M☐T☐W☐T☐F☐S H/W☐-C/W☐ Dated:........../........../20..........

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Section	"A"
Semester	4th
Subject	PRCD-1
Assignment	01
Submitted To	Engr Fawad.

Best Quality

Q#01 Explain In delail type of stirrup with Figure and also explain ACI code for shear design

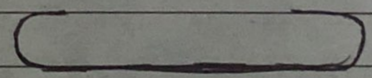
Stirrup:-

Stirrup are close loop bars ties at rectangular intervel in beam reinforcement to hold the bar in position

Types of stirrup:-

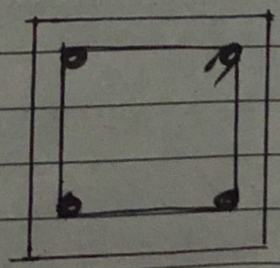
1) Single legged stirrup:-

The single legged stirrup have rarely been Used becuse they are mostly Used when binding only two rods



2) Two legged Stirrup:-

its is mostly common and widely used stirrup. Minimum 4 bars are required for providing This stirrup



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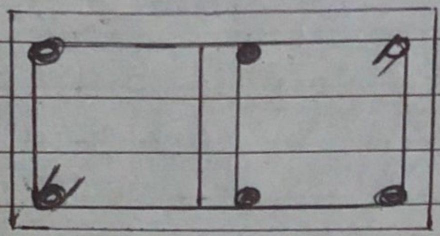
3) ~~Six~~ Four legged stirrup:-

These stirrup are Used in case of web reinforcement



4) Six legged stirrup:-

ACI code for shear design of a beam

According to ACI-318 following are the formulas Used for the shear design of a beam

1) Critical Section:-

Critical section occure at 45° and is at distance (d) from the face of support ~~with~~ which is equal to effective depth

2) Shear strength Capacity of Concrete

$$V_c = 2 \times \sqrt{f_c'} \times b_w \times d$$

3) Minimum Web Reinforcement:-

if $V_u \leq \phi V_c$, Then Theoretically no web reinforcement is required How ACI code required provision of atleast a minimum area of web reinforcement equal to

$\phi = 0.75 \rightarrow$ for shear design

(:- V_u = Total factored shear applied at a given section)

=) For Minimum Reinforcement Area:-

$$A_{v\,min} = 0.75 \times \frac{\sqrt{f'_c} \times b_w \times S}{f_y}$$

or

$$\frac{50 \times b_w \times S}{f_y}$$

By interchanging the above formula we can obtain the formula for max spacing

$$S_{max} = \frac{A_v \times f_y}{0.75 \times \sqrt{f'_c} \times b_w} \quad \text{or} \quad \frac{A_v \times f_y}{50 \times b_w}$$

4) No web reinforcment is reqired if

$$V_u < \frac{1}{2} \phi V_c$$

=) Between critical section "V_u" and "ϕV_c" spacing b/w web

$$S = \frac{\phi \times Av \times fy \times d}{Vu - \phi Vc}$$

5) if $Vs \leq 4 \times \sqrt{f'c} \times bw \times d$:-

Then max spacing for Stirrup will be the smallest of the following

1) - 24"
2) - d/2
3) - $S_{max} = \frac{Av \times Fy}{0.75 \times \sqrt{f'c} \times bw}$
4) - $S_{max} = \frac{Av \times fy}{50 \times bw}$

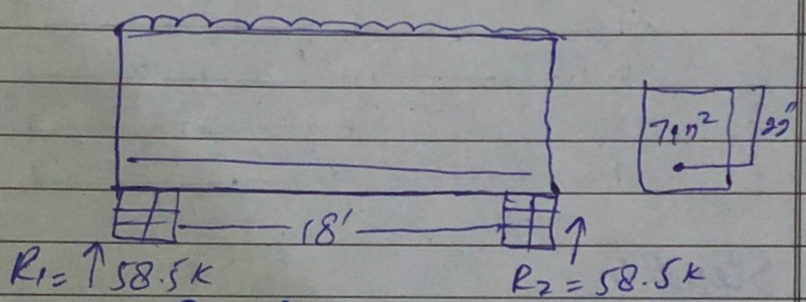
=> if $Vs > 4 \times \sqrt{fc'} \times bw \times d$
max. spacing will be halved

