Name Usama Ayaz (1) ID # 6977

Qno2)

Ans 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 b/w reinforcement &+ concrete togather. 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 hardened concrete, then this Bond stress resists the bar to come out.

Different grades of concrete has different bond stress.

Development length:-

At can be defined as the amount of bar length needed to be embedded or projected into the colomn to establish the desired bond strength b/w the concrete &+ steel

Reason for providing it:-

To devolp a safe bond b/w the bar surface &+ the concrete so that no faliure due to slippage of bar occurs during the ultimate load condition.

Ans(b) Condition for doubly reinforced beam:-

(1) when the dimensions of the beam are restricted for archituval or structure purpose.

(2) Sections that are subjected to the reversal of bending moment (piles, braces in watertower)

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

Ans c) Difference b/w T-beam analysis & rectangular beam analysis:-

1) In terms of geometry its very clear one is rectangular & the other is T. But here you should note that the T beam offers more moment of inertia than rectangular.

2) The fluxural capacity of T beam varies based on the sign of moment (+,-). The resistance of T beam is higher for positive moment b/c the flange section would be in compression. But for negative moment it yields the same strength as an equilant beam without the flange. while the rectangular section only depends on the location of reinforcement to yield the fluxural capacity.

(3) The design procedure of T beam depends on the location of moment as the case of its fluxural stregth. For positive moment we have three cases to be checked to proceed with designed one of the neutral axis is within the flange two neutral axis outside of the flange or in the web & three doubly reinforced beam.

Ans (d) In the design of fluxural stregth the strength reduction factor decrease from tension control section to compression controlled section to increase saftey with decreasing ductility. This show to determine the reduction factor for fluxural strength of reinforcement concrete.

Ans (e)

There are two methods ~~for~~ of designing method

1) ASD Method

2) USD Method.

As D 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 (ction of elastic) limit.

→ In this method all load are taken as service & no factor is applied to increase these service load.

USD Method;-

For the structure subjected to large external load the ultimate strength is determine by the inelastic analysis.

⇒ USD method is best for designing different structural method due to following reason

(1) As the ultimate strength of the material is considered we will get much slendar section for coloum & beam compare to other method.

2) USD Method result is more economical design for a building with fewer special need for customized area & requirement.

Usama Ayaz (5) ID 6977

Qno 1)

Ans 1) Given:-

Live Load = L.L = 2.47 Kips/ft

Dead load = D.L = 1.05 Kips/ft.

Length of simple span = 18 ft

Total Depth = t = 20 inches

width = 10 inches

f_y = 60000 Psi = 60 Ksi

f'_c = 4000 Psi = 4 ksi

Required:- Steel Area = ?

Solution:-

Step No 1:-

first we have to calculate the effective depth (d)

As

h - 3 = effective depth

20 - 3 = 17 inches

effective depth = 17 inches.

Step # 2:-

~~Calcula~~ As we have not given the effective cover we will assume it so

assume

d' = 2.5

Step # 3:-

checking the capacity of section as singly reinforced beam.

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

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

$$= 0.048166 \ (0.375)$$

$$\rho_{max} = 0.018062$$

↓ Reinforcement Ratio

Step # 4:-

As we know that

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

$$\Rightarrow Ast = 0.018062 \times 10 \times 17 = 3.0705 \ in^2$$

Step 5#

As by formula of design moment

$$Mu_2 = \phi \times Ast \times fy \times \left(d - \frac{a}{2}\right) \quad -(i)$$

As we have no "a" so first we will find "a".

$$a = \frac{Ast \times fy}{0.85 \times f'c \times b} = \frac{3.0705 \times 60}{0.85 \times 4 \times 10} = \frac{184.234}{34}$$

$$\boxed{a = 5.4186}$$

Putting values in eq (i)

$$Mu_2 = 0.90 \times 3.0705 \times 60 \times \left(17 - \frac{5.4186}{2}\right)$$

$$Mu_2 = 165.807\,(14.2907)$$

~~$Mu_2 = 3267.939$~~

$$Mu_2 = 2369.49.$$

Step #6:

Moment due to given load = b x t x fc

$$\frac{10}{12} \times \frac{20}{12} \times 150 = 208.33 \text{ lb/ft}^3$$

Total factored load:-

$$W_T = 1.2\,D.L + 1.6\,L.L$$

$$= (1.2)(1050 + 208.33) + (1.6)(2470)$$

$$= 1509.99 + 3952$$

$$= 5461.99 \text{ lb/ft}$$

$$W_T = 5.461 \text{ kips/ft.}$$

Step #7:

Ultimate factored load:-

$$Mu = \frac{wL^2}{8} \times 12 = \frac{5.461 \times (18)^2}{8} \times 12$$

$$= 2654.046$$

$$Mu > Mu_2$$

so designed of a section is Doubly reinforced.

