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PAPER : RICD

TECHNALOGY : B.Tech . Civil .

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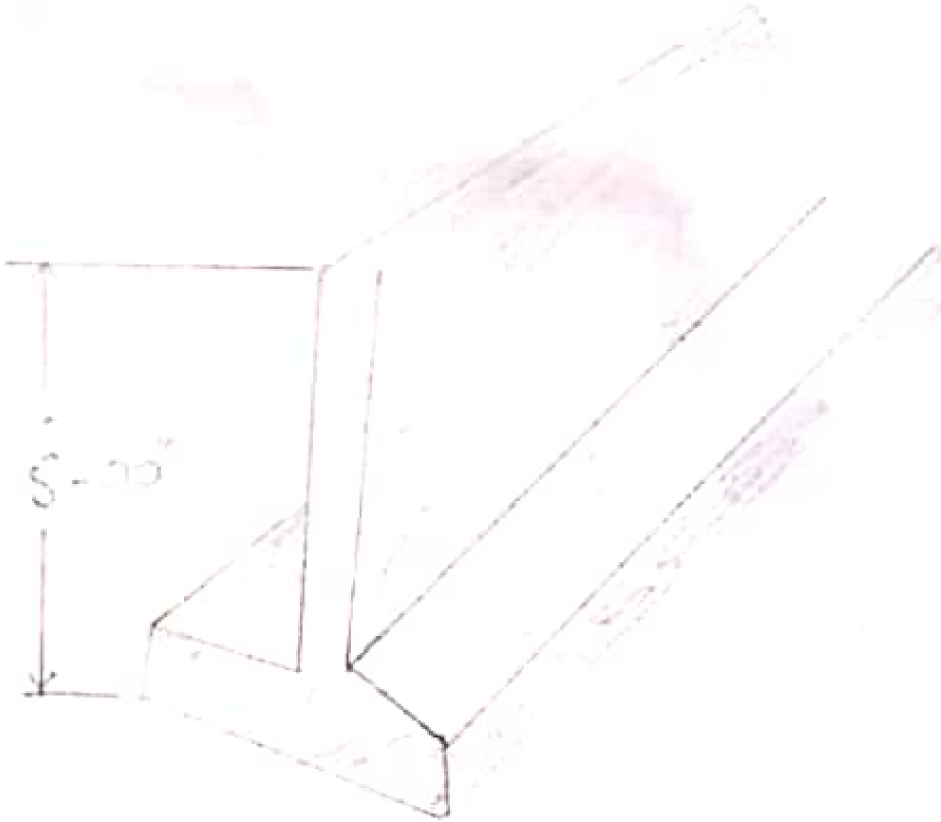
1 Ans:2

page=1

Question # 2

A 12-in-thick concrete wall carries a service dead load of 10 kips/ft and a service live load of 12.5 kips/ft. The allowable bearing capacity q_a is 5000 psf at the level of the base of the footing which is 5 ft below the final ground surface. Design a wall footing using $f'_c = 3500$ psi and $f_y = 60{,}000$ psi. The density of soil is 120 lb/ft^3.

Ans



Ans:2

Step#01 Estimate the thickness of footing, h

* Assuming a trial thickness, $h = 12$ in
* Effective depth $d = 12 - 3$ in. cover $- \frac{1}{2}$ (bar diameter) $= 8.5$ in.

Step#02 Calculate weight of fill and weight of concrete, W

* $W = W_{conc} + W_{fill} = 1 \times 0.15 + 4 \times 0.12 = 0.63$ ksf

Step#03: Calculate effective bearing capacity q_e

* $q_e = q_a - W$

  $q_e = 5 - 0.63 = 4.37$ ksf

Step#04 Calculate bearing area A_{req}

* $A_{req} = \text{Service load} / q_e$

  Service load $= 10 + 12.5 = 22.5$ kips/ft

  $A_{req} = 22.5 / 4.37 = 5.15\ ft^2$ per foot of Length

* Trying a footing 5 ft 2 in. wide.

