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# Analysis and Design of Reinforced Concrete Building using Different Software Programs

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***1.ABSTRACT***:

**The research dealt with how to analyze a multi-story building consisting of a ground floor and 5 floors using manual analysis and programs. Etabs and Excel programs were used to compare with the manual design.**
**The manual method used for the analysis is the moments distribution with excel program.**
**A structural analysis of wind loads for a building consisting of 6 floors was carried out using manual and computer methods. The results were compared and it was found that the results are close.**
**The slabs, columns, beams, and foundations were analyzed manually, and the structural design of the structural elements was made and compared with the program design, and it was found that the results are close.**

**Key word:**
**Analysis, Design, moment distribution (Excel program) and portal frame.**

Objective:
To analysis and design a multi-story RC building.
Manual analysis is done with the aid of Excel software.
Analysis and design is done with the aid of Etabs & SAFE software.
And compare the design with Robot software.
The design is done with the aid of revit software.
To gain design knowledge on various structural elements like beam, column, slab, and foundation ….etc.

INTRODUCTION:

Now a days due to overpopulation and high cost of land, multi-storied building is more essential for metropolitan city. Multi-storied Residential building is the perfect solution for living of high populated area. A multi-storied building, which possess multiple floor above the ground level, which aim to increase the floor area of building in shortest built up area.

Structure analysis is a subject which involves designing, planning to build up a perfect building. Basically each project are different with their design criteria such as incoming load, soil properties, dynamic load, built up area etc. Here we provided the details to complete a residential apartment theoretically.

We firstly collected some required data to measure the soil specific such as moisture content, bearing capacity of soil, types of soil etc. We provided the perfect parameter in beam, slab, column and footing with the consideration of incoming load to avoid shear and bending collapse. In
Accordance with limit state method of collapse in BS 0.0035
We built G+5 building which deal with strength and stability of structure under maximum design load
Flexure, compression, shear and torsion.

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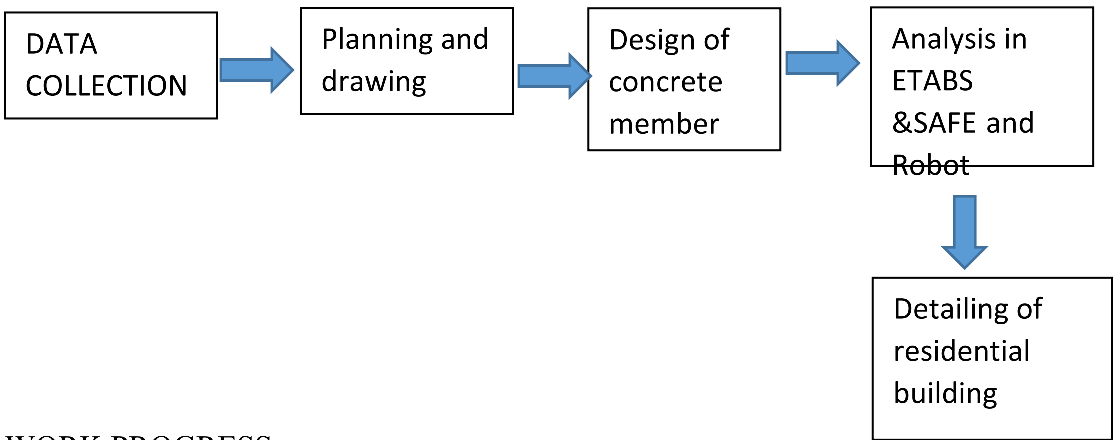
1. METHODOLOGY:




WORK PROGRESS

BASIC DATA
i. Type of building – Residential building.
ii. Type of structure –multi story rigid jointed framed iii. No. of story – 6 (G+5)
iv. Floor to floor height – 3 m.
v. External walls – 250 mm including plaster
vi. Internal walls – 150 mm including plaster.
vii. Bearing capacity of soil – 200 KN/m2
viii. Height of plinth – 0.5 m.
NOTE:-Others required data assume using NBC(national building code) for planning and (BS8110) & (ACI 318-14)for concrete design work.

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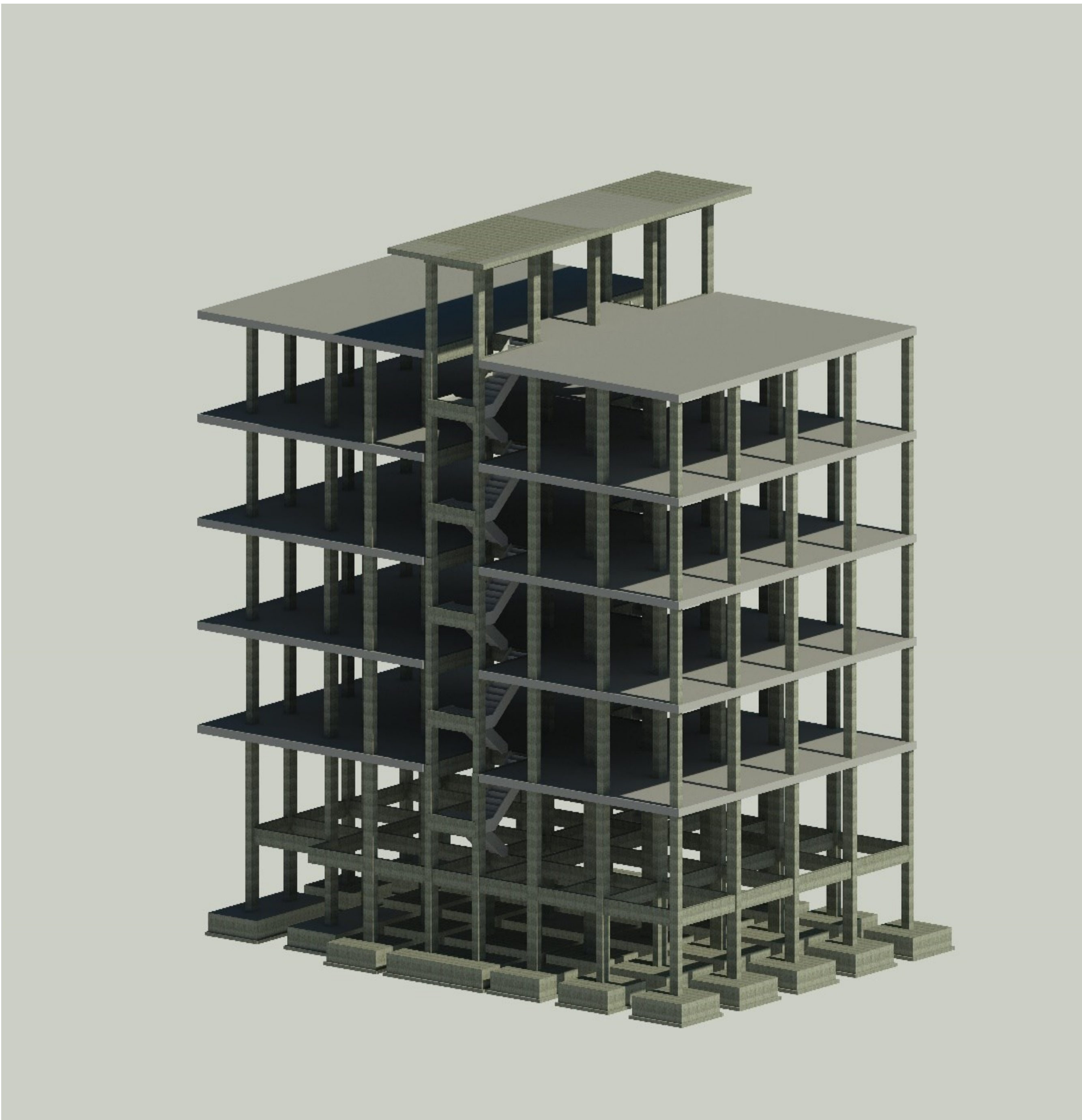

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### Table 2-1

| Name | Height mm | Elevation mm | Master Story | Similar To | Splice Story |
|---|---|---|---|---|---|
| Story7 | 3000 | 20400 | No | None | No |
| Story6 | 3000 | 17400 | Yes | None | No |
| Story5 | 3000 | 14400 | No | Story6 | No |
| Story4 | 3000 | 11400 | No | Story6 | No |
| Story3 | 3000 | 8400 | No | Story6 | No |
| Story2 | 3000 | 5400 | No | Story6 | No |
| Story1 | 2400 | 2400 | No | Story6 | No |
| Base | 0 | 0 | No | None | No |

### Table 2-2

| Name | Type | Self Weight Multiplier | Auto Load |
|---|---|---|---|
| Live | Live | 0 | |
| dead | Dead | 1 | |
| wl | Wind | 0 | BS 6399-95 |

### Table 2-3

| Name | Type | E MPa | v | Unit Weight kN/m³ | Design Strengths |
|---|---|---|---|---|---|
| A416Gr270 | Tendon | 196500.6 | 0 | 76.9729 | Fy=1689.91 MPa, Fu=1861.58 MPa |
| A615Gr60 | Rebar | 199947.98 | 0.3 | 76.9729 | Fy=413.69 MPa, Fu=620.53 MPa |
| fcu25 | Concrete | 24855.58 | 0.2 | 24 | Fc=25 MPa |
| fcu30 | Concrete | 24855.58 | 0.2 | 24 | Fc=30 MPa |
| fy 460 | Rebar | 199947.98 | 0 | 76.9729 | Fy=460 MPa, Fu=575 MPa |
| fy250 | Rebar | 199947.98 | 0 | 76.9729 | Fy=250 MPa, Fu=312.5 MPa |

### Table 2-4

| Name | Design Type | Element Type | Material | Total Thickness mm |
|---|---|---|---|---|
| SLAB 18 | Slab | Shell-Thin | Fcu25 | 180 |
| Slab 20C, | Slab | Shell-Thin | Fcu25 | 200 |

### Table 2-5

| Story | Label | Unique Name | Load Pattern | Direction | Load kN/m² |
|---|---|---|---|---|---|
| Story7 | F23 | 50 | Live | Gravity | 1.5 |
| Story6 | F7 | 4 | Live | Gravity | 1.5 |
| Story5 | F7 | 5 | Live | Gravity | 1.5 |
| Story4 | F7 | 6 | Live | Gravity | 1.5 |
| Story3 | F7 | 7 | Live | Gravity | 1.5 |
| Story2 | F7 | 3 | Live | Gravity | 1.5 |
| Story1 | F4 | 2 | Live | Gravity | 1.5 |
| Story7 | F23 | 50 | dead | Gravity | 1 |
| Story6 | F7 | 4 | dead | Gravity | 8.4 |
| Story5 | F7 | 5 | dead | Gravity | 8.4 |
| Story4 | F7 | 6 | dead | Gravity | 8.4 |
| Story3 | F7 | 7 | dead | Gravity | 8.4 |
| Story2 | F7 | 3 | dead | Gravity | 8.4 |
| Story1 | F4 | 2 | dead | Gravity | 8.4 |

### Table 2-6

| Name | Type |
|---|---|
| Live | Linear Static |
| dead | Linear Static |
| wl | Linear Static |

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**Table 2-7**

| Name | Load Case/Combo | Scale Factor | Type | Auto |
|---|---|---|---|---|
| uls | Live | 1.6 | Linear Add | No |
| uls | dead | 1.4 | | No |
| sls | Live | 1 | Linear Add | No |
| sls | dead | 1 | | No |
| DL&LL&WL | Live | 1.2 | Linear Add | No |
| DL&LL&WL | dead | 1.2 | | No |
| DL&LL&WL | wl | 1.2 | | No |

## BS 6399-95 Auto Wind Load Calculation

This calculation presents the automatically generated lateral wind loads for load pattern wl according to BS 6399-95, as calculated by ETABS.

