International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 11 Issue: 12 | Dec 2024 www.irjet.net p-ISSN: 2395-0072

ANALYSIS AND DESIGN OF A MULTISTOREY RESIDENTIAL BUILDING USING STAAD PRO

Pandilla Varshini[1], Yerra Naveen[2], Bhukya Siddu[3], Gude Rama Krishna[4]

[1,2,3]UG Scholar, Dept. of Civil Engineering, Institute of Aeronautical Engineering, India
[4]Assistant Professor, Dept. of Civil Engineering, Institute of Aeronautical Engineering, India

---

Abstract - *A structural engineer must save time in order to keep in pace with the ever-increasing competitive market. Hence, an attempt has been made by the author to work with the design and analysis of a multi-storied building using the software package STAAD Pro. When considering a multi-storey building, one should be able to consider all possible loading conditions and then make sure that the structure is made safe for all such loading conditions. For the analysis of different frames, various methods exist such as Kani's method. The current project is a study of a multi-storied residential building of G+7 heights. The building is subjected to dead loads, live loads, and earthquake loads and designed for beams, columns, and slabs. Generally, concepts and procedures are shown for the design of the main elements of a multistoried building. This software STAAD Pro also provides the elaborate value of shear force, bending moment, and torsion of each structural element in IS code limits. This STAAD software is a very powerful and time-saving design accuracy tool .*

Key Words: STAAD Pro, beams, columns, slabs, accurate, analysis, design, earthquake loads.

1.INTRODUCTION

Today, under those circumstances, the inevitable construction of multi-storey buildings raises the question of whether or not they should be considered as modern conveniences. It is, additionally, the High-Rise Construction Development Rent-a-long that has made people make up their minds towards building high-rise buildings. Without doubt, moving it upwards makes it difficult for security and comfort to take direct observations from beauty. Building today, therefore, seems to have stepped to a much higher plane, as it has entailed further research to capture the clients' needs. The building in itself has psychologically been declared an heir apparent of future generations. Damage to the building under consideration is more likely to arise due to environmental changes than to the general changes in human life. The design for multi-story buildings is primarily concerned with preventing financial losses, providing serviceability and safety against the earthquakes. Components designed using the Limit State Method have rather low reserve energy in them as they have been designed for the maximum moment and serviceability conditions they will ever experience. Tall buildings suffer much more due to earthquakes in comparison to smaller structures, and asymmetric constructions are provided by a larger number of chances of suffering severe damage than a symmetric structure. These horizontal forces cause considerable lateral displacements in high-rise structures, which are unfavorable for both stability of the structure and inhabitants.

Buildings with mounted stories are usually constructed in a limited space. It is hence assumed that there were greater migrations from rural-to-urban areas to realize these increased settlements, which were also complemented by their densities on land and shifting populations. Today, essential functional designs become possible buildings because each type has various functional needs. Civil engineers develop an idea of the building's operation by engaging their audience with the basic concepts of RCC design. This project is about the investigation and design of a multi-story building using STAAD Pro. The structure parts are manually designed as well as through software using limit state techniques. Specific Beams, Columns, and Slabs were manually designed in line with IS 456:2000, while IS 875:1987 (Part III) also covered deadloads, imposed loads, and external loads. Finally, the results were validated using software STAAD Pro.

1.1 Objectives

- Develop skills in the use of STAAD Pro for developing accurate and functional structural models of multi-storey residential buildings.
- Acquire STAAD Pro to learn all the load types, load combinations and to ensure that your building design can withstand all loads.
- Learn to achieve a balance between safety, utility and cost whenever you design structural components such as beams, columns and slabs using STAAD Pro.
- Ensure that the structural design conforms to the applicable national and international standards and codes of practice.

1.2 Scope of Study

Using STAAD Pro, engineers can effectively analyze complex multistoried building structures. With the use of

STAAD Pro, engineers will be able to execute the design optimization of different structural components like beams, columns, and foundations. The application has different international and national design codes, enabling engineers to ensure that the building designs are compliant with the applicable standards and regulations. It provides an extremely sophisticated system for visualizations applied in modelling, view, and analysis of structural behaviour. This takes care of many processes related to analysis and design, thus reducing manual calculations and speeding up the design time.

