Name:- Syeed Najeeb ullah Bacha

ID#:- 7855

Section :- B

Semester :- 6th

Program :- B.Sc Civil Engneering

Assignment:- Plain & Reinforced Concrete Design-I

Submitted to :- Eng Fawad Khan.

QuestionNo-01

Explain in detail types of stirrups with figures and also explain ACI codes for shear design

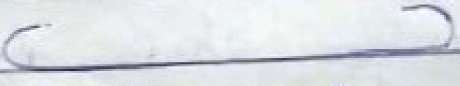
stirrup :-

stirrups are closed loop bars tied at regular intervals in beam reinforcement to hold the bars in position.

Types of stirrups:-

1) single legged stirrup:-

The single leg stirrups have rarely been used because they are mostly used when binding only two rods.



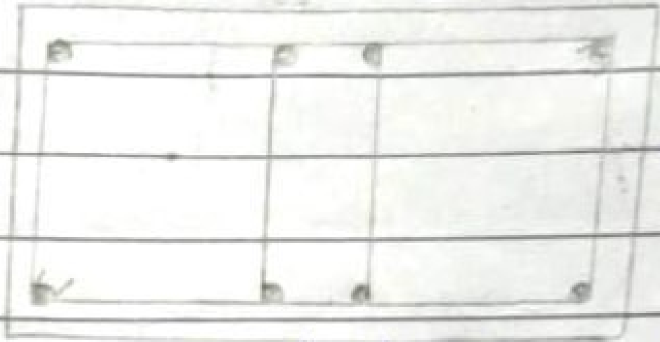
2:- Two legged stirrups:-

It is most commonly and widly used stirrup. Minimum 4 bars are required for providing this stirrup.

2legged stirrup

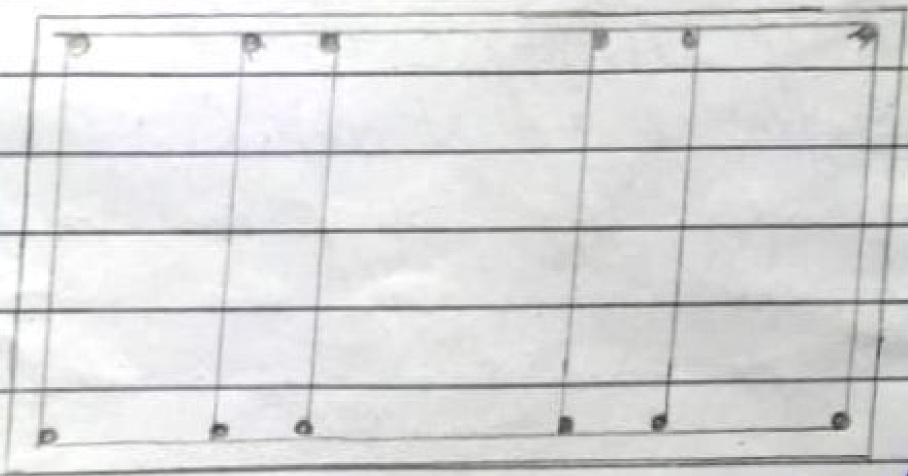
3. For Legged Stirrup:-

These stirrups are used in case of web reinforcement.



4- Legged stirrup

4:- Six Legged stirrup:- page 02



ACI codes for shear design of a Beam.

According to ACI - 318, following are formulas used for the shear design of a beam.

1. Critical Section.-

critical section occurs at us and equal to effective depth

2:- Shear strength capacity of

(3)

Conerete is..

$$V_c = 2 \times \sqrt{F_c} \times b_w \times d$$

3.- Minimum web Reinforcement:-

If $V_u < \phi V_c$, then theoritically no web reinforcement is required. However ACI code require provision of atleast a minimum area of web reinforcement equal to $\phi = 0.75$ ⟶ for shear design.