**Exposure Parameters**

Exposure From = Diaphragms

Wind Direction = 0;90 degrees

Effective Speed, $V_e$ — $V_e = 88 \frac{meter}{sec}$

Windward Coefficient, $C_{p,wind}$ — $C_{p,wind} = 0.85$

Leeward Coefficient, $C_{p,lee}$ — $C_{p,lee} = 0.5$

Top Story = Story7

Bottom Story = Story1

Include Parapet = No

**Factors and Coefficients**

Size Effect Factor, $C_a$ [BS 2.1.3.4] — $C_a = 0.89$

Dynamic Augmentation Factor, $C_r$ [BS 1.6.1] — $C_r = 0.25$

**Lateral Loading**

Dynamic Pressure, $q_s$ [BS Table 2] — $q_s = 0.613\ V_e^2$ — $q_s = 4747.072$

Wind Pressure, p [BS Eq. 2.3.1.6(7)] — $p = 0.85\ q_s\, C_a\,(C_{p,wind} + C_{p,lee})\,(1 + C_r)$

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3. OUT PUT ANALYSIS:

B.S CODE**:**

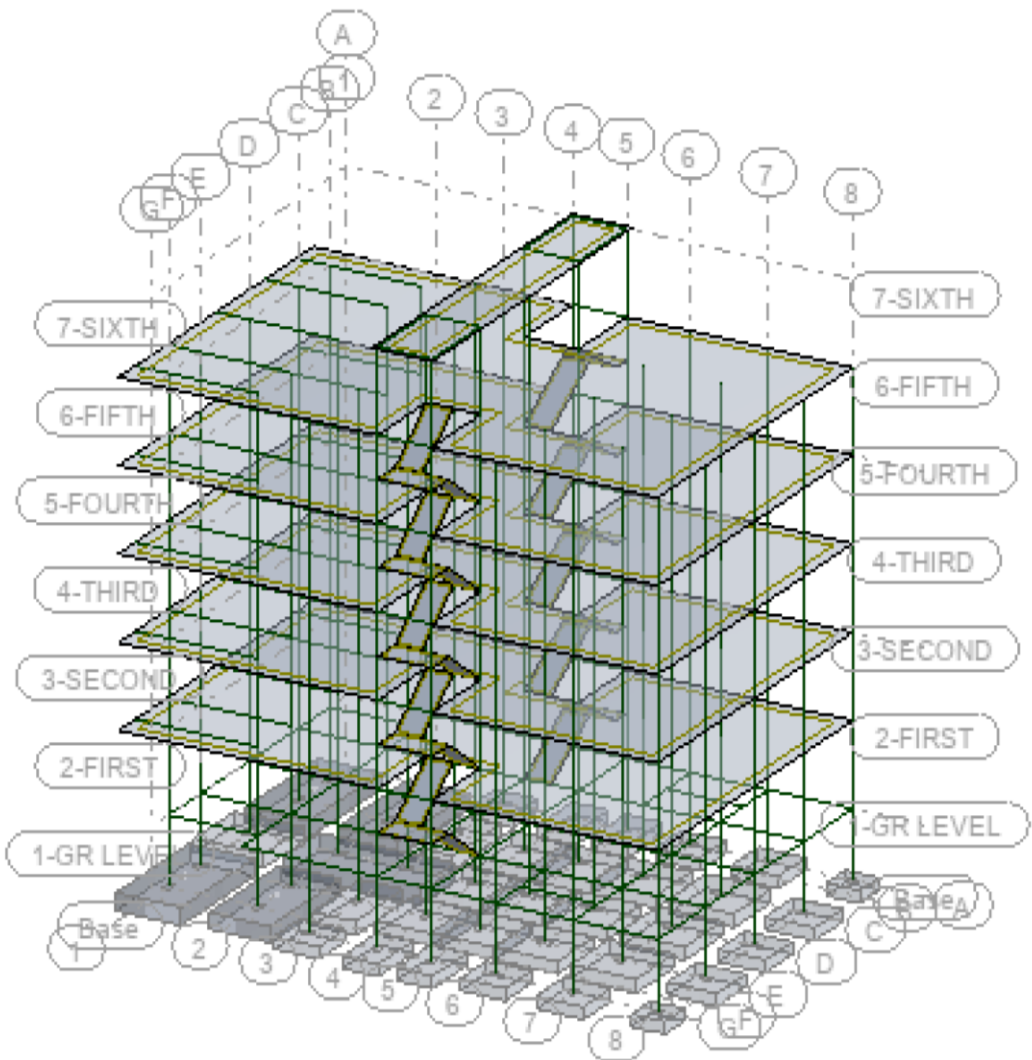


**Figure 3-1 Robot modeling**

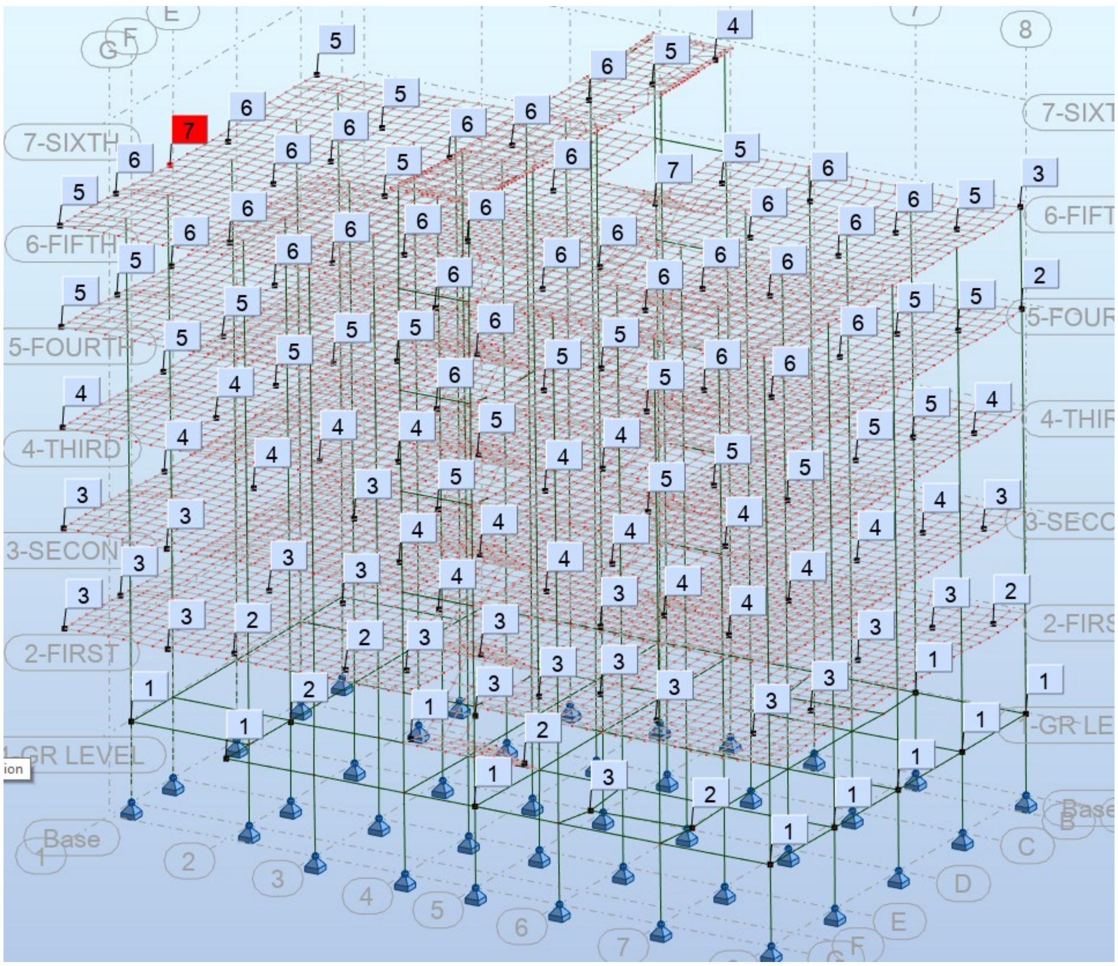


**Figure 3-2**: Deform shape

# COLUMN RESULT

Fcu=30N/mm2

**Table 3-1:** Loads & moment

| MEMBER | | ETABS | | | ROBOT | | |
|---|---|---|---|---|---|---|---|
| | | F | My | Mz | F | My | Mz |
| C1 | Short col&Gr | 2176 | -6.4 | 0.13 | 2104 | .79 | 7.16 |
| | 1st & 2nd | 1623 | 2.6 | 0.45 | 1564 | -1.2 | 6.16 |
| | 3rd & 4th &5th | 805 | 1.45 | -0.24 | 774 | -4.56 | 3.3 |
| C2 | Short col&Gr | 1283 | 0.8 | -3.6 | 1000 | 9.1 | -3.9 |
| | 1st & 2nd | 913 | -2.2 | 36.3 | 836 | 23 | -0.43 |
| | 3rd & 4th &5th | 683 | 17 | -30 | 496 | 20.3 | 0.25 |
| C3 | Short col&Gr | 714 | -4.3 | -3.2 | 451 | -2.7 | 1.4 |
| | 1st & 2nd | 509 | 10.8 | 18.3 | 364 | 9.4 | 9.98 |
| | 3rd & 4th &5th | 252 | 8.1 | 16.3 | 213 | -8.6 | -7.5 |

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**Table 3-2:** COLUMN DESIGN

| MEMBER | | ETABS | ROBOT | MANUAL |
|---|---|---|---|---|
| C1 | Short col&Gr<br>(30*60)cm | 6T16mm As=1206mm^2<br>$\Phi_l 6mm\ 120mmc/c$ | 6T16mm As=1206mm^2<br>$\Phi_l 6mm\ 120mmc/c$ | 6T16mm As=1206mm^2<br>$\Phi_l 6mm\ 150mmc/c$ |
| | 1st & 2nd<br>(30*55)cm | 6T16mm<br>As=1206mm^2<br>$\Phi_l 6mm\ 120mmc$ | 6T16mm<br>As=1206mm^2<br>$\Phi_l 6mm\ 120mmc$ | 4T16mm As=804mm^2<br>$\Phi_l 6mm\ 150mmc/c$ |
| | 3rd & 4th &5th<br>(45*25)cm | 4T16mm<br>As=804mm^2<br>$\Phi_l 6mm\ 120mmc$ | 4T16mm<br>As=804mm^2<br>$\Phi_l 6mm\ 120mmc$ | 4T16mm As=804mm^2<br>$\Phi_l 6mm\ 150mmc/c$ |
| C2 | Short col&Gr<br>(30*50)cm | 6T16mm As=1206mm^2<br>$\Phi_l 6mm\ 120mmc/c$ | 6T16mm As=1206mm^2<br>$\Phi_l 6mm\ 120mmc/c$ | 6T16mm As=1206mm^2<br>$\Phi_l 6mm\ 150mmc/c$ |
| | 1st & 2nd<br>(30*45)cm | 4T16mm<br>As=804mm^2<br>$\Phi_l 6mm\ 120mmc$ | 4T16mm<br>As=804mm^2<br>$\Phi_l 6mm\ 120mmc$ | 4T16mm As=804mm^2<br>$\Phi_l 6mm\ 150mmc/c$ |
| | 3rd & 4th &5th<br>(40*25)cm | 4T16mm<br>As=804mm^2<br>$\Phi_l 6mm\ 120mmc$ | 4T16mm<br>As=804mm^2<br>$\Phi_l 6mm\ 120mmc$ | 4T16mm As=804mm^2<br>$\Phi_l 6mm\ 150mmc/c$ |
| C3 | Short col&Gr<br>1st & 2nd<br>(40*25)cm | 4T16mm<br>As=804mm^2<br>$\Phi_l 6mm\ 100mmc$ | 4T16mm<br>As=804mm^2<br>$\Phi_l 6mm\ 100mmc$ | 4T16mm As=804mm^2<br>$\Phi_l 6mm\ 150mmc/c$ |
| | 3rd & 4th (40*20)cm | 4T16mm<br>As=804mm^2<br>$\Phi_l 6mm\ 100mmc$ | 4T16mm<br>As=804mm^2<br>$\Phi_l 6mm\ 100mmc$ | 4T16mm As=804mm^2<br>$\Phi_l 6mm\ 150mmc/c$ |

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**Table 3-3:** Beam Design

D.L=13.4KN/m fcu=25N/mm2

| section | ETABS | | | ROBOT | | | MANUAL | | |
|---|---|---|---|---|---|---|---|---|---|
| B(20*40) cm | Load | My | Fz | Load | My | Fz | Load | My | Fz |
| | 13.4 KN/m | 50 KN.m | 73KN | 13.4 KN/ m | 31.9 KN.m | +37 -37 KN | 13.4 KN/m | | |
| B(20*50) cm | Load | My | Fz | Load | My | Fz | Load | My | Fz |
| | 13.4 KN/m | +18.4 -28.3 KN.m | -45.1 | 13.4 KN/ m | -27.4 +16.5 KN.m | +51 -45.3 KN | 13.4 KN/m | 12.3 KN.M | 32.3 KN |

