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Analysis and Design of G+5 Residential Building Using AutoCAD and STAAD.PRO

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Abstract –

The Structural Planning and Design Process needs not only creativity and abstract thought, but also adequate knowle dge of structural engineering theory in addition to knowledge of practical aspects such as recent design codes, bye rule s, backed by extensive experience, insight perspecti-ve and judgment. The traditional way for construction of building is that the cross section for all the columns from basement up to top floor of a building is same but in general the load bear by the ground floor is much higher than the top floor as we go upwards. So we use the help of design softwares to see stresses, shear force and total displacement when the amount of material required for construction is varied. In this Study we will consider two cases. First case is Case A and second case is Case B. For the Case A cross section of all the columns from bottom to top will be same while for the second case B cross section of the columns will decrease as we go up and then we will analyze the building. The software used for analysis in this study is STAAD.Pro. After analysis of the building both the results obtained were compared with each other it was seen that stresses generated in the first case was high and the requirement for concrete and steel was also high while in the second case stresses generated was less as compared to the first case and the requirement of concrete and steel is also less as compared to the first one hence, Design software is very helpful to find out optimized size and dimensions of the building structure's component such as column and beam's cross sections, slab thickness etc.

The aim of the standards is to guarantee and improve safety, while maintaining a careful balance between safety economy and security.

INTRODUCTION

Buildings come in Variety of shapes and functions and have been adapted to a wide range of historical factors, ranging from available building materials to environment, land prices, soil conditions, specific uses and aesthetic reasons. A multi storey building in the tower above the ground is a multi Floor structure. The main aim for construction of multi floor buildings is to increase the building's floor area without increasing the land area on which the building is built, thereby saving land area and money (depending on the type of material used and price of lands). The Structural Planning and Design Process require not only creativity and abstract thought, but also adequate knowledge of structural engineering theory in addition to knowledge of practical aspects such as recent design codes, bye rules, backed by extensi ve experience, insight perspective and judgment.

LITERATURE REVIEW-

V.Varalakshmi et al. The protection of G+5 reinforced concrete building would depend on the initial architectural and structural configuration of the overall structure, the reliability of the structural analysis, layout and reinforcement detailing of the building frame to achieve the stability of the elements and their ductile efficiency. Additional building quality and stability of the filling walls and partitions.

B.K. Vimala et al. India is constructed (Slabs, Beams, Columns and Footings) using Auto CAD technology in the present study G+4 building in Anantapur, gooty road. The loads are calculated using IS:456-2000 and HYSD BARS FE415 as per IS:1786-1985, namely the dead loads depending on the unit weight of the materials used (concrete, brick) and the live loads.

J. Sankar et al. The building frame experiences the Earthquake forces ' cumulative effect creating stresses on different parts of nodal joints. Such powers are used in the system layout. The plan offers values for a number of protected cases of bending moments, shear forces, storey drifts.

Singh Shailendra et al. The provision of continuous stretches instead of a single span produces a significant reduction in dead load, live load and moments of layout. The provision of two spans instead of one span results in a decrease of 80% to 90% in moments. The provision of three spans instead of one span results in a decrease of about 92% in moments.

K. Prabin Kumar and Gopi bala Vinay Frame analysis is performed using the Staad Pro Software method of the stiffness matrix. Footings, columns, beams and slabs are manually designed using a limit state method as per IS456 – 2000, IS 875, and SP16.

R. Sanjaynath and K Prabin Kumar Structural members ' dimensions are defined and loads like dead load, live load and wind load are added. Beams, columns and slabs were tested for deflection and shear checks. The tests have been proven safe. There has been both theoretical and practical work done. I therefore believe that, as opposed to theoretical work, we will gain more experience in practical work.

A. Jhansi Rani The G+6 residential building site selected should be in areas where all amnesty forms are open. Sp16 is used for beam design, plate, floor, footing measurements, respectively, in the design IS 456-200. Limit state design is the best approach to building design. There are different types of slabs, beams and columns but only one type of slab, beam and column are built in the design.

Ms Aayillia and K. Jayasidhan The analysis was carried out using the STAAD Pro V8i software package, which proved to be premium software with great potential in the construction industry's analysis and design sections. Using AutoCAD 2013, all structural components were designed manually and in detail. The research and development was carried out to the extent possible in compliance with standard requirements.

METHODOLOGY

The methodology for this study is shown below as follows :-

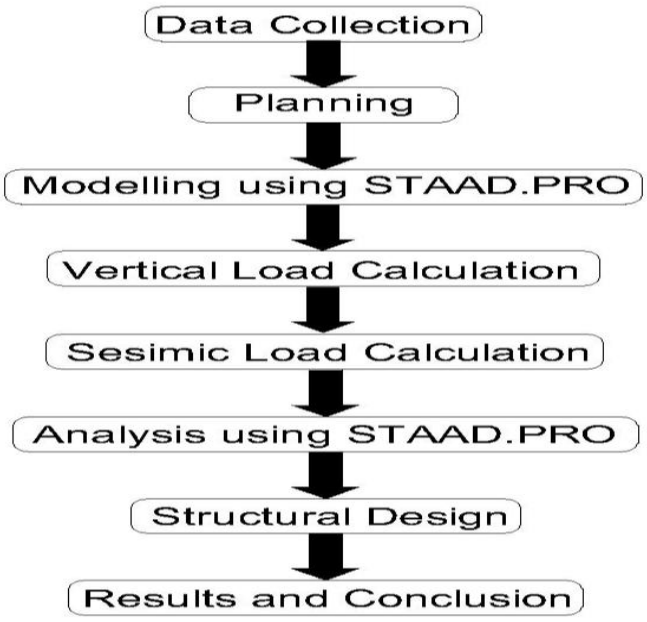


Fig. 1 Methodology

Data Collection -

Authentic data was collected such as dimensions of room thickness of wall size of columns from website of construction company named SuperTech Addressed at Supertech "The Valley" sector. It was made sure that this project was made and completed according to standards set by government of India.

