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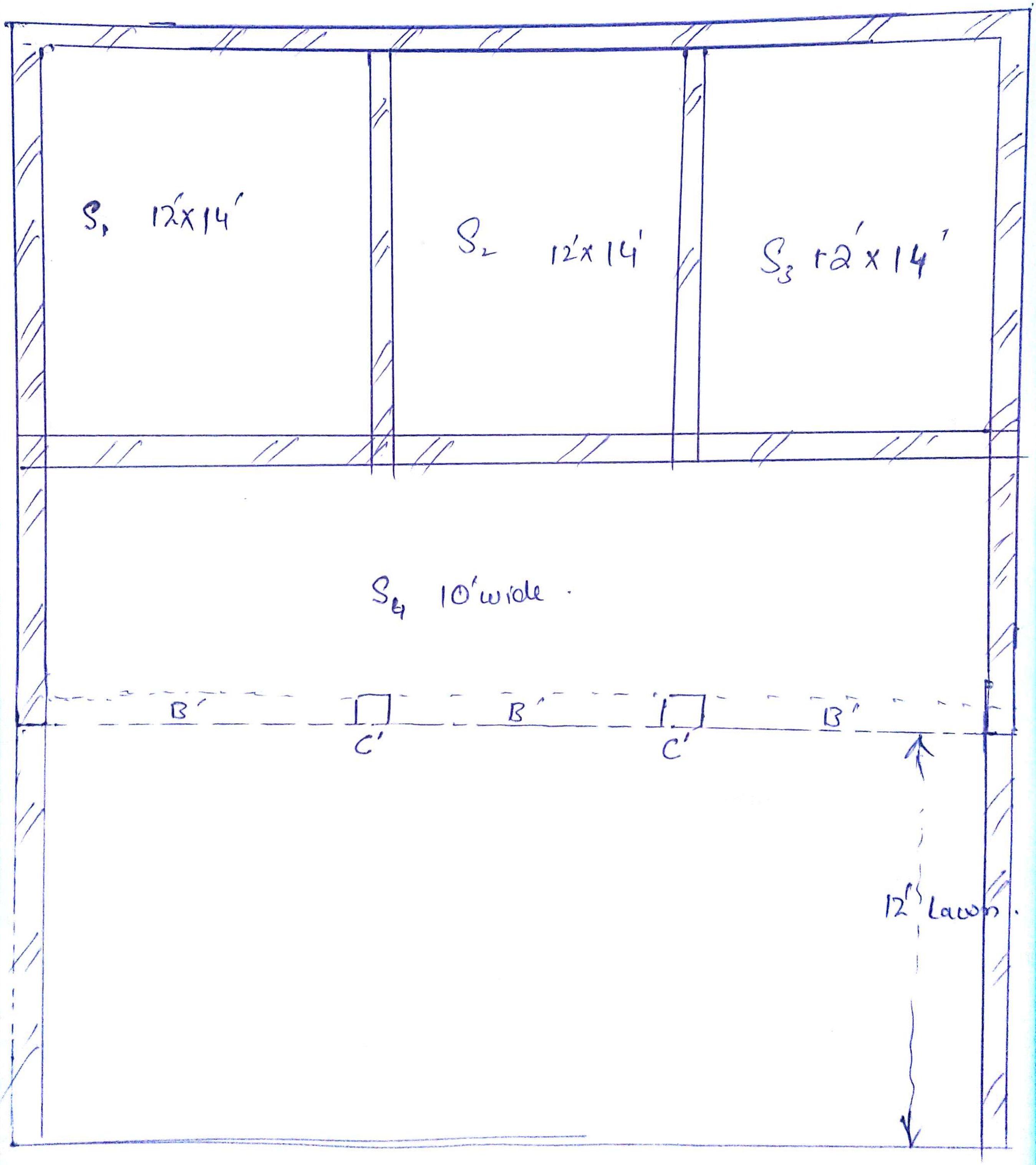
DEPT :- MS (T.E).

REG NO:- 15274

SUBJECT:- RCD (Minor Subject).

— :INU PESHAWAR:—

5 Marla House:-



First we design Slab:- for 8 Marla House:

So

Take $f_c' = 3ksi$ $f_y = 40ksi$

Slab Loads:

3" mud layer.
2" Brick tile + Betiumen Sheet.

1:- Design of Slab S_4:-

Step (i) Size.

$l_b / l_b = 36.75/9 = 4.083 > 2"$

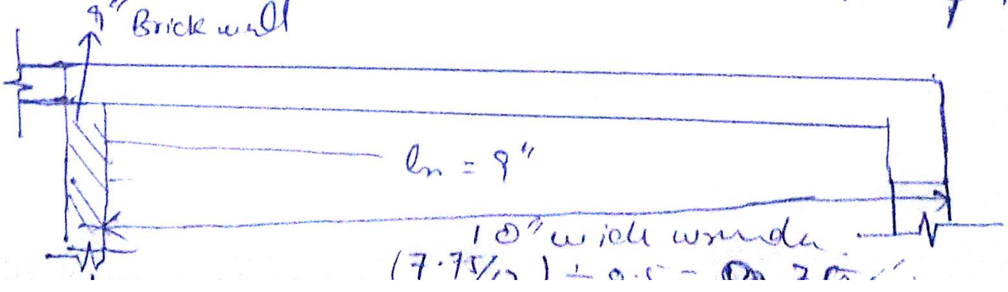
So one way Slab.