→ Step#05 calculate design pressure on base of footing due to factored loads q_u

q_u = factored load / Bearing area

Factored loads = 1.2(10) + 1.6(12.5)
= 32 kips

→ $q_u = 32/5.17 = 6.19$ ksf

→ Step # 06 Calculate the critical Shear, V_u

→ only one-way shear is significant in wall footing hence determining critical shear at distance d from the face of support

→ $d = 12 - 3$ in cover − ½ (bar diameter)
= 8.5 in.

→ $V_u = q_u b(k-d)$

→ $V_u = 6.19 \times 1(25-8.5)/12)$

= 8.51 kips/ft

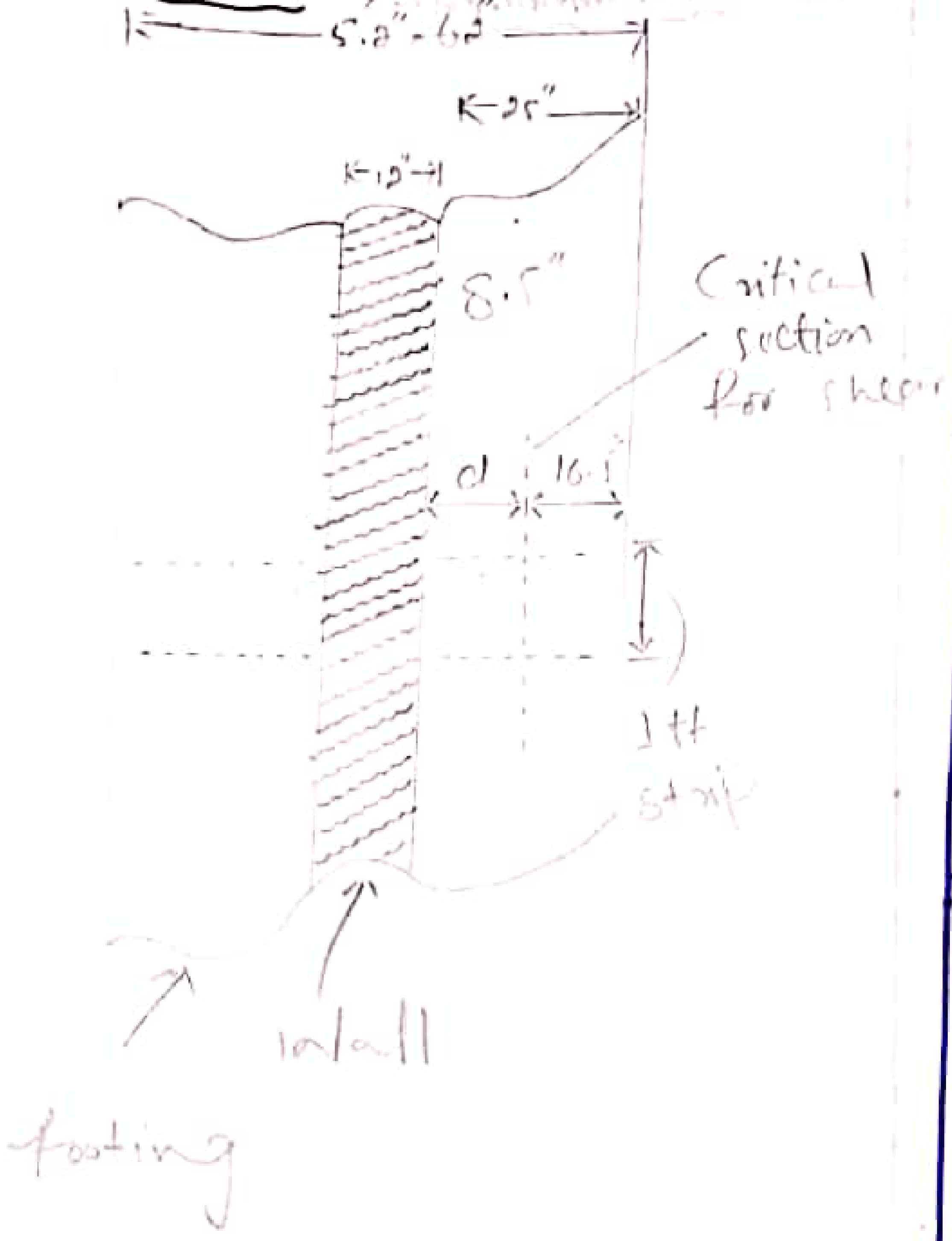
→ Step # 07 Check the Shear Capacity. ϕV_c

