IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 7, Issue 4, April 2020

Analysis and Design of G+5 Floor Residential Building under Seismic

Genius Raj[1], Dev Pratap Singh[2], Lucky Choudhary[3], Deepanshu Yadav[4]

B. Tech, Department of Civil Engineering, School of Civil Engineering, Galgotias University, Greater Noida, India[1-4]

Abstract: 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 software 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.

Keywords: AutoCAD, STAAD.Pro, Stress, Steel Take Off, Bending Moment.

I. INTRODUCTION

Building construction is the engineering deals with the construction of building such as residential houses. In a simple building can be define as an enclose space by walls with roof, food, cloth and the basic needs of human beings. In the early ancient times humans lived in caves, over trees or under trees, to protect themselves from wild animals, rain, sun, etc. as the times passed as humans being started living in huts made of timber branches. The shelters of those old have been developed nowadays into beautiful houses.

Homes come in a huge range of shapes and capabilities and were tailored for a huge variety of things in the course of history, starting from to be had building substances to climate conditions, land costs, floor situations, precise makes use of and aesthetic motives. A multi-store building is a shape with a couple of flooring within the tower above floor. Multi-storey homes aim to growth the construction’s ground region without raising the land vicinity on which the constructing is constructed, thereby saving land and, in maximum instances, money (depending at the fabric used and the area's land prices).

The multi-shop constructing design method calls for now not only imagination and conceptual wondering, but additionally sound understanding of structural engineering science similarly to knowledge of practical elements, inclusive of current design codes, bye laws, backed up by great revel in, instinct and judgment. The aim of the requirements is to ensure and enhance safety, at the same time as preserving a careful stability among economy and safety.

II. LITERATURE REVIEW

V.Varalakshmi et al. [1] -The safety of G+5 bolstered concrete constructing would depend upon the preliminary architectural and structural configuration of the overall structure, the reliability of the structural analysis, layout and reinforcement detailing of the constructing body to achieve the stability of the factors and their ductile efficiency. Additional constructing quality and balance of the filling partitions and partitions.

B.K. Vimala et al. [2] -India is constructed (Slabs, Beams, Columns and Footings) the use of car CAD era in the gift study G+4 constructing in Anantapur, gooty road. The hundreds are calculated the use of IS: 456-2000 and HYSD BARS FE415 as in line with IS: 1786-1985, specifically the dead masses relying at the unit weight of the materials used (concrete, brick) and the stay hundreds.

J. Sankar et al. [3] -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. [4] -The provision of continuous stretches in place of a single span produces a full-size reduction in dead load, stay load and moments of format. The availability of two spans rather than one span effects in a decrease of 80% to ninety% in moments. The availability of 3 spans as opposed to one span results in a lower of about 92% in moments.

K. Prabin Kumar and Gopibala Vinay [5] -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 [6] -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 [7] -The G+6 residential constructing website online selected need to be in areas in which all amnesty paperwork are open. Sp16 is used for beam layout, plate, floor, footing measurements, respectively, in the design IS 456-two hundred. Limit kingdom design is the nice approach to constructing design. There are specific varieties of slabs, beams and columns but best one type of slab, beam and column are constructed in the layout.

MsAayillia and K. Jayasidhan [8] -The evaluation changed into executed the use of the STAAD seasoned V8i software package, which proved to be top class software program with amazing capacity inside the production enterprise's evaluation and design sections. The use of AutoCAD 2013, all structural components had been designed manually and in element. The research and development changed into accomplished to the extent feasible in compliance with wellknown requirements.

