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Section:→ A

Semester:→ 6th

Department:→ Civil engineering

Assignment:→ PRCD-I

Submitted to:→ Sir Fawad Khan.

Q1:→ Explain in detail types of stirrups with figures and also explain ACI codes for shear design?

① **Ans:→ Stirrup:→**

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

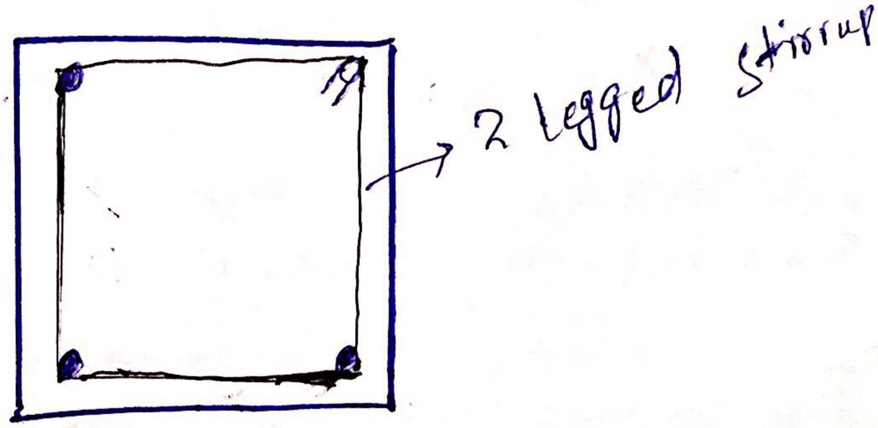
i):→ Types of Stirrups:→

i):→ Single legged stirrups:→

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

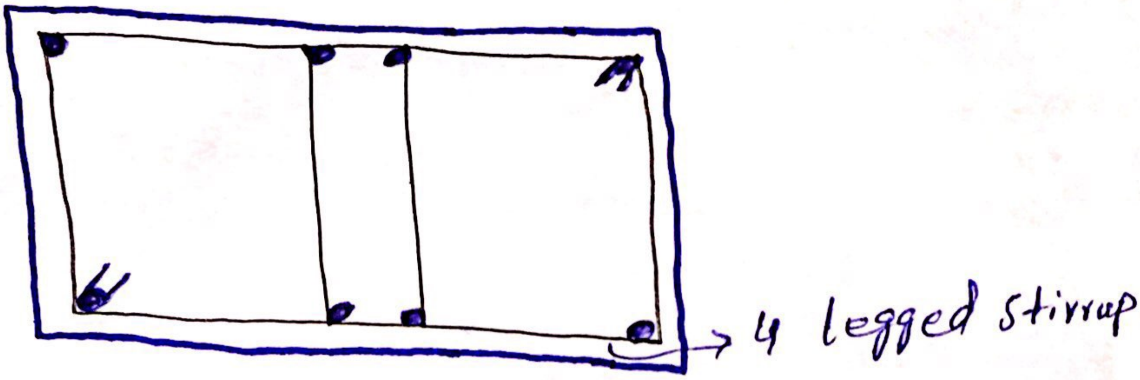
ii):→ Two legged stirrup:→

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

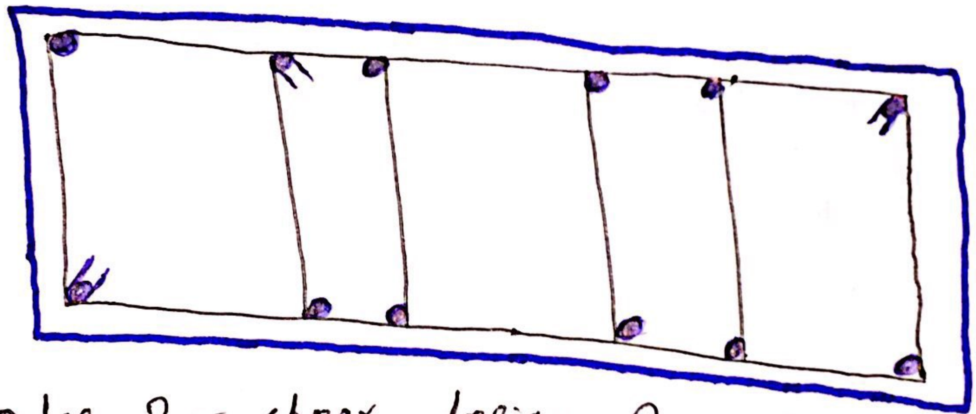


iii):→ Four legged stirrup:→

The stirrups are used in case of web reinforcement.