($\because V_u$ = Total factored shear applied at a given section

⇒ For minimum reinforcement area

$$A_{v\,min} = \frac{0.75 \times \sqrt{F_c} \times b_w \times S}{f_y} \text{ or } \frac{50 \times b_w \times S}{F_y} \rightarrow \text{[Higher value is selected]}$$

By interchanging the above formulas we can obtain the formula maximum spacing

$$S_{max} = \frac{A_v \times F_y}{0.75 \times \sqrt{F_c} \times b_w} \text{ or } \frac{A_v \times F_y}{50 \times b_w} \rightarrow \text{[Lesser value is selected]}$$

Q4 page 08

4- No web - reinforcement is required if

$$Vu < \frac{1}{2} \phi Vc$$

⇒ Between the critical section "Vu" and "ϕVc". Spacing b/w web reinforcement can be find by

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

5:- if $Vs \leq 4 \times \sqrt{Fc} \times bw \times d$. then max spacing for stirrups 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

$Vs > 8 \times \sqrt{Fc} \times bw \times d$

then either increase cross sectional dimensions or increase fc

Q.No 2

A simply supported rectangular beam 14" wide having an effective depth of 22" to carry a latteral load of 6.5 K/ft on a 8' simple span. It is reinforced with 7in² of tensile steel area. If

F_c' = 4ksi and f_y = 50 ksi, then design the beam for shear

Given.

Breath of web of beam (b_w) = 14"

Effective depth (d) = 22"

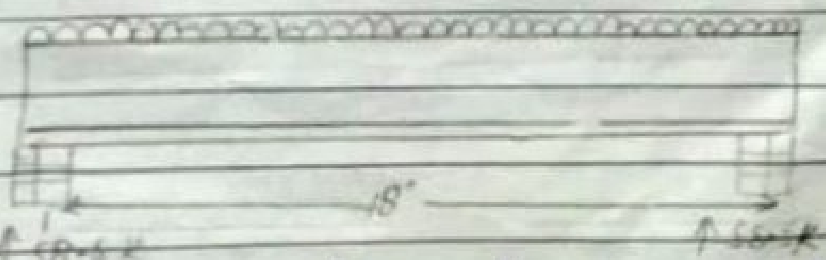
Given Load = 6.5 K/ft

Steel Area = 7in²

F_c' = 4ksi

F_y = 60ksi

Sol:—



Step # 01 (Reactions on supports)

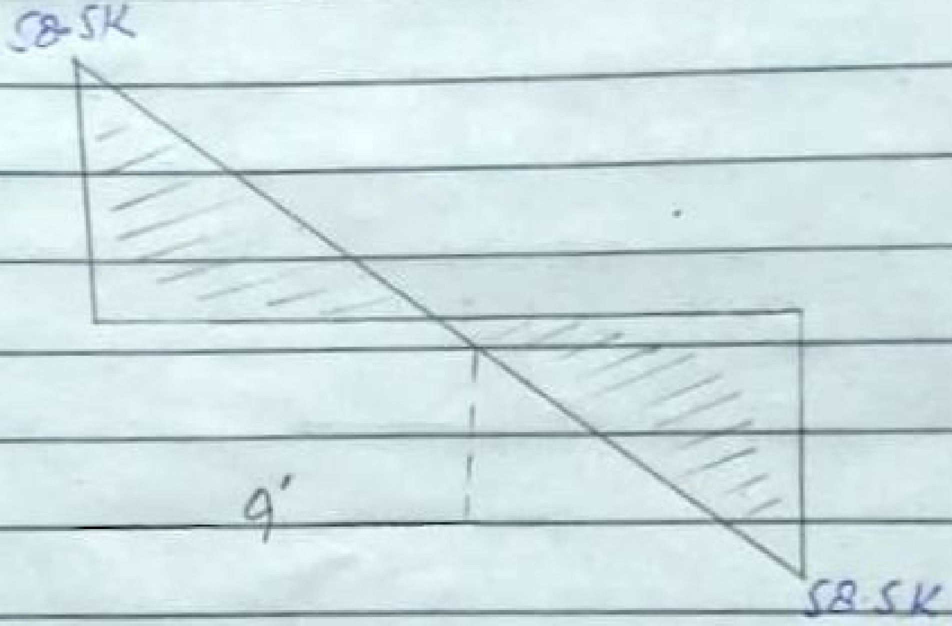
Finding the reactions due to applied load