- Seismic zone : 4
- Number of Storey's : G+5
- Floor Height : 3.5m
- Plinth Column : 3m
- Depth of Slab : 150m
- Size of beam : (350x250)mm
- Size of column : For Case A All Column (500x500)mm, For Case B Plinth Column (500X500)mm Ground Floor Column (450X450)mm First Floor Column (400X400)mm Second Floor Column (350X350)mm Third Floor Column (300X300)mm Forth Floor Column (250X250)mm Fifth Floor Column (200X200)mm
- Live load on Floor : 3Kn/m^2
- Floor finish : 0.6Kn/m^2
- Terrace water proof :1.5 Kn/m^2
- Materials M20 Concrete, Fe 415 Steel
- Wall thickness : 230 mm
- Density of Concrete : 25Kn/m^3
- Density of Infill : 20 Kn/m^3
- Type of soil : Medium
- Damping of structure : 5%
- Seismic Load : As per ISO 1893(Part-1) : 2002.
- Wind Load : As per IS 875 (Part 3)
- Design Building according IS 456

Planning -

The 2D drawing of the model was first made in AutoCAD Software. It was made sure that each and every dimension of the columns, beams and walls are properly mentioned. It was made sure that each and every dimensions of the girder have proper SI Units. The 2D Sketch helps to give an overview of the whole model which is yet to be drawn.

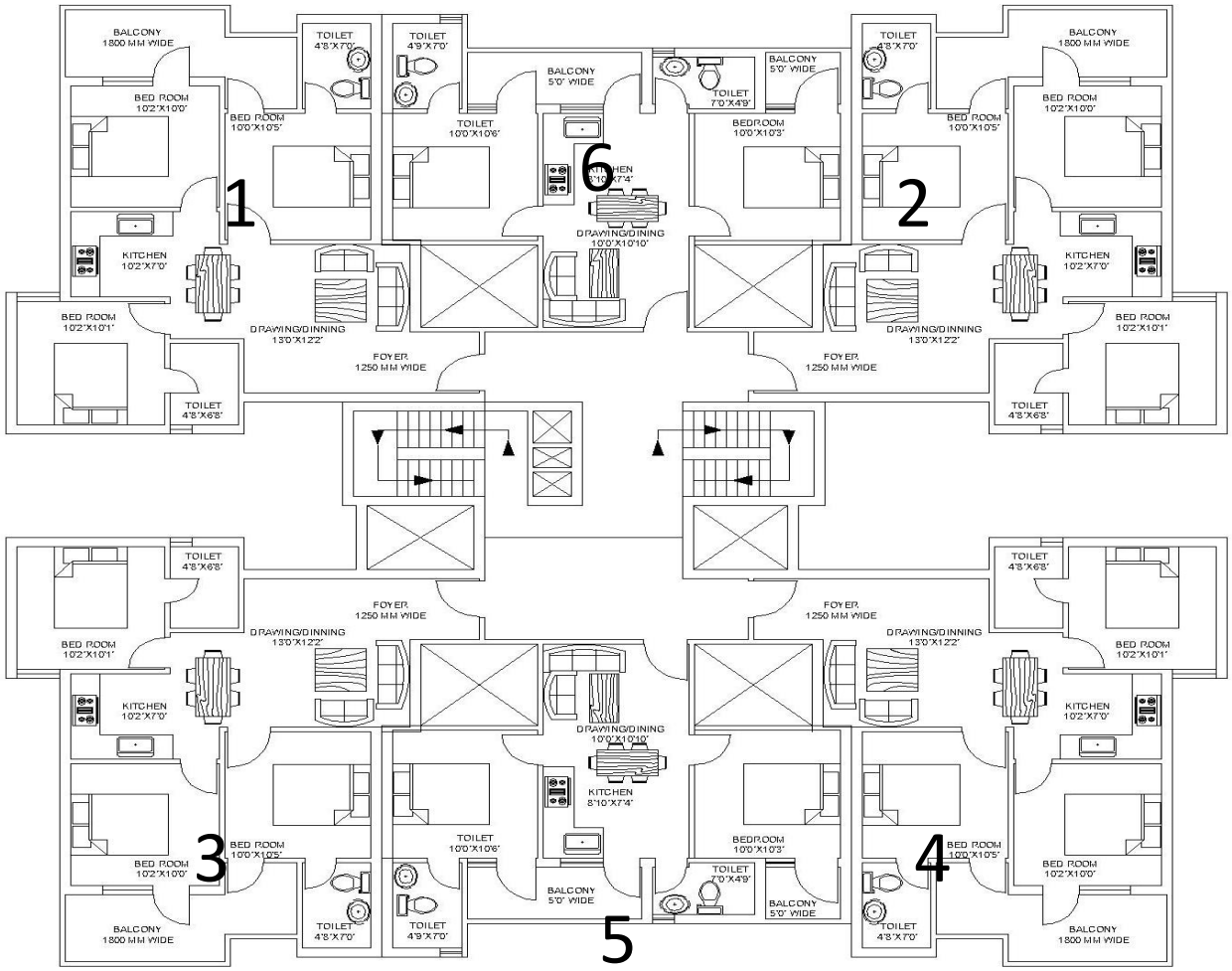
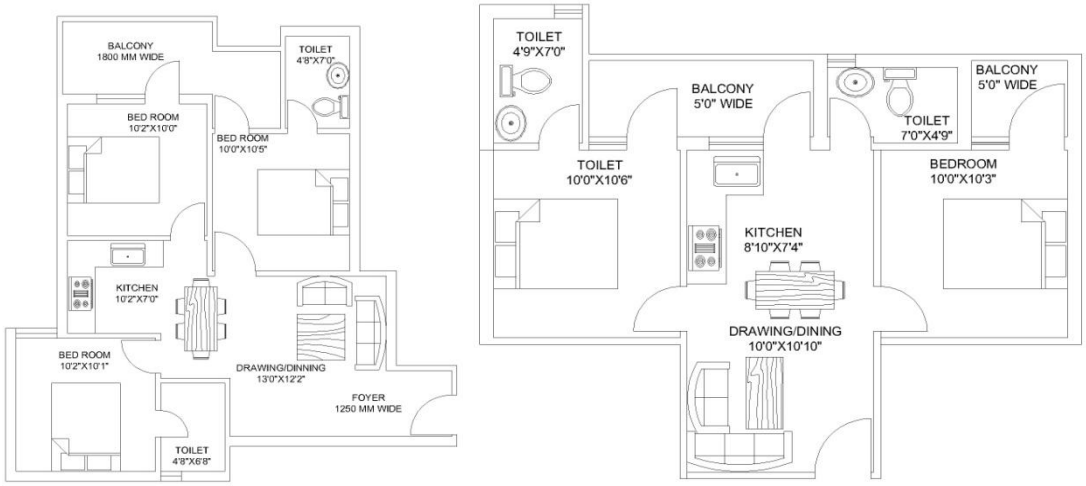


Fig. 2 Floor Plan.

