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ID	15341
Subject	Advance Design of Reinforced Concrete Structure.

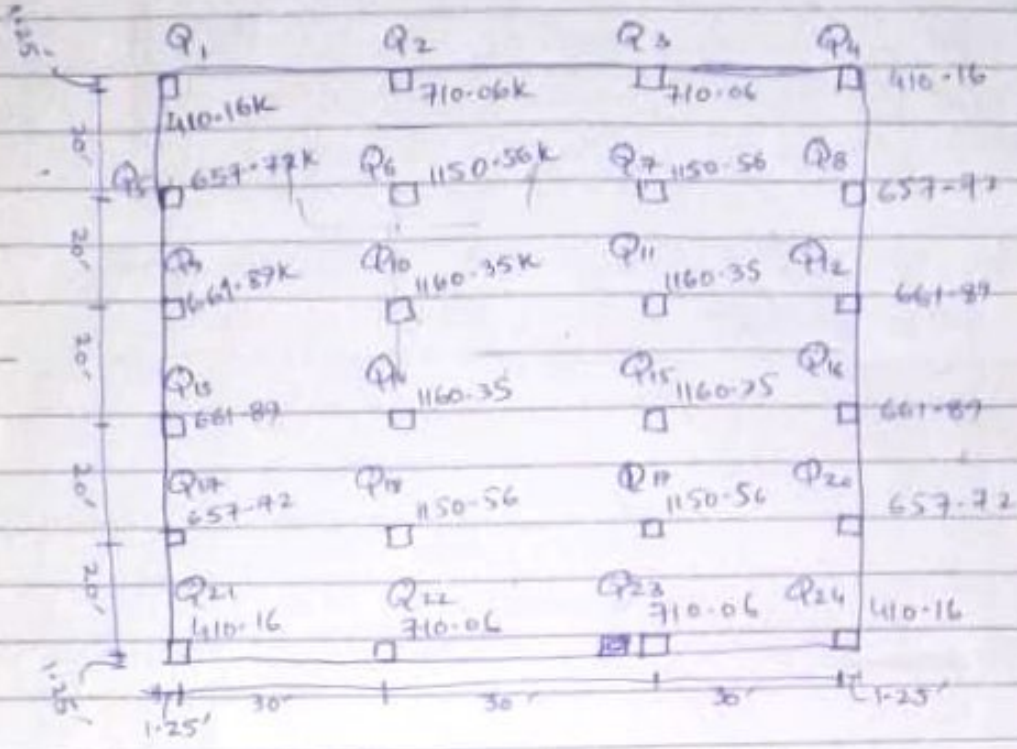
Design of foundation : (footing)

The Design of the foundation for a structure Comprises three stages.

- The first is to determine from an inspection of the site, the nature of the ground, & having selected the stratum upon which to imposed load, to decide the safe Bearing pressure.
- The second stage is to selecte the Type of foundation & the suitability of one or more types may have to be compared.
- The third stage is to design the selected foundation to transfer and distribute the load from the structure to the ground.

-- All Design steps carried with proper loading Criteria has been covered in the following Design Raft footing for Reinforced Concrete multi story structure.

DESIGN OF MAT FOUNDATIONS:



Total service load = T.D.L + T.L.L

= 13513.32 + 5489.76

= 19003.08 K

Total Factored load = 1.4 D.L + 1.7 L.L According to (ACI)

= 27700.764 K

$A = 92.5 + \frac{102.5}{} = 9481.25\ ft^2$

$I_x = \frac{BL^3}{12} = 8301031.901\ ft^4$

$I_y = \frac{LB^3}{12} = 6760328.776\ ft^4$

$Q = (4 \times 410.16) + 4(657.72) + (4 \times 661.89) + 4(710.06) + (4 \times 1150.56) + (4 \times 1160.35) = 19002.96K$

$M_y = Q e_x$

$e_x = x' - \frac{B}{2}$

To Find x':

$$x' = \frac{1}{19002.96}\Big[(1.25)(2\times410.16+2\times657.72+2\times661.89) + (31.25)(2\times710.06+2\times1150.56+2\times1160.35) + (61.25)(2\times710.06+2\times1150.56+2\times1160.35) + (91.25)(2\times410.16+2\times657.72+2\times661.89)\Big]$$

$$x' = \frac{1}{19002.96}\Big[4324.425 + 315683.025 + 188810.625 + 370068.825\Big]$$

$$\boxed{x' = 46.25'}$$

$$e_x = 46.25 - \frac{92.5}{2} = 0$$

$$\boxed{M_y = 0}$$

$M_x = Q e_y$

$e_y = 0 \Rightarrow \boxed{M_x = 0}$

$$q = \frac{Q}{A} \pm \frac{M_x Y}{I_x} \pm \frac{M_y x}{I_y}$$

As M_x and M_y both equal zero:

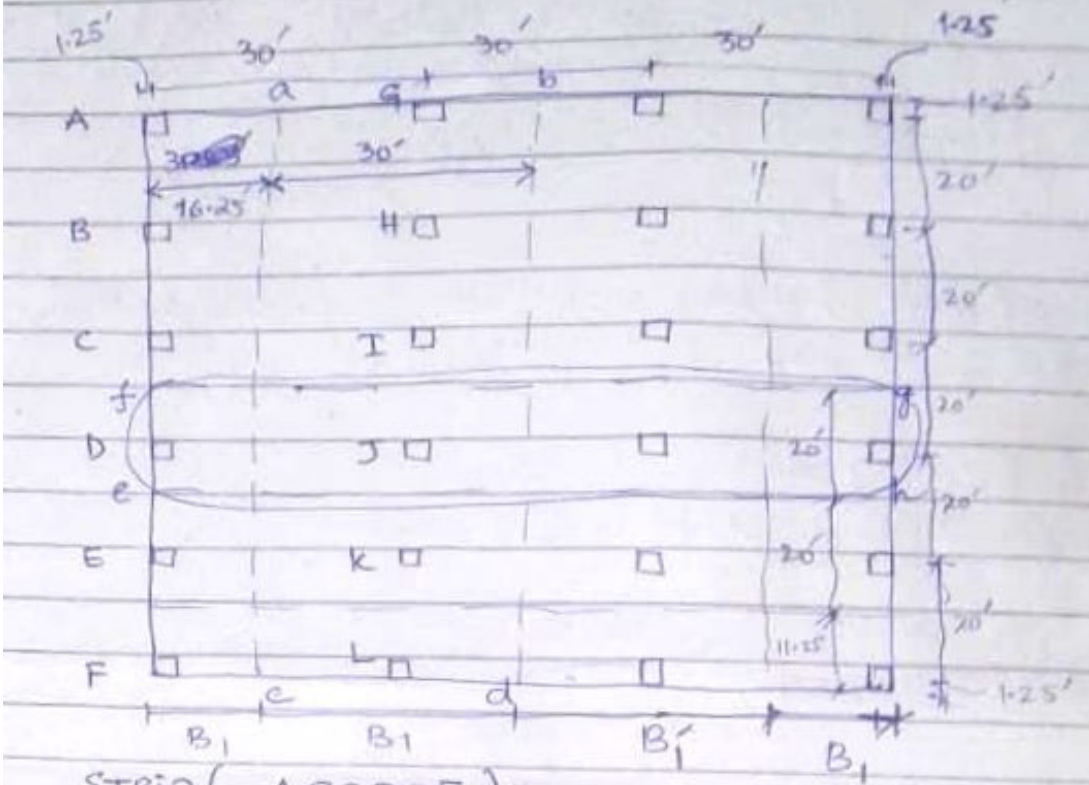
$$\Rightarrow \boxed{q = \frac{Q}{A}}$$, for all column loads.

$$q = \frac{19003.08}{(92.5)\times(102.5)} = \boxed{2.004\ k/ft^2}$$

As, $q \le q_{all(net)}$ so $(2.004 < 2.204)\ k/ft^2$

ok!

Now dividing the mat into strips;



STRIP (ABCDEF):

Average soil pressure = $\frac{q_A + q_F}{2}$

$= \frac{2.004 + 2.004}{2}$

$\Rightarrow q_{avg} = \boxed{2.004 \text{ k/ft}^2}$

Total soil reaction = $q_{avg} B_1 L$

$= (2.004)(16.25)(102.5)$

$= \boxed{3337.91 \text{ k}}$ ✓

Avg Load = $\frac{\text{load due to soil reaction} + \text{column loads}}{2}$

$= \frac{(3337.91) + (3459.54)}{2}$

$\boxed{\text{Avg Load} = 3398.73 \text{k}}$ ✓

So, modified avg soil pressure = $q_{av}\left(\frac{\text{Avg Load}}{\text{Total Soil Reaction}}\right)$

$= 2.004\left(\frac{4939.3}{6719.96}\right)\left(\frac{3398.73}{3337.91}\right)$

$\Rightarrow$ ~~$q_{avg\,(modified)} = 1.54\ k/ft^2$~~

$q_{avg\,(modified)} = 2.041\ k/ft^2$

→ The column loads can be modified in a similar manner by multiplying factors:-

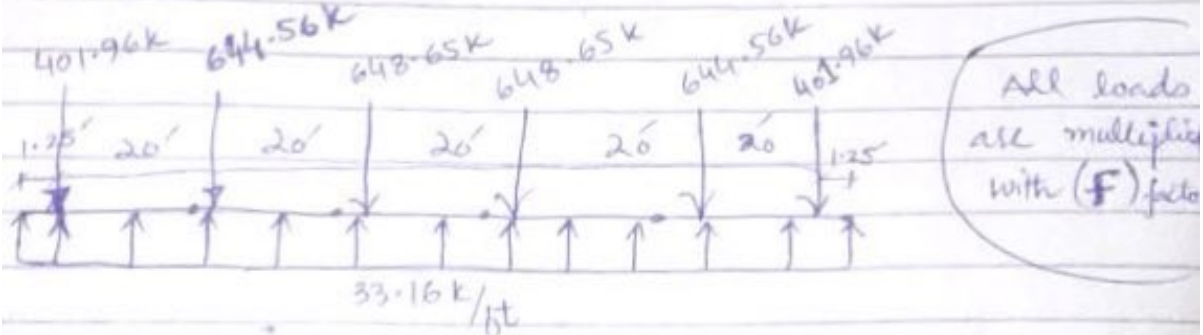
$F = \frac{\text{Avg load}}{\Sigma[\text{column loads in strip ABCDEF}]}$

