

# Design and Analysis of RCC Framed Structure(G+5) by using STAAD.Pro and STAAD.etc

M. Siva Naga Kanya<sup>1</sup>, A. Meghana Reddy<sup>2</sup>, A. Pujitha<sup>3</sup>, M. Dheeraj<sup>4</sup>

<sup>1</sup>Asst.Professor, Civil Engineering, Dhanekula Institute of Engg & Technology, Andhra Pradesh, India

<sup>2,3,4</sup>UG Student, Civil Engineering, Dhanekula Institute of Engg & Technology, Andhra Pradesh, India

\*\*\*

**Abstract** - In recent year the increase of population, commerce and trade and the cost of land in cities have resulted in a considerable increase in the number of tall buildings. At present, there are many factors effecting the selection and design of the high-rise building structural system. In order to compete in the ever growing competent market it is very important for a Structural Engineer to save time. The main objective of this project is to analyze and design(wind and seismic) a mutli-storied building by using STAAD Pro. The design involves load calculations manually and analyzing the whole structure by STAAD Pro and STAAD.etc. Complicated and high-rise structures need and very time taking and cumbersome calculations using conventional manual methods. STAAD Pro and STAAD.etc provides us a fast, efficient, easy to use accurate platform for analyzing an multi-storey building. Finally we will make an attempt to define the economical section of multistorey residential building using STAAD.Pro. software tool

**KeyWords:** Analysis, design, Residential building STAAD. Pro, STAAD. etc, Seismic loads.

## 1. INTRODUCTION

The enormous increase in population and scarcity of land makes the people to move from rural areas to urban paces and construction of multi-storied buildings in small areas is being common now-a-days. Functional designing of the building has become very important and the requirements vary from one building to another. Every Civil Engineer should know the usage of the buildings by contacting the people and basic principles of designing of the R.C.C structures. This is project is intended at Analyzing and designing the multi-storey structure using STAAD. PRO V8i and STAAD. ETC. In this project, we adopted limit state method of analysis and design the structural members manually and using STAAD.PRO.V8i and STAAD.ETC. Manually design is done for particular beam, column and slab by using IS456:2000 and loads are dead load, imposed load and external load considered according to IS 875:2000(PART I&II).It is then checked in STAAD.P RO.V8i and STAAD.ETC.

## About STAAD.etc

STAAD.etc delivers dynamic/interactive graphics for validation and verification for each step during the design process. STAAD.etc component design includes:

- Isolated rectangular footing
- Retaining wall
- Two way slab design
- Pile cap design
- Laterally loaded pile analysis
- Circular & Rectangular concrete column design
- Loss calculation in post tensioned tendon
- Pile group analysis
- Corbel design
- Combined footing with beam analysis & design
- Strip footing analysis and design
- Block foundation analysis

## 2. METHODOLOGY

- MODELLING
  - (G+5) Residential building
- LOADS
  - 1.Seismic loads
  - 2.Dead load:
    - Wall load - 10.5 kN/m(for outer walls)
    - 5kN/m (for inner walls)
    - 3.5 kN/m(for parapet walls)
    - 20kN/m(for staircase walls)
    - 15kN/m(for lift beams)
  - Floor load – 1.5 kN/m<sup>2</sup>
  - Live load - 1 kN/m<sup>2</sup>
- DESIGN
  - Design of beams, columns in STAAD.Pro.

Design of slab and pilecap in STAAD.etc

- GEOMETRIC PARAMETERS

Beams - 0.23m\*0.23m(for lift beams)

0.3m\*0.3m(for ground floor beams)

0.45m\*0.45m(for all remaining beams)

Columns - 0.45m\*0.3m(for columns c1)

0.3m\*0.45m(for columns c2)

Slabs - D=175mm

D=150mm

- ANALYSIS

Analysis of RCC structure. Shear force and Bending moment calculations.

- Compare result with manual result.
- Adopting safe and economical design.

### 3. DESIGN AND ANALYSIS

#### 3.1 MODELLING IN STAAD.PRO V8I

##### 3.1.1 MODEL WITH DETAILING

1. Open STAAD.PRO, click on add beam and then click on OK.
2. Then select units by clicking on meters and kilonewtons and then click OK.
3. Click on geometry and add nodes by using node cursor.
4. Add nodes by giving the assumed distances and the click on OK.
5. By using beam cursor join the nodes for forming beams.

##### 3.1.2SUPPORTS

1. Click on general and select support.
2. Creat a fixed support and click on assign to selected nodes then supports are assigned.

