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SECTION: B

Assignment: 02

SUBJECT: DRCD-I

SUBMITTED TO. Engr FAWAD KHAN.

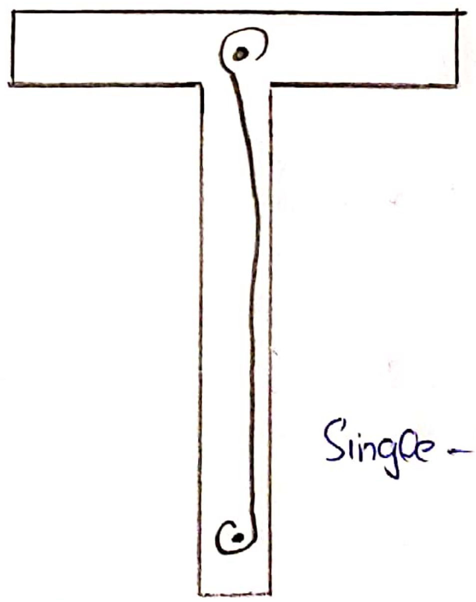
Q1 Explain in detial types OF Stirrups with figures & also Explain ACI codes For Shear design?

Ans Following are the types OF stirrups.

- Single legged stirrups.
- Two legged or double lagged strrups.
- Four lagged stirrups.
- Six lagged stirrups.

1- SINGLE LEGGED STIRRUPS:-

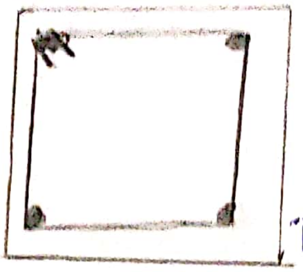
These type of stirrups are used to hold the longitudinal bars in position & prevent buckling.



Single - legged Stirrups.

2- DOUBLE LEGGED STIRRUP:-

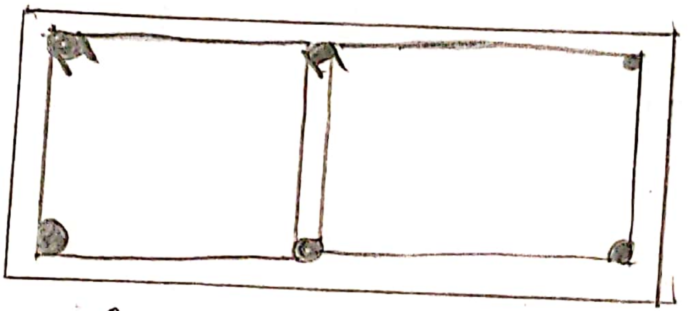
We use a Single Stirrup to tide a beam or a colum at a time, we say it is two legged stirrups - Double legged stirrups are adequate For typical beams with relatively short widths.



Two - legged Stirrups.

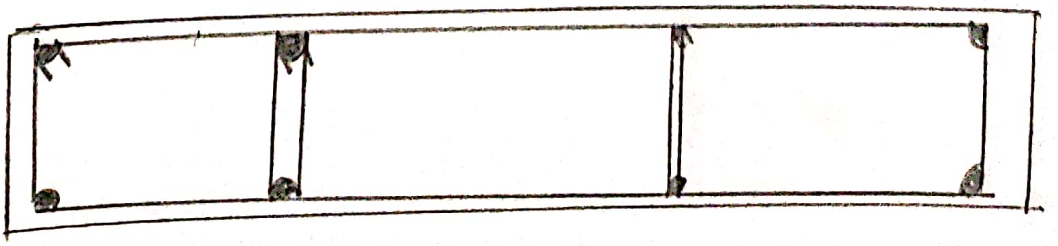
3- FOUR LEGGED STIRRUP:

We use double to the tie a beam or coloumn at a time, we say it is Four legged Stirrup - Four legged Stirrup - For beam having longer widthes multiple legged or Four legged or Four legged Stirrups are required.



4- SIX LEGGED STIRRUP:

These Six legged Stirrups are generally used For a Continous beam structure, It consists of regular upheling of structure at each junction while joints at the joining of beam & Colomn.



ACI CODES FOR SHEAR DESING.

1- Compute the design shear force, V_u, at appropriate location.

2- Compute shear strength capacity of concrete, $V_c = 2 \times \sqrt{f'_c} \times b_w \times d$

3- Compute minimum web reinforcement.

If $V_u \leq \phi \times V_c$ so no web reinforcement needed.

If it is not applicable then min area of web reinforcement equal to.

i) $A_v = 0.75 \sqrt{f'_c} \times \frac{b_w \times s}{f_y}$ OR $A_{v\,min} = \frac{50 \times b_w \times s}{f_y}$

→ Max spacings can be found by these formula's.

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

4- If $V_u < \frac{\phi V_c}{2}$, if its true no stirrups are required.

5- First stirrup is provided at a distance $S/2$

6- Between "V_u" and "ϕV_c" spacing b/w web reinforcement is found by formula.

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

7- If $V_s \leq 4 \times \sqrt{f'_c} \times b_w \times d$ then max spacing of stirrups will be smallest of the following.