**Table 3-4:** Beam design at X direction:

At mid span

| section | ETABS | | ROBOT | | MANUAL | |
|---|---|---|---|---|---|---|
| | mom | design | mom | design | mom | design |
| B2(20*40)cm | 0 | Assembly rein 2T16 As=402mm2 R6@160mm c/c | 31.9 | 2T16 As=402mm2 R6@160mm c/c | | 2T16 As=402mm2 R6@160mm c/c |
| B1(20*50)cm | +18.4 | 2T16 As=402mm2 R6@160mm c/c | +18.6 | 2T16 As=402mm2 R6@160mm c/c | 12.3 | 2T16 As=402mm2 R6@160mm c/c |

At interior support

| section | ETABS | | ROBOT | | MANUAL | |
|---|---|---|---|---|---|---|
| | mom | design | mom | design | mom | design |
| B2(20*40)cm | -56.6 | 2T16 As=402mm2 R6@160mm c/c | 3.3 | 2T16 As=402mm2 R6@160mm c/c | | 2T16 As=402mm2 R6@160mm c/c |
| B1(20*50)cm | -26 | 2T16 As=402mm2 R6@160mm c/c | -24.9 | 2T16 As=402mm2 R6@160mm c/c | -10.6 | 2T16 As=402mm2 R6@160mm c/c |

Maximum shear (concrete and stirrups):

| section | ETABS | | ROBOT | | MANUAL | |
|---|---|---|---|---|---|---|
| | shear | design | shear | design | shear | design |
| B2(20*40)cm | +72 | R6@160mm c/c | -34.9 | R6@160mm c/c | | |
| B1(20*50)cm | +43.3 | R6@160mm c/c | -44 | R6@160mm c/c | 34.8 | |

**Table 3-5:** Beam design at Y direction:

At mid span positive:

| section | ETABS | | ROBOT | |
|---|---|---|---|---|
| | mom | design | mom | design |
| B1(20*50)cm | +35 | 2 Φ16 As=402mm2 | +45 | 2 Φ16 As=402mm2 |

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At interior support negative

| **section** | **ETABS** | | **ROBOT** | |
|---|---|---|---|---|
| | mom | design | mom | design |
| B1(20*50)cm | -42 | 2 Φ16<br>As=402mm2 | -35 | 2 Φ16<br>As=402mm2 |

At support:

| **section** | **ETABS** | | **ROBOT** | |
|---|---|---|---|---|
| | mom | design | mom | design |
| B1(20*50)cm | -42.4 | 2 Φ16<br>As=402mm2 | -31.8 | 2 Φ16<br>As=402mm2 |

Maximum shear (concrete and stirrups):

| **section** | **ETABS** | | **ROBOT** | |
|---|---|---|---|---|
| | mom | design | mom | design |
| B1(20*50)cm | +74.8 | Φ6@160mm c/c | -68 | Φ 6@160mm c/c |

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SLAB DESIGN:

**Table 3-6:** Positive moment bottom:

| member | ETABS & SAFE | | ROBOT | | MANUAL | |
|---|---|---|---|---|---|---|
| | Moment | design | Moment | design | Moment | design |
| Roof slab(Y) | 7 | T10@300mmc/c | 7 | T10mm@300mmc/c | 13.6 | 3T12mm@300mmc/c |
| Floor slab(X) | 28 | T12mm@200mmc/c | 33 | T12mm@200mmc/c | 72.4 | 4T12mm@200mmc/c |
| Floor slab(Y) | 33 | T12mm@200mmc/c | 28.2 | T12mm@200mmc/c | 86.4 | 3T12mm@300mmc/c |

**Table 3-7:** Negative moment top

| member | SAFE | | ROBOT | | MANUAL | |
|---|---|---|---|---|---|---|
| | Moment | design | Moment | design | Moment | design |
| Roof slab(Y) | 16 | T10@300mmc/c | 12.7 | Middle strip<br>T10@300mmc/c<br>Col strip<br>T10@200mmc/c | 13.6 | Middle strip<br>T16@500mmc/c<br>Col strip<br>T16@500mmc/c |
| Floor slab(X) | 80 | Middle strip<br>T16@300mmc/c<br>Col strip<br>T16@100mmc/c | 72.7 | Middle strip<br>T16@300mmc/c<br>Col strip<br>T16@100mmc/c | 106.7 | Col strip<br>5T16mm@200mmc/c<br>Middle strip<br>2T16@500mmc/c |
| Floor slab(Y) | 116 | Middle strip<br>T16@300mmc/c<br>Col strip<br>T16@100mmc/c | 77.2 | Middle strip<br>T16@300mmc/c<br>Col strip<br>T16@100mmc/c | 98.7 | Col strip<br>5T16mm@200mmc/c<br>Middle strip<br>2T16@500mmc/c |

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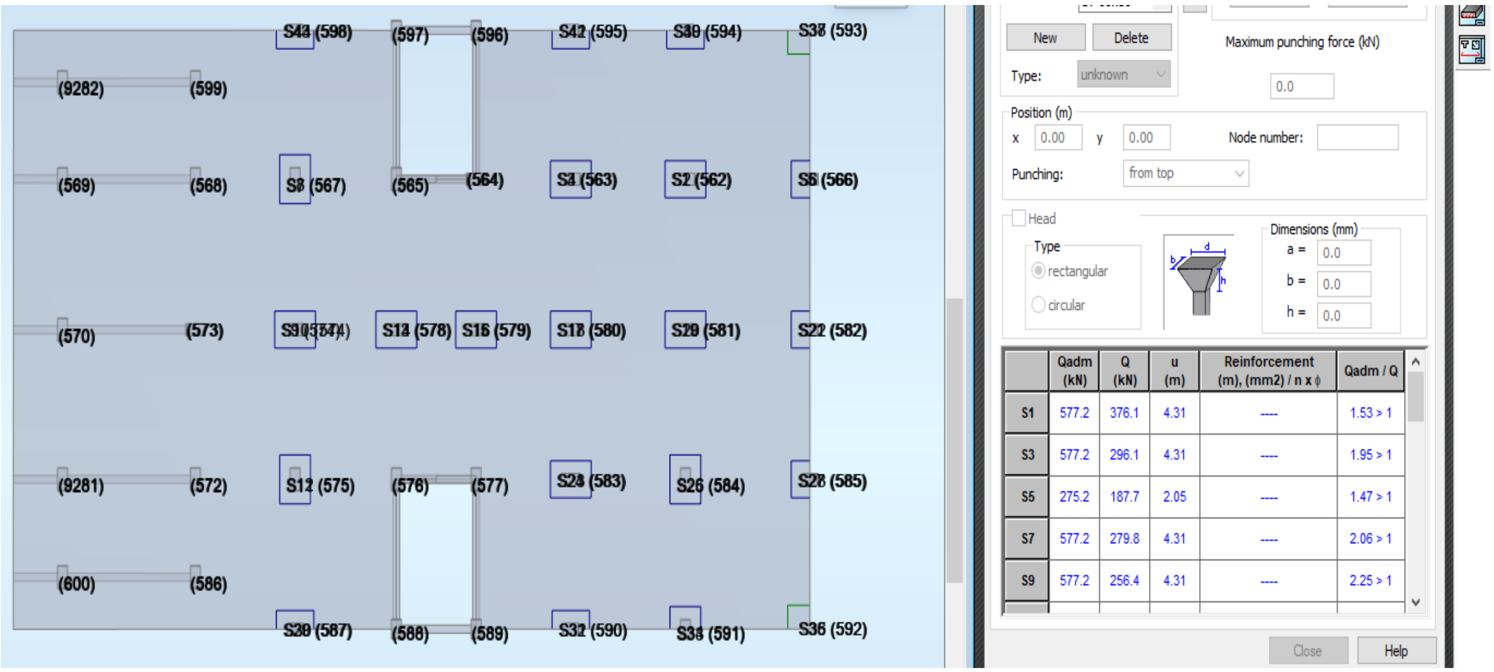
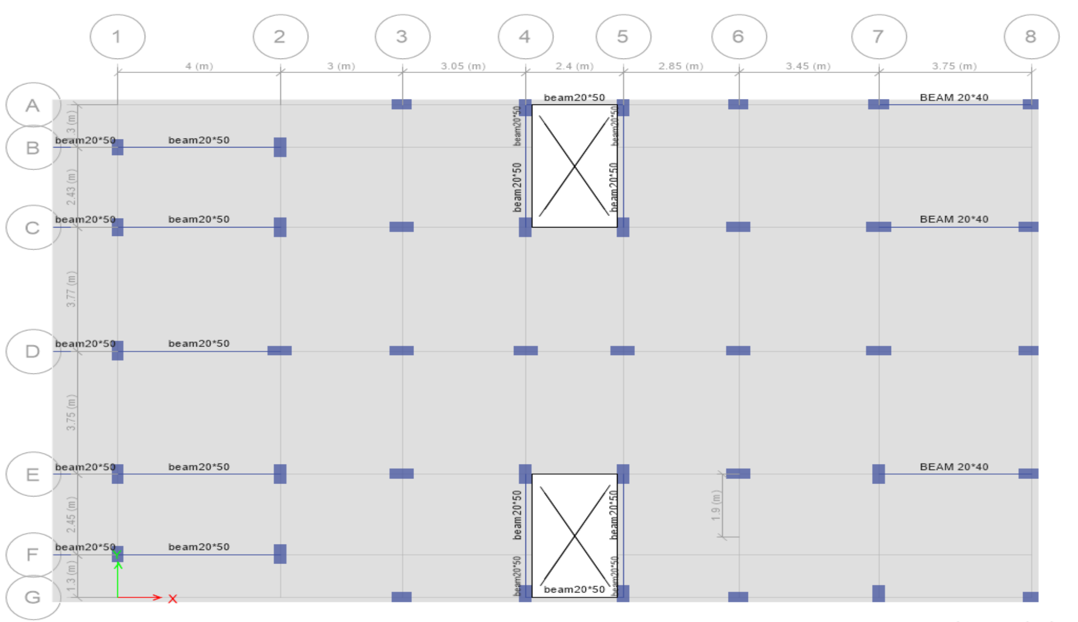



**Figure 3-3** Check of punching shear: **Robot**

## ETABS:



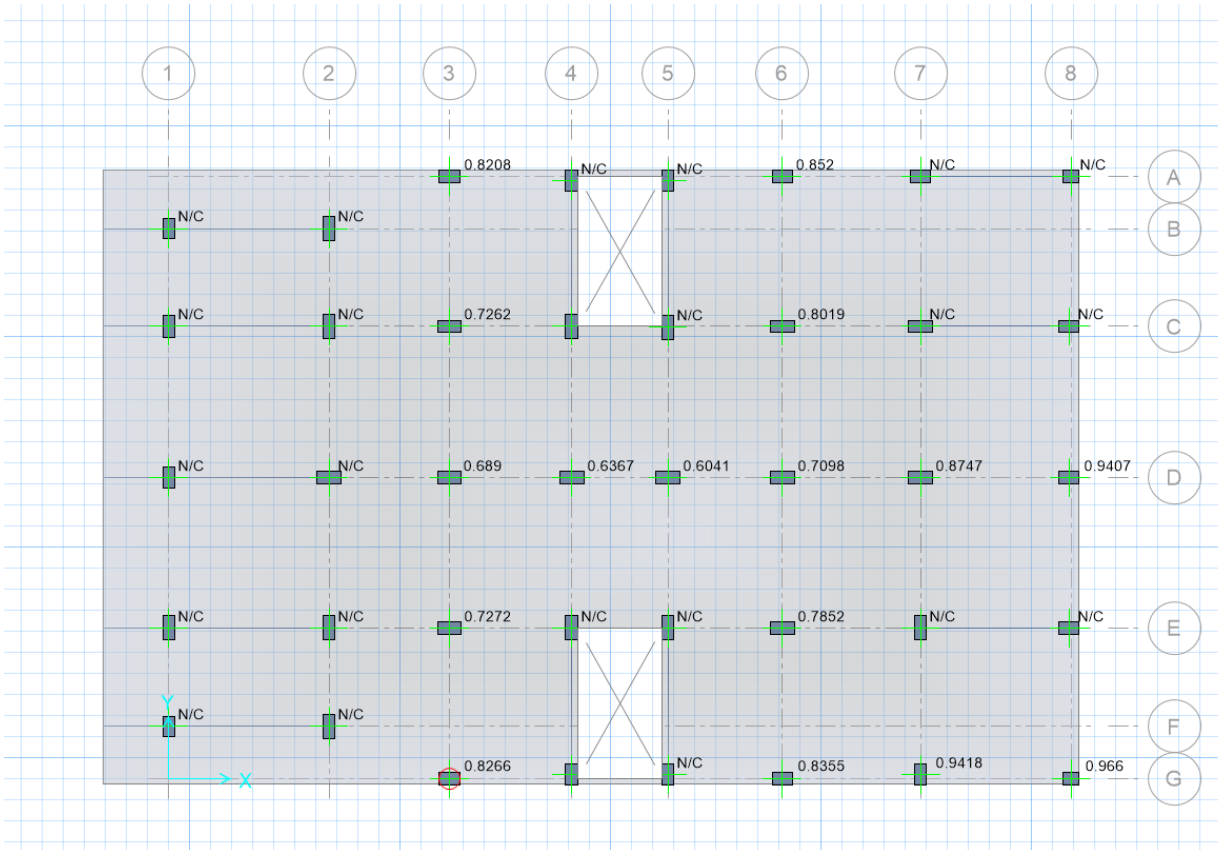



**Figure 3-4:** chech of punching shear

- **I added on ETABS modeling three beams to the slab to check the punching shear**

