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QUESTION- 1

GIVEN DATA:

$f_y = 60000\ psi$

$L.L = 2.47\ K/ft$

$D.L = 1.05\ K/ft$

$w = 10''$

$f_c = 4000\ psi$

$h = 20''$

$d = h - 3$

$d = 17''$

$d' = 2.5$

SOLUTION:

$$\rho_{max} = 0.85 \times B \times \frac{f_c'}{f_y} \times \left(\frac{\varepsilon_u}{\varepsilon_u + \varepsilon_y} \right)$$

putting values.

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

$$\rho_{max} = 0.018$$

Now Area of Steel.

$$f_{max} = \frac{A_{ST}}{b \times d}$$

$$A_{ST} = f_{ma} \times b \times d$$

$$A_{st} \Rightarrow 0.0181 \times 10 \times 17$$

$$A_{ST} \Rightarrow 3.07 \text{ in}^2$$

Now design factor Moment.

$$M_{U2} = \phi \times A_{ST} \times f_y \times (d - a/2)$$

$$a = \frac{A_{ST} \times f_y}{0.85 f_c' b}$$

$$a = \frac{3.08 \times 60}{0.85 \times 4 \times 10}$$

$$a = 5.4''$$

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$M_{U2} = 0.90 \times 3.08 \times 60 \times (17 - 5.4/2)$

$M_{U2} = 2378.3\ K''$

Now moment of a given Load:

Self weight of beam

$\Rightarrow b \times \gamma_c \times t$

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

$\Rightarrow 208.3\ lb/ft$

Total factored load = $1.2 D.L + 1.6 L.L$

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

$= 5.5\ K/ft$

Ultimate force moment

$M_U = \frac{5.5(18)^2 \times 12}{8}$

$M_U = 2653.6$

As 2378.3 is lesser Than 2653.6

It shows That beam should be

doubly design.

Now

$$M_{u1} = M_u - M_{u2}$$

$$= 2653.6 - 2378.3$$

$$M_{u1} = 275.2 \text{ K}''$$

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

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

$$\Rightarrow \frac{275.2}{0.90 \times 60 (17 - 2.5)}$$

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

$As' = AST + TAS$

$As' = 3.08 + 0.35$

$3.43 \ in^2$.

This lies in the tension zone of steel.

Bars selection:-

For tensile steel; lets ~~the~~ take bar no 8

No of bars $= \frac{As}{Ab} = \frac{3.48}{0.785}$

$= 4.36 \cong 5$ bars.

For compression steel;

lets Take #6 bar.

No of bars $= \frac{As'}{Ab} = \frac{0.35}{0.442}$

$\Rightarrow 0.75$ bars

$\cong 1$ bar.

id: 7880 ⑥

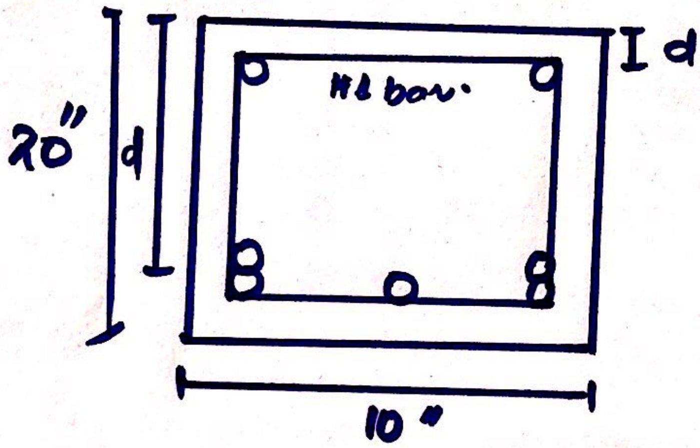
Minimum width of beam

$$(2\times1.5)+2\left(\frac{3}{8}\right)+\left(5\times\frac{8}{8}\right)+\left(4\times\frac{8}{8}\right)$$

$\Rightarrow 12.75''$

As $12.75''$ is greater than $10''$

Therefore it should be multiple layers.



