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Section :- "B"

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Subject :- PRCD1

Department :- Civil Engineering

Semester :- "Six"

Q No1

Ans:-

Given data:-

Width $(b) = 10'$

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

Dead Load $(D.L) = 1.05$ Kips/ft

Span $= 18'$

$f'_c = 4000$ Psi $= 4$ ksi

$f_y = 60{,}000$ Psi $= 60$ ksi

Height $(h) = 20''$

Solution:-

Step#1:-

Effective depth $(d) = h - 3$

$= 20 - 3$

$= 17''$

→ Effective Cover $(d') = 2.5''$

Reinforcement Ratio :-

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

Putting all the value.

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

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

Step#02:-

Now finding area of Steel.

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

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

Putting all the value

$$Ast = 0.0180 \times (10 \times 17)$$

$$Ast = 3.06 in^2$$

⇒ Step # 3:-

Using By formula of design moment,

$M_{u_2} = \phi \times A_{st} \times f_y \times (d - a/2)$

Now we also know that.

$$a = \frac{A_{st} \times f_y}{0.85 \times f'_c \times b}.$$

Putting all the value.

$$a = \frac{3.60 \times 60}{0.85 \times 4 \times 10}$$

$a = 5.4''$

$M_{u_2} = 0.90 \times 3.06 \times 60 \times (17 - 5.4/2)$

⇒ 2362.93 Kip-inch

Moment because of given load :-

Beam Self weight:-

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

$$= 208.33 \text{ lb/ft}$$

Total Factored load :-

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

$$= 5461.99 \text{ lb/ft}$$

$$= 5.46 \text{ Kips/ft}$$

Ultimate Factored Moment :-

By using formula.

$$\frac{wl^2}{8}$$

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

$$M_u = 2653.56$$

Now,

$$M_{u2} < M_u$$

$$2362.92 < 2653.56$$

"<" This is know doubly Reinforcement required.

-> Step#04:-

$$M_{u1} = 2653.56 - 2362.92$$
$$= 290.64 \text{ Kip-inch.}$$

-> Step#5:-

Now steel area in Compression zone will be,

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

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

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

$$= 0.37 in^2$$

→ Step #06:-

$$As = Ast + A'st$$

Putting all the knowing value

$$As = 3.06 + 0.37$$

$$= 3.43 in^2$$

→ Step#7:-

We have take #8 bars,

(diameter = 8/8 = 1")

$$Area = 0.785 in^2$$

Now No of Bars = $\frac{Ast}{\text{Area of Bars}}$

Putting all the value

$$= \frac{3.43}{0.785} = 4.36 \approx 5 \text{ bars}$$

So 5#8 bars
(∵ #, For tensile zone)

⇒ Compression Steel:-

Use #6 bars,

$dia\,(6/8) = 0.75''$

$Area = 0.44\ in^2$

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

$= 0.84 \approx 1$ bars

So 1#6 bars in → Compression zone

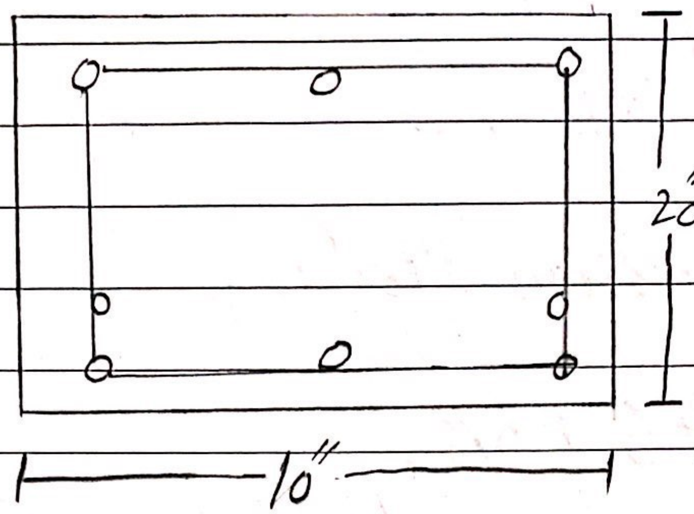
⇒ Step#08:-

Beam Minimum Width:-

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

$= 12.75 > 10''$

in multiple layers



→ Effective depth (d) =

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

$$d = 16.62"$$

⇒ Effective Cover (d') =

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

⇒ 2.25"