=> if $Vs > 8 \times \sqrt{fc'} \times bw \times d$
The either increase cross sectional diamension or increase f'c

Q#2 Given Data

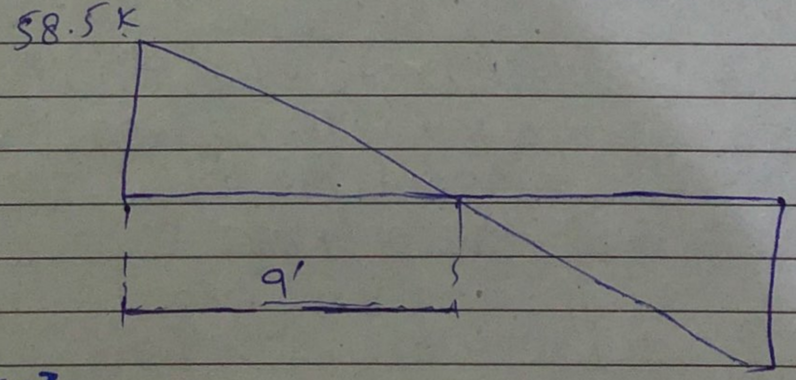
Breadth of web of beam = 14"
Effective depth = 22"
Given load = 6.5 K/ft
Steel Area = 7.
f'_c = 4 ksi
f_y = 60 ksi

Sol



Step # 01 Reaction on support and shear force diagram

The Required Shear force Diagram will be

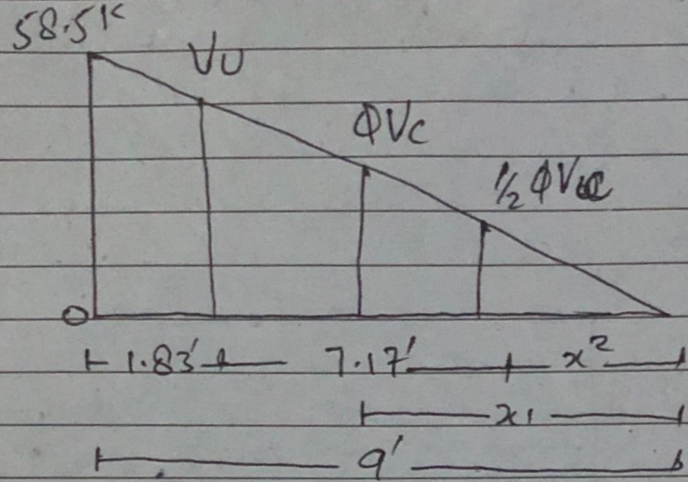


Step # 03

Finding the value of critical shear "Vu" and its location

We know that the critical shear is located is a distance d from the face of support

⇒ we will find the value of critical shear at distance d by use of similar triangle



Step#4

Finding the value of ϕV_c, $\frac{1}{2}\phi V_c$ and distance

By formula

$$\phi V_c = \phi \times 2 \times \sqrt{f_c} \times b_w \times d$$
$$= 0.75 \times 2 \times \sqrt{4000} \times 14 \times 22$$
$$= 29219 \text{ lbs}$$
$$= 29.21 \text{ Kips}$$

$$x_1 = 4.49'$$

$$\frac{1}{2}\phi V_c = 14.60 \text{ Kips}$$

$$x_2 = 2.24'$$

Step # 05

Finding the value of ϕV_s

$\phi V_s = 17.4$ Kips

Step # 06

Check on section ~~Aqu~~ Adequency

$= 116.87$ Kips

As $\phi \times 8 \times \sqrt{f_c'} = b_w \times d > \phi V_s$
So section is adequate.

Step # 07

Check max spacing for stirrup

By formula

$\phi \times 4 \times \sqrt{f_c'} \times b_w \times d$

$= 0.75 \times 4 \times \sqrt{4000} \times 14 \times 22 = 58438$ lb
$= 58.43$ Kips

As $\phi \times 4 \times \sqrt{f_c'} \times b_w \times d > \phi V$
So max will be selected from the following four condition

from the above 4 condition least value of spacing for #3 2 legged stirrup will be selected as