## Stair Design:

L.L=3KN/m2     D.L=3.7KN/m2

**Table 3-8:** Design of stair

| ETABS& SAFE | | | ROBOT | | | MANUAL | | |
|---|---|---|---|---|---|---|---|---|
| Mx | bottom | Top<br>At support | Mx | bottom | Top | Mx | X direction | Y direc |
| -21 | 4T10@250mmc/c | 4T12@250 mmc/c | -15.2 | 4T10@250 mmc/c | 4T10@ 250mm c/c | -10.4 | 4T10@250 mmc/c | 4T10@250 mmc/c |

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**Foundation design:**

Design of footings: p=200KN/m2 fc'=25N/mm2 K=120*q

Fy=460N/mm2 T16mm

Q=γh =20*1.4=28KN/m2

K=120*(200-28)=20640KN/m2

K=20.60MPa

Thickness=680mm


**Figure 3-5:** Ultimate load in footings

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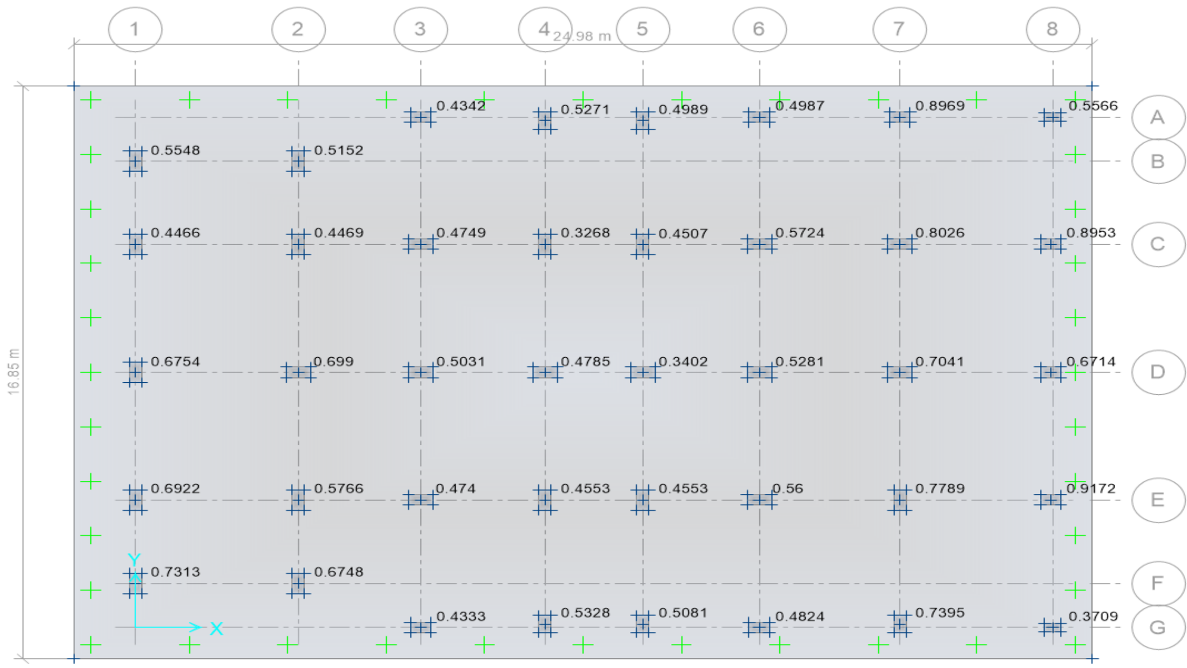


**Figure 3-6** check of punching shear

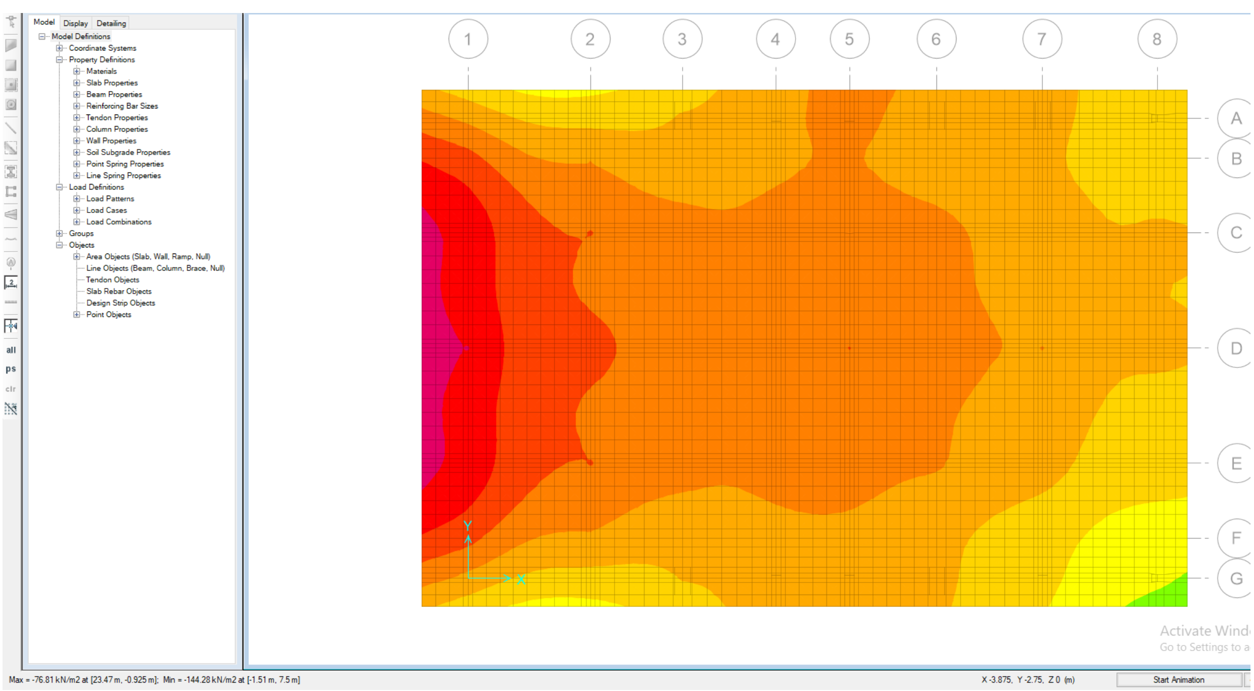


**Figure 3-7** Check of soil pressure:

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Robot:

Fy=460N/mm2 T16mm p=200KN/m2 fc'=25N/mm2 K=120*q

Q=γh =20*1.4=28KN/m2

K=120*(200-28)=20640KN/m2

K=20.60MPa

Thickness=600mm

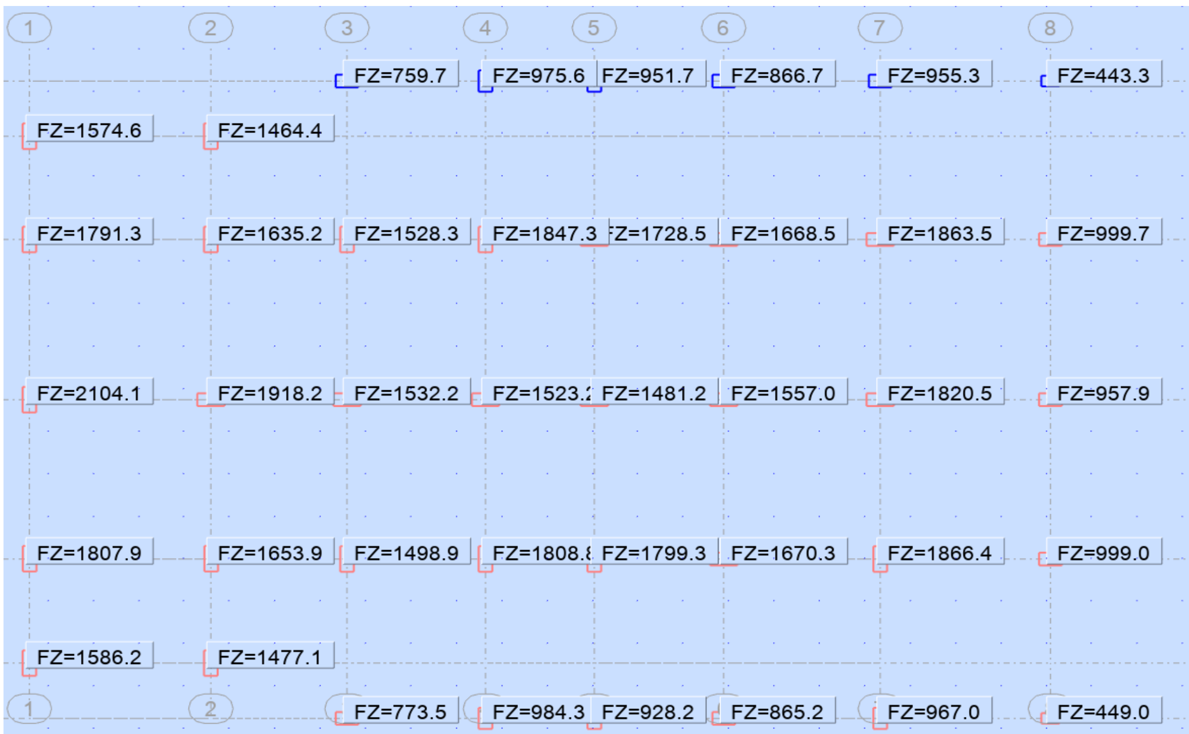


**Figure 3-8:** Ultimate load in footings

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FOUNDATION DESIGN:

**Table 3-9:** Positive moment top:

| member | ETABS & SAFE | | ROBOT | |
|---|---|---|---|---|
| | Moment | design | Moment | design |
| Floor slab(X) | 353 | T16mm@200mmc/c | 250 | T16mm@170mm c/c |
| Floor slab(Y) | 420 | T16mm@300mmc/c | 19.7 | T16mm@240mm c/c |

**Table 3-10:** Negative moment bottom:

| member | SAFE | | ROBOT | |
|---|---|---|---|---|
| | Moment | design | Moment | design |
| Floor slab(X) | -165 | Middle strip T16@200mmc/c Col strip T16@90mmc/c | -602.6 | Middle strip T16@120mmc/c Col strip T16@90mmc/c |
| Floor slab(Y) | -114.8 | Middle strip T16@200mmc/c Col strip T16@90mmc/c | -576 | Middle strip T16@120mmc/c Col strip T16@90mmc/c |

