Name: M. Abbas

IDNO: 7852

SEC: B

Assignment

PRCD-I

Numericals

Question No, 2, 5 & 6

Q No 2

GIVEN:

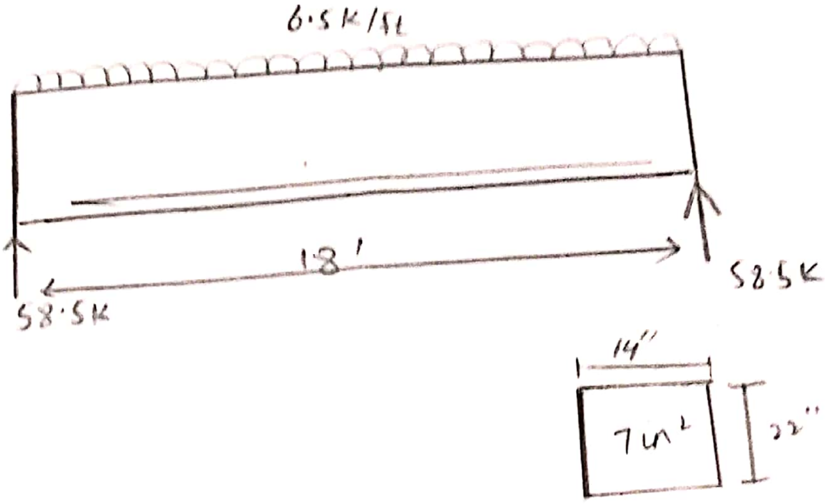
Breath of web of beam $(b_w) = 14''$

Effective depth $d = 22''$

Load = 6.5 K/ft

$f'_c = 4$ ksi

$f_y = 60$ ksi



Step: 02

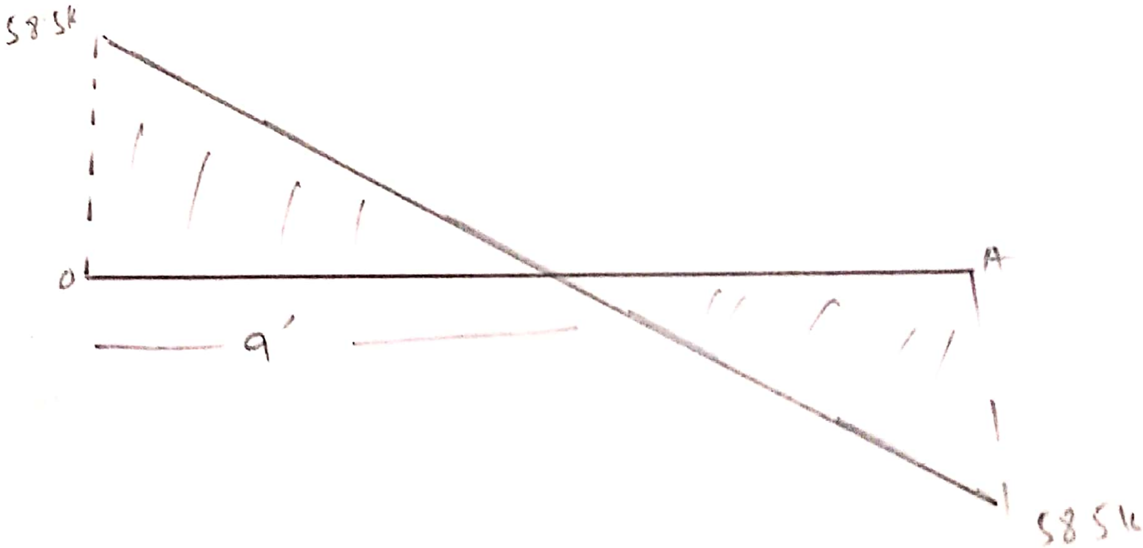
Rxn on supports

$$\frac{6.5 \times 18}{2} = 58.5 \text{Kips}$$

Step: 02

SFD

The require shear force Diagram is

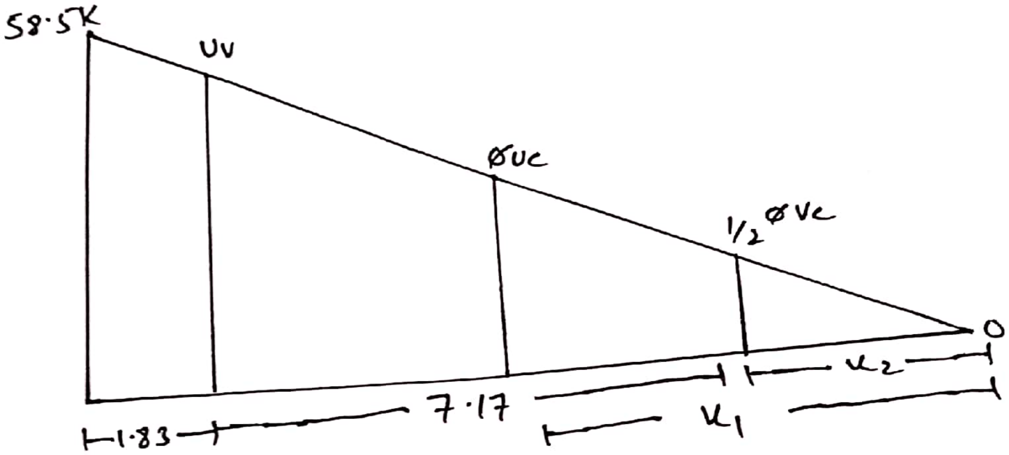


Step : 03

Finding value of Vu and its location

critical shear is located at distance d from support

$(d) = 22'' = 1.83'$



From similar Δs $\frac{58.5}{9} = \frac{V_u}{8.17}$

$V_u = 46.61$ kips

Step: 04:

find value of ϕV_c and $\frac{1}{2}\phi V_c$

$\phi V_c = \phi \times 2 \times \sqrt{f'c} \times b_w \times d$

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

$= 29.21$ kips

Location of ϕV_c by similar Δs

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

$x_1 = 4.49'$

Similarly

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

By formula

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

$$= 46.61 - 29.21$$

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

Step: 06

Check on section adequacy

By formula

$$= \phi \times 8\sqrt{f'c} \times b_w \times d$$

$$= 0.75 \times 8 \times \sqrt{4000} \times 14 \times 22$$

$$= 116877 \text{ lbs}$$

$$= 116.87 \text{ Kips}$$

S As

$\phi \times 8 \times \sqrt{f'c} \times bw \times d > \phi Vs$

F So Section is Adequate

C **Step : 07**

Check on Maximum Spacing for Stirrips

By formula

$= \phi \times 4 \times \sqrt{fc} \times bw \times d$

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

$= 58438$ lbs

$= 58.43$ kips

St As

$\phi \times 4 \times \sqrt{fc} \times bw \times d > \phi Vs$

bi

So Maximum will be selected from the foll

4 Conditions

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

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

3- $\dfrac{Av \times fy}{0.75 \times \sqrt{f'c} \times bw}$

Here we are using # 3 stirrips

$dia = (3/8)'' = 0.375''$

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

For 2-legged stirrup

Area x 2

$0.11 \times 2 = 0.22 in^2$

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

4- $$S_{max} = \frac{A_v \times f_y}{50 \times b_w} = \frac{0.22 \times 60,000}{50 \times 14} = 18.85''$$

