**UNIVERSITY OF ASIA PACIFIC**
**Department of Civil Engineering**

**SPRING 2020**

**CE 412**

# Structural Engineering Sessional II

**PROJECT**

ON

**Name** : Lamia Ahmed Sadia

**ID** : 20105084

**Section** : B

Submitted to-
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Lecturer, Department of CE

**Date of Submission:** 05/06/24

# Project

## 1. Introduction:

A six-Story residential structure in Cumilla will be built as Part of this project. The structure is made of reinforced concrete (RC) frames. The floor slabs are going to be built as beam -supported slabs. The site's initial land was probably largely level. Considering the report on soil testing shallow foundation design has been incorporated into the foundation. A project information sheet (doc. file), an Auto CAD soft copy of the architectural design drawing and a PDF soft copy of the soil investigation report slabs that were considered suitable in terms of thickness and reinforcement are provided.

Thus, we must supply the following: the project report (a soft copy of a doc file). the ETABS file (a soft copy of an EDE file), and the sample drawing (a soft copy of a hand sketch).

The Bangladesh Nation Building Code (BNBC) 2017 was followed in the analysis and design of this structure

## 1.2 Project Information:

| Project Information Sheet | | | |
|---|---|---|---|
| SL NO | Item Name | Item Description | |
| 1.1 | Client Information | Name: | Lamia Ahmed Sadia |
| | | Address: | Chandina, Cumilla |
| | | Profession: | Student |
| | | Contact NO: | 01757494898 |
| | | E-mail: | lamiaahmed1125@gmail.com |
| 1.2 | Project location | Plot Area | 3250 sft |
| | | Plot Number | |
| | | Thana/Upazila | Chandina |
| | | District | Cumilla |
| | | Division | Cumilla |
| | | Google Earth Location | |
| 1.3 | Site Information | Adjacent (Utility service lines, Building, Walls of others property etc) | North (front) Side: open ground |
| | | | East side: 6-Storied animation building (under construction) |
| | | | South Side: Boundary wall. |
| | | | West side: open ground area |
| | | Adjacent Road | |
| | | Road level (±0) | 0.0 Level |
| | | Earth Ground Level (EGL) | (-) 1'-0" |
| | | Plinth Level | (+) 2'-6" |

| SL NO | Item Name | Item Information | |
|---|---|---|---|
| 1.4 | Building Information | Occupancy Type: | Residential |
| | | No. of Story | 6 |
| | | Story height, Building height Restriction (RAJUK or any other Authorities) | 10' |
| | | No. of Unit Per floor, mezzanine floor | Two Units, No mezzanine floor |
| | | Structure Type | Office Building |
| | | Structure system | |
| | | Building foot print area | 3256sft |
| | | Floor Area | 19,402sft |
| | | No. of Basements | N/A |
| | | Parking facilities | 8 Nos. |
| | | Ground floor facilities | Car parking |
| | | Roof facilities | Over head water tank |
| | | Lift requirment and measurement | 8 persons lift, Size-5'-6"X6'-2" |
| | | UGWT Requirment and Location | From Grid 2-2 to Grid 3-3 southside area, Size: 13'-1" X 24'-10" |
| | | Septic Tank requirment and Location | N/A |
| | | OHWT requirements and Location | Top of stair and lift core area, Size: 17'-6" X 24'-1" |
| | | Ramp requirement and Location | (±) 0.00 level to (+) 2'-6" |
| | | Type of coarse Aggregate (Brick/ Stone | Brick chips |

# 2. Structural Design Criteria:

## 2.1 Codes, Standards and References

Structural analysis and design of this building have been reviewed according to Bangladesh National Building Code (BNBC) 2015.

ACI 318-08 ACI 318M-08: Building code requirement for Reinforced concrete, 2008.

ASCE 7-05 ASCE/SEI 7-05:05: Minimum Design Loads for Buildings and Other Structures.

* Structural Analysis has been considered according to BNBC 2015.
* Loading Criteria are considered according to BNBC 2015
* Material Specifications and properties have been considered according to BNBC 2015.
* Structural Design of RCC has been considered according to BNBC 2015.

## 2.2 Structural Geometry Considerations

Structural geometry (Shape, size, story height and number of stories) have been considered as per architectural design and further requirment also checked.

## 2.3 Material Specifications

Concrete

The following concrete grades f'c (28 days cylinder strength) are adopted in design:

| | |
|---|---|
| Columns | 5100 psi |
| Shear Walls | 5100 psi |
| Non-suspended slabs/slabs on grade plain concrete | 5100 psi |

| | |
|---|---|
| Concrete young's modulus, $E_c$ | 4106321.35 lb/in² |
| Poisson's ratio, u | 0.2 |
| Weight per Unit Volume | 150 lb/ft3 |

Steel

The following steel grades fy are adopted in design:

| | |
|---|---|
| Rebar | 50000 lb/in² |
| Modulus of elasticity | 29000000 lb/in² |
| Poisson's ratio, u | 0.3 |
| weigt per unit volume | 15.23 lb-s²/ft4 |

2.4 Loading Criteria

The building has been analyzed for possible load actions such as Gravity and Lateral Loads.

a) Gravity Loads, such as dead and live loads applied at the floors or roofs of the building according to the provision of BNBC 2015 are as follows:

- Dead Loads

  Self-weight of concrete = 150 pcf

  floor finish (FF) on floors = 25 psf

  Fixed Partition Wall (RPW) = 437.5 psf

- Live Loads

Live load on slab (without top story) = 42 PSF

Roof Live load on Slab = 20 psf

Stair and Lobby = 100 psf

Random Partition Wall = 25 psf

Floor Live Load = 42 psf

b) Lateral Loads, such as wind Load and seismic Load applied at the building in accordance with the provision of Chapter 2, part 6 of BNBC 2015 is as follows:

Wind Load consideration parameters:

Basic wind speed, $V_b$ = 137.35

Structural Importance Coefficient (CI): 1

Occupancy category = II

Importance factor = 1

Gust factor = 0.85

Topographic factor, $K_{zt}$: 1

Wind Directional factor, $K_d$ = 0.85

Exposure Category: B

Damping Ratio: 5%

Wind pressure Coefficient:

$C_{pw}$ = 0.8 (wind ward - direction)

$C_{pl}$ = 0.2725 (X-direction)

$C_{pl}$ = 0.5 (y- direction)

Seismic Load consideration parameters:

Seismic Zone: Zone-2 (Chandina, Cumilla)

Zone factor: (Z): 0.20

Response Modification Coefficient: (R): 5

System Overstrength, Omega: 3

Deflection Amplifications, Cd = 4.5

Structural Importance factor, I: 1.0

Site coefficient (fa): 1.15

Site coefficient ($F_v$) : 1.725

Occupancy category : II

Seismic Design Category: SDC C

Fundamental Period of Vibration. (T) = 0.885 sec

Spectral Response Acceleration Parameter: $S_s$ : 0.5

$S_1$ : 0.2

## 2.5 Load Plan

In X-direction: EX-1, EX-2, EX-3

In Y-direction: EY-1, EY-2, EY-3

Wind Loads:

In X direction: WX-1, WX-2, WX-3, WX-4

In Y direction: WY-1, WY-2, WY-3, WY-4

## 2.6 Boundary Conditions (Support conditions)

Column base supports have been considered as fixed supports in 3D model of super structure Spring supports have been considered for shallow foundation.

## 2.7 Design Method and Load combinations

USD/LFRD design method have been considered to design this structure: factored load combination.

$U = LL$

$U = DL + LL$

$U = DL + 0.5LL + 0.7WX$

## 2.8 Bearing Capacity of Shallow Foundation/Pile capacity

Bearing capacity of soil considered for this building is 4 ksf.

