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SECTION B

SEMESTER 6th

TECHNOLOGY Civil Engg

Paper PRCD 1

IQRA NATIONAL UNIVERSITY

PESHAWAR HAYATABAD

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TOTAL PAGE = 1,... 20

Q:1

Given Data:

Service Live load = 2.47 Kips/ft

Dead load = 1.05 Kips/ft

Beam Span = 18 ft

f_y = 60,000 psi

f_c' = 4000 psi

Required Data:

Steel Area = ?

Solution:

Beam Cross-section 10" × 20" (Given)

Effective Depth d = t - 2.5"

= 20" - 2.5"

d = 17.5"

Beam Self weight

$$\Rightarrow \frac{10 \times 20}{12 \times 12} \times 0.15 \Rightarrow 0.020 \text{ Kip/ft}$$

P.T.O

Factored Load:

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

$\Rightarrow 1.2(1.05 + 0.02) + 1.6(2.47)$

$W_u = 5.236\ KP/ft$

Ultimate factored Load:

$M_u = \dfrac{W_u l^2}{8}$

$= \dfrac{5.236 \times (18)^2}{8} \times 12$

$M_u = 212.658 \times 12$

$M_u = 2544.696\ \text{kip in}$

Designing:

As by trial and error Method.

Trial#01 let $a = 0.2 \times t$

P.T.O

$a = 0.2 \times 20 = \boxed{4'' = a}$

$$As = \frac{Mu}{\phi f_y \left(d - \frac{a}{2}\right)}$$

$$As = \frac{2544.696}{0.9 \times 60 \,(17.5 - 4/2)}$$

$$\boxed{As = 3.04 \text{ in}^2}$$

<u>Trial 02</u>:

$$a = \frac{As\, f_y}{0.85 \times f'_c \times b} \Rightarrow \frac{3.04 \times 60}{0.85 \times 4 \times 10''}$$

$$\boxed{a = 5.364}$$

$$As = \frac{2544.696}{0.9 \times 60 \times \left(17.5 - \frac{5.364}{2}\right)}$$

$$\boxed{As = 3.180 \text{ in}^2}$$

<u>Trial 03:</u>

$$a = \frac{3.18 \times 60}{0.85 \times 4 \times 10}$$

$$\boxed{a = 5.611}$$

$$As = \frac{2544.696}{0.90 \times 60 \times \left(17.5 - \frac{5.611}{2}\right)}$$

$$\boxed{As = 3.206}$$

Trial 04 :

$$a = \frac{3.206 \times 60}{0.85 \times 4 \times 10}$$

$$\boxed{a = 5.659}$$

$$As = \frac{2544.696}{0.90 \times 60 \times \left(17.5 - \frac{5.65}{2}\right)}$$

$$\boxed{As = 3.21}$$

So $\boxed{As = 3.21 \ in^2}$

Selection of Bar Size:

Using # 8 bar

no of Bar = As/Ab

$$= \frac{3.21}{0.7855} \Rightarrow \boxed{4.086}$$

P.T.O

Let take 5# 8 bars

Reinforcement Ratio Check ;

$$\rho_{provided} = \frac{A_s}{b \times d} = \frac{3.21}{10 \times 17.5}$$

$$\boxed{\rho_{provided} = 0.018}$$

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

$$\boxed{\rho_{min} = 0.00033}$$

$$\rho_{max} = \frac{0.85 \times \beta \times f_c'}{f_y} \left(\frac{\varepsilon_c}{\varepsilon_c + \varepsilon_{st}} \right)$$

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

$$\boxed{\rho_{max} = 0.018}$$

$$\rho_{min} \leq \rho_{provided} \leq \rho_{max}$$

P.T.O

Design Moment:

$\phi M_n = \phi A_s f_y \left(d - a/2\right)$

$\phi M_n = 0.9 \times 3.927 \times 60 \times \left(17.5 - \frac{5.65}{2}\right)$

$\boxed{\phi M_n = 3111.95 \text{ Kip in}}$

As $\phi M_n = 3111.95 > 2544.696$

and Capacity > Demand

So it is OK.