$F = \frac{4939.3}{3459.54} = 1.42$

$F = \frac{3398.73}{3459.54} = 0.98$

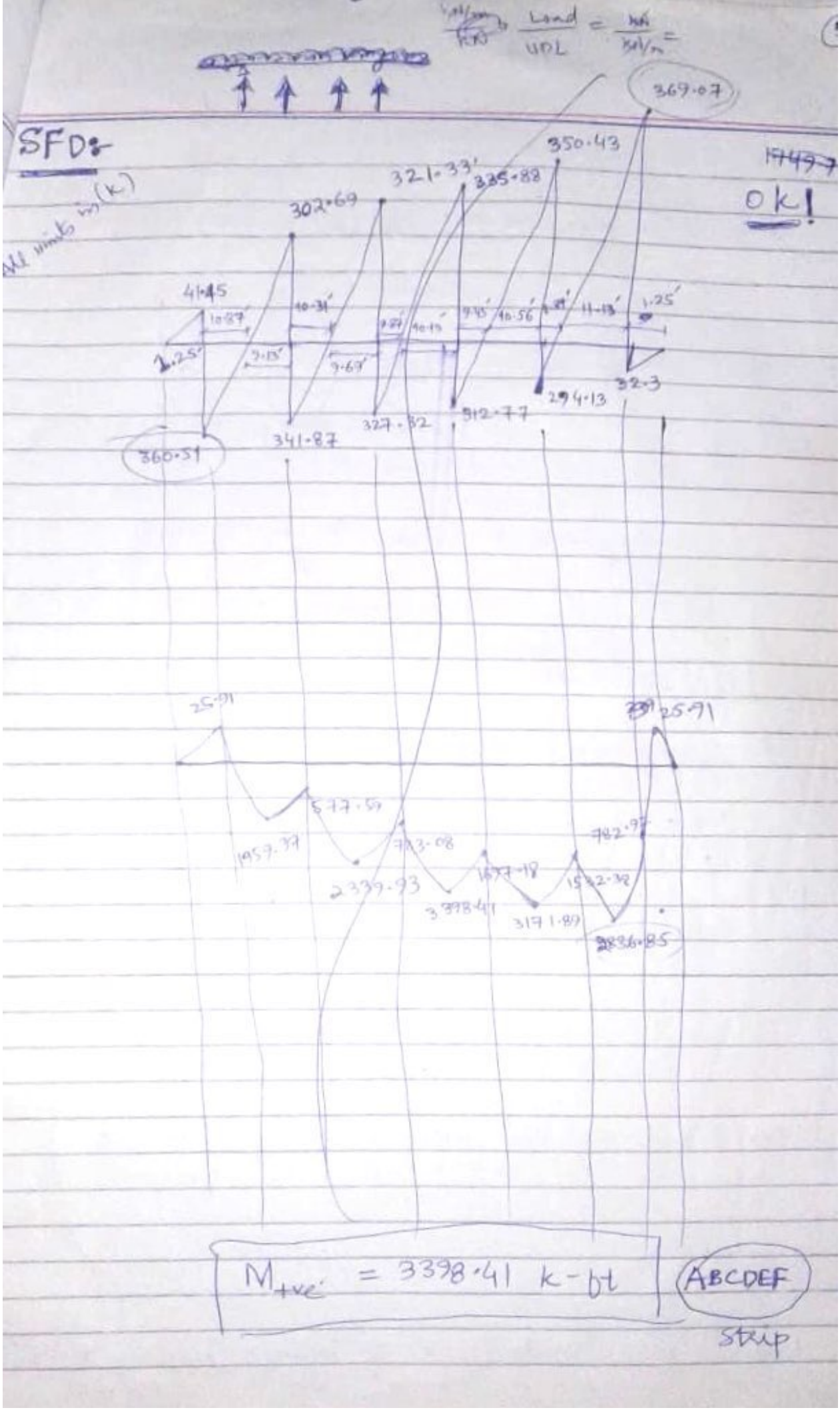
Load per unit length of the beam $= q_{avg\,(modified)} * B_1$

$= 16.25 \times 2.041 = 33.16\ k/ft$



All loads are multiplied with (F) factor

(P.T.O)



For strip (abcd):

Avg soil pressure = $\frac{q_a + q_b}{2} = \frac{2.004 + 2.004}{2}$

$q_{avg} = \boxed{2.004\ k/ft^2}$

Total soil reaction pressure = $q_{avg}\ B, L$

$= 2.004 \times 30 \times 102.5$

$= \boxed{6162.3\ k}$

Avg Load = $\frac{(6162.3) + (6041.94)}{2}$

$= \boxed{6102.12\ k}$

$\boxed{Q = 19002.96\ k}$

As we know that our plan is symmetri

$\Rightarrow \quad e_x = e_y = 0$

$\Rightarrow \quad M_x = M_y = 0$

Now;

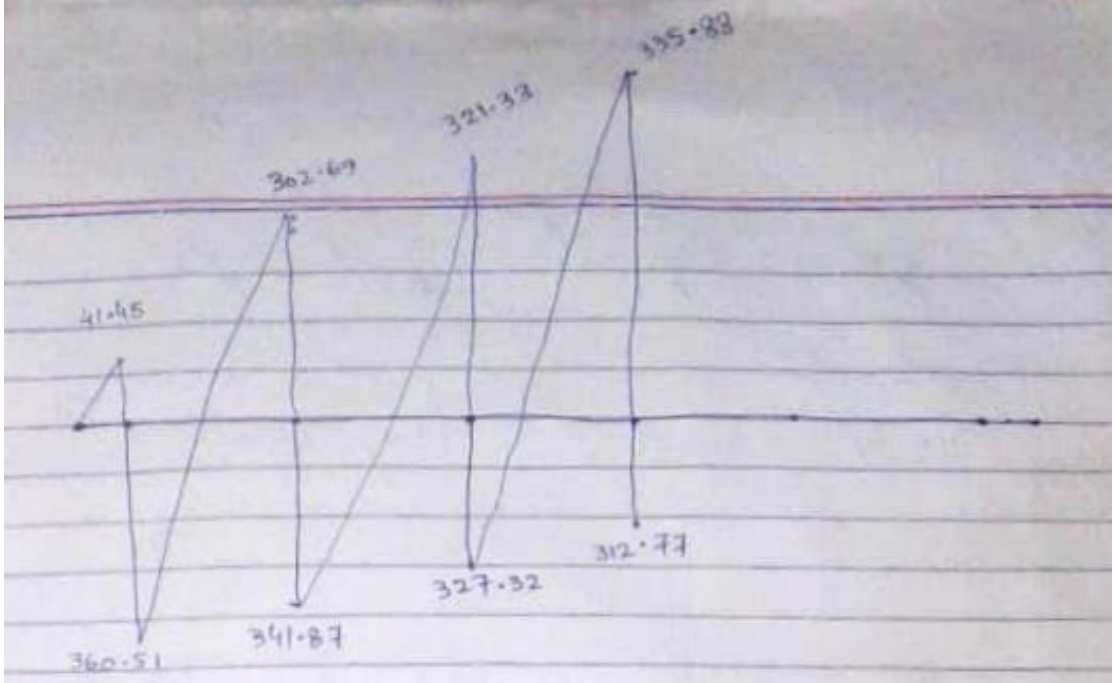
$\Rightarrow \quad \boxed{q = \frac{Q}{A}}$

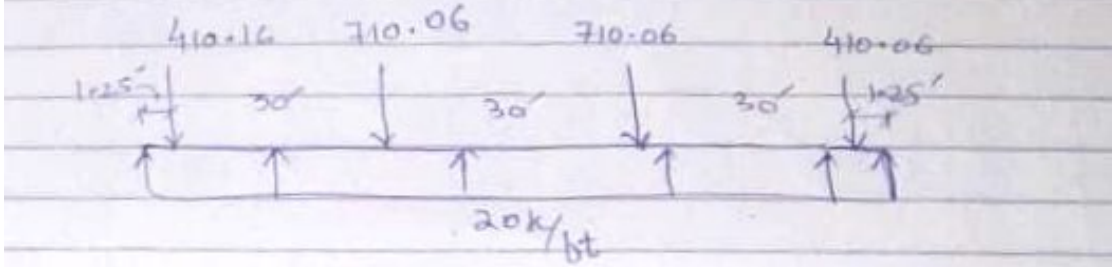
$q = \frac{19002.96}{92.5 \times 102.5} = \boxed{2.004\ k/ft^2}$

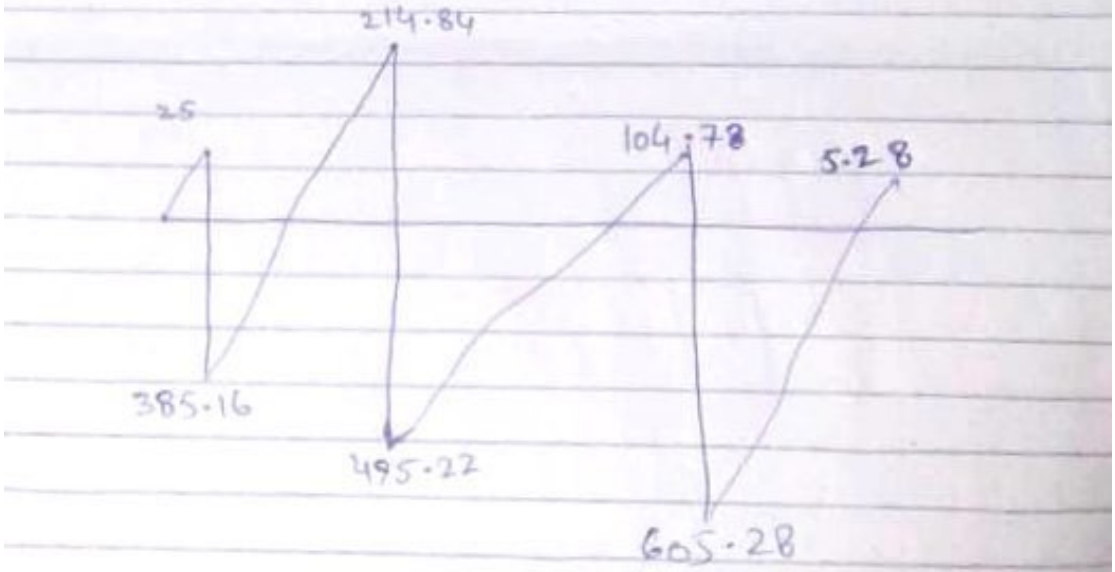
Modified avg soil pressure = $2.004 \times \left(\frac{6102.12}{6162.3}\right)$