Step:08

Stirrup spacing from/at critical section will be by formula

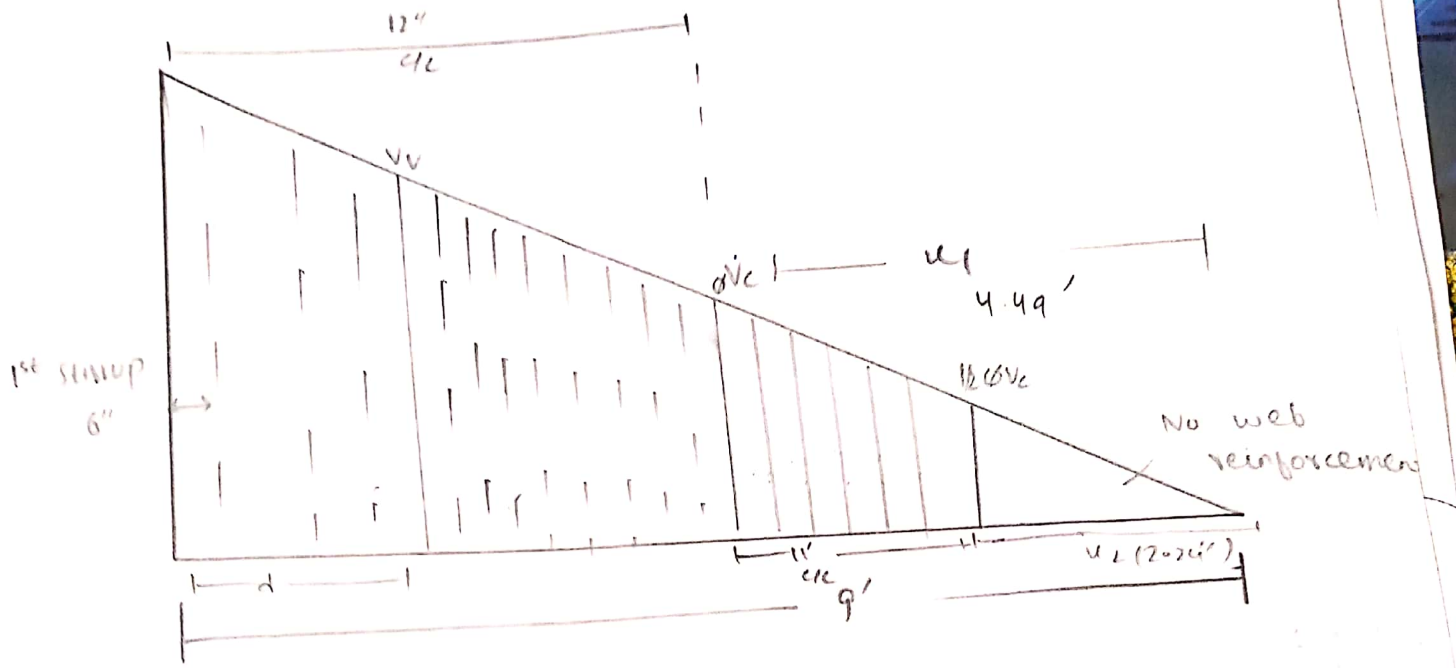
$$S = \frac{\phi \times A_v \times f_y \times d}{V_u - \phi V_c}$$

$$= \frac{0.75 \times 0.22 \times 60 \times 22}{46.61 - 29.21}$$

$S = 12.5'' \approx 12''$

So 12 c/c

Step # 09



As

First stirrup from face of support =

$$S/_2 = 12/_2 = 6''$$

Question No 5

GIVEN:

Height of flange (h_f) = 3.5''

ϕ_c distance = 9'

Span of beam = 16'

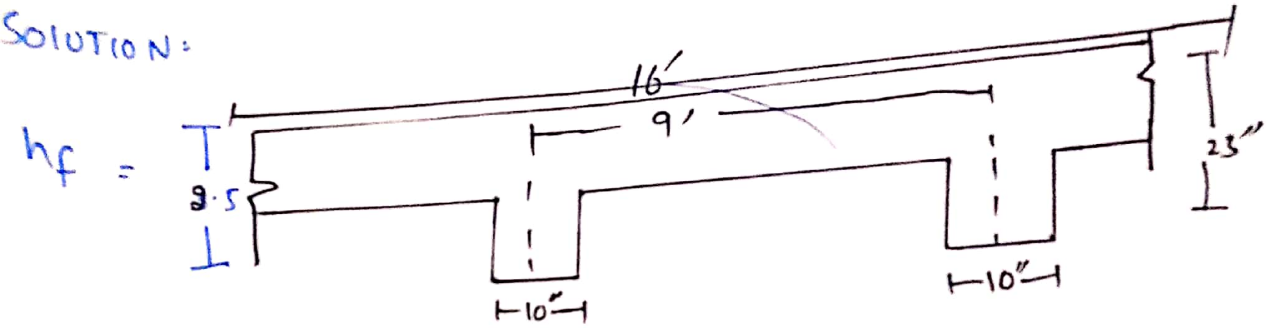
web width (b_w) = 18''

Height, (h) = 23'

Mu = 5800 kip-inch

$f'_c = 3ksi$
$f_y = 60ksi$

SOLUTION:



Step: 01

Calculate the effective width (b_e) for T-beams

1- $16(h_f) + b_w$ = ~~9x12~~ $16(3.5)+10 = 66''$

2- c/c distance = $9 \times 12 = 108''$

3- Span/4 $= \frac{16}{4} \times 12 = 48''$

Selecting the least value of b_e as,

$b_e = 48''$

Step: 02

Check whether Rectangular or T-beam Analysis is required

Trial 01:

Let $a = h_f = 3.5'$

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

$$= 6.61 \text{ in}^2$$

Trial #02

$$a = \frac{A_{st} \times f_y}{0.85 \times f'c \times b_e}$$

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

$$= 3.2''$$

$$3.2'' < 3.5''$$

and

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

So Rectangular Beam Design in Required!