The above drawing shows the 2D sketch of the floor. The complete floor plan was drawn in AutoCAD Software. The numbers mentioned in the drawing indicates whether the flat is 3BHK or 2BHK. The numbers 1,2,3 and 4 indicates 3 BHK flats while the numbers 5 and 6 indicates 2 BHK flats. 2 Stairs are clearly shown in the Drawing. 4 large shaft area and two small shaft area is also shown in Drawing.



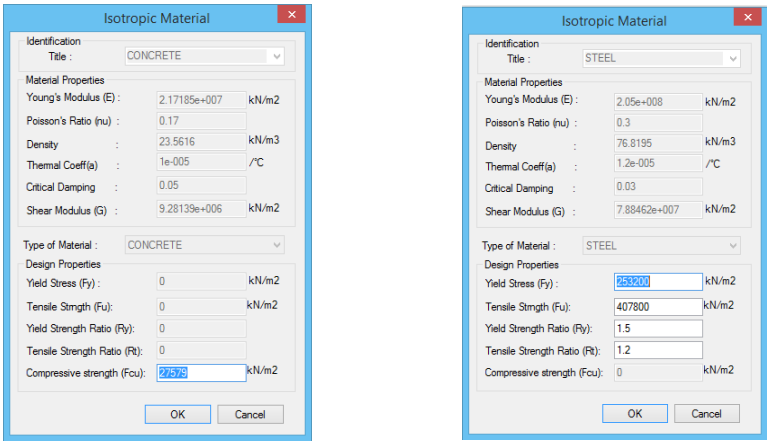
a.) 3 BHK Floor Plan **b.)** 2BHK Floor Plan

Fig. 3 Floor Plan **a).** 3BHK Floor Plan **b).** 2BHK Floor Plan

The above drawing shows the figure of 3BHK flat. The complete drawing was drawn in AutoCAD software. The drawing clearly indicates 3 Bedrooms dining and foyer area. It was made sure that space in the floor is properly utilized so that the area is properly optimized. The above drawing shows the figure of 2BHK flat. The complete drawing was drawn in AutoCAD software. The drawing clearly indicates 2 Bedrooms dining area and Balcony. It was made sure that space in the floor is properly utilized so that the area is properly optimized.

Modeling using STAAD.PRO -

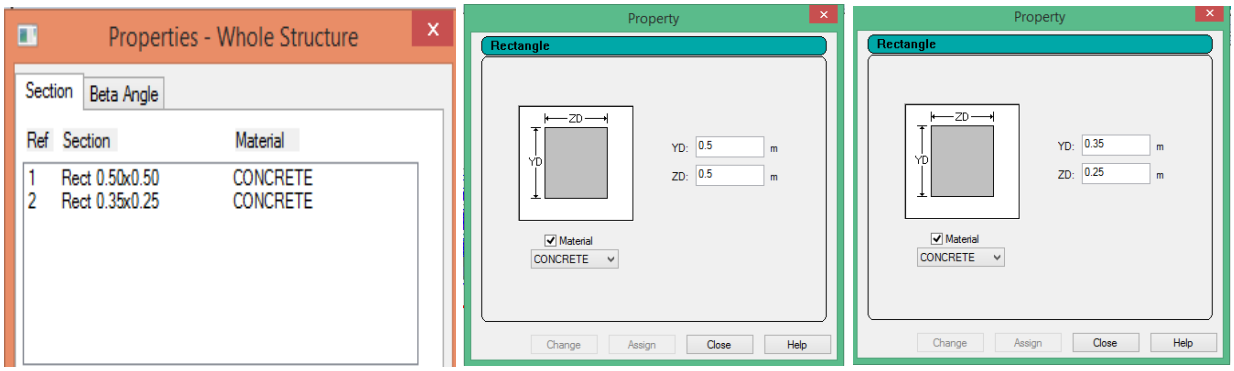
In this analysis used material property of Concrete and Steel bars are shown in Fig. 4



a.) Materials property for Case A **b.)** Material property for case B

Fig. 4 Material properties of Concrete and Steel Bar **a.)** Materials property for Case A **b.)** Material property for case B

The complete analysis of stresses generated in the Columns and beams was done in STAAD.Pro Software. The Fig. 4 shows us the material properties of the columns and beams such as Young's Modulus, Poisson's Ratio, density, thermal coefficient etc. The materials properties for both the cases A and Case B is same. The material considered as in Isotropic behavior.



a.) Cross Section of Column and Beam **b.)** Column Cross Section profile **c.)** Beam Cross Section profile

Fig. 5 Column and Beam Cross Section **a.)** Cross Section of Column and Beam **b.)** Column Cross Section profile **c.)** Beam Cross Section profile

The figure 5 shows the Cross section profile of Beams and Columns. Fig. 5a Shows the Cross section of both Columns and beams While, Fig. 5b shows Individual cross section profiles of Columns and Fig. 5c shows Individual Cross section profiles of Beams.