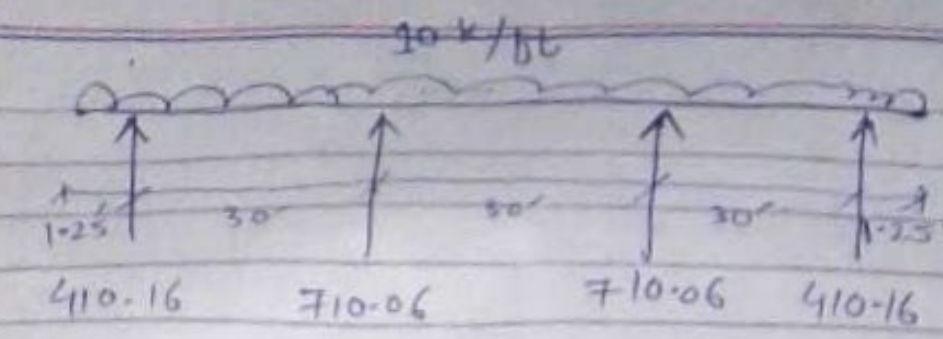
$= \boxed{1.98\ k/ft^2}$

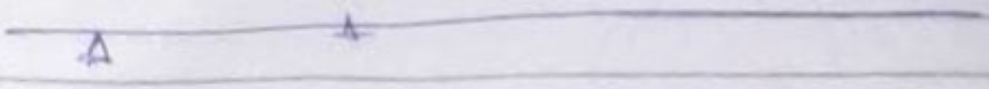
Load per unit length of beam = q_{avg} (Modified) $* 1$



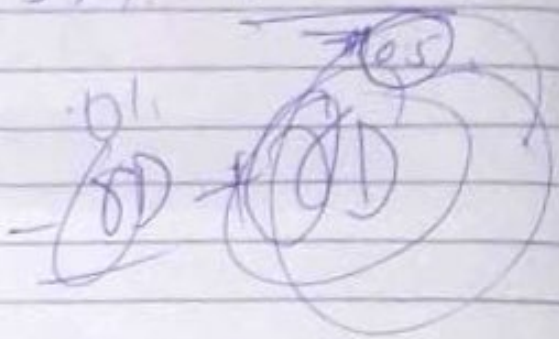


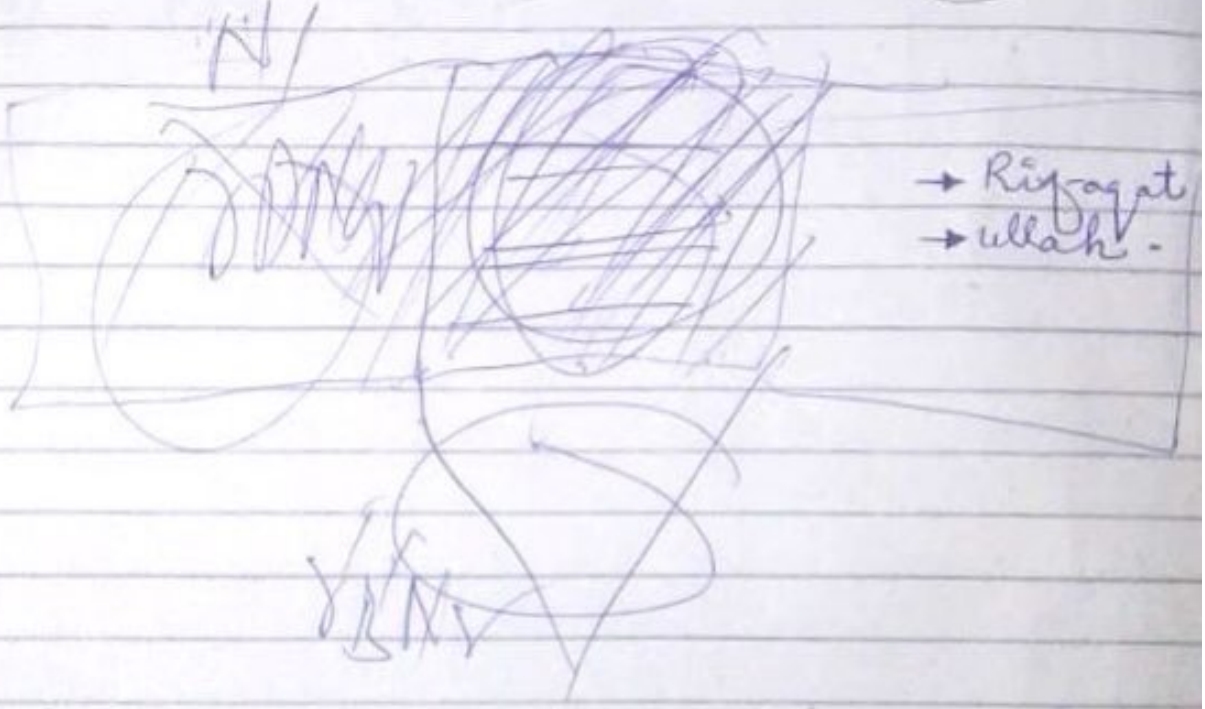






3358.9 → 3390.34, 8.56 k-p



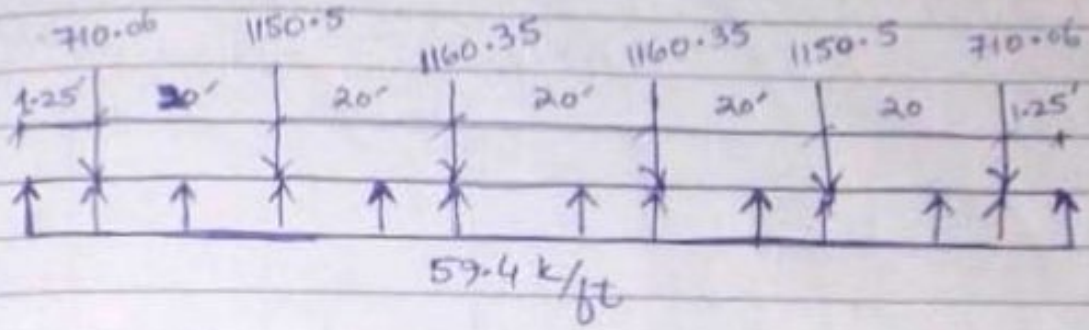


→ Rifaqat
→ ullah.

$= q_{avg} \times B_1 = 1.98 \times 30$
(modified)

$= \boxed{59.4\ k/ft}$

Without factor:



$\Rightarrow 59.4 \times 102.5 - 6041.94 = \boxed{49.56\ k}$

With factor:

$$F = \frac{\text{Avg. Load}}{[\Sigma \text{ col. loads}]}$$

$$F = \frac{6102.12}{6041.94} = \boxed{1.009\ k}$$

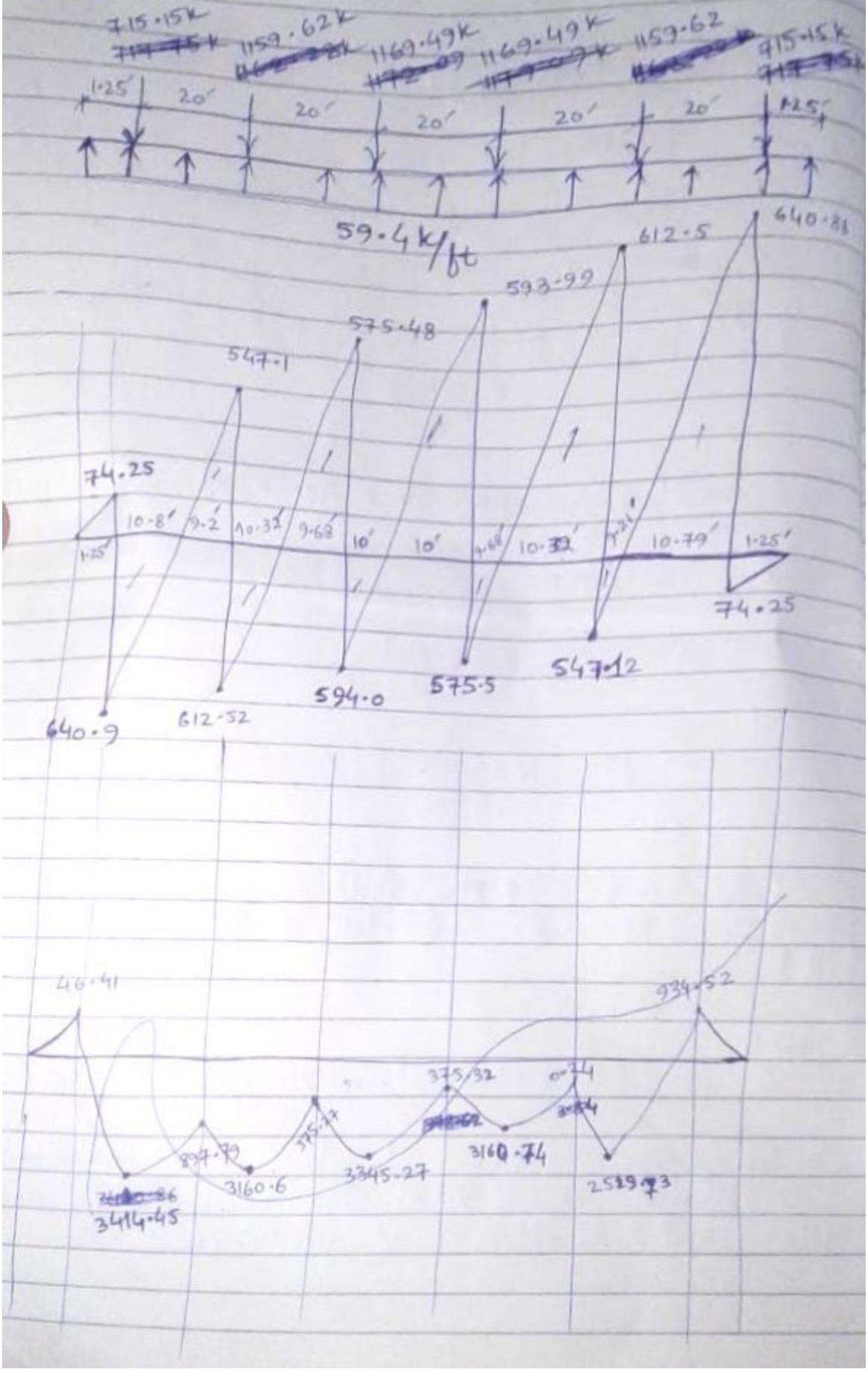
Now;