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

$d = 16.62''$

$$d' = 1.5 + \frac{3}{8} + \frac{1}{2}\left(6/8\right) = 2.25.$$

Design moment:

$$Md = \phi \times [As' \times fy \times (d-d') + (As-As') \times fy \times (d - \frac{d}{2})$$

$$a = \frac{(As-As')fy}{0.85 fc \times b} = \frac{(5 \times 0.785 - 1 \times 0.44) \times 60}{0.85 \times 4 \times 10}$$

$a = 6.15''$

$$0.90 \times [1 \times 0.44 \times 60 \times (16.62 - 2.25 + 5 \times 0.785 - 1 \times 0.44 \times 60 \times (16.25 - \frac{6.15}{2})]$$

$Md = 2891.50$

$Md = 2891.50$ is greater than 2.653.561k so the design is fine.

QUISTION- 2

<a> BOND STRESS:-

The bond stress design is defined as the shear force per unit nominal surface area of reinforcing bar. The stress is acting on the interface bars between bars and sorrounding concrete and along the direction parallel to the bar.

DEVOLOPMENT LENGHTH:-

It is defined as that length of embadment necessary to devolop the full tensile strength of the bar controlled by spliting or pullout. The length over which force devolops is called devolopment length.

<b>

Doubly Reinforced beam:-

Because of the high design stresses, Double Reinforced beams are not common as they are in WSD. They are more usefull for control of cracks and deflection as well as binding the top and bottom reinforcement.

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T- BEAM:-

↳ Fluxure capacity of T-Beam varies based on sign of moment

↳ In T-beam slabs and beams are connected and acts as one member.

↳ Design procedure depends on the location of moment.

RECTENGULAR BEAM:-

↳ In Rectengular beam fluxure capacity depends on location of reinforcement to the yield.

↳ Simple design and require no complecations.

↳ Slab is placed on the beam so that there is no connection between slab and beam.

<d>

Effect of strength reduction factor on flexure strength:

In the design of flexure strength the strength reduction factor decreases from tension - controlled section to compression controlled section to increase the safty width decreasing ductility. Depending on the structure compression controlled section have less ductility thus they acts simultaneously to hold together the structure.

<e>

Following are design methods of PRC.

ULTIMATE LOAD DESIGN:-

The method which limits the structural usefullness of material of the structure upto ultimate load.

LIMIT STATE METHOD:-

Method which limits the structure usefulness of material or structure upto certian load at which acceptible limit of service ability and safety are applied.

ELASTIC METHOD:-

Methods which limits the structural usefull ness of material of structure upto certian load at which the min stress is extreme fiber reaches the characteristics strength of material in bending.

QUESTION- 3

GIVEN DATA:-

c c distance = 10'

Span = 32'

Slab = 6"

width = 14"

total depth = 28"

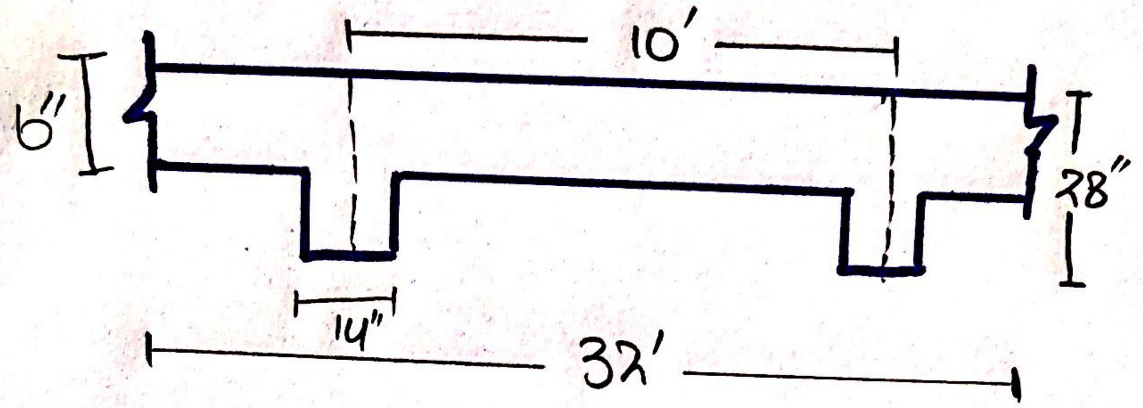
Effective depth = 25"

dead load = 50 lb/ft²

S.S = 225 lb/ft².

f_c = 4000 psi = 4ksi

f_y = 60000 psi



U·F·M

$$M_u = \frac{w_u \, l^2}{8}$$

Self waight per foot

$wt = b \times t \times \gamma c$

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

$\rightarrow 408.33$ lb/ft.

Total factored load.

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

$w_u = 909.96$ lb/ft.

