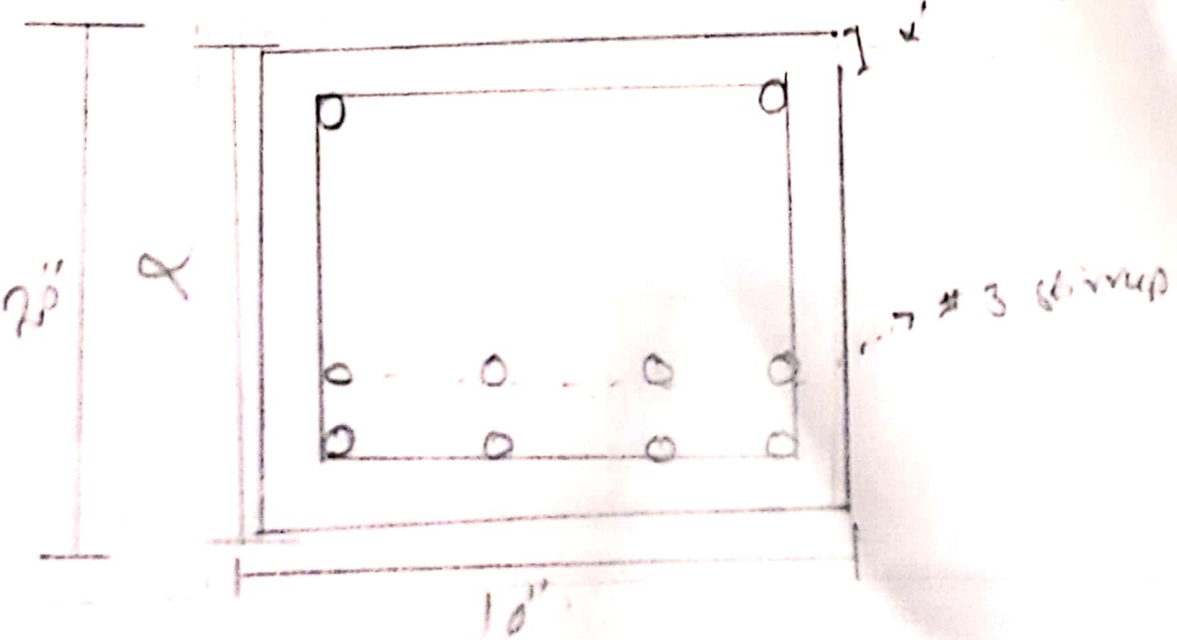
Step #08

Beam minimum width.

$b_{min} = (2 \times 1.5) + 2(3/8) + \left(8 \times \frac{6}{8}\right) + \left(7 \times \frac{8}{8}\right)$

$= 16.75'' > 10''$

It should be in multiple layers...



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$d = 20 - 1.5 - 3/8 - \frac{6}{8} - 6/8 - 1/2\,(6/8)$

$d = 17$

$d' = 1.5 + 3/8 + 1/2\,(6/8) = 2.25''$

Step :→ 9

Design moment:

$M_d = \phi \times [\,A_s \times F_y \times (d - d') + (A_s - A_s') \times F_y \times (d - \frac{a}{2})$

$a = \frac{(A_s - A_s') \times F_y}{0.85\,F_c \times b} \Rightarrow \frac{8 \times 0.442 - 1 \times 0.44 \times 60}{0.85 \times 4 \times 10}$

$a = 6.15''$

$M_d = 0.90 \times (1 \times 0.44^2 \times 60 \times (17 - 2.25) + (17 - \frac{6.15}{2})$

$M_d = 2666.466\ K'' > 2653.56''$

Q2. ① Bond Stress :-

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Bond stresses is the result of the Bonding between the concrete surface and the reinforcement steel. The stress Acting ~~on~~ at the interface of of rebars and Concrete that Acts parrellel to the bar as a result of Adhesion, mechanical interlock and frictional forces b/w The Concrete and steel is called bond Stress.

⇒ Development length :-

The amount of of ~~The reinforcement~~ 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 types of meterial)

b) In which Condition doubly Reinforcemend beam can used?

Ans The Condition in which we used doubly Reinforcemend is.

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→ When ther are for Archtichural difference Restriction. then we need to use doubly Reinforcment beam

C) T-beam analysis	Rectangular Beam analysis.
→ In T. beam analysis slab and beam are connected with one another and act as a one member.	→ In case of Rectangular beam ~~analysis~~ slab has been placed on the beam so that there is no connection b/w slab and beam.
→ The resistance of T beam is heighier for positive moment b/c the flange section would be in compression. But for negative moments it yields the same strength as an equivalent beam without the flange.	→ the Rectangular beam section only depends on the location of reinforcment to yield the flexural capacity.