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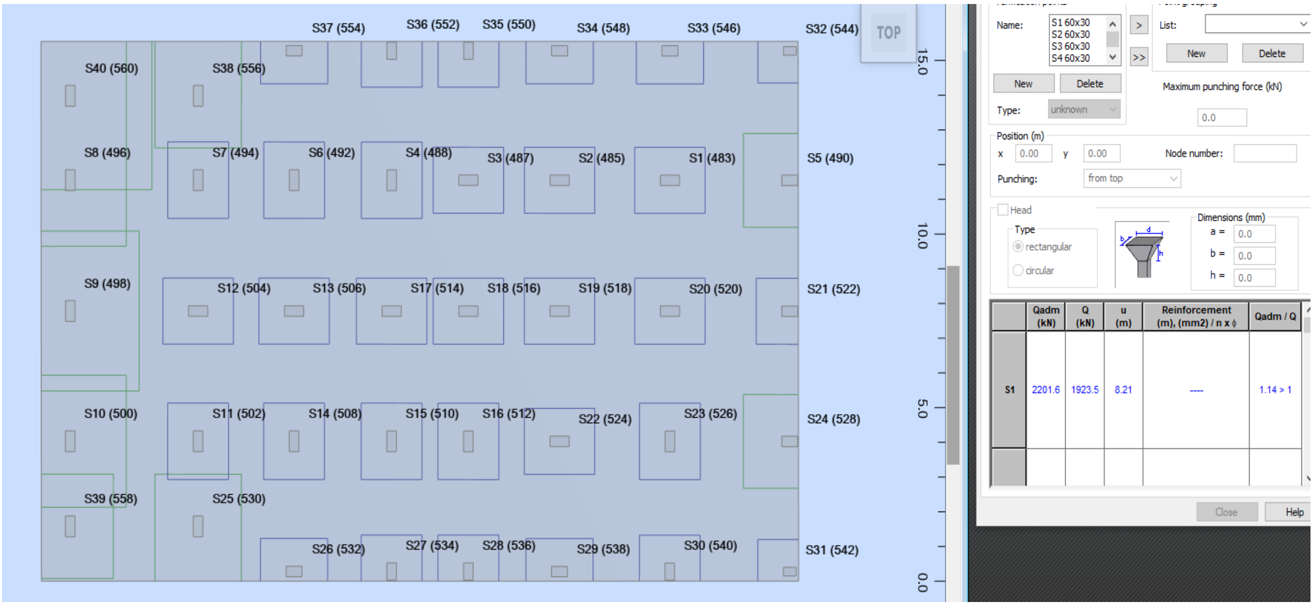


**Figure 3-9** check of punching shear

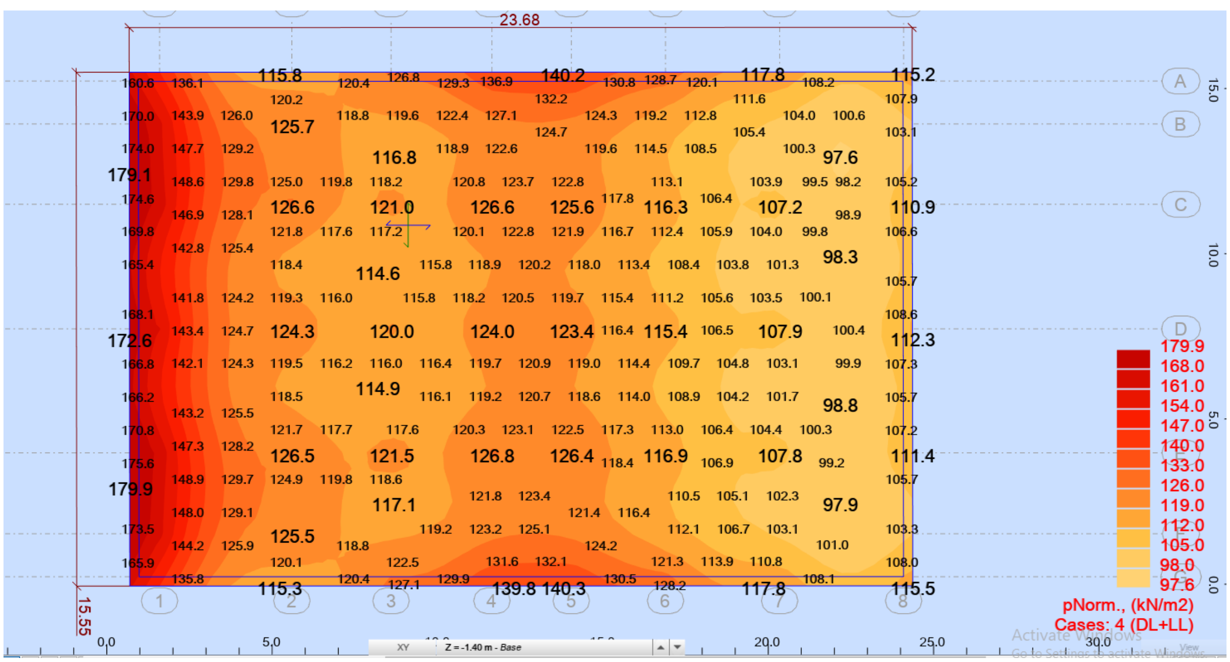


**Figure 3-10** Check of soil pressure:

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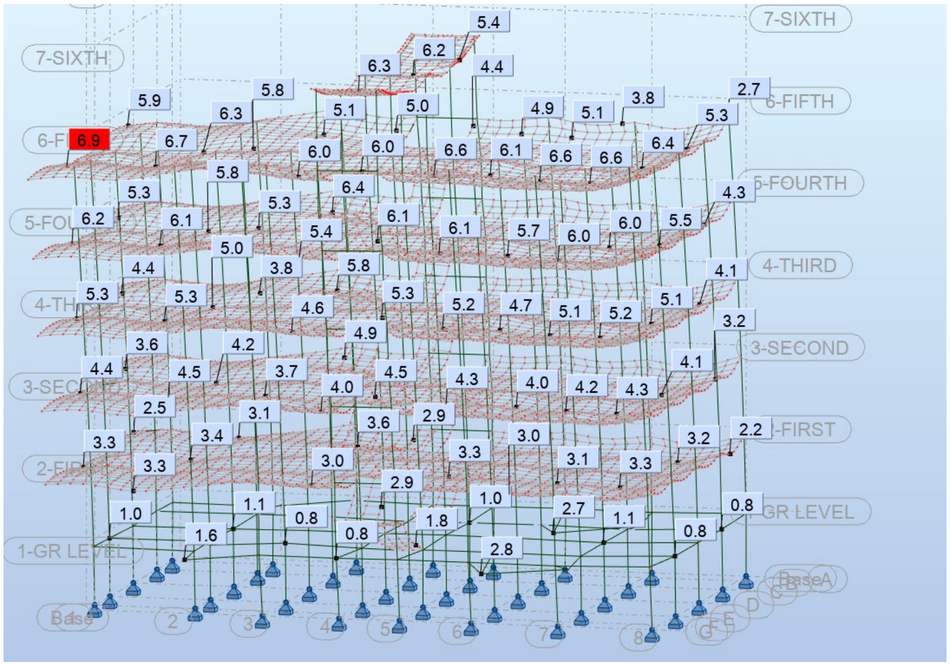


**Figure 3-11:** Deform shape in Robot

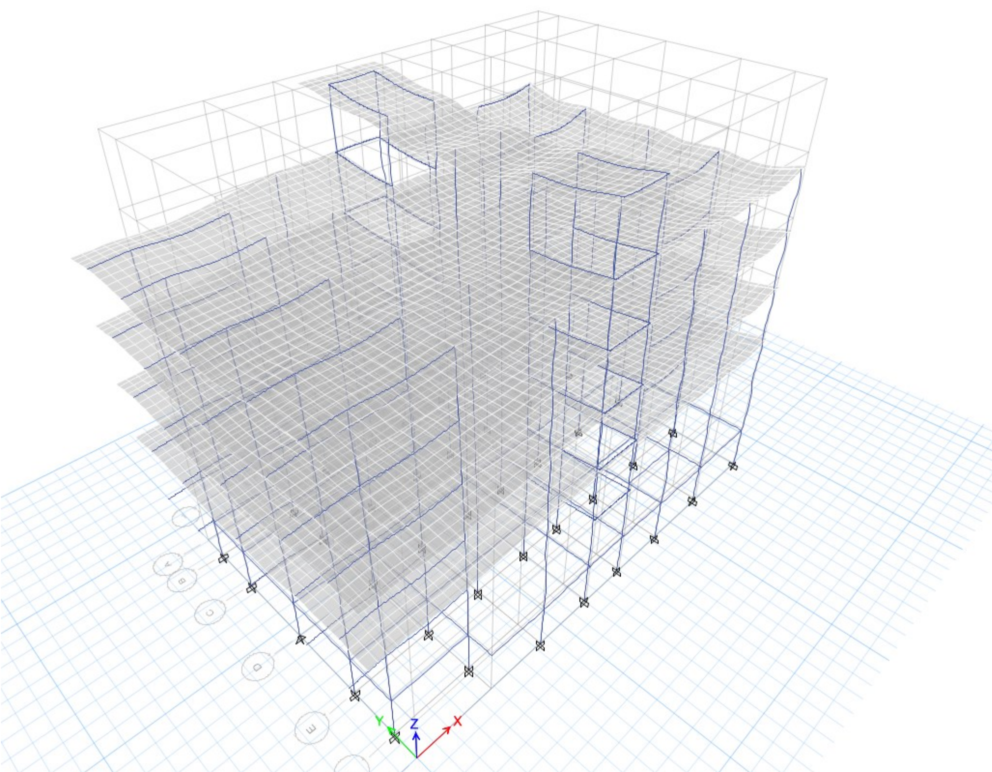

**Figure 3-12** Deform shape in ETABS

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**Table 3-11:** Column design:

| member | | ETABS | ROBOT |
|---|---|---|---|
| C1 | Short col&Gr (30*60)cm | 6T16mm As=1206mm^2 $\Phi_l 6mm\ 120mmc/c$ | 6T16mm As=1206mm^2 $\Phi_l 6mm\ 120mmc/c$ |
| | 1st & 2nd (30*55)cm | 6T16mm As=1206mm^2 $\Phi_l 6mm\ 120mmc$ | 6T16mm As=1206mm^2 $\Phi_l 6mm\ 120mmc$ |
| | 3rd & 4th &5th (45*25)cm | 4T16mm As=804mm^2 $\Phi_l 6mm\ 120mmc$ | 4T16mm As=804mm^2 $\Phi_l 6mm\ 120mmc$ |
| C2 | Short col&Gr (30*50)cm | 6T16mm As=1206mm^2 $\Phi_l 6mm\ 120mmc/c$ | 6T16mm As=1206mm^2 $\Phi_l 6mm\ 120mmc/c$ |
| | 1st & 2nd (30*45)cm | 4T16mm As=804mm^2 $\Phi_l 6mm\ 120mmc$ | 4T16mm As=804mm^2 $\Phi_l 6mm\ 120mmc$ |
| | 3rd & 4th &5th (40*25)cm | 4T16mm As=804mm^2 $\Phi_l 6mm\ 120mmc$ | 4T16mm As=804mm^2 $\Phi_l 6mm\ 120mmc$ |
| C3 | Short col&Gr 1st & 2nd (40*25)cm | 4T16mm As=804mm^2 $\Phi_l 6mm\ 100mmc$ | 4T16mm As=804mm^2 $\Phi_l 6mm\ 100mmc$ |
| | 3rd & 4th (40*20)cm | 4T16mm As=804mm^2 $\Phi_l 6mm\ 100mmc$ | 4T16mm As=804mm^2 $\Phi_l 6mm\ 100mmc$ |

**Table 3-12:** Beam design at X direction:

At mid span positive

| section | ETABS | | ROBOT | |
|---|---|---|---|---|
| | mom | design | mom | design |
| B(20*40)cm | +19.3 | 2 Φ16 As=402mm2 | 27 | 2 Φ16 As=402mm2 |
| B(20*50)cm | +14 | 2 Φ16 As=402mm2 | +11 | 2 Φ16 As=402mm2 |

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At interior support negative

| section | ETABS | | ROBOT | |
|---|---|---|---|---|
| | mom | design | mom | design |
| B2(20*40)cm | -7.8 | 2 Φ16 As=402mm2 | 3 | 2 Φ16 As=402mm2 |
| B1(20*50)cm | -22 | 2 Φ16 As=402mm2 | -14 | 2 Φ 16 As=402mm2 |

Maximum shear (concrete and stirrups):

| section | ETABS | | ROBOT | |
|---|---|---|---|---|
| | shear | Dist of stirrups | shear | Dist of stirrups |
| B2(20*40)cm | -32 | Φ6@160mm c/c | -29 | Φ 6@160mm c/c |
| B1(20*50)cm | -33 | Φ 6@160mm c/c | -38.8 | Φ 6@160mm c/c |