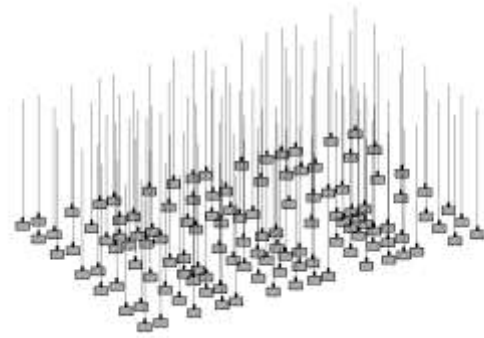


Fig 1: supports diagram

#### 3.1.3 -3D- VIEW OF STRUCTURE

Click on translational repeat and give spacing of 2m and select number of storeys and click on OK.

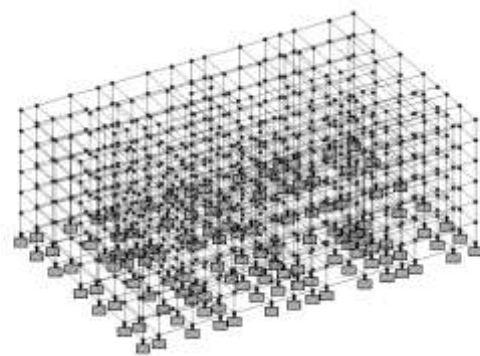


Fig 2: Full structure

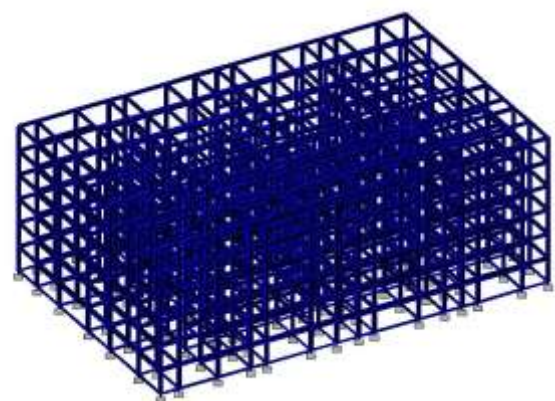


Fig 3: 3D structure

#### 3.1.4 ASSIGNING OF PROPERTIES TO THE STRUCTURE

1. Go to general and select property.
2. Then click on define and select rectangle and give the dimensions of required size.

PLINTH BEAMS – 0.2m\*0.2m

LIFT BEAMS – 0.23m\*0.23m

GRADE AND FLOOR BEAMS – 0.45m\*0.45m

OUTER COLUMN – 0.45m\*0.3m

INNER COLUMN – 0.3m\*0.45m

LOAD COMBINATION 17 – 1.2(L2+L5+L6)

LOAD COMBINATION 18 – 1.2(L3+L5+L6)

LOAD COMBINATION 19 – 1.2(L4+L5+L6)

After adding load combinations select assign to view and assign.

3. Click on the required property and select assign to selected beams and assign

**3.1.5 APPLICATION OF LOADS APPLICATION OF SEISMIC LOAD**

1. Go to load case details and add seismic load in positive X-direction and in negative X-direction.

LOAD CASE 1(L1) – Seismic load in positive X-direction

LOAD CASE 2(L2) – Seismic load in negative X-direction

2. In second load case add seismic load in positive Z-direction and negative Z-direction.

LOAD CASE 3(L3) – Seismic load in positive Z-direction

LOAD CASE 4(L4) – Seismic load in negative Z-direction

**APPLICATION OF DEAD LOAD AND LIVE LOAD**

1. In third and fourth load cases give dead load and live load according to the IS Codes.

LOAD CASE 5(L5) – Dead load

LOAD CASE 6(L6) – Live load

2. Click on assign to view and assign.

**APPLICATION OF LOAD COMBINATIONS**

LOAD COMBINATION 7 – 1.5(L5+L6)

LOAD COMBINATION 8 – 1.5(L1+L5)

LOAD COMBINATION 9 – 1.5(L2+L5)

LOAD COMBINATION 10 – 1.5(L3+L5)

LOAD COMBINATION 11 – 1.5(L4+L5)