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(d) Effective of strength reduction factor on ~~flexural~~ flexural strength.

⇒ 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 comparision of the strength reduction factor with experimental data and factors proposed for that.

e) Design Methods ⇒

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

→ Three methods of structral design

(i) Working stress,

(ii) Limit state

(iii) Ultimate load method.

⇒ Limit State method is used mostly Because it provide Strength and Serviceability.

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Q3 A Concrete floor system consists of parallel T beams spaced 10 ft on centers and spanning 32ft b/w supports. The 6" thick slab is cast monolithically with T-beam webs having width bw = 14" and total depth measured from the top of the slab of h = 28". The effective depth will be taken 3" less than the total depth. In addition to its own weight each beam must carry a superimposed D.L of 50 psf and S.L = 225 Psf. Material strengths are fy = 60,000 psi & f'c = 4000 psi. Determine the required tensile steel area and select the reinforcement needed for a typical member. Draw sketch of your final design.

Sol Given data

C/c distance = 10'

span = 32'

h_f = 6"

b_w = 14"

h = 28"

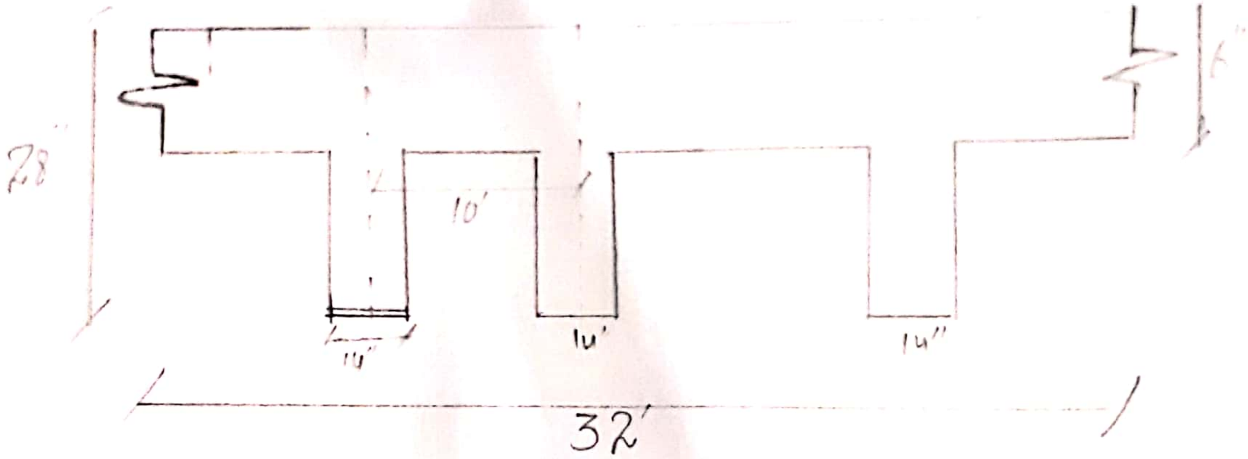
d = Effective depth = h-3 = 28-3 = 25"

D.L = 50 lb/ft²

L.L = 225 lb/ft²

f_y = 60,000 psi = 60 ksi.

f'_c : 4000 psi = 4 ksi



Step # 01 Ultimate factored moment.

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

i self weight of the beam

$w_t = b \times t \times \gamma_c$

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

$= 408.33$ lb/ft

γ_c:
For PCC = 140 lb/ft
For RCC = 150 lb/ft

ii= 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

$Mu = 0.909 \times (32^2) = 116.352 \times 12 = 1396.224\ k/ft$

=> Step #02 Determine the effective width b_e"

1- $16 \times h_f \times b_w$ = $16 \times 16 + 14$ = 110"

2- C/c distance = 10×12 = 120"

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

Select at least value of b_e i.e 96.

=> 3 => Step:

Check whether Rectangular or T beam analysis is required.

