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Section	A
Subject	PRCD I
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Sectio (A)

Q No. 1

{PROBLEM SOLUTION}

Given Data:-

→ Depth (Height) = 20"
→ width = 10"
→ Dead Load = 1.05 kip/ft
→ Live Load = 2.47 kip/ft
→ Span = 18'
→ f'_c = 4000 Psi = 4 ksi
→ F'_y = 60,000 Psi = 60 ksi

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Section (A)

Solution :-

⇒ Step No# 1

⇒ Effective depth (d) = h-3

Effective depth (d) = 20"-3

Effective depth (d) = 17"

⇒ Effective cover (d') = 2.5"

⇒ Step No# 2

First Check the Capacity of Section as singly reinforced beam

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

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

$$\rho_{max} = 0.0180$$

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⇨ Step No # 3

check area of steel

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

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

$$Ast = 0.0180 (10 \times 20)$$

$$\boxed{Ast = 3.06 \text{ in}^2}$$

⇨ Step No # 4

Design moment Formula.

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

$$a = \frac{Ast \times fy}{0.85 \times f'c \times b} = \frac{3.06 \times 60}{0.85 \times 4 \times 10} \boxed{= 5.4''}$$

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$$Mu_2 = 0.90 \times 3.06 \times 60 \times \left(17 - \frac{5.4}{2}\right)$$

$$\boxed{Mu_2 = 2362.93 \text{ Kips-inch}}$$

⇒ Step No# 5

Moments:- due to given Loads.

⇒ Beam self weight $= \frac{10}{12} \times \frac{20}{12} \times 50$

$$\boxed{\text{Beam self weight} = 208.33 \text{ Lb/ft}}$$

⇒ Total Factored Load $= 1.2(1050 + 208.33) + 1.6(2470)$

$$\boxed{\text{Total Factored Load} = 5.46 \text{ Kips/ft}}$$

⇒ Ultimate Factored ~~Load~~ Moment $= \frac{W \times L^2}{8}$

Ultimate Factored moment $= \frac{5.46 \times (18)^2}{8} \times 12$

$$\boxed{\text{Ultimate Factored moment} = 2653.56}$$

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Now

$$Mu_2 < Mu$$

$$2362.92 < 2653.56$$

So we will use doubly reinforce beam.

⇒ Step No# 6

$$Mu_1 = ~~26~~ 2653.56 - 2362.92$$

$$\boxed{Mu_1 = 290.64 \text{ kip-inch}}$$

⇒ Step No# 7

Area of Steel in Compression zone

$$Mu_1 = \phi \times Ast' \times fy \times (d - d')$$

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$$Ast' = \frac{Mu_1}{\phi \times fy \times (d-d')}$$

$$Ast' = \frac{290.64}{0.90 \times 60 \times (17-2.5)}$$

$$\boxed{Ast' = 0.37\,in^2}$$

⇨ Step No # 8

Total steel area

$$Ast = Ast + Ast'$$

$$Ast = 3.06 + 0.37$$

$$\boxed{Ast = 3.43\,in^2}$$

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⇨ Step No# 9

{ Select Bar no# 8
whose dia is 1"
Area = 0.785 in^2 }

Know we will Find ~~are~~ No # of Bars.

$$\text{No\# of Bars} = \frac{A_{st}}{\text{Area of 1 Bar}}$$

$$= \frac{3.43}{0.785}$$

No# of Bars = 4.36 ≈ 5 bars

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Compression steel.

use #4 bar.

