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DESIGN AND ANALYSIS OF G+10 GRAND AVENUE RESIDENCY BUILDING BY USING ETABS SOFTWARE

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Abstract: This project focuses on the structural analysis and design of a G+10 grand avenue residency building model using the ETABS software. The grand avenue residency building model will be designed as a ten-storey incorporating residency of various spaces like bedrooms, living rooms, office room, hall, kitchen, store room, and worship room and bathrooms. The building has gym, mini function hall and mini theater. The design considers the specific requirements and preferences including aesthetic consideration and functional needs. The analysis in ETABS involves modeling the building's structural components, including columns, beams, slabs, and foundations. Different loading scenarios, such as dead loads, live loads, and combination of both the dead and live loads and shear wall technology were applied to the model to assess its structural behavior under various conditions. ETABS was used to create the model of the structure ETABS which are specifically designed to take advantage of the unique physical and numerical characteristics associated with building type structures. Post analysis of the structure, maximum shear forces, bending moments, are computed and compared with all the other analyzed cases. The architectural planning of the building carried out using AUTOCAD where detailed 2D drawings including floor plans, elevations and sections are prepared. These drawings ensure proper space utilization, ventilation, and functionality of each unit. The 2D plans are imported into SKETCHUP to develop a 3D architectural model that offers realistic visualization, which helps better understanding of the spatial arrangement, facade treatment and material finishes.

Index Terms **- ETABS for structural analysis, load analysis, IS codes, multi-storied building, AUTOCAD for drafting, SKETCHUP for visualization**

I. INTRODUCTION

The rapid growth of urban populations has led to an increased demand for multi-storey residential buildings in modern cities. Efficient structural design and analysis are essential to ensure the safety, stability, and economy of such buildings. With the advancement of computational tools, structural engineers increasingly rely on specialized software to analyze complex structures and predict their behavior under various loading conditions. One of the widely used structural engineering software packages is ETABS, which is specifically developed for the analysis and design of multi-storey buildings. Multi-storey structures such as G+10 residential buildings must be designed to safely withstand various loads including dead loads, live loads, wind loads, and seismic forces. Accurate analysis of these loads and their effects on structural elements such as beams, columns, slabs, and foundations is crucial for achieving a safe and economical design. Traditional manual calculations are time-consuming and may not efficiently handle the complexity involved in high-rise structures. Therefore, advanced structural analysis software like ETABS plays a significant role in simplifying the modeling, analysis, and design process. The present study focuses on the design and analysis of a G+10 Grand Avenue Residency building using ETABS software. The building is modeled by defining structural components such as beams, columns, slabs, and shear walls according to standard engineering practices and relevant design codes. Various load combinations are applied to evaluate the structural performance and stability of the building. The analysis helps determine internal forces, moments, displacements, and other critical parameters required for structural design. The primary objective of this study is to analyze the structural behavior of the proposed G+10 residential building under different loading conditions and to ensure that the design satisfies the safety and serviceability requirements specified in design standards. The use of ETABS software allows for accurate modeling and efficient evaluation of structural performance, thereby helping engineers develop safe, reliable, and economical building designs.

II. LITERATURE REVIEW

Recent research in structural engineering has focused on the analysis and design of multi-storey reinforced concrete buildings using advanced structural analysis software such as ETABS. These tools allow engineers to model complex structures, evaluate load effects, and ensure safety according to standard design codes. Vaishnavi M. Gote (2025) conducted a study on the analysis of a multistorey building using ETABS, emphasizing the importance of accurate modeling in predicting structural behavior under dead load, live load, wind load, and earthquake forces. The research analyzed parameters such as storey displacement and storey drift, which are essential for evaluating structural safety and serviceability of multi-storey buildings. The study demonstrated that ETABS provides efficient modeling and reliable analysis results for high-rise structures. Niba et al. (2022) investigated the analysis and design of a multi-storey RCC building using ETABS. In their work, a three-dimensional model was developed incorporating beams, columns, slabs, and foundations. Loads were applied according to Indian Standard codes, and the results highlighted the effectiveness of ETABS in reducing computational complexity while ensuring compliance with design requirements. The study concluded that the use of structural analysis software improves accuracy and reduces manual calculation errors in multi-storey building design. Sapkota et al. (2022) performed a dynamic analysis of regular and irregular buildings using ETABS to study the seismic performance of structures. The study compared structural responses such as storey stiffness, displacement, and base shear under different configurations. The results indicated that irregular buildings experience higher displacement and drift compared to regular buildings, highlighting the need for proper seismic design considerations during structural planning. Swain and Parhi (2022) conducted a comparative study of seismic behavior in G+10 buildings with RCC and composite columns using ETABS software. The analysis evaluated parameters such as storey drift, storey displacement, base shear, and stiffness under seismic loading conditions. The study revealed that composite columns can enhance structural performance and reduce displacement compared to conventional RCC columns in certain configurations. Yelmeli and Verma (2024) investigated the static and seismic performance of a G+20 RCC building using ETABS. The study analyzed structural response parameters including bending moments, shear forces, and lateral displacement. The findings showed that incorporating seismic analysis in the design stage significantly improves the structural resilience of high-rise buildings against earthquake loads. Pandit et al. (2025) presented a comparative analysis of multi-storey buildings using ETABS and STAAD.Pro, focusing on seismic performance evaluation. Their research highlighted that modern structural software tools provide efficient modeling capabilities and allow engineers to perform accurate analysis within a shorter time frame compared to traditional manual methods.