Total load = $\frac{6.5 \times 18}{2}$ = 58.5 kips

(ab)

step # 02 (Shear force Diagram)

the required shear diagram will be



Step # 3:-

Finding the value of critical shear "Vu" and its Location As,

we Know that critical shear is located at distance "d" from face of support (d) = 22" = 1.83

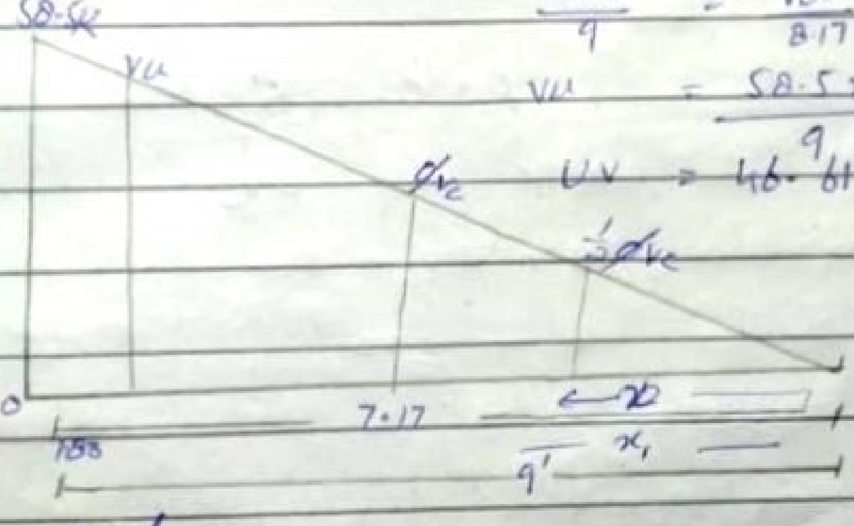
⟹ we will find values of critical shear at distance "d" by use of similar triangles.

From similar Triangles

$$\frac{58.5}{9} = \frac{Vu}{8.17}$$

$$Vu = \frac{58.5 \times 7.17}{9}$$

$$Uv = 46.61 \text{ Kips}$$



step # 04

Finding the values of "ϕVc" and $\frac{1}{2}$ "ϕVc" and also its distance from zero shear to right side.

By formula.

$$\Rightarrow \phi Vc = \phi \times 2 \times \sqrt{f'c} \times bw \times d$$

$$= 0.75 \times 2 \times \sqrt{4000} \times 14 \times 22 = 29219 \text{ Lbs}$$

$$= 29.21 \text{ Kips}$$

→ Location of ϕv_c by similar triangle

$$\frac{58.5}{9} = \frac{\phi v_c}{x_1} \longrightarrow \frac{58.5}{9} = \frac{29.21}{x_1}$$

$$\Longrightarrow x_1 = \boxed{4.149'}$$

→ Similarly

$$\frac{1}{2}\phi v_c = \frac{\phi v_c}{2} \longrightarrow \frac{29.21}{2} = 14.60 \text{ Kips}$$

→ Location of $\frac{1}{2}\phi v_c$ will be

$$\frac{58.5}{9} = \frac{14.60}{x_2}$$

$\longrightarrow 2.24$

Step # 05 page ⑥

Finding the value of ϕv_s by formula $v_u = \phi v_s + \phi v_c$

$\longrightarrow \phi v_s = v_u - \phi v_c$

$= 46.61 - 29.21$

$= \phi v_s$ 17.4 kips

step # 06

check on section adequacy by formula.

$= \phi \times 8 \times \sqrt{f_c} \times b_w \times d$

$= 0.75 \times 8 \times \sqrt{4000} \times 14 \times 22 = 116877 \text{ lbs}$
$= 116.87 \text{ Kips}$

$AS = \phi \times 8 \times \sqrt{f_c} \times b_w \times d > \phi v_s$

so section is adequacy

(09

step # 07:-

check on maximum spacing for stirrups

By for mula.