Check for Maximum and Minimum Reinforcement

Min Reinforcement $= \frac{0.85 \times b \times d}{f_y}$

$\Rightarrow \frac{0.85 \times 10 \times 17.5}{60}$

Minimum Reinforcement $= 2.47 \text{ in}^2$

Maximum Reinforcement:

$A_{st\,max} = 0.4 \times 10 \times 20 \Rightarrow \boxed{A_{st\,max} = 80 \text{ in}^2}$

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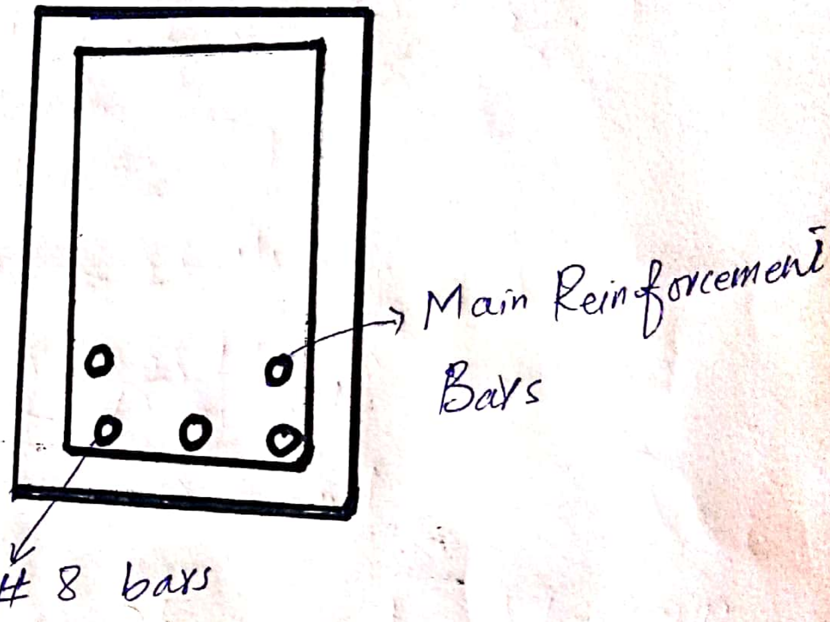
$Ast_{max} > As > As_{min}$



P.T.O For Question No 02

QN.O 02 is on page 08

Q - 02 (a)

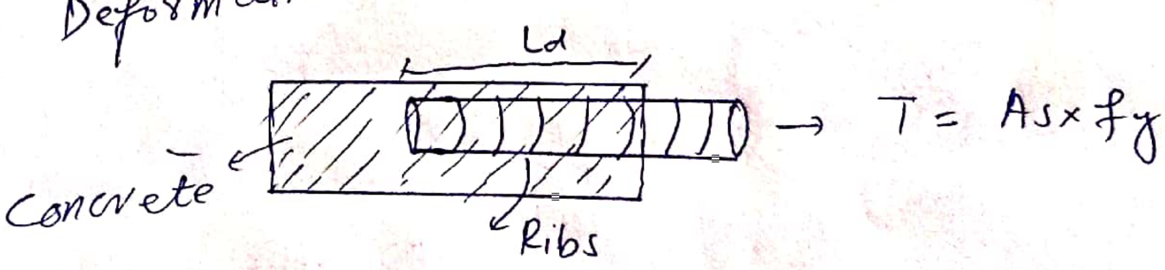
Bond Stress: The pulling out of steel bar from concrete is resisted by gripping action of concrete is known as Bond and the resulting stress is called Bond stress.

Resistance offered to slipping of bars is due to three reasons.

i) chemical adhesion b/w two materials

ii) Friction due to Natural roughness of bars.

iii) Due to closely spaced - rib-shaped Deformation mode on the bar surface



Development Length:

Development Length of Deform Bars

"The necessary length b/w the point of maximum stress in a bar and the end of bar"

For # 11 or smaller bars the development length must not be less then the value obtained from the following three equations.

Development Length Require For Tension Bars:

i - $l_d = \dfrac{0.04 \times A_b \times f_y}{\sqrt{f'_c}}$ ii) $l_d = 0.0004 \times d_b \times f_y$

iii) - $l_d = 12''$

Select the minimum value

For # 14 Bars $l_d = \dfrac{0.085 \times f_y}{\sqrt{f'_c}}$

For # 18 Bars $l_d = \dfrac{0.11 \times f_y}{\sqrt{f'_c}}$

Development Length for Compression Bars:

$L_{dc} = \dfrac{0.02 \times d_b \times f_y}{f'_c} \geq 0.0003\, d_b \times f_y$

Note: Development Length Required for compression bars will be less than required for tensile steel because No tensile cracks are present to encourage slipping.