III. METHODOLOGY

The methodology adopted in this study focuses on the modeling, analysis, and design of a G+10 Grand Avenue Residency building using advanced structural and modeling software tools. The structural analysis is performed using ETABS, while the architectural and three-dimensional visualization of the building is developed using SketchUp. The design and analysis procedures follow the guidelines specified in Indian Standard codes such as IS 456:2000, IS 875, and IS 1893 (Part 1):2016.

1. **Architectural Modeling Using SketchUp**
The initial stage of the project involves creating a three-dimensional architectural model of the proposed G+10 Grand Avenue Residency building using SketchUp software. SketchUp is widely used for conceptual and architectural modeling due to its flexibility and user-friendly interface. In this stage, the building layout, floor plans, elevations, and overall geometry are developed to represent the architectural configuration of the structure. The 3D model helps visualize the building components such as walls, floors, and structural layout before structural analysis is carried out. The SketchUp model provides a clear representation of the building's spatial arrangement and aids in identifying the placement of structural elements. The developed model can also be used for presentation and visualization purposes, allowing engineers and architects to better understand the building's form and structural arrangement.
2. **Structural Modeling in ETABS**
After the architectural configuration is finalized, the structural model of the G+10 building is developed in ETABS. The building geometry is defined by specifying grid lines, storey heights, and structural layout based on the architectural plan. Structural components such as beams, columns, slabs, and shear walls are modeled using appropriate section properties and material characteristics. The modeling process ensures that the structural system accurately represents the real building configuration for effective analysis.
3. **Definition of Material and Section Properties**
Material properties for reinforced concrete and steel reinforcement are defined according to the provisions of IS 456:2000. Parameters such as modulus of elasticity, density, and compressive strength of concrete are specified in the ETABS model. Structural sections including beams, columns, and slabs are assigned appropriate dimensions based on preliminary design assumptions. These properties influence the stiffness and load-carrying capacity of the structural members.
4. **Load Calculation and Assignment**
Various loads acting on the building are calculated and assigned in the ETABS model. Dead loads include the self-weight of structural elements along with additional permanent loads such as wall loads and floor finishes. Live loads are applied according to occupancy requirements as specified in IS 875 (Part 2). Lateral loads such as earthquake forces are determined according to IS 1893 (Part 1):2016 by considering parameters including seismic zone factor, importance factor, response reduction factor, and soil type.
5. **Load Combinations**
Load combinations are defined in accordance with the provisions specified in IS 456:2000 and IS 1893:2016. These combinations include various permutations of dead load, live load, and seismic load to simulate critical loading conditions. The load combinations help evaluate the structural response of the building under maximum possible stress conditions.
6. **Structural Analysis**
After defining the structural model and loading conditions, the analysis is performed in ETABS. The software computes internal forces and structural responses such as bending moments, shear forces, axial forces, storey displacement, and storey

drift. These results help in understanding how the building behaves under different load cases and ensure that the structural design meets safety and serviceability requirements.

7. Design and Verification

Based on the analysis results, structural elements including beams, columns, and slabs are designed according to the provisions of IS 456:2000. The design verification ensures that all structural members satisfy the required strength and serviceability criteria. Reinforcement requirements, member capacities, and deflection limits are checked to confirm the adequacy of the design.

IV. ETABS MODELING PARAMETERS

The structural modeling and analysis of the proposed G+10 Grand Avenue Residency building were carried out using ETABS. The building considered in this study is a reinforced concrete residential structure consisting of a ground floor and ten upper floors with a total height of approximately 33 m, with each storey having a uniform height of 3 m. The structural system adopted is a reinforced concrete moment-resisting frame structure designed according to the provisions of IS 456:2000. Seismic analysis of the structure was performed following the guidelines of IS 1893 (Part 1):2016, while load calculations were carried out based on the recommendations of IS 875. The structural elements were modeled with standard dimensions commonly used in residential buildings. Beams were assumed to have a cross-sectional size of 300 mm × 690 mm, while columns were modeled with dimensions of 650 mm × 650 mm. The slab thickness was taken as 150 mm, and shear walls with a thickness of 200 mm were incorporated where required to improve lateral stability. The foundation system considered for the structure consists of isolated footings designed to safely transfer structural loads to the soil. Material properties were assigned according to standard engineering practices, with concrete of grade M30 and reinforcement steel of grade HYSD 500 used for structural members. The unit weight of reinforced concrete was considered as 25 kN/m³, and the unit weight of steel was taken as 78.5 kN/m³. The modulus of elasticity for concrete was determined as per the provisions of IS 456:2000.