iv):→ Six legged stirrup:→



x):→ ACI codes for shear design of a beam:→

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

i):→ Critical section:→ Critical section occurs at 45° and is at distance (d)" from the face of support which is equal to effective depth.

ii):→ Shear strength capacity of concrete is:→

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

iii):→ Minimum web reinforcement:→

If $V_u \leq \phi V_c$, then Theoritically no web reinforcement is required. However ACI code require provision of at lest a minimum area of web reinforcement equal to

$$\phi = 0.75$$

=> For minimum reinforcement area:→

$$A_{v min} = \frac{0.75 \times \sqrt{f_c'} \times b_w \times s}{f_y}$$

By interchanding the above formulas, we can obtain the formula for maximum spacing

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

iv):→ No web-reinforcement is required if

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

→ B/w critical section "V_u" and "ϕV_c", spacing b/w web reinforcement can be find by

$$S = \frac{\phi \times A_v \times f_y \times d}{V_u - \phi V_c}$$

V):→ If $V_s \leq 4 \times \sqrt{f_c'} \times b_w \times d$, then max spacing for stirrup will be the smallest of the following

1):→ 24"

2):→ $d/2$

3):→ $S_{max} = \dfrac{A_v \times f_y}{0.75 \times \sqrt{f_c'} \times b_w}$

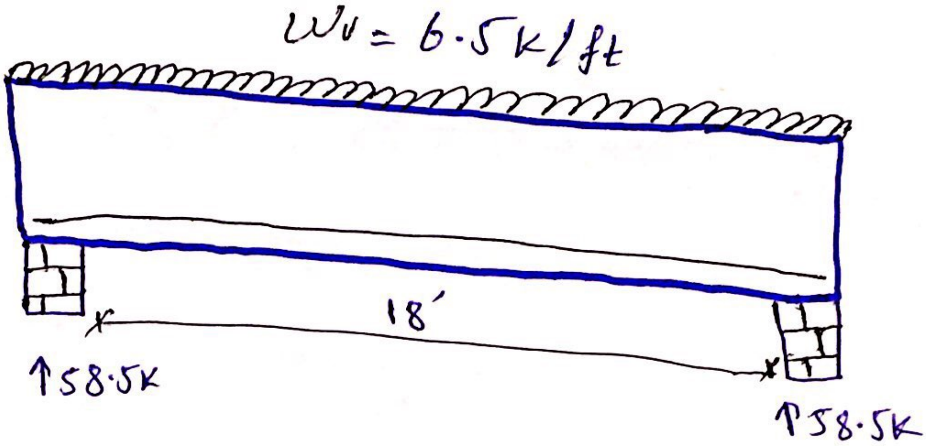
4):→ $S_{max} = A_v \times f_y / 50 \times b_w$

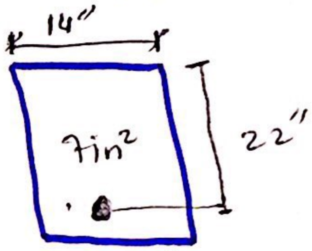
→ If $V_s > 4 \times \sqrt{f_c'} \times b_w \times d$ → max. spacing will be halved

→ If $V_s > 8 \times \sqrt{f_c'} \times b_w \times d$ → Then either increase cross-sectional dimensions or increase f_c'

Q2:→ A simply supported rectangular beam 14" wide having an - - - - - - then design the beam for shear? Page (6)

