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Sec : "A"

Subject : PRCD-I

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: Assignment :

INU

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QNo : 01

Given data :

$Fc' = 4000$ psi

$Fy = 60,000$ psi

Depth , $20''$

$b' = 10$

Span Length = 18 ft

Solution :

Step # 01

Effective Depth

$d = 2.5$

$d = 20 - 2.5 = 17.5$

Reinforcement Ratio :

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

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

$$\rho_{max} = 0.0180$$

P-T-O →

Step # 02 :

Area of bars :

$$\rho = \frac{A_s}{bd}$$

$$A_s = \rho \times bd$$

$$A_s = 0.0180 \times 10'' \times 17.5'' = 3.15 \, in^2$$

$$A_s = 3.15 \, in^2$$

Minimum Thickness

$$h = \frac{l}{16} = \frac{18}{16} \times 12 \Rightarrow 13.5 \, in$$

Step # 03 :

Beam Self weight :

$$b = 10''$$

$$h = 13.5''$$

$$B.S.W = \frac{b \times h}{144} \times 150$$

$$= \frac{10 \times 13.5}{144} \times 150 = 140 \, lb/ft$$

Live Load = 2.47 kips/ft or 2470 lb/ft

Dead Load = 1.05 kips/ft or 1050 lb/ft

Total Dead Load = 1050 + 140 = 1190 lb/ft

Now we have to find Wu:

$W_u = 1.2\ D.L + 1.6\ L.L$

$W_u = 1.2(1050 + 140) + 1.6(2470)$

$W_u = 5380\ lb/ft \Rightarrow 5.38\ kips/ft$

Required Moment = $M_u = \frac{W_u l^2}{8} = \frac{5.38 \times 18^2 \times 12}{8}$

$M_u = 2614$ in-kips

Step#04:

$M_n = A_s f_y \left(d - \frac{a}{2}\right)$

First we have to find "a"

$a = \frac{A_s f_y}{0.85 f'_c b} = \frac{3.15 \times 60}{0.85 \times 4 \times 10}$

$a = 5.5$

$M_n = \phi 3.15 \times 60 \times \left(17.5 - \frac{5.5}{2}\right)$

$M_n = 2787$ in-Kips

P.T.O →

$\phi M_n = 0.9 \times 2787 = 2508$ in-kips

Now:

$M_u > \phi M_n$

$2614 > 2508$ → Doubly Reinforcement Required

Step # 05:

$M_{u2} = M_u - \phi M_n$

$M_{u2} = 2614 - 2508$

$M_{u2} = 106$ in-kips

Step # 06:

$M_{u2} = \phi A_s f_y (d - d')$

$$A_s' = \frac{M_{u2}}{\phi f_y (d - d')}$$

$$A_s' = \frac{106}{0.9 \times 60 \times (17.5 - 2.5)}$$

$A_s' = 0.1308$ in^2

Step : 07

Total Area of Steel

$A_{ST} = A_s + A_s'$

$A_{ST} = 3.015 + 0.1308$

$A_{ST} = 3.2808 \text{ in}^2$

Step # 08 :

No of bars

(i) For A_s'

Use # 2 bar

$No = \frac{A_s'}{A_b} = \frac{0.1308}{\frac{\pi}{4} \times \left(\frac{2}{8}\right)^2}$

$No = \frac{0.1308}{\frac{\pi}{4}\left(\frac{2}{8}\right)^2}$

$= 2.66 \cong 3$

No of bar 3

(ii) $A_{st} = 3.2808\ in^2$

use # 9 bar

$$No = \frac{A_{st}}{\frac{\pi}{4} \times \left(\frac{9}{8}\right)^2}$$

$$= \frac{3.2808}{\frac{\pi}{4} \times \left(\frac{9}{8}\right)^2}$$

$No = 3.22 \approx 4$

$No = 4$

Step #09 :