2. METHODOLOGY

In order for a structural engineer to make an accurate analysis, these elements must include structural loads, configuration, support conditions, and material characteristics. Typically, analysis results supplied evidence for displacements, tensions, and responses; failure possible to be identified by comparing these assessments against predetermined criteria. Advanced structural analysis can then assess overall stability for non-linear responses and dynamic behavior.

2.1 Loads considered

Various loads are used in STAAD Pro such as dead load, live load, wind load, seismic loads, etc. for a complete analysis to ensure the integrity and safety of the multistorey building.

Dead load

All parts of the constructed building that are intended to be fixed and cannot be moved are called dead loads-the walls, floors, false ceilings, partitions, and all the other fixed parts of the structure. These loads can be calculated using unit weight and dimensions of different structural elements. For the purpose of dead load calculations, normally, guidelines state that the unit weight of plain concrete is 24 kN/m2, compared to about 25 kN/m2 for reinforced concrete using crushed stone aggregate or sand and gravel.

Imposed load

Applicable design conditions are imposed loads arising from the weight or movement of modular partitions, distributed and concentrated loads associated with short-term effects or impacts and vibrations due to equipment, as well as any loads due to the dust. However, they do not include temperature stresses, wind loads, seismic effects, snow loads, creep, shrinkage, or differential settlements within the structure.

Wind load

Winds refer to movements of air about the earth's surface. The primary causes of these movements are the Earth's rotation and terrestrial radiation changes causing convection currents propulsion either upward or downward. Winds are fast in a horizontal direction across the earth. "Referring to horizontal air flow, wind" distinguishes from small vertical air movements described otherwise. Anemometers or anemographs detect wind speeds. They are used at meteorological stations either 10-30m from the ground level.

Seismic load

The seismic loads are determined by looking at the reaction of the superstructure to ground acceleration. Depending on their severity, earthquake intensity levels were classified into four categories.

1. Zone I and II are combined as zone II.
2. Zone III.
3. Zone IV.
4. Zone V.

2.2 Analysis Of G+7 Residential Building Using STAAD Pro

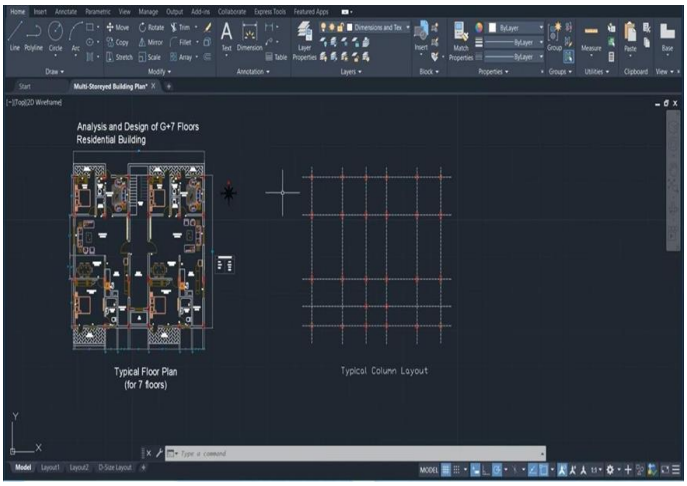

Fig -1: Plan of the G+7 Residential Building

Beam Design

1. Singly Reinforced Beam: Steel bars are installed towards the bottom of single reinforcement simply supported beams where it is most effective in resisting tensile bending loads.
2. Doubly reinforced beams: The tension and compression zones are both strengthened on these beams. Two conditions arise regarding the need for such a configuration in the compression zone:

   (i) when there is restriction in available depth of beam

   (ii) when singly reinforced cannot fulfill the strength requirements.