Sol:→



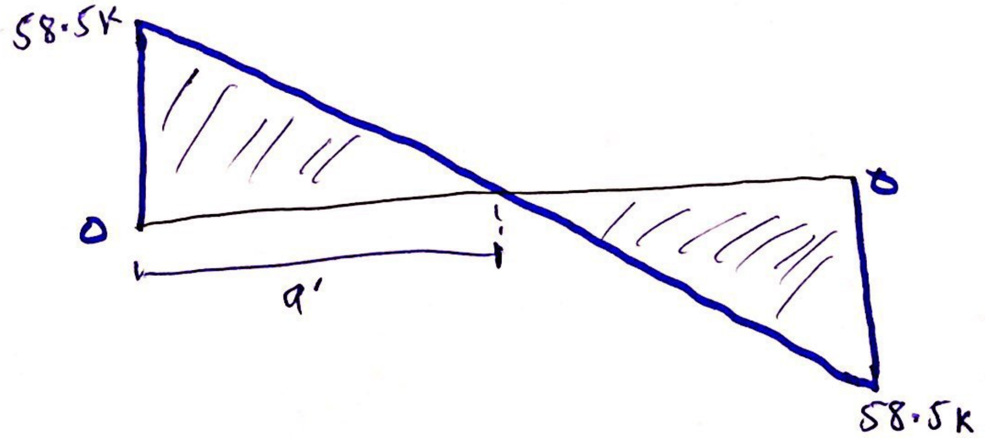


Step #01:→ Reaction on Supports

→ Finding the reaction due to applied Load

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

step #02:→ shear force diagram.



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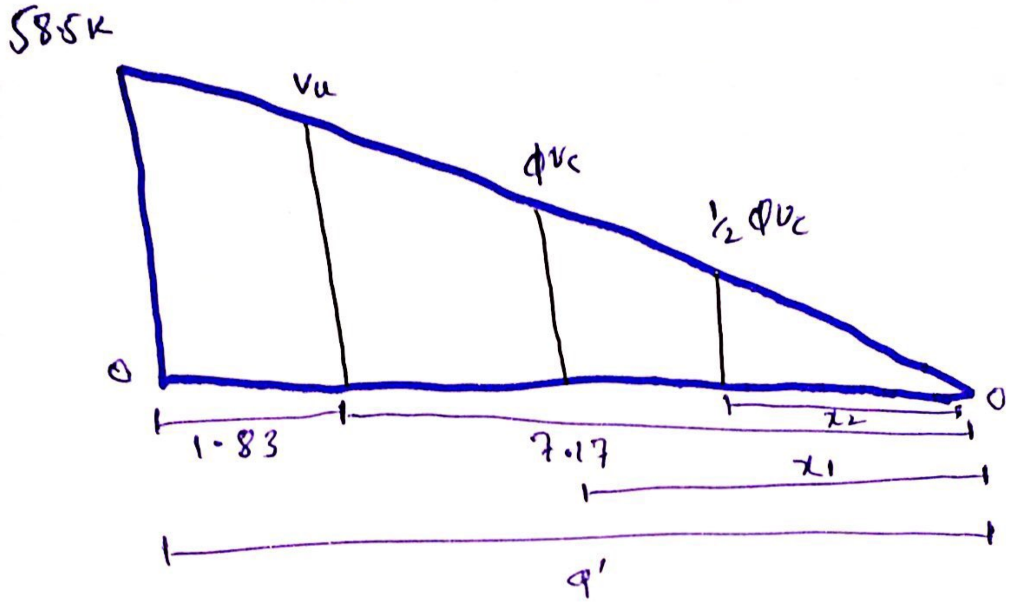
Step # 03:→

"Vu" and it location — Finding the value of critical shear

→ Critical shear is located at distance 'd' from face of support (d) = 22" = 1.83'



Step # 04:→ Finding the value of "ΦVc" and "½ ΦVc" and also its distances from zero shear to right side.

