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Question No 1

Step : 01

Beam self weight

$wB = b \times d \times \gamma_c$

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

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

Step : 02

Factored load

$w_u = (1.2 \times DL) + (1.6 \times L.L)$

$w_u = (1.2 \times (1050) + (208.33)) + (1.6 \times 2470)$

$w_u = 5461.996 \text{ lb/ft}$

$w_u = 5.46 \text{ Kip/ft}$

Step : 03

ultimate factored moment

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

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

$M_u = 2653.56 \text{ kip}''$

Step 04 :

Capacity of reinforcement as singly reinforced beam.

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

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

$$\rho_{max} = 0.0180$$

Step : 05

To find area of steel : Ast

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

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

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

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

Step 06:

$$M_{u2} = \phi \times A_{st} \times f_y \times (d - a/2)$$

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

$$a = \frac{3.06 \times 60}{0.85 \times 4 \times 10}$$

$$\boxed{a = 5.4''}$$

$$M_{u2} = 0.90 \times 3.06 \times 60 \times (17 - 5.4/2)$$

$$\boxed{M_{u2} = 2362.93K''}$$

Step 07

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

$$M_{u1} = 2653.56 - 2362.93$$

$$\boxed{M_{u1} = 290.63\ K''}$$

Step 08:

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

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

$$A'_s = \frac{290.63}{0.90 \times 60 \times (17 - 2.5)}$$

$A'_s = 0.37\ in^2$

Step = 9

Total steel area.

$As = 3.06 + 0.37$

$As = 3.43\ in^2$

Step 10 :

selection of bar

let use bar no 8 for tensile steel

* Area of #8 bar $= \frac{\pi}{4} \times \frac{8}{8}^2$

$Area = 0.785\ in^2$

* no of bar $= \frac{As}{Ab} = \frac{3.43}{0.785} = 4.37 \approx 5$

For compression:

lets use bar #6

Area of bar 6 $= \frac{\pi}{4} \times \left(\frac{6}{8}\right)^2$

$Area = 0.44\ in^2$

No of bar $= \frac{0.37}{0.44} = 0.84 \approx 1$

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Step 11

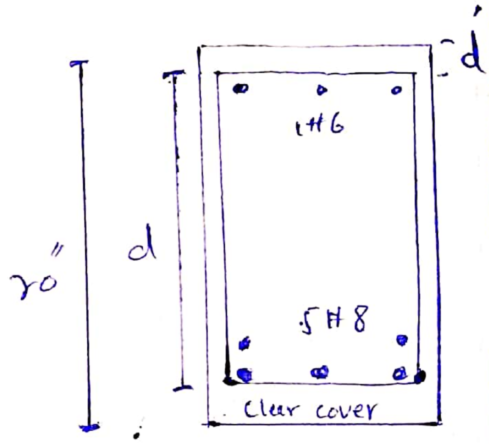
mini-width of beam

$= (2 \times 1.5) + (2 \times 3/8) + (5 \times 8/8) + (4 \times 8/8)$

$b_{mini} = 12.75''$

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

$d = 16.625''$



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

$d = 2.25''$

Step : 12

$M_d = \varnothing \{A'_s \times f_y \times (d - d') + (A_s - A'_s) \times f_y \times (d - a/2)\}$

$$a = \frac{A\,(5 \times 0.785)(1 \times 0.44] \times 60}{0.85 \times f'_c \times b}$$

$a = 6.15''$

$M_d = 0.9\{(1 \times 0.44) \times 60 \times (16.625 - 2.25) + (3.485) \times 60 \times (16.625 - 6.15/2)\}$

$M_d = (0.9)(3212.805)$

$M_d = 2891.52\ K'$

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Question No "02"

Part "a"

Bond stress:-

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

⇒ This stress helps in keeping bond between reinforcement and concrete together. Bond stress resists any force that tries to pull out the rods from the concrete.

=> when you try to pull out the reinforcement bar from concrete, then this bond stress resist the bar to come out.

Development length:-

The necessary length between the point of maximum stress in a bar and the end of the bar, is called Development length.

Question No 2

part "b"

Double reinforced beam can be used in the following condition.

(i) When the load are eccentric.

(ii) when beam is subjected to accidental lateral loads.

(iii) when the cross section of beam is restricted due to any constrains like architectural or space consideration etc.

(iv) In case of continuous beams or slabs, the sections at supports are generally designed as doubl reinforced sections.

Part "c"

Difference between T and rectangular beam

T-Beam:-

(i) There is no joint between slab and beam in T-beam.

(ii) Slab and beam are constructed at the same time and it have different method of analysis.

(iii) Beam with T-shape cross section is built when concrete beams are poured monolitically with slabs.