Design Moment :

$$Md = \varphi \times (A_{st} - A_s') f_y \left(d - \frac{a}{2}\right) + A_s' f_y (d - d') \text{ --- (i)}$$

$A_s' = ?$

$$No = \frac{A_s}{A_b}$$

$A_s' = No \times A_b$

$A_s' = 2 \times \frac{\pi}{4} \left(\frac{2}{8}\right)^2 = 0.098$

$A_{st} = ?$

$$No = \frac{A_{st}}{A_b}$$

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$$No = \frac{Ast}{Ab}$$

$$Ab \times No = Ast$$

$$Ast = 4 \times \frac{\pi}{4} \left(\frac{9}{8}\right)^2$$

$$Ast = 3.97$$

$$a = \frac{(Ast - As')fy}{0.85 fcb}$$

$$= \frac{(3.97 - 0.098) \times 60}{0.85 \times 4 \times 10}$$

$$\boxed{a = 6.83}$$

put all the values in eq (1)

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

$$= 0.9 \times \left\{\left((3.96 - 0.098) \times 60 \times \left(17.5 - \frac{6.83}{2}\right)\right) + \left(0.098 \times 60 \times (17.5 - 2.5)\right)\right\}$$

$$= \boxed{3016.7785}$$

ok

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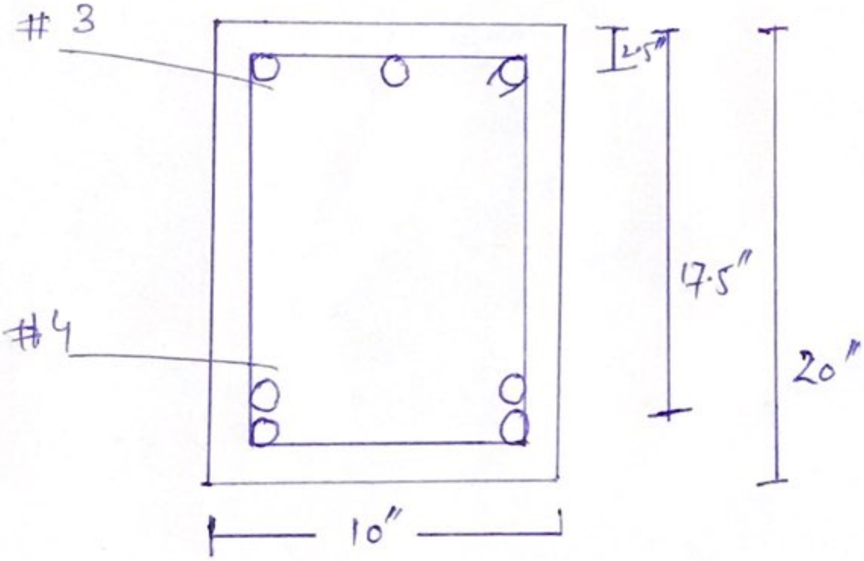
(8)



QNo: 02

Part a :

Bond Stress :

The bond Stress helps in Keeping bond between Concrete and reinforcement bar together. When try to pull out the Rod from hardened Concrete, Then This bond Stress Resists The bar to Come out is Known to be "Bond Stress"

Development Length :

The Length of bar necessary to be embedded into Concrete to produce The Required bond Strength between Steel and Concrete. is Known to be Development Length ;

Part b :

Following are the main Condition for using doubly Reinforcement beam.