Four Conditions.

1- 24" 2- d/2 3- $S_{max} = \frac{A_v \times f_y}{0.75 \times \sqrt{f_c} \times b_w}$ 4- S_{max}

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

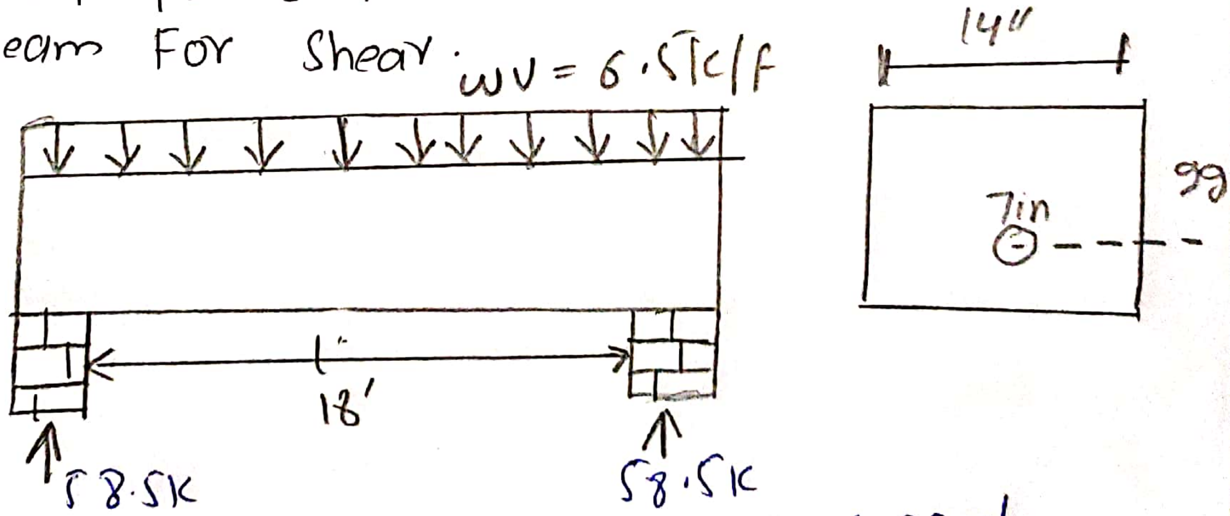
8 If $V_s > 4 \times \sqrt{f_c} \times b_w \times d$ → then max Spacing will be halved

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

then increase cross-sectional dimensions or increase "f_c"

Q-2 A Simply supported rectangular beam 14" wide having an effective depth 22-10 carry a letral load of 6.5 K/ft on a 18 Simple span. It is reinforced with 7in of tensile steal area, if f_c' is 4K & fy is 60ksi then design the beam For Shear.

