Name: Osama Asghar Khan

ID # 7820

Section: A

Semester # 6th

Q. No. 1

Given Data:

height = h = 20"

width = b = 10"

Live load = L.L = 2.47 kips/ft

Dead load = D.L = 1.05 kips/ft

Span = 18'

f_y = 4000 psi = 4 ksi

f'_c = 60000 psi, = 60 ksi

Required Data:

Area of steel = ?

Solution:

Effective depth = h-3

= 20-3

= 17"

ben

Effective cover = 2.5"

Now **Reinforcement Ratio:**

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

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

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

Step # 02:

Area of steel

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

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

$$= 0.0180 \times 10 \times 17 = 3.06 \text{ in}$$

Step # 03:

Now using formula of design moment,

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

$$a = \frac{A_{st} \times f_y}{0.85 \times f'_c \times b} = \frac{3.06 \times 60}{0.85 \times 4 \times 10} = 5.4"$$

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

$$\boxed{M_{u_2} = 2362.9 \text{ kip-inch}}$$

(3)

Step #3:

Moment due to the given loads.

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

$= 208.3$

Total Factored load $= 1.2(1050 + 208.3) + 1.6(2470)$

$= 5461.9$ lb/ft

$= 4.46$ kips/ft

Ultimate Factored load $= \frac{WL^2}{8}$

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

$\boxed{= 2653.5}$

Now,

$Mu_2 < Mu_1$

$2362.92 < 2653.56$

↓

Doubly Reinforcement is required

Step # 04:

$Mu_1 = 2653.56 - 2362.9$

$= 290.64$ kip-inch

Step #05:

The area of steel in compressive zone will be,

$Mu_1 = \phi \times A'_{st} \times f_y \times (d - d')$

$A'_{st} = \frac{Mu_1}{\phi \times f_y \times (d - d')}$

Scanned with Car

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

$$\boxed{A_{st} = 0.37 \text{ in}^2}$$

Step # 06:

$$A_{st} = A_{st} + A'_{st}$$
$$= 3.06 + 0.37$$
$$= 3.43 \text{ in}^2$$

Step # 07:

Now we use #8 bars, (dia = 8/8 = 1")

Area = 0.785 in^2

$$\text{No. of bars} = \frac{A_{st}}{\text{Area of 1 bar}}$$
$$= \frac{3.43}{0.785}$$
$$= 4.36 \approx 5 \text{ bars}$$

So, 5 # 8 bars

For Compression Steel:

Use #6 bars

dia (6/8) = 0.75",

Area = 0.44 in^2

$$\text{No. of bars} = \frac{A'_{st}}{\text{Area of 1 bar}} = \frac{0.37}{0.44} = 0.84 \approx 1 \text{ bar}$$

So, 1 # 6 bar in the compression zone

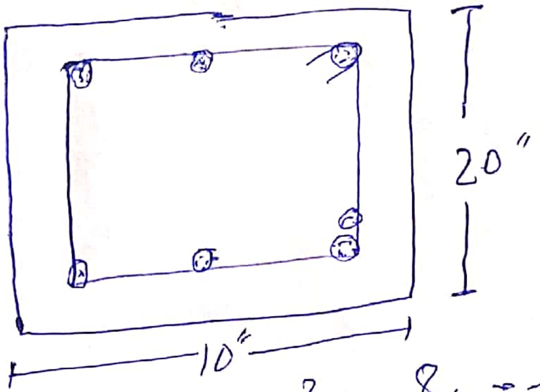
Step #8:

Minimum width of Beam

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

$$= 12.75 > 10''$$

so in multiple layers



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

$$d = 16.62''$$

$$\Rightarrow \text{Effective cover } (d') = 1.5 + 3/8 + \frac{1}{8}(6/8)$$

$$= 2.25''$$

Step # 09

Design Moment

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

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

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

$$= 6.15''$$

$$Md = 0.90 \times [(61 \times 0.44) \times 60 \times (16.62 - 2.25) + (15 \times 0.785 - 1 \times 0.44) \times 60 \times (16.62 - \frac{6.15}{2}))$$

$$Md = 2890.46$$

Now as $Md = 2890.46 > 2653.56$

The Design is Ok!

Question No. 2

Part (a):

Bond Stress:

The bond stress is that stress which acts on the inner interface of steel ~~surrounding~~ to the surrounding concrete is called Bond stress. This ~~bond~~ stress helps in keeping bond between the reinforcement/steel and concrete.