Rectangular Beam:-

(i) Beam with rectangular shape cross section is built when concrete beam are poured, polylithically with slab.

ii) Firstly Beams are constructed and then slabs over it are constructed and it have its own way of analysis.

iii) There is a proper joint between slab and beam in rectangular shape Beams.

Part "d"

In the design of flexural strength The strength reduction factor decrease from tension controlled section to compression controlled section to increase safety with decreasing ductility. This Paper Present how to determine the reduction factor for flexual strength of reinfroced concrete beam according to ACi design code.

=) The deflection of concrete structures depend on flexure strength of concret. Many factor have effected of strength reduction factor on flexural strength, particularly the level of stress, size, age, and confinement to flexure member etc.

Part "E"

There are three methods of structural member design which are the following.

(i) Ultimate load Method
(ii) working stress Method
iii) limit state Method.

Ultimate load method:

This method is also know as

load factor method. This method is based on the ultimate strength where the design member would fail. In this method factored are taken into accont only on load factor, This method of is designed in which limits the structural usefulness of the material of the structure up to ultimate load.

working stress method:-

This method basically assumes that the structural material behaves as a linear elastic maner and the adeauate safety can be ensured by suitably restricting the stresses in the material induced by the expected working loads on structure.

Limit state method:-

The philosophy of the limit state method of design represents a definite advancement over the traditional design philosophies.

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"Question 03":

Step 01:

Beam self weight per feet.

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

$$\boxed{W_B = 408.33 \text{ lb/ft}}$$

Step 02:-

Factored load

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

$$W_U = 909.99 \text{ lb/ft}$$

$$\boxed{W_U = 0.909 \text{ kip/ft}}$$

Step 03:-

ultimate factored moment

$$M_U = \frac{W_U \times L^2}{8}$$

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

$$\boxed{M_U = 1396.224 \text{ kip}''}$$

Step 04 :-

Calculate Effective width

(a) $16 \times h_f + b_w$

$= 16 \times 6 + 4$

$= 110''$

(b) 10×12

$= 120''$

(c) $\frac{Span}{4}$

$= \frac{32 \times 12}{4}$

$= 96''$

Step : 05

To check rectangular or T-Beam

Let $a = h_f = 6''$

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

Put the value.

Step 06:

Check ρ_{max} and ρ_{min}

$$\rho_{max} = 0.85 \times B \times \frac{f'_c}{f_y} \times \left(\frac{\varepsilon_v}{\varepsilon_v - \varepsilon_y}\right)$$

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

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

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

$$\rho_{min} = \frac{200}{60.00}$$

$$\boxed{\rho_{mini} = 0.003}$$

$$\Rightarrow \rho = \frac{A_{st}}{b_w \times d}$$

$$\rho = \frac{1.04}{14 \times 25}$$

$$\boxed{\rho = 0.0029}$$

$$A_{st} = \frac{1396.224}{0.90 \times 60 \times (25 - 6/2)}$$

$$\boxed{A_{st} = 1.1752\ in^2}$$

$$a = \frac{A_s \times f_y}{0.85 \times f'_c \times b_e}$$

$$a = \frac{1.1752 \times 60}{0.85 \times 4 \times 96}$$

$$\boxed{a = 0.2''} < 6''$$

$$A_{st} = \frac{1396.224}{0.90 \times 60 \times (25 - 0.2/2)}$$

$$\boxed{A_{st} = 1.04\ in^2}$$

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

$$\boxed{a = 0.19''}$$

$$A_{st} = \frac{1396.224}{0.90 \times 60 \times \left(25 - \frac{0.19}{2}\right)}$$

$$\boxed{A_{st} = 1.04\ in^2}$$

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

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

$Ast = 0.003 \times (14) \times (25)$

$Ast = 1.05\ in^2$

Step : 07

Bar selection:-

let use # 7

dia of bar 7 = $7/8 = 0.875''$

area $= \frac{\pi}{4} d^2 = \frac{\pi}{4}(0.875)^2$

$Area = 0.601\ in^2$

$$\text{Number of bar} = \frac{Ast}{Ab} = \frac{1.05}{0.601} = 1.746 \approx 2$$

so we use 2 bar

Step : 08

Minimum width

$= 2 + (2 \times 1.5) + (2 \times 3/8) + (2 \times 7/8) + (1 \times 7/8)$

$= 6.375'' < 14''$

Step 09:-

First Find "Ast" and "a"

Area of one bar × no of bars = Ast

$Ast = (0.601 \times 2)$

$$Ast = 1.202 \ in^2$$

$$a = \frac{Ast \times fy}{0.85 \times fc \times be}$$

$$a = \frac{1.202 \times 60}{0.85 \times 4 \times (96)}$$

$$a = 0.22''$$

So $MD = \varnothing \times fy \times Ast \times (d - a/2)$

$MD = 0.90 \times 60 \times 1.202 \times (25 - 0.22/2)$

$$MD = 1615.56 \ Kip''$$