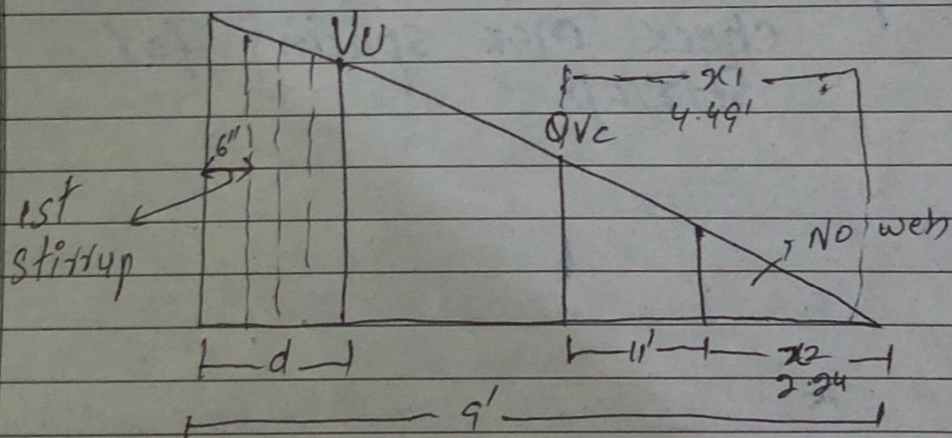
$S_{max} = 11''$

Step #8

Stirrup spacing from 1st critical section will be

$S = 12''$

Step #09 Final sketch

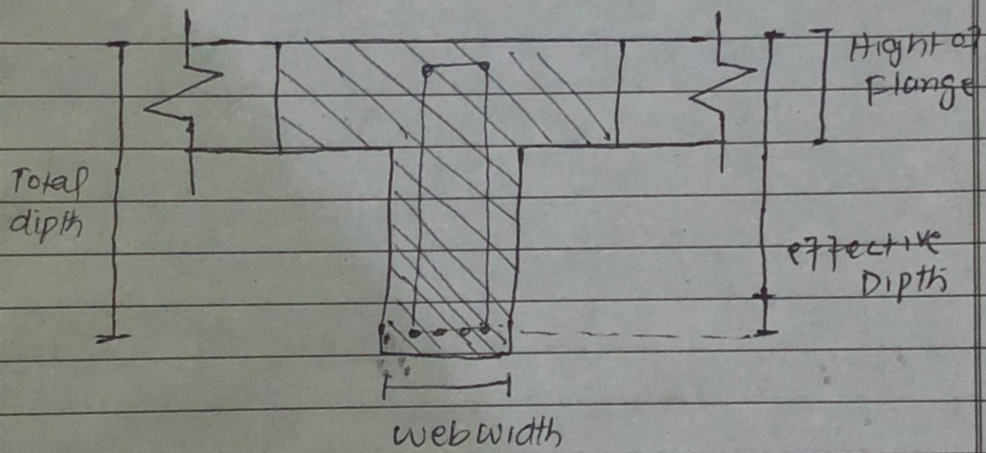


Question 3

Define both the T-Beam and L-Beam with the help of diagram. Also explain flexiral analysis of T-Beam.

T-Beam:-

In most of the reinforoced concrete stucture, concrete slab are cost monolitically with the slab so, in this case the beam that act as an intermediate beam are called T-Beam



⇒ Because of theis T-shape these beams are called T-Beams.

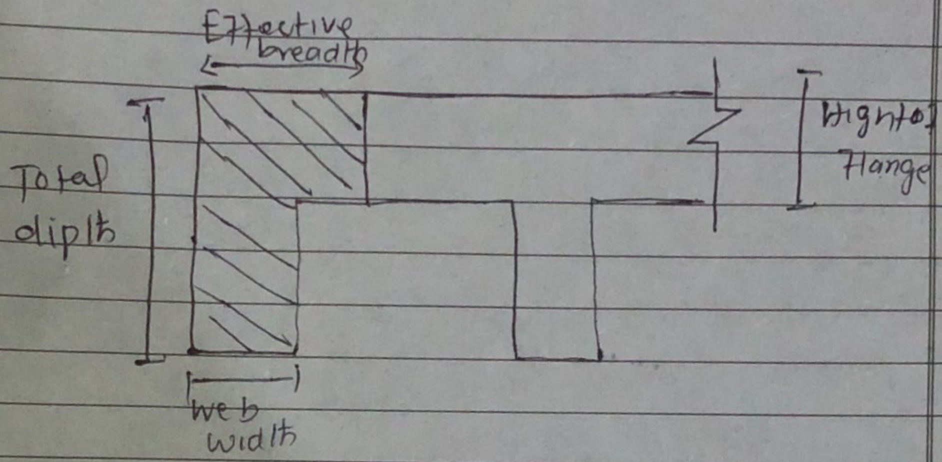
⇒ It is provided at the center of the slab to resist the load.