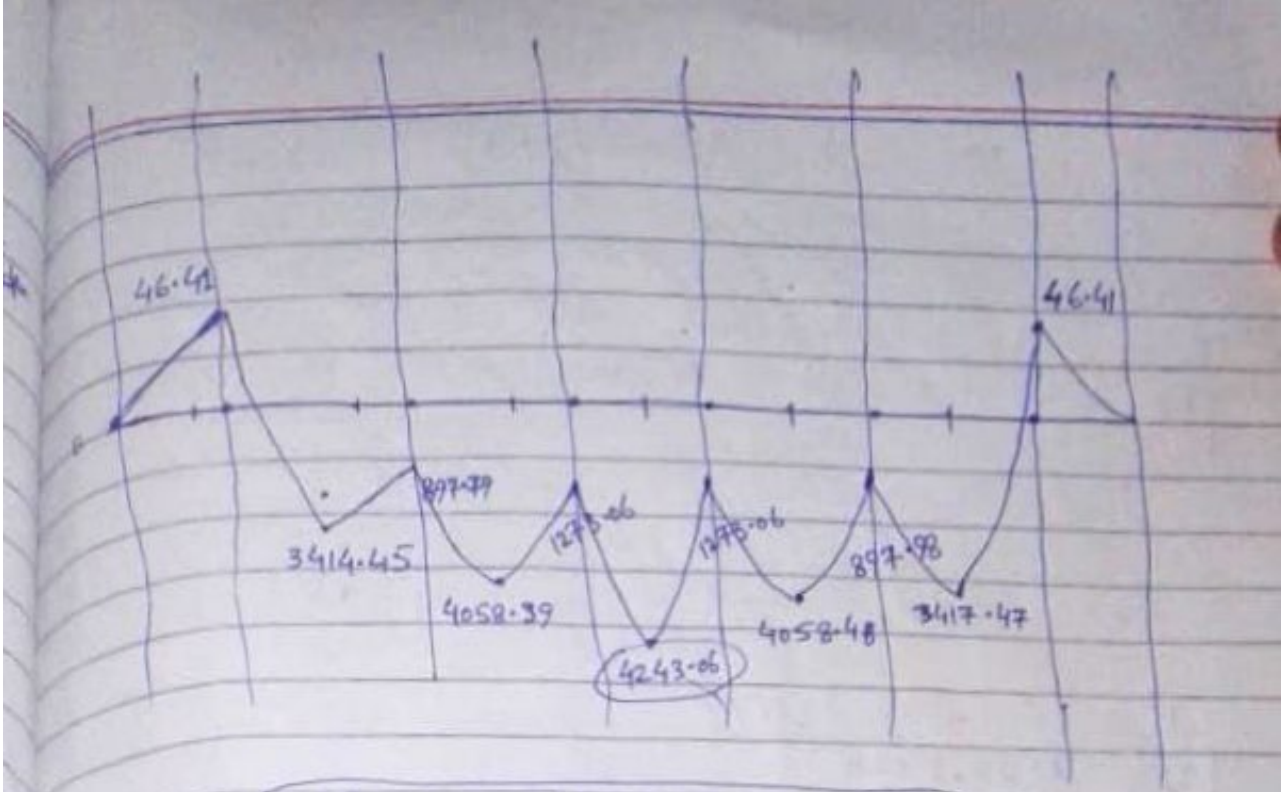
$\Rightarrow (59.4 \times 102.5) - (6041.94 \times 1.009) = -7.8$

→ Here the column loads are increased a value of (7.81k), and hence redu the soil reaction of (49.56k).

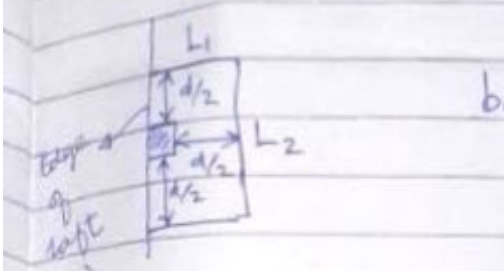
59.4 x 20 = 1188

Now;



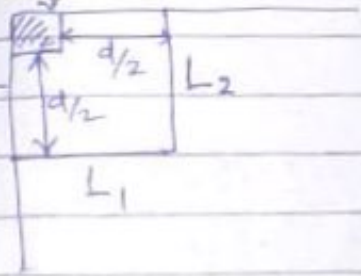


$$\Rightarrow \quad M_{+ve\ (max)} = 4243.06 \text{ k-ft}$$

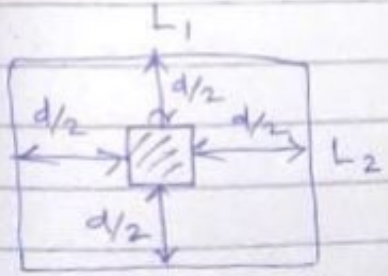


$$b_o = 2L_1 + 2L_2$$

top of wall



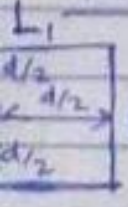
$$b_o = L_1 + L_2$$



$$b_o = 2L_1 + 2L_2$$

$\Rightarrow$ $\boxed{U = b_o\, d\, [\phi (0.34) \sqrt{f_c'}]}$ $\rightarrow$ Eq (*)

For Edge column:



Load = 661.89k

Column size = 30 x 30 " $\left(\frac{30}{12} = 2.5'\right)$

$b_o = 2L_1 + L_2 = 2\left(30 + \frac{d}{2}\right) + (30 + d)$

$b_o = 60 + d + 30 + d \Rightarrow \boxed{b_o = 90 + 2d}$

$U = (661.89k)(1.7)$

$\boxed{U = 1125.213k}$

Putting values in above Eq (*),

$1125.213 = (90 + 2d)(d)[0.85 \times 0.34 \times \sqrt{3000}]$

$d = 167.36" = \frac{167.36}{12} = \boxed{13.94\ ft}$

If $f_c' = 4$ ksi

$\Rightarrow d = 154.38" = \boxed{12.86\ ft}$

(U) used with factor (1.7);

For $f_c' = 3$ ksi $\Rightarrow$ $d = 123.84" = (10.32\ ft)$

For $f_c' = 4$ ksi $\Rightarrow$ $d = 114" = (9.5\ ft)$

For Corner Column:

Load = 410.16 k

$$b_o = \left(30 + \frac{d}{2}\right) + \left(30 + \frac{d}{2}\right) = 30 + 30 + \frac{d}{2} + \frac{d}{2}$$

$$\Rightarrow \boxed{b_o = 60 + d}$$

Without Factor: For ($f_c' = 3$ksi),

$410.16 \times 1000 = (60+d)(d)[0.85 \times 0.34 \times \sqrt{3000}] \Rightarrow d = 133.74''$

$\Rightarrow \boxed{d = 11.15 \text{ ft}}$

for ($f_c' = 4$ksi),

$\Rightarrow d = 122.77''$

$\Rightarrow \boxed{d = 10.23 \text{ ft}}$

With Factor:

For $f_c' = 3$ksi $\Rightarrow d = 182.1'' \Rightarrow \boxed{d = 15.2 \text{ ft}}$

$f_c' = 4$ksi $\Rightarrow d = 167.6'' \Rightarrow \boxed{d = 13.96 \text{ ft}}$

For Middle column:

Load = 1160.35 k

$$b_o = 2L_1 + 2L_2 = 2(30+d) + 2(30+d)$$

$$\boxed{b_o = 120 + 4d}$$

With Factor

For $f_c' = 3$ksi;

$d = 162.14''$

$\Rightarrow \boxed{d = 13.52 \text{ ft}}$

For $f_c' = 4$ksi;

$d = 149.94''$

$\Rightarrow \boxed{d = 12.5 \text{ ft}}$

Without Factor

for $f_c' = 3$ksi;

$d = 121.2''$

$\Rightarrow \boxed{d = 10.1 \text{ ft}}$

for $f_c' = 4$ksi;

$d = 111.87''$

$\Rightarrow \boxed{d = 9.32 \text{ ft}}$

DEPTH OF RAFT (MAT):

For edge column:

Load = 661.89 k (Service load)

$b_o = 90 + 2d$

As we know that;

$$U = \phi 4 \sqrt{f_c'}(b_o d) \quad \therefore (\phi = 0.85)$$

For ($f_c' = 3$ksi) ⇒ $d = 25.28''$ ⇒ $d = 2.1$ ft

For ($f_c' = 4$ksi) ⇒ $d = 22.72''$ ⇒ $d = 1.89$ ft

For Middle column:

Load = 1160.35 k

$b_o = 120 + 4d$

For ($f_c' = 3$ksi) ⇒ ~~27.68''~~ ⇒ $d = 27.23''$ ⇒ $d = 2.27$

($f_c' = 4$ksi) ⇒ ~~24.50''~~ ⇒ $d = 24.67''$ ⇒ $d = 2.05$ ft

For Corner column:

Load = 410.16 k

$b_o = 60 + d$

For ($f_c' = 3$ksi) ⇒ $d = 25.69''$ ⇒ $d = 2.14$ ft

($f_c' = 4$ksi) ⇒ $d = 22.98''$ ⇒ $d = 1.915$ ft

Taking middle strip in horizontal (x-direction)

Avg. soil pressure = $\frac{2.004 + 2.004}{2}$ = $\boxed{2.004\ k/ft^2}$

Total soil reactim = $q_{avg} \times B_1 \times L = 2.004 \times 20 \times 92.5$

= $\boxed{3707.4\ K}$

Avg. Load = $\frac{3707.4 + 3644.48}{2}$

= $\boxed{3675.94\ K}$

Modified Avg. soil pressure = $2.004 \times \left(\frac{3675.94}{3707.4}\right)$

$q_{avg.\ (modified)}$ = $\boxed{1.98\ k/ft^2}$

$F = \frac{\text{Avg. load}}{\Sigma[\text{column Loads}]} = \frac{3675.94}{3644.48}$

$\boxed{F = 1.008}$

Load per unit length of the beam = $q_{avg.\ (modified)}$

= 1.98×20

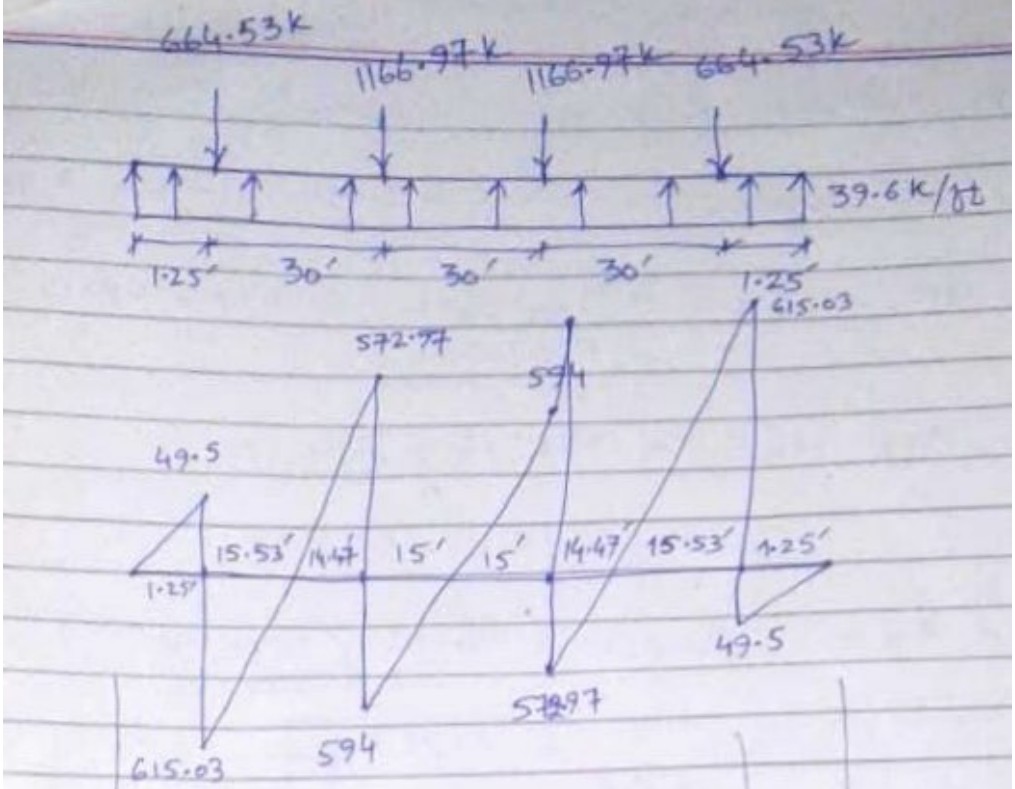
= 39.6 (3663)