## 2.9 3D view and Typical Plan of Building

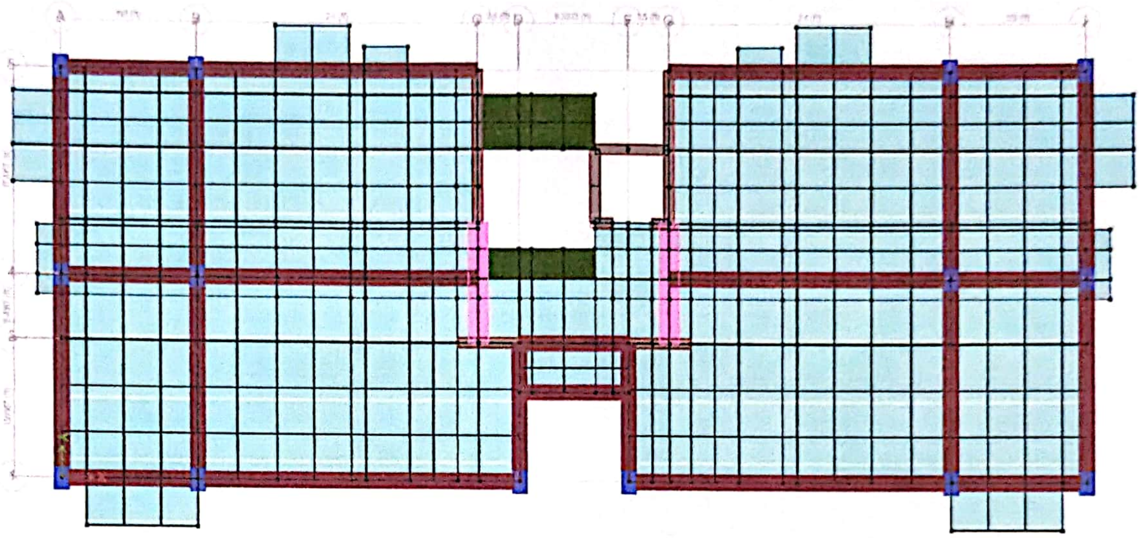

Fig. 2.1 Typical Plan of Building

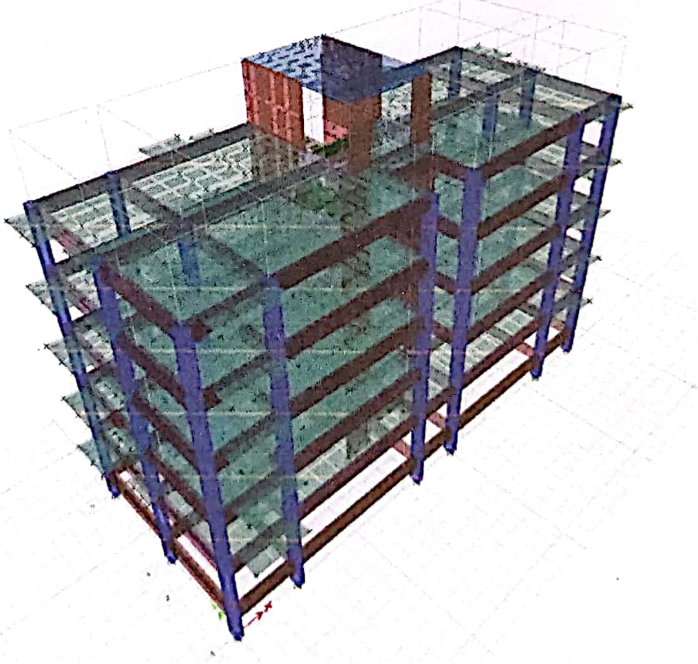

Fig. 2.2 3D view of Building

2.10 Building Irregularity

| SL NO | Item Name | Yes/NO |
|---|---|---|
| 1 | Torsional Irregularity | Yes |
| 2 | Re-entrant Corners | NO |
| 3 | Diaphragm Discountinuity | NO |
| 4 | Out-of-Plane offsets | NO |
| 5 | Stiffness Irregularity-soft story | NO |
| 6 | Mass Irregularity | NO |
| 7 | Vertical Geometric Irregularity | NO |
| 8 | Verotical In-Plane Discontinuity | NO |
| 9 | Discontinuity in Capacity-Weak Story | NO |
| 10 | Non-parallel system | NO |

2.11 Selection of Analysis type

Structural analysis has been performed by ETABS 2020.

3. Analysis and design software freatures:

| | |
|---|---|
| MS Excel | Spread Sheets |
| ETABS 20 | Extended 3D Aanalysis of Building System |

B24X15   C-15X24

# 4. SERVICEABILITY CRITERIA AND BUILDING IRREGULARITIES:

## 4.1 SERVICEABILITY CRITERIA

Column Size 15''X24''

Beam Size 24''X15''

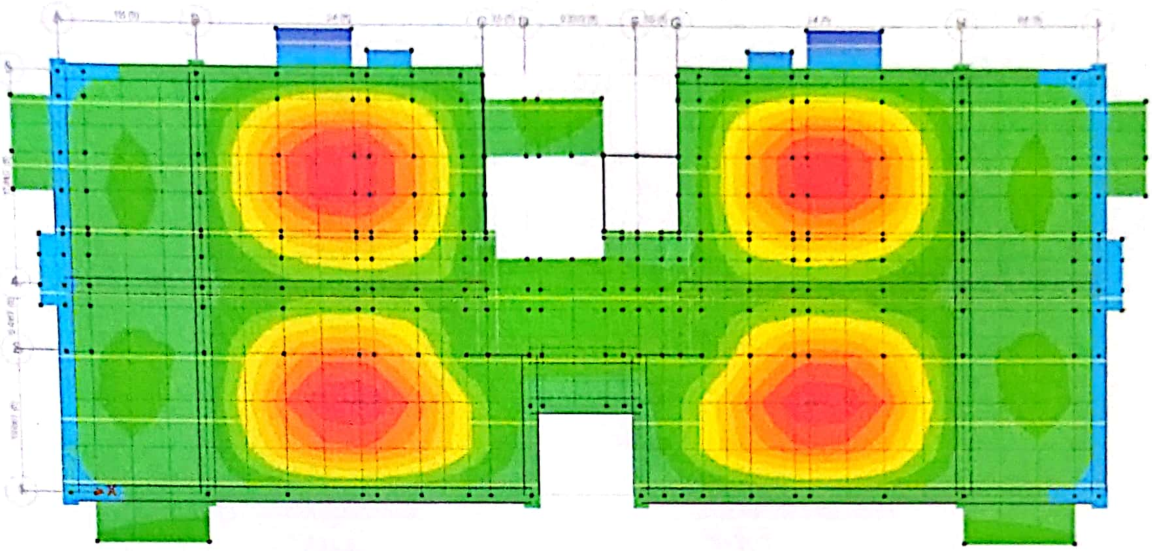

Fig. 4.1: Vertical Deflection Limits for Live Load

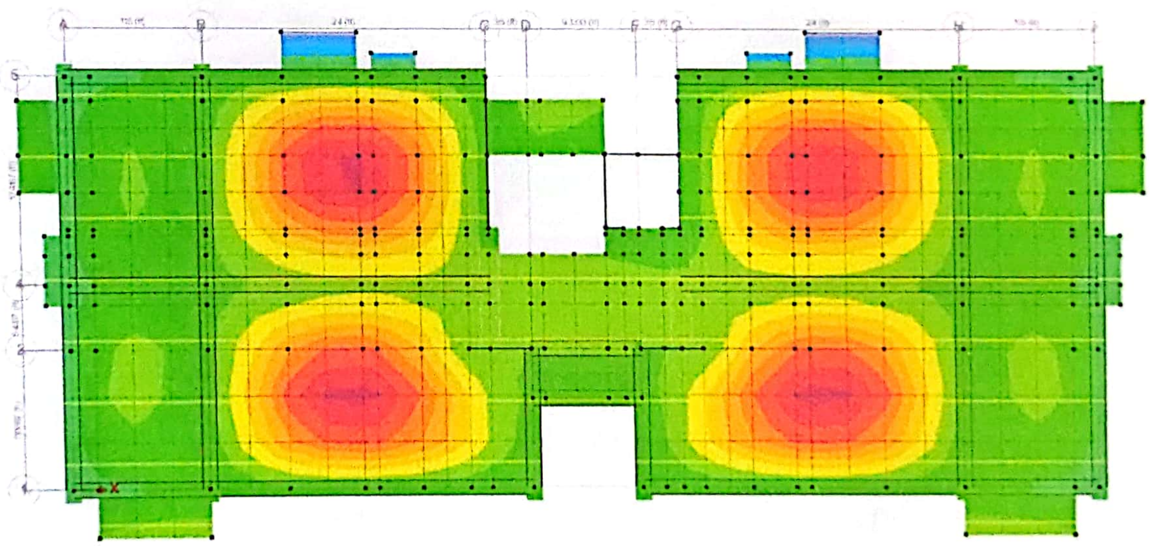

Fig. 4.1: Vertical Deflection Limits for DL+LL

① Vertical deflection limits (D+L and L)

Deflection limits (D+L) $= \frac{l}{240} = \frac{17.42 \times 12}{240} = 0.871''$

from ETABS

$U_Z(D+L) = 0.103'' < 0.871''$ [OK]

Deflection limits (L) $= \frac{l}{360} = \frac{17.42 \times 12}{360} = 0.581''$

from etabs,

$U_Z(L) = 0.0256'' < 0.581''$ [OK]

② maximum lateral displacement for wind load.

maximum limits $= \frac{H}{500} = \frac{60 \times 12}{500} = 1.44''$

for load combination $(D+0.5L+0.7W \times 4)$

Maximum story displacement = 0.242

③ Story drift for wind load [section 1.5.6.1]

$T = C_t (h_n)^m$

$= 0.0466 \times \left(\frac{60}{3.28}\right)^{0.90}$

$= 0.637$ sec

here, $T < 0.7$ sec

$\therefore \Delta \leq 0.005h$

$\Rightarrow \frac{\Delta}{h} = 0.005$

maximum story drifts from ETABS $(D+0.5L+0.7W \times 4)$

$= 0.000357 < 0.004$ [OK]

(4) Maximum lateral displacement for earthquake Load.

for all other structures, [Table 6.2.21]

Allowable story drift limit, $\Delta = 0.020 h_{sx}$

[occupancy category I and II]

$\Rightarrow \Delta = 0.020 \times (60 \times 12) = 14.4"$

We know,

$$S_x = \frac{C_d S_{xe}}{I}$$

From ETABS,

maximum story displacement for earthquake

$S_{xe} = 2.179"$ [OK]

$S_x = 4.5 \times 2.179$

$= 9.80" < 14.4"$

(5) Story Drift for earthquake load:

Allowable limit for story drift = 0.02

Story drift value $\times 4.5 \leq 0.02$

From ETABS,

maximum value for drift = 0.0035

$\therefore 0.0035 \times 4.5 = 0.01575 < 0.02"$ [OK]

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## 4.2 Torsional Irregularities

| Story | Load Case | Max Drift | Ratio |
|---|---|---|---|
| OHWT | EX1 | 0.039292 | 1.109 |
| OHWT | EX2 | 0.039231 | 1.326 |
| OHWT | EX3 | 0.039256 | 1.226 |
| OHWT | EY1 | 0.015571 | 2.428 |
| OHWT | EY2 | 0.015666 | 2.138 |
| OHWT | EY3 | 0.015675 | 2.159 |
| Roof | EQX1 | 0.03478 | 1.13 |
| Roof | EQX2 | 0.03475 | 2.01 |
| Roof | EQX3 | 0.03485 | 2.122 |
| Roof | EQY1 | 0.029459 | 1.416 |
| Roof | EQY2 | 0.02946 | 3.263 |
| Roof | EQY3 | 0.029455 | 3.843 |
| 5F | EX1 | 0.038287 | 1.409 |
| 5F | EX2 | 0.038289 | 1.506 |
| 5F | EX3 | 0.038869 | 2.04 |
| 5F | EY1 | 0.031455 | 1.219 |
| 5F | EY2 | 0.031458 | 1.367 |
| 5F | EY3 | 0.031468 | 1.4 |
| 4F | EX1 | 0.042802 | 1.024 |
| 4F | EX2 | 0.042902 | 1.942 |
| 4F | EX3 | 0.042703 | 1.859 |
| 4F | EY1 | 0.032506 | 1.432 |
| 4F | EY2 | 0.032508 | 3.254 |
| 4F | EY3 | 0.032608 | 2.245 |
| 3F | EX1 | 0.044766 | 1.052 |
| 3F | EX2 | 0.044865 | 1.942 |
| 3F | EX3 | 0.044975 | 1.833 |
| 3F | EY1 | 0.005849 | 1.429 |
| 3F | EY2 | 0.030733 | 3.153 |
| 3F | EY3 | 0.030873 | 3.886 |
| 2F | EX1 | 0.046329 | 1.151 |
| 2F | EX2 | 0.046429 | 1.856 |
| 2F | EX3 | 0.046623 | 1.023 |
| 2F | EY1 | 0.032592 | 1.396 |
| 2F | EY2 | 0.033592 | 2.985 |
| 2F | EY3 | 0.035692 | 2.987 |
| 1F | EX1 | 0.02275 | 1.526 |
| 1F | EX2 | 0.02375 | 1.651 |
| 1F | EX3 | 0.03689 | 1.535 |
| 1F | EY1 | 0.013375 | 1.579 |
| 1F | EY2 | 0.013475 | 1.252 |
| 1F | EY3 | 0.01599 | 1.581 |

4.3 Stiffness Irregularity-Soft-Story

| Story | Load case | Shear X (kip) | Drift X (in) | Stiffness X (kip/in) | Ke/Ka | Status | Ke/Kavg | Status |
|---|---|---|---|---|---|---|---|---|
| OHWT | EX1 | 7.601 | 0.036224 | 209.8221 | - | - | - | - |
| Roof | EX1 | 51.059 | 0.031574 | 1617.09 | 7.706 | OK | - | - |
| 5F | EX1 | 88.055 | 0.038091 | 2311.70 | 1.429 | OK | - | - |
| 4F | EX1 | 115.692 | 0.042553 | 2718.74 | 1.176 | OK | 1.970 | OK |
| 3F | EX1 | 134.455 | 0.041811 | 3215.79 | 1.182 | OK | 1.451 | OK |
| 2F | EX1 | 145.684 | 0.035842 | 4047.89 | 1.258 | OK | 1.472 | OK |
| 1F | EX1 | 68.168 | 0.014913 | 4571.16 | 1.129 | OK | 1.373 | OK |
| Story | Load case | Shear Y (kip) | Drift Y (in) | Stiffness Y (kip/in) | Ke/Ka | Status | Ke/Kavg | Status |
| OHWT | EY1 | 7.601 | 0.028941 | 269.6289 | - | - | - | - |
| Roof | EY1 | 51.059 | 0.021356 | 2390.83 | 2.9 | OK | - | - |
| 5F | EY1 | 88.055 | 0.026195 | 3361.50 | 1.40 | OK | - | - |
| 4F | EY1 | 115.692 | 0.027967 | 4136.67 | 1.23 | OK | 2.06 | OK |
| 3F | EY1 | 134.455 | 0.026925 | 4993.61 | 1.20 | OK | 1.514 | OK |
| 2F | EY1 | 145.084 | 0.022599 | 6420.00 | 1.28 | OK | 1.541 | OK |
| 1F | EY1 | 49.729 | 0.008469 | 5872.08 | 0.91 | OK | 1.132 | OK |

## 5. ADEQUACY OF STRUCTURAL MEMBERS:

### 5.1 Adequacy of Column

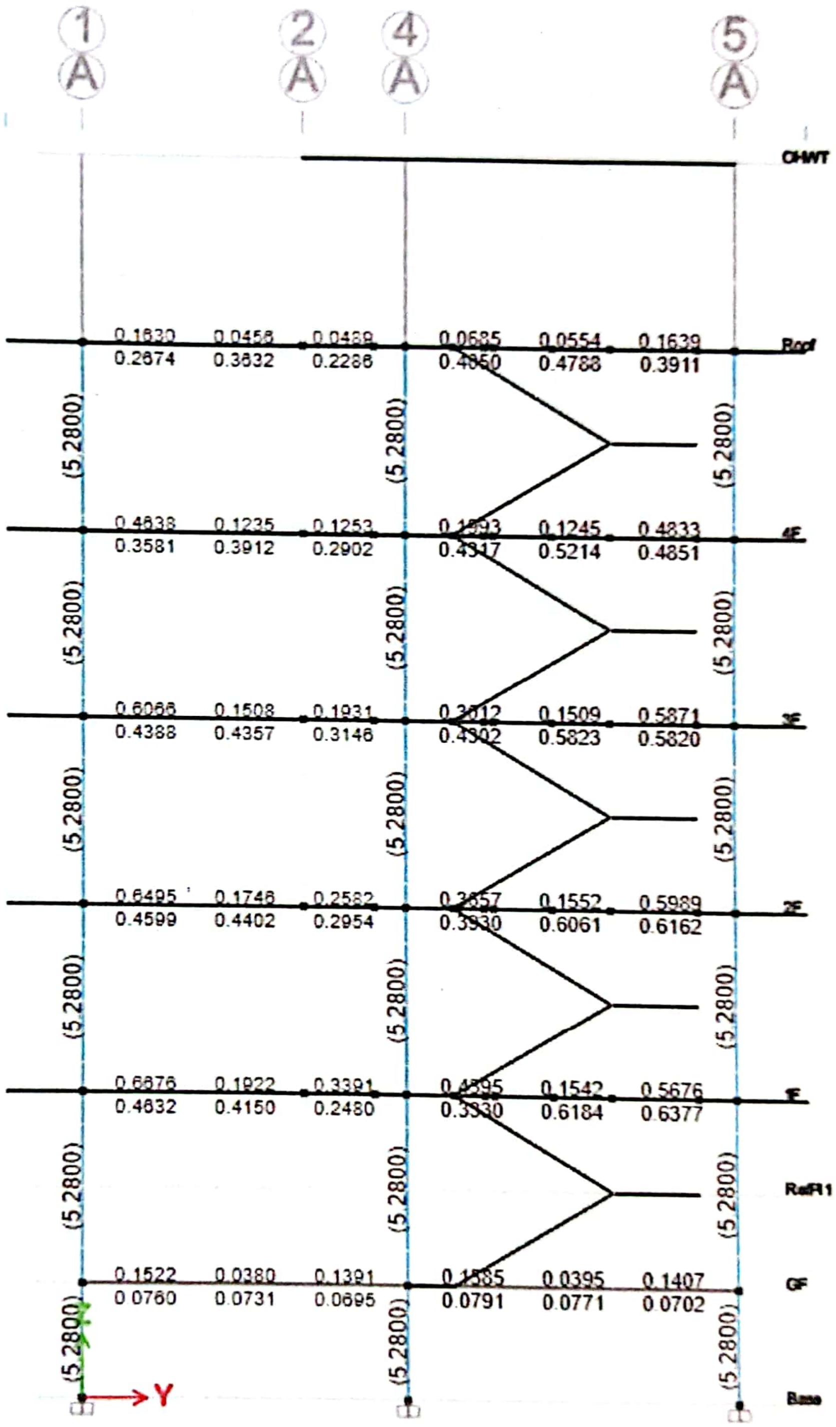



Fig. 5.1: Longitudinal Reinforcing of Column

However here provided section 15" x24". for this size maximum reinforcement showing 5.28in². The design done taking this value because by using this value structure might be resist againsts all kinds of load and shear.

Using #6 bar.