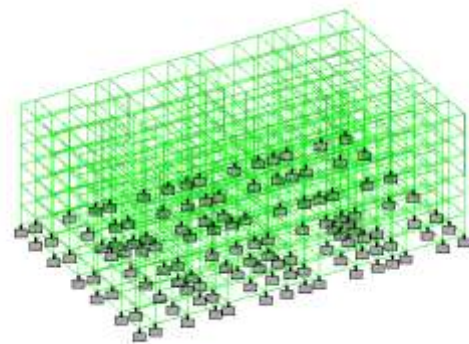
LOAD COMBINATION 12 – 1.5L1+0.9L5

LOAD COMBINATION 13 – 1.5L2+0.9L5

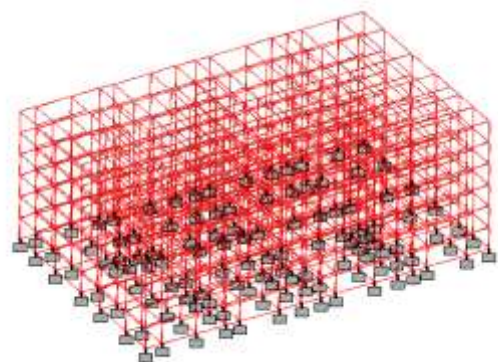
LOAD COMBINATION 14 – 1.5L3+0.9L5

LOAD COMBINATION 15 – 1.5L4+0.9L5

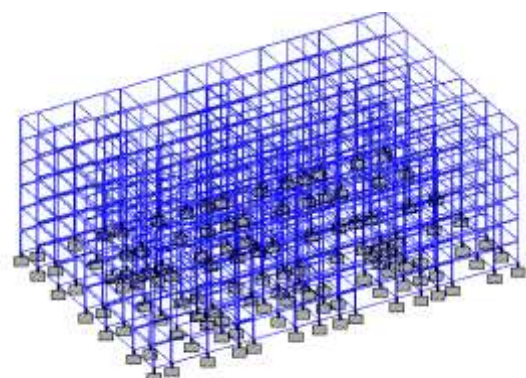
LOAD COMBINATION 16 – 1.2(L1+L5+L6)



**Fig 4:** Deflection diagram



**Fig 5:** Bending moment diagram



**Fig 6:** shear force diagram

### 3.1.6 ANALYSIS

Go to analysis/print and select all and click on OK.

Click on analysis and select run analysis.

### 4. DESIGN OF RCC ELEMENTS:

#### 4.1 SLAB DESIGN IN STAAD.etc

1. Open staad.etc and click on new job.
2. Select Indian code and select concrete and click on two-way slab.
3. Enter the file name and click on OK.

##### 4.1.1 Geometry data

Give the length along shorter direction and length along longer direction. Then click on next. It displays the slab structure on the right side of the geometry data

##### 4.1.2 Material data

Enter the material data that is grade of concrete and grade of steel.

##### 4.1.3 Loads

Enter the values of superimposed dead load and live load

##### 4.1.4 Load combinations

Give factor for superimposed dead load and self weight. Enter the factor for live load and click on next.

##### 4.1.5 Reinforcement data

1. Give bar size along shorter dimension and bar size along longer dimension.
2. Provide clear cover according to codes.

##### 4.1.6 Design of slab

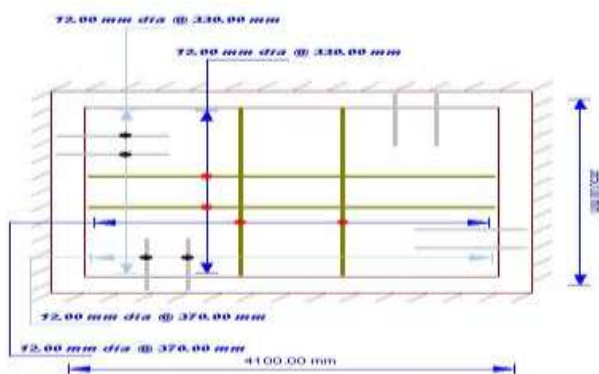


Fig 7: slab design

### 4.2 BEAM DESIGN:

There are two types of reinforced concrete beams

1. Single reinforced beams
2. Double reinforced beams

**4.2.1 Single reinforced beams:** In singly reinforced simply supported beams steel bars are placed near the bottom of the beam where they are effective in resisting in the tensile bending stress.

**4.2.2 Double reinforced beams:** It is reinforced under compression tension regions. The necessities of steel of compression region arise due to two reasons. When depth of beam is restricted. The strength availability singly reinforced beam is inadequate.