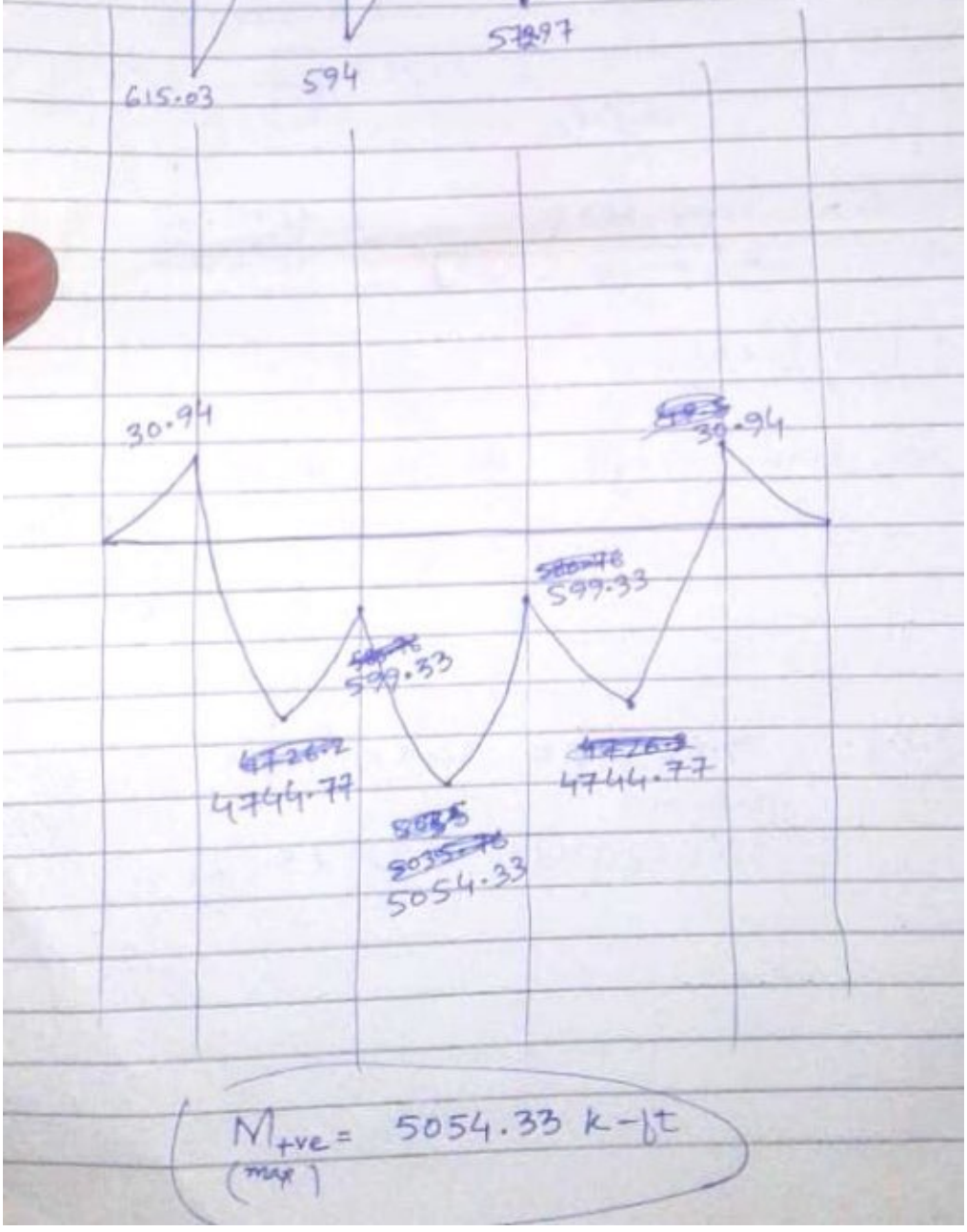
R.W: $39.6 \times 92.5 = 3663\ K$ (up)

~~39.6×20~~

$3644.48 \times 1.008 = 3673.65$ (down)

⇒ 2.6625 should be misused

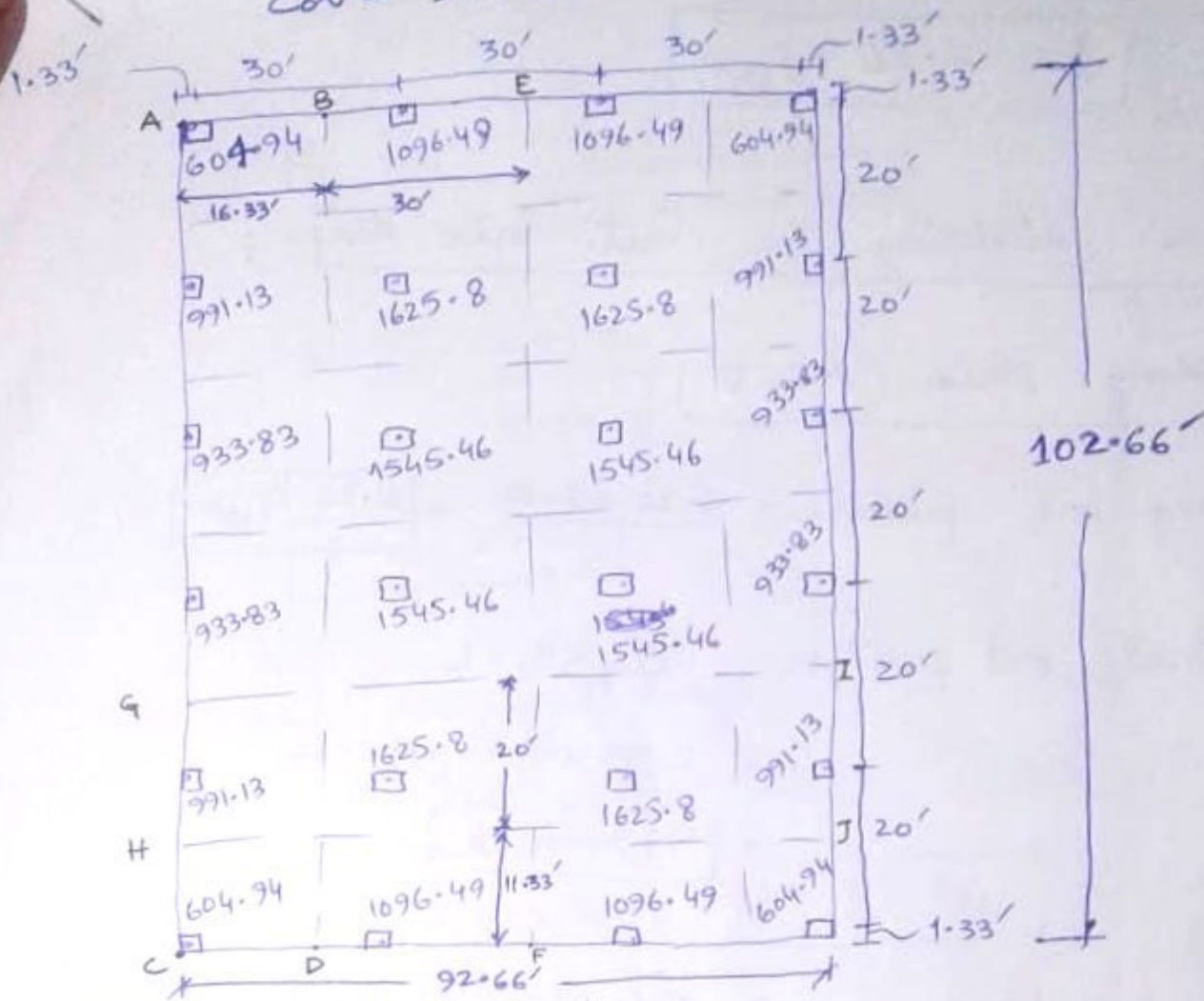




$M_{+ve\ (max)} = 5054.33$ k-ft

RAFT DESIGN: (Without Beams)

col = 32" x 32"



Total service load = Q

$$\Rightarrow \boxed{Q = 27190.6\,k}$$

As our plan is symmetric

$$\Rightarrow (M_x = 0)\ \&\ (M_y = 0).$$

So eq. becomes;

$$\Rightarrow \boxed{q = \frac{Q}{A}}$$

$$q = \frac{27190.6}{(32.66) \times (102.66)}$$

$$\Rightarrow \boxed{q = 2.86 \text{ k/ft}^2}$$

Now dividing the mat into strips;

Taking strip (ABCD):

Avg soil pressure $= \frac{2.86 + 2.86}{2} = \boxed{2.86 \text{ k/ft}^2}$

Total soil reaction $= q_{avg} \times B_1 \times L$

$= 2.86 \times 16.33 \times 102.66$

$= \boxed{4794.61 \text{ k}}$

Avg Load $= \frac{\text{soil reaction} + \Sigma(\text{Column Loads})}{2}$

$= \frac{4794.61 + 5059.8}{2}$

$= \boxed{4927.2 \text{ k}}$

Modified Avg. soil pressure $= q_{avg} \left(\frac{\text{Avg. Load}}{\text{Soil reaction}} \right)$