Step # 8:-

$Mu_1 = ?$

$Mu_1 = Mu - Mu_2$

$= 2654.046 - 2369.49.$

$Mu_1 = 284.556$ kip-inch.

Step # 9:-

As

$Mu_1 = \phi \times As' \times fy \times (d-d')$

$As' = \frac{Mu_1}{\phi \times fy \times (d-d')}$

$As' = \frac{284.556}{0.90 \times 60 \times (17-2.5)}$

$As' = 0.3634 in^2$

Step # 10:-

Total steel Area = $Ast + As' = 3.0705 + 0.3634$

$As = 3.4339 in^2$

Step # 11:- Selecting Bars

For Tensile steel:-

we use No 8 bar which has diameter 1"

& Area 0.785 inch^2

$$\text{Number of \#8 bars} = \frac{A_s}{A_b} = \frac{3.433}{0.785} = 4.373 \cong 5$$

5 bars.

For compression steel:-

we use No 6 bar which diameter is

0.75 in & area is 0.44 in^2

so

$$\text{No of \#6 bar} = \frac{A_s'}{A_b} = \frac{0.363}{0.44}$$

$$= 0.825 \cong 1$$

No of #6 bar = 1

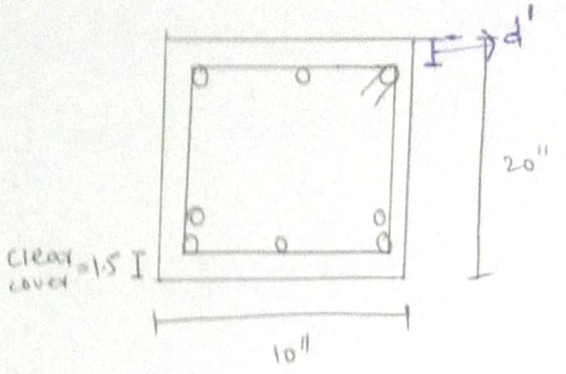
Step 12:- Minimum width of Beam

Bmin = 2 x clear cover + 2 x diameter of stirrup + No of main bar + No main Bars + Diameter of main bar + No of spaces b/w main bars x dia of main bar

$$= 2 \times 1.5 + 2 \times \left(\tfrac{3}{8}\right) + 5 + 1 + (4)(1)$$

$$= 12.75'' > 10$$

which is not good in one layer.



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

$$d = 16.62 \text{ inch}$$

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

$$= 2.25 \text{ inch}$$

Step #13 :-

Design Moment:-

$$Md = \phi \times \left[As' \times fy \times (d - d') + (Ast - As') \times fy \times \left(d - \frac{a}{2}\right) \right] \quad \text{(ii)}$$

~~0.90~~ first find "a"

$$a = \frac{(Ast - As') \times fy}{0.85 \times f'c \times b}$$

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

$$a = 6.15$$

Put in eq (ii)

$Md = 0.90\left[(1\times0.44)\times60\times(16.62-2.25) + [(5\times0.785)-(1\times0.44)]\times60\times(16.62-\frac{6.15}{2})\right]$

$Md = 0.90\left[(26.4\times14.37) + (209.1)\times(13.545)\right]$

$= 0.90\left[379.368 + 2832.259\right]$

$Md = 2890.464 > 2654.046$

So it is OK)

Qno3)

Ans 3) Given:-

c/c distance = 10'

span = 32'

$h_f = 6''$

$b_w = 14''$

$h = 28''$

effective depth = $h - 3 = 28 - 3 = 25''$

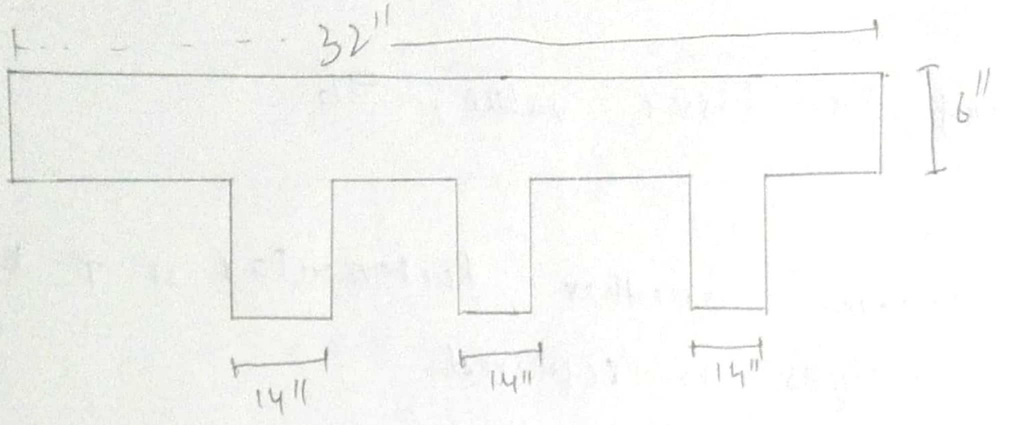
$\Rightarrow d = 25''$

D.L = 50 lb/ft²

L.L = 225 lb/ft²

$f_y = 60000$ psi = 60 ksi   1 ksi = 1000 psi

$f'_c = 4000$ psi



Step # 1)

