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Section " " 'A'

Subject " " PRCD-1

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Q No.2 ·

a) Briefly describe Bond stress and Development length?

Bond stress

Bond stress is the shear stress developed along the contact surface between the reinforcing steel and surrounding concrete which prevent the bar from sliping out of concrete. The permissible bond stress depend upon the grade of concrete and type of steel.

Development length:

It is minimum length of bar which must be embedded in concrete beyond any section to develop its full strength. This is also called anchorage length in case of axial tension or axial compression and development length in case flexural tension or flexural compression

Development length in tension $= \frac{\phi \sigma_{st}}{4\tau_{bd}}$

Development length in compression $= \frac{\phi \sigma_{st}}{5\tau_{bd}}$

3) In which condition doubly reinforced beam can be used:

Ans Doubly reinforced beam can be used in following situation.

→ when singly reinforced beam in not provided in term of moment-resisting capacity.

→ where the cross sectional of the beam are restricted by architectural or other consideration

→ when the size of the beam is confined

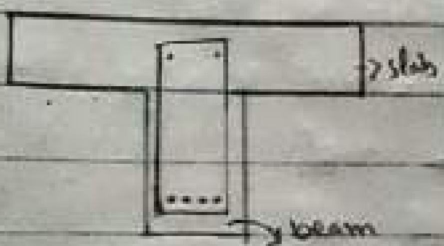
→ when the section of the beam is subjected to inversion stress

→ when the beam is non stop more than a few backing.

(C) differentiate b/w t- beam analysis and reglangulr beam analysis:

T - Beam

In T-Beam both the slab and Beam are connected each other and we called this joint is mono-lithic joint



Reglangoler - beam

It should look like reglanular cross section and there should no joints b/w slab and beam but it should act seperately from one another.

d) write a short note on the effect of strength reduction factor on Flexural strength.

Effect of strength Reduction factors:-

(I) Due to strength reduction factor, it is possible to cope with the variation in dimension i.e structure remain safe

2) strength reduction factors help to absorb the effects due to change in material strength

(III) Possible inaccuracies in the strength equation.

(IV) Ensure good level of safety of reinforced concret Structure.

(e) **Design method:-**

Design method are procedure, techniques and aid for designing. They offer a number of different kind of activities that a designer might use with an overall design process.

Following are design method are given as

Sample design:-

This is the most commonly used design method. it is used where end connections of the member in a structure do not develop restraint moment that would affect the structure:

Sami rigid Design method:-

it permits a reduction in maximum bending moment in beam suitably connected to thier support as compared to sample design.

In case where this method of design is employed experimental evidance shall be made to show that stress in any part of structure are not in excess.

(7)

Q No # 01

A rectangular beam that must carry a service live load of 2.47 Kips/ft and a calculated dead load of 1.05 Kips/ft (without self weight) on an 18-ft simple span limited to 10 inches width and 20 inches total depth for architectural reasons. if f_y = 60000 psi and f_c = 4000 psi. what steel area must be provided? Draw sketch of your final design:-

Given data:-

Live load (L.L) = 2.47 Kips/ft

dead load (D.L) = 1.05 Kips/ft

Span = 18'

width (b) = 10"

depth (h) = 20"

f_y = 60,000 Psi = 60 Ksi

f_c = 4,000 Psi = 4 Ksi

Solution :-

Step # 01

Effective depth (d) = h − 3 ⇒ 20 − 3 = 17"

Effective cover (d') = 2.5"

Reinforcement Ratio :-

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

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

$\boxed{\rho_{max} = 0.0180}$

Steep # 2

As we Know that

$\rho_{max} = \frac{A_{st}}{b \times d} \Rightarrow A_{st} = \rho_{max} (b \times d)$

$A_{st} = 0.0180 \times (10 \times 17)$

$\boxed{A_{st} = 3.06 \text{ in}^2}$

Step # 3

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

$a = \frac{A_{st} \times f_y}{0.85 \times f'_c \times b} = \frac{3.06 \times 60}{0.85 \times 4 \times 10} = 5.4$