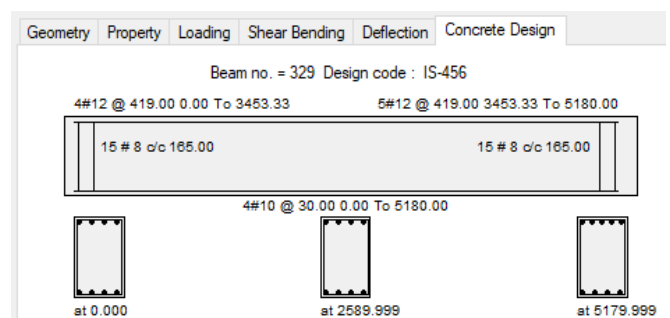


Fig 8: Beam reinforcement

### 4.3 COLUMN DESIGN:

A column may be defined as an element used primarily to support axial compressive loads and with a height of a least three times its lateral dimension. The strength of column depends upon the strength of materials, shape and size of cross section, length and degree of proportional and dedicational restrains at its ends.

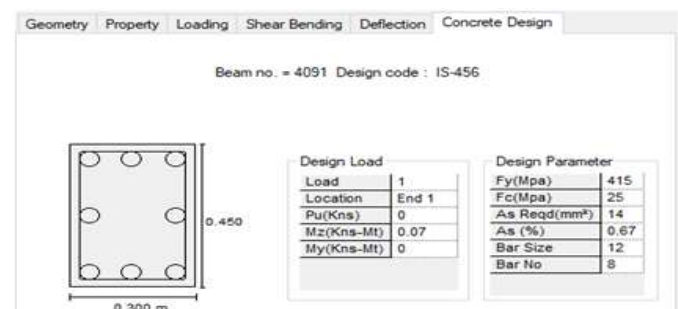


Fig 9: Column reinforcement

**5. PILE DESIGN** - Based on the soil tests results we considered the type of foundation as under reamed pile foundation as the soil is silty clay.

## 5.1 DESIGN OF PILES

### 5.1.1 Diameter of piles

The diameter of under-reamed bulbs may vary from 2 to 3 times stem diameter depending upon the feasibility of construction and design requirements. In bored cast in situ under-reamed piles the bulb diameter shall normally be 2.5 times, and in under-reamed compaction piles two times.

### 5.1.2 Spacing of piles

According to IS 2911(part 3) 1980 the spacing of piles is chosen as, In under-reamed compaction piles, at the usual spacing of  $1.5D_u$  the group capacity will be equal to the safe load on individual pile multiplied by the number of piles in the group.

### 5.1.3 Reinforcement of piles

The provision of reinforcement will depend on nature and magnitude of loads, nature of strata and method of installation. It should be adequate for vertical load, lateral load and moments, acting individually or in combination.

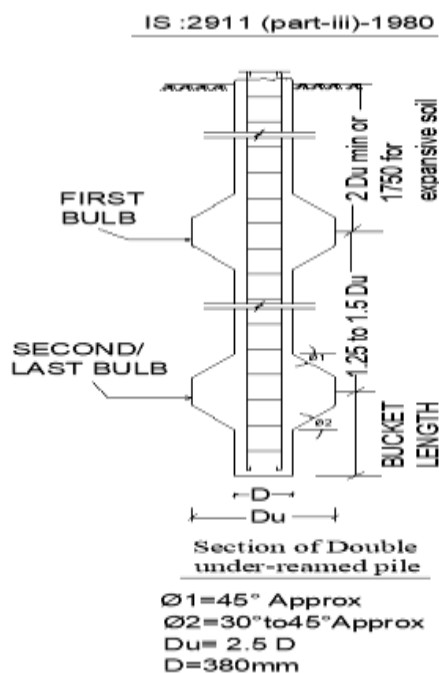


Fig 10: cross section of under-reamed pile

## 6. PILES LAYOUT IN AUTOCAD

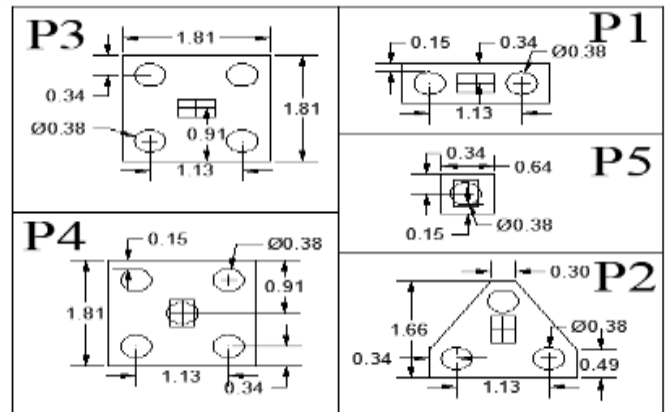


Fig 11: Cross sections of different pile caps

Piles layout is drawn in AUTOCAD to prevent overlapping of piles. If, there is any over lapping then change the direction of the pile structure or change the diameter of piles.