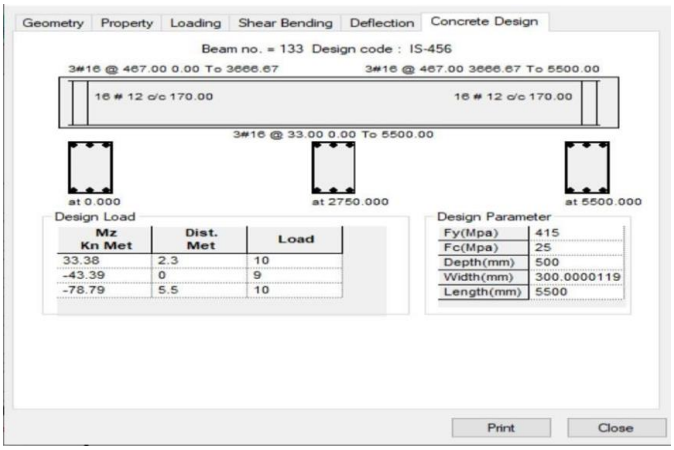

Fig-2: Beam design

Column Design

A column is any such element, the height of which is at least three times the lateral dimension, and whose primary use is for the support of axial compressive stress. The strength of a column depends on several factors, including its material characteristics, length, form, size of the cross-sectional area, and the kind and degree of support or restrictions at the ends.

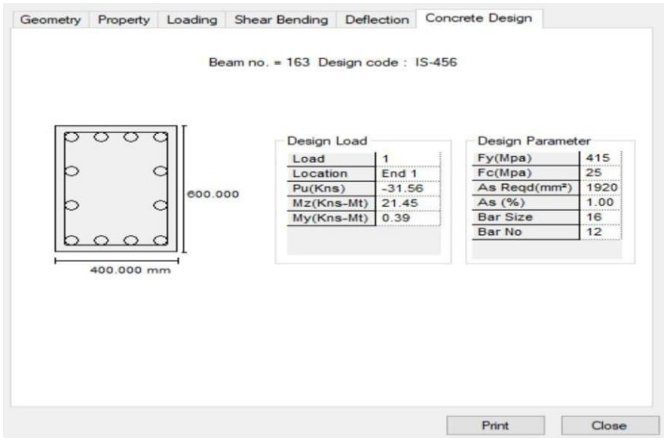

Fig-3: Column design

3. RESULTS AND DISCUSSIONS

STAAD Pro is a software that proved its worth in the analysis and design of a multistorey residential building. With its accurate calculation of loads and effective optimization in design, the program ensures safety and cost-effectiveness in its results. It demonstrated the capacity to carry complex loads while providing detailed insights into beam, column, and slab behavior under different conditions.

