Analysis and Design of a Multi-Storey Building

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Abstract - A multi-storey is a building which actually has floors above the ground. It can be a residential or commercial building. In this project the analysis and design of multi-storey building G+5 is done using the software like AutoCAD and STAAD.Pro. In general, the analysis of multi-storey is little lengthy and complex because these are statically indeterminate in nature. Forces due to Shears and moments, due to different loading conditions are determined by many methods such as portal method, moment distribution method and matrix method but in this multistorey building project, majorly two software is used which is mentioned above. The project deals with the analysis of a G+5 building. The dead load & live loads are applied and the design for beams, columns, the footing is obtained using the software Staadpro. The Analysis part of the structure is done using using the software and the obtained values are taken for design. The limit state of method was adopted while working with project.

Key words: STAAD.Pro, Multi-storey building, AutoCAD, G+5, Limit state method.

I. INTRODUCTION

Due to the high increase in population growth, there is decrement of land resources, people have migrated from rural to urban areas and are currently building large-scale houses in small areas. This is the reason why the purposeful design of a building is very essential and requirements of the people vary from building to building. In this project, we have done the Analysis and design of multi-story structures by using STAAD Pro software. Code for the design of reinforced element by using IS456:2000, and loads are calculated according to dead loads, imposed loads, and wind loads IS 875: 2000 (Part-1,2 and 3). Steel requirement is calculated as per IS 800:2007 for the design of the building. Planning and design processes require not only imagination and conceptual thinking but also a deep knowledge of civil engineering sciences and practical aspects supported by new design code, by-laws, integrated design, insights and decisions. The standards are intended to ensure and improve safety and to ensure a balance between economy and safety. The design process begins with a design project, mainly meeting its functional requirements. The structural style creates a structure that is safe, functional and durable, technical, economical and simple. To be able to carry out a precise analysis, the structural loads, the support conditions and the intensive properties must be determined.

II. BASIC CODES FOR DESIGN

The design should be carried so as to conform to the following Indian code for reinforced concrete design, published by the Bureau of Indian Standards, New Delhi:

Purpose of Codes

National building codes have been formulated in different countries to lay down guidelines for the design and construction of the structure. The codes have evolved from the collective wisdom of expert structural engineers, gained over the years. These codes are periodically revised to bring them in line with current research, and often, current trends. Firstly, they ensure adequate structural safety, by specifying a certain essential minimum requirement for design. Secondly, they render the task of the designer relatively simple; often, the result of sophisticate analyses is made available in the form of a simple formula or chart. Thirdly, the codes ensure a measure of consistency among different designers. Finally, they have some legal validity in that they protect the structural designer from any liability due to structural failures that are caused by inadequate supervision and/or faulty material and construction.

(i)IS456: 2000– Plain and Reinforced Concrete– Code of Practice (Fourth Revision)

(ii)Loading Standards

These loads to be considered for structural design are specified in the following loading standards:

IS 875 (Part 1-5): 1987 – Code of practice for design loads (other than earthquake) for buildings and structures (second revision)

Part 1: Dead loads

Part 2: Imposed (live) loads

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Part 3: Wind loads/Earthquake load

Part 5: Special loads and load combinations

BRIEF DESCRIPTION OF SOFTWARE USED

- Auto CAD
- STAAD.Pro

Auto CAD is one of the most widely software used for designing and drafting work. It is used to develop 2-dimensional and 3-dimensional structures. It was developed and sold by Autodesk. This software is a vector graphics drawing programme. It uses ancient entities- comparable to lines, polylines, circles, arcs and text as the foundation for the complex. Auto CAD's native file format, DWG, and to a lesser extent, its interchange file format, DXF has become the drawing and detailing works were done by creating use of Auto CAD 2014.

STAAD.PRO is a very familiar software which is used for analysis and design of structures by the engineers so called structural engineers. This software gives a lot of precise and correct results as compared to analysis and design. It's the foremost computer code for 3D model generation and multimaterial design. The software is fully compatible with all windows operating system but is optimized for windows XP. This software can be used for static or dynamic analysis of the structures such as bridges, low rise or high-rise buildings, stadiums, steel structures and so on. First of all, the step taken in STAAD.Pro is to specify the geometry of the structure and then after the properties of the members are mentioned. After that supports are generated and loadings are specified on the structure and hence, the structure is analysed.

