Date:

Day: M T W T F S S

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Subject :- PRCD-1
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Q1 :- A rectangular beam that must carry - - - - - - - - final design.

Ans :- Given Data :-

L.L = 2.47 Kips/ft
D.L = 1.05 Kips/ft (without self wt).
L = 18'
b = 10" (Given) $f_c' = 4ksi$, $f_y = 60ksi$
h = 20 inches

Required :- A_{st} = ?

Sol :- Step no. 1 :- size and Dimension :-
As due to Architectural resons sizes can not be changed so b = 10", h = 20 inches

Step no. 2 :- Loads and bending moment :-

* Self weight :-

Self weight = Unit wt of concrete * volume of beam X-section

so,

$$\gamma \times r = (150\ lb/ft^3) * \left(\frac{10}{12} * \frac{20 * 18}{12}\right)$$

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= 3750 lb

$\Rightarrow \frac{3750}{1000} = 3.750$ kips

changing this point load to U.D.L.

So, $\frac{\text{Self wt}}{\text{span length}} = \frac{3.750}{18}$

$\Rightarrow$ Self wt = 0.2083 kips/ft

Therefore Total D.L will be

D.L = (1.05 + 0.2083)
D.L = 1.2583 kips/ft
and
L.L = 2.47 kips/ft

* $w_u = 1.2\,D.L + 1.6\,L.L = 1.2 * 1.2583 + 1.6 * 2.47$

$w_u = 5.462$ kips/ft.

* $M_u = \frac{w_u L^2}{8} = \frac{5.462 * 324}{8} = 221.211$

$M_u = 221.211$ K.ft * 12

$M_u = 2654.532$ Kips-inch.

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Step No 3 :- $M_n = A_s f_y (d - a/2)$

Let = $a = 0.2d$

$a = (0.2)(17.5)$ ∴ $d = h - 2.5' = 20 - 2.5 = 17.5''$

$a = 3.5''$

Putting value of "a" in

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

$$A_s = \frac{2654.532}{0.9 * 60 (17.5 - 3.5/2)} \Rightarrow \boxed{A_s = 3.121 \text{ in}^2}$$

Now calculate "a" from

$$a = \frac{A_s f_y}{0.85 f'_c b} = \frac{3.121 * 60}{0.85 * 4 * 10}$$

$$a = 5.5076 \text{ in}^2$$

Now again

$$A_s = \frac{M_u}{\phi f_y (d - a/2)} = \frac{2654.532}{0.9 * 60 \left(17.5 - \frac{5.5076}{2}\right)}$$

$$= 3.33 \text{ in}^2$$

for "a"

$$a = \frac{3.33 * 60}{0.85 * 4 * 10} = 5.88 \text{ in}^2$$

Again

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$$As = \frac{Mu}{\phi fy(d - a/2)} = \frac{2654.532}{0.9*60(17.5 - \frac{5.88}{2})}$$