P-T-O →

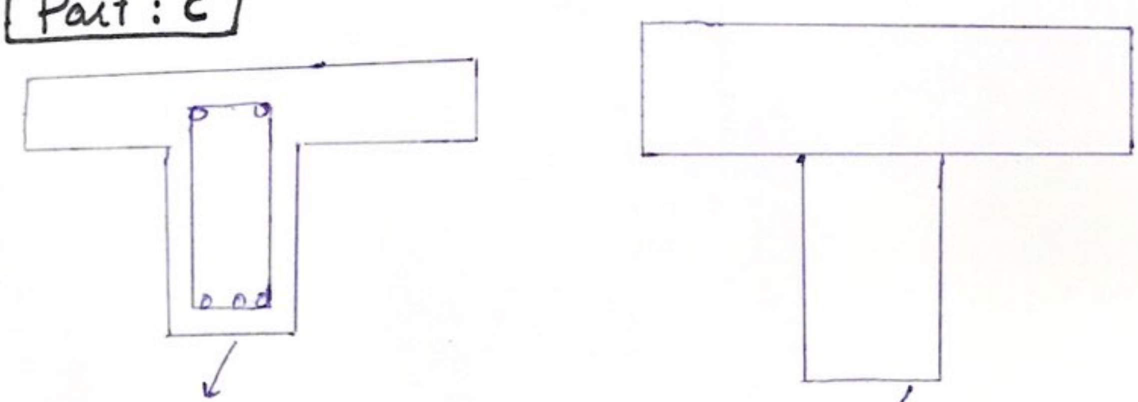
(1) When depth of a beam/dimension is restricted from architectural or other necessary purpose, we use doubly reinforcement beam.

(2) When simply reinforced beam is not adequate in term of moment resisting capacity. Then we prefer doubly reinforcement beam.

(3) To protect or reduce deflections due to shrinkage and creep we prefer doubly reinforcement beam.

(4) For increasing the ductility of beam the doubly reinforced beam are used.

Part : C



T - Beam

Rectangular Beam

Fig 4

P-T-O →

→ From Figure :

both beams are Look like T- Shape, but Their analysis is quite different from one another

→ In Case of Rectangular beam Slab are placed on The beam so There is no Connection between Slab and beam In This Case, The beam is analysis/design as a Rectangular beam.

→ In Case of T- beam Slab and beams are Connected with each other both These members acting as one member, So in This Case The design/ analysis are different.

Part d :

Effect of Strength Reduction factor on flexural Strength:

Strength Reduction factor Can be used to take into account the uncertainties of material Strengths, Errors in the design equations, approximations in an analysis, possible variations and dimensions of the Concrete Sections and placement of reinforcement, The importance of members in the Structures of which They are part and So on. The Strength Reduction factor (φ) are varies for most Situations/Conditions or as follows

→ 0.90 for tension Control beams and Slabs

→ 0.65 or 0.70 for Coloumn

→ 0.75 for Shear and torsion in beams.

Part e:

Design Methods:

- Working Stress Method (WSM)
- Ultimate Load Method (ULM)
- Limit State Method (LSM)

① Working Stress Method (WSM):

WSM is based on the elastic Theory in which the material (Steel & Concrete) are assumed to be Stressed well below Their elastic Limit under the design Load..

② Ultimate Load Method (ULM):

A Method which Limit the Structural usefulness of the material of the Structure upto ultimate Load.

③ Limit State Method (LSM)

It is defined as a Method which Limits the Structural usefullness of the material of the Structure upto a Certain Load at which acceptable Limit of Safety & serviceability are applied

So That, the failure of Structure doesn't occur It is the Combination of WSM & ULM.

P-T-O →

⟹ In the above Three methods the LSM is the best Method, because this method is advance over other methods, since Safety & Serviceability are Considered.

→ In This Method partial factor of Safety is Considered on both Loads and Stresses.

QNO: 03 :

Given data:

Center to Center distance (C/c) = 10 ft

Span Length(L) = 32 ft

Slop Thickness (h_f) = 6 inch

width of web = b_w = 14 inch

Total depth of beam = 28 inch

Effective depth of beam(d) = 28 - 3 = 25 inch

Super dead Load = 50 psf

Live Load = 225 psf

Grade of Concrete = f_c = 4 psi

Grade of Steel = f_y = 60000 psi

Required:

Tensile Steel area and Reinforcement needed for typical member.