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

$= 0.75 \times 4 \times \sqrt{4000} \times 14 \times 22 = 58438 lbs$

$= 58.43 Kips$

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

so maximum will be selected from the following 4 conditions

1- $S_{max} = 24''$

2- $d/2 = 22/2 = 11''$

3- $S_{max} = \frac{A_v \times f_y}{0.75 \times \sqrt{f_c'} \times b_w}$

Here we are using # 3 stirrup

dia $= (3/8) = 0.375$

so area $\frac{\pi}{4}(0.375)^2 = 0.11 in^2$

for 2-legged stirrup

→ area × 2

→ 0.11 × 2 = 0.22 in^2

3:– $S_{max} = \frac{0.22 \times 60000}{0.75 \times \sqrt{4000} \times 14} = 19.87''$

4: $S_{max} = \frac{A_v \times F_y}{50 \times b_w} = \frac{0.22 \times 60000}{50 \times 14} = 18.8''$

From above 4 conditions.

~~~~ Least value of spacing for # 3, 2 legged stirrup will be selected as

$S_{max} = 11''$

step # 08

~~strip~~

stirrup spacing from/at critical section will be

By formula.

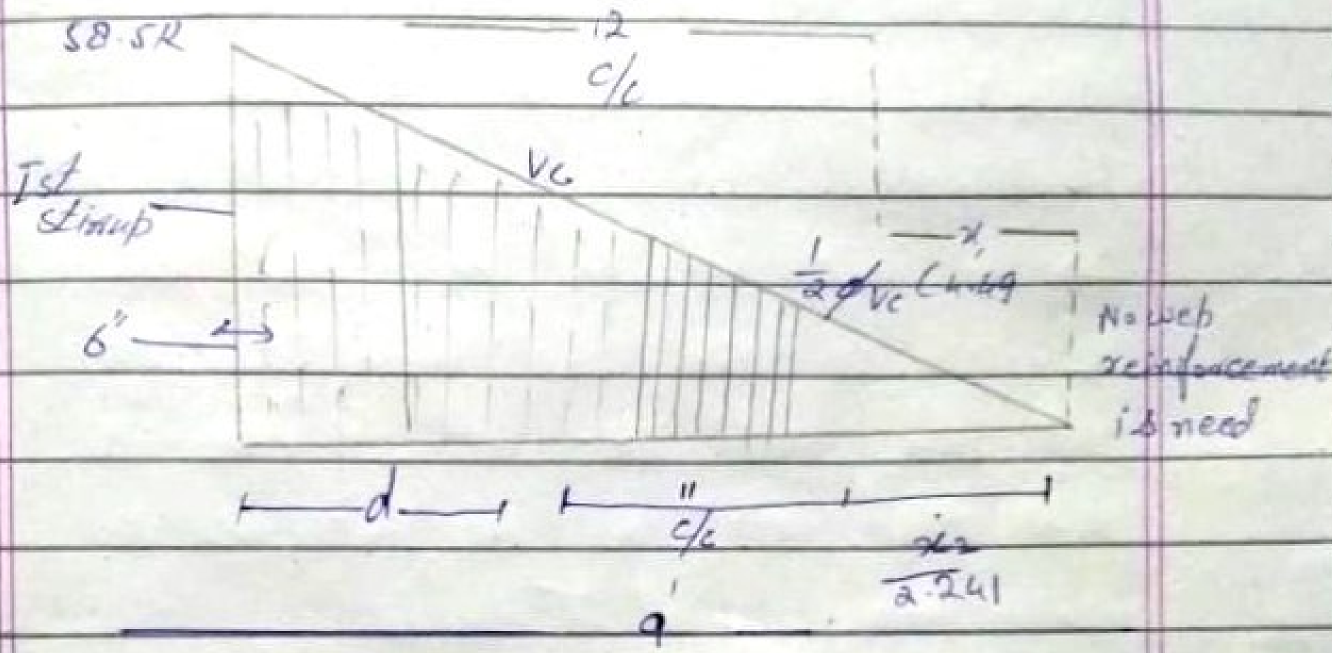
$S = \frac{\phi \times A_v \times F_y \times d}{V_u - \phi V_c} = \frac{0.75 \times 0.22 \times 60 \times 22}{46.61 - 29.21}$

$S = 12.5'' \simeq 12''$

so 12 c/c

step # 09

Final sketch will be
~~~~