$$= 3.376 in^2$$

$$a = \frac{3.376*60}{0.85*4*10} = 5.96 in^2$$

Again,

$$As = \frac{2654.332}{0.9*60(17.5 - \frac{5.96}{2})} = 3.385 in^2$$

$$a = \frac{3.385*60}{0.85*4*10} = 5.97 in^2$$

Again

$$As = \frac{2654.332}{0.9*60(17.5 - \frac{5.97}{2})} = 3.386 in^2$$

$$a = \frac{3.386*60}{0.85*4*10} = 5.975$$

Again,

$$As = \frac{2654.332}{0.9*60(17.5 - \frac{5.975}{2})}$$

$$= 3.387 in^2$$

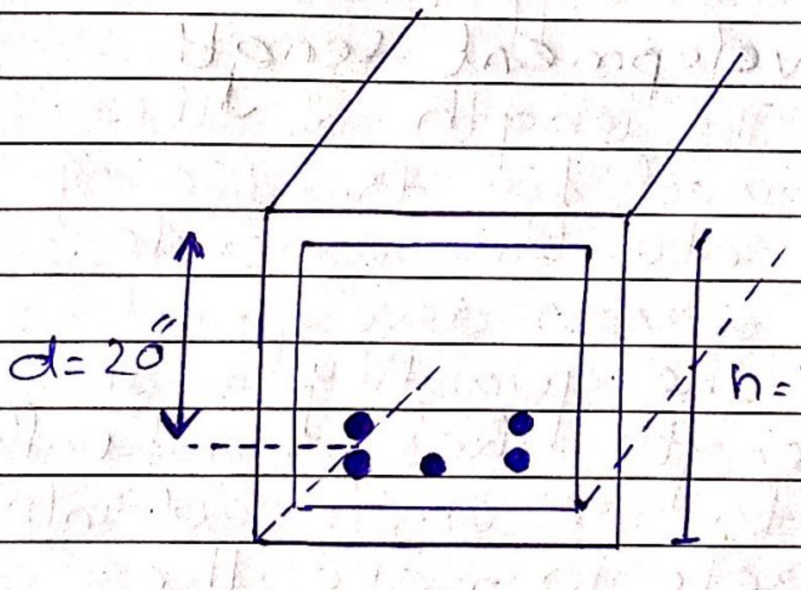
$$a = \frac{3.387 * 60}{0.85 * 4 * 10} = 5.977 in^2$$

again,

$$As = \frac{2654.332}{0.9 * 60\left(17.5 - \frac{5.977}{2}\right)} = 3.387 in^2$$

Using #8 bars so,

$$\text{No of bars} = \frac{3.387}{0.79} = 4.89 \approx 5 \text{ bars}$$



∴ The bars are provided in 2 layers.

Q2 Part a:-

a) Bond stress:-
The stress which is acting on the outer interface of steel to the surrounding concrete is called

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bond stress.

⇒ The stress help in keeping bond b/w reinforcement and concrete together. Bond stress resists any force that tries to pull out the rod from the concrete.

⇒ when we try to pull out the reinforcment bar from hardest concrete. Then this bond stress resist the bar to come out.

⇒ It is different grades of concrete has different bond stress

Development length:-

The length of the bar required for transfering the stress into the concrete.

⇒ In other words development length is the quantity of the rebar length that is actually required to be enclosed into the concrete to make the desired bond strength b/w two materials and further more to produced required stress in the steel at that area.

Why we providing development length

we providing development length b/c of

=> To develop a safe bond b/w the bar surface and concrete so that no failure due to slippage of bar occur during the ultimate loading condition.
=> Also the extra length is responsible for transfering the stress development in any section of the section.

Q2 (b) :-

Doubly Reinforced beam:-
Beams reinforcement with steel in compression zone and tension zone are called Doubly reinforced Beam.
Condition why Doubly reinforced Beam used.
We can used the doubly reinforced beam on that condition when the rastriction occure in the size of beam.
For example:-
If some one said that the depth of the beam should not be greater than 12" and the external

Load on beam is very much which can not resist a beam of singly reinforcement in that condition we used Doubly reinforcement beam.

Q2 C// :-

T - Beam	Rectangular Beam.
⇒ T-Beam having beam and slab composite section.	⇒ A rectangular Beam is one which is generally used as compression in top fiber and tension in bottom of that beam.
⇒ A T-Beam is more economical than Rectangular Beam.	⇒ Rectangular beam is less economical than T-Beam.
⇒ T-Beam are more often used for more heavy duty or Larger span such as bridges. These are almost always precast using pre-stress reinforcement.	⇒ Rectangular beam are more often used in office or commercial building. These can be cost in-site using standard reinforcement.
⇒ In case of T-Beam	In case of

slab are connected with one another and act as one member.	rectangular beam slab has been placed on the beam so there is no connection b/w slab & beam.

Q2 (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 the compression controlled section to increase cafly with decrease ductility this show to determine the reduction factor. For flexural strength of reinforcement concrete.

Q2 (e) :-

Designing Method :-

Two method are wordly used for the designing of concrete and different structure member :-

1) ASD method.
2) USD method.