Development length:

A development length is defined as the amount of reinforcement length needed to be embedde into the column to establish the desire bond strength between the concrete & steel.

Part (b):

Answer:

The conditions where the doubly reinforcement beams can be used are given below:

1, When the dimensions of the beam are restricted for architectural or structural purposes.

2, The portion of the beam over middle support in continous T beams has to be designed as doubly reinforced section.

3, Sections that are subjected to the reversal of bending moment (piles braces in water towers etc).

Question No. 2

Part (c):

T-Beam Analysis	Rectangular Beam Analysis
=> T-Beam have beam & slab composite section	=> A rectangular beam is one which are generally used as compression in top fibre and tension in bottom fibre of that beam.
=> A T-beam is more economical than rectangular beam	=> Rectangular beam is less economic than T-beam
=> In case of T-beam, slab 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 b/w the slab & beam.

Q. No. 2

Part (d):

Effect of strength reduction factor on flexural strength:

In the design of flexural strength, the strength reduction factor decrease from tension control section to compression controlled section to increase safety with decreasing ductility. This show to determine the Reduction factor for Flexural strength of reinforcement concrete.

Q.No.2

Part(e):

Answer:

Two methods are generally used for the designing of concrete and different structure members.

① USD Method:

Ultimate strength design method is also known as the load factor method.
For this structure is subjected to large external load the ultimate strength is determined by unelastic analysis.

② ASD Method.

ASD method is also known as working stress design method. It is based on the principle that stresses developed in the structural member should not exceed a certain limit friction of elastic limit.

130

Question No. 3

Given Data:

C/C distance = 10'

Span = 32'

Slab thickness = 6"

Total depth (h) = 28"

web width = 14"

Effective depth = 28" - 3" = 25"

Dead load = 50 lb/ft

S.S = 225 lb/ft^2

f_c = 4000 psi

f_y = 60,000 psi

Solution:

Step#01

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

1- Beam self weight per feet

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

$= \frac{14}{12} \times \frac{28}{12} \times 150 = 408.3$ lb/ft

Total Factored Load :-

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

$= 909.99$ lb/ft $= 0.909$ kip/ft

Moment.

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

⇒ Effective Breadth :-

1) $16(6) + 14 = 110''$

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

3) Span/4 $= \frac{32}{2} \times 12 = 96''$

So $\boxed{b_e = 96''}$

Step # 03

Trial # 01.

let $a = h_f = 6''$

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

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

Trial # 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

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

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

Trial #03:

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

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

Step #04:

ρ_{max} & ρ_{min}

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

$$\rho_{max} = 0.018$$

$$\Rightarrow \rho_{min} = \frac{200}{f_y} = \frac{200}{60000} = 0.003$$

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

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

$$0.003 < 0.002 < 0.018$$

As,
ρ is less than ρ_{min}

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

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

Step # 05.

No. of section of bar

lets use # 8 bar,

dia = $8/8 = 1''$, Area = $0.785\ in^2$

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

So we use 2 # 8 bars

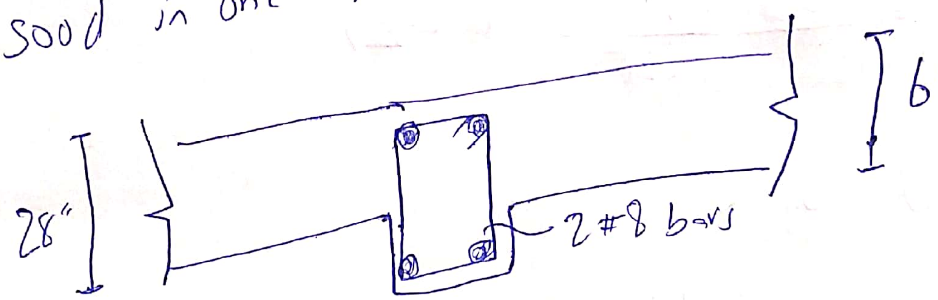
Step # 06.

Minimum width

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

$= 6.25'' < 14''$

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 bars

$= 0.785 \times 2 = 1.57\ in^2$

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

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

$= 2111.02$ kip-inch

As, $2111.02 > 1396.23$ Design is Ok!