Trial #1.

let a h_f = 6"

$$AST = \frac{Mu}{\phi \times f_y \times d(d - a/2)} = \frac{1396.244}{0.90 \times 60 \times (25 \times 6/2)}$$

$$AST = 1.175\ in^2$$

Trial # 2.

$$a = \frac{AST \times f_y}{0.85 f'_c \times b_e} = \frac{1.75 \times 60}{0.85 \times 4 \times 96}$$

$$= 0.22" < 6"$$

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Thus Reactangular beam analysis is Required.

$$AST = \frac{Mu}{\phi \times fy \times (d - a/2)} = \frac{1396.244}{0.90 \times 60 \times (25 - 0.2/2)}$$

$$= 1.04 \ in^2$$

Trial # 3

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

$$AST = \frac{1396.244}{0.90 \times 60 \times (25 - 0.19/2)} \Rightarrow 1.04 in^2$$

Same Area :

Step # 04

Check ρmax and ρmin.

$$\rightarrow \rho max = 0.85 \times \beta \times \frac{f'c}{fy} \times \left(\frac{\varepsilon u}{\varepsilon u + \varepsilon t} \right)$$

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

$$\rho max = 0.018$$

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

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

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

$0.003 < 0.002 < 0.018$

As ρ is less than ρ_{min} so

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

$= 0.003 \times 14 \times 25$

$= 1.05 in^2$.

Step #05:

Select No of bars.

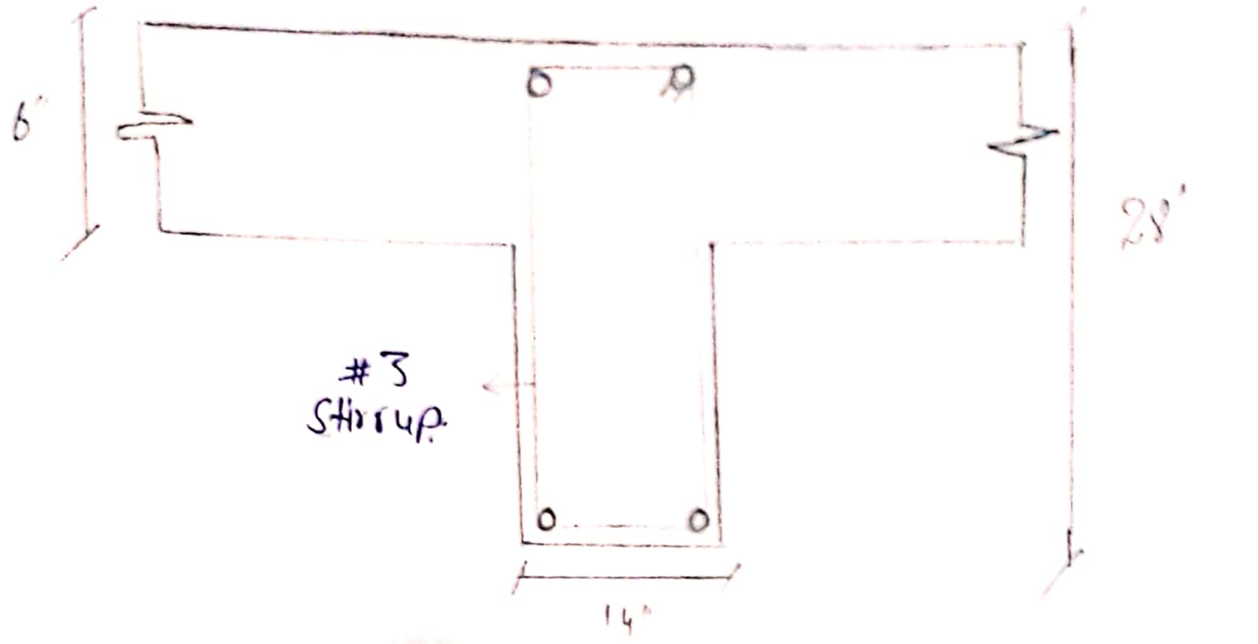
using #10 bar having Area $\cdot 1.27 in^2$.

No of bars $= \frac{Ast}{Ab} = \frac{1.05}{1.27} \approx 2$ bars.

Step # 06 Check on minimum width.

$b_{min} = (2 \times 1.5) + (2 \times 3/8) + 2(10/8) + 1(10/8)$

$= 7.5'' < 14''$



Step # 7 Design Moment.

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

→ $A_{st} = 1.27 \times 2 = 2.54 in^2$

→ $$a = \frac{A_{ST} \times f_y}{0.85 f'_c \times b_e} = \frac{2.54 \times 60}{0.85 \times 4 \times 96} = 0.467"$$

$$Md = 0.90 \times 60 \times 2.54 \times \left(25 - \frac{0.467}{2}\right)$$

$\Rightarrow 3396.97$

$3396.97 > 1396.244$

Design is Correct.