III.METHODOLOGY

3.1 METHODOLOGY

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

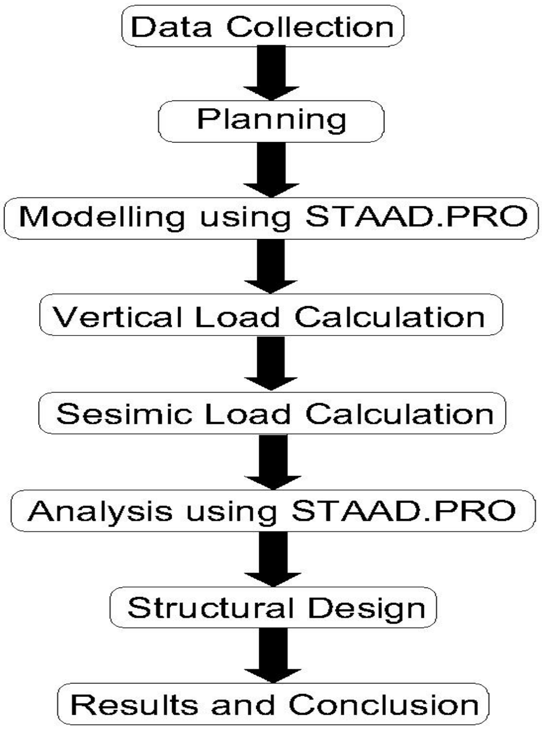


Fig.3.1-Flow Chart

3.2 Data Collection -

Authentic data was collected such as dimensions of room thickness of wall size of columns from website of Construction Company. 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

3.3 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.

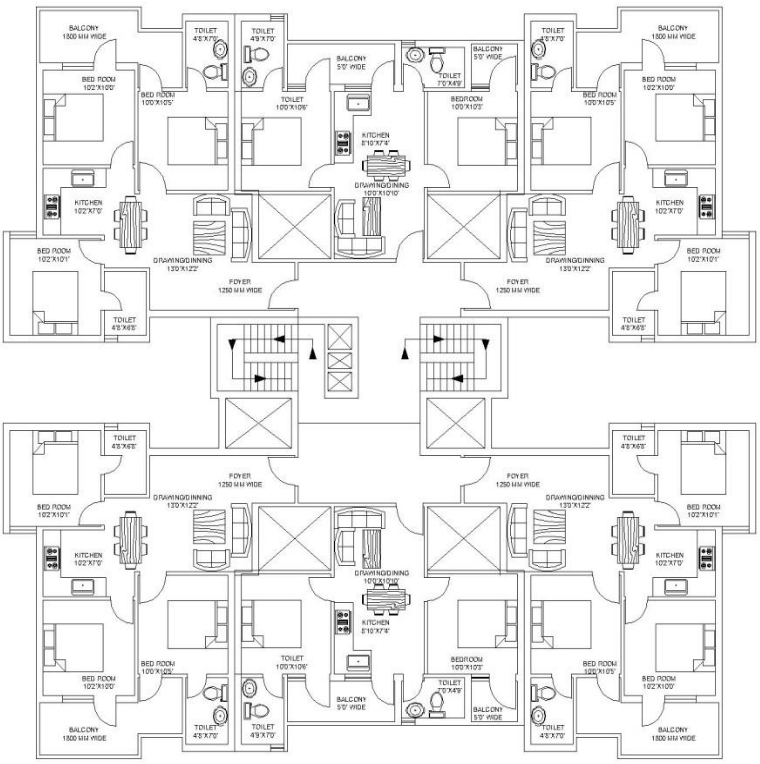


Fig.3.2-Floor Plan

IARJSET

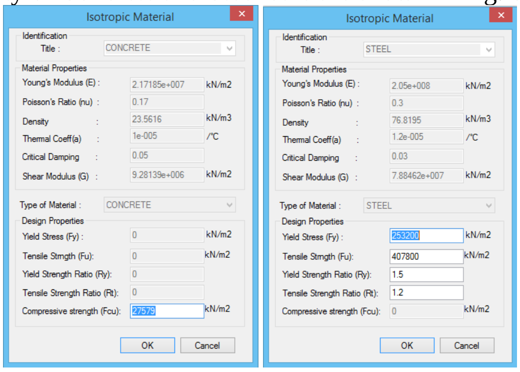
ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 7, Issue 4, April 2020