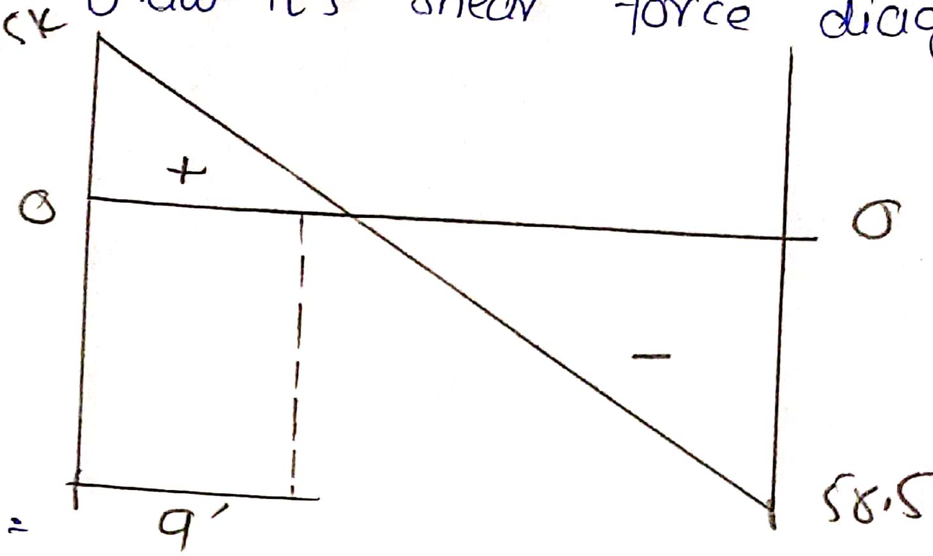
$w_v = 6.5 K/f$



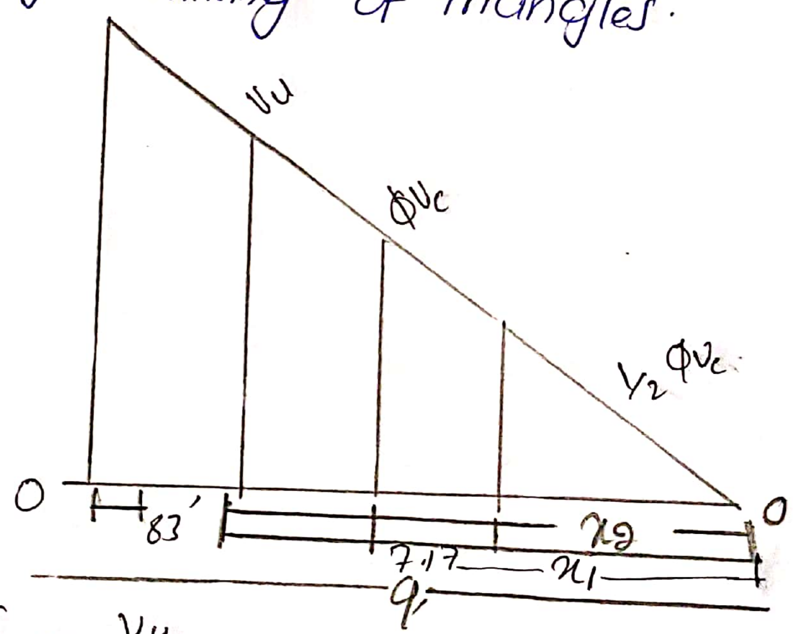
Step 01: Find the reaction on support.

total load $= \frac{6.5 \times 18}{2} = 58.5K$

Step 02 = Draw it's Shear force diagram.



Step 03 = Finding the value of critical stress "V_u" and it's from the Face of Supports d = 22" = 1.83' using Similarity of triangles.



$$\frac{58.5}{9} = \frac{V_u}{7.17}$$

$$V_u = \frac{58.5 \times 7.17}{9} = 46.605k$$

Step 04 : Finding the value of "ΦV_c" and "$\frac{1}{2}\Phi V_c$" and also it's distance from zero shear to right side.

By Formula,

$$\Rightarrow \Phi V_c = \phi \times 2 \times \sqrt{f'_c} \times b_w \times d$$

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

$$= 29.21k$$

* location of "ϕV_c" by Similar triangles.

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

$$x_1 = 4.49'$$

Now,

→ $\frac{1}{2}\phi V_c = \frac{29.21}{2} = 14.60k$

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

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

$$\boxed{x_2 = 2.24'}$$

Step.05: Finding the value of "ϕV_s"

$$\phi V_s = V_u - \phi V_c$$
$$= 46.605 - 29.21$$
$$\boxed{\phi V_s = 17.395}$$

Step 06: Check on Sect~~ion~~ adequacy

By Formula

$$= \phi \times 8 \times \sqrt{f'c} \times bw \times d$$
$$= 0.75 \times 8 \times \sqrt{4000} \times 14 \times 22$$
$$= \boxed{116.87K}$$

As $\phi \times 8 \times \sqrt{f'c} \times bw \times d > \phi V_s$ thus section is adequate.

Step 07 :- Check on Max spacing for Stirrups

By Formula:

$$= \phi \times \sqrt{f'c} \times bw \times d = 0.75 \times 4 \times \sqrt{4000} \times 14 \times 22$$
$$= 58.43K$$

As $\phi \times 4 \times \sqrt{f'c} \times bw \times d > \phi V_s$

So max spacing will be selected from the following 4 condit~~ion~~.

1- 24"   2- $\frac{d}{2} = \frac{22}{2} = 11"$ 3- $S_{max} = \frac{A_v \times f_y}{0.75 \times \sqrt{f'_c} \times b_w}$

Lets Suppose we use # 3 Stirrups, dia = 3/8 = 0.375"

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

For - 2 legged stirrup' Area x2

$= 0.11 \times 2 = 0.22 in^2$

3 - $S_{max} = \frac{0.22 \times 60000}{50 \times 14} = 18.25"$

4- $S_{max} = \frac{A_v \times f_y}{50 \times b_w} = \frac{0.22 \times 60000}{50 \times 14} = 19.87"$