Trial #03

$$a = 3.21''$$

and

$$A_{st} = \frac{5800}{0.90 \times 60 \left(18 - \frac{3.21}{2}\right)}$$

$$= 6.55 \text{ in}^2$$

So Area of steel is 6.55 in^2

Step : 03

Check ρ_{max} and ρ_{min}

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

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

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

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

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

$$0.003 < 0.036 < 0.013$$

As the value of ρ_{max} is less than ρ, so we have to design it as Doubly Reinforced Bear

First we have to find the Area of steel against ρ_{max}

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

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

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

$Ast = 2.34\ in^2$

Step: 04

Finding the values of Mu_2

By formula

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

first finding value of a

$$a = \frac{Ast \times fy}{0.85 \times f'c \times b}$$

$$= \frac{2.43 \times 60}{0.85 \times 3 \times 10}$$

$$a = 5.72''$$

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

$$Mu_2 = 1986.67 \text{ inch}$$

$$Mu_2 < Mu$$

$$1986.67 < 5800$$

So we have to design the beam in such a way that it can resist more bending moment than the applied external moment.

Step: 05

Finding difference in moments and Area of Steel

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

$$= 5800 - 1986.67$$

$$= 3813.33 \text{ kip-inch}$$

By formula:

$$A_{st} = \frac{M_u}{\phi c \times f_y \times (d - d_1)}$$

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

Step: 06

Finding total steel Area

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

$$= 2.43 + 4.56$$

$$= 6.99 \text{ in}^2$$

Step: 07

Selection of Bar:-

(12)

In tension zone:-

let we have use #8 bar

dia (8/8) = 1"

$$Area = \pi/4 (1)^2 = 0.785 in^2$$

By formula

$$\text{No of bars} = \frac{\text{Area of Steel}}{\text{Area of single bar}} = \frac{6.99}{0.785} \simeq$$

So 9 # 8 bars

~~By formula~~

In compression zone

let use no 7 bar

$$Area = \frac{\pi}{4} d^2 = 7/8 \times \pi/4$$

$$= 0.60 \ in^2$$

By formula

$$= \frac{\text{Area of steel}}{\text{Area of single bar}} = \frac{6.99}{0.785} =$$

$$\frac{4.56}{0.60} = 7.5 \approx 8$$

So 8 # 7 bars

Step: 08

Maximum width for Accomodation of bars

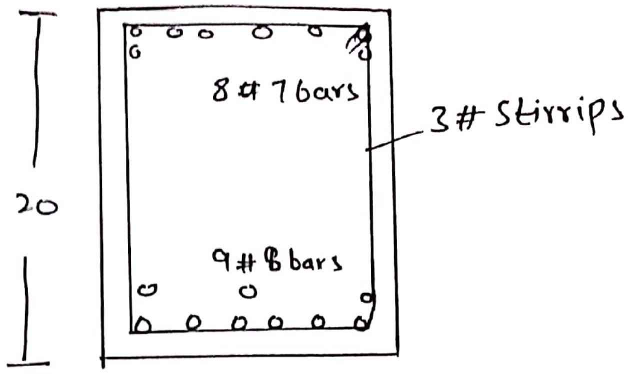
$$b_{min} = (2 \times 1.5) + (2 + 3/8) + 9(8/8) + 8(8/8)$$

$$= 20.75''$$

As

$$20.75'' > 10$$

bars will be place in multiple layers



Effective depth (d) = 23 − 1.5 + 8/8 + 8/8 + 1/2 (8/8) = 19.6"

Effective Cover (d') = 1.5 + 3/8 + 7/8 + 1/2 (7/8) = 3.18"

Step: 09

Finding Design Moment

$$Md = \phi \frac{[As' \times fy \times (d - d')}{0.85 \times fc \times b}$$

$$= \frac{(9 \times 0.785 - 8 \times 0.601) \times 60}{0.85 \times 3 \times 10} = 5.31''$$

$$Md = 0.90 [(8 \times 0.60) \times 60 \times (19.6 - 3.18) + (9 \times 0.785 - 8 \times 0.6 ...$$

$$60 \times (19.6 - \frac{5.31}{2})]$$

Md = 6328.88

As 6328.38 > 5800

⇒ So Design is ok!