3.4 Modeling using STAAD.PRO -

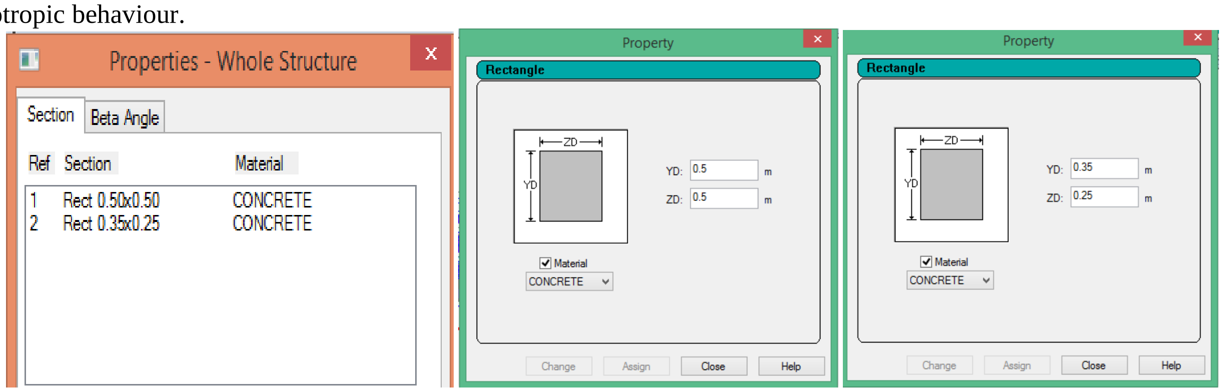
In this analysis used material property of Concrete and Steel bars are shown in Fig. 3.3



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

Fig. 3.3 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. 3.3 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 behaviour.



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

Fig. 3.4 Column and Beam Cross Section a.) Cross Section of Column and Beam b.) Column Cross Section profile c.) Beam Cross Section profile

The Fig.3.5 shows the Cross section profile of Beams and Columns. Fig.3.4 (a)Shows the Cross section of both Columns and beams While, Fig.3.4 (b)shows Individual cross section profiles of Columns and Fig.3.5 (c)shows Individual Cross section profiles of Beams.

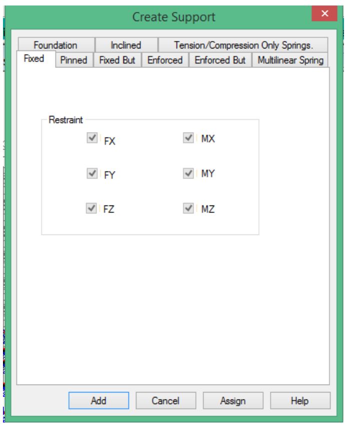


Fig. 3.5 Fix Support

Applied 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. 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. 3.6 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+5 building plan.

3.5 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.

3.6 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.

3.7 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, and 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.

IV. RESULTS AND DISCUSSIONS

4.1 RESULTS AND DISCUSSIONS

CASE A

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

4.2 Beam 889 Reinforcement

Fig. 4.1 shows us the Reinforcement of the Beam.

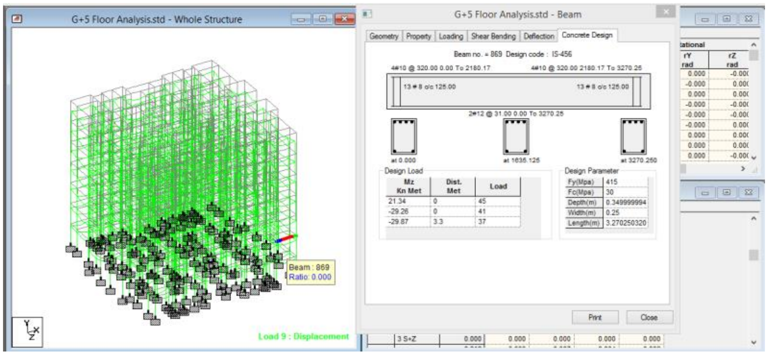


Fig. 4.1 Beam 869 Reinforcement

4.3 Beam bending moment, shear force and axial force diagram

The Fig. 4.2 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.