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1) 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 for elastic limit.

⇒ In this method all load are taken as service load and no factor is applied to increase these services load.

2) USD method :-

Ultimate strength design method is also known as load factor method. For the structural subjected to large external load the ultimate strength is determine by the inelastic

⇒ USD method is best for designing different structure method b/c of the following reason.

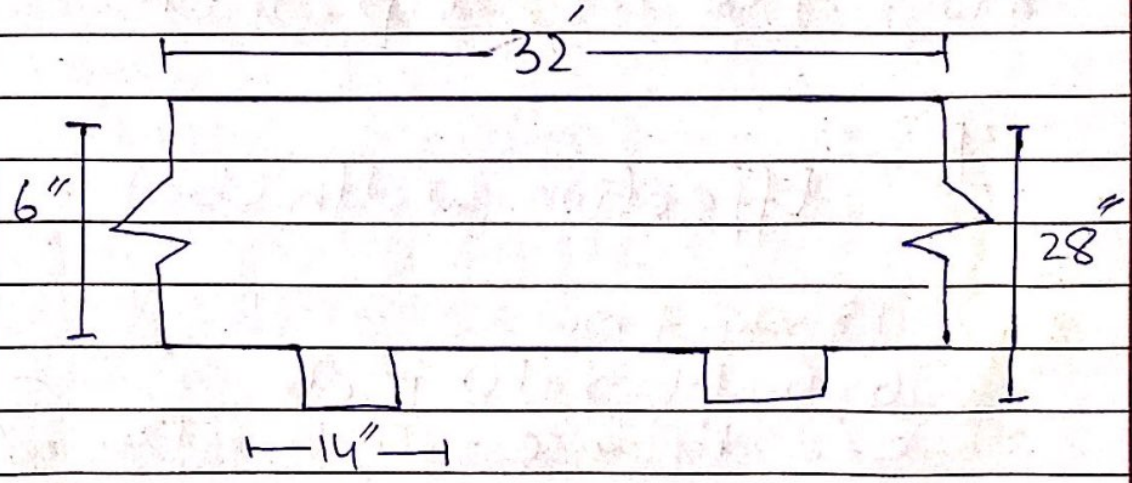
1) As the ultimate strength of the material is considered we will get much standard section for column and

beam compare to other method.

Q3 :-

Given data :-
c/c distance = 10 ft
Total span = L = 32 ft
Slab thickness = hf = 6 inch
width = bw = 14 inch
depth = h = 28 inch
D.L = 50 psf = 50 lb/ft^2
L.L = 225 psf = 225 lb/ft^2
f_c' = 4000 psi = 4 ks.
f_y = 60000 psi = 60 ks.

Sol :- Effective depth = h − 3
= 28 − 3
25 inch



Step 1 :- To find factored load
To find Beam self weight near feet.

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$\Rightarrow wt = b \times h \times \gamma_c$

$$wt = \frac{14}{12} \times \frac{28}{12} \times 150 \ lb/ft^2$$

$$wt = 408.33 \ lb/ft$$

As we know that total factored load.

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

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

$$w_u = 909.996 \ lb/ft$$

$$w_u = 0.91 \ kip/ft.$$

Step 2 :-

Ultimate factored moment.

$$M_u = \frac{w_u \times l^2}{8} = \frac{0.91 \times (32)^2}{8} \times 12$$

$$M_u = 1397.76 \ kip\text{-}inch.$$

Step 3 :-

Effective width (be)

★ 1) $18 \times h_f + b_w$

$16 \times 6 + 14 \Rightarrow 110$ inch

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

3) $\frac{span}{4} = \frac{32}{4} = 8' = 8 \times 12 = 96''$

Then the $\boxed{be = 96 \text{ inch}}$

Step 4 :- To check which type of analysis is required

Trial :- 1 :- Let suppose $a = h_f = 6''$

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

$$= \frac{1397.76}{0.9 \times 60 \times (25 - 6/2)}$$

$A_{st} = 1.177 \text{ in}^2$

Trial :- 2 :-

$$a = \frac{A_{st} \times f_y}{0.85 \times f_c' \times b_e} = \frac{1.177 \times 60}{0.85 \times 4 \times 96}$$