Question No : 06 (15)

SOLUTION:

Breadth (b) = 14"

Height (h) = 26"

Concrete Compression strength $f'c$ = 4ksi

Steel Tensile strength (f_y) = 60ksi

M_u = 6000 kip-inch

Effective depth of beam (d) = 22"

Assume effective cover (d') = 2.5"

Step: 01 (Reinforcement Ratio

By formula

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

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

$$\rho_{max} = 0.0180$$

Step: 2 (Area of steel)

As we know that

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

$= 0.0180 \times (14 \times 22)$

$= 5.54 \text{ in}^2$

Step: 03 (Design Moment)

By using formula

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

$$a = \frac{Ast \times fy}{0.85 \times f'c \times b} = \frac{5.54 \times 60}{0.85 \times 4 \times 14}$$

$= 6.98''$

So,

$$Mu_2 = 0.90 \times 5.54 \times 60 (22 - 6.98/2)$$

$= 5537.4 < 6000$

So, we have to design a section as doubly reinforced

Step: 04 (Difference In Moment)

$$Mu_1 = Mu - Mu_2$$

$= 6000 - 5537.4$

$= 462.6$ kip-inches

Step: 05: (Area of steel)

$$Mu_1 = \varnothing \times Ast \times fy \times (d - d')$$

So Area of steel in compresive zone will be

$$\Rightarrow Ast = \frac{Mu_1}{\varnothing \times fy \times (d-d')} = \frac{462.6}{0.90 \times 60 \times (22-2.5)}$$

$$\Rightarrow Ast = 0.44 \, in^2$$

Step # 06

(Total steel Area)

$$As = Ast + Ast$$

$$= 5.54 + 044$$

$$= 5.98 \, in^2$$

Step: 07

1- Steel in tension zone:-

we use # 7 bars

$$dia = (7/8) = 0.875''$$

$$Area = \frac{\pi}{4} (0.875)^2$$

$$= 0.601 \, in^2$$

So,

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

$= \frac{5.98}{0.601} = 9.9 \approx 10$ bars

So 10 # 7 bars

2- Steel in compressive zone:

we use # 5 bars

dia = $5/8 = 0.625''$

Area = $\frac{\pi}{4}(0.625)^2$

$= 0.306 \, in^2$

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

$= \frac{0.44}{0.306} = 1.43 \approx 2$ bars

So 2 # 5 bars

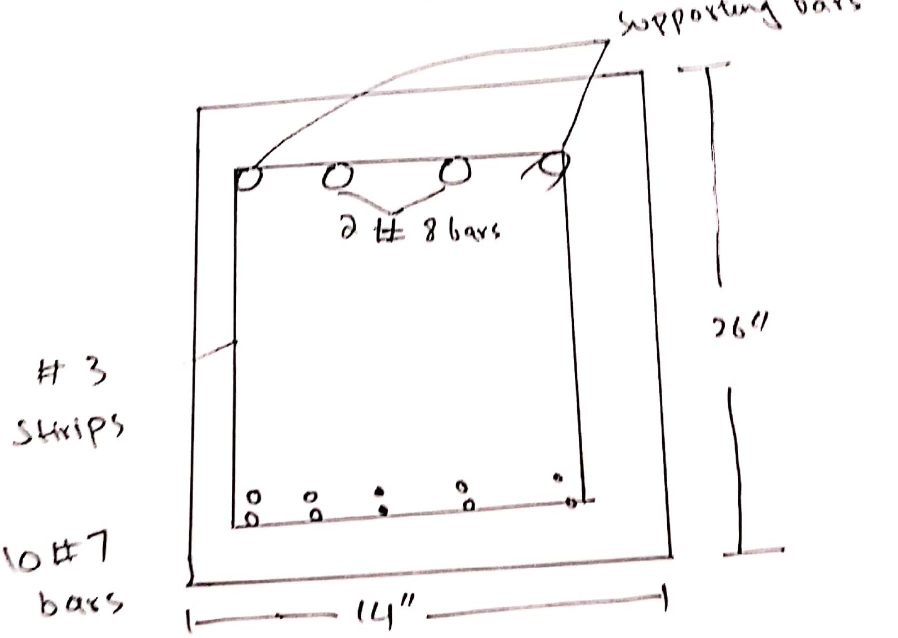
Step : 08

(Minimum width of Beam)