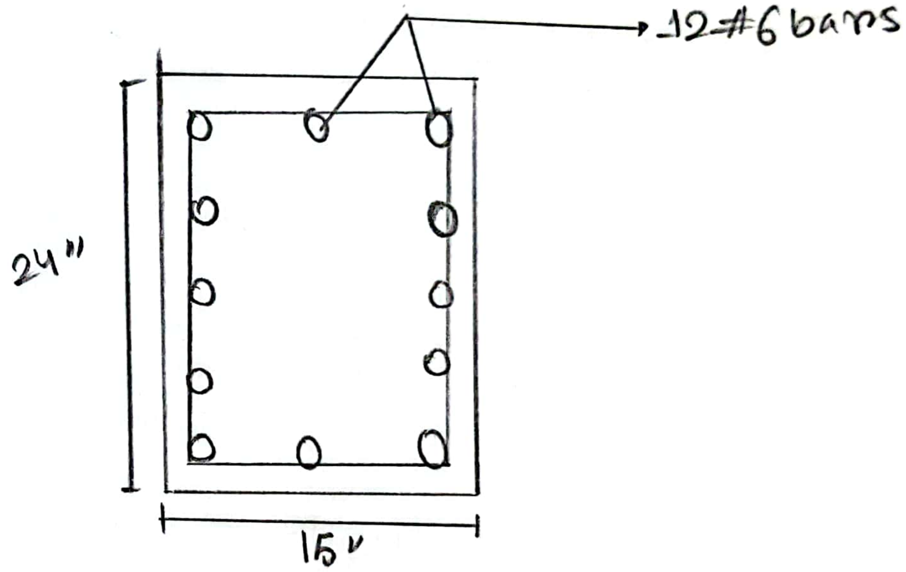
∴ No of bar = $\frac{5.28}{0.44}$

= 12 NOS

$N = \frac{A_s}{A_s'}$

$A_s = 5.28 in^2$

$A_s' = 0.44 in^2$




# 6 use as a longitudinal reinforcement and 3# are as a tie.

This section will be use for all column at each and every section.

spacing of hoop within Lo, $C_2$, $h_{col}/6$, 18"

$C_2 = 24"$

$\frac{h_{col}}{6} = \frac{10 \times 12}{6} = 20"$

18"

$\therefore$ spacing of hoop within $L_o$ = 24" c/c

End spacing $\leq \frac{b_c}{4} = \frac{20}{4} = 5"$ or 4"

$\therefore$ End spacing = 4" c/c

for special confinement,

Area of rectangular hoops $\geq 0.35\, s\, d \left(\frac{f'_c}{f_y}\right)\left(\frac{A_g}{A_c - 1}\right)$

$\therefore$ Core area $A_c = 12 \times 21$
$= 252\ in^2$

$A_g = 24 \times 15 = 360\ in^2$

area of hoops $= 0.3 \times 4 \times 12.5 \times \left(\frac{5}{50}\right) \times \left(\frac{360}{252 - 1}\right)$
$= 2.15\ in^2$