So we choose the last value From the above values

$S_{max} = 11"$

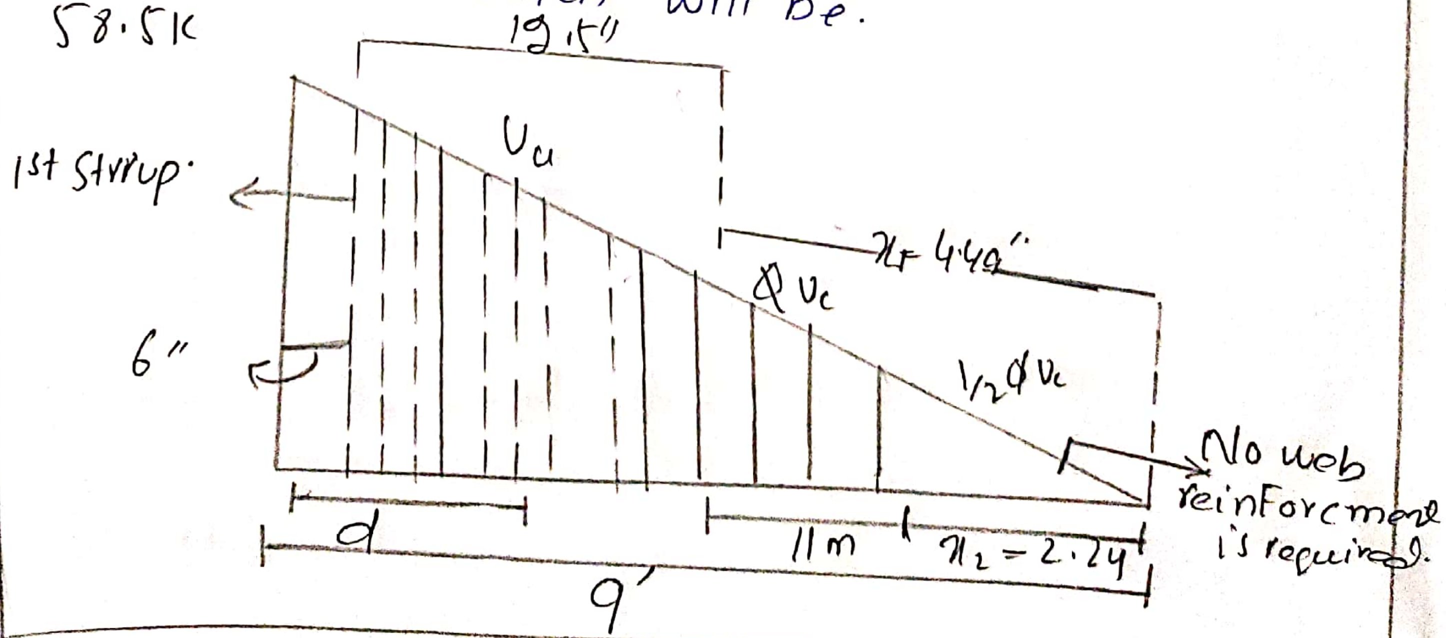
Step 08 : Stirrups spacing Froomlat critical Section.

By Formula $S = \frac{\phi \times A_v \times f_y \times d}{V_u - \phi V_c} = \frac{0.75 \times 0.22 \times 60 \times 22}{46.605 - 29.21}$

$S = 12.52 \simeq 12.5"$

So 12.5" ck.

Step 09 :: Final Sketch will be.



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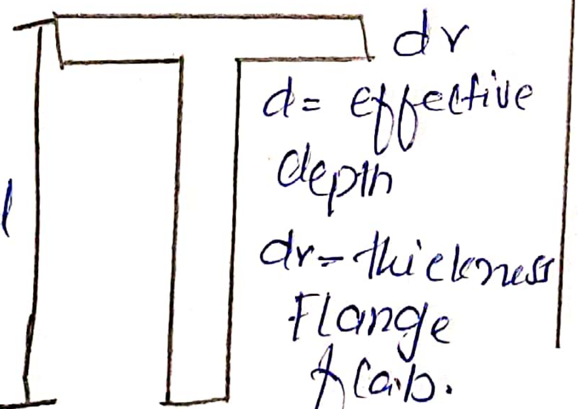
First Strrup: From Face OF Support.

$S/2 = \frac{12.5}{2} = 6.25 \approx 6''$

Q3 DEFine both the T-beam and L-beam with the help OF diagram - Also Explain Flexural Strength analysis For T-Beam

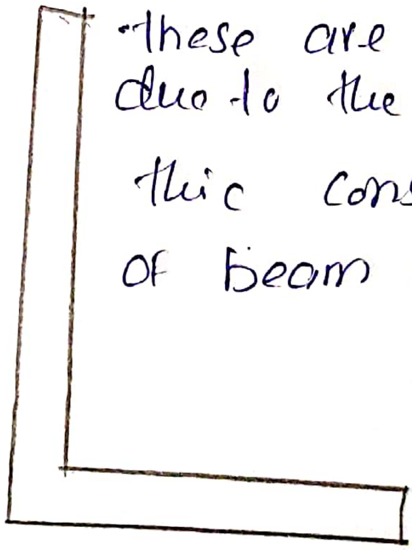
T BEAM

- It is local bearing Structure OF reinforcement Concert, wood or metal, with a T-Shaped crossection
- the top of the T-Shaped Serves as Flange or Compression member in resisting Compressive Stress



L-BEAM

- A beam whos section has the Form of an inverted L, usually placed So that it's top flange forms part of the edge OF a Floor.



-these are produce due to the monolithic Construction OF beam & Slab.

FLEXURE STRENGTH ANALYSIS FOR T-BAEM.

1- Find the ultimate factored load (moment) by the Formula -

$$m_u = \frac{w_u \times l^2}{8}$$

3- Effective depth "be" For T-beam is Computed as Formula.

i. 16 (hF) + bw ii, c/c distance iii) Span/4 iv CTS + $\frac{th}{2}$

Select last value from the above values.