$= 2.86 \left(\frac{4927.2}{4794.61} \right)$

$q_{avg\ (Modified)} = 2.93\ k/ft^2$

$$F = \frac{\text{Avg. Load}}{\Sigma[\text{cl. in strip ABCD}]}$$

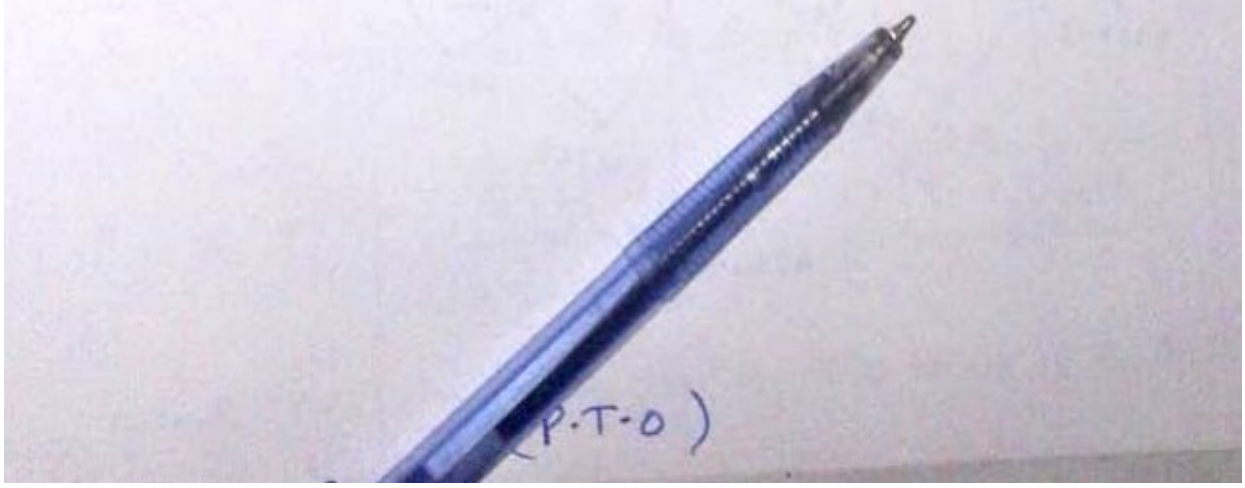
$$F = \frac{4927.2}{5059.8}$$

$$\Rightarrow \boxed{F = 0.97}$$

Now, Load per unit length of the beams

$$= q_{avg\ (Modified)} \times B_1$$

$$= 2.93 \times 16.33 = \boxed{47.85\ k/ft}$$



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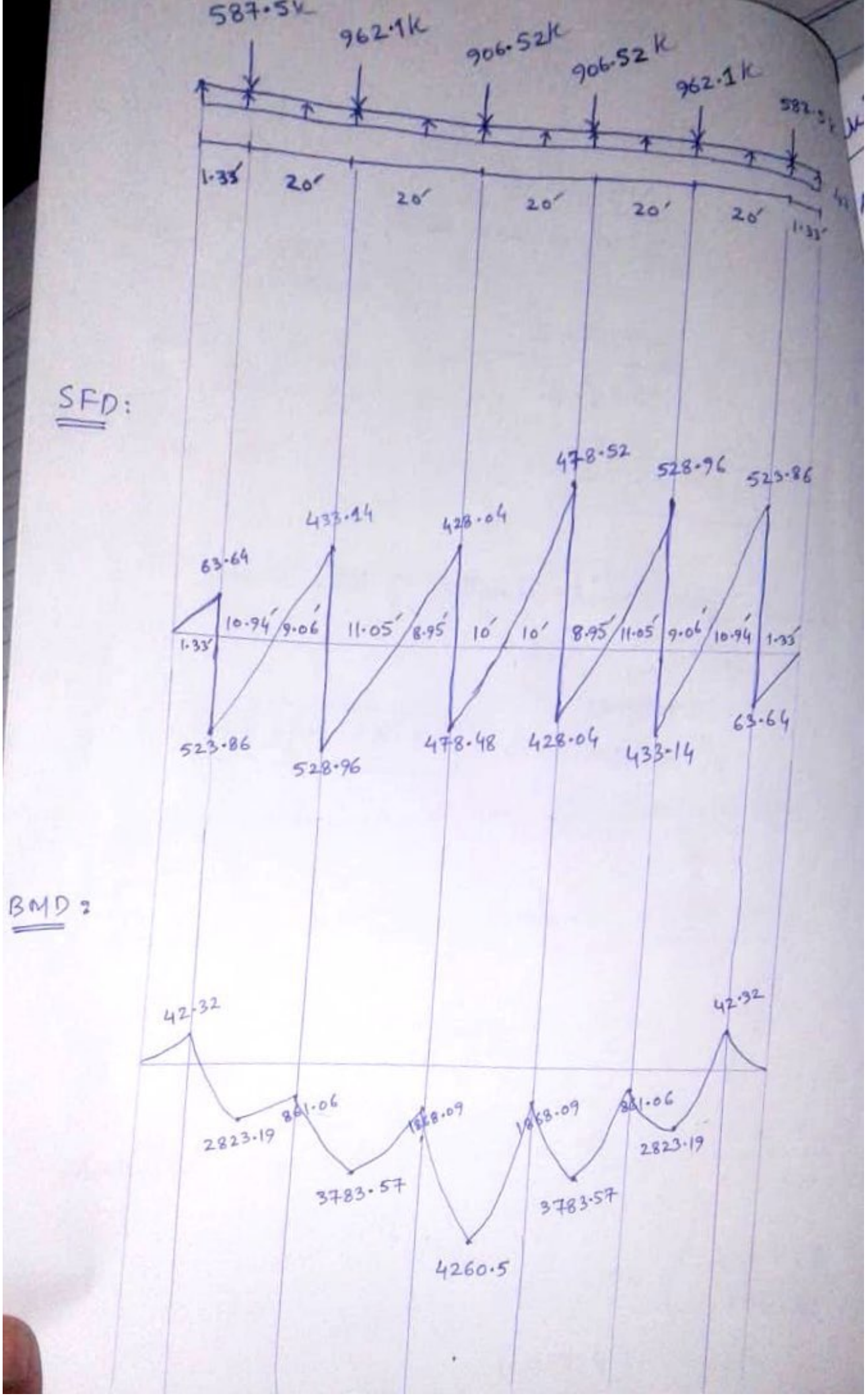


aking strip (BEDF):

Avg. soil pressure $= \frac{2.86 + 2.86}{2} = 2.86 \ k/ft^2$

Total soil reaction $= q_{Avg} \times B_1 \times L$

$= 2.86 \times 30 \times 102.66$

$= \boxed{8808.22 \ k}$

Avg. Load $= \frac{\text{Soil react.} + (\text{column loads})}{2}$

$= \frac{8808.22 + 8535.5}{2}$

$= \boxed{8671.86 \ k}$

Modified Avg. soil pressure $= q_{Avg} \left(\frac{\text{Avg. Load}}{\text{Soil reaction}} \right)$

$= 2.86 \left(\frac{8671.86}{8808.22} \right)$

$\Rightarrow \boxed{q_{Avg} \text{ (modified)} = 2.81 \ k/ft^2}$

$F = \frac{\text{Avg. Load}}{\Sigma [\text{col. in strip BEDF}]}$

$F = \frac{8671.86}{8535.5} \Rightarrow \boxed{F = 1.016}$

$\Rightarrow$ Load per unit length of the beam $= 2.81 \times 30 = \boxed{84.3 \ k/ft}$

When we take column loads without factor;

⇒ $8535.5 - (84.3 \times 102.66) = \boxed{-118.74\ k}$

⇒ The negative sign shows that the downw force is greater than the upward forces.

With Factor:

~~⇒ (8535.5 x~~

⇒ $(8535.5 \times 1.016) - (84.3 \times 102.66) = \boxed{17.83\ k}$

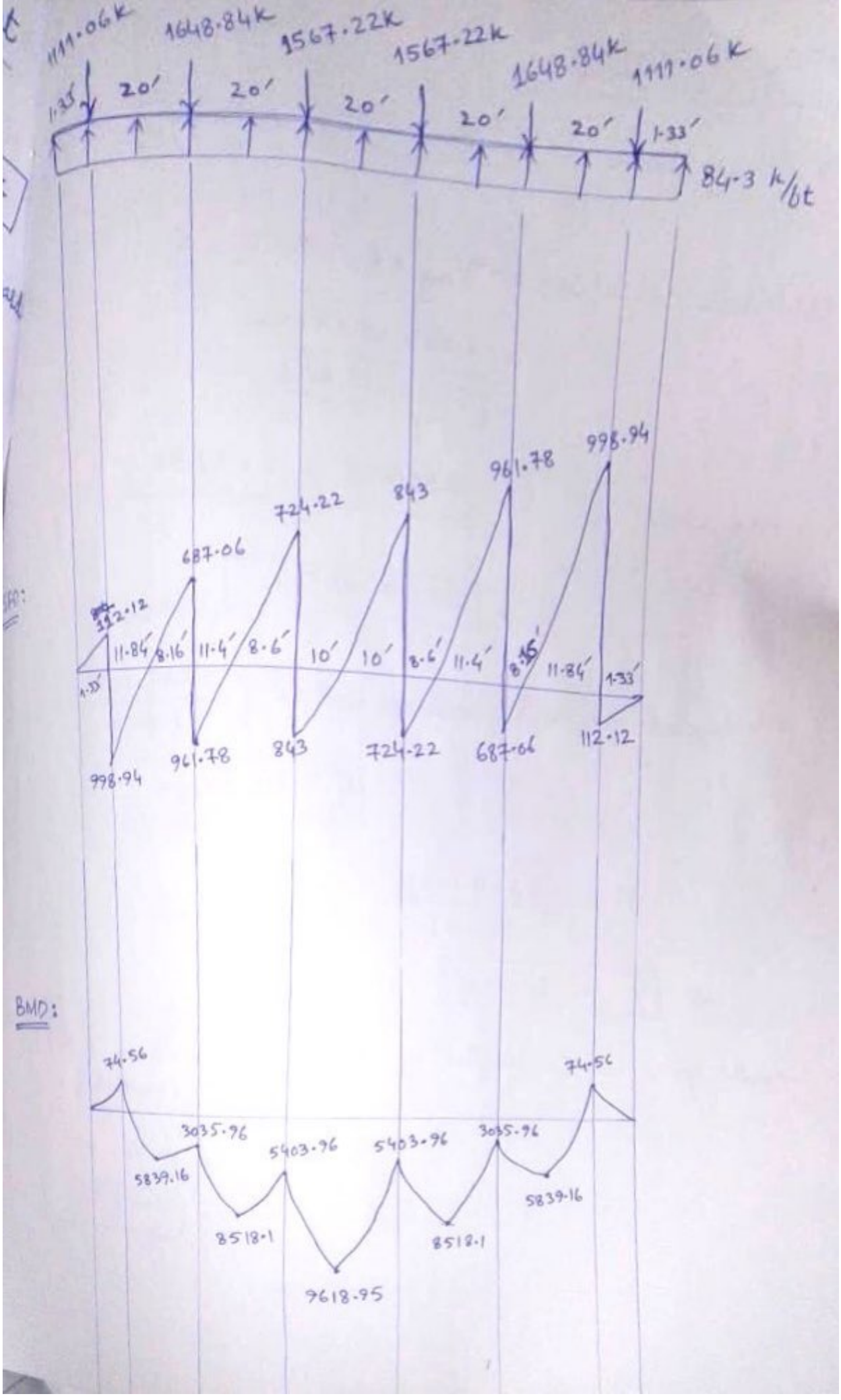
The upward force is greater in this case.