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 7, Issue 4, April 2020

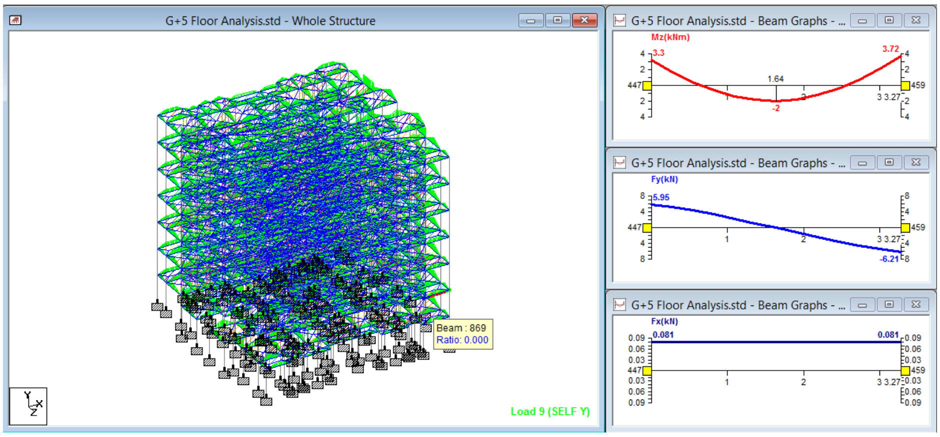


Fig. 4.2Beam bending moment shear force and axial force diagram

4.4 Beam stress diagram

The Fig. 4.3 shows us the stresses generated in the beam of the structure

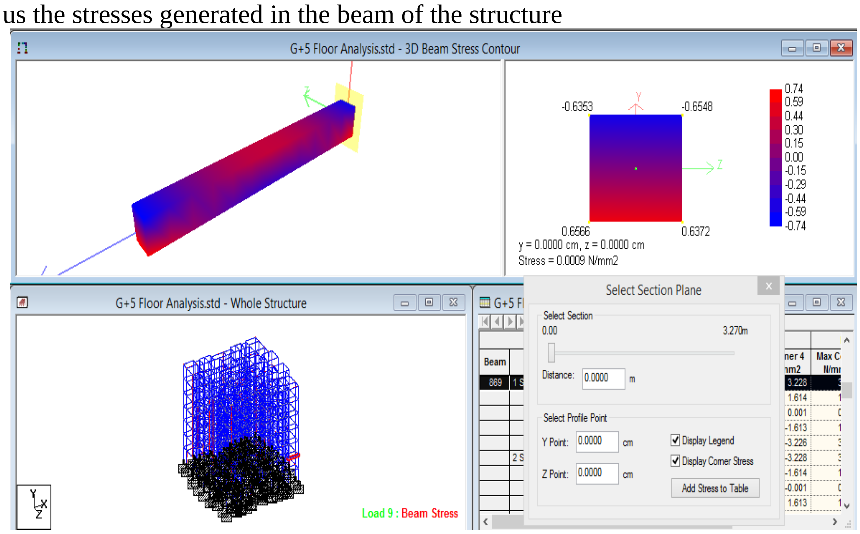


Fig. 4.3Beam stress diagram

4.5 Column 672 Reinforcement

Fig. 4.4 shows us the Reinforcement of the Beam.