2 - (b) Conditions :-

Conditions in which doubly reinforced beam can be used are listed below.

(i) When the capacity comes than that of the demand i.e. When we are designing beam and capacity comes less than the demand then we use doubly reinforced beam

Capacity < Demand

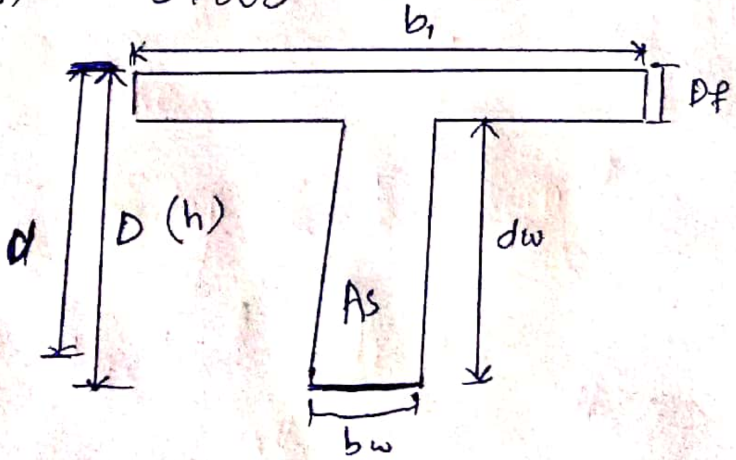
(ii) Restricted Area :-

Whenever there is condition that the beam area is restricted and cannot be changed, then we use doubly reinforced beam.

2- (c) Difference b/w T and Rectangular Beam Analysis:-

In case of T beam slab and beams are connected with one another and acts as a one member.

While in case of Rectangular Beam, slab has been placed on the beam so there is no connection between slab and beam.



2 - (d) :- Effect of strength Reduction Fectors:-

i) Due to strength reduction factors, it is possible to cope with the variations in dimensions i.e structure remain safe.

ii) Strength reduction factors helps to absorb the effects due to change in material strength.

iii) Possible inaccuracies in the strength Equation.

iv) Ensure good level of safety of reinforced concrete structures.

P.T.O

2-(e)

Design Method:-

Design Method are procedure, techniques and add for designing. They offer a number of different kids of activities that a designer might use with an overall design process

Some of design method are given as.

Simple Design:-

This is most commonly used design method.

It is used where end connections of the member in a structure do not develop restrain moment that would effect the structure

Semi rigid Design Method:-

Permits a reduction in maximum bending moment in beam suitably connected to their support as compared to simple design.

In cases where this moment of designed is employed, it is ensured that assumed partial fixity is available and calculation based on general or particular experimental evidence shall be made to show that stress is any part of structure are not in excess.

P.T.O For Question No (03)

Q.NO 03 start on page (15)

Question N.O (03)

Given Data.

c/c distance = 10'

span = 32'

slab thickness = 6"

Web depth = 14"

Total Depth (h) = 28"

Effective Depth = 28" − 3" = 25"