→ Check the thickness for shear

→ shear capacity. $\phi V_c = \phi 2\sqrt{f'_c}\, bd$

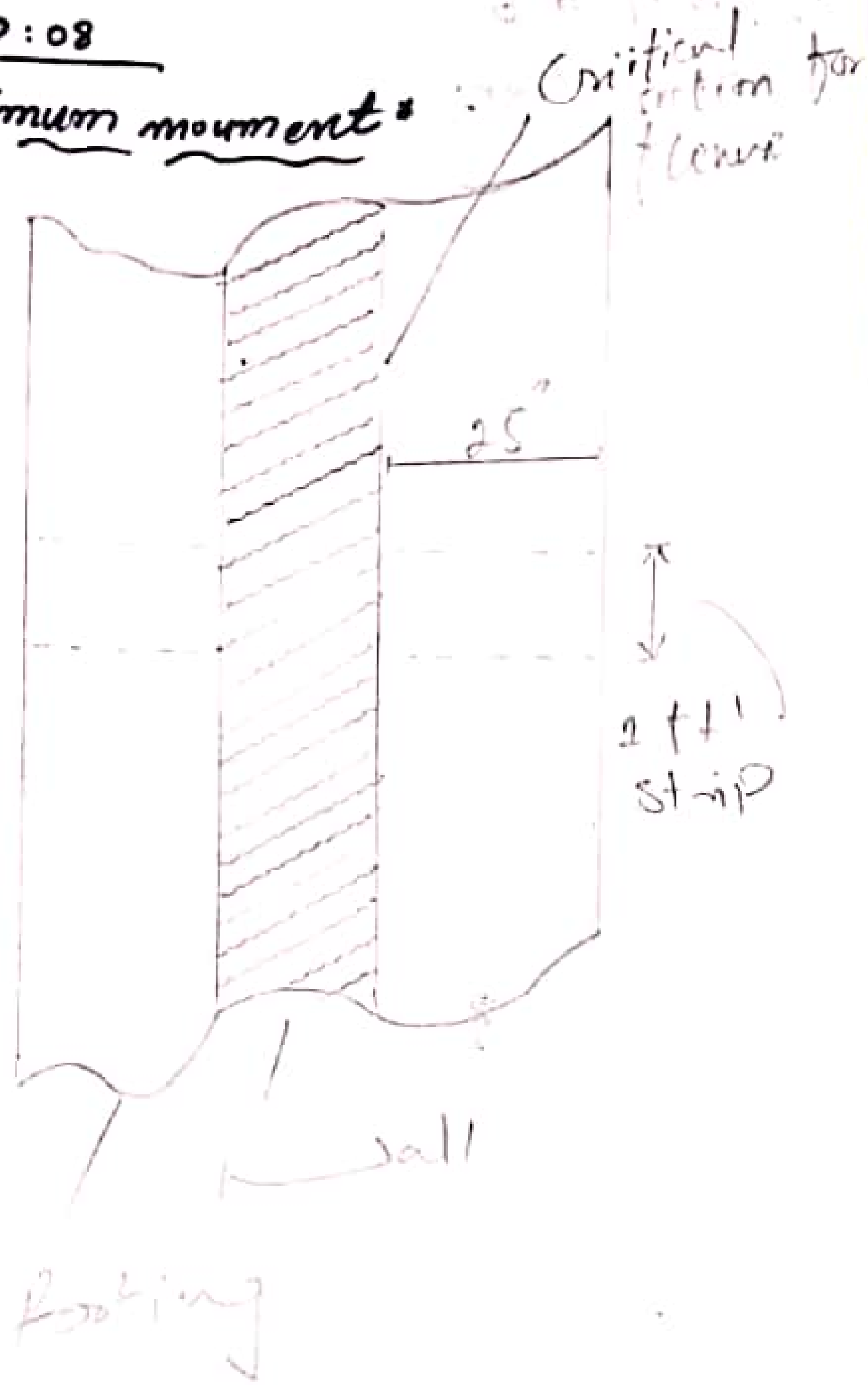
Ans#2 # Step # 6

Critical shear:



Ans#2#Step: 08

maximum moument:



$= (0.75 \times 2 \times \sqrt{(3500)} \times 12 \times 8.5)/1000$

$\phi V_c = 9.05$ kips

→ Since $\phi V_{cr} > V_u$, the footing depth is ok. Otherwise, chose a new thickness and repeat the previous steps.

→ Using 12 in thick and 5 ft 2 in wide footing.

→ Step # 08 Calculate maximum moment M_u

→ $M_u = \frac{q_u b k^2}{2} = 6.19 \times 1 \times (25/12)^2/2$

$= 13.43$ ft. kips per ft

→ Step # 09 Calculate steel area A_s

→ Now using trial and success method for determining A_s.

$A_s = M_u / \phi f_y (d - a/2)$ $a = 0.2h$

→ $A_s = 0.390$ in^2 per foot.

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Step #10 Minimum reinforcement check

Min reinforcement

$A_{s\,min} = 0.0018bh = 0.0018 \times 12 \times 12 = 0.26$ in²/ft

$A_s (0.390 in^2) > A_{s\,min} (0.26 in^2)$ ok

Step #11 main Bars Spacing and maximum spacing check.

Main Bars spacing $= A_b \times 12 / A_s$

Using #5 bars, spacing $= 0.31 \times 12 / 0.390$
$= 9.53 = 9$ in c/c

Max spacing $= 3h$ or $18'' = 3(12) = 36''$
or $18''$ (ok)