III. METHODOLOGY

PROCEDURE CAN BE BROADELY CATEGORIZED INTO 4 PARTS:

Part A: modelling of the building

Modelling of the building is done using the software AUTOCAD. A plan of the building is 2D is shown via AutoCAD software. This plan of the multistorey building is prepared with proper dimension and the measurement for the proper and exact analysis and designing of the of the multistorey building. In the figure1, the model of the building i.e., the frame structure of the building is shown. In this model, it consists of G+5 storey building. The total number of joints in the framed structure is found to be 536 with 936 members. The modelling work is done in the StaadPro software. The size of the beam is taken as 300x300mm. The size of the column is taken as 500x300mm. In the figure 2, the plates are applied to the structure.The plate thickness is taken as 150mm. In figure 3, the support provided to the structure is shown. The type of support provided is fixed support.

Figure 1

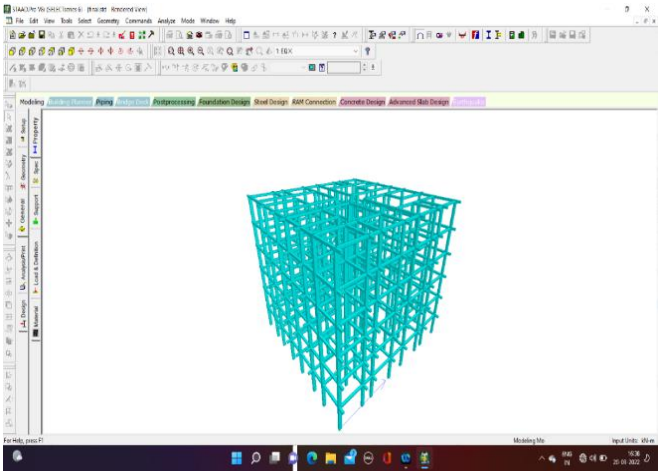


Figure 2

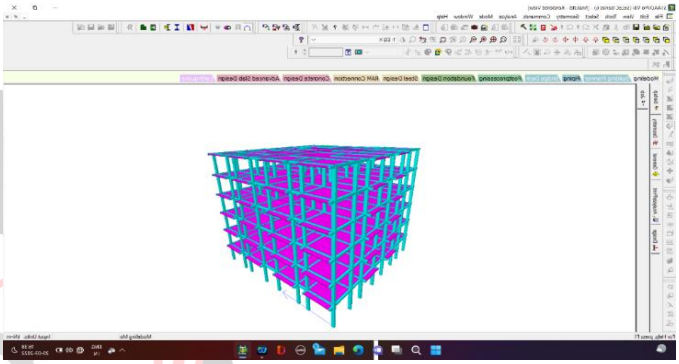
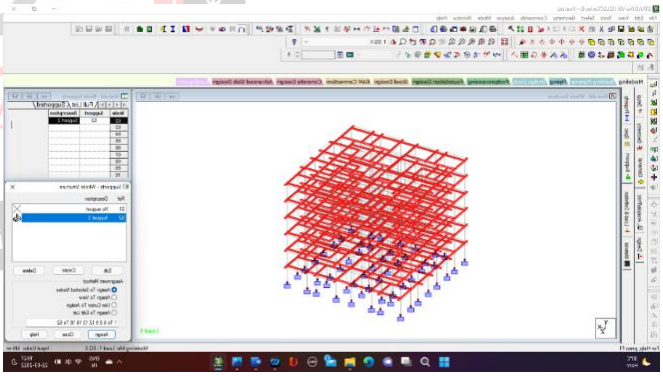


Figure 3



Part B: Load and load combination

Various types of loads including dead loads, live loads, wind loads and earth quake loads are being taken into the consideration while designing of the structure. The loads were applied to structures in different coordinate system. The loads were applied to the structure as per the IS 456:2000. Various types of loads applied to the structure are shown below. In figure 4, The member weight of the structure which is applied to the structure is 2.25KN/m. In figure 5, the seismic load is applied to the structure in the X direction as per IS1893:2002. In figure 6, the seismic load is applied to the structure in the Z direction as per IS1893: 2002.In the figure 7, the red colour shows the dead load is applied to the structure as per IS456: 2000.The figure 8 shows the live load