Assume the

| Thickness of Slab = 5" |

According to ACI 8.7:-

Span length = $l = l_n + h_f = 9 + 5/12 = 9.42'$



c/c distance b/w Support = 9.75' (Fig(ii))

According ACI 9.5.2.1.

Slab thickness = $h_f = (L/20) \times (0.4 + f_y/100000)$ ∵ $f_y < 60ksi$

$= (8.42/20) * (0.4 + \frac{40000}{100000}) \times 12$

$= 4.52''$ (minimum slab thickness)

So Select $h_f = 5''$

$d = h_f - 0.75 - (3/8)/2$

$= 5'' - 0.75 - (3/8)/2 = 4''$

Step 2
Now loading

(i) Slab: 5''

L_s (slab load) $= 0.15 \times 5/12 = 0.0625$ ksf

(ii) L_m (Mud load (3'')) $= 0.12 \times 3/12 = 0.03$ ksf

(iii) Brick Tile $= L_T = 0.12 \times 2/12 = 0.02$ ksf.

Total D.L = 0.0625 + 0.03 + 0.02 = 0.1225 ksf

D.L = 0.1225 ksf.

L.L = 40 psf = 0.04 ksf (ACI 9.4.2 For Residensal house)

Factored load = W_u = 1.2 × DL + 1.6 L.L

= 1.2 × 0.1225 + 1.6 (0.04)

= 0.211 ksf.

Step 3:- Analysis

$M_u = W_u l^2/8 = 0.211 \times 9.42^2/8$ ft-k/ft

= 2.340 ft-k/ft

| M_u = 28.08 in k/ft. |

Step 4: Design.

A_{smin} = 0.002 b hf For fy = 40 ksi ACI 10.5.4.

= 0.002 × 12 × 5

| A_{smin} = 0.12 in² |

$a = A_{smin}\, f_y / 0.85\, f_c'\, b$

$= 0.12 \times 40 / 0.85 \times 3 \times 12$ = 0.156 in.

$\phi M_{min}(mm) = \phi\ A_{s\,min}\ f_y\ (d - a/2)$

$= 0.9 \times 0.12 \times 40 \times (4 - 0.156/2)$.

$= 16.94 \text{ in k} < M_n$

Theree fore:

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

$A_s = 28.08 / \{0.9 \times 40 \times (4 - 0.2 \times 4/2)\}$

$A_s = 0.2166 \text{ in}^2$

$a = 0.2166 \times 40 / (0.85 \times 3 \times 12) = 0.283$.

$$A_s = \frac{28.08}{0.9 \times 40 \times (4 - (0.283/2))} = 0.2$$

$$a = \frac{0.2 \times 40}{0.85 \times 3 \times 12} = 0.261$$

$$A_s = \frac{28.08}{0.9 \times 40 \left(4 - \left(\frac{0.261}{2}\right)\right)} = 0.201$$

$$a = \frac{0.201 \times 40}{0.85 \times 3 \times 12} \approx 0.2$$

(OK)

Now

Steel design

using $\frac{1}{2}'' \phi (\#4)$ $A_b = 0.2 in^2$.

$Spacing = A_b / A_s$

$= 0.2/0.16 \times 12 = 15 in$

$Spacing = 15 in.$

using $\phi \, 3/8''$ #.3 $A_b = 0.11 in^2$

$Spacing = A_b/A_s = 0.11/0.16 \times 12 = 7.5'' \approx 6''$

So Select.

#3 @ 6'' c/c

Temperature Bars: A_{st}

$A_{st} = 0.2bh_f$

$= 0.2 \times 12 \times 5 = 0.12 in^2$.

Try $3/8'' \phi - \#3$ $A_b = 0.11 in^2$

$Spacing = A_b/A_s = 0.11/0.12 \times 12 = 11''$ c/c

So #3 @ 9'' c/c

Steel spacing Checking

According to ACI 7.6.5	ACI 7.12.2
Main Steel Spacing	Temperature Steel spacing
(i) $3t_f = 3 \times 5 = 15''$	$5h_f = 5 \times 5 = 25''$
(ii) $18''$.	(ii) $18''$.
Therefore. $6''$ Spacing (OK)	Therefore $9''$ spacing = (OK).

Design of Slab: $S_1 = S_2 = S_3 = 12' \times 14'$

Slab:- $12' \times 14'$.

Step 1. Size = $l_b / l_a = 14/12 = 1.166 > 2$.

Two way Slab.

Minimum depth of two way slab:

$h_{min} = \text{perimeter}/180$

$= 3 \times (14 + 12) \times 12/180 = 4.75$.

Assume $h = 5''$

Step 2: Loads.

