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Subject : PRC

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GIVEN DATA:

Width, b = 10"

height, h = 20"

L.L = 2.47 kip/ft = 2470 lb/ft

D.L = 1.05 kip/ft = 1050 lb/ft

Span = 18'

$f'c$ = 4000 Psi

fy = 60,000 Psi

Step: 01 Self weight per feet

$\frac{10}{12} \times \frac{20}{12} \times 150 = 208.30$

Step: 02 Factored load

$= 1.2(D.L) + 1.6(L.L)$

$=$ 5461.0 lb/ft

5.460 K/ft

Step: 03 Ultimate factored load

$$M_u = \frac{w \times l^2}{8}$$

$$= \frac{5.460 \times (18)^2 \times 12}{8}$$

$$M_u = 2653.55 \text{ Kip inch}$$

Step: 04 Check the capacity of singly reinforcement beam.

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

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

$$\rho_{max} = 0.018$$

Step 05:

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

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

$= 0.0180\ (10 \times 12)$

$= 3.06\ in^2$

Step: 06

$Mu_2 = \phi \times Ast \times fy \times (d - a/2)$

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

$= \dfrac{3.06 \times 60}{0.85 \times 4 \times 10} = 5.4''$

$Mu_2 = \phi \times Ast \times fy \times (d - a/2)$

$= 0.90 \times 3.06 \times 60 \times (12 - 5.4/2)$

$= 2362.93$ kip inch

Now

$Mu_2 = 2362.93$

$Mu = 2653.55$

c

$Mu > Mu_2$

Design a Section as doubly Reinforced

Step: 07

$$M_{U_1} = M_U - M_{U_2}$$

$$= 2653.55 - 236293$$

$$= 290.63$$

Step 08:

$$M_{U_1} = \phi \times A_s \times f_y \, (d - d^2)$$

$$A_s = \frac{M_{U_1}}{\phi \times f_y \times (d - d^2)}$$

$$= \frac{290.62}{0.90 \times 60 \, (12 - 2.5)}$$

$$= 0.371 \text{ in}^2$$

$$M_{U_1} = 0.90 \times 0.37 \times 60 \times (12 - 2.5)$$

$$= 289.71$$

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

$$= 3.06 + 0.37$$

$$= 3.43 \text{ in}^2$$

Selection of Bar (tensile)

M Let try #08 bar having area 0.78 in^2

$$\text{No of bar} = \frac{A_{st}}{A_b}$$

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

$$= 4.36 \text{ bars}$$

5# bars

Selection For compression

Let try # 4 bar

$$\text{No of bar} = \frac{A_{st}}{A_b}$$

$$= \frac{0.37}{0.20} = 1.85 = 2 \text{ bars}$$

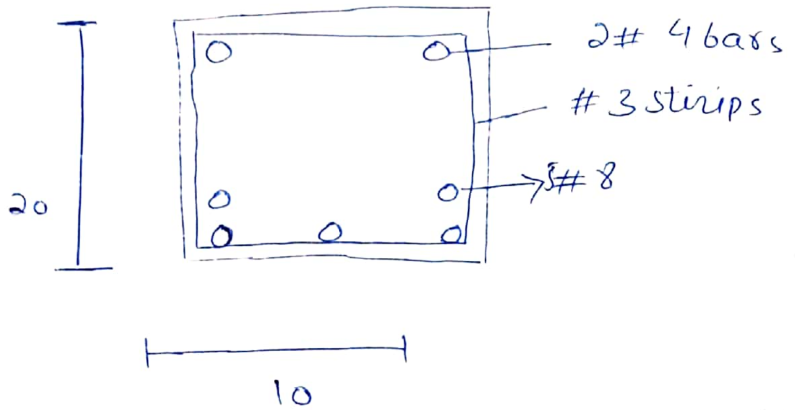
Checking minimum width of Beam

$$b_{min} = 2 \times 1.5 + 2 \times 3/8 + 5 + 8/8 + 4 \times 8/8$$

$b_{min} = 12.75'' > 10''$

Not good in one layer

Md



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

$= 16.68''$

$d' = 1.5 + 3/8 + 1/2(4/8) = 2.125''$

Step: 09 Design Moment

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

where

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

$$= \frac{(5 \times 0.785 - 2 \times 0.20) \times 60}{0.85 \times 4 \times 10} = 6.21''$$

$M_{d1} = 0.90\,((2\times0.20)\times60\times(16.68-2.125)+(5\times0.785-2\times0.20)\times60\times(16.62-\frac{6.2}{2}$

$= 0.90\,(6.40)\times60\times(14.55)+(3.925-0.40)\times60\,(16.62-3.105)$

$= 2886.860$

$M_d = 2886.86 > M_u = 2.653$

Design is OK.

QNo 2 (a) (8)

BOND Stress:

The stress which is acting on the outer interface of steel to the surrounding concrete is called bond stress

Devlopment Length:

Length of bar required to transfer the force in the bar to the surrounding concrete through bond is called Development length.

QNo 2 (b)

CONDITION FOR DOUBLY REINFORCED BEAM:

- When the dimension of the beam are restricted for architectural or structural purposes.
- Section that are subjected to the reversal of bending moment.

Q No 2(c)

Differentiate b/w T Beam analysis and Rectangular Beam analysis

ANSWER:

Both beams 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 act as one member.

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

Q No 2(d)

Write a short note on the effect of strength reduction factor on flexural strength.

ANSWER:

strength reduction factor is define as the ratio of elastic strength the yield strength. The importance of estimating R factor originates in the need for directly deriving inelastic spectra

Q No 2(5)

DESIGN METHOD

These are procedure, techniques, aids or tools for designing.