$b_{min} = 2(1.5) + 2(3/8) + 10(7/8) + 9(7/8)$

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

∴ so not good in one layer



Now,

Effective depth (d) $= 26 - 1.5 - 3/8 - 7/8 - 1/2(7/8)$

$= 22.82''$

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

$= 2.18''$

Step : 09 : (Design Moment)

$$M_d = \phi\left[A_{st} \times f_y \times (d - d') + (A_{st} - A'_{st}) \times f_y \times (d - a/2)\right]$$

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

$$= \frac{(10 \times 0.601 - 2 \times 0.306) \times 60}{0.85 \times 4 \times 14}$$

$$= 6.80''$$

$$M_d = 0.90\{(2 \times 0.306) \times 60 \times (22.82 - 2.18) + (10 \times 0.601 - 2 \times$$

$$\times 60 \times (22.82 - 6.80/2)$$

M_d = 7047.6 kip-inches

As 7047.6 > 6000

Design is OK

THEORY

Question No

1, 3 & 4

QNO 1

Explain in detail types of stirrips with figures and Also explain ACI codes for shear design.

ANSWER:

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:

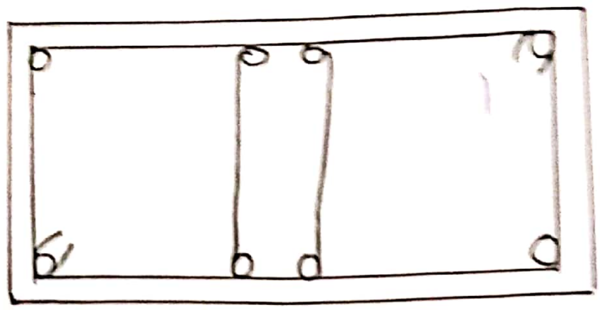
The single legged stirrups have rarely been used because they are mostly used when binding only two rods.

2- Two- Legged Stirrup:

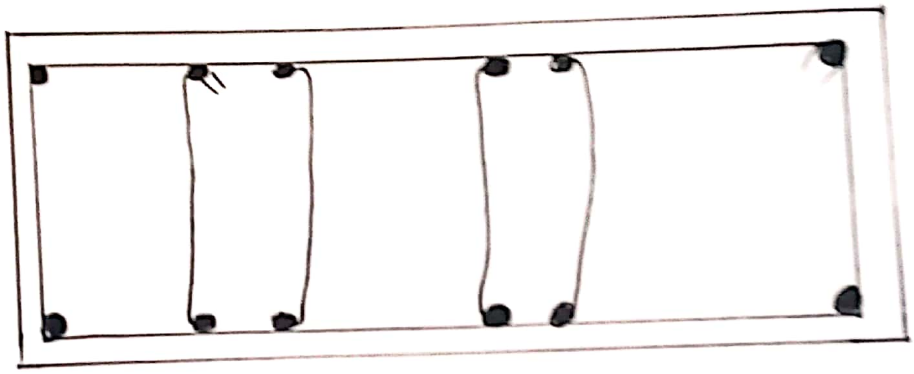
It is most commonly and widely used stirrup. Minimum 4 bars are required for providing this stirrup

3- Four Legged Stirrup:-

These stirrups are used in case of web reinforcement.



4- Six Legged Stirrup:



ACI CODES FOR SHEAR DESIGN OF A BEAM:

According to ACI-318, following are the shear des[ign] of a beam.

1- Critical Section:

Critical Section occur at 45° an[d] is at distance "(d)" from the face of support which is equal to effective depth.

Four Legged Stirrup:-

ok

2- Shear Strength Capacity of Convete is:

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

3 - Minimom web Reinforcement:

If $V_u \leq \phi V_c$, then theoritically no web reinforcement is required. However ACI Code require provision of at least minimum area of web reinforcement. equal to

4- For Minimum Reinforcement Area:

If $V_u \leq \phi V_c$, then theorolically no web reinforcement is required. However ACI Code require provision of at least minimom area of web reinforcemen.

$\phi = 0.75 \longrightarrow$ For Shear design.