$$M_u = \frac{wL^2}{8}$$

(i) self weight of the beam

$W_t = b \times t \times \gamma_c$ ∵ γ_c For PCC = 140 lb/ft, For RCC = 150 lb/ft.

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

$= 408.33$ lb/ft

(ii) Total factored load:-

$= 1.2\ D.L + 1.6\ L.L$

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

$= 909.99$ lb/ft

$= 0.909$ k/ft

$M_u = 0.909 \times (32^2) = 116.352 \times 12 = 1396.2$ k/ft

Step 2:-

Determine the effective width "be"

1. $16 \times h_f + b_w = 16 \times 6 + 4 = 110"$

2) c/c distance $= 10 \times 12 = 120"$

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

Selecting the lesser value; 96.

Step 3:-

check whether Rectangular or T-beam analysis is required.

Trial # 1;

let $a = h_f = 6"$

$$A_{ST} = \frac{M_u}{\phi \times f_y \times (d - a/2)} = \frac{1396.244}{0.90 \times 60 \times (25 - 6/2)}$$

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

Trial 2;-

$$a = \frac{A_{ST} \times f_y}{0.85 f_c \times b_e} = \frac{1.175 \times 60}{0.85 \times 4 \times 96}$$

$$= 0.22" < 6"$$

Thus rectangular beam analysis is required

$$A_{ST} = \frac{M_u}{\phi \times f_y \times (d - a/2)} = \frac{1396.244}{0.90 \times 60 \times (25 - \frac{0.2}{2})}$$

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

Trial 3;-

$$a = \frac{1.04 \times 60}{0.85 \times 4 \times 96} = 0.19"$$

$$A_{ST} = \frac{1396.244}{0.90 \times 60 \times (25 - \frac{0.19}{2})} = 1.04 \text{ in}^2$$ → same Area

Step 4:

check ρ_{max} & ρ_{min}

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

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

$$\rho_{max} = 0.018$$

$$* \ \rho_{min} = \frac{200}{fy} = \frac{200}{60000} = 0.003$$

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

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

$$0.003 < 0.002 < 0.018$$

As ρ is less than ρ_{min} Thus;

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

$$= 0.003 \times 14 \times 25$$

$$= 1.05 \ in^2$$

Step 05:

selection & No of bears

lets use #10 bar having area of 1.27 in^2

$$\text{No of bars} = \frac{A_{ST}}{A_b} = \frac{1.05}{1.27} \cong 2 \text{ bars.}$$

(15) ID. 6977.

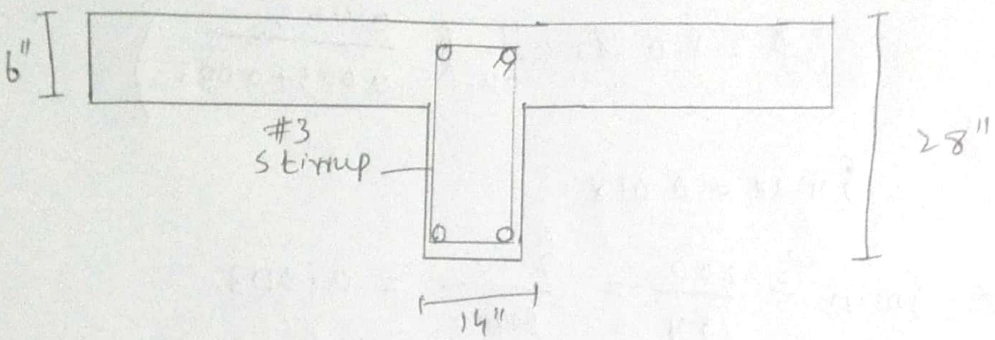
Step 6:-

check on minimum width

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

$= 7.5'' < 14''$

It is good in one layer.



Step 7:-

Design moment

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

* $A_{ST} = 1.27 \times 2 = 2.54$ inch^2
* $a = \frac{A_{ST} \times f_y}{0.85 f'_c b_e} = \frac{2.54 \times 60}{0.85 \times 4 \times 96} = 0.467''$

→ $M_d = 0.90 \times 60 \times 2.54 \times (25 - \frac{0.467}{2}) = 3396.97$

⇒ $3396.97 > 1396.244$ Design is ok)