AS first stirrup from face of support

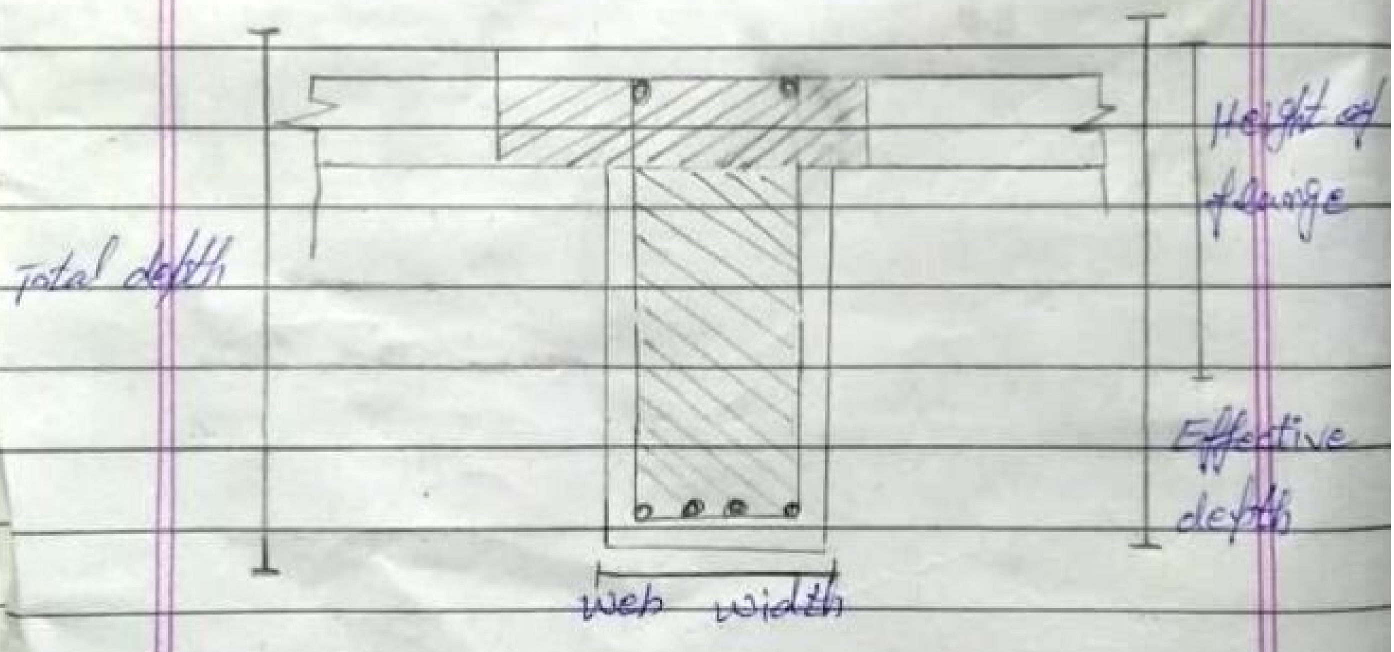
$S/2 = 12/2 = 6''$

Question No. 03

Define both the T-beam and L-beam with the help of diagram. Also explaine flexural analysis of T. Beam

T. Beam :-

→ in most of the reinforced concrete structures are cast monolithically with the slab so in this case the beam that act as an intermediate beam are called T. beams.



→ because of their T- shape these beams are called T. beams.

→ It is provided at the center of the slab to resistes the loads.