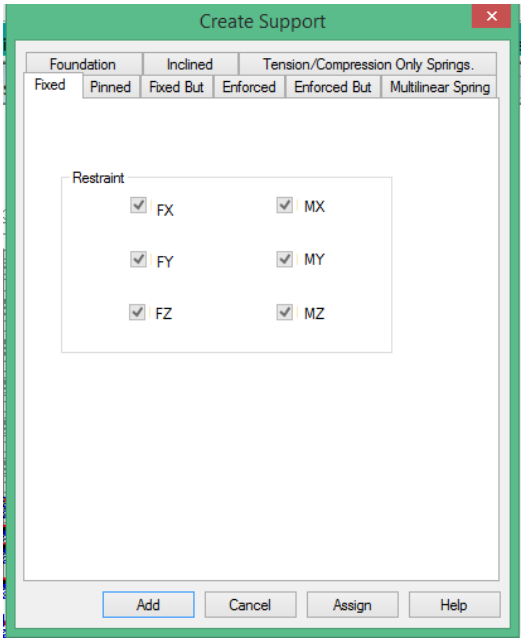
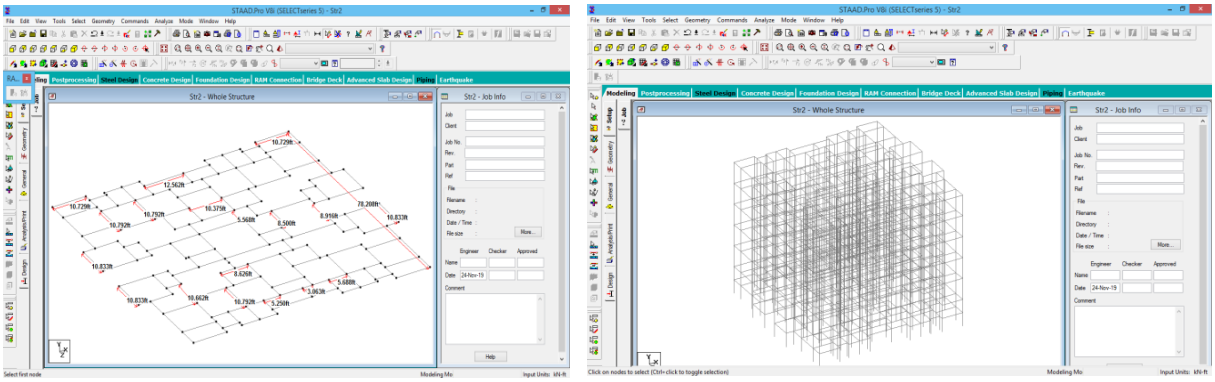


Fig. 6 Fix Support

The Fig. 6 shows the supports which are fixed to stop the rotation. Every 3D Point have 6 degree of freedom, three are linear and three are rotational. In this analysis applied fix support at bottom node. Fix support means fully constraint, behave as node cannot move or rotate any direction.



a.) Floor Plan view **b.)** Isometric view

Fig. 7 Plan view Imported from AutoCAD to STAAD.PRO **a.)** Floor Plan view **b.)** Isometric view

The 2D sketch was then imported into STAAD.PRO and a 3D model was created for analysis of beams and columns in the building. Fig. 7 Shows the Floor plan view and isometric Plan view of the building. After Importing the file into STAAD.PRO the plan drawing was vertically dragged upwards in positive Y direction to create a G Plus 5 building plan.

Vertical Load Calculation

Calculation for the load exerted on the structure such as beams columns and slabs on the column due to Gravitational forces. Dead load of building work as Vertical load.

Seismic Load Calculation

Seismic load is one of earthquake engineering's basic concepts, which means applying an earthquake-generated agitation to a building structure or design. This happens either with the ground or neighboring structures or with tsunami gravity waves on the contact surfaces of a building. Applied Seismic Load according IS 1893- 2002/2005 for both case. In this analysis applied seismic, wind, live and dead load according to IS 456, IS 1893- 2002/2005 and IS 875 Part 3.

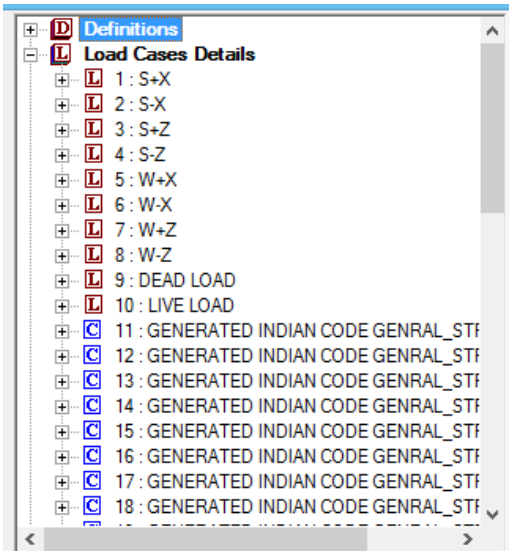


Fig. 8 Load applied in STAAD.Pro

Analysis using STAAD.PRO

Using STAAD.Pro completed analysis and solution process. After that STAAD.Pro generated results of building such as total deformation, stress, shear force, Bending moment, required concrete for building and required steel bar for building. Completed analysis and Design process using IS 456, IS 1893- 2002/2005 and IS 875 Part 3. This process done for both case, Case A and Case B.

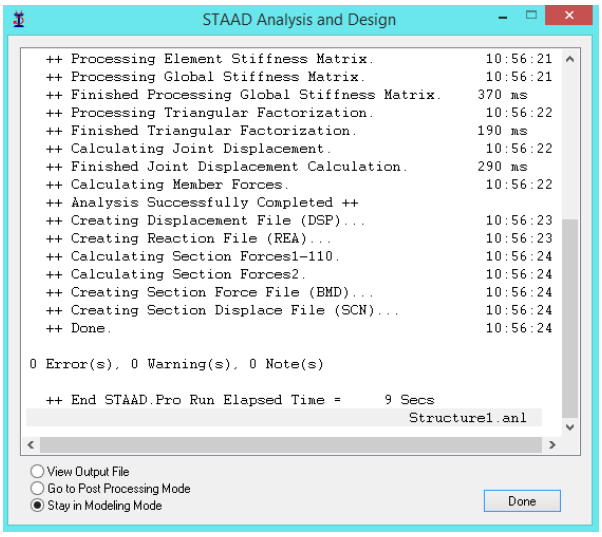


Fig. 9 Solution Status of Analysis

RESULTS AND DISCUSSIONS

CASE A

For Case A results such as Total deformation, Stress, Shear Force, Bending Moment etc. are following as -

Beam 889 Reinforcement

Fig. 10 shown below shows us the Reinforcement of the Beam.