$h' = 24 - 3"$
$= 21"$

$b = 15 - 3"$
$= 12"$

$d = 15 - 2.5$
$= 12.5"$

$\therefore$ Using at least 4 legged #6

spacing through the column $= \frac{b_c}{2} = \frac{15}{2} = 7.5" \simeq 7"$ c/c

$S_p = \frac{L_c}{4} = \frac{10 \times 12}{4} = 30"$

Between this length provided spacing 4" c/c

Anchorage at end Joints, $L_{anch} = L_d + 10\, d_b$

$L_d$ = for # 6 bar $= 0.04 \times A_s \times \frac{f_y}{\sqrt{f'_c}}$

$= 0.04 \times 0.44 \times \frac{50}{\sqrt{5/1000}} = 12.44"$

$L_{anch} = 12.44 + 10 \times \frac{7}{8} = 21.19 \simeq 21"$

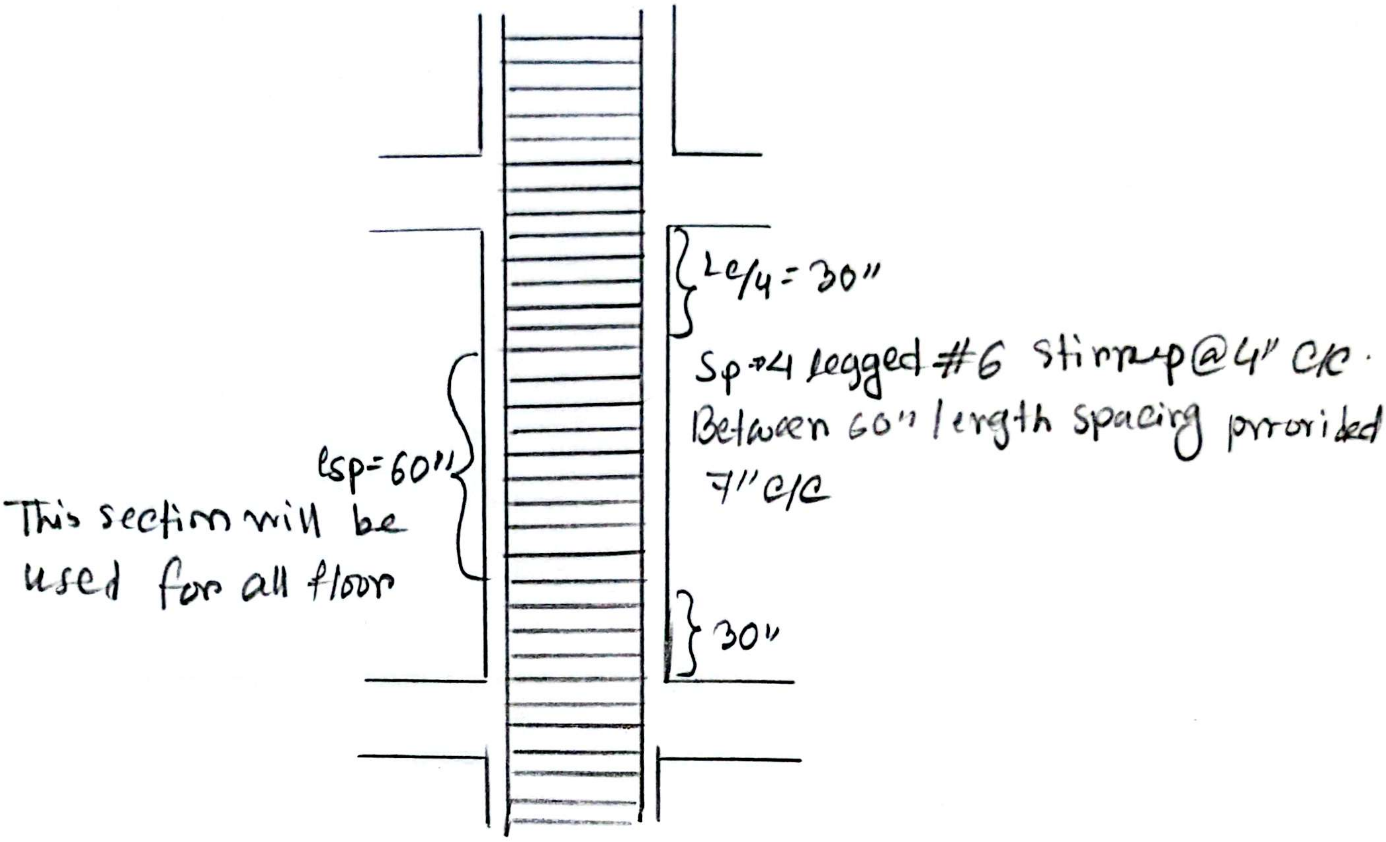



Fig: 5.3: Long section of Column

## 5.2 Adequacy of Beam

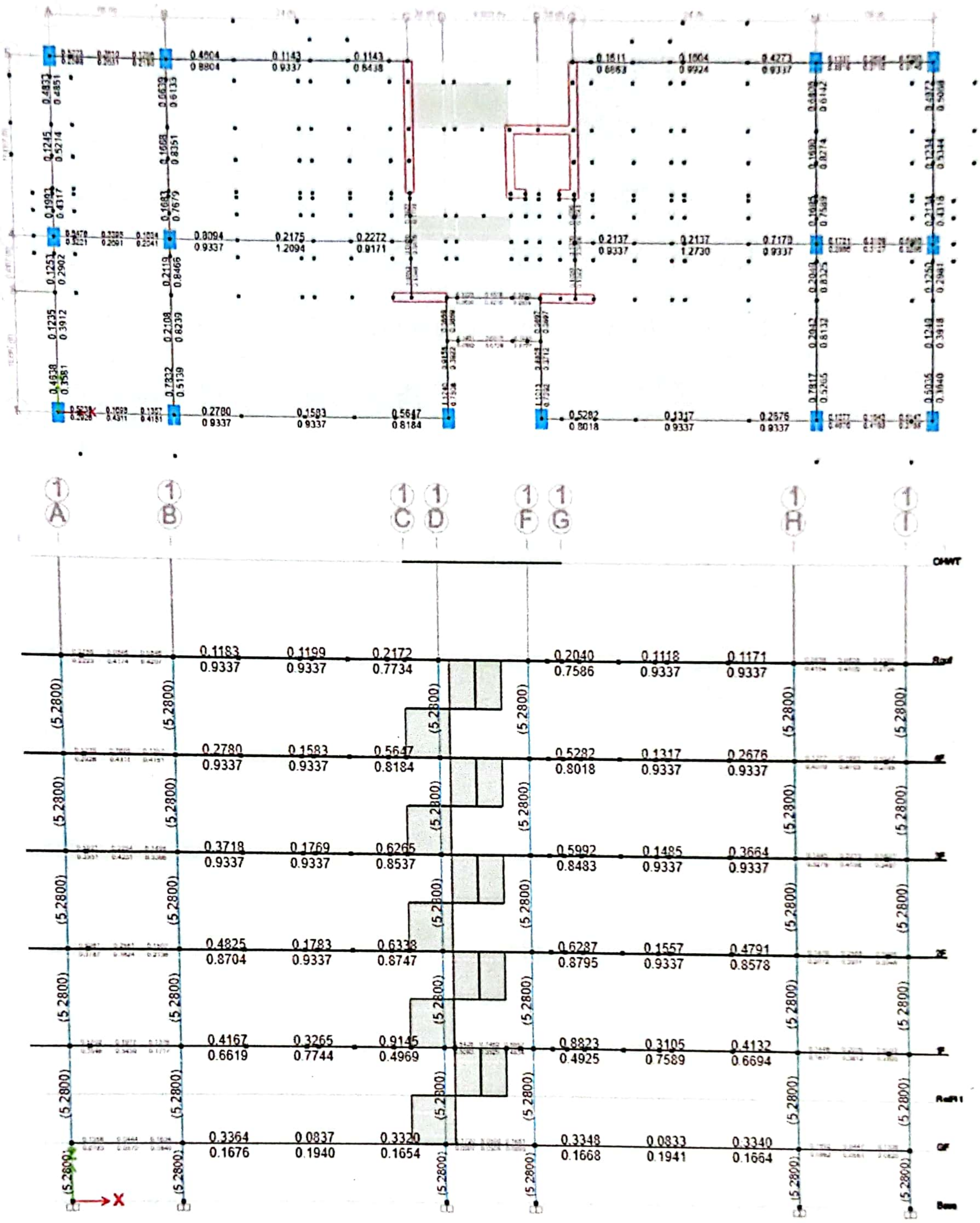



Fig. 5.4: Longitudinal Reinforcing of Beam

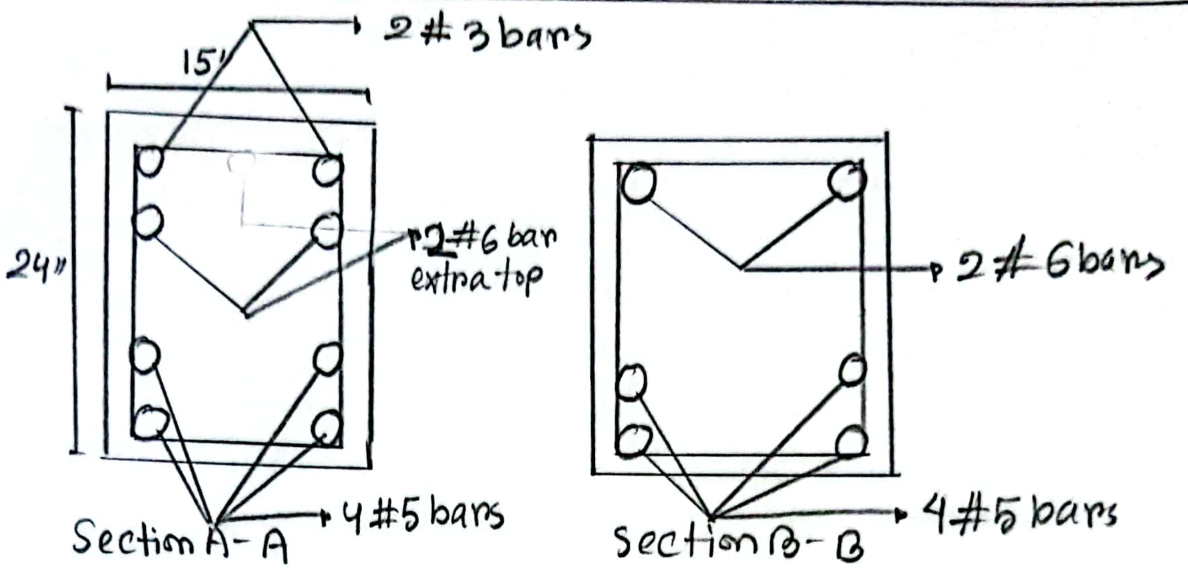



Fig. 5.6: Cross section of beam

Total depth = 24"

$d = 24'' - 3.5'' = 20.5''$

Lap splices are allowed for ≤50% of bars, only where stirrups are provided @ ≤ $d/4$ (= 5.13") or 4" c/c.

spacing of hoop within 2d (=41"), beginning at ≤2", at either end of a beam must be ≤

$d/4 = 5.13''$

$8d_b = 8 \times \frac{5}{8} = 5''$

$\therefore$ spacing = 5" c/c

Elsewhere, $S_t = \frac{d}{2} = \frac{20.5}{2} = 10.25'' \simeq 10''$ c/c

## 5.3 Adequacy of Shear Wall

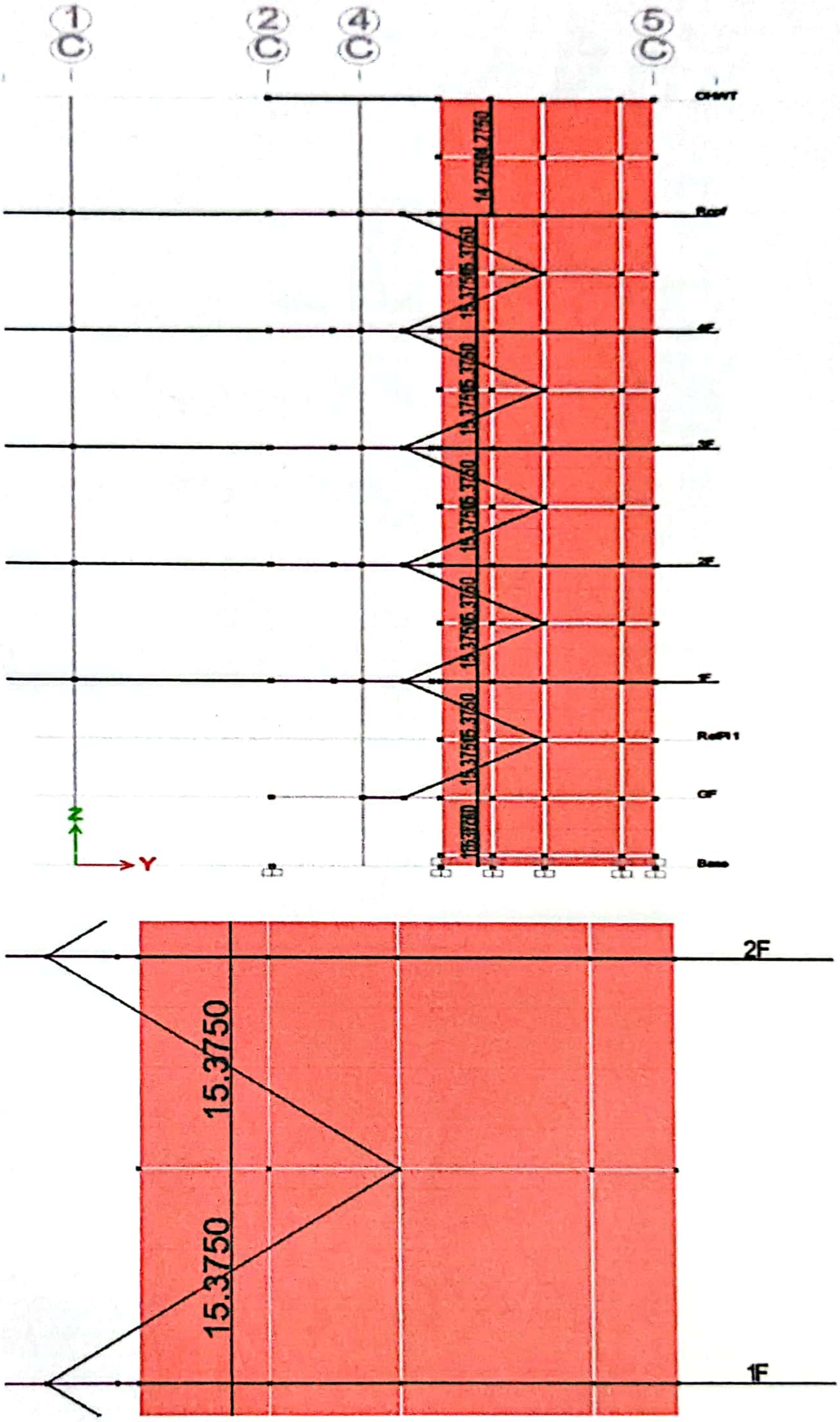



Fig. 5.7: Longitudinal Reinforcing of Shear Wall

from shear design flexural reinforcement found = $15.375\ in^2$

Using # 7 bars,

$$\therefore N = \frac{15.375}{0.60}$$

$$= 25.625 \simeq 26\ Nos$$

$\therefore$ At Every face = $\frac{26}{2}$ = 13 Nos $\simeq$ 14 Nos

$\therefore$ Use 14 # 7 bars on each side

for vertical reinforcement;

Using 2-legged # 3 bars.