NOTE:

The differences of the values in the bove two cases can be seen when factor applied and if not applied.

Also as we know that for a (SFD & BMD) to be close down the upward orces should be equal to the downward orces.

Hence, when factor is multiplied with dumn loads the differences drastically educes and hence now it can be anaged.



Strip (GHIJ):

Avg. soil pressure = $\frac{2.86 + 2.86}{2} = 2.86\ k/ft^2$

Total soil reaction = $q_{avg} \times B_2 \times L$

$= 2.86 \times 20 \times 92.66$

$= \boxed{5300.15\ k}$

Avg. Load $= \frac{5300.15 + 5233.86}{2}$

$= \boxed{5267.005\ k}$

Modified Avg. soil pressure $= 2.86 \left(\frac{5267.005}{5300.15} \right)$

$= \boxed{2.84\ k/ft^2}$

$F = \frac{5267.005}{5233.86}$

$\Rightarrow \boxed{F = 1.006}$

Load per unit length of the beam = q_{avg} (modified) $\times B_1$

$= 2.84 \times 20$

$= \boxed{56.8\ k/ft}$

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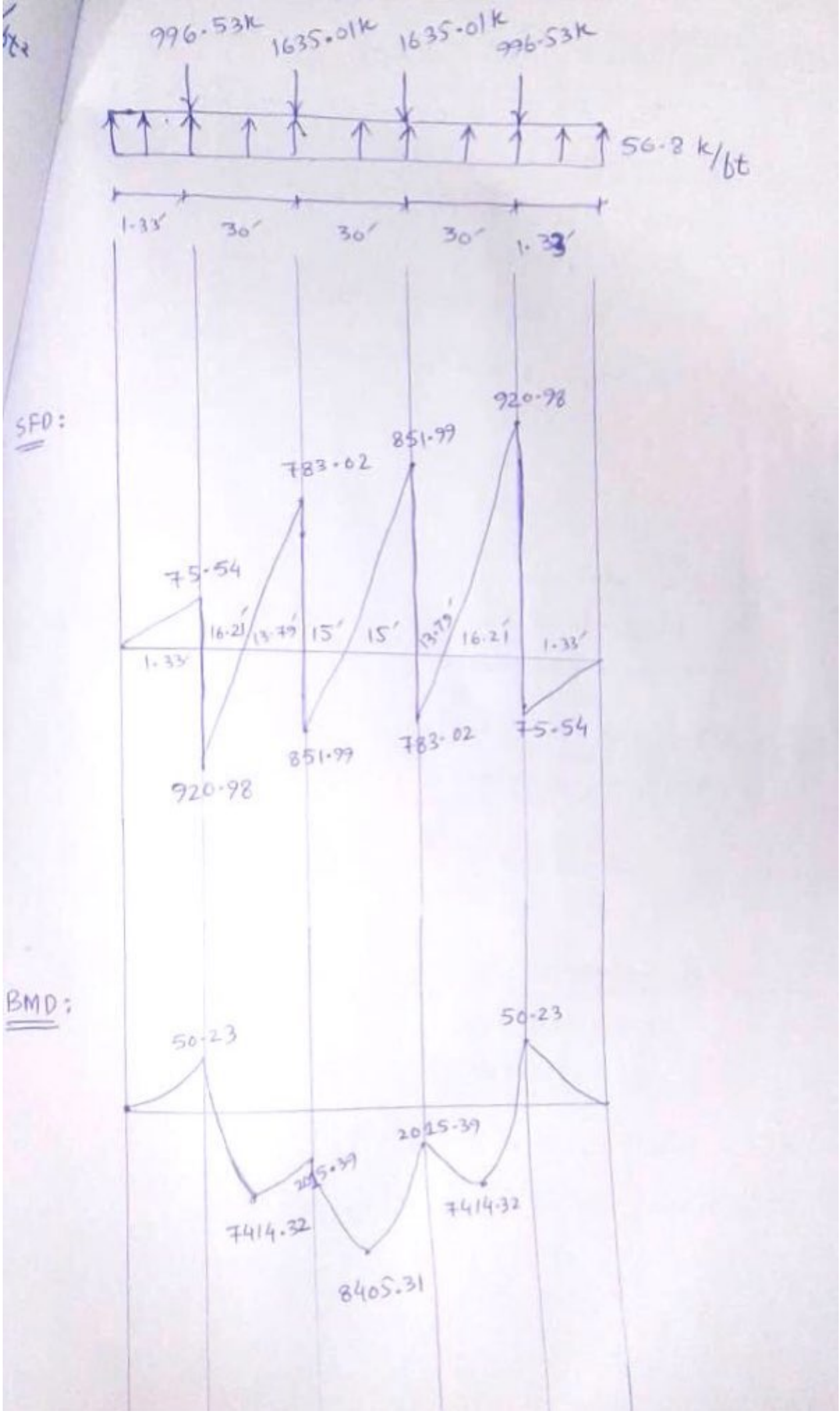


FINDING DEPTHS OF RAFT:

$$U = \phi 4 \sqrt{f_c'}\, b_o d \qquad \because (\phi = 0.85)$$

For Edge Column:

Load = 991.13 k

$b_o = 96 + 2d$

For $(f_c' = 3\,ksi) \Rightarrow d = 32.9'' \Rightarrow \boxed{d = 2.74'}$

$(f_c' = 4\,ksi) \Rightarrow d = 29.67'' \Rightarrow \boxed{d = 2.47'}$

For Middle Column:

Load = 1625.8 k

$b_o = 128 + 4d$

For $(f_c' = 3\,ksi) \Rightarrow d = 33.38'' \Rightarrow \boxed{d = 2.78'}$

$(f_c' = 4\,ksi) \Rightarrow d = 30.32'' \Rightarrow \boxed{d = 2.53'}$

For Corner Column:

Load = 604.94 k

$b_o = 64 + d$

For $(f_c' = 3\,ksi) \Rightarrow d = 33.36'' \Rightarrow \boxed{d = 2.78'}$

$(f_c' = 4\,ksi) \Rightarrow d = 29.95'' \Rightarrow \boxed{d = 2.5'}$

$d = 2.78' = 33.36''$

$h = 33.36 + 3'' = 36.36 = 37''$

Design of Raft : (Without Beam)

$h = 33.4'' + 1.5'' + 1'' = 35.9''$

Max Positive moment:

$$M' = \frac{9618.95}{30} = 320.63 \text{ k-ft/ft}$$

$$M_u = (M')(\text{load factor}) = \phi A_s f_y \left(d - \frac{a}{2}\right)$$

$$(320.63)(1.7) = 0.9 \times A_s \times (60)\left(33.4 - \frac{a}{2}\right) \rightarrow \text{Eq (*)}$$

$$\Rightarrow a = \frac{A_s(60)}{0.85 \times 3 \times 12} \Rightarrow \boxed{a = 1.96 A_s}$$