⇒ The upper most area of beam attracted to the slab is called Flange.

⇒ The bottom rectangular portion of the beam is called web of the beam.

L-Beam:-

L shaped stucture that is in contect with the slab and present at the corner of floor is called L-beam.



⇒ L-Beam is also called Edge beam
⇒ it is always provided at the corner of slab
⇒ L-beam are typical floor beam b/c of their reduced overall stuctural depth, the beam are in ~~presen~~ prestreed or reinforced concrete

Functional analysis of T-Beam:-

Flexural Analysis of T-beam consist of the following steps.

(1) For finding the ultimate factord moment we use the following formula.

$$m_u = \frac{W_u \times L^2}{8}$$

(W_u = Total Factored load

L_{ts} = clear transverse span

2- Effective width (bw) for T-beam is calculated as

1- 16 (hf) + bw
2- c/c distance
3- span/4
4- $\frac{CTS}{2}$ + bw

(hf = hight of flange)
(CTS = clear transverse span)

we have to be select the least value from above formula.
- if c/c distince is given then there is no need of $\frac{CTS}{2}$ + bw

3- Cheaking ~~weather~~ wheather Rectangular or T-beam analysis is given
i- If a > hf → special analysis is Required
ii- If a < hf → Rectangular beam analysis is Required

where
a = Depth of compression block
hf = hight of flange

4- For Finding Area of steel we have to use.

$$Ast = \frac{Mu}{\phi \times Fy \times (d - a/2)}$$

where $a = \frac{Ast \times Fy}{0.85 \times f'_c \times bw}$

∴ (ϕ = strength Reducing factor
d = effective depth
a = compression block depth
bw = web width of beam)

5- For cheaking the range of Rainforcement Ratio:

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

$$f_{min} = \frac{200}{fy}$$

$$f = \frac{Ast}{b \times d}$$

6- Formula for finding No of bar Requied is.

$$\text{No of bars} = \frac{\text{Area of steel}}{\text{Area of single bar}}$$

7- For cheaking minimum width for bars accmudation.

$$b_{min} = 2(\text{clear cover}) + 2\left(\text{dia of stirrup}\right) + \text{No of bar}\left(\text{dia of bar}\right)$$
$$+ \text{spacing b/w bar}\left(\text{dia of bar}\right)$$

8- Design Moment is given by

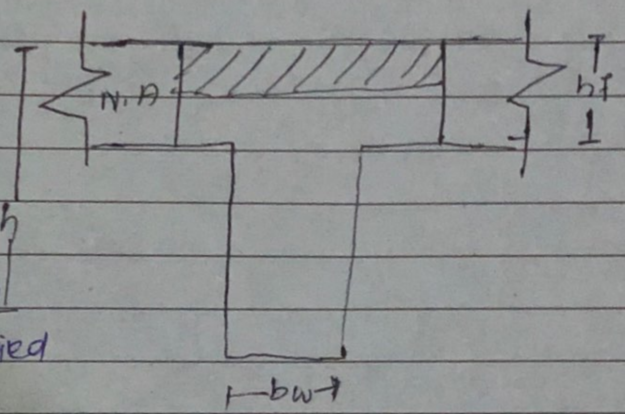
$$Md = \phi \times fy \times Ast \times (d - a/2) \rightarrow \text{if } a < hf$$

$$Md = \phi \times (As \times fy \times (d - hf/2) + (As - Ast) + fy \times$$
$$(d - a/2) \rightarrow \text{if } a > hf$$

Question – 04

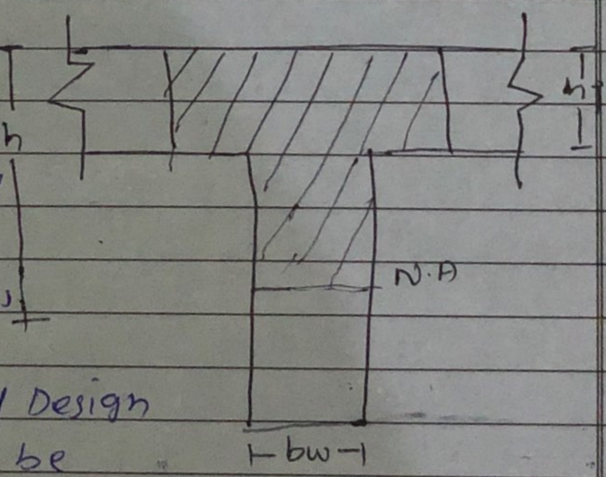
What is the diffrence b/w CASE-I and CASE-2 in the digsn of T-beam?