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

By interchanging the above formula, we can obtain the formula for maximum spacing

$$S_{max} = \frac{A_v \times f_y}{0.75 \times \sqrt{f'_c} \times b_w} \quad \text{or} \quad \frac{A_v \times f_y}{850 \times b_w}$$

3 4- No web reinforcement is required if

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

⇒ Between critical section "V_u" and "ϕV_c" spacing b/w web reinforcement can be find by

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

5- If $V_s \leq 4 \times \sqrt{f'c} \times b_w \times d$, then max spacing of web rein for stirrops will be the smallest of the following

1- 24"

2- d/2

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

4- $S_{max} = \frac{A_v \times f_y}{50 \times b_w}$

If

$V_s > 4 \times \sqrt{f'c} \times b_w \times d$

Max spacing will be halved.

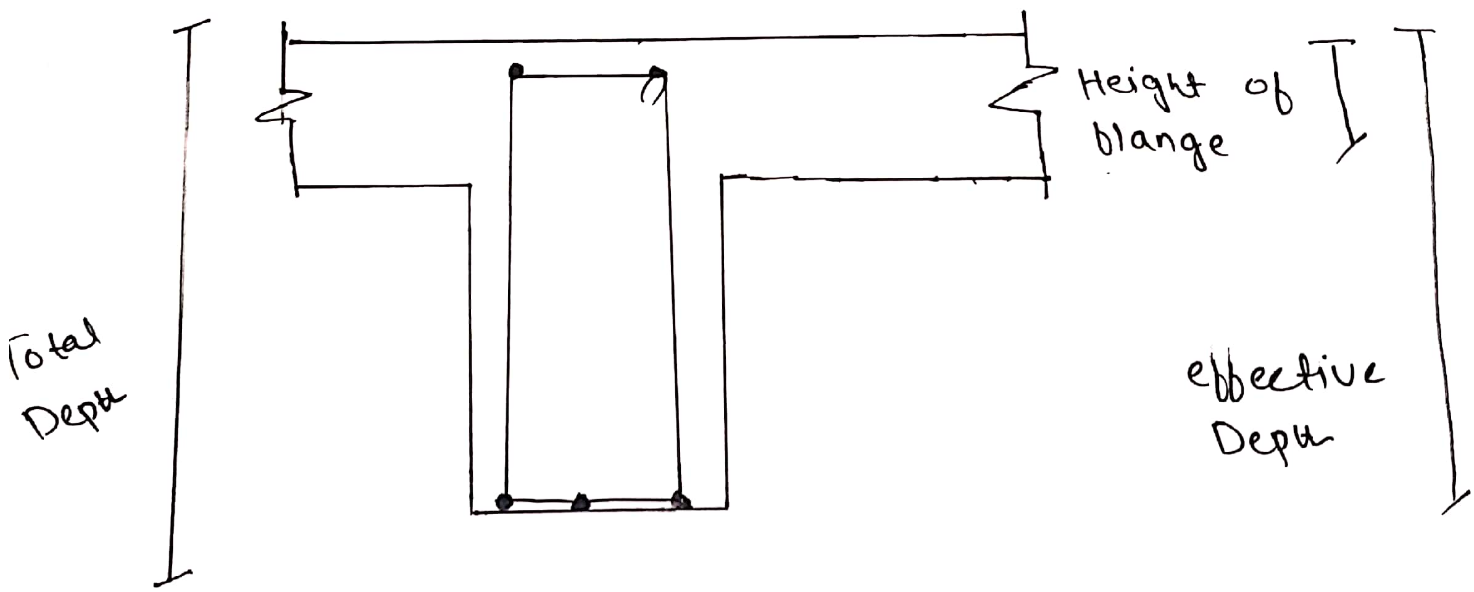
Question No: 3

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

ANSWER:

T-BEAM:

In most of reinforcement Concrete Slabs are Cast monolithically with the Slab so, in this case the beam that act as an intermediate beam are Called T-beam

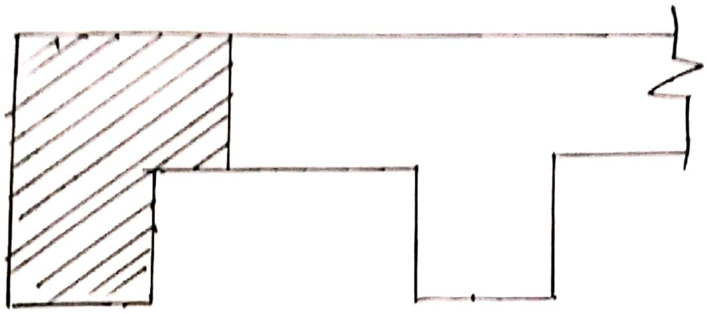


Because of their T-shape these beams are called T-beams

> It is provided at the center of the slab to resists the load.