3 Check whether Rectangular or T-beam analysis is required.

i. If $a > h_F$ then T-beam analysis required.

ii If $a < h_F$ then rectangular analysis is required

4- Find the Area of Steel.

$$A_{st} = \frac{m_u}{\phi \times f_y \times (d - a/2)} \quad ; \quad a = \frac{A_{st} \times f_y}{0.85 \times f'_c \times b_w}$$

6- Check the range of reinforcement ratio

$$\rho_{max} = 0.85 \times \beta \times \frac{f'_c}{f_y} \left(\frac{\epsilon_u}{\epsilon_u + \epsilon_y}\right)$$

$$\rho_{min} = \frac{200}{f_y}$$

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

5 Find the bars - No of bars = Ast / Ab.

7 Check min width for bar accomodation (bmin = 2 × c.c + 2 dia of stirrups + No of bars (dia of bar) + spacing b/w bars (dia bar)

8- Design moment is given as $m_d = \phi \times f_y \times A_{st} \times (d - a/2)$
= If $a < h_F$

$m_d = \phi \times [A_{sf} f_y \times (d - h_F/2)] (A_s - A_{st})$
$+ f \times f_y (d - a/2)$
If $a > h_f$.

What is the diffrence b/w CASE-I & Case-II in the desingh of T-beam.

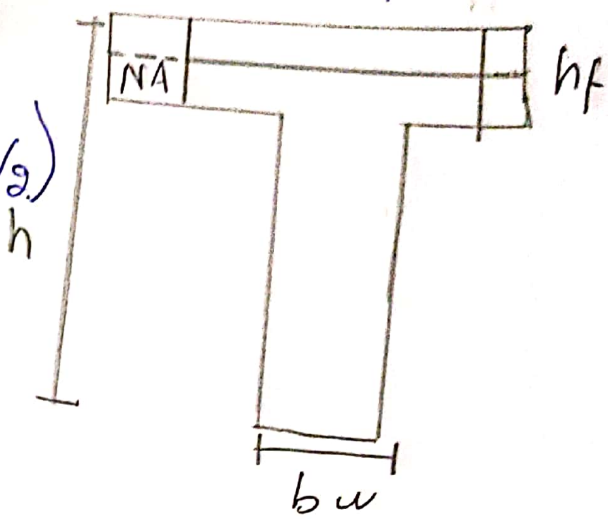
CASE-I:

From the figure

$a < h_f$

So in this case, rectangulae beam analysis is required So the design moment formula will be.