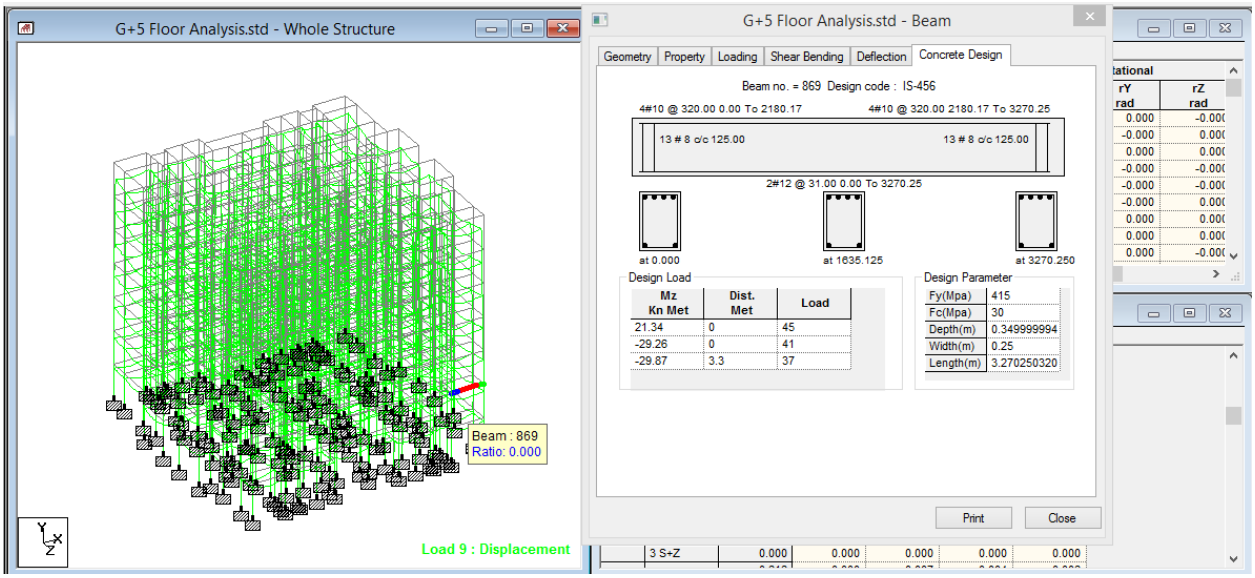


Fig. 10 Beam 869 Reinforcement

Beam bending moment, shear force and axial force diagram

The Fig. 11 shown below shows us the Bending moment, Shear forces and Axial stresses generated in the structure. The graphs shows us the total displacement. This figure shows results of beam number 869.

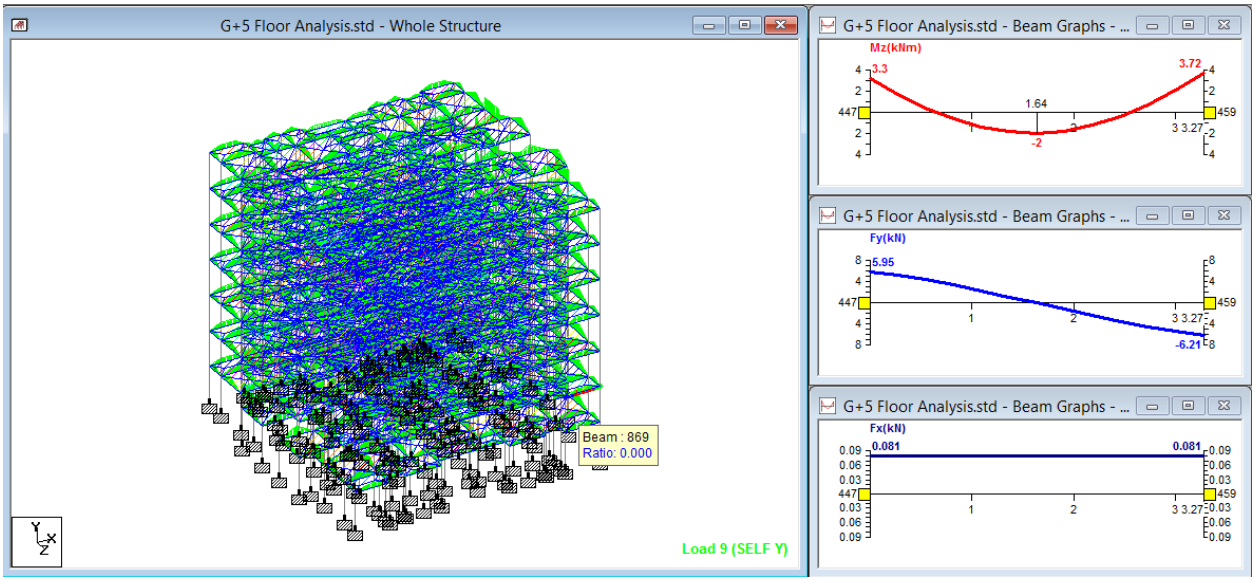


Fig. 11 Beam bending moment shear force and axial force diagram

Beam stress diagram

The Fig. 12 shown below shows us the stresses generated in the beam of the structure