CASE-1:



From fig
$a < h_f$
So in this case, Rectangular Beam Analysis is reqcied
So,
The Design Moment formula will be

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



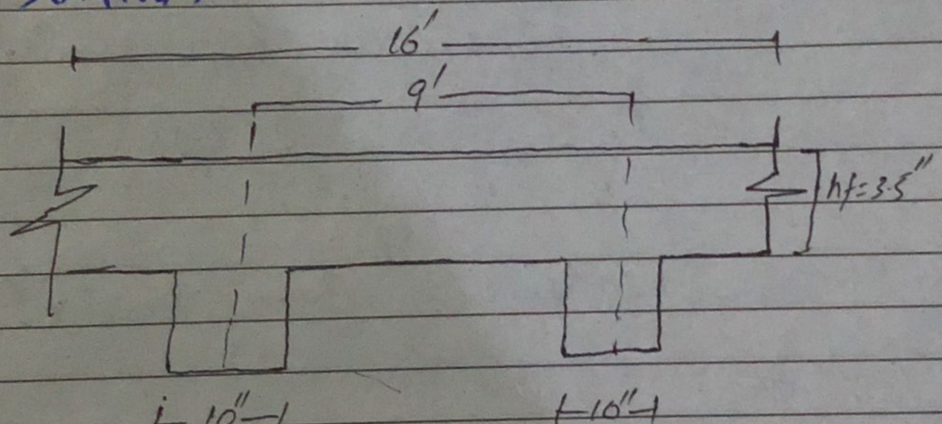
From The Figure
$a > h_f$
So in this, special beam analysis i.e T-beam Analysis is required
So the required Design moment will be

$$M_d = \phi \times \left[A_s \times f_y \times \left(d - \frac{h_f}{2}\right) + (A_s - A_{st}) + f_y \times \left(d - a/2\right) \right.$$

Q:5 Given Data:-

Height of flange (h_f) = 3.5"
c/c distance = 9'
length/span of the Beam = 16'
web width (b_w) = 10"
Effective depth (d) = 18"
Height (H) = 23"
Total factored moment (M_U)
= 5800 kip-inch
f_c' = 3 ksi
f_y = 60 ksi

Solution:-



Step #01

Calculate the effective width (b_e) for T beam

1) $16(h_f) + b_w = 16(3.5) + 10 = 66"$
2) c/c distance $= 9 \times 12 = 108"$
3) Span/4 $= \frac{16}{4} \times 12 = 48"$

Select the least value
$b_e = 48"$

Step#02

Check whether Ractangular or T-beam Analysis are Required

Trail #01

let $a = h_f = 3.5''$

$$A_{st} = \frac{M_U}{\phi \times f_y \times (d - a/2)} = \frac{5800}{0.90 \times 60 \times (18 - 3.5/2)}$$

$$A_{st} = 6.61\ in^2$$

Trail #02

$$a = \frac{A_{st} \times f_y}{0.85 \times f_c' \times b_e} = \frac{6.61 \times 60}{0.85 \times 3 \times 48}$$

$$a = 3.2'' < 3.55''$$

$$A_{st} = 6.55\ in^2$$

So Rectangular Beam Required

Trail #03

$$a = 3.21''$$

$$A_{st} = 6.55\ in^2$$

So Area of steal is $6.55\ in^2$

Step #03

Check ρ_{max} and ρ_{min}

$$\Rightarrow \rho_{max} = 0.85 \times \beta \times \frac{f_c'}{f_y} \left(\frac{\varepsilon_u}{\varepsilon_u + \varepsilon_t}\right)$$

$$= 0.85 \times 0.85 \times \frac{3}{60}\left(\frac{0.003}{0.003+0.005}\right) = 0.013$$