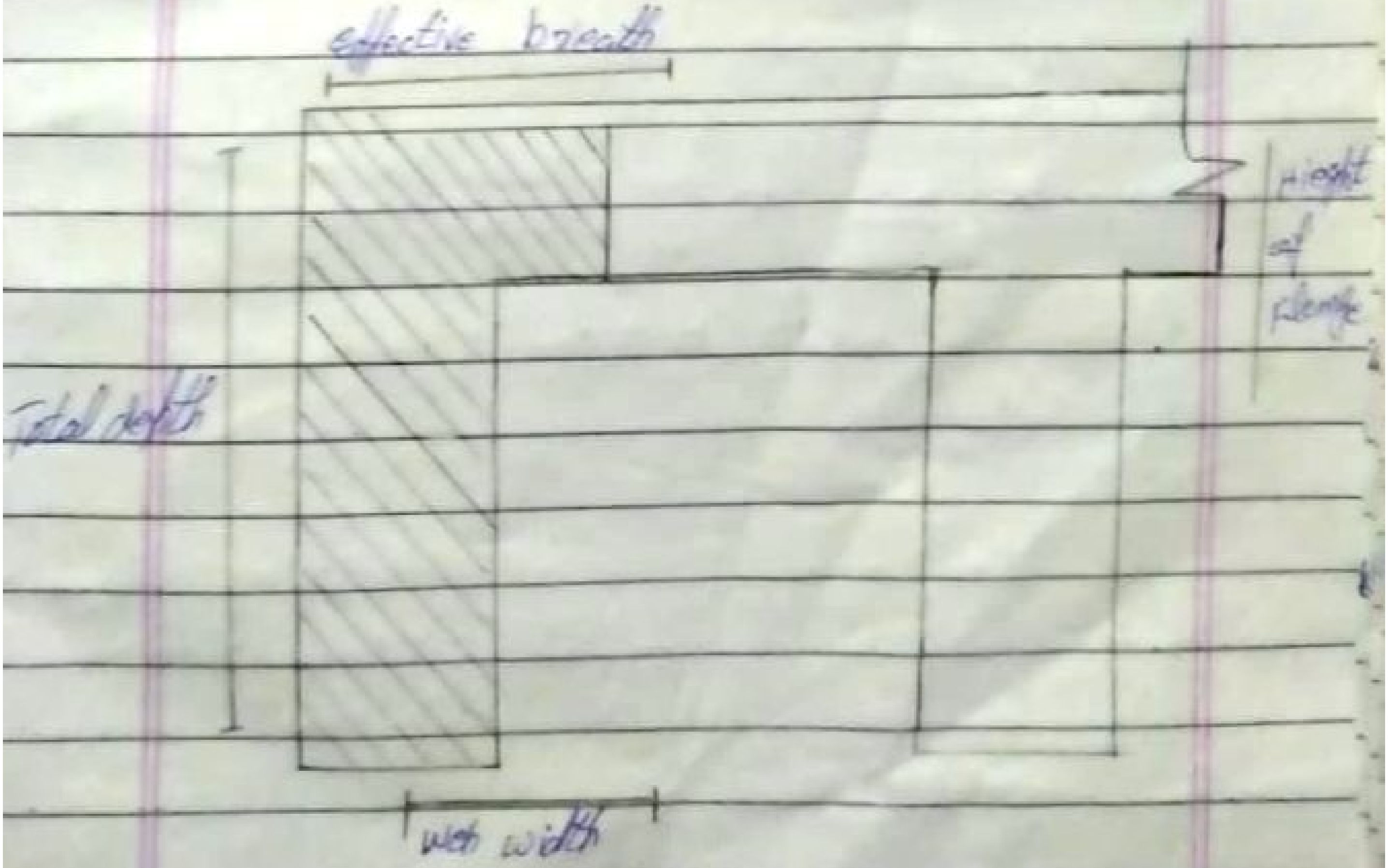
→ The upper most area of the beam attached to be slab is called flange.

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

L - Beam :-

→ L - shaped structure that is in contact with the slab and present on the corner of the floor is called L-beam.

Sheet No 09



→ L. Beam are also called edge beams

→ it is always provided at the corners of this lab.

→ L Beams are typical floor beams because of their reduced ous overall structured depth the beams are in prestressed of reinforced concrete.

Flexural Analysis of T. Beam:-

Flexural Analysis of T. Beam consists of the following steps

(1) For finding the ultimated factored moments we use the following Formula.

$$Mu = \frac{Wu \times L^2}{8}$$ ∵ wu = Total factor load, L = Total span of the beam

(2) effective width (bc) for T-beam is calculated as.