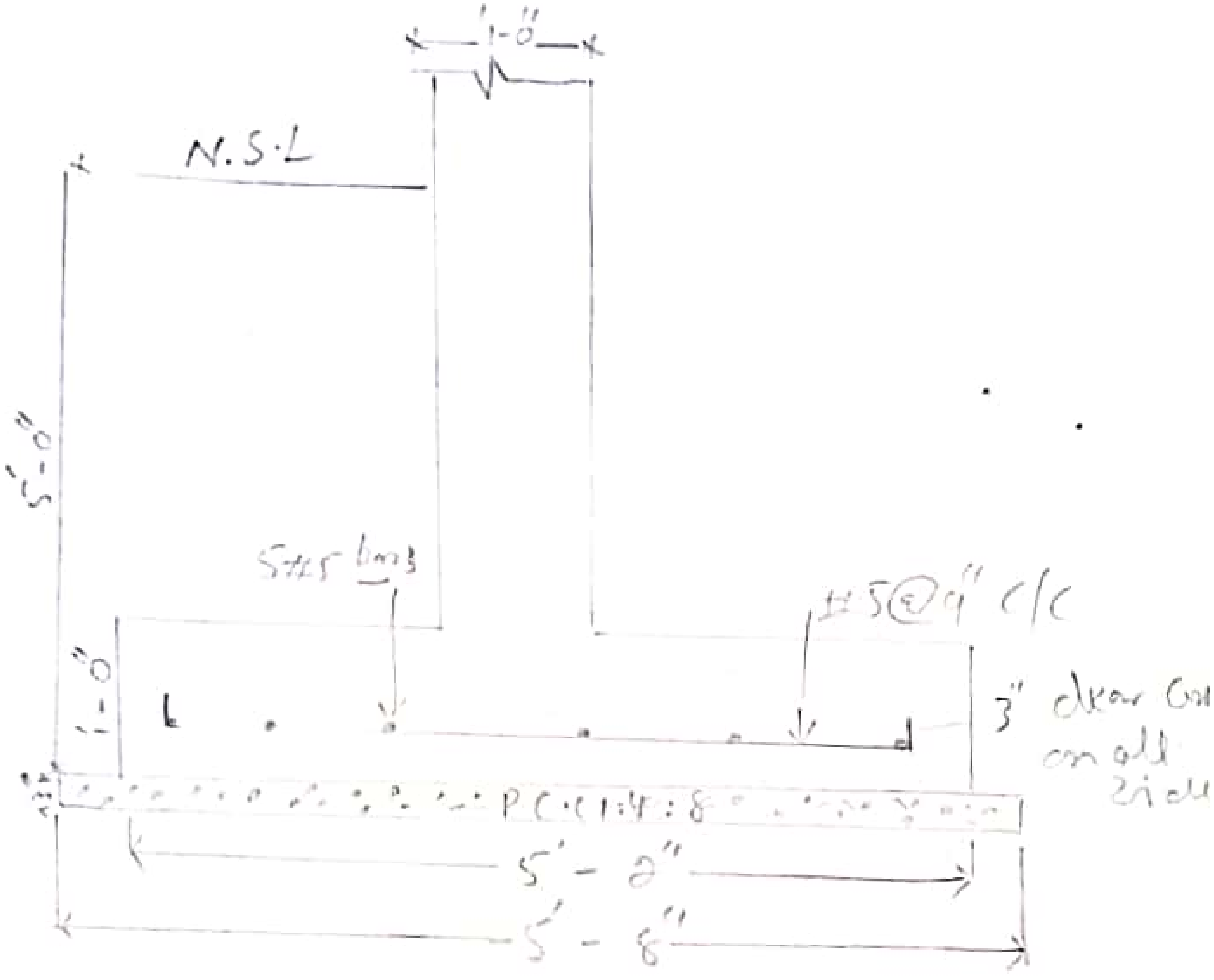
Step #12 Distribution Bars Placement

$A_{dist} = 0.0018Bh = 0.0018 \times 62 \times 12 = 1.34 in^2$

No of bars $= A_{dist} / A_b = 1.34 / 0.31 = 4.32$
$= 5$ bars.

Ans: 2 page#8

Ans#3 #Step: 13 Drafting:



Ans3 page #9

Question No# 3

Design a 18"x 18" tied column for a factored axial compressive load of 300 kips. The material strengths are f'_c = 3ksi and f_y = 40 ksi.

Answer

Sol: Nominal strength ($a\phi P_n$) of axially loaded column is:

$$a\phi P_n = 0.80\phi\{0.85 f'_c(A_g - A_{st}) + A_{st} f_y\}$$

$$A_g = 18 \times 18 = 324 \text{ in}^2$$

Let A_{st} = 1% of $A_g = 0.01 \times 324 = 3.24$

$$a\phi P_n = 0.80 \times 0.65 \times \{0.85 \times 3 \times (324 - 3.24) + 3.24 \times 40\}$$

492 kips > (P_u = 300 kips), O.k

Therefore, $A_{st} = 0.01 \times 324 = 3.24 \text{ in}^2$

MAIN bar:

Using # 6 bar, with bar area $A_b = 0.44 \text{ in}^2$

No of bars $= A_s/A_b = 3.24/0.44 = 7.36$
= 8 bars.

Ans:3 page #10

→ Use 8 # 6 bars.

Tie Bars:

→ using # 3 bar, with bar area $A_b = 0.11 in^2$

→ center to center spacing shall not exceed the least of,

(i) → $16 d_b$ of longnitudal bar $= 16 \times 0.75 = 12''$

(ii) → $48 d_b$ of tie bar $= 48 \times 3/8 = 18''$

(iii) Smallest dimension of member $= 18''$

→ These fore use # 3 ties

→ @ 12'' c/c.