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

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

$$\Rightarrow 29.21 \text{ kips}$$

⇒ Location of ϕV_c by similar triangles,

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$$\frac{58.5}{9} = \frac{\phi V_c}{x_1} \Rightarrow \frac{58.5}{9} = \frac{29.21}{x_1}$$

$$\Rightarrow x_1 = 4.49'$$

$$\frac{1}{2}\phi V_c = \phi V_c/2 \Rightarrow \frac{29.21}{2} = 14.60 \text{ kips}$$

→ location of $\frac{1}{2}\phi V_c$ will be

$$\frac{58.5}{9} = \frac{14.60}{x_2} \Rightarrow x_2 = 2.24$$

Step #05:→ Finding the value of ϕV_s

$$\phi V_s = V_u - \phi V_c$$

$$\phi V_s = 46.61 - 29.21$$

$$\phi V_s = 17.4 \text{ kips}$$

Step #06:→ Check on section adequacy

$$= \phi \times 8 \times \sqrt{f_c'} \times b_w \times d \Rightarrow 0.75 \times 8 \times \sqrt{4000} \times 14 \times 22$$

$$= 116.87 \text{ kips}$$

$$\phi \times 8 \times \sqrt{f_c'} \times b_w \times d > \phi V_s$$

section is Adequate.

Step # 07

Check on maximum spacing for Stirrups,

$$= \Phi \times 4 \times \sqrt{f_c'} \times b_w \times d \Rightarrow 0.75 \times 4 \times \sqrt{4000} \times 14 \times 22$$

$$= 58.43 \text{ kips}$$

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

maximum will be selected from the following 4 conditions.

1) :→ $S_{max} = 24''$

2) :→ $\frac{d}{2} = \frac{22}{2} = 11''$

3) $S_{max} = \frac{A_v \times f_y}{0.7 \times \sqrt{f_c'} \times b_w} = \frac{0.22 \times 60000}{0.75 \times \sqrt{4000} \times 14} = 19.87''$

4) :→ $S_{max} = \frac{A_v \times f_y}{50 \times b_w} = \frac{0.22 \times 60000}{50 \times 14} = 18.85''$

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

$$S_{max} = 11''$$

Step # 8:→

Stirrups spacing from/at critical section

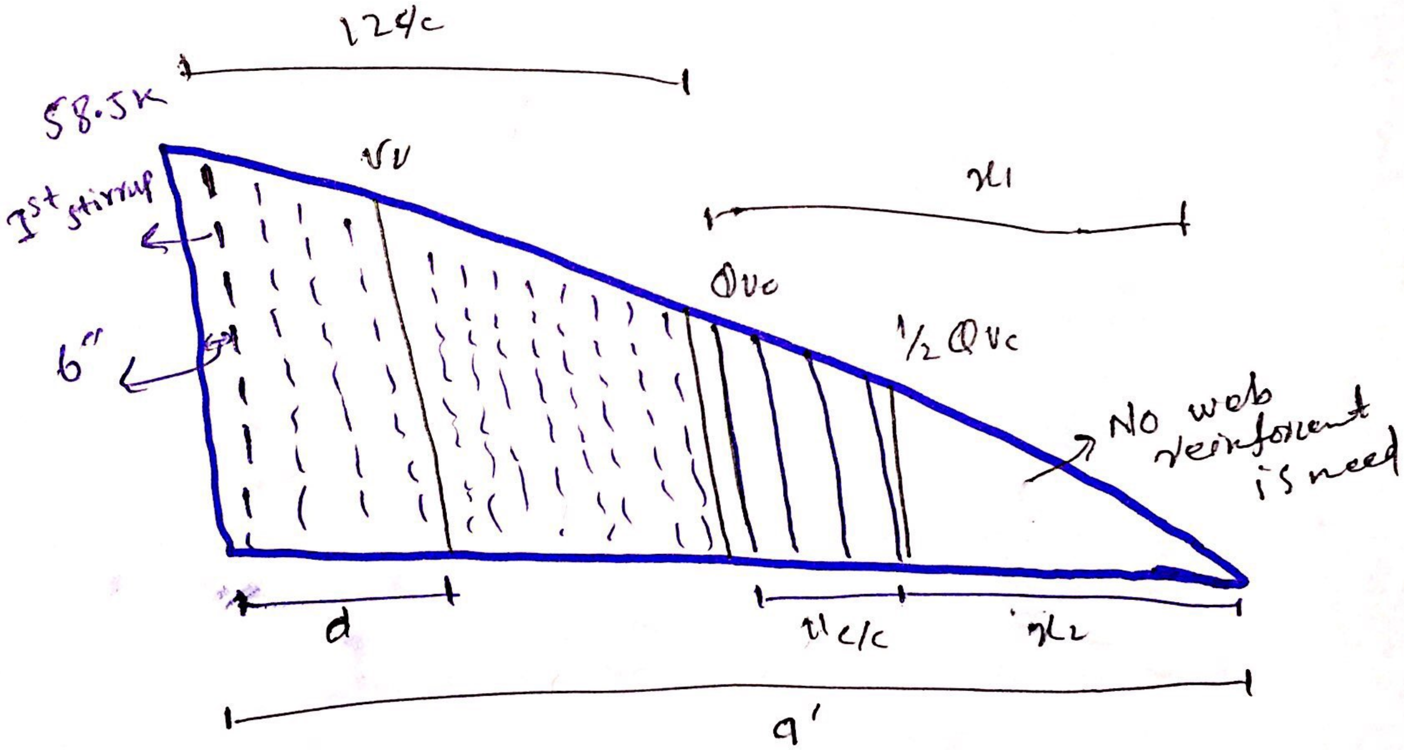
$$S = \frac{\phi \times A_w \times f_y \times d}{V_u - \phi V_c} = \frac{0.75 \times 0.22 \times 60 \times 22}{46.61 - 29.21}$$