Spacing

$L_w = 153$
$h = 10''$

i) $S = \frac{A_v h}{\rho_v h} = \frac{0.11 \times 2}{0.0025 \times 10} = 8.8''$

ii) $S = 3h = 3 \times 10 = 30''$

iii) $S = 18''$

iv) $S = \frac{L_w}{3} = \frac{153}{3} = 51''$

$\therefore$ Minimum spacing = $8.8'' \simeq 8''$ c/c

use 2-legged # 3 bars @ 8'' c/c

for horizontal reinforcement spacing,

$$S = \frac{l_w}{5} = \frac{153}{5} = 30.6''$$

$$S = 3h = 3\times10 = 30''$$

$$S = 18''$$

$$S = \frac{A_{vh}}{0.0025h} = \frac{0.11\times2}{0.0025\times10}$$

$$= 8.8'' \simeq 8''$$

Use-2 legged #3 bars @ 8" c/c

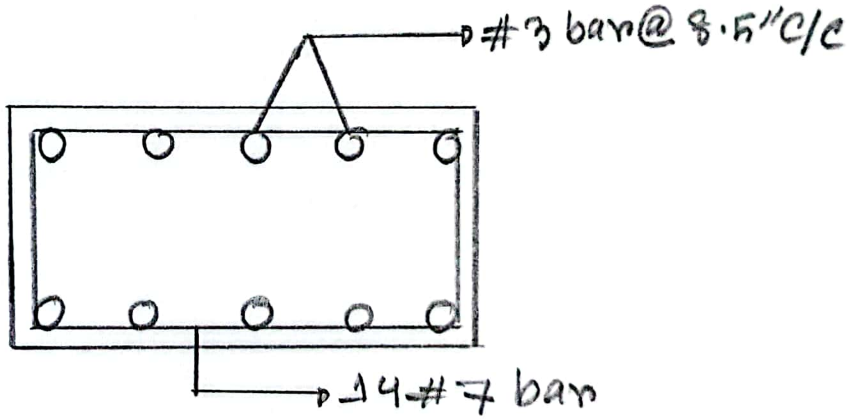



Fig. 5.8: Cross section of shear Wall

## 5.4 Adequacy of Slab

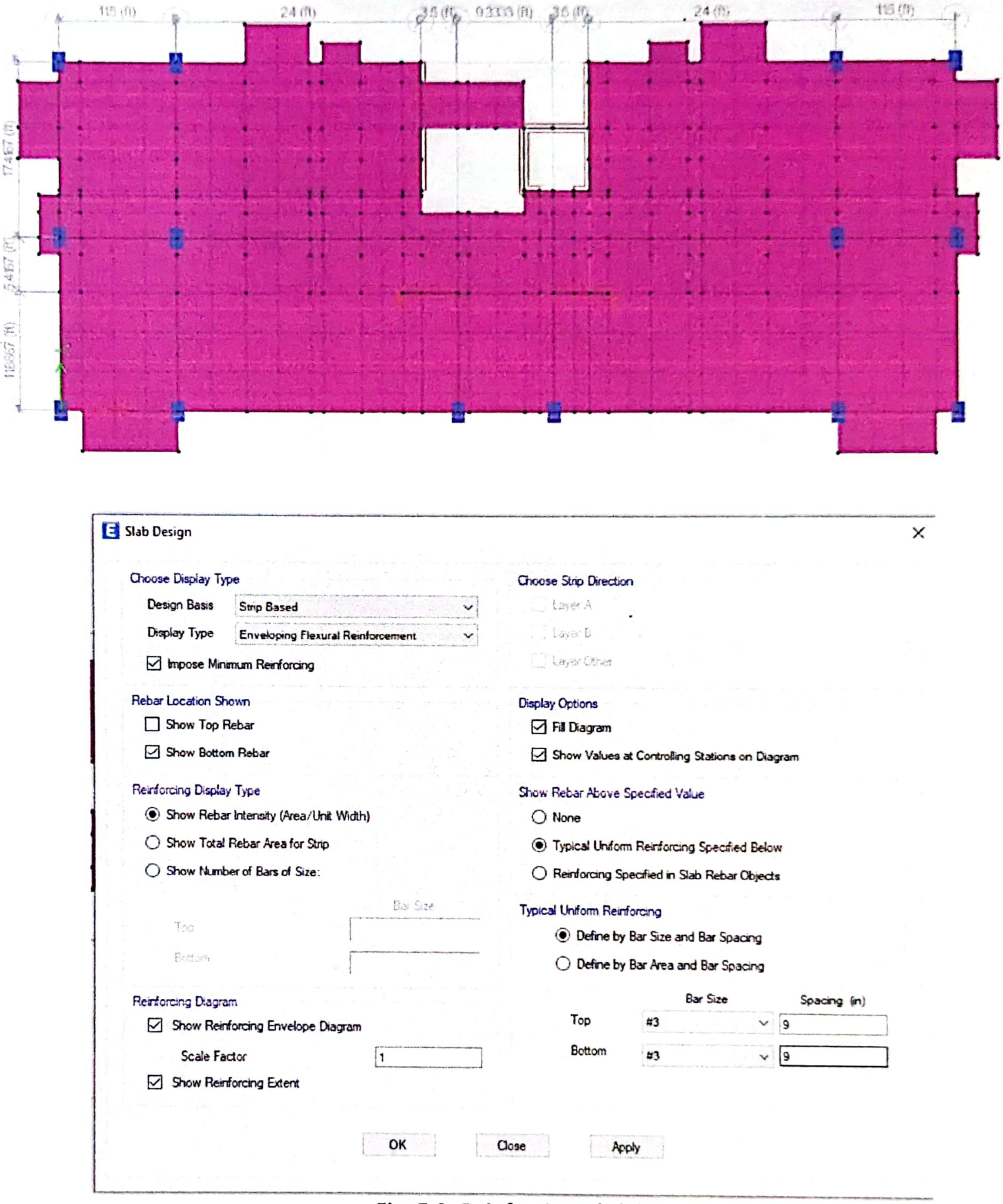
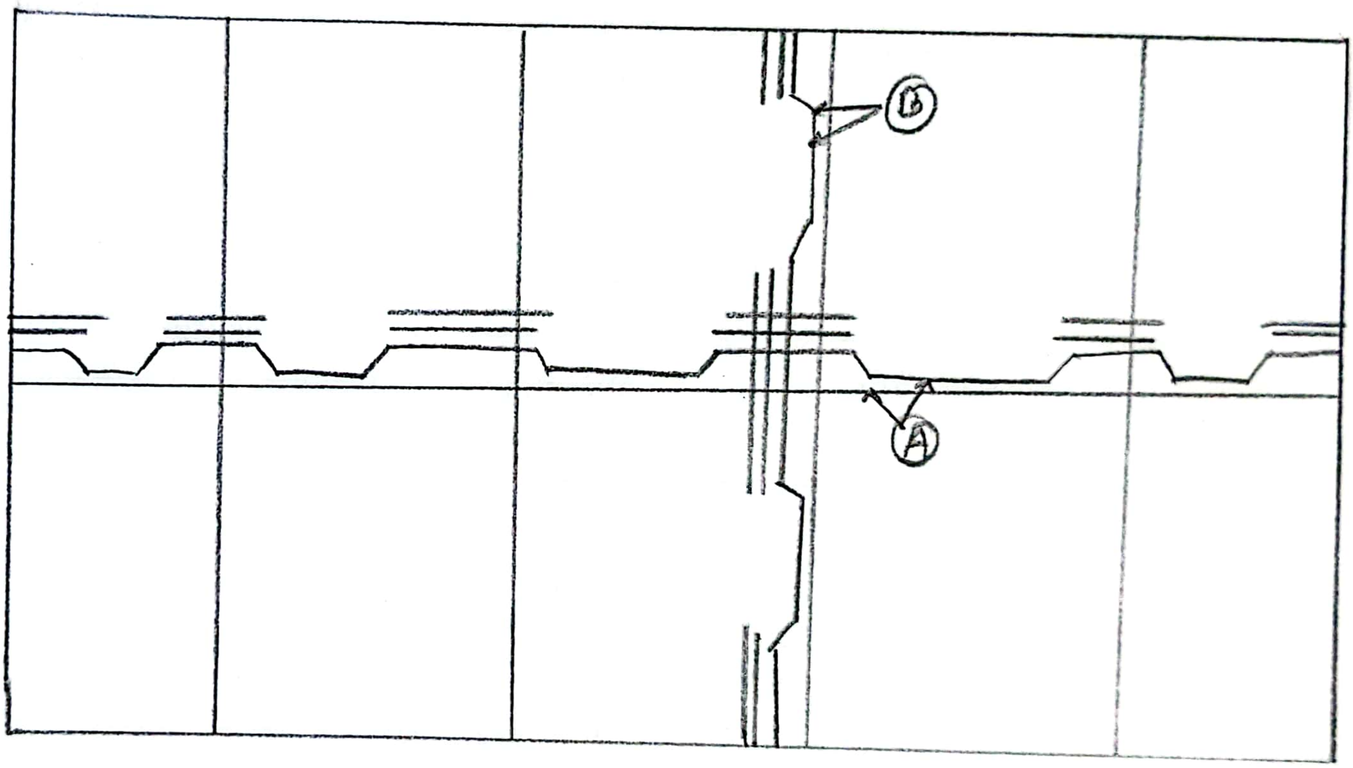