Moment:-

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

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

$$\Rightarrow 1396.20 \text{ kip/in}$$

Effective width

1 → $16 \times h_f + b_w = 16 \times 6 + 14 \Rightarrow 110''$

2 → c/c distance $= 10 \times 12 \Rightarrow 120''$

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

Choose least value i.e 96″

Check Rectengular or T-beam is needed

Trial ①

$$a = h_f = 6''$$

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

$$\Rightarrow \frac{1396.24}{0.90 \times 60 \times 25 - (6/2)}$$

$A_{ST} = 1.175 \text{ in}^2$

Trial ②

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

$$\Rightarrow \frac{1.175 \times 60}{0.85 \times 4 \times 96} \Rightarrow 0.22''$$

0.22'' is less than 6''

Rectangular beam is required.

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

$$\Rightarrow \frac{1396.24}{0.90 \times 60 \times (25 - 0.2/2)}$$

$\Rightarrow 1.04 \text{ in}^2$

Trial (3)

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

$\Rightarrow 0.19''$

$$A_{ST} = \frac{1396.24}{0.90 \times 60 \times (25 - 0.19/2)}$$

$\Rightarrow 1.04 \text{ in}^2$

Check ρ_{max} an ρ_{min}

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

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

$\rho_{max} = 0.018$

$$\rho_{min} = \frac{200}{f_y} = \frac{200}{6000}$$

$\Rightarrow 0.003$

$$\rho = \frac{A_{st}}{b \times d} = \frac{1.03}{14 \times 25}$$

$$\Rightarrow 0.0029$$

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

$0.003 < 0.002 < 0.018$

if ρ is less than ρ_{min} Then

$$\rho = \frac{A_{ST}}{b \times d}$$

$A_{ST} = \rho_{min} \times b \times d.$

$0.003 \times 14 \times 25$

$\Rightarrow 1.05 \text{ in}^2$

No and Selection of bar

Let use #08 Then

dia = (8/2) = 1"

Area = 0.785^{2}

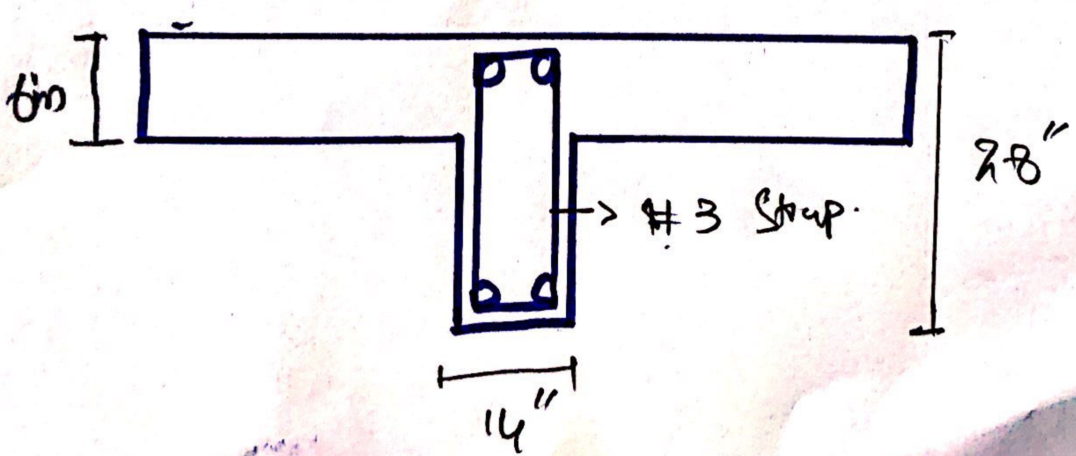
No of bars = $\frac{1.05}{0.785}$ = 1.3 ≅ 2 bars

Minimum width

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

⇒ 7.5" < 14"

It will be fine in one layer.



Design Moment.

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

$A_{ST} = 1.27 \times 2$

$\Rightarrow 2.55\ in^2$.

$a = \dfrac{A_{ST} \times f_y}{0.85 f'_c \times b_e}$

$\Rightarrow \dfrac{2.54 \times 60}{0.85 \times 4 \times 96}$

$\Rightarrow 0.46''$

$M_d = 0.90 \times 60 \times 2.54 \times (25 - \dfrac{0.46}{2})$

$\Rightarrow 3396.97$

$\Rightarrow 339.97$ is greater than

1396.24

Design is fine.