Question: 1
Design the Beam for Shear and flexural Stresses Shown as Per ACI 318-14

W_d = 0.75 kip/ft
W_L = 0.75 kip/ft Take f'_c = 3 ksi
f_y = 40 ksi

Answer:

Flexural and Shear Design of Beam as per ACI:

Sol:

Step No 01: Sizes

- For 20' length h min = 1/16 = 20'12/16 = 15"
- For grade 40 we have = h min = 15" × (0.4 + 40000/100,000) = 12"
- This is the minimum requirement of the code for depth of beam.
- However we select 18" deep beam.
- Generally the minimum beam width is 12" therefore, width of the beam is taken as 12"

The final Selection of beam Size depends on several factors specifically the availiblity of formwork.

Step No 1 sizes:

Depth of beam, h = 18"

h = d + $\bar{y}$, $\bar{y}$ is usually taken from 2.5 to 3.0 inches

For $\bar{y}$ = 2.5 in, d = 18 − 2.5 = 15.5"

width of beam cross of Section (bw) = 12"

In RCD width of beam is usually denoted by bw instead of b

Step No 02 : Load:

Self weight of beam = $\gamma_c b_w h$ = 0.15 × (12×18/144) = 0.225 kips/ft

$w_u = 1.2 w_D + 1.6 w_L$

$= 1.2 \times (0.225 + 0.75) + 1.6 \times 0.75 = 2.37$ kips/ft

Step No 03 Analysis

Flexural Analysis:

$M_u = W_u L^2/8 = 2.37 \times (20)^2 \times 12/8 = 1422$ in kips

Analysis for Shear in beam:

$V = 23.7$ kips

To find V_u at a distance 'd' from face of support, $d = 15.5'' = 1.29'$

using similarity of triangles

$V_u/(10 - 1.29) = 23.7/10$

$V_u = 23.7 \times (10 - 1.29)/10 = 20.63$ k

Step No 04: Design.

Design for flexure.

$\phi M_n \geq M_u$ (ϕM_n is M_{design} or $M_{capacity}$)

For $\phi M_n = M_u$

$\phi A_s f_y (d - a/2) = M_u$

$A_s = M_u / \{\phi f_y (d - a/2)\}$

Calculate A_s by trial and success method.

Flexural and shear Design of Beam as per ACI:

Design for flexure:

First trial:

Assume $a = 4''$

$A_s = 1422 / [0.9 \times 40 \times \{15.5 - (4/2)\} = 2.92\ in^2$

$a = A_s f_y / (0.85 f_c b_w)$

$= 2.92 \times 40 / (0.85 \times 3 \times 12) = 3.81$ inches

Second Trial:

$A_s = 1422 / [0.9 \times 40 \times \{15.5 - (3.82/2)\}]$

$= 2.90\ in^2$

$a = 2.90 \times 40 / (0.85 \times 3 \times 12) = 3.79$ inches

Third trial:

$A_s = 1422 / [0.9 \times 40 \times \{15.5 - (3.79/2)\} = 2.90\ in^2$

$a = 4.49 \times 40 / (0.85 \times 3 \times 12) = 3.79$ inches

close enough to the previous value of

a' So that $A_s = 2.90\ in^2$ O.K

Check for maximum and minimum reinforcement allowed by ACI

$A_{smin} = 3(\sqrt{f'_c}/f_y)\, b_w d \geq (200/f_y) b_w d$

$3(\sqrt{f'_c}/f_y)\, b_w d = 3 \times (\sqrt{3000}/40000)$

$b_w d = 0.004 \times 12 \times 15.5 = 0.744\ in^2$

$(200/f_y)\, b_w d = (200/40000) \times 12 \times 15.5$

$= 0.93\ in^2$

$A_{smin}\ 0.93\ in^2$

$A_{smax} = 0.27\,(f'_c/f_y)\, b_w d = 0.27 \times (3/40) \times 12 \times 15.5 = 3.76\ in^2$

$A_{smin}(0.93) < A_s(2.90) < A_{smax}(3.76)$

ok

Bar placement 5 #7 bars will provide 3.0 in² of steel area which slightly greater than required

other options can be explored for example.