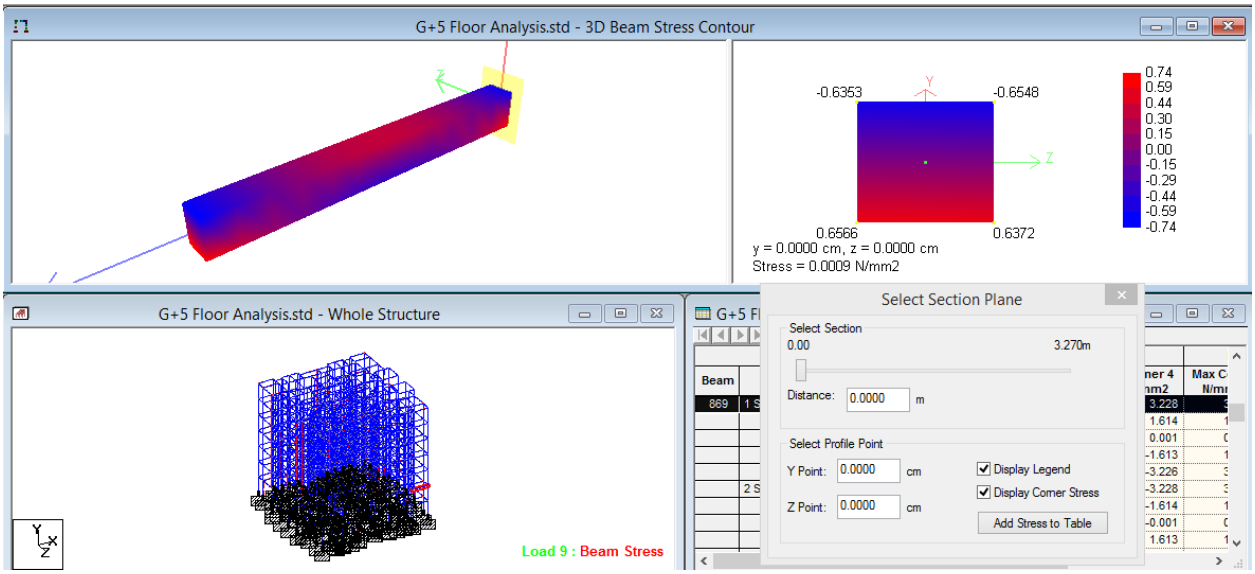


Fig. 12 Beam stress diagram

Column 672 Reinforcement

Fig. 13 shown below shows us the Reinforcement of the Beam.

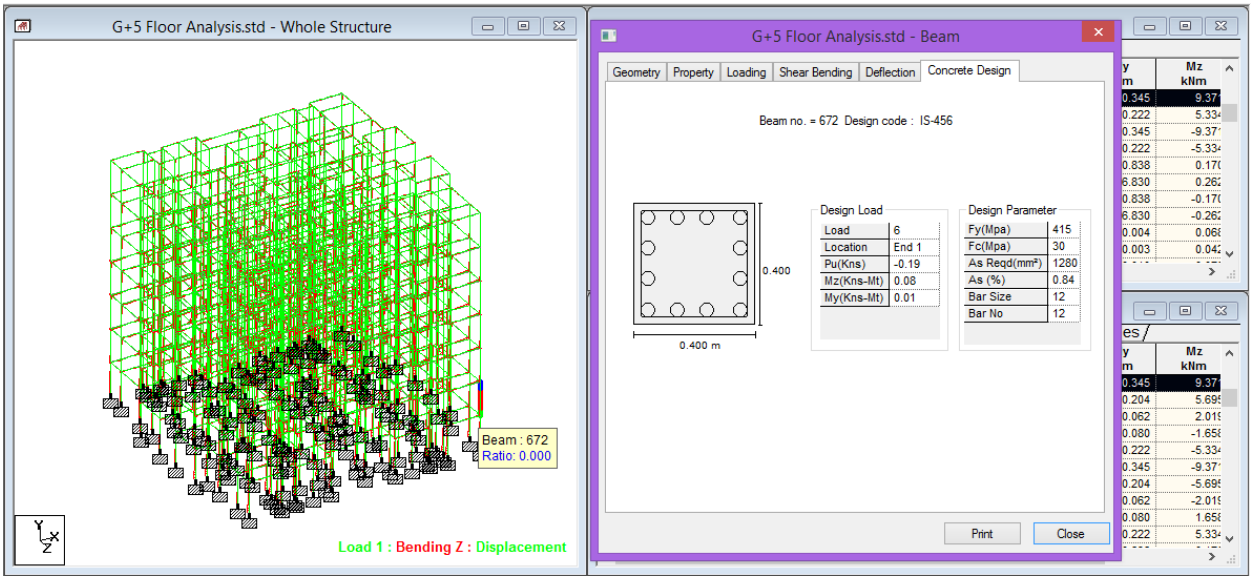


Fig. 13 Column 672 Reinforcement

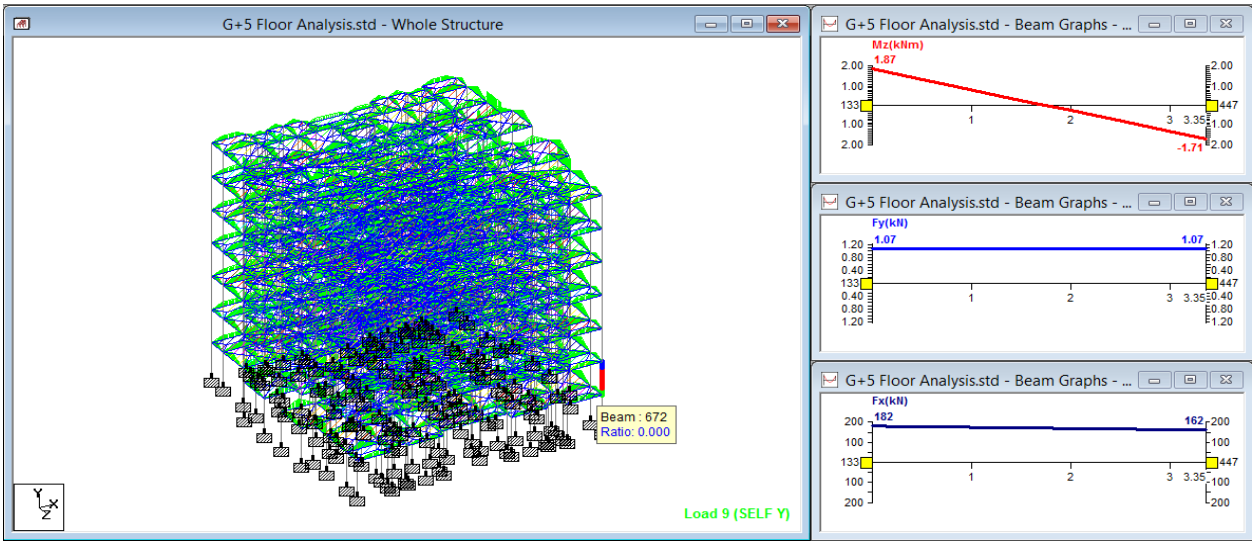


Fig. 14 Beam bending moment shear force and axial force diagram of Column No. 672

The Fig. 14 shown above shows us the Bending moment, Shear forces and Axial stresses generated in the structure. The graphs shows us the total displacement. This figure shows results of beam number 672.