## 7. PILE CAP DESIGN IN STAAD.etc

Pile caps are generally designed considering pile reaction as either concentrated loads or distributed loads. The depth of pile cap should be adequate for the shear for diagonal tension and it should also provide for necessary anchorage of reinforcement both for the column and the piles.

### 7.1 Creating file

1. Open staad.etc and click on new job.
2. Select Indian code and select foundation design.
3. In foundation design select pile cap design and enter the file name.

### 7.2 Pile properties

1. Give total number of piles required.
2. Enter the pile diameter, pile length, clear edge distance, column width, column length, depth of pile cap bottom, depth of pile cutoff level, thickness of pilecap.
3. After that enter vertical pile capacity, pile uplift capacity, pile cap against lateral load from IS CODE

2911(part 3) 1980.

### 7.3 Column/Pile locations

1. Give column/pile locations.
2. Enter X and Y co-ordinates and column C.G.

3.It will display the pile structure on the right side.

### 7.4 Loads

Enter the vertical dead load which is falling on the column

### 7.5 Load combinations

Enter factored dead load and factored live load and click on next

### 7.6 Constants

Enter the grade of steel and grade of concrete and provide shear reinforcement. Click on design.

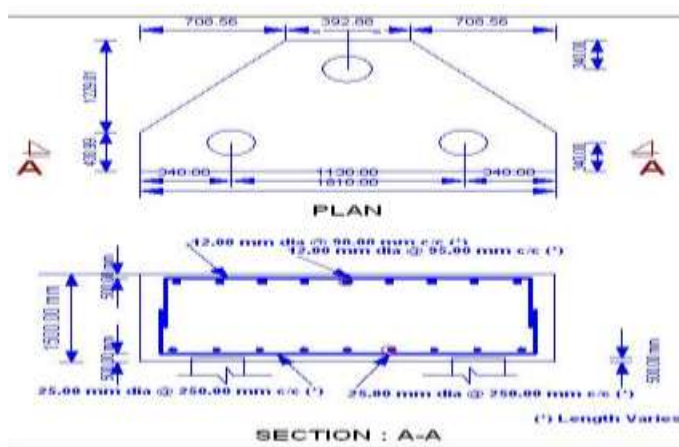


Fig 4: pile cap design in staad.etc

## 8. CONCLUSIONS

1. Building plan was developed in AUTOCAD with required dimensions.
2. The structural model was developed in STAAD.PRO and STAAD.etc for execution of analysis and design.
3. The analysis and design was carried out manually.
4. The area of steel reinforcement required for beam design showed 9% less in STAAD.Pro when compared to manual design.
5. The area of steel reinforcement required for column design showed 11% less in STAAD. Pro when compared to manual design.
6. pile cap design and analysis was done in Staad.etc
7. The area of steel reinforcement required for slab design showed 2% less in STAAD.etc when compared to manual design.
8. Beam design showed optimum results in STAAD.Pro. Hence economical beam design and

area of steel required was chosen from STAAD.pro.

9. Column design showed optimum results in STAAD.Pro. Hence economical column design and area of steel required was chosen from STAAD.pro.
10. Slab design showed optimum results in STAAD.etc. Hence economical slab design and area of steel required was chosen from STAAD.etc.

## REFERENCES

- [1] "Planning Analysing AndDesign of Multi Storeyed Building By STAAD.PRO.V8i" Anoop.A, Fousiya Hussain, Neeraja.R, Rahul Chandran, Shabina.S, Varsha.S, Anjali.A, August(2016).
- [2] "Analysis and Designing of G+5 Residential Building Using STAAD-PRO" S.Sudheer, May(2017).
- [3] "Analysis and Design of Multi Storey Building By Using STAAD.PRO" SK Salem, B. Ravi Kumar, January(2017).
- [4] "Analysis and Design of a (G+5) Multi Storey Residential Building Using STAAD.PRO" Deevi Krishna Chaitanya, L. Santosh Kumar, January(2017).

## IS CODES:

- IS 456:2000- (design of RCC elements)
- IS 1893(part 1):2002 -(for earthquake design)
- IS 2911(part 3)- (for pile design.)
- IS 875 part 1- (Dead loads)
- IS 875 part 2-(live loads)
- SP-16& SP-34