$a = 0.216'' < h_f = 6''$

so design is rectangular beam

$$A_{st} = \frac{1397.76}{0.9 \times 60 \times (25 - \frac{0.216}{2})}$$

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

Trial :- 3 :-

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

$$A_{st} = \frac{1397.76}{0.9 \times 60 \times (25 - 0.191/2)}$$

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

Step: 5 :-

To find ρ_{max} and ρ_{min}

As we know that.

$$\rho_{max} = 0.85 \times \beta \times \frac{F_c'}{F_y} \times \left(\frac{\varepsilon_u}{\varepsilon_u + \varepsilon_y} \right)$$

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

$$\rho_{max} = 0.0181$$

$$\rho_{min} = \frac{200}{f_y} = \frac{200}{60,000} = 0.0033$$

As we know that

$$\rho = \frac{A_{st}}{b_e \times d} = \frac{1.04}{14 \times 25}$$

$$\rho = 0.00297$$

So $\rho_{min} < \rho < \rho_{max}$ → not ok

b/c $\rho_{min} < \rho$ not satisfied by

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

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

$= 0.0033 \times 14 \times 25$

$A_{st} = 1.155 \ in^2$

Step: 6

No of Bar and Bar section. Let #8 bar use

$\text{No of bar} = \frac{A_{st}}{A_s} = \frac{1.155}{0.785}$ ∴ Area of #8 is 0.785

No. of bar $= 1.47 \cong 2$

we take 2 #8 bar As main bar.

Step #7 :- Minimum width.

$b_{min} = 2 \times \text{L.C} + 2 \times \text{Stirup} + 2 \times \text{Main bar} + 1 \times \text{spacing}$

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

$b_{min} = 6.75'' < 14''$

So the main bar are good in one Layer.

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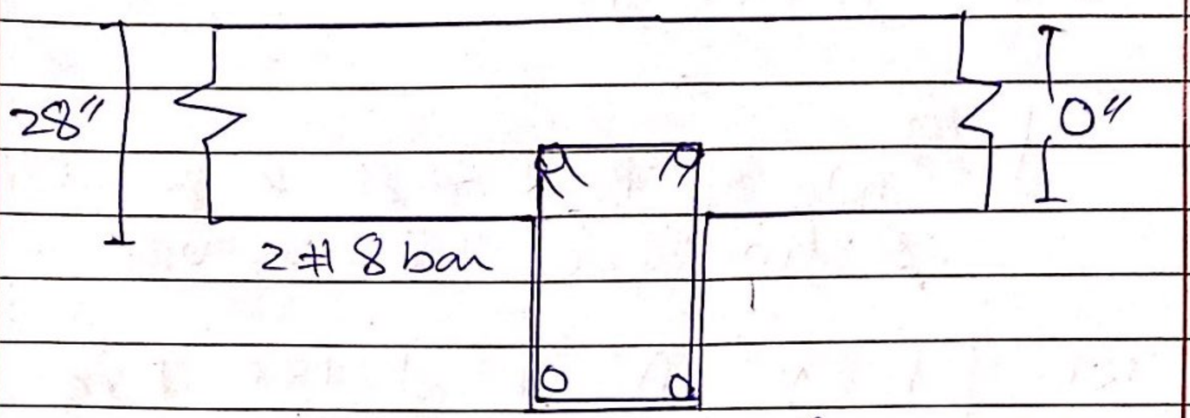

$A_{st} = 0.785 \times 2$

$= 1.57\ in^2$

$a = \dfrac{A_{st} \times f_y}{0.85 \times f'_c \times b_e}$

$a = 0.289\ in$

Step # 8

Design moment

As we know that

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

$= 0.9 \times 60 \times 1.57 \times \left(25 = \frac{0.289}{2}\right)$

$M_d = 2160.24$

$M_d > M_U$

Design is OK!.