⇒ **Step#09:-**

Design Moment is given by,

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

$$a = \frac{[A_{st} - A_{s}'t] \times f_y}{0.85 \times f'c \times b}$$

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

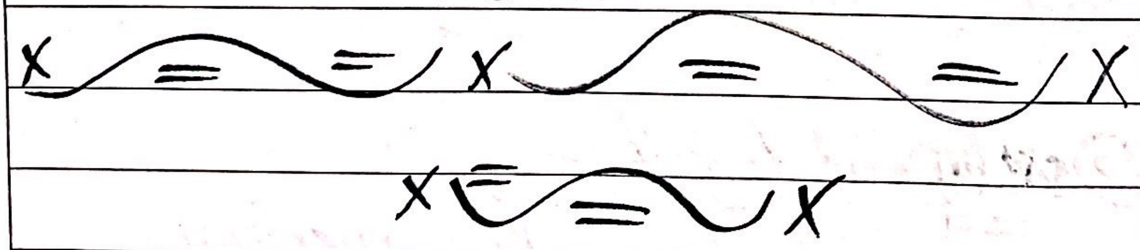
$$= 6.15''$$

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

$$M_d = 2890.46$$

$$\therefore M_d = 2890.46 > 2653.56$$

This is Vequired Design



Q No 2
(a)
Ans

Bond Stress :-

The force of adhesion per unit area of Contact between two bounded Surface, between Contrete and Steel reinforcing bar.
Now Bond Stress is Shear Strass at the Surface of reinforcing bar which prevent movement between bar and Surrounding Concrete.

Bond Stress resist any force that tries to pull out rods from Concrete.

Development Length :-

The maximum length of a Steel rod that is insorted inside Concrete

Column, to ensure Sufficient adhesion force between Concrete and Steel.

Development length Creates a Safe bond between bar Surface and Concrete it. also ensuring during ultimate load Conditions the reinforcement bar Should not Sleep through the Complete it transfer Stress from column to bar.

QNo2
(b)

Ans:- Doubly reinforced Concrete beam's are used when aesthetic of functional requirements dictate that the beam needs to be Smaller then that which Can be acconodated using a Singly reinforced Concrete beam.

QNo2

(C) Difference b/w T and Rectangular Beam:-

Ans: Both beam have T Shape but their analysis and design is quite different from one another In Case of T beam, Slab and beam are Connected with one another and also acts as a one member In Case of Vectangular beam, Slab has been placed on the beam So there are no Connection between Slab and beam.

QNo2

(d)

Ans:- Effect Of Strength Reduction

Factors:-

i) Due to strength veduction factors, It is possible to cope with the variation in dimension i.e structure remain safe.

ii) Strength reduction factors helps to absorb effect due to changes in material strength.

iii) Possible inaccuracies is the strength equation.

iv) Ensure good level of safety of reinforced concrete structure.

QNo2
(e)

Ans:- There are two types of design method.

i) Ultimate Strength Design Method.
ii) Allowable Stress Design Method.

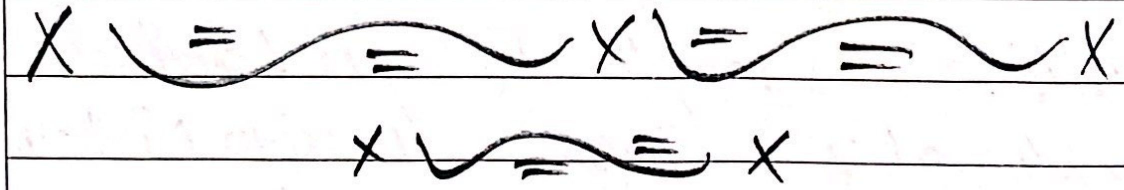
USDM:-

Due to this method we can find thickness of beam and depth of the beam.

ASDM:-

In this method we only count service load. In this method actual loads are considered mean (live loads + dead loads).

=> ASDM is more preferable because it consider actual loads.