3-f L-BEAM:

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



4

⇒ L-beam are also called Edge Beam

⇒ It is always provided at the corner of the slab.

Flexural Analysis. OF T-BEAM:

Flexural Analysis of T-Beam consists of the following steps

For finding the ultimate factored moment, we use the following formula.

$$M_u = \frac{w_u \times L^2}{8}$$

2- Effective width (b_e) for T-Beam is calculated as

L- BEAM:

3- Fo L- Shaped structure ...
Th the Slab.

5- For checking the range of Reinforcement Ratio,

$$\rho_{max} = 0.85 \times \beta \times \frac{f'c}{fy} \times \left(\frac{\varepsilon u}{\varepsilon u + \varepsilon y} \right)$$

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

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

Question No 4

What is the difference b/w Case-I and Case-2 in the Design of T-Beam?

ANSWER:

CASE-I

From the figure

$a < hf$

So in this case, Rectangular Beam Analys is required so, Fo 1- $16(h_f) + b_w$

Th 2- c/c distance

w 3- Span/4

4- $\frac{CTS}{2} + b_w$

3 - Checking whether Rectangular or T-Beam Axial

i - If $a > h_f$ → Special Analysis Required

⇒ ii - If $a < h_f$ → Rectangular beam analysis is required.

⇒

a = Depth of compression block

Fl. h_f = Height of flange

Le 4- For finding Area of Steel, we have to use

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

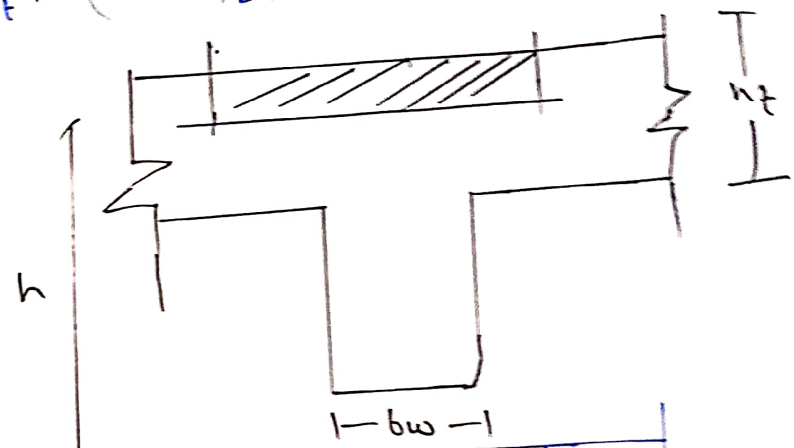
where

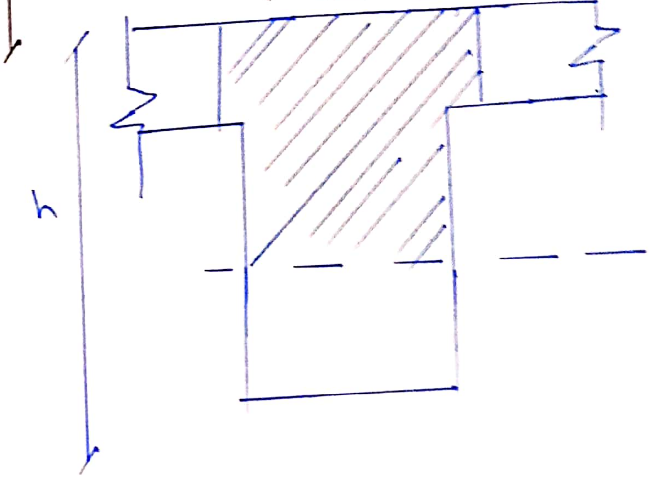
$$a = \frac{A_{st} \times f_y}{0.85 \times f_c' \times b_w}$$

1- $16(h_f) + b_w$

the Design Moment formula will be

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





Case - II

from figure

$a > h_f$

So in this special beam analysis is required

So the required Design Moment

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