Factored loads $= W_u = W_{ud} + W_{uL}$.

$$W_u = 1.2\, D.L + 1.6\, L.L$$

$$W_u = 1.2 \times 0.1225 + 1.6(0.04) \quad \text{(From prem } S_4 \text{ sketch (ws))}$$

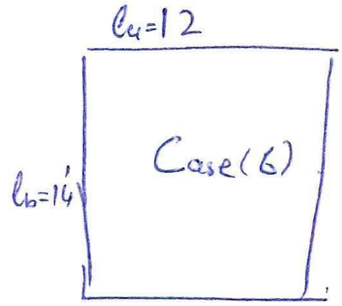
$$W_u = 0.147 + 0.064 = 0.211\ ksf.$$

$$\boxed{W_u = 0.211\ ksf}$$

Now

$$m = l_a / l_b.$$

$$= 12/14 = 0.85.$$



From Table 12.3

$$M_a^{-}\ neg = C_{a\,neg} \times W_u \times l_{a^2}.$$

$$= 0.088 \times 0.211 \times 12^2 = 32.04\ in\text{-}k.$$

$$\boxed{M_a\ neg\ 32.04\ ink.}$$

$$M_b^{-}\ neg = C_{b\,neg} \times W_u \times l_b^2 = 0 \times 0.211 \times 10^2 = 0$$

$$M_{a\,dl}^{+} = C_{a\,dl}^{+} * W_{u\,dl} \times l_a^2 = 0.012 \times 0.147 \times 16^2$$

$$M_{a\,dl}^{+} = 1.06 = 12.18\ ink$$

$$M_b^{+} = C_b^{+} dl * W_{u\,dl} + l_b^2 = 0.018 \times 0.147 \times 16^2$$

$$\boxed{M_b^{+}\ 5.48\ ink}$$

$M_a^+{}_{ll} = C_a^+{}_{ll} \times w_u{}_{ll} \times l_a^2 = 0.055 \times 0.064 \times 12^2$

$M_a^+{}_{ll} = 6.13 \text{ in-k}$

$M_b^+{}_{ll} = C_b^+ \times w_u{}_{ll} + l_b^2 = 0.016 \times 0.64 \times 16^2$

$M_b^+{}_{ll} = 0.262 \text{ ft-k} = 3.144 \text{ in-k}$

So

$M_a^- = 32.04 \text{ in-k}$ $M_b^- = 0 \text{ ft-k}$

$M_a^+{}_{dl+ll} = 18.4 \text{ in-k}$ $M_b^+{}_{(dl+ll)} = 8.545 \text{ in-k}$

Step# 4   Design.

$A_{s\,min} = 0.002\, b h_f = 0.002 \times 12 \times 5 = 0.12 \text{ in}^2$

$a = A_{s\,min} f_y / 0.85 f_c' b = 0.12 \times 40 / 0.85 \times 3 \times 12$

$a = 0.158 \text{ in}$

$\phi M_{n(min)} = \phi A_{s\,min} f_y (d - a/2)$

$= 0.9 \times 12 \times 40 (4 - 0.158/2) = 116.90 \text{ in-k}$

Here $\phi M_n > M_b^+{}_{(dl+ll)}$ But

$\phi M_n < M_a^-{}_{(dl+ll)}$ & $M_a^+{}_{(dl+ll)}$ ...

There fore . $A_{s\,min} = 0.12 in^2$ governs

using ϕ 3/8" — #3 bar. $A_b = 0.11 in^2$.

Spacing = $0.11/0.12 \times 12 = 11"$

Maximum. Spacing ACI 13.3.2. for Two way Slab.

$2h_f = 2 \times 5 = 10"$

So. provide #3 @ 9" c/c (Longer direction).

$M_a^+ = 18.4$ ink $> \phi M_n$.

So. Let $a = 0.2d = 0.2 \times 4 = 0.8$

~~As = 0.83 x 12~~, $A_s = 18.4 / (0.9 \times 40 (4 - (0.8/2)))$

$A_s = 0.15 in^2$.

$a = 0.15 \times 40 / 0.85 \times 3 \times 12$.

$a = 0.190 in^2$

$A_s = 18.4 / 0.9 \times 40 (4 - 0.19/2)) = 0.130 ink$

$a = 0.130 \times 40 / 0.85 \times 3 \times 12 = 0.170$ (OW)

$A_s = 18.4 / (0.9 \times 40 - (4 - 0.170/2)) = 0.130 ink$

using 3/8" ϕ (#3) $A_b = 0.11 \, in^2$.

Spacing $= 0.11/0.123 \times 12 = 10.7" \approx 9"$ c/c

using | #3 @ 9" c/c |

$M_a^- = 2.67 = 32.03$ in-k

Similarly. $a = 0.2d = 0.8$.

$\Rightarrow A_s = 0.24$ in $\longrightarrow$ $a = 0.32$ in.

$A_s = 0.23$ in $\longrightarrow$ $a = 0.31$ in

$A_s = 0.23$ in $\longrightarrow$ $a = 0.31$ in

using 3/8" ϕ (#3) $A_b = 0.11 \, in^2$

$\Rightarrow$ Spacing $= 0.11/0.23 \times 12 = 5.8" \approx 5"$ c/c

So use. | #3 @ 4.5" c/c. |

Beam Design.

(3 Span Continue).

$f_c' = 3$ ksi $f_y = 40$ ksi

Col = 12" x 12"

Scanned by CamScanner

Step # Size $h_{min} = l/18.5$.

l = Clear span (l_n) + depth of mbr (ACI 18.7)

End span = $12.375 - (12/12)/2 = 11.875'$.

Let depth = 16"

l_n + depth of Beam = $11.875' + 16/12 = 13.08'$.

$l = 13.08'$.

Depth = $(13.08/18.5)(0.4 + 40000/100000)$

So minm reqd = 6.78.7".

So | ACI 9.5.2.1. |

So select | h = 16" |.

| d = 16 - 3' = 13" |.