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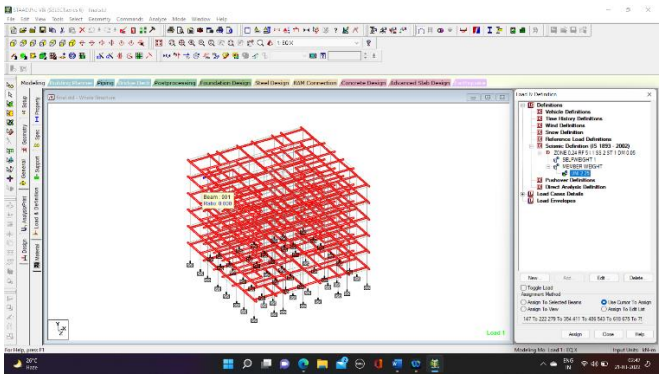
applied to the structure as per IS456:2000 at the rate of 3KN/m2. The last figure shows in blue colour i.e., figure9, shows the position of floor load applied to the the structure.

Figure 4



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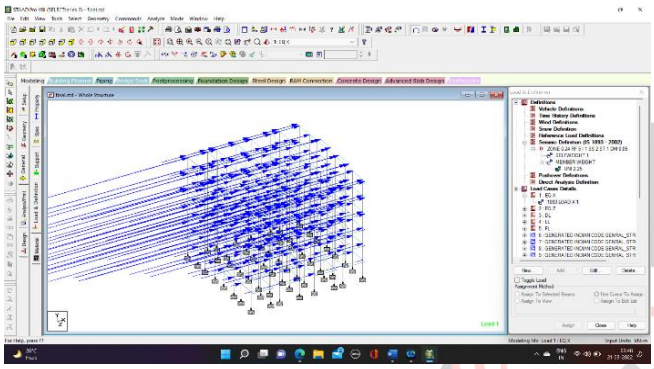

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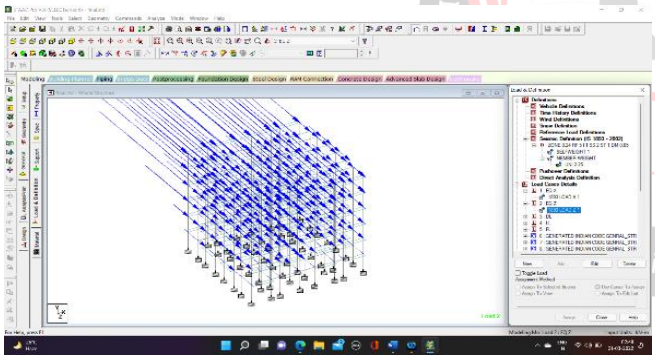