7 # 6 bars (3.08 in²)

4 # 8 bars (3.16 in²)

or combination of two different size bars.

Design for Shear:

→ $V_u = 20.63$ kips

→ ϕV_c = (Capacity of concrete in Shear) $= \phi 2 \sqrt{f'c}\, b_w d$

$= 0.75 \times 2 \times \sqrt{3000} \times 12 \times 15.5/1000$

$= 15.28$ kips

As $\phi V_c < V_u$ shear reinforcement is required.

→ Assuming #3, 2 legged ($0.22 in^2$) vertical stirrups.

→ spacing required $(S_d) = \phi A_v f_y d / (V_u - V_c)$

$= 0.75 \times 0.22 \times 40 \times 15.5 / (20.63 - 15.28) \approx 19.12''$

→ Maximum spacing and manimum reinforcement requirement as permitted by ACI is minimum of

→ $S_{max} = A_v f_y / (50 b_w) = 0.22 \times 40000 / (50 \times 12)$

$= 14.66''$

→ $S_{max} = d/2 = 15.5/2 = 7.75''$

→ $S_{max} = 24'$

→ $A_v f_y / 0.75 \sqrt{f'_c}\, b_w = 0.22 \times 40000 / (0.75 \times \sqrt{3000} \times 12) = 17.85''$

→ Therefore $S_{max} = 7.75''$

Other Checks:

Check for depth of beam.

$\phi V_s \leq \phi 8 \sqrt{f'c}\, bwd$

$\phi 8 \sqrt{f'c}\, bwd = 0.75 \times 8 \times \sqrt{3000} \times 12 \times 15.5/1000$
$= 61.12\ K$

$\phi V_s = V_u - \phi V_c = 20.63 - 15.28 = 5.35\ K < 61.12K$, o.k.

Therefore depth is o.k if not increase depth of beam.

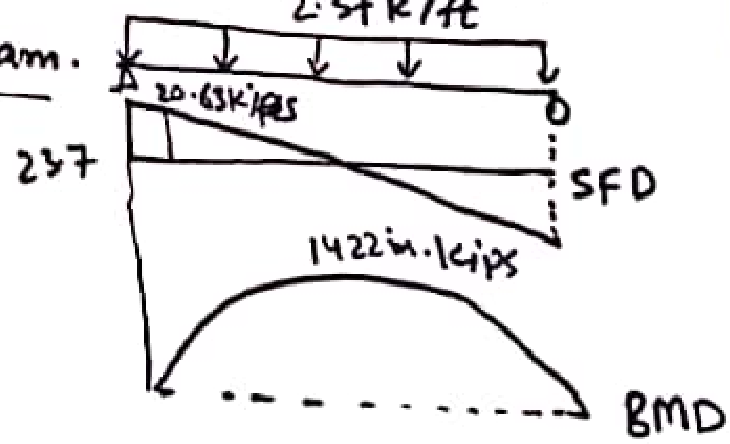
Check if $\phi V_s \leq \phi 4 \sqrt{f'c}\, bwd$