Step# Load.

D.L = 0.625 + 0.04 + 0.02 = 0.1225 (prim Slab) (Post)

L.L = 40 psf = 0.04 ksf.

Scanned by CamScanner

Service D.L from Slab = 0.1825 × 5 = 0.615 k/ft

Service LL = hw bwγc = 13×12/144 × 0.15

= 0.165 k/ft

Total D.L = 0.775 k/ft

LL = 0.04 × 5 = 0.2 k/ft

⇒ w_u = 1.2 (0.775) + 1.6 (0.2) = 1.25 k/ft

w_u = 1.25 k/ft

Step # 3: Analysis

ACI 8.3.3.

(1) At interior support

$-M$ = Coeff × $w_u l_n^2$ = 1/9 (1.25 × 11.875²)

= 19.6 ft k = 236.08 in k

(2) At mid span

$+M$ = coeff × $w_u l_n^2$ = 1/11 × (1.25 × 11.875²)

$+M$ = 16.02 ft k = 192.24 in k

$R_g = 15274$ (p-14)

$V_{int} = 1.15 w_u l_n/2 = 1.25 \times 1.25 \times 11.875/2$

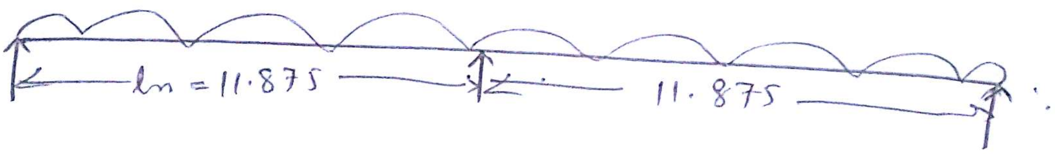
$V_{int} = 8.54$

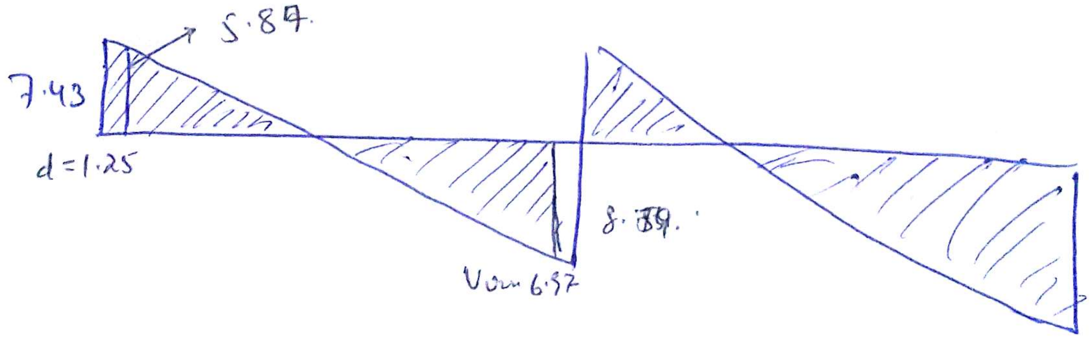
$V_{u(int)} = 8.54 - 1.25 \times 1.25$

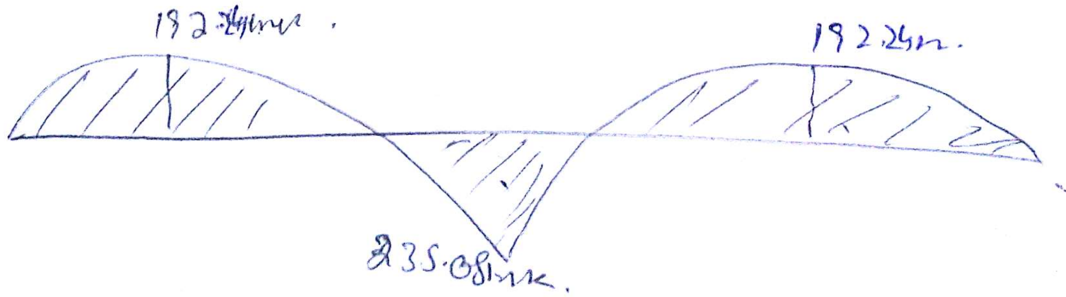
$V_{u\,int} = 6.97$ K.

$V_{u\,ext} = 7.43 - 1.25 \times 1.25 = 5.86$K.

$V_{ext} = w_u l_n/2 = 1.25 \times 11.875/2 = 7.42$k.







Step #4. Design.

(A) flexural Design

(1) + M.

Accarding ACI 8.10 beff. L-Beam

(i) $6h_f + b_w = 6 \times 5 + 12 = 42''$

(ii) $b_w + \text{Span}/12 = 12 + (13.08 \times 12)/12 = 24.85''$

So $b_{eff} = 24.85''$

Check: Beam Desing Rectangular or not.

Trail 1

$a = h_f = 5''$ $A_s = M_n / \phi f_y . (d - a/2)$

$A_s = 192.24 / 0.9 \times 40 \times (13 - 5/2) = 0.45 \text{ in}^2$.

So $a = A_s f_y / 0.85 f_c' b_{eff} = 0.45 \times 40 / 0.85 \times 3 \times 24$.

$a = 274 < h_f$.

The beam is design as retangular

Trail 2

$A_s = 0.364 \text{ in}^2$...