dia $\left(\frac{4}{8}\right) = 0.5$

Area = 0.2 in^2

No of Bars = $\frac{Ast'}{\text{Area of 1 bar}}$

$= \frac{0.37}{0.2}$

No of Bars = 1.85 ≈ 2

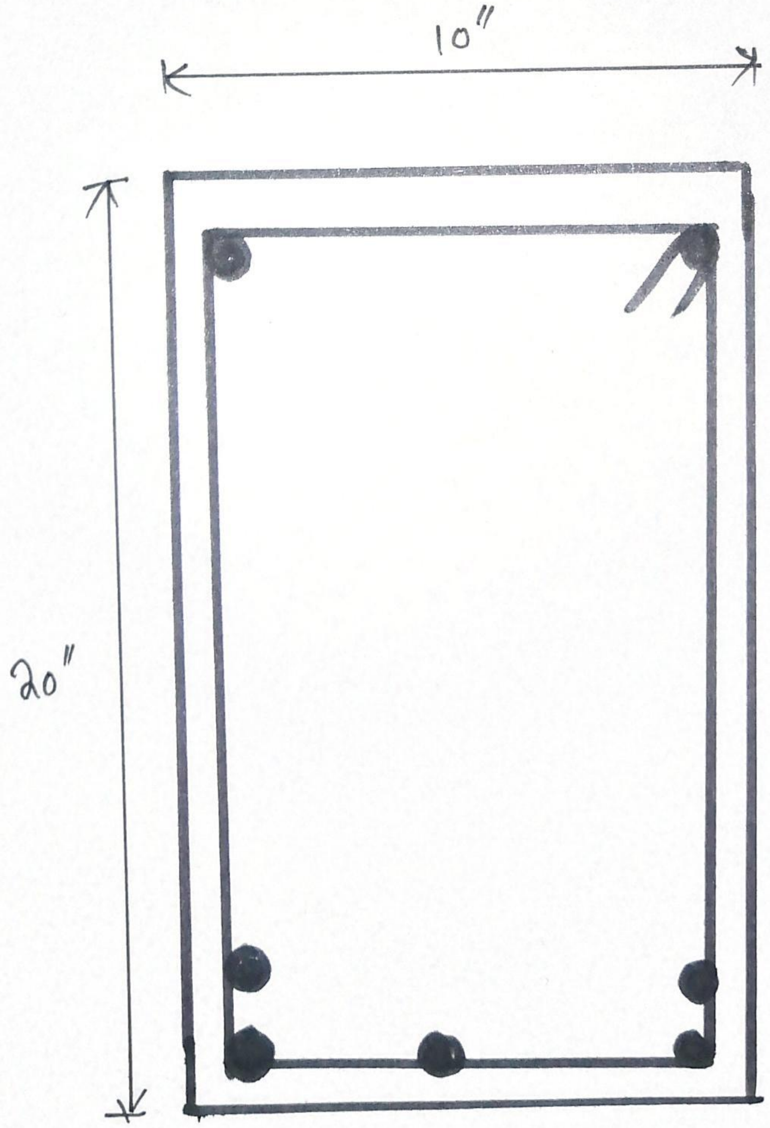
So 2 #4 bars in Compression zone.

⇒ Step No # 1

Beam minimum width

$$b_{min} = 2(1.5) + 2\left(\frac{3}{8}\right) + \left(\frac{8}{8}\right) + 4\left(\frac{8}{8}\right)$$

$$= 12.75 > 10''$$



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effective depth (d)

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

$$\boxed{d = 16.62''}$$

effective cover depth (d')

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

$$\boxed{d' = 2.25''}$$

⇨ Step No # 11

Design moment is give by

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

$$a = \frac{(Ast - Ast') \times fy}{0.85 \times f'c \times 10}$$

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(11)

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

$$Md = 0.90 \times \left[(1 \times 0.44) \times 60 \times (1.622 - 2.25) + (5 \times 0.785 - 1 \times 0.44) \times 60 \times \left(16.62 - \frac{6.15}{2}\right)\right]$$

$$Md = 2890.46$$

$$Md = 2890.46 > 2653.56$$

Structure is safe

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QNo 2

(a) Briefly describe Bond Stress and development lenght.

Answer:

Bond Stress:

The stress which is acting on the outer interface of steel to the surrounding concrete is called bond stress. This stress help in keeping bond between reinforcement and concrete together. Bond stresses resists any force that tries to pull out the rods from the concrete.