Step: 01

Calculate of effective flange width (b_e): for T- beam

(i) $16 \times h_f + b_w$ (ii) $C/c \times 12$ (iii) $\frac{Span}{4} \times 12$

(iv) $\frac{C/S}{2} + b_w$

P-T-O →

(i) $16h_f + b_w = 16 \times 6 + 14 = 110$ inch

(ii) $C/c \times 12 = 10 \times 12 = 120$ inch

(iii) $\frac{Span}{4} = \frac{32}{4} \times 12 = 96$ inch

If C/c distance is given Then There is no need for This check or Condition - 4 So Select least value of "be" from above

$So = b_e = 96$ inch

Step : 02 :

Check whether Rectangular or T-beam Analysis is Required

Now we first Computing Moments

Assuming $\phi = 0.90$

$M_u = 1.2(50) + 1.6(225) = M_0 = 420$ psf

$M_n = \frac{M_U}{\phi} = \frac{420}{0.90} = 466.67$ psf

$M_n = 466.67$ psf
$M_n = 5600$ psi

$M_n = 466.67 \times 12$

Trial # 01

Let $a = h_f = 6''$

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

$$A_{st} = \frac{5600}{0.90 \times 60 (25 - \frac{6}{2})} \Rightarrow \boxed{A_{st} = 4.71 \text{ inch}^2}$$

Trial # 02

$$a = \frac{A_s \times f_y}{0.85 \times f_c \times b_e}$$

$$a = \frac{4.71 \times 60}{0.85 \times 4 \times 96} \Rightarrow \boxed{a = 0.86 \text{ inch}}$$

$$a = 0.86'' < h_f = 6''$$

$\Rightarrow$ Rectangular beam Design

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

$$A_{st} = \frac{5600}{0.90 \times 60 \times (25 - \frac{0.86}{2})} = \frac{5600}{1326.78}$$

$$\boxed{A_{st} = 4.22 \text{ inch}^2}$$

P-T-O →

Trial : 03

$$a = \frac{As \times fy}{0.85 \times fc \times be} \Rightarrow \frac{4.22 \times 60}{0.85 \times 4 \times 96} \Rightarrow a = 0.77 in$$

$$a = 0.77 \text{ inch}$$

$$Ast = \frac{Mn}{\phi fy \times (d - \frac{a}{2})} \Rightarrow \frac{5600}{0.90 \times 60 \times (25 - \frac{0.77}{2})} \Rightarrow \frac{5600}{1329.21}$$

$$Ast = 4.21 \ in^2$$ — ok Close enough to the preious value

Step # 03

Check minimum Reinforcing

$$Ast_{min} = \frac{3\sqrt{fc}}{fy} \times bw \times d = \frac{3 \times \sqrt{4000}}{60000} \times 14 \times 25$$

$$Ast_{min} = 1.10 \ in^2$$

but not Less Than

$$Ast_{min} = \frac{200 \ bwd}{fy} = \frac{200 \times 14 \times 25}{60000}$$

$$Ast_{min} = 1.667 \ in^2$$

$$Ast_{min} \ 1.1667 \ in^2 < 4.21 \ in^2$$ ok

Step # 04

Compute the equivelent, c, value and the Strain in the Steel 'ε_s'

$$C = \frac{a}{\beta_1} = \frac{0.77}{0.85} \Rightarrow \boxed{C = 0.93 \text{ in}}$$

$$\varepsilon_s = \left(\frac{d}{c} - 1\right) 0.003$$

$$\varepsilon_s = \left(\frac{25}{0.93} - 1\right) 0.003 \Rightarrow \boxed{\varepsilon_s = 0.077}$$

$$\varepsilon_s = 0.077 > 0.005$$

Steel will yield in the tension zone

Step # 05

Compute the Reinforcement, ρ, and Check to make Sure it is greater than ρ_{min}

$$\rho_{mean} = \frac{Ast}{bwd} = \frac{4.21}{14 \times 25} \Rightarrow \boxed{\rho = 0.012}$$

$$\rho_{min} = \frac{200}{f_y} = \frac{200}{60000} \Rightarrow 0.003$$

$$\boxed{\rho_{min} = 0.003}$$

$\rho > \rho_{min}$] Section works for
$0.012 > 0.003$] minimum Reinf.