$a = 0.358$

$a \approx A_s$ ok.

$A_s = 0.364 \text{ in}^2$

Step I c Minm. & max Reinft.

$A_{s\,max} = \rho_{max}\, b w d$

$\rho_{max} = 0.85 \times 0.85 \times 3/40 \times (0.003/(0.003+0.005))$

$\rho_{max} = 0.0203$.

$A_s = 0.0203 \times 12 \times 15$

$A_s = 3.66\ in^2$.

$A_{s\,min} = \rho_{min}\, b w d$.

$A_{s\,m} = 0.005 \times 12 \times 13 = 0.83\ in^2$

$A_s = 0.364\ in^2 < A_{s\,min}$.

so take $A_{s\,min} = 0.9\ in^2$.

using 5/8" ϕ (#5) $A_b = 0.31\ in^2$.

No of Bars = $A_s/A_b = 0.9/0.31 = 2.90$.

= 3 bars are use.

4 # 5 bars. used

(2) Negative Moment (-M)

Step (a) $b_w = 12''$

Calculating "a"

$M_u = 236.08$ in K

$b_w = 12''$ $h = 16''$

$d = 13''$

i) $A_s = M_u / (\phi f_y (d - a/2))$ Let $a = 0.2 = 0.2 \times 13 = 0.8$

$A_s = 236.08 / 0.9 \times 40 \times (13 - 0.2 \times 13/2) = 0.468 in^2$

$a = 0.630 in$

(ii) $A_s = 0.438 in^2 \longrightarrow a = 0.58 in$

$A_s = 0.44 \longrightarrow a = 0.58 in^2$

$A_s \nless A_{s min}$ so take $A_{s min}$.

use $5/8'' \phi$ (#5) $A_b = 0.31 in$

No of bars $= A_s / A_b = 0.9 / 0.31 = 2.90 \approx 3$ bars

So use. | 4 #5 bars |

Shear Design.

Step (a) $d = 13'' = 1.08'$

$V_u ext = 5.86 k$

$V_u int = 6.97 k$

~~(B) Step Design~~:

Step (B) Check

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

$= 0.75 \times 2 \times \sqrt{(3000)} \times 12 \times 15 / 1000 = 14.8k > V_{u,ew}$ & V_{int}

(Ok)

So Spacing ACI 11.5.4 & 11.5.5.3.

(i) $A_v f_y / 50 b_w = 0.22 \times 40000 / 50 \times 12 = 14.7''$ c/c

(ii) $d/2 = 13/2 = 6.5''$ c/c

(iii) 24'' c/c

(iv) $A_v f_y / 0.75\sqrt{f_c} b_w = 17.85''$ (Ok)

Other check

$\phi V_s < \phi 8\sqrt{f_c} b_w d$

$= 0.75 \times 0.22 \times 40 \times 13 / 6.5 = 13.0k < 82.8k$

(Ok)

Depth is ok

Spacing Check

$\phi V_s = \phi 4\sqrt{f_c'} b_w d$. (ACI 11.5.4.8)

$\Rightarrow 13.0k < 28.57$ (ok)

144

So

| #3, 2 legged @ 6.5" c/c |

Starting at | $S/2 = 6.5/2 = 3.25"$ |

Colum Design (12"x12")

(i) Load on Colum

$P_u = 2\,V_{int} = 2 \times 8.54 = 17.08k$

$A_g = 12" \times 12" = 144 in^2$ $f_c' = 3ksi$

$f_y = 40ksi$.

(ii) Design

$\phi P_n = 0.80\,\phi\,\{0.85 f_c' (A_g - A_{st}) + A_{st} f_y\}$ —— (1)

ACI - 10.3.6.

Let A_{st} = % of A_g

⇒ (1) ⇒

$\phi P_n = 0.80 \times 0.65 \{0.85 \times 3 \times (144 - 0.01 \times 144) + 0.01 \times 144 \times 4\}$.

| $\phi P_n = 218.9k$. | > P_u. (Ok)

| $A_{st} = 0.01 \times 144 = 1.44 in^2$ |

using 3/4" ϕ (#6) $A_b = 0.44 in^2$

No of Bars = A_s/A_b. = 1.44/0.44 = 3.27 ≈ 4 bars.

4 #6 bars

Tie Bars.

using 3/8" ϕ (#3)

Tie Spacing

According. ACI 7.10.5.1

(a) 16 x dia of Bar = 16 x 3/4 = 12" c/c.

b) = 48 x Dia of tie Bar = 48 x 3/8 = 18" c/c.