At support:

| section | ETABS | | ROBOT | |
|---|---|---|---|---|
| | mom | design | mom | design |
| B1(20*50)cm | -23 | 2 Φ16 As=402mm2 | -12 | 2 Φ16 As=402mm2 |

**Table 3-13:** Beam design at Y direction:

At mid span positive:

| section | ETABS | | ROBOT | |
|---|---|---|---|---|
| | mom | design | mom | design |
| B1(20*50)cm | +29 | 2 Φ16 As=402mm2 | +39 | 2 Φ16 As=402mm2 |

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At interior support negative

| section | ETABS | | ROBOT | |
|---|---|---|---|---|
| | mom | design | mom | design |
| B1(20*50)cm | -27 | 2 Φ16 As=402mm2 | -30 | 2 Φ16 As=402mm2 |

At support:

| section | ETABS | | ROBOT | |
|---|---|---|---|---|
| | mom | design | mom | design |
| B1(20*50)cm | -38.3 | 2 Φ16 As=402mm2 | -27 | 2 Φ16 As=402mm2 |

Maximum shear (concrete and stirrups):

| section | ETABS | | ROBOT | |
|---|---|---|---|---|
| | mom | design | mom | design |
| B1(20*50)cm | -52 | Φ6@160mm c/c | -58.7 | Φ 6@160mm c/c |

**SLAB DESIGN:**

Fy=420N/mm2 fc'=20N/mm2 h=250mm

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**Table 3-14:** Positive moment

**Bottom:**

| member | ETABS & SAFE | | ROBOT | |
|---|---|---|---|---|
| | **Moment** | **design** | **Moment** | **design** |
| Roof slab(Y) | 7 | Φ6@200mmc/c | 6 | 5Φ6 |
| Floor slab(X) | 26 | Φ10mm@150mmc/c | 22 | 6Φ10 |
| Floor slab(Y) | 29.8 | Φ10mm@150mmc/c | 20 | 6Φ10 |

**Table 3-15:** Negative moment top

| member | SAFE | | ROBOT | |
|---|---|---|---|---|
| | **Moment** | **design** | **Moment** | **design** |
| Roof slab(Y) | 20.4 | Middle strip<br>Φ 6@250mmc/c<br>Col strip<br>Φ 6@100mmc/c | 27 | Middle strip<br>Φ 6@200mmc/c<br>Col strip<br>Φ 6@100mmc/c |
| Floor slab(X) | 75 | Middle strip<br>Φ 16@400mmc/c<br>Col strip<br>Φ 16@100mmc/c | 111 | Middle strip<br>3Φ16<br>Col strip<br>6Φ 16 |
| Floor slab(Y) | 103 | Middle strip<br>Φ 16@400mmc/c<br>Col strip<br>Φ 16@100mmc/c | 86 | Middle strip<br>3Φ16<br>Col strip<br>6Φ 16 |

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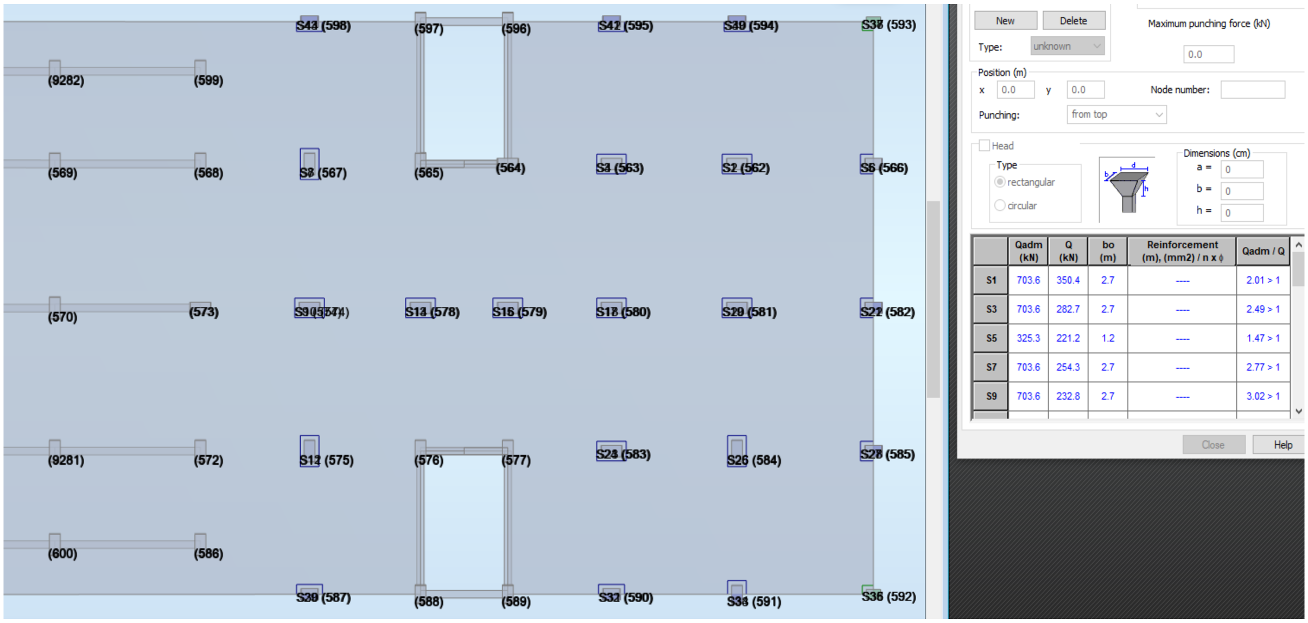
## ROBOT




- **For economy slab I must minimize the thickness of slab to 22cm**

**Figure 3-1: Check of punching shear:**

## ETABS:

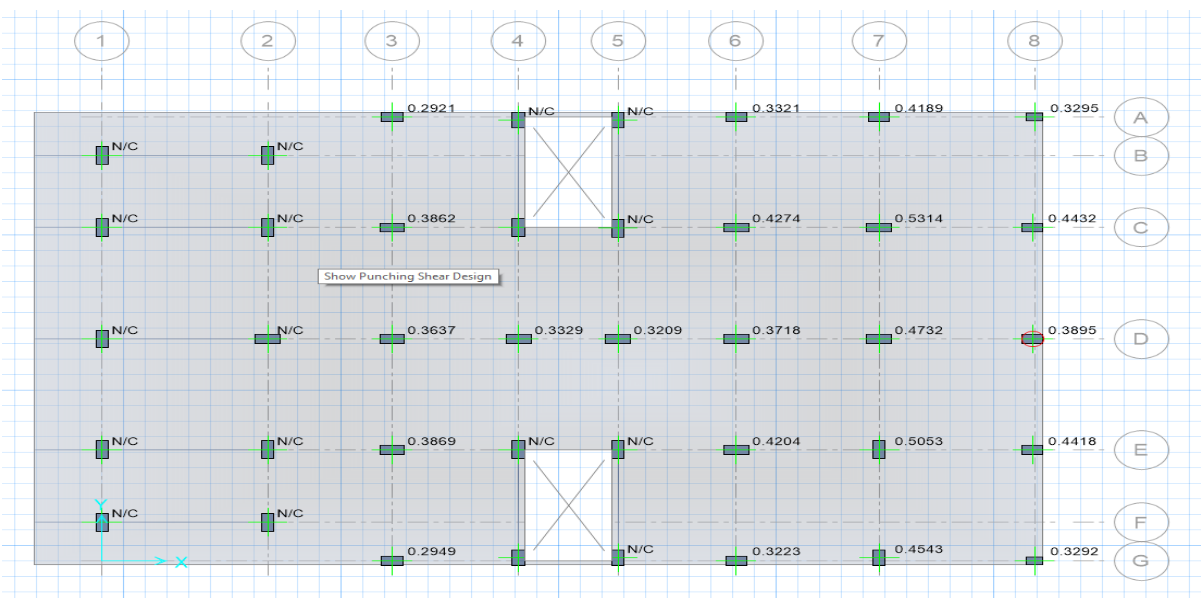



**Figure 3-14:** Check of punching shear:

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**<u>Stair Design</u>:**

L.L=4.79KN/m2 D.L=3.7KN/m2 Fy=420N/mm2 h=0.18m

**Table 3-16:** stair design

| **ETABS** | | | **ROBOT** | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Mx** | **bottom** | **Top** | **Mx** | **bottom** | **Top** | **Mx** | **bottom** | **Top** |
| -18 | 4Φ 10 | 4Φ 10 at support | -16 | 4Φ 10 | 4Φ 10 at support | -10.4 | 4Φ 10 | 4Φ 10 at support |

**Design of footings:**

Fy=280N/mm2 Ø=16mm p=200KN/m2 fc'=25N/mm2 K=120*q

Q=γh =20*1.4=28KN/m2

K=120*(200-28)=20640KN/m2

K=20.60MPa

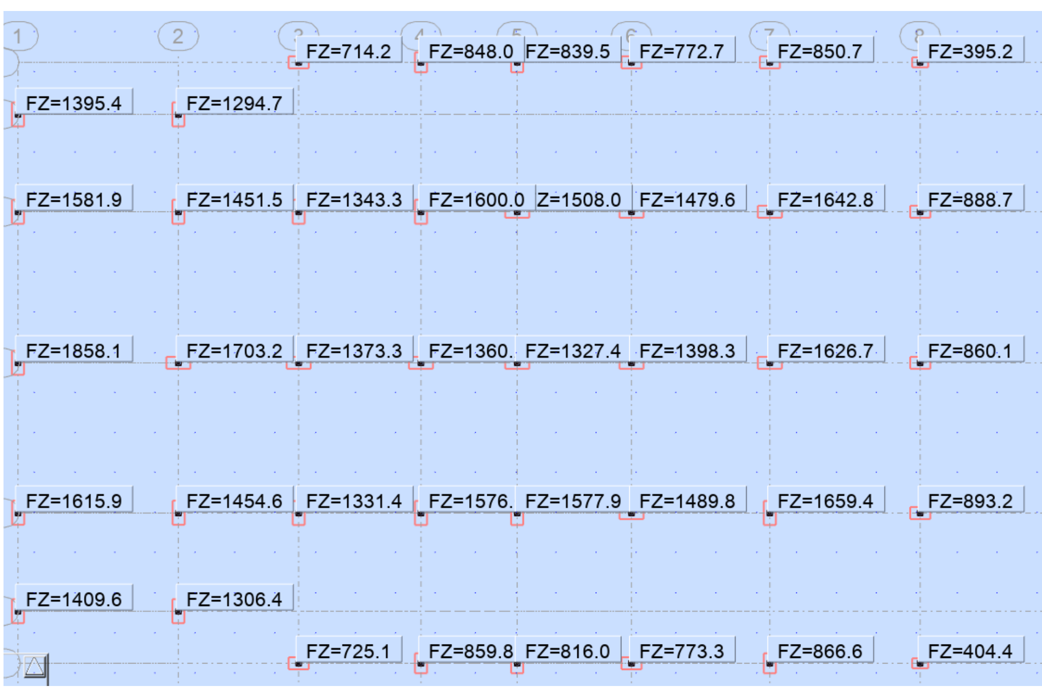


**Figure 3-15:** Ultimate load in footings in robot

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**Figure 3-16:** Ultimate load in footing in ETABS

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**Table 3-17:** design of footings with ROBOT program

| ROBOT | | | | | | | |
|---|---|---|---|---|---|---|---|
| Type | L | B | H | bottom | | top | |
| | | | | X direction | Y direction | X direction | Y direction |
| F1 | 1.5 | 1.5 | 0.5 | 7Ø16@250mm | 7Ø16@250mm | | |
| F2 | 5.5 | 2.7 | 0.6 | 20Ø16@100mm | 34Ø16@150mm | | |
| F3 | 2.2 | 2.2 | 0.5 | 10Ø16@200mm | 10Ø16@200mm | | |
| F4 | 3.7 | 1.9 | 0.5 | 20Ø16@100mm | 24Ø16@150mm | | |
| F5 | 3.1 | 3.1 | 0.5 | 33Ø16@90mm | 25Ø16@120mm | | |
| F6 | 2.7 | 6 | 0.7 | 20Ø16@130mm | 39Ø16@150mm | 17Ø16@300mm | 14Ø16@200mm |
| F7 | 5.7 | 2.9 | 0.7 | 38Ø16@150mm | 22Ø16@130mm | ` | |
| F8 | 2.7 | 1.6 | 0.5 | 13Ø16@200mm | 10Ø16@160mm | | |
| F9 | 5.5 | 2.8 | 0.6 | 26Ø16@100mm | 34Ø16@160mm | | |
| F10 | 7.8 | 2.9 | 0.5 | Ø16@100mm | Ø16@100mm | Ø16@220mm | Ø16@220mm |
| F11 | 7.4 | 2.7 | 0.5 | Ø16@100mm | Ø16@100mm | Ø16@220mm | Ø16@220mm |
| F12 | 8 | 2.8 | 0.5 | Ø16@100mm | Ø16@100mm | Ø16@220mm | Ø16@220mm |