Figure 7

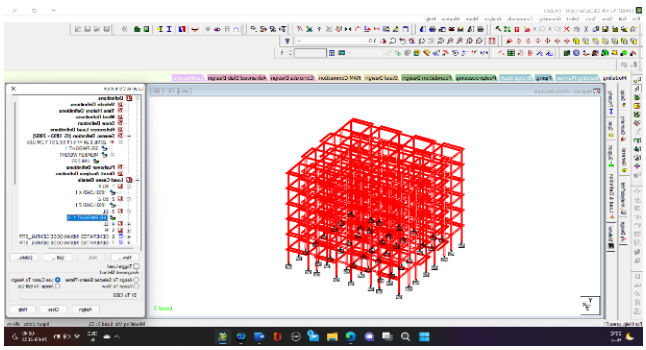


Figure 8

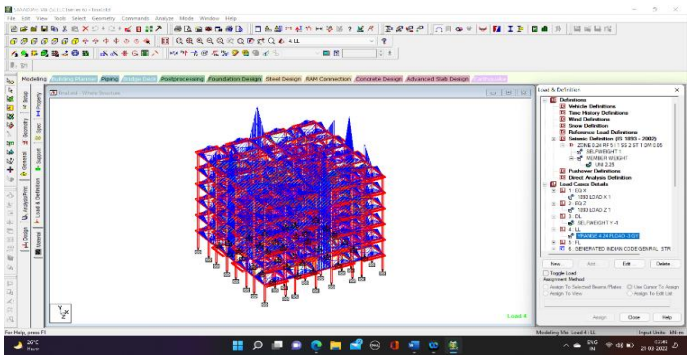
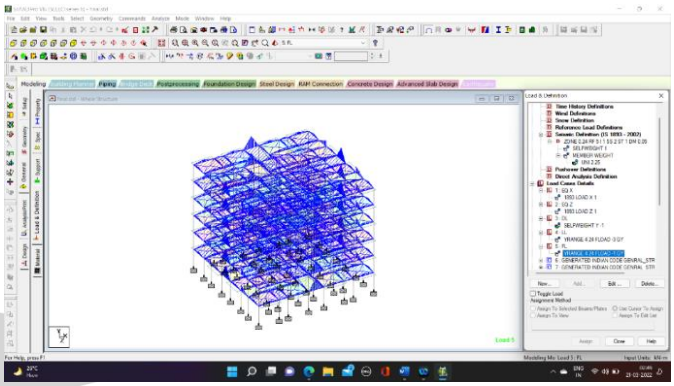


Figure 9



Part C: Analysis

The analysis of the building was done using the Staad pro software. The analysis helps us to know the maximum shear force, bending moment, reaction forces, and other types of loads on the structures keeping in mind the safety and economy of the structures. In the figure 10, the displacement of the structure is shown in green colour and its corresponding values are given in the table in figure 1 itself. In figure 11, the values of maximum axial forces, maximum shear forces are and maximum bending moments are given in the corresponding table. In figure 12 and 13, just a single member of the structure is selected randomly to analyse its behaviour.

Figure 10

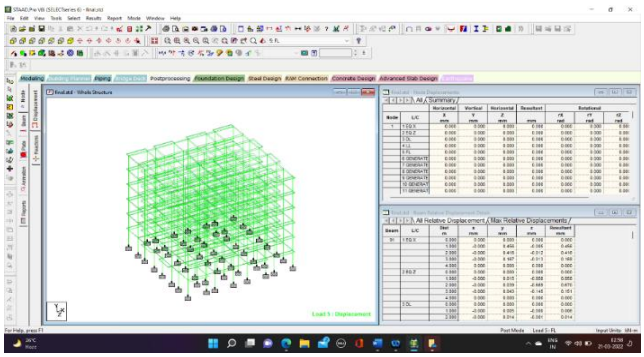


Figure 11

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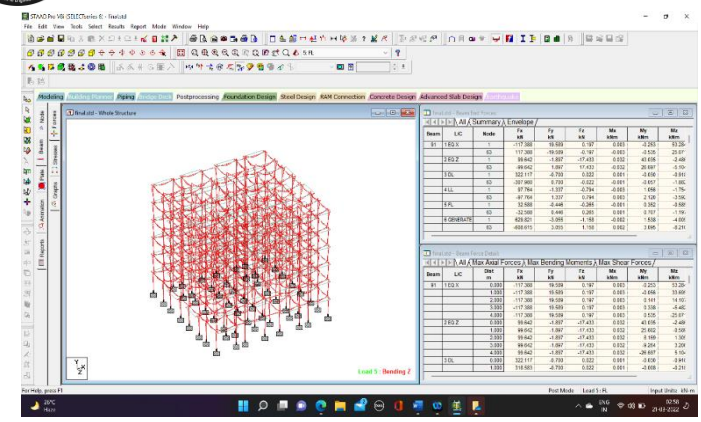