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



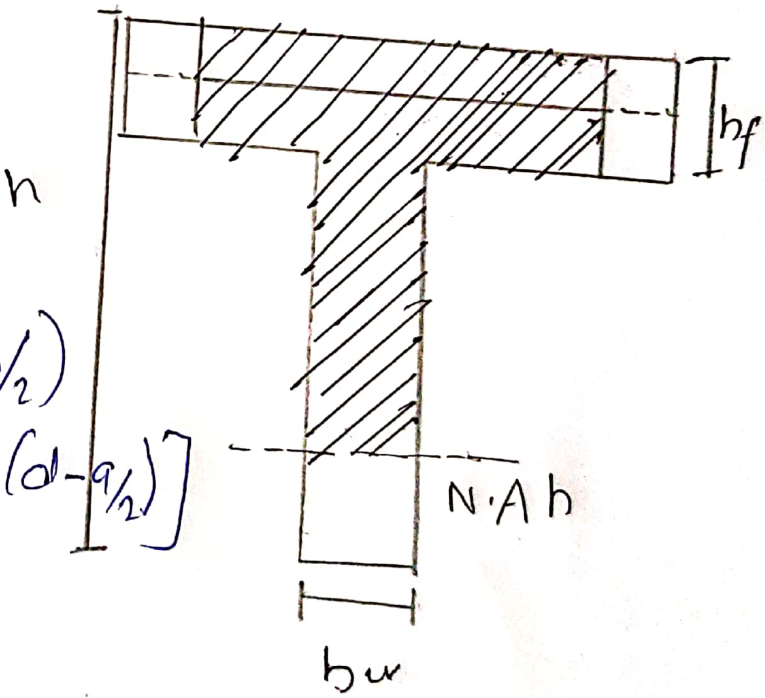
CASE II

From the figure

$a > h_f$

So in the, special beam analysis is required

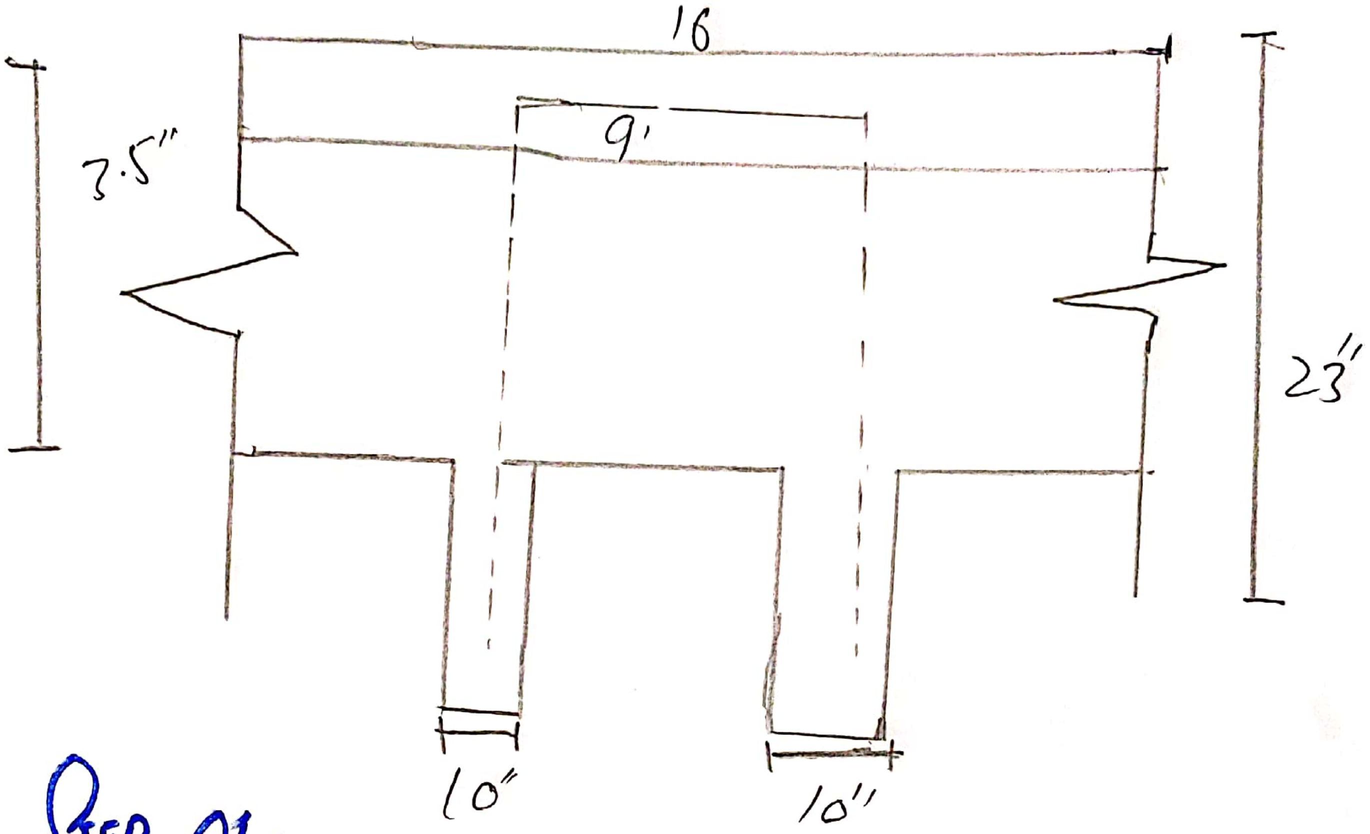
So design moment will be.



$$M_d = \phi \times \left[A_s \times f_y \times (d - h/2) + (A_s - A_{sT}) + f_y \times (d - a/2)\right]$$

Q5 A floor comosist of 3.5" concert slab support by 16' simple span spaced at 9 c/c, the beam having a web wedth of 10" and effective

depth of 18" and total height is 23"
Calculat the necessory Flexural reinforcement.
applied momentom is 5800 k-in use f'c = 3ksi and fy 60 ksi



STEP 01: Calculat the effective width (be) for T beam -

1- 16 hF + bw = 16(3.5) + 10 = 66"
2 - c/c distance = 9x12 = 108"
3- Span/4 = 16/4 x 12 = 48"

Selecting the last value of Be = 48"

STEP 02: Check the whether rectangular or T-beam angles is required.

Trial # 1

let $a = h_f = 3.5"$

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

Trial# 2

$$a = \frac{AST \times fy}{0.85 \times f_c \times b_e} = \frac{6.61 \times 60}{0.85 \times 3 \times 48} = 3.24$$

$$AST = \frac{Mu}{\phi \times fy \times (d - a/2)} = \frac{5800}{0.90 \times 60 (18 - \frac{3.24}{2})} = 6.56 in^2$$

Trial# 3

$$a = \frac{Ast \times fy}{0.85 f'_c \times b_e} = \frac{6.56 \times 60}{0.85 \times 3 \times 48} = 3.21 in^2$$

$$AST = \frac{Mu}{\phi \times fy \times (d - a/2)} = \frac{5800}{0.90 \times 60 \times (18 - \frac{3.21}{2})} = 6.58 in^2$$

thus rectangular beam analysis is required

STEP 03: Check ρ_{max} & ρ_{min}

$$\rho_{max} = 0.85 \times \beta \times \frac{f'_c}{fy} \times \left(\frac{\varepsilon u}{\varepsilon u + \varepsilon t}\right)$$

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

$$= 0.014$$

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

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

thus the value of ρ_{max} < ρ_{min} so we have to calculate AST again

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

$0.003 < 0.036 < 0.014$

$$AST = \rho_{max} \times b \times d$$

$$AST = 0.014 \times 10 \times 18$$

$$AST = 2.52 in^2$$

STEP 04: Slection and No of Bars.

let's use #8 So dia (8/8) = 1"