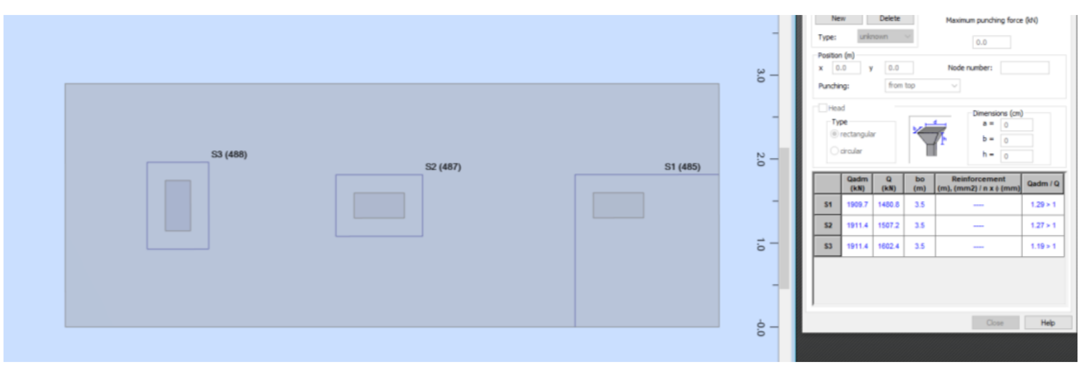


**Figure 3-17:** Check of punching shear for F10

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**Figure 3-18:** Check of punching shear for F11

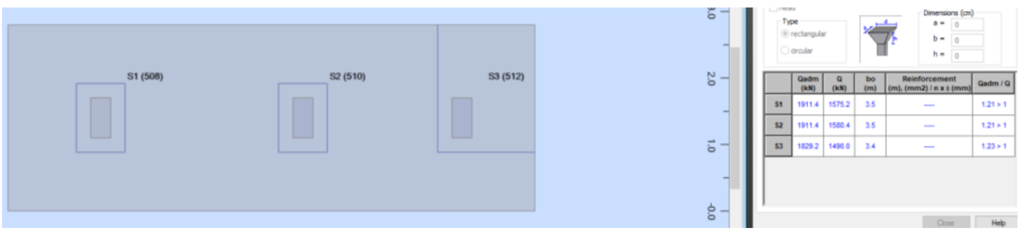


**Figure 3-19:** Check of punching shear for F12

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CHEACK WITH SAFE PROGRAM:

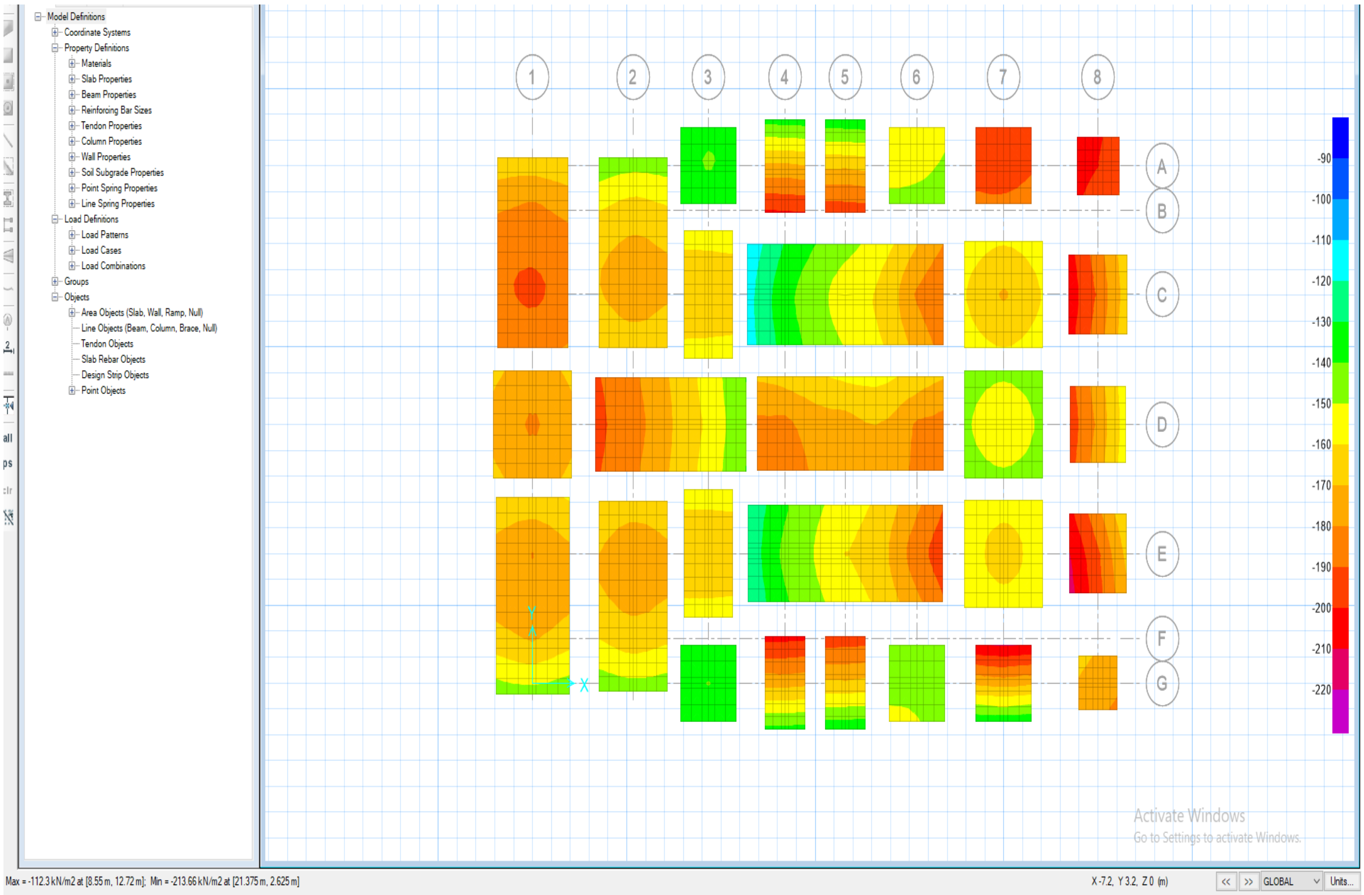


**Figure 3-20:** Check of soil pressure:

- **F(A-8) , F(C-8)& F(E-8) I have increase their dimensions because the soil pressure was not exceeded**.

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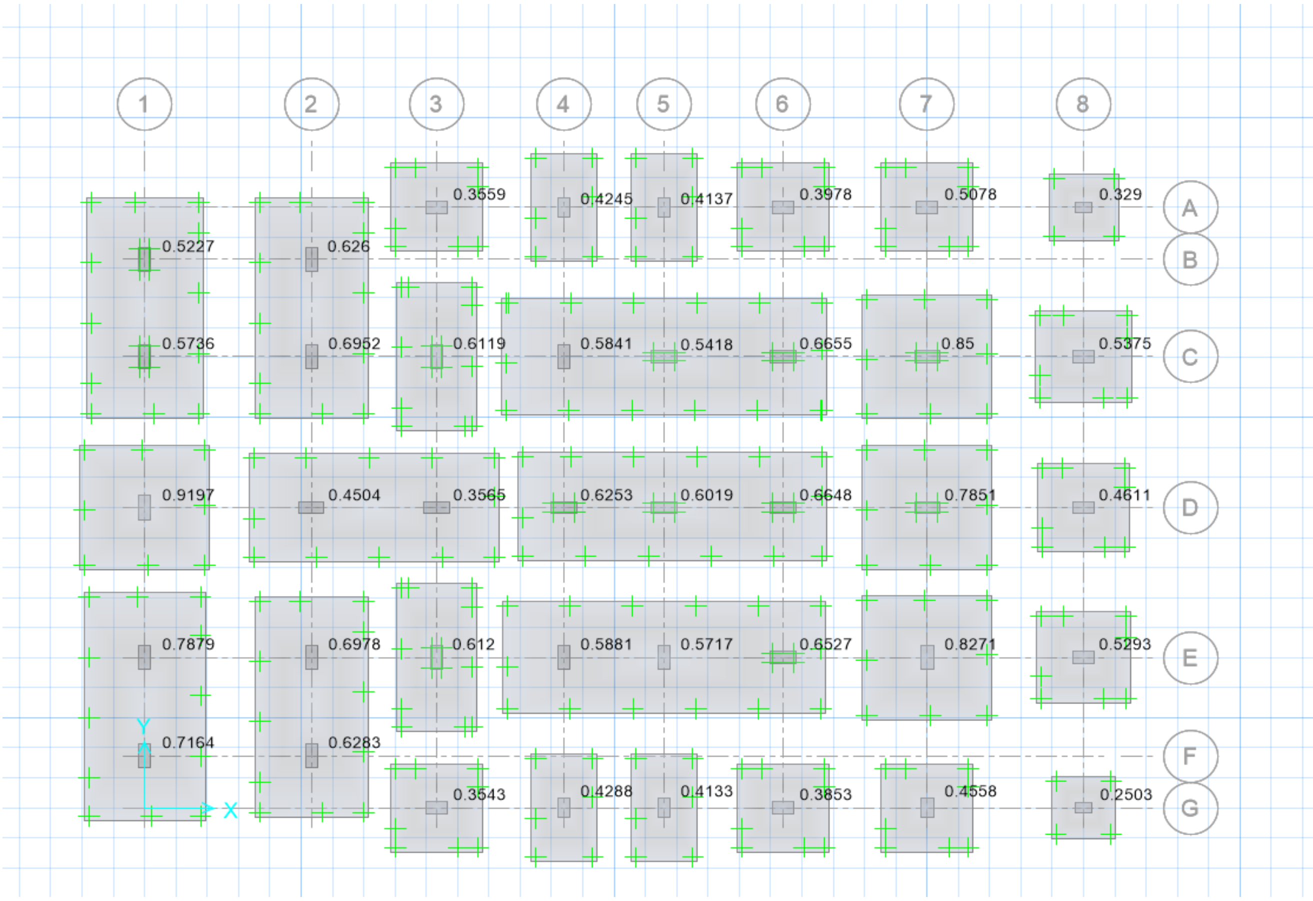


**Figure 3-21:** Check of punching shear

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**Table 3-18:** design of footings with SAFE program

| **SAFE** | | | | | | | |
|---|---|---|---|---|---|---|---|
| Type | L | B | H | bottom | | top | |
| | | | | X direction | Y direction | X direction | Y direction |
| F1 | 1.5 | 1.5 | 0.5 | Ø16@250mm | Ø16@250mm | | |
| F2 | 5.5 | 2.7 | 0.6 | Ø16@120mm | 34Ø16@150mm | | |
| F3 | 2.2 | 2.2 | 0.5 | Ø16@150mm | Ø16@150mm | | |
| F4 | 3.7 | 1.9 | 0.5 | Ø16@100mm | Ø16@150mm | | |
| F5 | 3.1 | 3.1 | 0.5 | Ø16@90mm | Ø16@80mm | | |
| F6 | 2.7 | 6 | 0.7 | Ø16@130mm | Ø16@150mm | | |
| F7 | 5.7 | 2.9 | 0.7 | Ø16@150mm | Ø16@130mm | ` | |
| F8 | 2.7 | 1.6 | 0.5 | Ø16@200mm | Ø16@150mm | | |
| F9 | 5.5 | 2.8 | 0.6 | Ø16@100mm | Ø16@100mm | | |
| F10 | 7.8 | 2.9 | 0.5 | Ø16@120mm | Ø16@100mm | Ø16@250mm | Ø16@250mm |
| F11 | 7.4 | 2.7 | 0.5 | Ø16@100mm | Ø16@100mm | Ø16@250mm | Ø16@250mm |
| F12 | 8 | 2.8 | 0.5 | Ø16@100mm | Ø16@100mm | Ø16@250mm | Ø16@250mm |