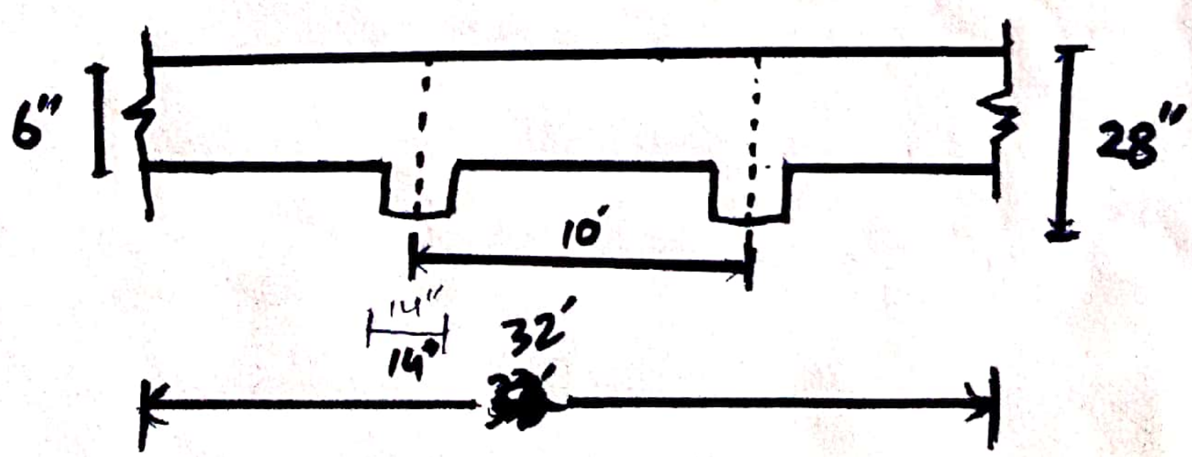
D.L = 50 lb/ft²

S.S = 225 lb/ft²

f_y = 60,000 psi

f'_c = 4000 psi

Solution:-



Step#01

$$Mu = \frac{Wu \times l^2}{8}$$

1) Beam self weight per feet

$Wt =$ ~~bt~~ $b \times t \times \gamma_c$

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

Total factored load:-

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

$= 909.99\ lb/ft = \boxed{0.909\ kip/ft}$

step# 02

Moment:-

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

$= 1396.23$ kip-inch.

Effective Breadth:-

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

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

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

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

Step# 03 (Rectangular or T-Beam):-

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 # 2

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

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

$$= 0.2'' < 6''$$

So Rectangular Beam Design.

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

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

Trial # 03

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

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

Step # 04 Check ρ_{max} and ρ_{min}

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

$$\rho_{max} = 0.018$$

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

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

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

$$0.003 < 0.002 < 0.018$$

As ρ is less than ρ_{min}

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

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

P.T.O

Step# 05: No. and Selection of Bar.

let use #8 bar, then

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

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

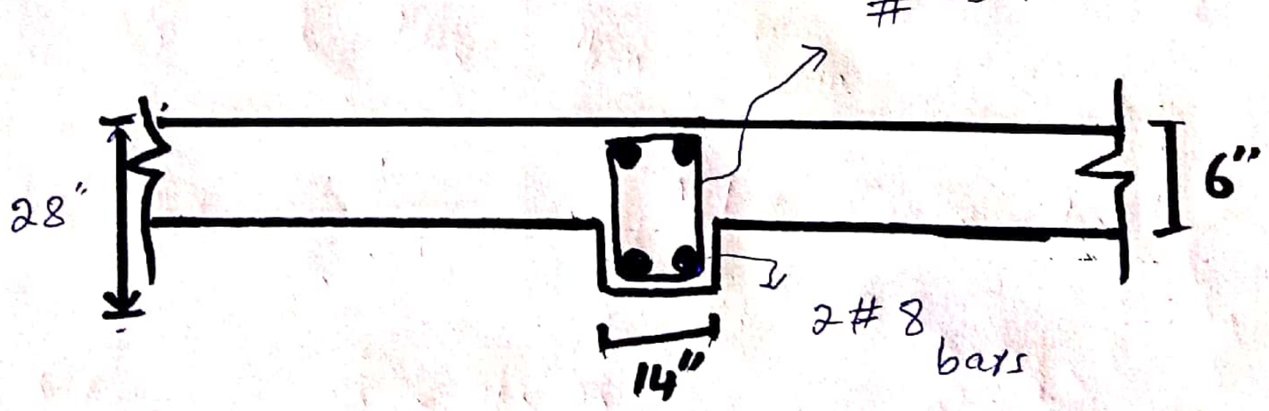
So we use 2 #8 bars.

Step # 06: Minimum Width:

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

$= 6.75'' < 14''$

So good in one layer.



Step # 7 Design Moment.

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

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

$= 0.785 \times 2$

$= 1.57\ in^2$

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

$\Rightarrow$ $M_d = 0.90 \times 60 \times 1.57 \times \left(25 - \frac{0.2}{2}\right)$

$= 2111.027$ kip-inch

As, $2111.027 > 1396.23$

So Design is <u>OK</u>.

END PAPER PRCD 1