$M_u = 0.90 \times 3.06 \times 60 \times (17 - 5.4/2)$

$= 2362.97 \text{ kip-inc}$

<u>Moment due to given load:-</u>

Beam self weight $= \frac{10}{12} \times \frac{20}{12} \times 150$

$= 208.33 \text{ Lb/ft}$

Total factored load $= 1.2(1050 + 208.33) + 1.6(2470)$

$= 5461.99 \ lb/ft$

$= 5.46 \ kip/ft$

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

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

$M_U = 2653.56$

So

$M_{U2} < M_U$

$2362.97 < 2653.56$

Doubly Reinforcement Required

Step # 4

$M_{U1} = 2653.56 - 2362.97$

$= 290.64$ Kip-Inch

step # 5

$M_{U1} = \phi \times A_{st} \times f_y \times (d - d')$

$A_{st}' = \frac{M_{U1}}{\phi \times f_y \times (d - d')}$

$= \frac{290.64}{0.90 \times 60 \times (17 - 2.5)} = 0.37 \ in^2$

step # 6 Total steel area

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

$A_s = 3.06 + 0.37 = 3.43 \text{ in}^2$

⇒ Step No #07

We use #8 bar (dia = 8/8 = 1")

Area = 0.785 in²

No. of bars = $\dfrac{A_s}{\text{Area of 1 bar}}$

$= \dfrac{3.43}{0.785} = 4.36 \approx 5$ bars

So 5 #8 bars for Tensil zone

→ Compression steel :-

Use #6 bars :

dia (6/8) = 0.75 , Area = 0.44 in²

No of bars = $\dfrac{A_s'}{\text{Area of 1 bar}} = \dfrac{0.37}{0.44} = 0.84$

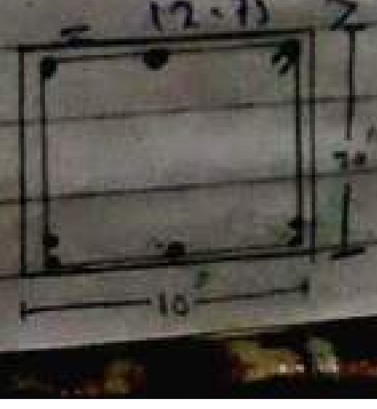
0.84 ≈ 1 bar

So 1 #6 bars in compression zone

Step # 8

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

$= 12.75 > 10"$ multiple layer



Effective depth (d) = 20 - 1.5 - 3/8 - 8/8 - 1/2(8/8)

$d = 16.62''$

Effective cover (d') = 1.5 + 3/8 + 1/2(8/8)

$d' = 2.25''$

Step # 09 :-

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

$$a = \frac{(A_{st} - A_{st}') \times f_y}{0.85 \times f_c' \times b}$$

$$= \frac{(5 \times 0.785 - 1 \times 0.44) \times 60}{0.85 \times 4 \times 10} = 6.15''$$

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

$M_d = 2890.46$

As $M_d = 2890.46 > 2653.56$

Design is ok.

No 3

Given data:-

c/c distance = 10'

Total depth = 28"

Effective depth = 28" - 3" = 25"