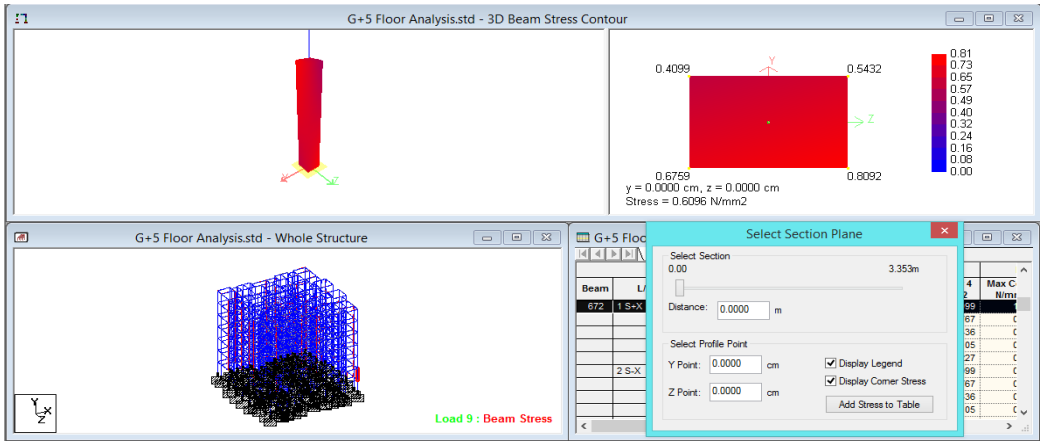


Fig. 15 Beam bending moment shear force and axial force diagram of Column No. 672

The Fig. 15 shown above shows us the stresses generated in column 672. Red color shows the maximum stress generated while Blue color shows minimum stress.

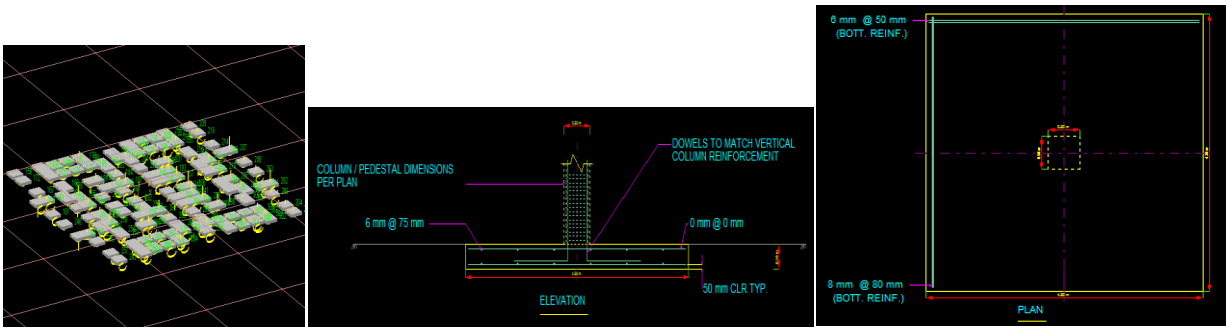
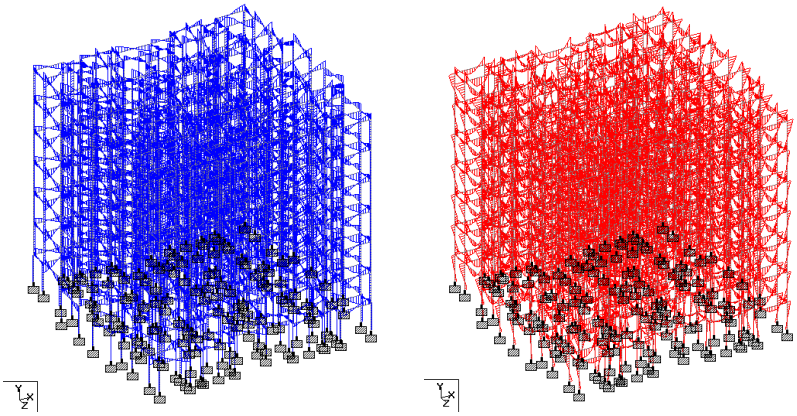


Fig. 16 Beam bending moment shear force and axial force diagram of Column No. 67

The Fig. 16 a.) shows foundation block of building, Fig. 16 b.) shows footing dimensions also shows the required concrete and steel for foundation, Fig 16 c.) shows Foundation block dimensions.