→ when you try to pull out the reinforcement bar from hardened concrete, then bond stress resists the bar to come out.

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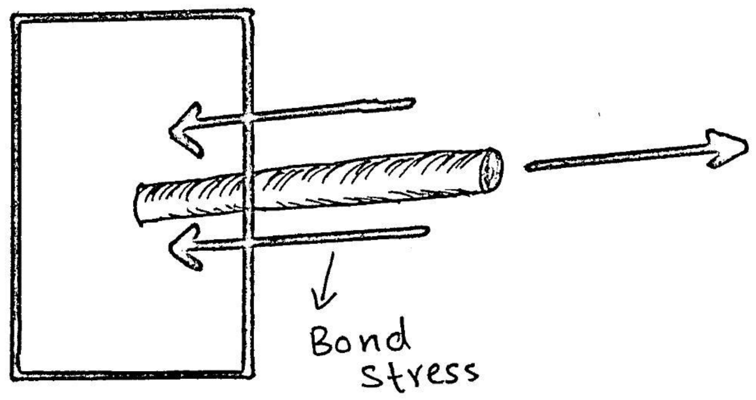
→ Resistance offered to slipping of ~~bond~~ bar is due to the following reasons.

1. Friction due to natural roughness of bar
2. Chemical adhesion between two materials
3. Due to closely spaced rib-shaped deformation made on the bar surface.



Development lenght:-

The lenght of bar required to transfer the force in the bar to the surrounding concrete through bond is called development lenght

|| OR ||

A development lenght can be defined as the amount of reinforcement (bar) lenght needed to be embedded or projected into the column to established the desired bond strenght between the concrete and steel (or any other two types of material)

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Reason For Providing Development lenght :

→ To develop a safe bond between the bar surface and Concrete so that no failure due to slippage of bar occurs during the ultimate load conditions.

→ Also, the extra lenght of the bar provided as development lenght is responsible for transferring the stresses development in any section of the adjoining section (such as ~~that~~ at column beam junction the extra lenght of bars provided from beam to column.

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Development lenght Required For Compression Bar :-

$$L_{dc} = \frac{0.02 \times d_b \times f_y}{f'_c} \geq 0.0003 \times d_b \times f_y$$

Develpment lenght required for compression bars will be less than that required for tensile steel because No tensile cracks are presented to encourage slippage.

Development lenght for Tension Bar :-

1- $L_d = \dfrac{0.04 \times A_b \times f_y}{\sqrt{f'_c}}$

2- $L_d = 0.004 \times d_b \times f_y$

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(17)

3- $L_d = 12''$

select the maximum value.

For #14 Bar ⇒ $L_d = \frac{0.085 \times f_y}{\sqrt{F'_c}}$

For # 18 Bar ⇒ $L_d = \frac{0.11 \times f_y}{\sqrt{f'_c}}$

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(18)

Q No [2]

(b) In which Condition doubly reinforced beam can be used?

Answer:

we use doubly reinforced beam when restriction occure on the sizes of beam

⇒ For ~~e/g~~ example If some one said that the depth of beam should not be greather then 10" and the external load on beam is very much and can not be resist by a beam of 10" with singly reinforment so in that Condition we skip singly reinforment beam and Construct doubly reinforment beam.

Q No 2

c

Differentiate between T-Beam analysis and Rectangular beam analysis

Answer:-

⇒ In case of T beam slab and beam are connected with one another and act as a one member. while

⇒ In case of rectangular beam slab has been placed on the beam so there is no connection between slab and beam.

⇒ The Flexural capacity of T beam varies based on the sign of moment (positive and negative) because the Flange section should be in Compression. But for negative moment It yields the same strengnt as an equivalent beam without the flange. while

=> The rectangular section only depends on the location of reinforcement to the yield Capacity.