Fig. 5.9: Reinforcing of Slab

Slab design is ok when define bar size #3 and bar spacing 9" c/c. But near the lift provided reinforcement area not ok for top rebar. The slab design is fully ok if we provided 2#3 extra top through the section. Slab design checked by ETABS




A = #3 @ 9" c/c alt. ckd + 2#3 extra top

B = #3 @ 9" c/c alt. ckd + 2#3 extra top

Fig. 5.10: Slab reinforcement detailling for typical floor

## 5.5 Adequacy of Foundation

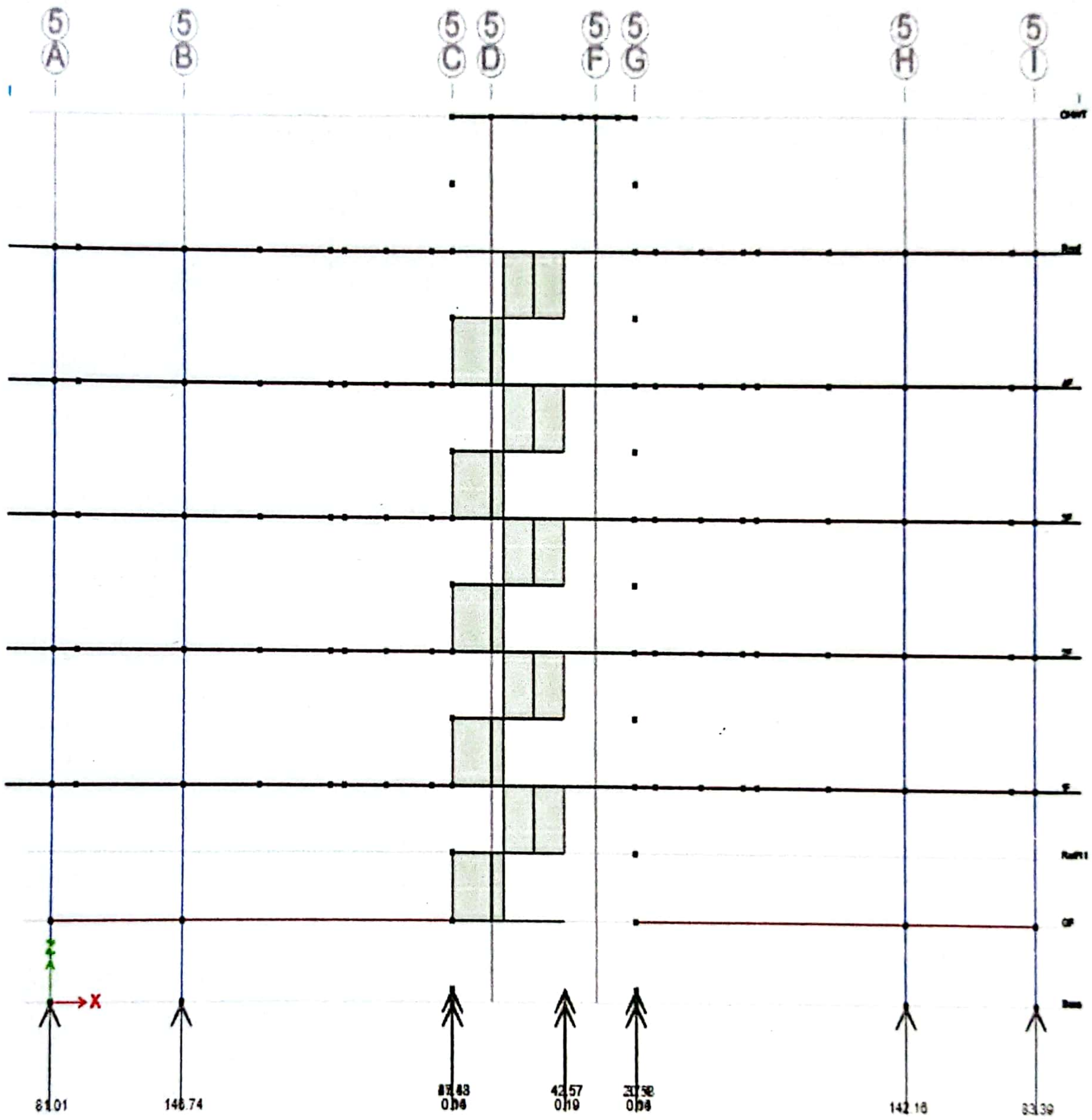
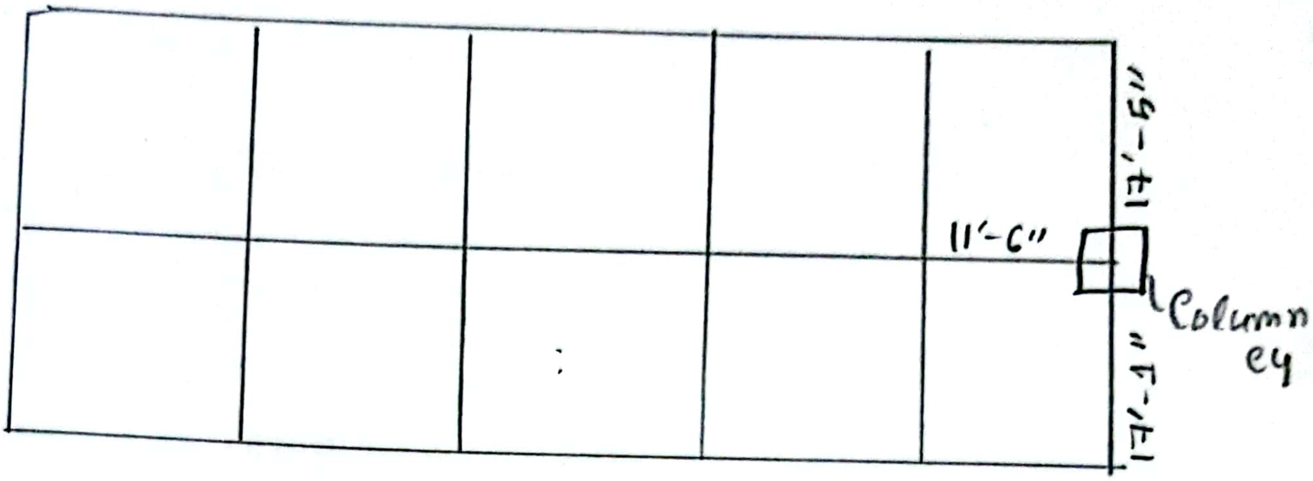


Fig. 5.11: Column load




Data

Column Size $= 15'' \times 24''$

$f'c = 5\,ksi$

$fy = 50\,ksi$

Allowable Net BC(soil) $= 4\,ksf$

$P(D+L) = 83.39$ kip

footing load $= 1.1 \times 83.39 = 91.72$ Kip

$\therefore$ footing area $= \dfrac{91.72}{4} = 22.93\ ft^2$

$= 6' \times 4'$

effective depth, $d = 24''$

$\therefore$ Punching shear area, $A_p = d\left[2\left(c_1 + d/2\right) + \left(c_2 + d\right)\right]$

$= d\left[2\left(15 + d/2\right) + \left(24 + d\right)\right]$

$= d\left[\left(30 + 2d/2\right) + \left(24 + d\right)\right]$

$= d\left(54 + 2d\right)$

$\therefore$ Punching shear strength $= 4\phi\sqrt{f'c}$

$= 4 \times 0.85 \times \sqrt{5000}$

$= 240.41$ psi

$= 0.240$ ksi

effective bearing pressure $= \frac{83.391}{6\times4} = 3.47 \simeq 3.5$ ksf

$\therefore 0.204\times\{d(54+2d)\} = 83.39 - 3.5\times\frac{(15+d/2)(24+d)}{(12)^2}$

$\therefore d = 5.36 \simeq 5.5''$

here,

Flexural shear strength $= 2\phi\sqrt{f'c}$

$= 2\times0.85\times\sqrt{5000}$

$= 120.20$ Psi

$= 0.1202$ Ksi

$= 17.30$ ksf

Maximum flexural shear force $= 3.5\times\left\{\left(\frac{4-\frac{15}{12}}{2}\right)-d\right\}$

$\Rightarrow 17.30\times1\times d = 3.5(1.375-d)$

$\therefore d = 0.2313' = 2.77''$

footing thickness, $t = 13.5+4 = 17.5'' > 2.77''$ [OK]

Total bending moment $= \frac{\left[3.5\times\left\{\frac{4-\frac{15}{12}}{2}\right\}^2\right]}{2}\times6$

$= 19.85$ k-ft

$f_c = 0.85 f'c$

$= 0.85\times5000 = 4250$ Psi

$= 4.25$ Ksi

$\alpha = 0.68$ if $f'c \leq 5000$ Psi

$\therefore \rho_{max} = \frac{0.75\times0.68\times4.25}{50}\times\frac{87}{87+50}$