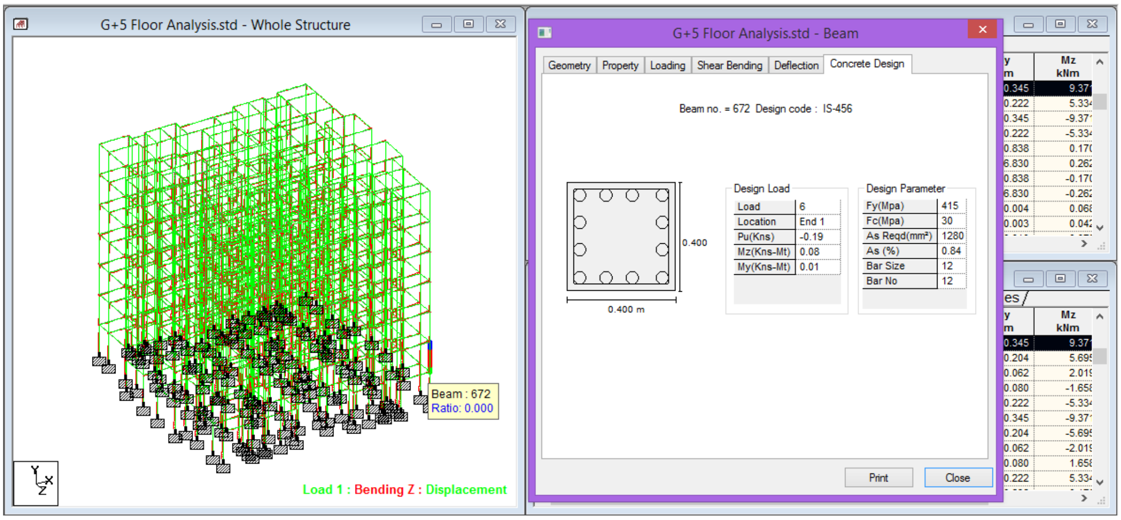


Fig. 4.4 Column 672 Reinforcement

IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 7, Issue 4, April 2020

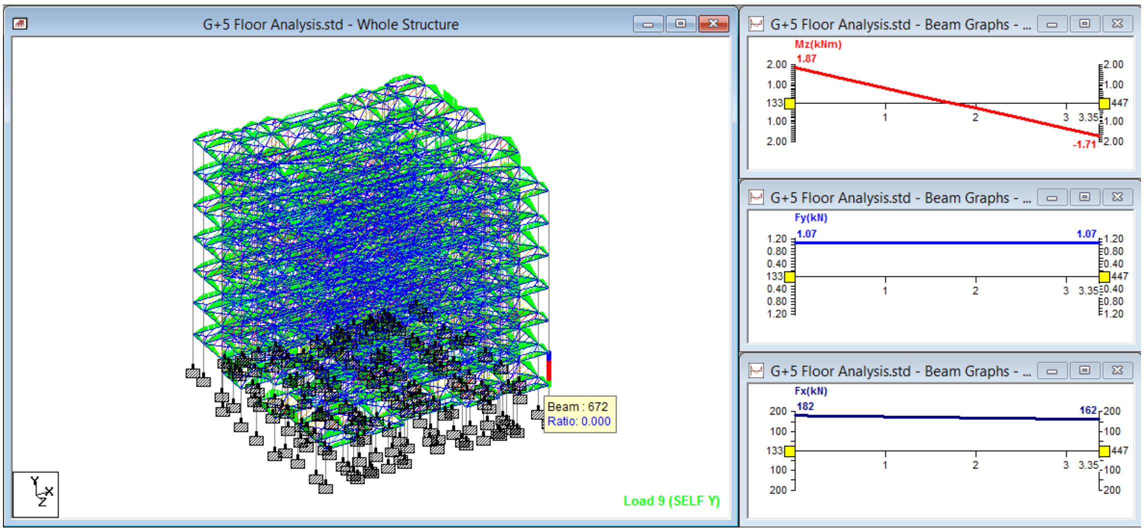


Fig. 4.5 Beam bending moment shear force and axial force diagram of Column No. 672

The Fig. 4.5 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.