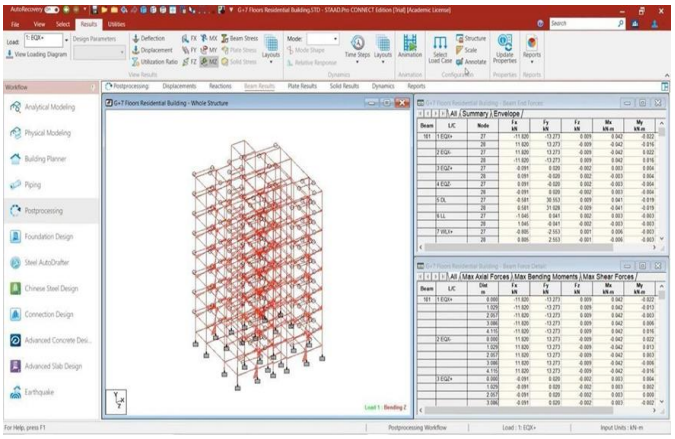

Fig-4: Post-processing mode in STAAD Pro

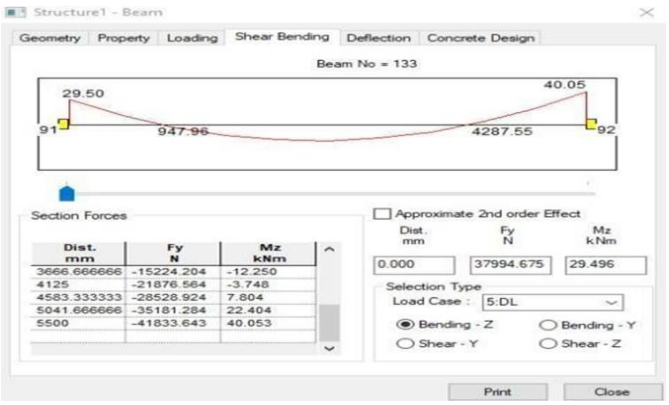

Fig-5: Shear bending of beam no.133

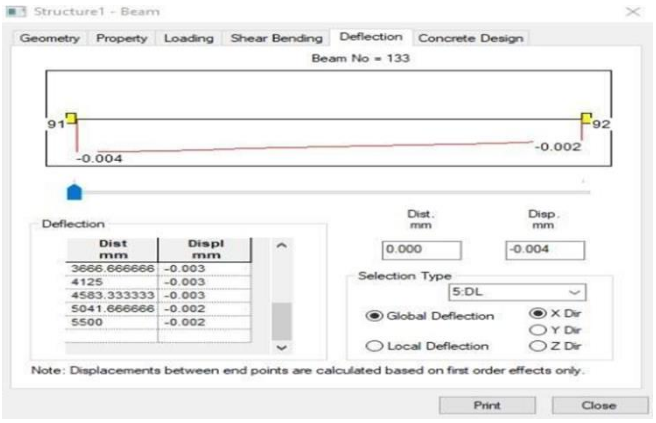

Fig-6: Deflection of beam no.133

```
C O L U M N   N O.   132   D E S I G N   R E S U L T S

     M25                  Fe415 (Main)              Fe415 (Sec.)

LENGTH:  3000.0 mm   CROSS SECTION:  230.0 mm X  300.0 mm  COVER: 40.0 mm

** GUIDING LOAD CASE:    3  SHORT(Z)        /BRACED LONG(Y)


REQD. STEEL AREA   :      637.24 Sq.mm.
REQD. CONCRETE AREA:    68362.77 Sq.mm.
MAIN REINFORCEMENT : Provide   4 - 16 dia. (1.17%,    804.25 Sq.mm.)
                     (Equally distributed)
TIE REINFORCEMENT  : Provide  8 mm dia. rectangular ties @ 230 mm c/c

SECTION CAPACITY BASED ON REINFORCEMENT REQUIRED (KNS-MET)
----------------------------------------------------------
Puz :    967.42   Muz1 :     43.42   Muy1 :     31.14

INTERACTION RATIO: 0.99 (as per Cl. 39.6, IS456:2000)

SECTION CAPACITY BASED ON REINFORCEMENT PROVIDED (KNS-MET)
----------------------------------------------------------
WORST LOAD CASE:     3
Puz :   1017.52   Muz :     54.30   Muy :     37.44   IR: 0.79
```

Fig-7: Summary of Reinforcement of Column No. 132

```
ELEMENT DESIGN SUMMARY
----------------------

ELEMENT     LONG. REINF      MOM-X /LOAD     TRANS. REINF      MOM-Y /LOAD
            (SQ.MM/ME)       (KN-M/M)        (SQ.MM/ME)        (KN-M/M)

  134 TOP :      120.          0.00 /   0        120.          0.14 /   5
     BOTT:      120.         -0.91 /   3        120.         -0.02 /   2

  135 TOP :      120.          1.51 /   3        120.          0.57 /   3
     BOTT:      120.          0.00 /   0        120.          0.00 /   0

  136 TOP :      120.          0.06 /   5        120.          0.29 /   5
     BOTT:      120.         -0.03 /   2        120.         -0.01 /   2

  137 TOP :      120.          0.29 /   3        120.          1.99 /   3
     BOTT:      120.          0.00 /   0        120.          0.00 /   0

  138 TOP :      120.          1.82 /   3        120.          2.31 /   3
     BOTT:      120.          0.00 /   0        120.          0.00 /   0

  139 TOP :      120.          0.00 /   0        120.          1.79 /   3
     BOTT:      120.         -0.63 /   3        120.          0.00 /   0
```