Figure 12

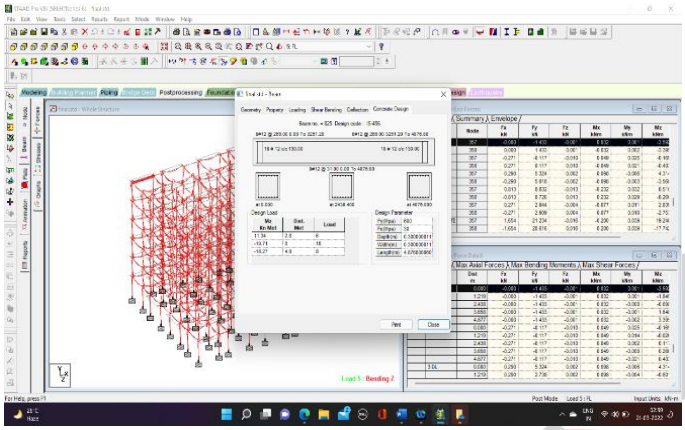


Figure 13

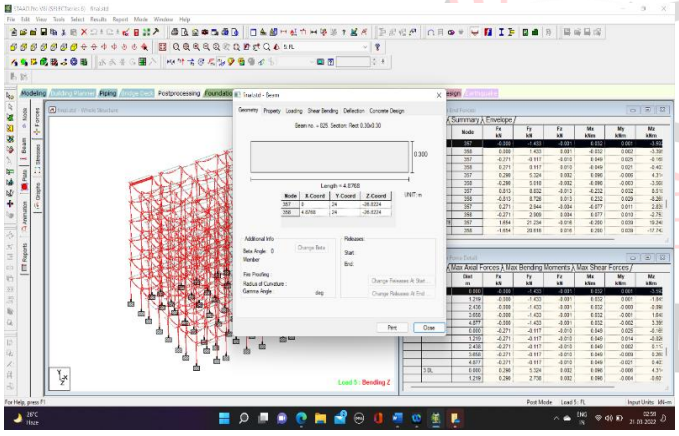
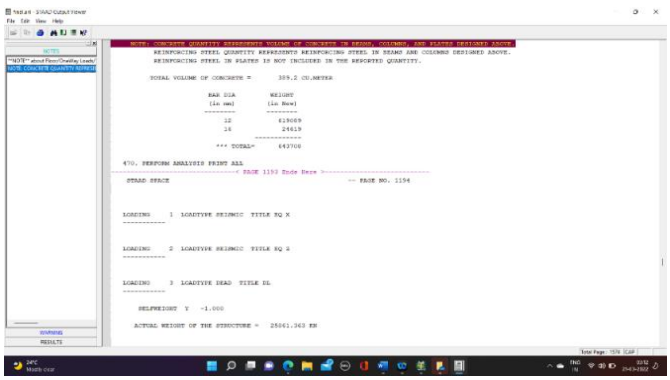


Figure 14

Part D: Design and Detailing

The designing and detailing of the building were done via Staad pro software based on IS456:2000. The designing of the building was done to calculate the maximum area of steel reinforcement and concrete which is required the completion of the project. Fe600 is used in the designing of the structure. In this structure 12mm diameter bar is used as secondary bars whose weight is 619089KN and 16 mm bars are used as main bars whose weight calculated is 24619KN. M30 grade of concrete is used while designing of the structure. The figure 14 shows the actual result obtained after the designing of the structure.



IV. RESULTS AND DISCUSSION

Actual weight of the structure= 25861.369 KN

The number of joints = 536

The number of members =936

The number of supports = 56

Total volume of concrete = 389.2cum

Total area of steel reinforcement = 643708 KN

After the completion of the work, the values of maximum bending moment found when the earthquake load was applied to the in the x direction was found to be 53.284KNm whereas when the same earthquake load was applied in the z direction, the value of bending moment was found to be 2.486KNm. The maximum value of shear force recorded was 117.388KN when earthquake load was applied in the x direction but when the earthquake load was applied in the z direction , its value was found to be 99.642KN.

V. CONCLUSION

The analysis and design of a Multi-Story Building was performed as a part of our project. The effort helped us to gain not only the beautiful exposure to various field practices in the analysis and design of multi-Story building but also in various construction techniques used in current industry. The analysis was done in staad pro software and the bending moment and shear force diagrams are obtained after the analysis that can be used to take the most efficient and economical building design for the loads acting. The work became very simple through the use of the software like AutoCAD and Staad pro which would have been a little tedious work when you go for the manual analysis and designing.

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