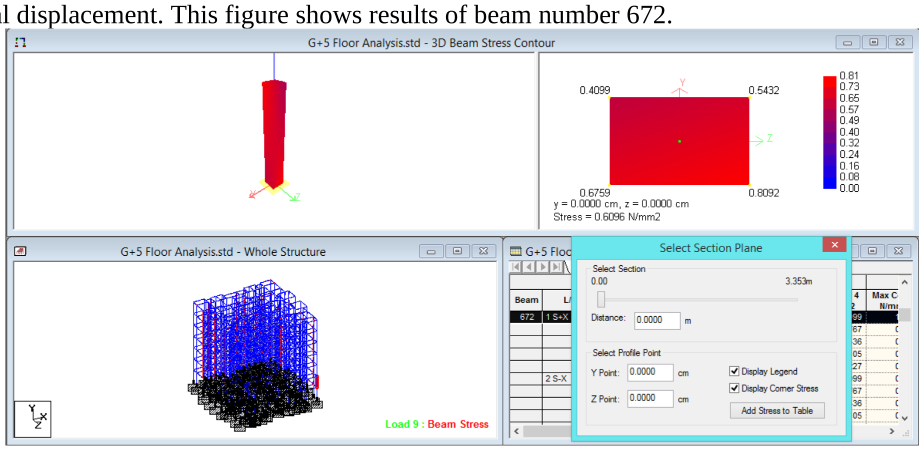


Fig. 4.6 Beam bending moment shear force and axial force diagram of Column No. 672

The Fig. 4.6 shows us the stresses generated in column 672. Red color shows the maximum stress generated while Blue color shows minimum stress.

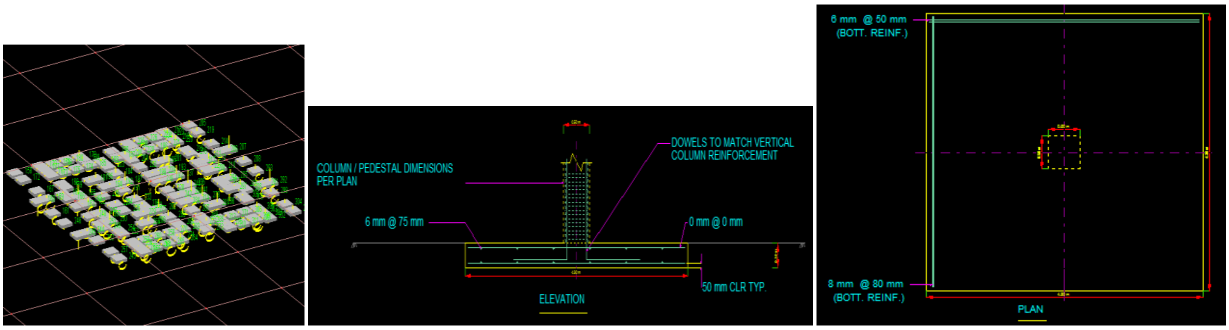
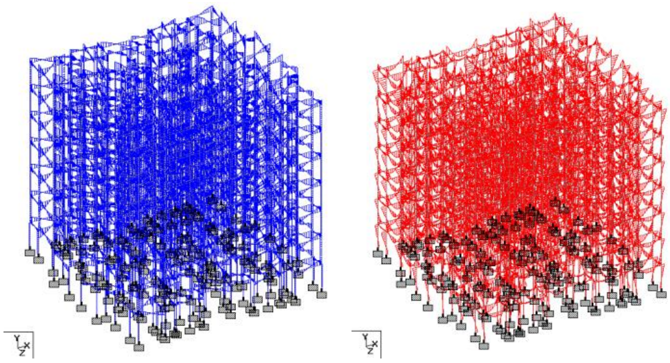


Fig. 4.7 Beam bending moment shear force and axial force diagram of Column No. 67
a.) Foundation Block of Building b.) Footing Dimensionsc.) Foundation Block Dimensions.

The Fig. 4.7(a) Shows foundation block of building, Fig. 4.7(b) Shows footing dimensions also shows the required concrete and steel for foundation, Fig. 4.7(c) shows Foundation block dimensions.