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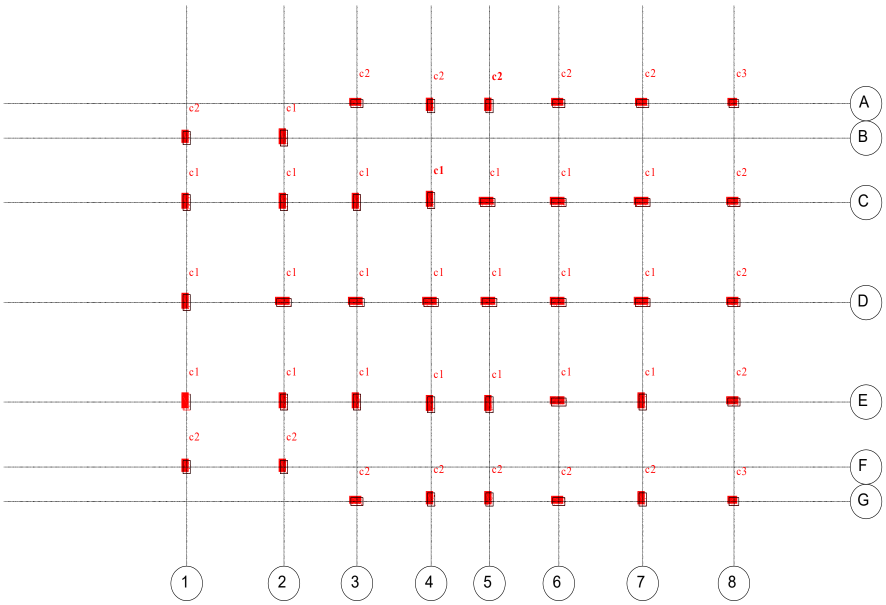
## Details:



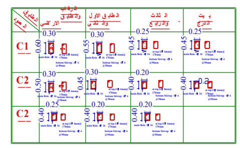



**Figure 3-22** columns

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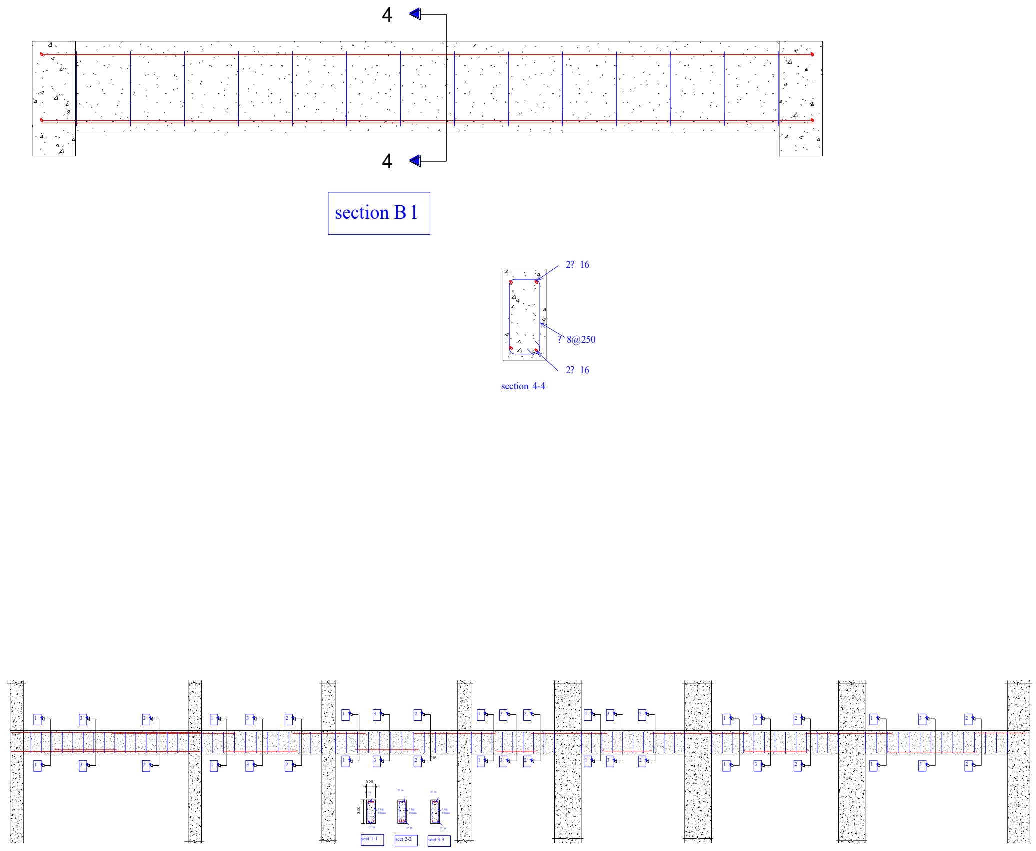


**Figure 3-23:** Beams

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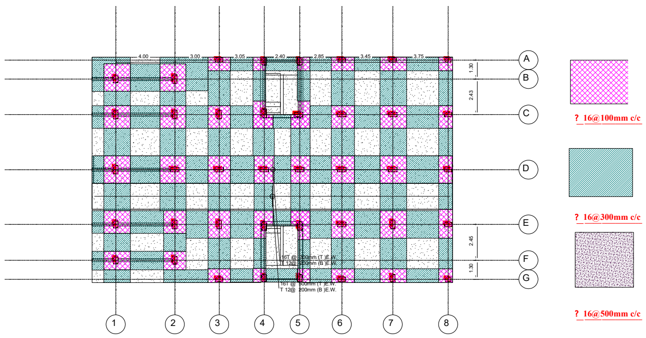
Top




bottom

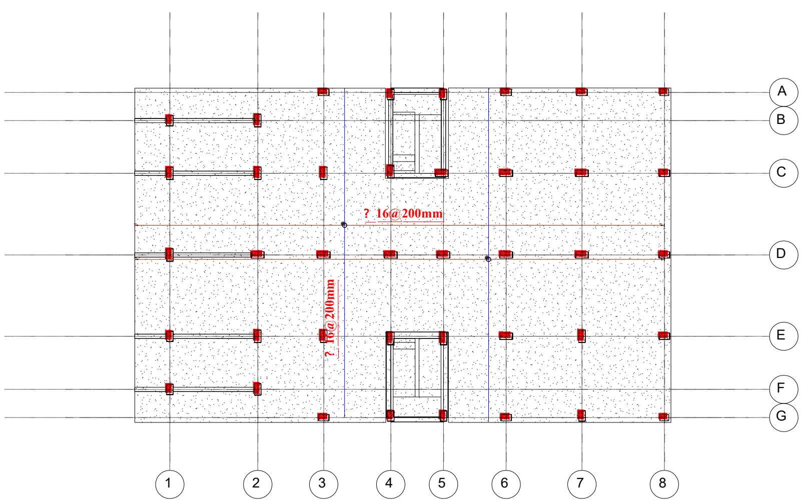



**Figure 3-24:** Slab details

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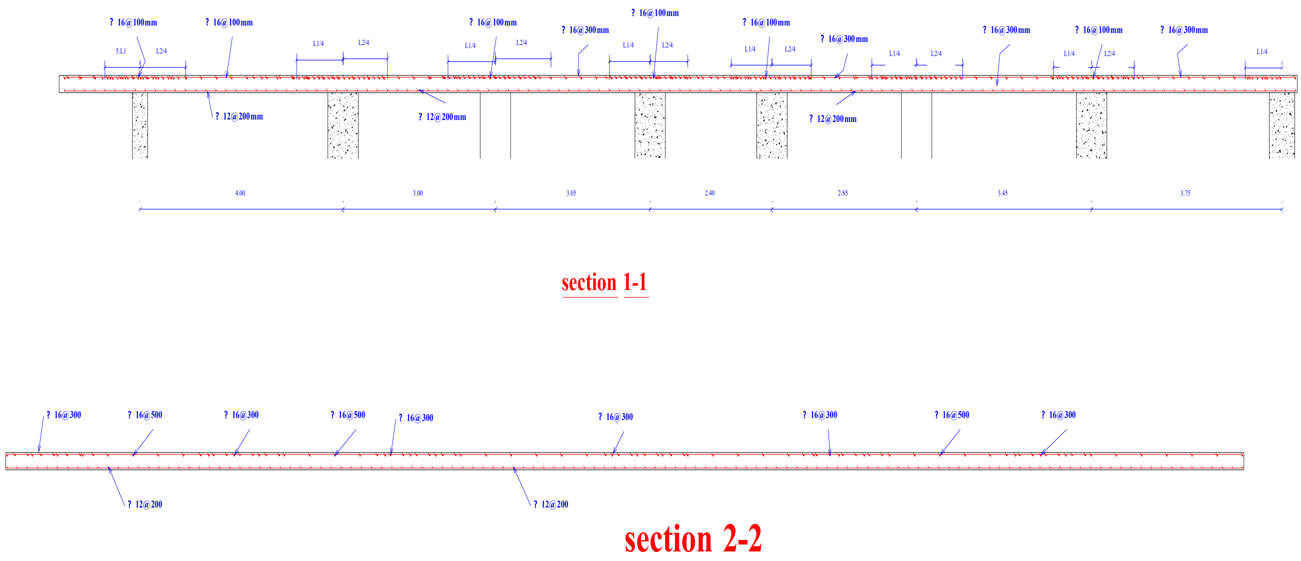


**Figure 3-25: section of slab**

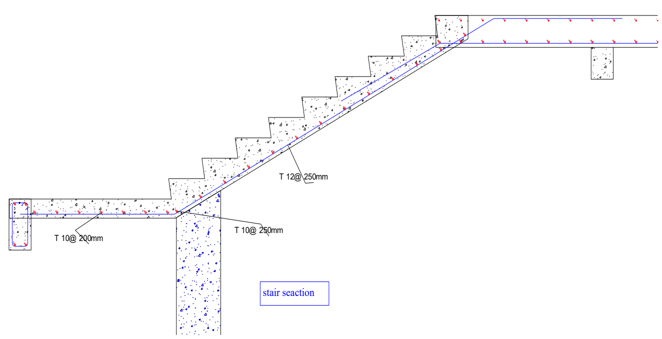


**Figure 3-26:** stairs

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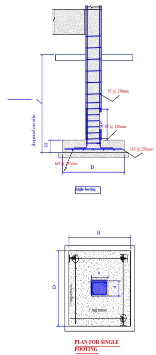

**Figure 3-27:** Isolate footing:

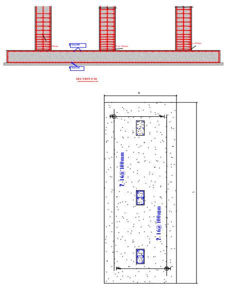

**Figure 3-28:** Continues footing:

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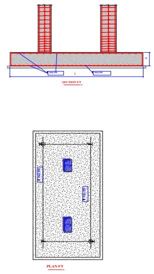

**Figure 3-29:** Combined footing:

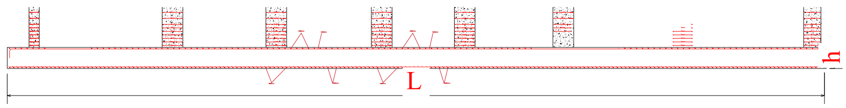


**Figure 3-30:** raft foundation

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## 4. CONCLUSIONS:

I- After analyzing the G+5 story building structure, concluded that structure is safe in loading like dead load, live load and wind load.

II- Member dimensions (Beam, Column and Slab) are assigns by calculating the load type and its quantity applied on it. AutoCAD plan gives detailed information of the structure member's length, height, size and numbers etc.

III- ETABS & ROBOT has the capability to calculate the reinforcement needed for any concrete section. SAFE program used to check the foundation design. The program contains a number of parameters which are designed as per.

IV- The next paper the analysis will be done using deformed shape by using software programs.

V- The ETABS program extracts high values, while the robot extracts low values. In my personal opinion, the robot produces more accurate values. The program uses the Finite method and works on analyzing all the elements, even the foundations, while ETABS designs most of the elements, and the design of the foundation and slab is verified using the SAFE program.

VI- The difference in torque values is somewhat large, especially in beams, but as for the design, the design is almost uniform.

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