=> The design proced of T beam depends on the location of moment as the Case of its Flexural strenght. For Positive moment we have three Cases to be checked to proceed with design one of the neutral axis is with in the Flange two neutral axis outside the flange or in the web and three doulbly reinforced T beam so you need to make sure which case is your beam ~~befo~~ beforce proceeding to design.

Q No [2]

(22)

[d] write short note on effect of strenght reduction factor on flexural strenght.

Answer:.

The value of strenght reduction factor is 0.9.

"In short strenght reduction factor reduce the actual strenght of a ~~mem~~ flexural member for the purpose of safety."

" To decrease the risk of failure".

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(23)

Q No [2]

(e) Briefly describe design method, which one of them can be best used for design of different structural member and why?

Answer:.

There are two types of design method

(1) ASD (Allowable stress design)

(2) USD (ultimate strenght design)

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(1) (ASD) is based on the Conventional Stress Calculation of structure with respect to the allowable Stress limit.

(2) (USD) defines the actual Strenght requuired against the required strenght. Calculation are entirely different.

⇒ Which one is best

USD is best

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⇒ Why USD is best

USD is best because

→ It provides flexibility to the designer in selecting design methodology.

→ when dead load is larger as compared to live load then USD is best.

→ safer structure may result under LRFD method because of considering behaviour at collapse. But behaviour at collapse is not considered in ASD method.

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Q No # 3

{ PROBLEM SOLUTION }

Given Data:-

- → C/C distance = 10'
- → span = 32'
- → slab thickness = 6"
- → web width = 14"
- → Total depth = 28"
- → Effective depth = 28" - 3" = 25"
- → D.L' = 50 lb/ft²
- → S.S = 225 lb/ft²
- → f_y = 60,000 psi
- → f'_c = 40,00 psi

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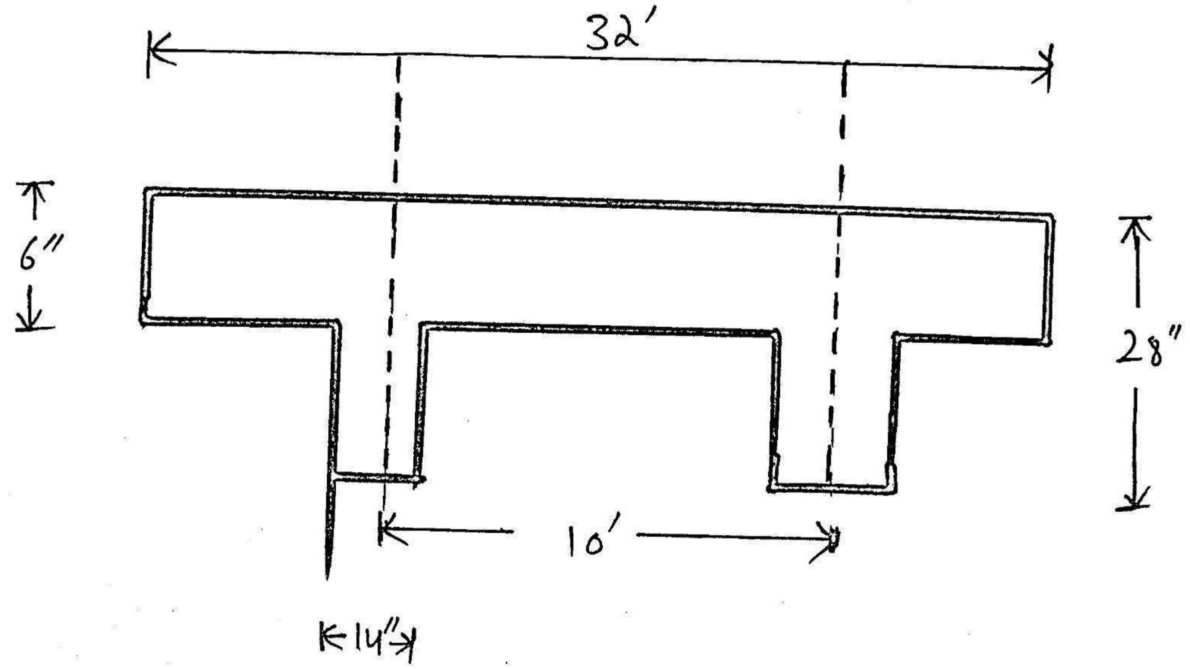
Solution:



Step No# 1

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

(1) weight of Beam per feet.