Fig. 4.8(a) shows the Shear Force generated in the whole building while Fig. 4.8(b) shows the bending moment generated in the whole building.

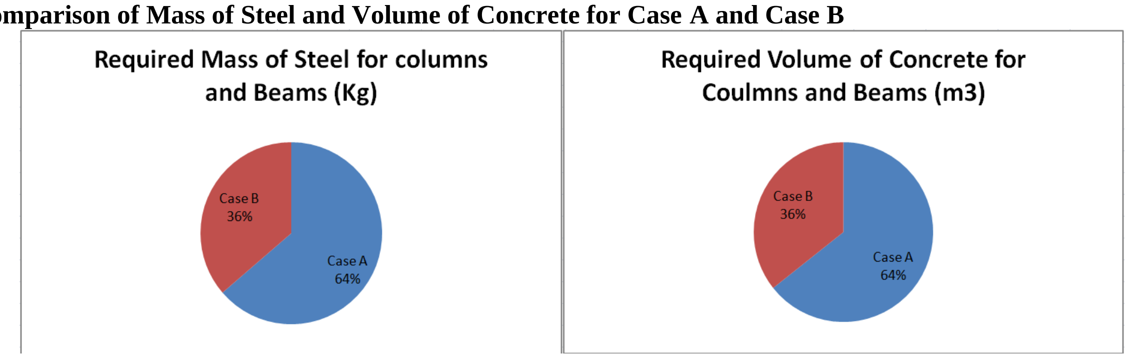


a.) Shear force generated b.) Bending moment generated

Fig. 4.8 Beam bending moment shear force and axial force diagram of Column No. 672

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.

4.6 Comparison of Mass of Steel and Volume of Concrete for Case A and Case B



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

Fig. 4.9Required Maas of steel and Volume of concrete in Case of A and B a.) Required mass of steel for columns and beam b.) Required volume of concrete for

Fig. 4.9(a) shows the requirement of steel for columns and beams while the Fig. 4.9(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.

4.7 Comparison of Axial Force for Columns and Beam in Case of A and B

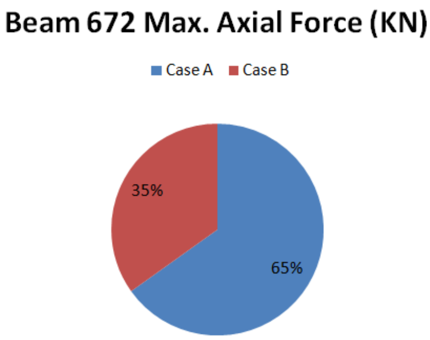


Fig. 4.10 Beam axial force for columns and beam in Case of A and B

Fig. 4.10 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.

The figure shown above in Fig. 4.11shows 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.

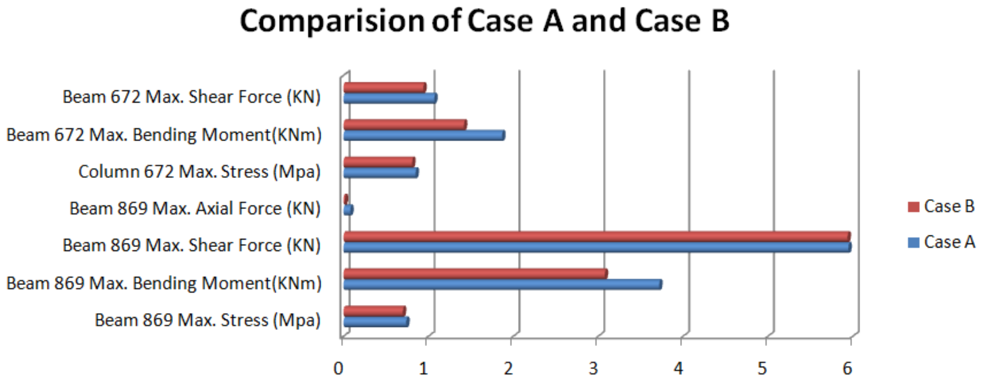


Fig. 4.11Comparison chart for Case A and Case B.