1. 16(hf) + bw
2. c/c distance
3. span 14
4. $\frac{CTS}{2}$ + bw

∵ (Hf = height of flange, CTS = clear transverse span)

(15)

value from above formulas
is c/c distance is given then their is
no need of $\frac{CTS}{2} + bw$

Page (10)

3 Checking weathers rectangular or
T- beam Analysis is required.
(i) if a > hf → special Analysis is
required
(ii) if a < hf → Rectangular beam
analysis is required
where

a = depth of compression block
hf = Height of flange

(4) For finding area of steel, we
have to use

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

where

$$a = \frac{Ast \times Fy}{0.85 \times F'c \times bw}$$

φ = strength of Reduction factor
d = Effective depth
a = compression block depth
bw = web width of beam

(5) For checking the range of reinforcement
Ratio

$$Smax = 0.85 \times B \times \frac{F'c}{Fy} \times \left(\frac{\varepsilon u}{\varepsilon u + \varepsilon y}\right)$$

16

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

6. Formula for finding No of bars required is

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

7: For checking minimum wide for bars accomodation

bmin = 2(clear cover) + 2(dia of stirrup) + No of bars (dia of bars) + spacing b/w bars (dia of bars)

8:- Design movement is given by

$Md = \phi \times Fy \times Ast \times (d - \frac{a}{2}) \rightarrow$ if $a < hf$

$Md = \phi \times [as \times Fy \times (d - hf/2) + (As - Act) \times Fy \times (d - a/2)] \longrightarrow$ if $a > hf$

(17)

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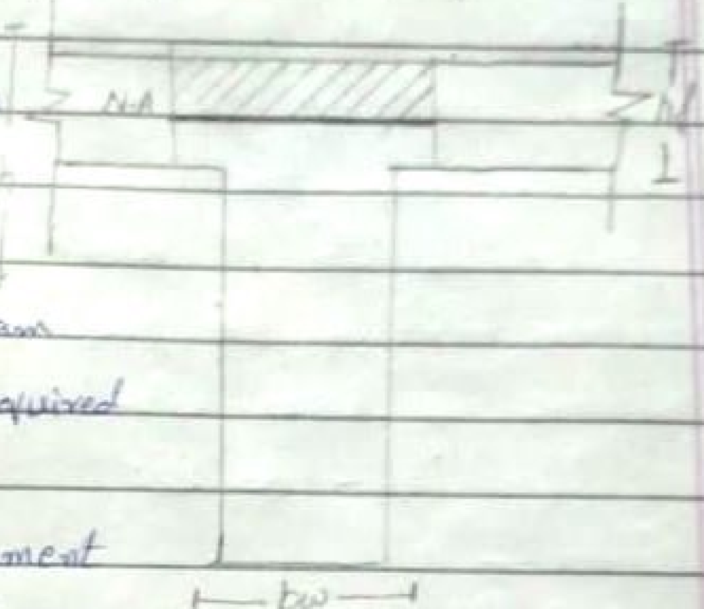
Question No # 04

what is diffrence b/w CASE-1 and CAse 2 design of T beam

Case-I:-



From the figure

$a < hf$

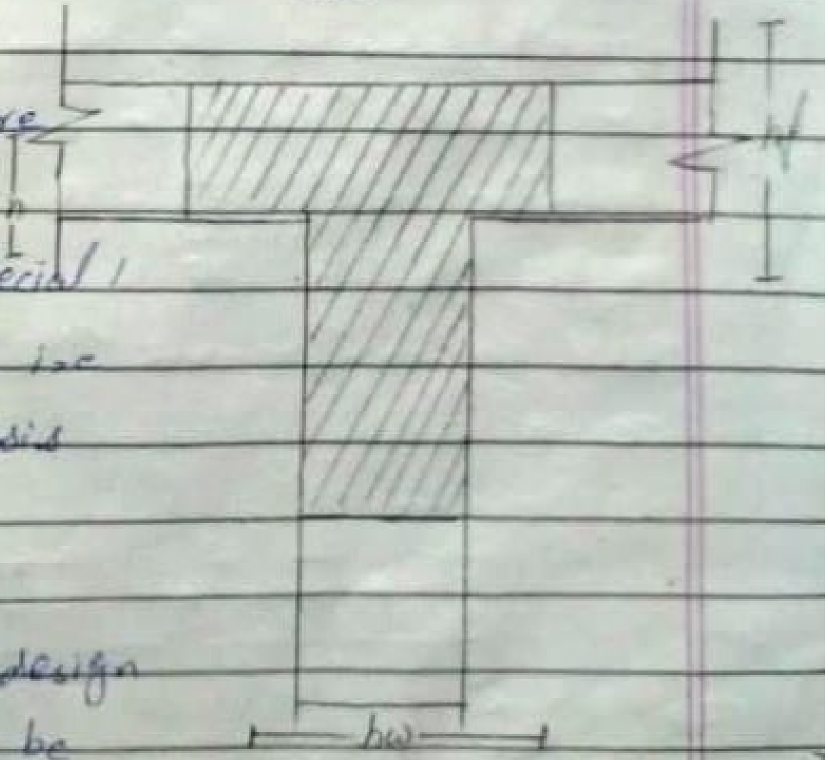
So in the case Rectangular beam Analysis is required