P-T-O →

Step # 06 :

Selection and Nos of bars

Let try #10 main bars having Area of one bar #10 = $A_b = 1.27\ in^2$

$$\text{No of bars} = \frac{A_{st}}{A_b} = \frac{4.21}{1.27} \Rightarrow 3.31 \simeq 4 \text{ bars}$$

So Take 4 # 10 Main bars

Step # 07 :

Design Moment

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

but first we find Actual Steel area (A_{st}) and 'a'

$$A_{st} = 1.27 \times 4 \Rightarrow \boxed{A_{st} = 5.08\ in^2}$$

$$a = \frac{A_{st} \times f_y}{0.85 \times f_c' \times b_e} \Rightarrow \frac{5.08 \times 60}{0.85 \times 4 \times 96} \Rightarrow \boxed{a = 0.93\ in}$$

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

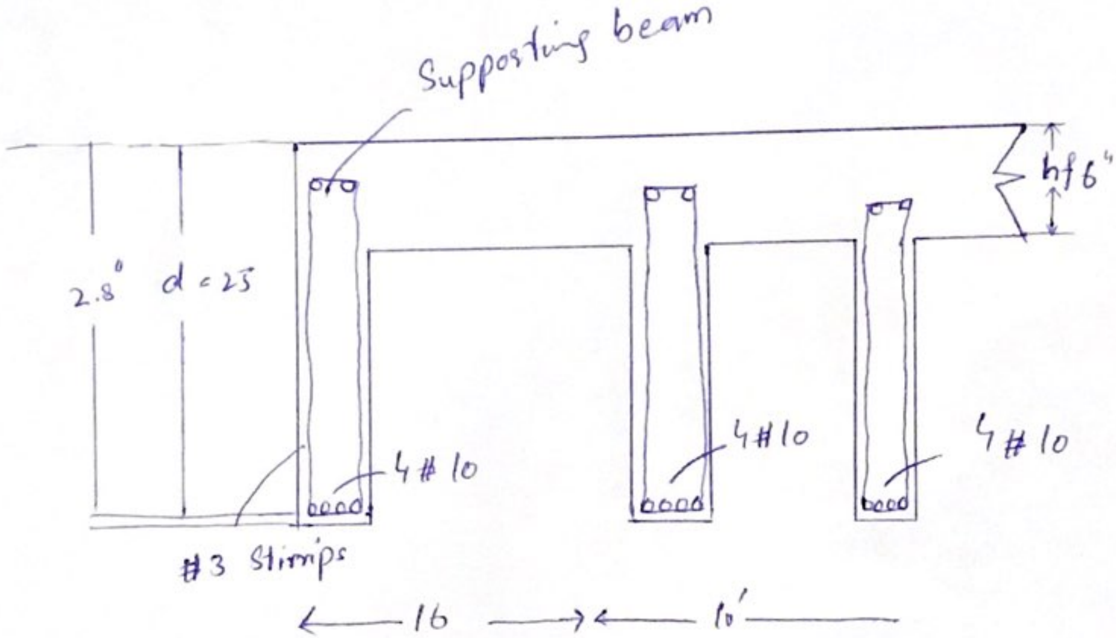
$$M_d = 0.90 \times 60 \times 5.08\left(25 - \frac{0.93}{2}\right) = 6730.44\ psi$$

$$M_d = 6730.44\ psi$$

$M_d > M_u$ $6730.44 > 5600$

Design is ok

P-T-O →



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