V. CONCLUSION

5.1 Conclusion

The 2D drawing was made in AutoCAD and then this 2D drawing was imported in STAAD.PRO and the analysis of thestructure 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.

5.2 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.

REFERENCES

1]. V.Varalakshmi et al.-Analysis and Design of G+5 Residential Building, IOSR Journal of Mechanical and Civil Engineering,INDIA, 2014, Vol. No 4.Issue 5, PP74-77.
2]. B.K. Vimala et al.-Analysis and Design of Multistoried Residential and Commercial Building with Base Isolation Techniques, International Journal of Innovative Research in Science, Engineering and Technology, INDIA, 2015, Vol No.4 Issue No. 5, PP 67-71.
3]. J. Sankar et al. Design of G+4 Hospital Building For Earthquake Resistant, International Journal of Engineering Science and Research Technology, INDIA, 2016, Vol No 5, Issue No 12, PP 546-552.
4]. Singh Shailendra et al. A Comparative study of simply supported and continuous R.C.C Slab Bridges, International Journal of Engineering Research and General Science, INDIA, 2015, Vol No 3, Issue No 3, PP 1510-1520.
5]. K. Prabin Kumar and Gopibala Vinay Design and analysis of G+8 Commercial building using STAAD PRO,International Journal of Pure and Applied Mathematics, INDIA, 2018, Vol. No 119, Issue No 17, PP - 2981-2987.
6]. R. Sanjaynath and K Prabin Kumar Piping Analysis and design of (G+20) Multistorey Residential Building using STAAD.PRO, InternationalJournal of Pure and Applied Mathematics, INDIA,2018, Vol No. 119, Issue No 17, PP-139-145.
7]. A. Jhansi RaniAnalysis and Housing Design (G+4) Using E-Tabs, International Journal and Magzine of Engineering and Technology, INDIA, 2015, Vol No.2, Issue No.12, PP - 1471-1477.
8]. MsAayillia and K. JayasidhanAnalysis and Design of a Industrial Building, International Journal of Engineering Research & Technology (IJERT), INDIA, 2015, Vol No. 4, Issue No 3, PP 444 -467.
9]. C.V.S Lavanya et al.Analysis and design of G+4 residential building using ETabs,International Journal of Civil Engineering and Technology (IJCIET), INDIA, 2017, Vol No 8, Issue No. 4, PP 1845-1850.
10]. Rinkesh R. Bhandarkar et al.Seismic Analysis & Design of Multistory Building Using Etabs,International Journal of Engineering Development and Research, INDIA, 2017, Vol No 5, Issue No 2, PP78-90.
11]. Syed FaheemuddinAnalysis of Multi-Storeyed Building, International Journal for Innovative Research in Science & Technology, |INDIA, 2016, Vol No 3, Issue No 6, PP 215- 223.
12].Nasreen M. Khan Analysis And Design Of Apartment Building,International Journal of Innovative Science, Engineering & Technology, INDIA, 2016, Vol No 3, Issue No 3, PP 526-555.
13]. Sakshi A. Manchalawar et al Comparative Study of Analysis and Design of RC Frame, International Journal of Science, Engineering and Technology Research (IJSETR), INDIA,2016, Vol No.5 , Issue No 4, PP 1084-1089.
14].M Siva Naga KanyaDesign and Analysis of RCC Framed Structure(G+5) by using STAAD.Pro, International Research Journal of Engineering and Technology (IRJET), INDIA, 2019, Vol No.6, Issue No. 3, PP-2829-2834.
15]. S. SudheerAnalysis and design of G+5 Residential building using STAAD.PRO, Global Journal for Research Analysis, INDIA, 2017, Vol No. 6, Issue No. 5, PP- 490-491.