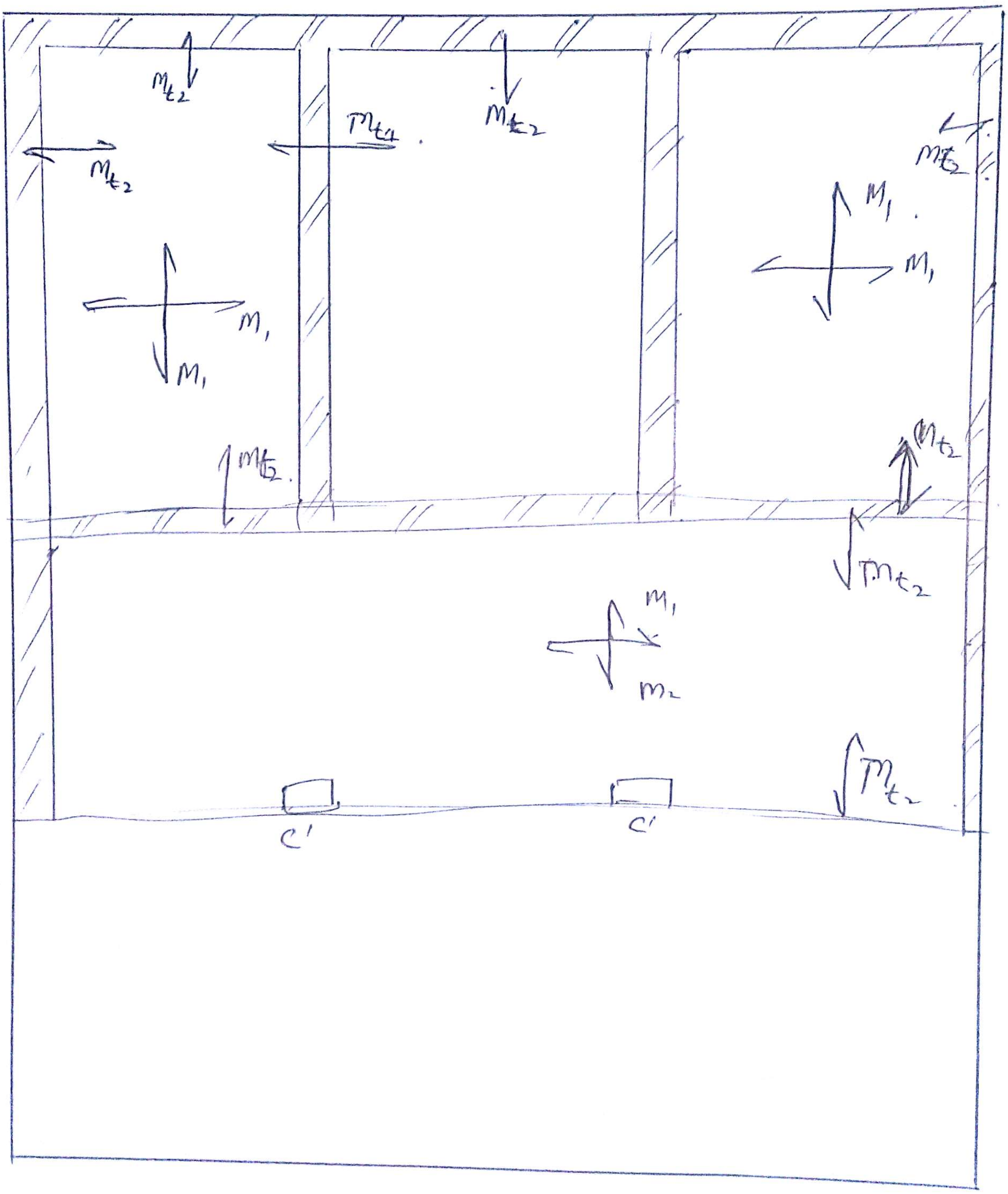
(c). least column dimension = 12" c/c

So use. **#3, tie bars @ 12" c/c**

Drafting

p.T.O

Reg NO: 15274 . P - '21



$M_1 = 3/8" \phi$ @ 9" c/c.