D.L = 50 lb/ft^2

S.S = 225 lb/ft^2

fy = 60,000 Psi

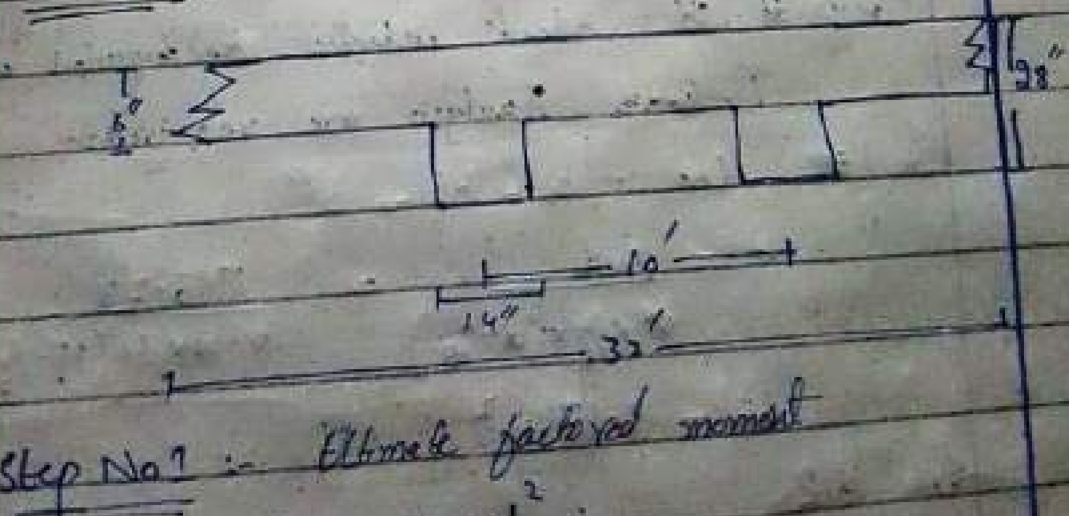
f'c = 4000 Psi

span = 32'

slab thickness = 6"

web width = 14"

Solution:-



Step No 1 :- Ultimate factored moment

$$Mu = \frac{wu \times L^2}{8}$$

Beam self weight per feet

wt = b × t × γ_c

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

Total Factored load :-

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

= 909.99 lb/ft = 0.909 kip/ft

Moment :-

$\frac{wl^2}{8}$ = $\frac{0.909 \times (38)^2}{8} \times 12$ = 1398.23 kip-inch

Step #02 calculate Effective ~~breadth~~ :- width "be"

a) 16(hf) + bw = 16(6) + 14 = 110"

b) c/c distance = 10(12) = 120"

c) span/4 = $\frac{38}{4} \times 12$ = 76"

So be = 76"

Step # 03 check whether Rectangular or T-Beam Analysis are required :-

Trail #1 Let a = hf = 6"

Ast = $\frac{Mu}{\phi \times fy \times (d - a/2)}$ = $\frac{1398.23}{0.90 \times 60(25 - \frac{6}{2})}$

Ast = 1.17 in²

Trail # 2

a = $\frac{Ast \times fy}{0.85 \times f'c \times b}$ = $\frac{1.17 \times 60}{0.85 \times 4 \times 76}$ = 0.2" < 6"

So R-beam design

$$Ast = \frac{1396.23}{0.90 \times 60 \times (25 - 0.2/2)} = 1.03 in^2$$

Trail # 03

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

$$Ast = \frac{1396.23}{0.90 \times 60 (25 - 0.18/2)} = 1.03 in^2$$

step # 4

Cheak ρ_{max} and ρ_{min}

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

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

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

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

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

$0.003 < 0.002 < 0.018$

So

ρ is less than ρ_{min}

So,

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

$A_s = 0.003 \times 14 \times 25 = 1.05\ in^2$

Step # 05 :-

selection of No of bars

Let bar #8 , than

dia = $8/8 = 1$, Area = $0.785\ in^2$

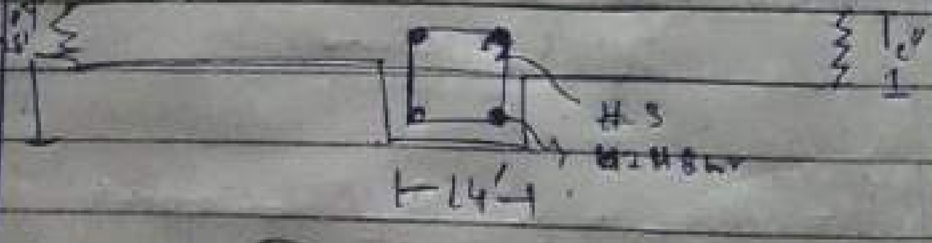
No of bars = $\frac{1.05}{0.788} = 1.3 \approx 2$

Step # 06

Check minimum width

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

$= 6.75'' < 14''$



Step # 7 Design moment:

$M_d = \phi \times f_y \times A_s \times (d - a/2)$

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

0.785×2 $1.57\ in^2$

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

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

$= 2111.02$ kip-inc

As $2111.02 > 1396.23$

okey