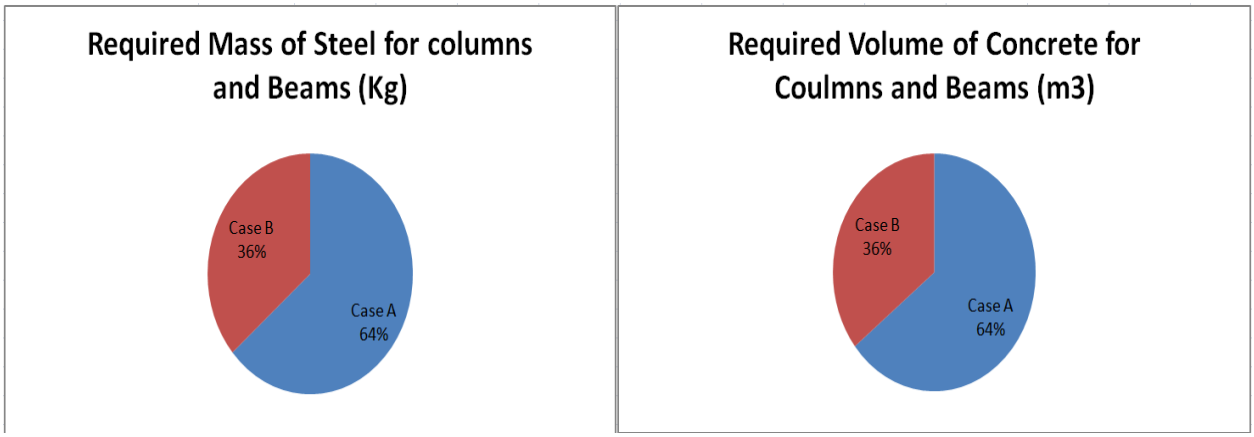


a.) Shear force generated **b.)** Bending moment generated

Fig. 17 Beam bending moment shear force and axial force diagram of Column No. 672

Fig 17 a.) shows the Shear Force generated in the whole building while Fig 17 b.) Shows the bending moment generated in the whole building.

The same cases were considered and the same analysis was done for the case B as done in case A. After the analysis both the results were compared and the obtained results were plotted to see the difference. The results obtained are shown below as follows.



a.) Required mass of steel for columns and beam **b.)** Required volume of concrete for columns and beam

Fig. 18 Required Maas of steel and Volume of concrete in Case of A and B

Fig. 18 a.) shows the requirement of steel for columns and beams while the Fig. 18 b.) shows the required volume of concrete. The pie chart clearly shows here that the requirement for mass of steel and volume of concrete is less for case B.

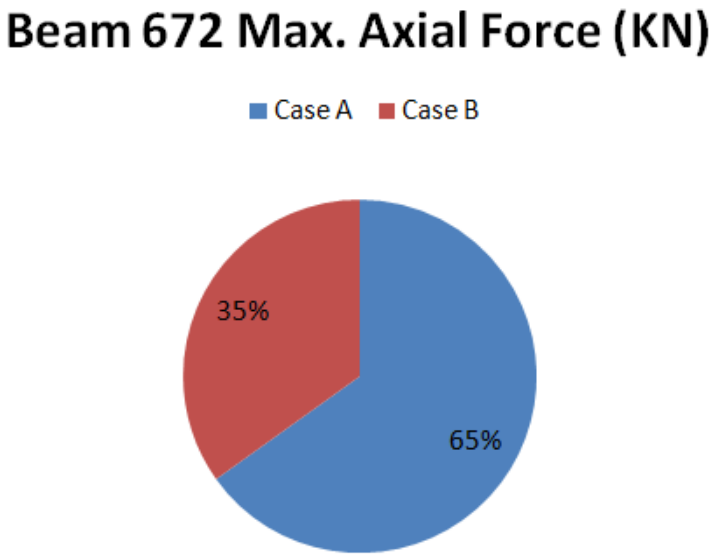


Fig. 19 Beam axial force for columns and beam in Case of A and B

Fig. 19 shows the comparison of Axial forces in Case A and Case B. The pie chart clearly shows Axial stresses generated in case B is less as Compared to the stresses generated in Case A.

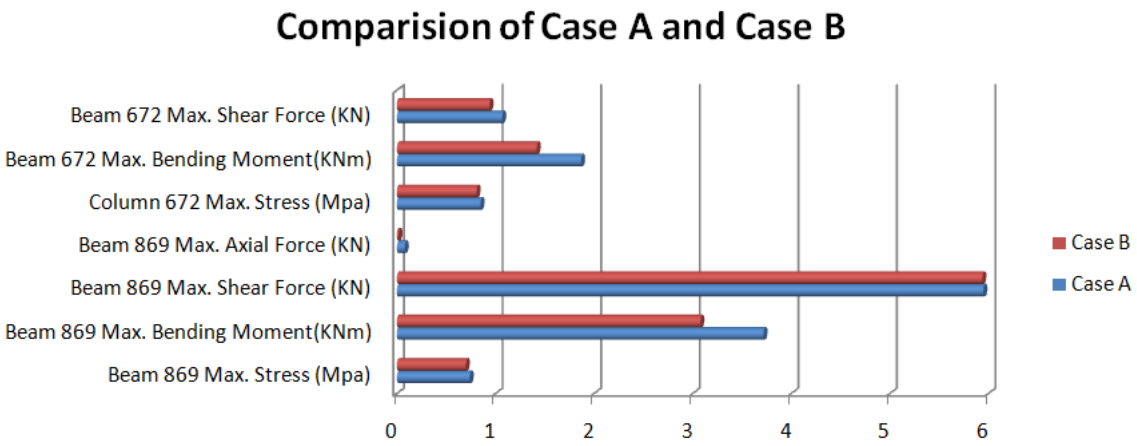


Fig. 20 Comparison chart for Case A and Case B.

The figure shown above in Fig. 20 shows the comparison chart for both the cases. It was seen that number of beams and columns required in Case B were less as compared to Case A. It was also seen that all the forces generated were also were less in Case B. The Red Color in the graph shows results for case B. While the Blue color in the graph shows results for Case A.

Conclusion

The 2D drawing was made in AutoCAD and then this 2D drawing was imported in STAAD.PRO and the analysis of the structure was done. Two cases were considered for analysis. In the first Case A Beams and columns of the building were uniform from bottom to top while in the second Case B the beams in the bottom floors was relatively larger and thicker as compared to the top floors. It was seen that stresses generated for Case A is much higher as compared to the stresses generated in Case B. The requirement of steel and concrete was also less as compared to the Case A. Hence, it was concluded that Case B is best as per the analysis in the Software.

Future Scope -

The Future scope of this analysis is as follows -

1.) Building can be optimized by changing the cross section of beams.

2.) Building can be optimized by changing the size of slabs

3.) The complete structure can be optimized in a very effective way by decreasing the unnecessary requirement of number of columns, beams and slabs.

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