By formula:- Area = $\pi/4 (1)^2 = 0.785 \, in^2$

No of bars = $\frac{AST}{Ab} = \frac{2.52}{0.785} = 3.21 \approx 4$ bars

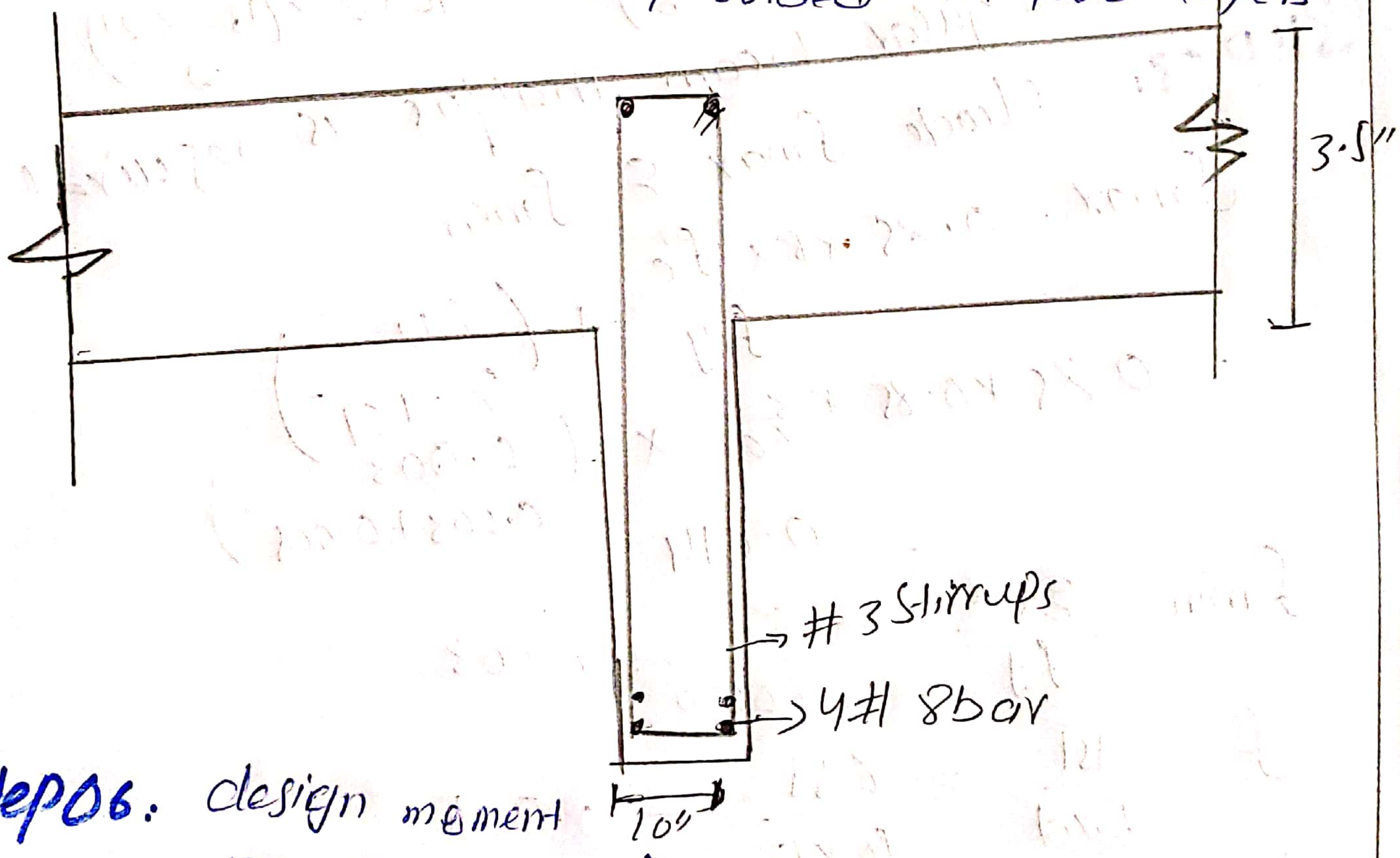
STEP 05: Check on minimum width

bmin $(2 \times 1.5) + (2 \times 3/8) + (4 \times 8/8) + 3\,(8/8)$

$= 10.75''$

As $10.75'' > 10''$

So it should be provided in two layers.



Step 06. design moment

By using Formula

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

∴ AST ⇒ No of bars × Area of single bar

$= 4 \times 0.785$

$= 3.14 \, in^2$

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$$a = \frac{A_{ST} \times f_y}{0.85 \times f'_c \times b} = \frac{3.14 \times 60}{0.85 \times 3 \times 48} = 1.54$$

$$M_d = 0.90 \times 60 \times 3.14 \times \left(18 - \frac{1.54}{2}\right)$$

$$M_d = 2921.52 \text{ k-in}$$

2921.52 < 5800 thus design is ok!

Q6 A beam is revised to developed and ultimate moment of 6000 k-m limited to 14×26 inch size use f'c is 4ksi and fy is 60ksi Determine flexural reinforcement and effective depth of beam is 22"

56 given data.