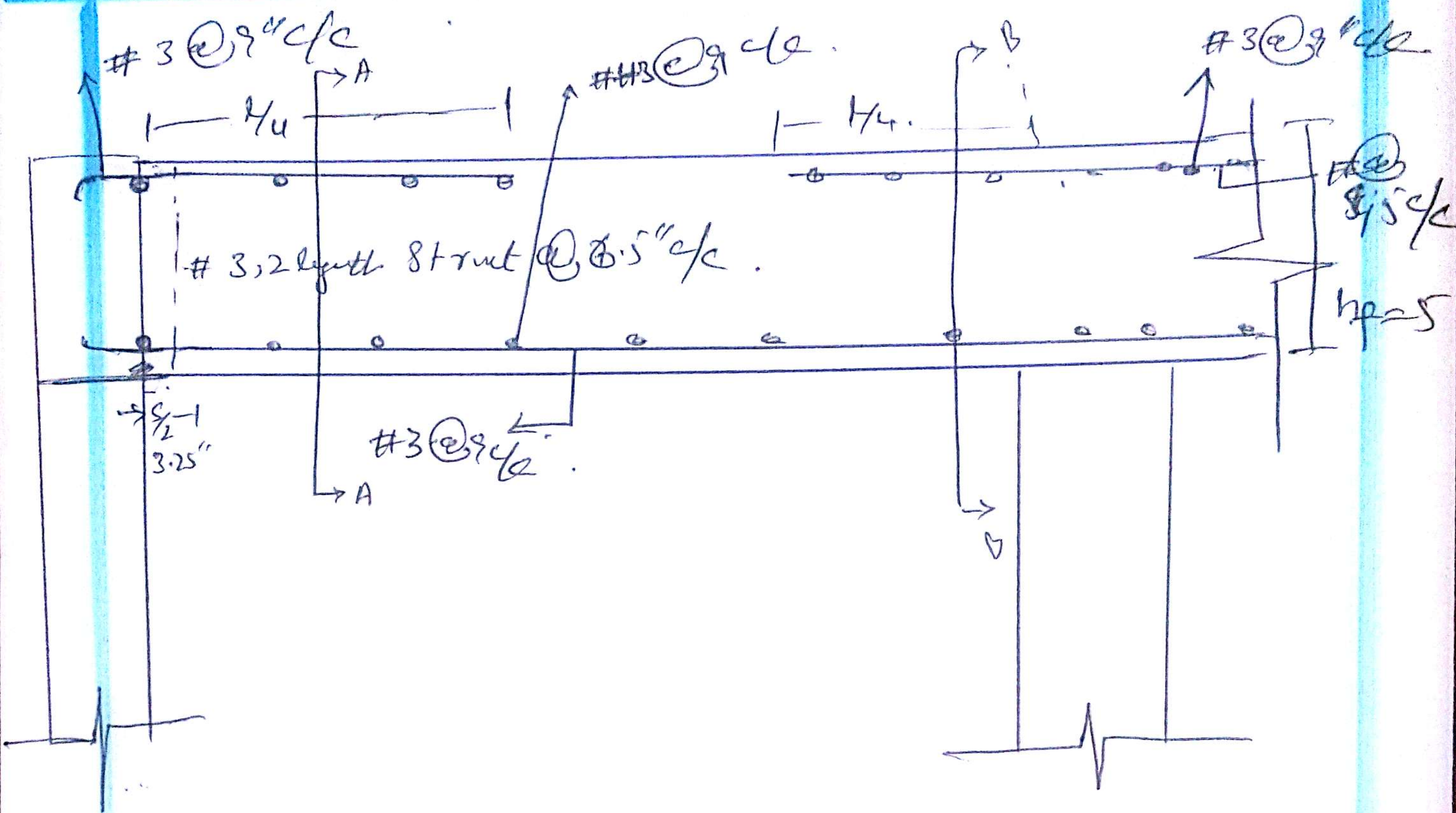
$M_2 = 3/8" \phi$ 6" c/c

$M_{t_1} = 3/8" \phi$ @ 4.5" c/c (Continuous)

M_{t_2} 3/8" @ 9" c/c

~~Mt2~~ 3/8" (Non Continuous)

Rg No = 15274 . P-22



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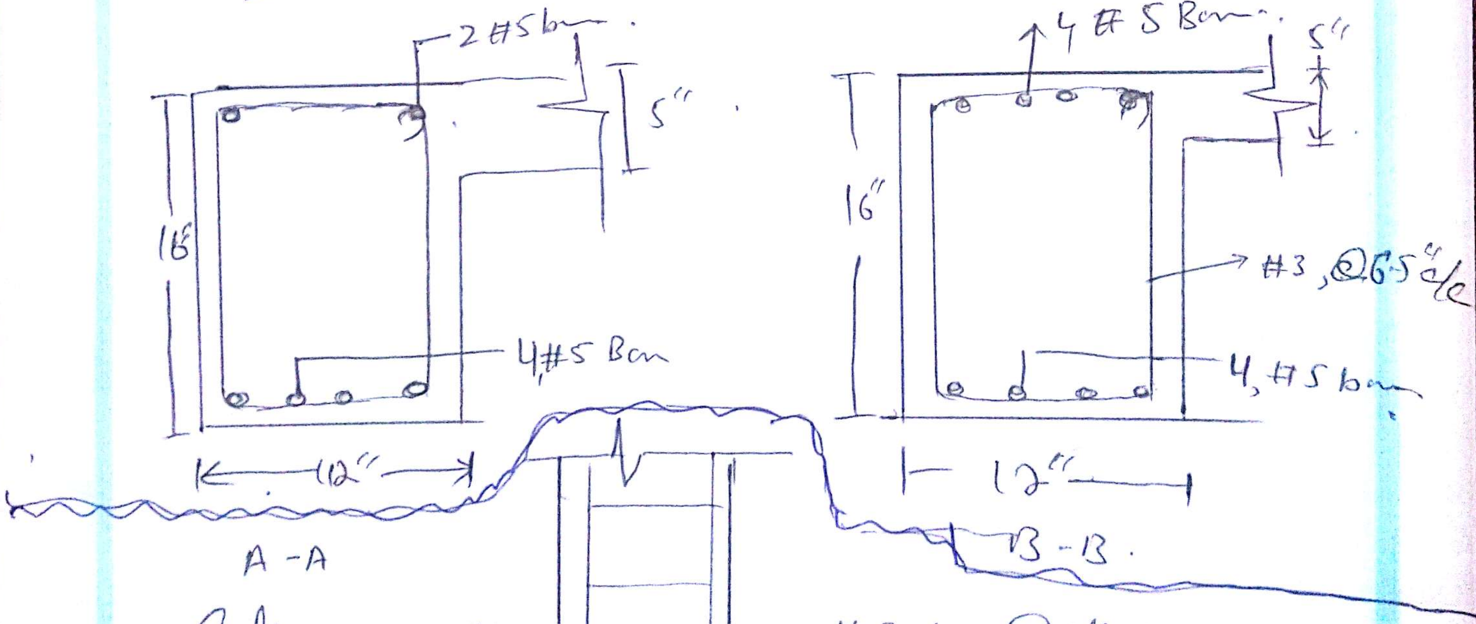