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

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

$$W_t = 408.33 \text{ lb/ft}$$

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Total Factored load:-

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

$= 909.99\ lb/ft$

$= 0.909\ kip/ft$

Moment:

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

$= 1396.23$ kip-inch.

Effective Bredth:-

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

$b_e = 96''$

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Step No#2

Rectangular or T Beam:-

Trail 1

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

$$Ast = \frac{1396.23}{0.90 \times 60 (25 - \frac{6}{2})}$$

$$Ast = 1.17 \ in^2$$

Trail 2

$$a = \frac{Ast \times fy}{0.85 \times f'c \times b}$$

$$a = \frac{1.17 \times 60}{0.85 \times 4 \times 96}$$

$$a = 0.2'' < 6''$$

Rectangular Beam Design.

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

$$\boxed{A_{st} = 1.03\ in^2}$$

Traid 3

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

$$A_{st} = \frac{1396.23}{0.90 \times 60 (25 - \frac{0.18}{2})}$$

$$\boxed{A_{st} = 1.03\ in^2}$$

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Step No# 3

(31)

Now Find ρ_{max} and ρ_{min}

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

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

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

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

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

$$0.003 < 0.002 < 0.018$$

As ρ is less than ρ_{min}

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

$$Ast = 0.003 \times 14 \times 25 = \boxed{1.05\ in^2}$$

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Step No #4

(32)

Select Bar and also select number of Bar.

let use #8 bar.

then

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

$$\text{Area} = 0.785 \text{ in}^2$$

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

So use Bars.
of #8 size.

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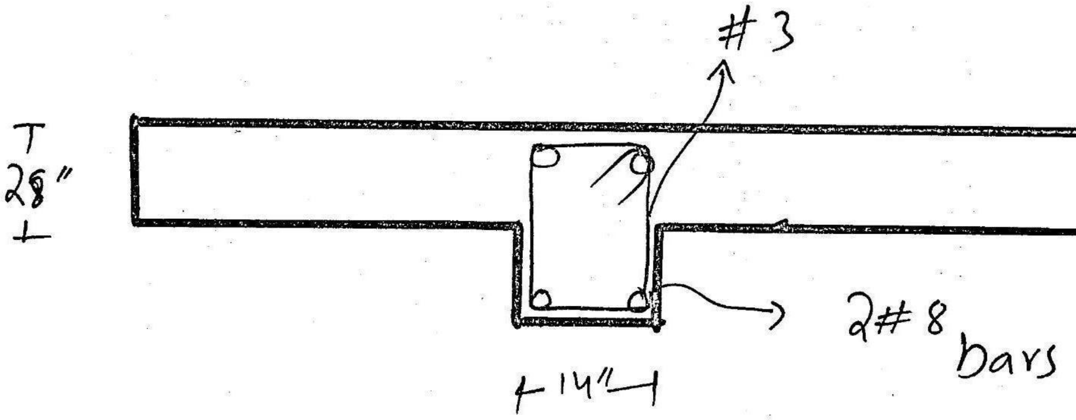
Step No #5

Minimum width.

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

$$b_{min} = ~~6.25~~\ 6.75'' < 14''$$

So one layer is best



Step No #6

Design moment:

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

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(34)

Area of steel = Area of 1 bar × No of Bars

= 0.785 × 2

Area of steel = 1.57 in²

~~Med~~

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

a = 0.2''

⇒ $M_d = 0.90 \times 60 \times 1.57 \times \left(25 - \frac{0.2}{2}\right)$

As 2111.02 > 1396.23

Structure is safe.

Section A

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END OF PAPER