O.1):

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QNO.1):

Given Data:

Width (b) = 10"

Height (h) = 20"

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

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

span = 18'

$f'c = 4000\ psi = 4\ Ksi$

$fy = 60{,}000\ psi = 60\ Ksi$

Sol:

Step #1:

Effective depth (d) = h - 3

= 20 - 3 = 17"

Effective cover (d') = 2.5"

Renifor cement Ratio:

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

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

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

Total Factored Load:

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

= 909.99 Lb/ft = 0.909 Kip/ft

Moment:

$$\frac{WL^2}{8} = \frac{0.909\,(32)^2}{8} \times 12 = 1396.23\ \text{kip-inch}$$

Effective Breadth

1) 16 (hf) + bw = 16 (6) + 14 = 110"

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2) C/C distance = 10(12) = 120"

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

So $b_e = 96"$

Step # 3: (Rectangular or T-Beam)

Trail # 1 Let $a = h_f = 6"$

$$A_{st} = \frac{M_u}{\phi \times f_y \times (d - a/2)} = \frac{1396.23}{0.90 \times 60(25 - 6/2)}$$

Trail # 02

$$a = \frac{A_{st} \times f_y}{0.85 \times f'_c \times b} = \frac{1.17 \times 60}{0.85 \times 4 \times 96}$$

$= 0.2" < 6"$

So Rectangular beam design

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

$= 1.03 \text{ in}^2$

Trail # 03

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

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

Step # 04: Check ρ_{max} and ρ_{min}

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

$\rho_{max} = 0.018$

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

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

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

$$0.003 < 0.002 < 0.018$$

As ρ is less than ρ_{min}

so;

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

$$A_{st} = 0.003 \times 14 \times 25 = 1.05 \text{ in}^2$$

Step # 05: No. and selection of Bar

Let use # 8 bars, then

dia $= (8/8) = 1''$, Area $= 0.785 \text{ in}^2$

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

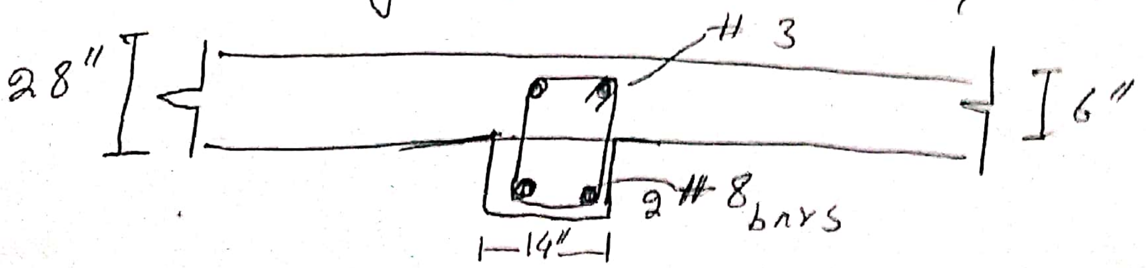
So we use 2 #8 bars.

Step # 06: Minimum width

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

$$= 6.75'' < 14''$$

So good in one layer.



Step # 7: Design Moment

$$Md = \phi \times fy \times Ast \times (d - a/2)$$

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

$= 0.785 \times 2 = 1.57 \text{ in}^2$

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

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

$= 2111.02$ Kip-inch

AS $2111.02 > 1396.23$

Design is OK!

Pb # 02:

Given Data:

C/C distance = 10'

Span = 30'

Slab thickness = 6"

Web width = 14"

Total depth (h) = 28"

Effective depth = 28" − 3" = 25"

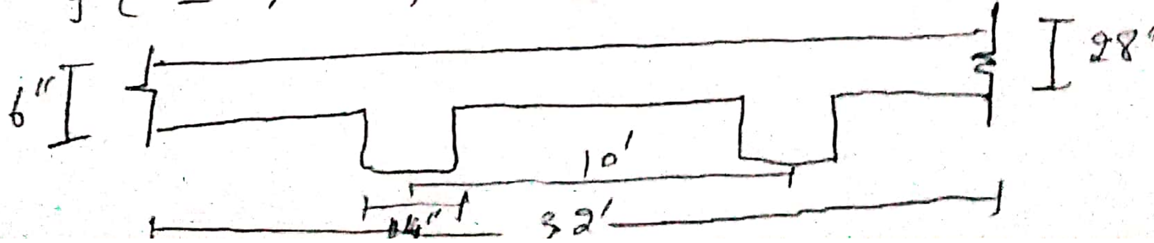
D.L = 50 lb/ft^2

S.S = 225 lb/ft^2

f_y = 60,000 psi

f'_c = 4000 psi

sol:



Step # 1:

$$Mv = \frac{Wv \times L^2}{8}$$

1- Beam self wgt per feet

$$Wt = b \times t \times \gamma_c$$

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

Step # 02:

Finding Area of Steel

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

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

$$Ast = 0.0180 \times (10 \times 17) = 3.06 \, in^2$$

Step # 03:

By formula of design Moment;

$$Mv_2 = \phi \times Ast \times fy \times (d - a/2)$$

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

$$Mv_2 = 0.90 \times 3.06 \times 60 \times (17 - 5.4/2)$$

$$= \boxed{2362.93 \text{ Kip-inch}}$$

Moment due to given loads:

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

$$= 208.33 \, lb/ft$$

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

$$= 5461.99 \, lb/ft$$

$$= 5.46 \, kips/ft$$

Ultimate factored Moment $= \frac{WL^2}{8}$

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

$$M_v = \boxed{2653.56}$$

Now As

$M_{v2} < M_v$

$2362.92 < 2653.56$

↓

Doubly Reinforcement Required

Step# 4:

$M_{v1} = 2653.56 - 2362.92$

$= 290.64$ kip-inch

Step# 05:

Steel Area in compression Zone;

$M_{v1} = \phi \times A'st \times fy (d - d')$

$$A'st = \frac{M_{v1}}{\phi \times fy \times (d - d')}$$

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

Step # 6:

$As = Ast + A'st$

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

Step # 07:

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

Area = 0.785 in²

$$\text{No. of bars} = \frac{Ast}{\text{Area of 1 bar}} = \frac{3.43}{0.785}$$

$= 4.36 \simeq 5$ bars

So 5 # 8 bars

↓

For Tension Zone

Compression steel:

use # 6 bars

dia (6/8) = 0.75" , Area = 0.44 in²

$$\text{No. of bars} = \frac{Ast'}{\text{Area of 1 bar}} = \frac{0.37}{0.44} = 0.84$$

$= 0.84 \approx 1$ bar

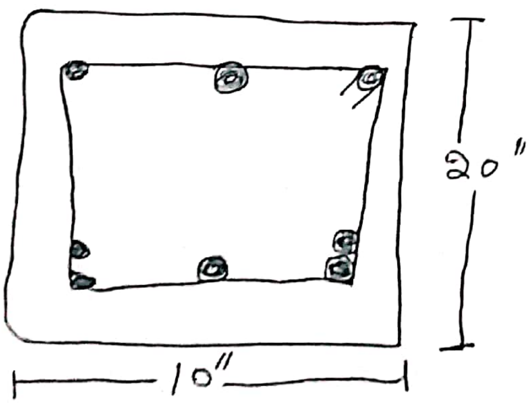
So 1 # 6 bars in → Compression Zone

Step # 8: Beam Minimum Width

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

$= 12.75 > 10"$

↳ in multiple layers



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

$d = 16.62"$

$$\text{Effective cover } (d') = 1.5 + \frac{3}{8} + \frac{1}{2}\left(\frac{6}{8}\right)$$

$= 2.25"$

Step # 9: Design Moment is given by.

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

$$a = \frac{(A_{st} - A'_{st}) \times f_y}{0.85 \times f'_c \times b}$$

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

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

$$= 2890.46$$

$$Md = 2890.46 > 2653.56$$

Design is ok!

QNo.2):

<u>Bond Stress</u>: Bond stress acting on at the interface of the rebar and concrete that acts parallel to bar as result of adhesion, mechanical interlock and frictional forces between the concrete and the steel is called Bond stress.

↳ It helps in transfer of axial loads from steels to concrete by development of forces along the contact surface.

↳ We can not pull out reinforced bar from the concrete when its hardened because the bond stress resist the bar from coming out.

↳ The bond between reinforcement bars and concrete is because of this bond stress.

<u>Development Length</u>: Development length is the necessary length between the point of maximum stress in a bar and the end of bar is called development length of reinforcement bars.

→ We provide the development length, to develop a safe bond between the bar surface and concrete so that no failure due to slippage of bar occur during ultimate loading condition.

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b) In which conditions doubly reinforcement beam can be used?

Ans: Doubly Reinforced beam can be used when there is some resistance on dimensions and we can not decrease depth of beam.

↳ Also we design for saftey factor.

↳ To increase the moment carrying capacity of section.

c) Differeniate b/w T-beam and Rectangular beam Analysis.

Ans: In case of T-beam Design, there is & analysis.

1) T-beam analysis:

When $a > hf$.

↳ when depth of compression block (a) is greater than height of flange or slab thickness(hf) then we design T-beam.

2) Rectangular Beam Analysis:

$a \leq hf$

When depth of compression block is smaller or equal to height of flange of T-beam, then we design the beam as rectangular beam.

d) Write short note on effect of strength reduction factor on flexural strength.

<u>Answer:</u> The strength reduction factor ϕ decreases from tension controlled section or Tension Zone to Compression controlled section or compression zone to increase safety, in the design of flexural strength.

→ strength reduction factor ϕ is ratio of elastic strength and yield strength.

→ $\phi = 0.90$ or 90 % which means that 90 % of strength value is considered here in design and the rest is for saftey factor.

e) Briefly describe design method which one of them can be used for design of different structure members and why?

<u>Method of Design:</u> 2

1- <u>USD:</u> It is also called load factor method. because we use factor load while designing on this method.

→ USD is best method for designing different structure.

→ Provide more saftey.

→ Tensile strength is neglected in USD.

→ $F.L = 1.2 \times D.L + 1.6 \times L.L$

2) **ASD**: Allowable Strength design method is also called working stress design method.

→ It is based on principal that stresses developed in structural members should not exceed a certain fraction of elastic limit.

→ old method of design.

→ All loads are taken as service loads and no factor is applied.

→ $W = D.L + L.L$