$= 0.02752$

Now,

$$R_u = \phi \rho_{max} f_y \left(1 - 0.59 \rho_{max} \times \frac{f_y}{f'_c}\right)$$

$$= 0.85 \times 0.02752 \times 50 \left(1 - 0.59 \times 0.02752 \times \frac{50}{5}\right)$$

$$= 0.9796 \simeq 0.98$$

$\therefore$ Depth required by m is $= \sqrt{\dfrac{m}{R_u b}}$

$$= \sqrt{\frac{19.85}{0.98 \times 4}} = 2.25'' < 13.5'' \text{ [OK]}$$

$$\therefore A_s = \frac{f'_c}{f_y}\left[1 - \sqrt{\{1 - 2m/\phi f'_c b d^2)\}}\right] bd$$

$$= \frac{4.25}{50}\left[1 - \sqrt{\left\{1 - \frac{(2 \times 19.85 \times 12)}{(0.90 \times 4.25 \times 4 \times 12 \times 5.5^2)}\right\}}\right] \times 4 \times 12 \times 5.5$$

$$= 0.98 \simeq 1 \text{ in}^2$$

Minimum Reinforcement $= \dfrac{0.2}{f_y} \times bd$

$$= \frac{0.2}{50} \times 4 \times 12 \times 5.5 = 1.05 \text{ in}^2 > A_s$$

$A_s$ (provided) $= 1.05 \text{ in}^2$

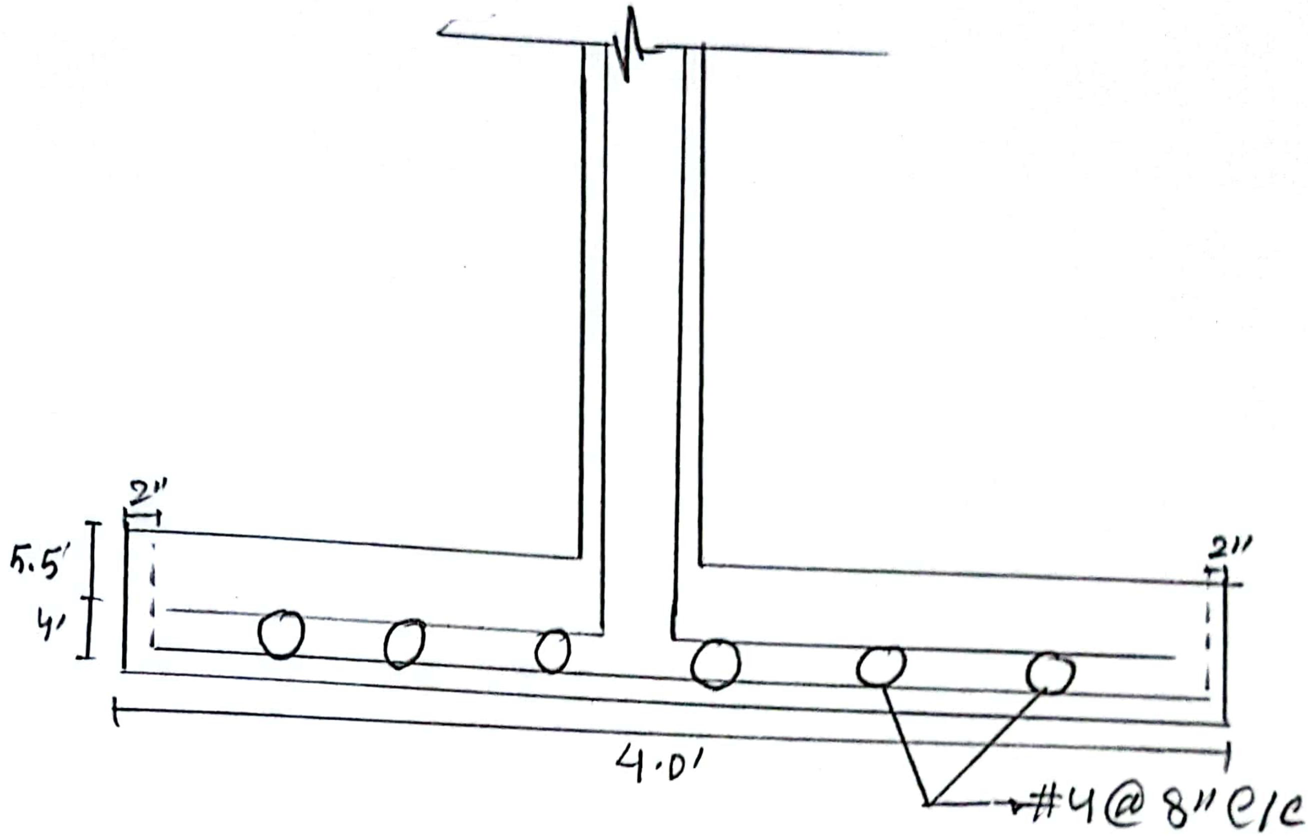
Using #4 bars,

$A'_s = 0.2 \text{ in}^2$

$$N = \frac{1.05}{0.2} = 5.25 \simeq 6 \text{ Nos}$$

$\therefore$ spacing $= \dfrac{4 \times 12}{6} = 8''$ c/c in Short direction

$\therefore$ spacing $= \dfrac{6 \times 12}{6} = 12''$ c/c in long direction



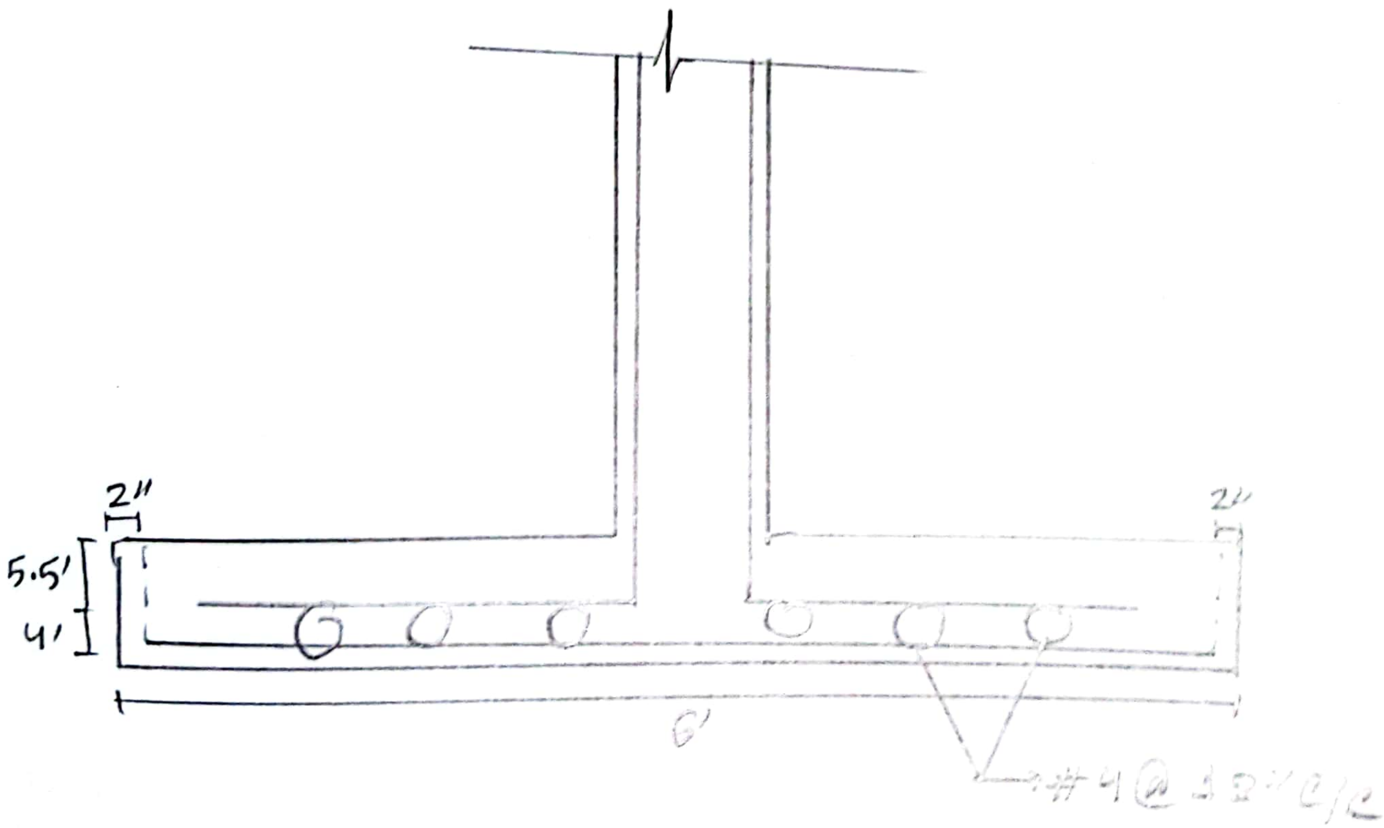




Fig: 5.12: Detailing of Footing

## 6. Conclusion and Recomendations:

The purpose of this project was to examine the BNBC 2020's Analysis and Design of a Multi-Story RC Building. With the use of the software ETABS 20, these models were additionally numerically analyzed.

By examining the stress, strain and other parameters in this model, such as, the slab and beam details. Shear wall and columns were identified.

The following calculations have been found -

→ All the columns and slabs of the building found to be structurally adequate in terms of strength.

→ Thickness of mat foundation is found to be adequate in considerations of punching shear capacity but top reinforcements are found to be moderately inadequate for flexure

→ All shear walls are adequate againts loads.

Recommendation:

We provide same column and beam section in every floor. For economical design, section must be defined different according to the applied load.