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

$$\Rightarrow \rho = \frac{Ast}{b \times d} = \frac{6.55}{10 \times 18} = 0.036$$

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

$$0.003 < 0.036 < 0.013$$

As the value of ρ_{max} is less Then ρ so we have design the doubly Rainforcement Beam

$\Rightarrow$ first we have to find the are of steel against ρ_{max}

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

$$Ast = 0.013 \times (10 \times 18)$$

$$Ast = 2.34\, in^2$$

Step #04 Finding the value of Mu_2

By formula

$$Mu_2 = \phi \times Ast \times fy \times (d - a/2)$$

$$a = \frac{Ast \times fy}{0.85 \times f_c' \times b} = \frac{2.43 \times 60}{0.85 \times 3 \times 10}$$

$$a = 5.72''$$

$$\Rightarrow Mu_2 = 0.90 \times 2.43 \times 60 \times (18 - 5.72/2)$$

$$Mu_2 = 1986.67 \text{ kip-in}$$

As $Mu_2 < Mu$

$$1986.67 < 5800$$

So we have design a beam in such away that it can resist more bending moment then the applied external moment

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Step # 05

Finding Difference in Moment and Area of steel:-

$Mu_1 = Mu - Mu_2$

$= 5800 - 1986.67$

$Mu_1 = 3813.33$ kip-inch

By formula,

$A_{st}' = \frac{Mu}{\phi \times fy \times (d-d')} = \frac{3813.33}{0.90 \times 60 \times (18-2.5)}$

$A_{st}' = 4.56\ in^2$

Step # 06

Finding Total Steel Area

$A_s = A_{st} + A_{st}'$

$= 2.43 + 4.56$

$A_s = 6.99\ in^2$

Step # 07

Selection of Bars

In Tension Zone:-

let we use #8 bar

dia = (8/8) = 1" Area = 0.785 in^2

By formula:-

$$\text{No of bar} = \frac{\text{Area of steel}}{\text{Area of single bar}}$$

$$= \frac{6.99}{0.785} = 8.9 \simeq 9$$

So 9 #8 bars

In Compression Zone:-

let we Use #7 bar.

dia = (7/8)" Area = 0.601 in^2

By formula

$$\text{No of bar} = \frac{\text{Area of steel}}{\text{Area of single bars}}$$

$$= \frac{4.56}{0.601} = 7.5$$

$$\cong 8$$

So 8 #7 bars

Step # 8

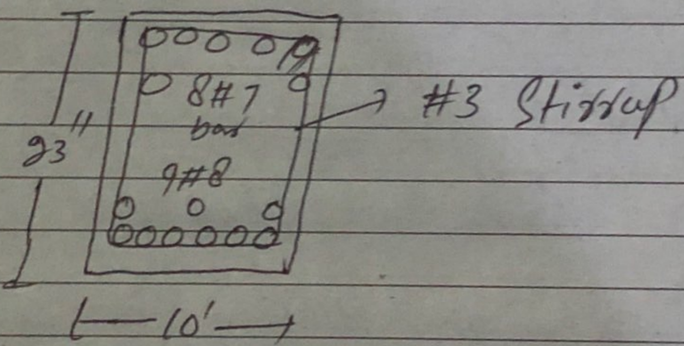
Minimum width for Accomodation of bars

$b_{min} = (2 \times 1.5) + (2 \times 3/8) + 9(8/8) + 8(8/8)$

$= 20.75''$

As $20.75'' > 10''$

So the bars will be placed in multiple layer



Effective depth $(d) = 23 - 1.5 + 3/8 + 8/8 + 1/2 (8/8)$

$= 19.6''$

Effective cover $(d') = 1.5 + 3/8 + 7/8 + 1/2 (7/8)$

$= 3.18$

Step # 9

Finding The Design Moment

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

$$a = \frac{(A_s - A_{st}') \times f_y}{0.85 \times f_c' \times b} = \frac{9 \times 0.785 - 8 \times 0.601}{0.85 \times 3 \times 10}$$

$$a = 5.31''$$

$$\Rightarrow Md = 0.90[(8 \times 0.601) \times 60 \times (19.6 - 3.18) + (9 \times 0.785 - 8 \times 0.601) \times 60 \times (19.6 - \frac{5.31}{2})]$$

$$\boxed{Md = 6328.38}$$

As 6328.38 > 5800

So The Design is ok