Breadth = 14"

Heagth = 26"

concrete compression strength (f'_c) = 4ksi

f_y = 60ksi

M_U = 6000 k-in

d = 22"

Assume d' = 2.5"

Step 01: Reinforcement Ratio

$$\rho_{max} = 0.85 \times B \frac{f'_c}{f_y} \times \left(\frac{\varepsilon_u}{\varepsilon_u + \varepsilon_y}\right)$$

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

$$\boxed{\rho_{max} = 0.0180}$$

Step 02: Area of Steel

As we know that

$$\rho_{max} = \frac{A_{ST}}{bxd} \Rightarrow A_{ST} = \rho_{max} \times bxd$$

$$= 0.0180 \times 14 \times 22$$

Area 5.54 in^2

STEP 03 : Design Moment

Using Formula

$M_{u2} = \phi \times A_{ST} \times f_y \times (d - a/2)$

$a = \frac{A_{ST} \times f_y}{0.85 \times f'_c \times b} = \frac{5.54 \times 60}{0.85 \times 4 \times 14} = 6.98''$

$M_{u2} = 5537.4 \text{ kin}$

As $5537.4 < 6000$

So we have to design a section as double reinforcement beam

STEP 04: Differnce in moment.

$M_{u1} = M_u - M_{u2}$

$= 6000 - 5537.4$

$M_u = 462.\ k\text{-}in$

STEP 05 : Area OF Steel

$M_{u1} = \phi \times A_{ST} \times f_y \times (d - d')$

So Area OF Steel in Compression Zone will be

$A'_{ST} = \frac{M_{u1}}{\phi \times f_y \times (d - d')} = \frac{462}{0.9 \times 60 \times (22 - 2.5)} = 0.44 in^2$

STEP 06: Selection and No of bars used.

Steel and tension Zone

We use #7 bar.

dia $(7/8) = 0.875''$, Area $\pi/4\ (0.875) = 0.601 in^2$

So, No OF bars in compression

$= \frac{A_s}{A_b} = \frac{5.98}{0.601} = 9.9 \approx 10$ bar

So, 10 #7 bars.

2 - Steel in Compression Zone.

Let's use # 5 bar

dia $5/8 = 0.625''$, $A = \frac{\pi}{4}(0.625)^2 = 0.306\,in^2$

So, No of bars $= \frac{A_s}{A_b} = \frac{0.44}{0.306} = 1.43 \approx 2$ Bars

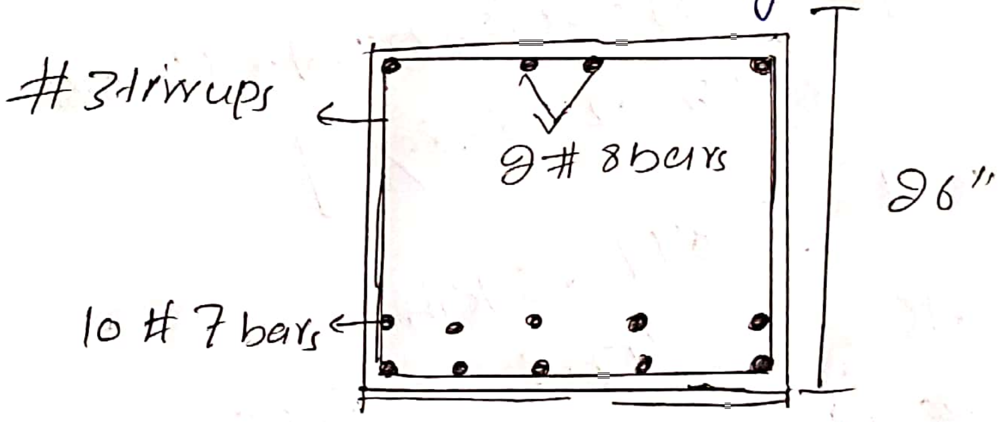
So 2 # 5 Bars.

STEP 08: Minimum width of Beam

$b_{mini} = (2\times1.5) + (2\times 3/8) + 10\,(7/8) + 9\,(7/8)$

$b_{min} = 20.37 > 14''$

So not good in one layer



Now,

→ Effective depth $(d) = 26 - 1.5 - 3/8 - 7/8 - \frac{1}{2}(7/8)$

$= 22.88''$

→ Effective cover $(d') = 1.5 + 3/8 + (5/8)\cdot\frac{1}{2}$

$= 2.18''$

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Step 09: Design Moment.

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

$$a = \frac{(A_{ST} - A_{ST}') \times f_y}{0.85 \times f_c' \times b} = \frac{(10 \times 0.601 - 2 \times 0.306) \times 60}{0.85 \times 4 \times 14}$$

$$a = 6.80''$$

$$M_d = 0.90[(2 \times 0.306) \times 60 \times (22.82 - 2.18) + (10 \times 0.61 - 2 \times 0.306) \times 60 \times (22.82 - 6.80/2)]$$

$$M_d = 7047.6 \text{ Kin}$$

$$A_S = 7047.6 > 6000$$

Design is ok!