So,

The design moment formula will be

$Md = \phi \times Fy \times AST \times (d - a/2)$

Case-2:-



From the figure

$a > hf$

So in this Special beam analysis i.e T Beam Analysis is required

So

the required design moment will be

$Md = \phi \times [As \times Fy \times d(d - \frac{hf}{2}) + (As - Act) Fy (d ...$

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(10)

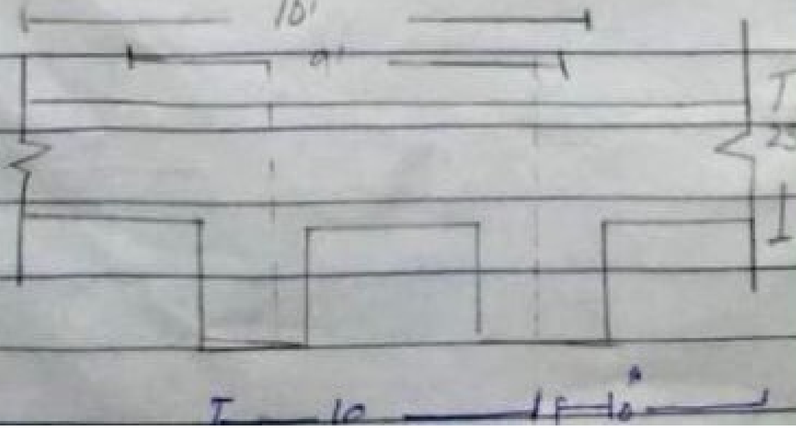
PageNo 12

Q.No 05

A floor system consist of 3.5 concrete slab supported by 16 simple span spaced at 9' c/c the beam having web width of 10 and effective depth of 18 and total height is 23.
calculate the necessary flexural reinforcement if the factored applied moment is 5800 Kip-inch use fc = 3ksi and = 60 Ksi

Given:-
Height of flange (hf) = 3.5
c/c distance = 9
Length / span of the beam = 16
web width (bw) = 10"
Effective depth (d) = 18"
Height (h) = 23"
Total factored moment (Mu) = 5800 Kip inch
Fc = 3 Ksi
Fy = 60 Ksi

Sol:-
hf = 3.5



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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 is $9 \times 12 = 108''$
3. $\frac{span}{4} = \frac{16}{4} \times 12 = 48''$

Selecting the least value of be as

$b_e = 48''$

Sheet No 13

Step # 2:-

Check weather Rectangular or T-beam Anaylsis is required.

Trial # 01 let $a = h_f = 3.5$

$$A_{st} = \frac{M_u}{\phi \times f_y \times (d - a/2)} = \frac{5800}{0.90 \times 60 \times (18 - 3.5/2)} = 6.61 \, in^2$$

Trial # 02 $a = \frac{A_{st} \times f_y}{0.85 \times f'_c \times b_e}$

$$a = \frac{6.61 \times 60}{0.85 \times 3 \times 48} = 3.2''$$

And $\boxed{A_{st} = 6.55 \, in^2}$

So Rectangular beam design is required

Trial # 03 : $a = 3.21''$

and $A_{st} = \frac{5800}{0.90 \times 60 (18 - \frac{3.21}{2})} = 6.55 \, in^2$

(20)

So Area of steel is $6.55 in^2$

Step # 03:-

Check Smax and Smin

$$\Longrightarrow S_{max} = 0.85 \times B_1 \times \frac{F'_c}{F_y}\left(\frac{\varepsilon_u}{\varepsilon_u + \varepsilon_t}\right)$$

=