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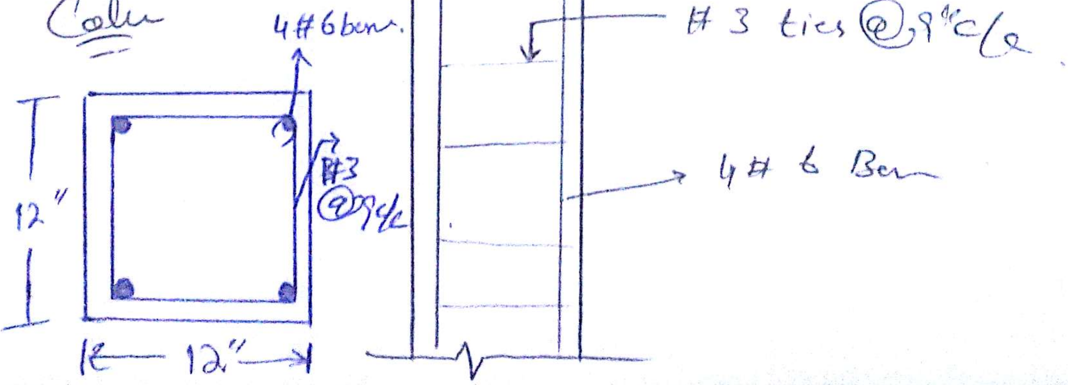


Footing: Col 12" x 12"

$f_c' = 3$ $f_y = 40$ ksi

Assumed bearing pressure = 2.204 k/ft^2

Total D.L = 100 kips. L.L = 80 kips. from the Building

Step I: Assumed $h = 1.5' = 18"$.

$d_{avg} = h - 3 -$ (one dia of bar) $= 18 - 3 - 1 = 14"$

$b_o = 4(c + d_{avg}) = 4 \times (18 + 14) = 128$ in

$z = 5'$

$W = \gamma_{fill}(z - h) + \gamma_c h) = 100(5 - 1) + 150(1)$
$= 450$ psf

$q_e = q_a - W = 2204 - 450 = 1754$ ksi $= 1.728$ ksi

$A_{req} = 150/1.698 = 92.08$ ft^2

$B \times B = A_{req} = 92.08$ ft^2

$B = 9.59\,ft = 9.75\,ft$ $A = 95.06\,ft^2$

Step 2.

$q_u = ((1.2\times100 + 1.6\times50)/(9.75\times9.75)) = 2.10\,kf$.

Stp_3: Analysis.

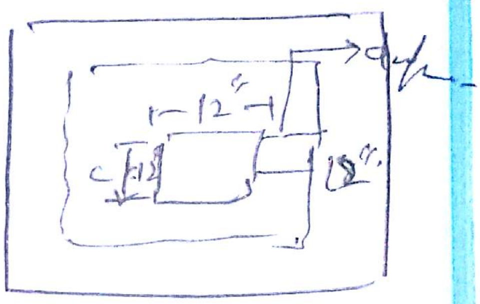
$V_{up} = q_u A - q_u (c + d_{eq})^2$.

$V_{up} = 2.10 \times 95 - 2.1 \times (18+14)^2$.

$= 184.\,kips$.

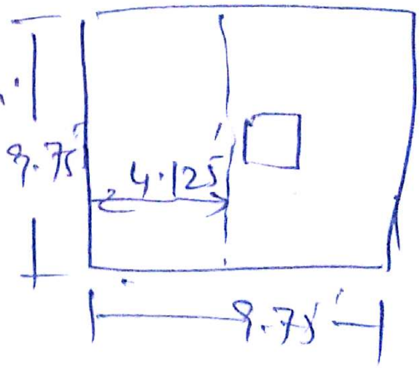
(ii) $V_{ub} = q_u \left(\frac{B}{2} - \frac{c}{2}\right) - d_{eq}\} B$.

$V_{uB} = 60.56\,k$.



Flexural $M_u = q_u \times 4.125 \times 9.75 \times 4.125/2$.

$M_u = 2090.28$ in kips.



Stpt Design

(i) $V_{up} = 184.05\,kip$.

$\phi V_{cp} = \phi 4 \sqrt{f_c'}\, b_o d_{eq}$.

$\phi V_{cp} = 0.75 \times 4 \times \sqrt{3000} \times 128 \times 14/1000 = 294.45\,k > V_{up}$ ok

Rg 15274 P 25

Ben Shear

$V_{ub} = 60.56K$

$\phi V_u = \phi 2\sqrt{fc'} B\,d_{avg}$.

$\phi V_{cb} = 134.57 > V_d$ (ok)

(iii) Flexural design.

$M_u = 2090.88$ kpm.

Let $a = 0.2d = 0.2 \times 14 = 2.8''$

Trail → ① $A_s = M_u / \phi f_y (d_{avg} - a/2) = 4.6\ in^2$. → $a = 0.616''$

Trail → ② $A_s = 4.24$. → $a = 0.57''$.

$A_s = 4.23\ in^2$ ok

Check.

$A_{s\,min} = \{3\sqrt{f_c'}/f_y)\,B d_{avg} \geq (200/f_y) B d_{avg}$

$= 8.19\ in^2 > 4.23\ in^2$ (ok)

So $A_{s\,min} = 8.19\ in^2$.

Spacing $B \times A_b / A_{s\,min}$.

$= 9.75 \times 12 \times 0.79 / 8.12 \approx 11$ in c/c.

Use #8 @ 11" c/c.