- They offer a number of different kind of activities that a designer might use with in an overall design process.

- Conventional procedure of design such as drawing can be regarded as design method, but since the 1950s new procedures have been developed that are more usually grouped together under the name of "design methods"

T - Beam

Given Data:

Total depth (h) = 28"

Web width = 14"

Slab thickness = 6"

Span = 30'

c/c distance = 10'

Effective depth = 28 − 3 = 25"

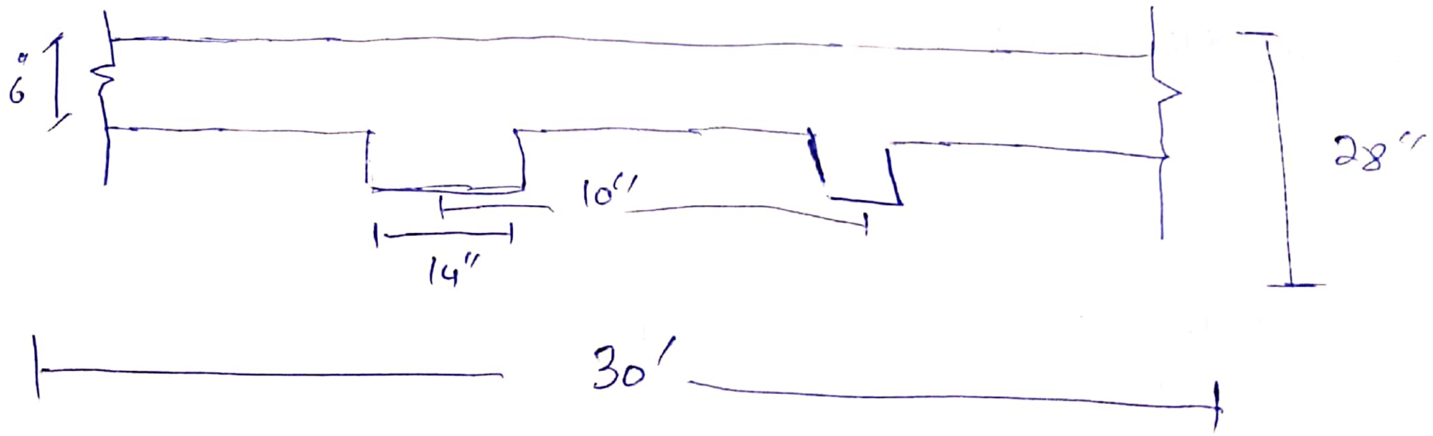
D.L = 50 lb/ft

S.S = 225 lb/ft

f_y = 60,000 Psi

f_c = 4000 Psi

SOLUTION:



Step: 01

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

Beam self weight per feet

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

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

Total factored load

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

$= 909.9$ lb/ft   0.90 Kip/ft

Moment

$$\frac{Wl^2}{8} = \frac{0.900 \times (32)^2}{8} \times 12 = 1396.23 \text{ Kip inch}$$

Breath

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

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

Span/4 $= 32/_4 \times 12 = 96''$

Step: 02 (Rectangular or T-Beam)

Trial #1

Let $a = h_f = 6''$

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

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

$A_{st} = 1.17 \, in^2$

Trial #02

$$= \frac{A_{st} \times f_y}{0.85 \times f'c \times b}$$

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

$= 0.2'' < 6''$

So Rectangular Beam Design

$$A_{st} = \frac{1396.23}{0.90 \times 60 \times (25 - 0.1)}$$

$= 1.03 \, in^2$

Trial #03

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

$$A_{st} = \frac{1396.83}{0.90 \times 60 (25 - 0.18/2)}$$

$$= 1.03 \text{ in}^2$$

Step # 04

Check ρ_{max} and ρ_{min}

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

$$\rho_{max} = 0.0180$$

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

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

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

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

$$0.003 < 0.002 < 0.018$$

As

ρ less than ρ_{min}

So,

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

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

$A_{st} = 0.003 \times 14 \times 25$

$= 1.05\ in^2$

Step# 05

No of bar & selection bar

let use #6 bar, then

$dia = (6/8)$

$Area = 0.44\ in^2$

$\text{No of bars} = \frac{1.05}{0.44} = 2.38\ in^2$

So we use 3 # 6 bars

Step# 06

$b_{min} = 2(1.5) + 2(3/8) + 2(6/8) + 1(6/8)$

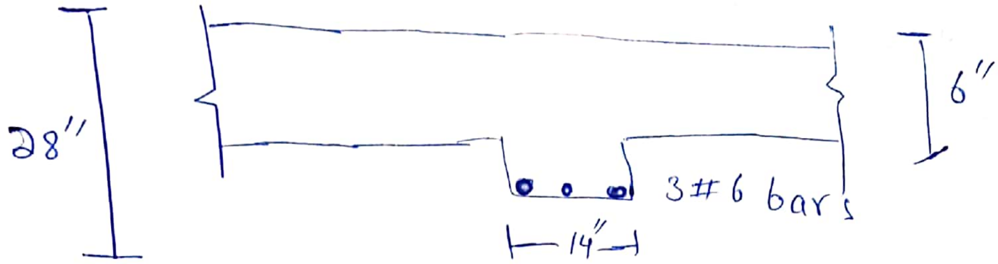
$= 2(1.5) + 2(0.375) + 2(0.75) + (0.75)$

$= 3 + 0.75 + 1.5 + 0.75$

$= 6$

$6 < 14''$

So good in one layer



Step # 07

Design Moment

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

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

= 0.44 × 3

= 1.32

$M_d = 0.90 \times 60 \times 1.32 \times (25 - 0.2/2)$

As 1774.87 > 1396.2

Design is ok