QNo3

Ans

Given data:-

$f'_c = 4000 psi$

$f_y = 60,000 psi$

S.S = 225 lb/ft^2

Dead load (D.L) = 50 lb/ft^2

Effective depth = 28" - 3"

= 25"

Total depth (h) = 28"

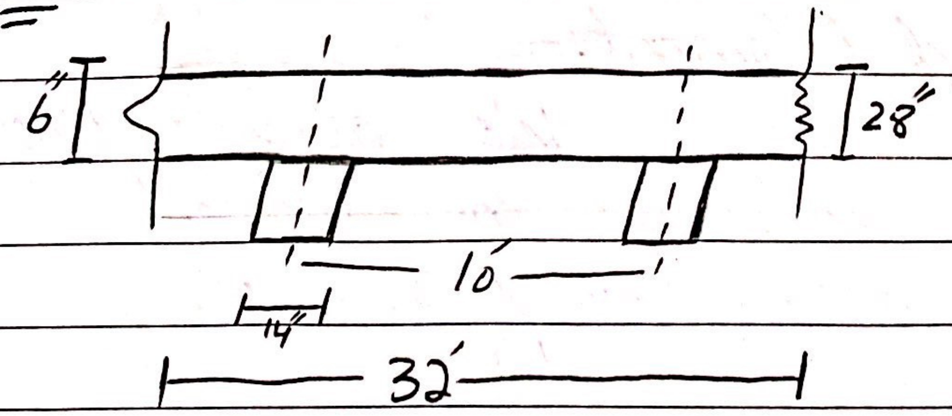
web width = 14"

Slab thickness = 6"

C/c distance = 10'

Span = 32'

Solution:-



Step#1:-

$$M_u = W_u \times L^2/8$$

Self weight beam per feet

$$wt = b \times t \times \gamma_c$$

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

$$= 408.33 \, lb/ft$$

Total Factored Load:-

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

$$= 909.99 \, lb/ft$$

$$= 0.909 \, kip/ft$$

Find Moment:-

We already know to find out the moment

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

$= 1396.23$ Kip-inch

⇒ **Effective breadth:-**

How to find effective breadth

i) $16(h_f) + b_w$

$= 16(6) + 14 = 110''$

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

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

So effective breadth $(b_e) = 96''$

Step # 03 :-

(Rectangular or T-Beam)

Trial # 1 :-

Let $a = h_f = 6''$

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

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

$Ast = 1.17 in^2$

Trial #2:-

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

Putting all the Knowing value.

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

$= 0.2'' < 6''$

So Rectangular beam are design

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

$Ast = 1.03 in^2$

Trial # 3:-

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

$$a = 0.18''$$

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

$$\boxed{Ast = 1.03 in^2}$$

Step # 4 :-

Check ρ_{max} and ρ_{min}

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

$$\rho_{max} = 0.018$$

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

$$= 0.003$$

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

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

$$0.003 < 0.002 < 0.018 .$$

As

ρ is less than ρ_{min}

So,

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

putting the value

$Ast = 0.003 \times 14 \times 25$

$Ast = 1.05\ in^2$

Step#5

No. and Choosen of Bar

Let use #8 bar, then

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

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

Let we use 2#8 bars

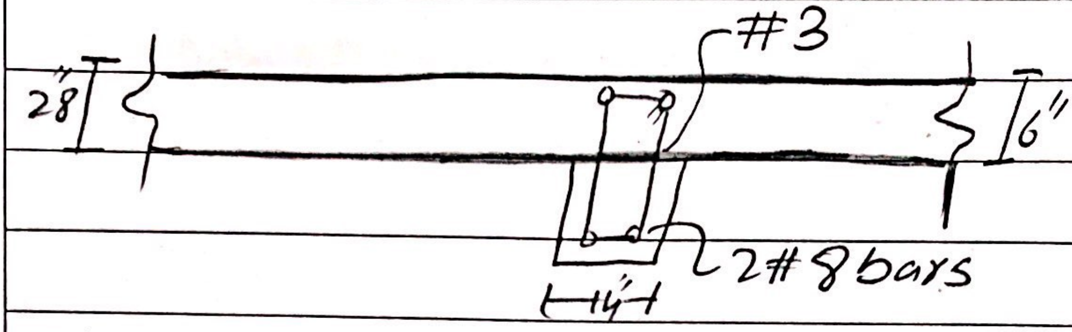
Step#06:-

Minimum width

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

$= 6.75" < 14"$

That's good in one layer.



Step#7:-

Design Moment:-

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

Area of steel = Area of 1bar × no. of bars.

Putting value

$= 0.785 \times 2$

$= 1.57 in^2$

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

$a = 0.2"$

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

$= 2111.02$ Kip-inch

As $2111.02 > 1396.23$

So This is the required design.