Fig-8: Summary of Reinforcement of Slab

4. CONCLUSIONS

- STAAD Pro is much more reliable, fast, and efficient than a manual procedure for analyzing and designing multistorey buildings.
- It is safe to adopt the recommended beam and column circumstances for construction.
- In shear, bending, and deflection, the structure is safe.
- It is also free from the negative effects due to the effects of seismic loads and wind effects on the structure.
- The structure is stable and structurally defined under a variety of stresses and combinations.
- The deflection value is higher for the Wind Load (WL) combination compared to the Seismic Load (SL) combination.
- STAAD pro is a good tool to understand the behavior of a material when subjected to various loads like dead load, live load, wind load, and seismic load.
- This includes responses, bending moments, displacements, and shear forces.
- A dynamic analysis was conducted using STAAD Pro, which gave more efficient and accurate results than theoretical approaches to analysis and design.

In essence, STAAD Pro indeed proves it in the analysis as well as design of those multistory buildings that are strictly meant for residential purposes, in that it produces structurally sound, efficient, and code-compliant models. As it lays the bases for load investigations and optimizations, STAAD Pro generates buildings that are engineered for safety as well as for making their evolutionary designs possible and simple by the engineering workflow. The features include quick modification of the designs and help decision-making, thus, ensuring that the final structure is watertight in terms of the safety standards and compliant with the needs of a client. This project actually reiterates the need of modern technology in present-day construction.

REFERENCES

[1] Chaitanya, Deevi Krishna, and L. Santhosh Kumar. "Analysis And Design Of A (G+ 6) Multi Storey Residential Building Using STAAD Pro." Anveshana's International Journal Of Research In Engineering And Applied Sciences (AIJREAS) 2.1 (2024).

[2] Reddy, K. Yugandhara, et al. "STATIC AND DYNAMIC ANALYSIS OF MULTISTORY BUILDING USING STAAD PRO."

[3] Nagraju, A., and Eera Srinivas. "ANALYSIS AND DESIGN OF RESIDENTIAL (G+ 4) BUILDING USING SOFTWARE."

[4] Nagraju, A., and Eera Srinivas. "ANALYSIS AND DESIGN OF RESIDENTIAL (G+ 4) BUILDING USING SOFTWARE."

[5] Joshy, Suraj Kumar, et al. "Earthquake Response In Multistory Buildings With Bracing Systems And Shear Walls Using STAAD. Pro Software: A Comparative Study."

[6] Jyothirmayee, S., et al. "A Comparative Study on Design of Commercial Building using Etabs and Staad Pro." Journal of Physics: Conference Series. Vol. 2779. No. 1. IOP Publishing, 2024.

[7] Verma, Monika, et al. "Research on Design and Analysis of Multi-Story Building by using AutoCAD and STAAD-Pro." IOP Conference Series: Earth and Environmental Science. Vol. 1327. No. 1. IOP Publishing, 2024.

[8] Rao, Kocharala Srinivasa, et al. "Analysis, Design and Estimation of G+ 5 Residential Building Using Staad Pro." International Journal of Research in Engineering, Science and Management 7.4 (2024): 87-93.

[9] Arif, Md, Sanjeev Jangde, and Vagesh Kumar. "ANALYSIS AND DESIGN OF A TYPICAL DUPLEX BUILDING UNDER DIFFERENT SEISMIC ZONES USING STAAD PRO AND COST COMPARISON."

[10] Giri, Rachana A., Shreyas R. Shende, and Shradhesh R. Marve. "A SOFTWARE- BASED ANALYSIS OF MULTI STOREY HOSPITAL BUILDING."

[11] Jha, Nitya Nand, Rohit Kumar Singh, and Sushila Sharma. "Behaviour and design of a (G+ 5) multi storey framed structure under different loading condition." Asian Journal of Civil Engineering (2024): 1-13.