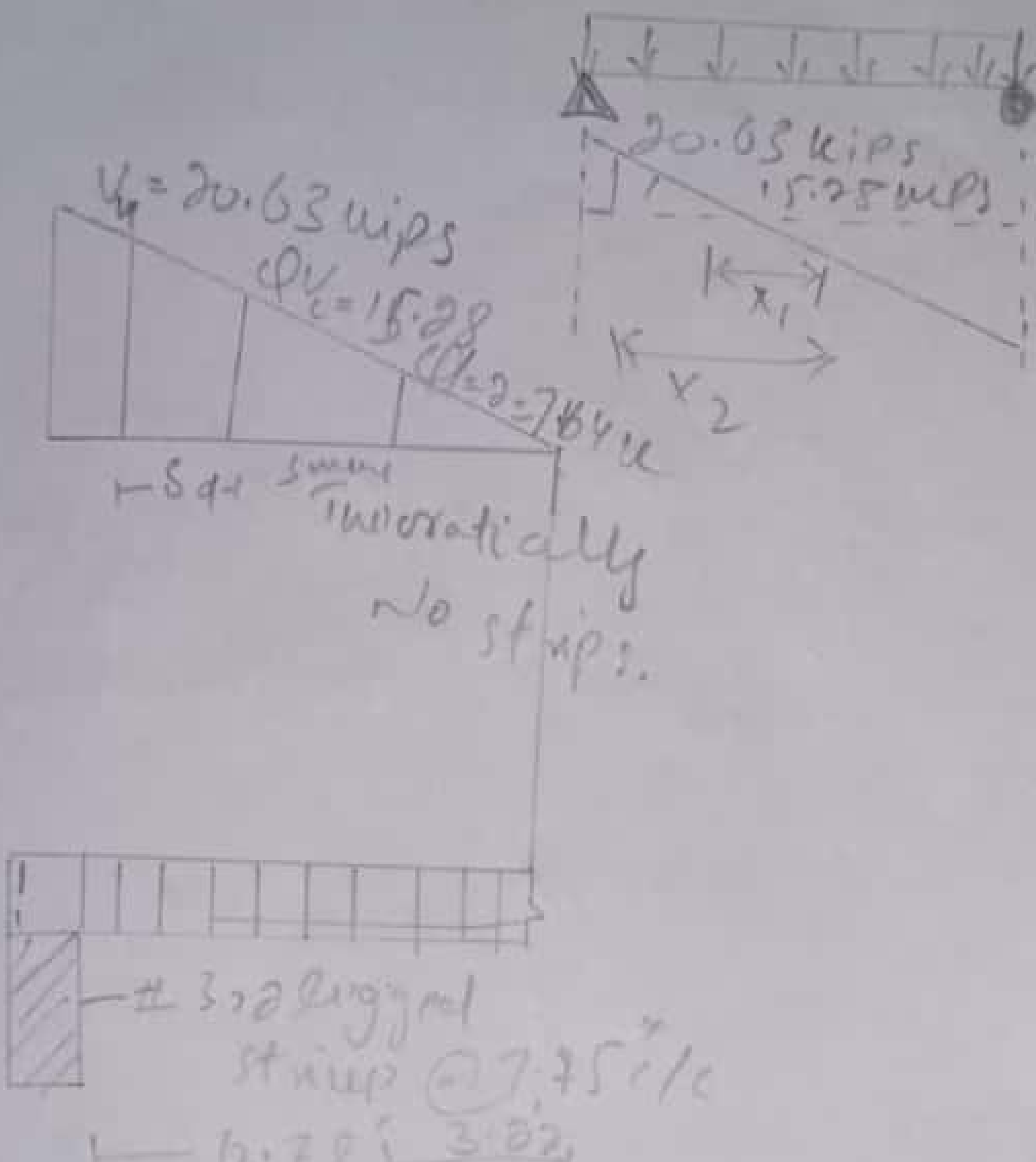
5.35 kips < 30.56 kips o.k

$\phi V_s \leq \phi 4 \sqrt{f'c}\, bwd$ the maximum spacing (S_{max}) is o.k otherwise reduce spacing by one half.

:diagram

* **Analysis for shear in beam.**




20.63 kips
15.28 kips
x_1
x_2
V_u = 20.63 kips
ϕV_c = 15.28
$\phi V_c/2$ = 7.64 k
5 ft
theoretically no stirups.
#3 2 legged stirrup @ 7.75" c/c
6.78
3.82