$A_s = 0.0033 \times 12 \times 33.4$

$A_{s_{min}} = 1.32 \text{ in}^2$

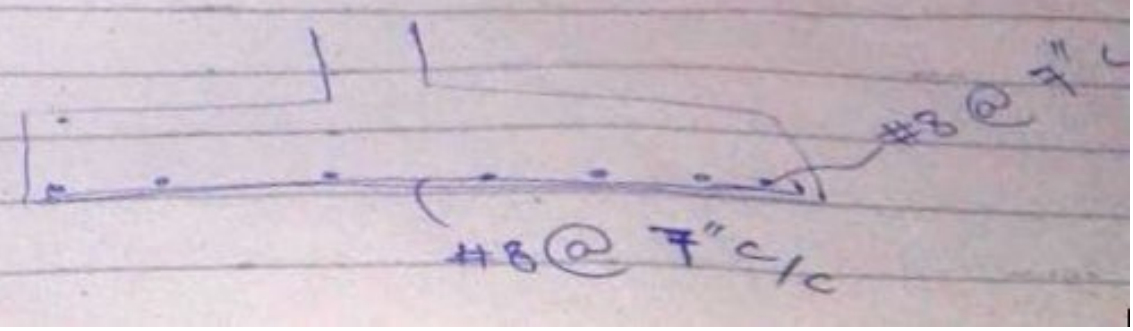
$\boxed{A_s = 0.305 \text{ in}^2}$

$A_{s\,min} > A_s$

Spacing =

using $A_s = 1.32 \text{ in}^2$

$$\text{Spacing} = \frac{A_b}{A_s} \times 12 = 7'' \text{ c/c}$$



$$M' = \frac{8405.31}{20} = 420.26 \text{ k-ft/ft}$$

$$M_u = M' * \text{load factor} = \phi A_s f_y \left(d - \frac{a}{2}\right)$$

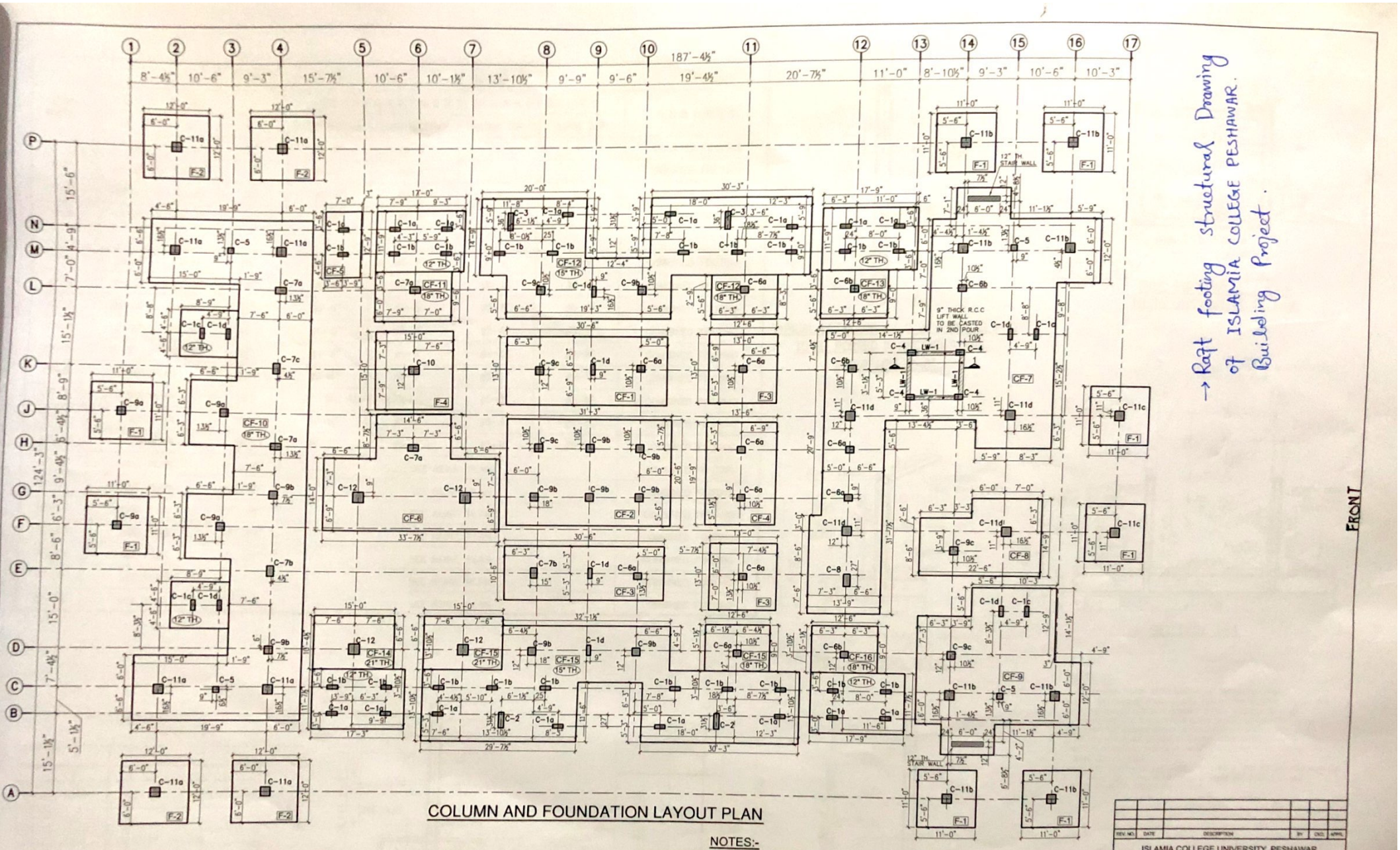
$$a = 1.96 A_s$$

$$\Rightarrow A_s = 0.4 \text{ in}^2$$

$$A_{s\,min} = 0.0033 \times 12 \times 33.4$$

$$A_{s\,min} = 1.32 \text{ in}^2$$

Spacing = 7" c/c



→ Raft footing structural Drawing of ISLAMIA COLLEGE PESHAWAR. Building Project.

NOTES:-

1-FOR GENERAL NOTES, REFER DRAWING NO. 3929/3315/C/06G01.
2-READ THIS DRAWING IN CONJUNCTION WITH ALL THE RELEVANT PROJECT DWG.
3-THE FOUNDATION HAS BEEN DESIGNED ON NET ALLOWABLE BEARING CAPACITY OF 0.79 TON/SFT AT A DEPTH OF 6'-0" BELOW N.S.L.
4-IF COMPETENT BEARING STRATA IS NOT FOUND AT INDICATED DEPTH, THE ENGINEER SHALL BE NOTIFIED FOR HIS PRIOR INSTRUCTIONS.
5-BOTTOM OF FOOTING SHOULD BE PROVIDED 6'-0" BELOW NSL OR FGL WHICH EVER IS LOWER.
6-FOR FOOTING SECTION 1-1, REFER DWG. NO. 3929/3315/C/06G03.
7-FOR FOOTING REINF. DETAILS REFER DWG. NO. 3929/3315/C/06G03 TO G05.
8-FOR SCHEDULE OF COLUMNS REFER DWGS. NO. 3929/3315/C/06G06 TO G09.
9-FOR EL. ±0'-0", REFER MASTER PLAN.
10-ALL COLUMNS ARE CENTRED WITH GRIDS UNLESS MARKED OTHERWISE.
11-LIFT WALLS LW-1 FROM PLINTH LEVEL & ABOVE ARE CASTED AS 2ND STAGE CONCRETE. FOR DETAILS, REFER DWG. NO.3929/3315/C/06G03.

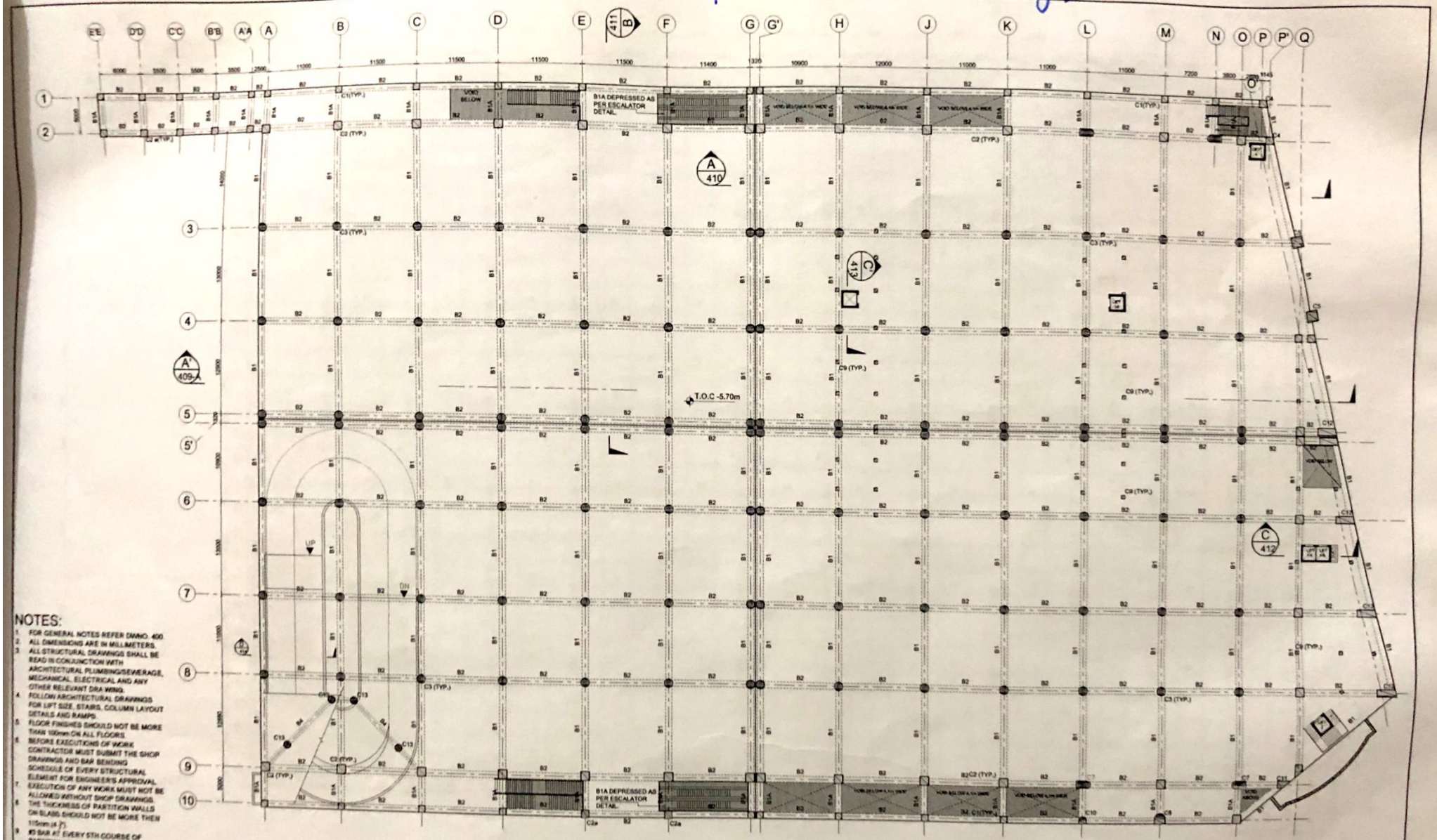
CONSTRUCTION DRAWING

REV. NO.	DATE	DESCRIPTION	BY	CKD.	APPVD.

ISLAMIA COLLEGE UNIVERSITY, PESHAWAR
IT INDUSTRIAL INNOVATION, RESEARCH CENTER & STRENGTHENING OF ISLAMIA COLLEGE UNIVERSITY, PESHAWAR
ADMIN BLOCK
FOUNDATION AND COLUMN LAYOUT PLAN
NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD. ISLAMABAD

DESIGNED	RECOMMENDED	REVISED	APPROVED
DRAWN			
CHKD.			
DATE	DRAWING NO.		
	3929/3315/C/06G02		0

Example 07 Raft footing structural Drawing
(BRT Hayatabad Depot Basement Drawing)



NOTES:

1. FOR GENERAL NOTES REFER DWNO. 400
2. ALL DIMENSIONS ARE IN MILLIMETERS.
3. ALL STRUCTURAL DRAWINGS SHALL BE READ IN CONJUNCTION WITH ARCHITECTURAL PLUMBING/SEWERAGE, MECHANICAL, ELECTRICAL AND ANY OTHER RELEVANT DRA WING.
4. FOLLOW ARCHITECTURAL DRAWINGS FOR LIFT SIZE, STAIRS, COLUMN LAYOUT DETAILS AND RAMPS.
5. FLOOR FINISHES SHOULD NOT BE MORE THAN 100mm ON ALL FLOORS.
6. BEFORE EXECUTIONS OF WORK CONTRACTOR MUST SUBMIT THE SHOP DRAWINGS AND BAR BENDING SCHEDULE OF EVERY STRUCTURAL ELEMENT FOR ENGINEER'S APPROVAL.
7. EXECUTION OF ANY WORK MUST NOT BE ALLOWED WITHOUT SHOP DRAWINGS.
8. THE THICKNESS OF PARTITION WALLS ON SLABS SHOULD NOT BE MORE THEN 115mm (4 ½").
9. #3 BAR AT EVERY 5TH COURSE OF PARTITION WALL MUST BE PROVIDE PROPERLY ANCHORED IN COLUMNS AND CROSS WALLS

NOTE:
1. FOR NOTES REFER DRAWING NO MMP-1020P01-BRT-ST-HD-400
2. FOR SECONDARY BEAMS REFER DRAWING NO MMP-1020P01-BRT-ST-HD-409

MMM MOTT MACDONALD

Client: Transport and Mass - Transit Department (TMTD) Government of Khyber Pakhtunkhwa Pakistan

Financing Agency: ADB ASIAN DEVELOPMENT BANK

Project: Peshawar Sustainable Bus Rapid Transit Project - Hayatabad Depot

Rev	Date	Drawn	Description	Ch'k'd	App'd
0	03-11-2018	JEH	CONSTRUCTION DRAWINGS	MIK	TM
A	01-12-2018	JEH	CONSTRUCTION DRAWINGS	MIK	TM

Title: HAYATABAD DEPOT BASEMENT-1 MAIN BEAM LAYOUT PLAN (NEW DESIGN)

Designed	JS
Drawn	JEH
Checked	MIK
Approved	TM
Scale	AS SHOWN
Drawing No.	MMP-1020P01-BRT-ST-HD-408
Rev	A
Status	CON