$S = 12.5'' \cong 12''$

So $12''$ c/c

Step # 09:→

Final sketch



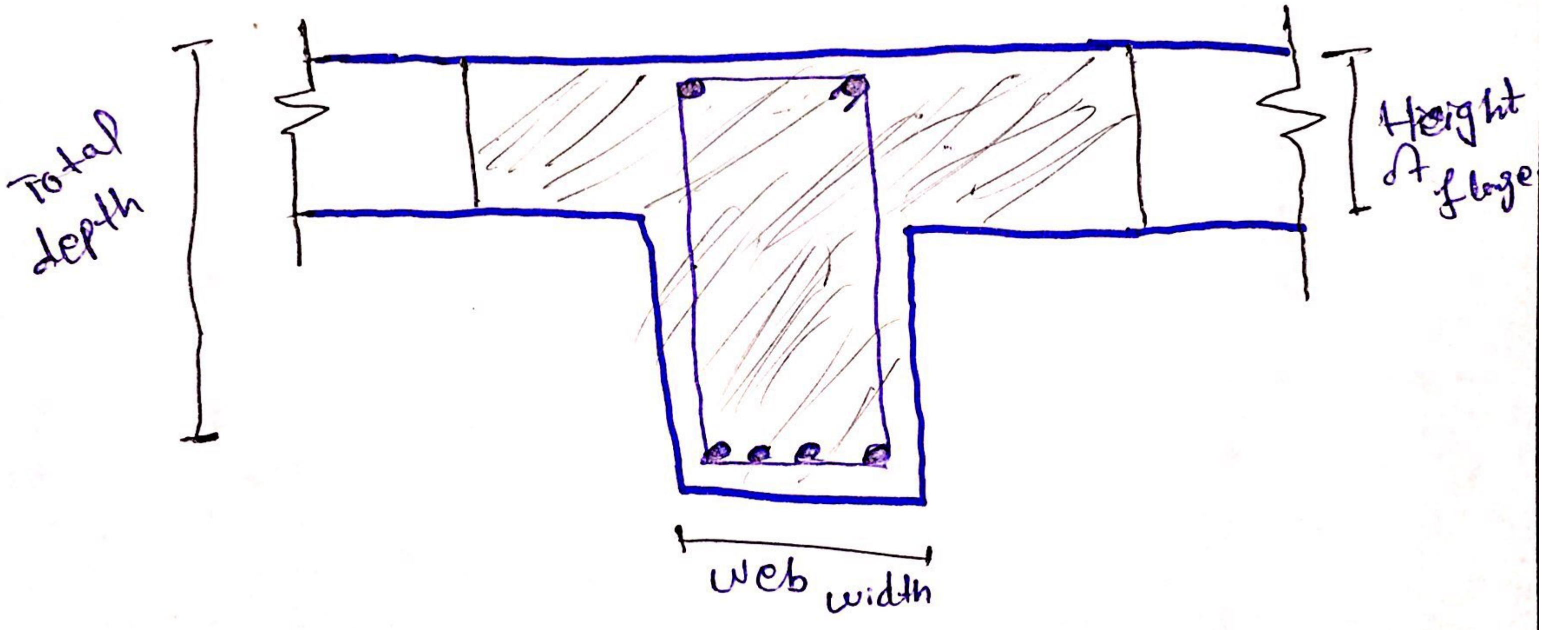
first stirrup from face of support

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

Q3) :→ Define both T and L Beam with the help of diagram. Also explain flexural analysis of T- Beam. page(12)

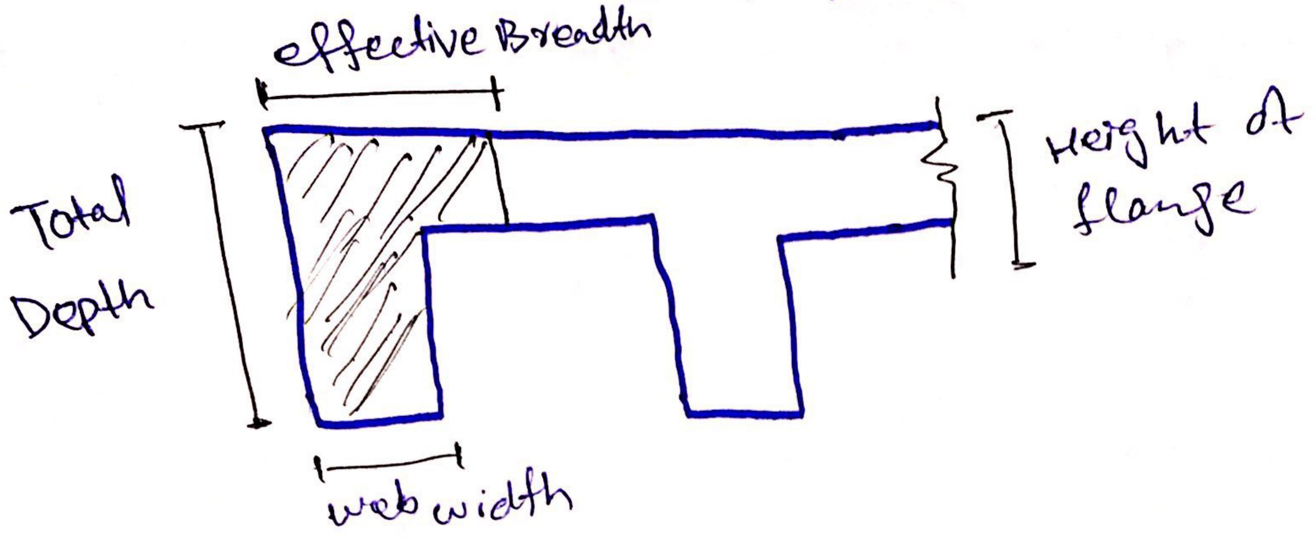
Ans :→ **T- Beam :→**

In most of the reinforced concrete structures, concrete slabs are cast monolithically with the slab so in this case the beam that act as an intermediate beam are called T- Beam.



L- Beam:→

L-shaped structure that is in contact with the slab and present at the corner of the floor is calle L-Beam.



*):→ flexure analysis of T-Beam:→

→ flexure analysis of T-Beam consist of the following steps.

i):→ for finding the ultimate factored moment

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

ii):→ Effective width (be) for T- beam.

1) 16(hf) + bw
2) c/c distance
3) span/4
4) CTS + bw

Page(14)

iii):→ Checking whether rectangular or T-Beam :→

1) If $a > h_f$ → special analysis is required

2):→ If $a < h_f$ → Rectangular beam analysis is required

iv):→ for finding Area of steel,

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

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

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