Various loads acting on the structure were considered during the analysis. Dead loads included the self-weight of structural components along with additional loads such as wall loads and floor finishes. A live load of 3 kN/m² was applied to floors according to the recommendations of IS 875 (Part 2). Floor finish loads of 1 kN/m² and wall loads of approximately 12 kN/m were also included in the analysis. Seismic loading was applied considering the building to be located in seismic Zone III with an importance factor of 1.0 and a response reduction factor of 5 for a moment-resisting frame system, assuming medium soil conditions. To evaluate the structural performance under different loading scenarios, several load combinations were considered in accordance with IS code provisions, including 1.5(DL + LL), 1.2(DL + LL + EQ), 1.5(DL + EQ), and 0.9DL ± 1.5EQ. These combinations were used to determine the critical design forces acting on structural members and to ensure that the structure satisfies both strength and serviceability requirements.

The reinforcement detailing of structural members was carried out based on the analysis results to ensure adequate ductility and load-carrying capacity. Figure 4.1 illustrates the detailed drawings of stirrups and reinforcement markings used in beam elements, which play a significant role in resisting shear forces and providing confinement to the concrete core. Proper stirrup spacing and detailing were adopted in accordance with the design provisions to enhance structural performance. In addition, column identification and arrangement within the structural grid were carried out systematically in the ETABS model. Figure 4.2 presents the column marking and modeling of the G+10 structure in ETABS, which helps in identifying column locations and analyzing the load transfer mechanism throughout the building height. The analysis results obtained from ETABS were further used to evaluate parameters such as storey displacement, storey drift, base shear, and internal forces in structural members, which are essential for assessing the stability, safety, and overall performance of the building.

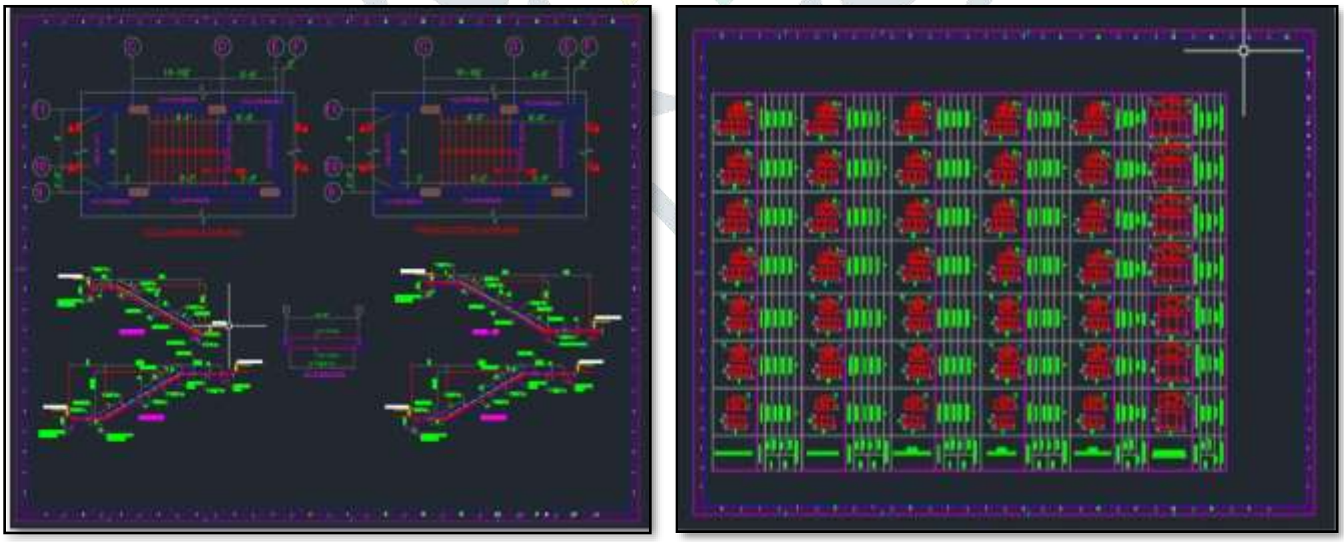

Fig 4.1 Detailed Drawings of stirrups and markings

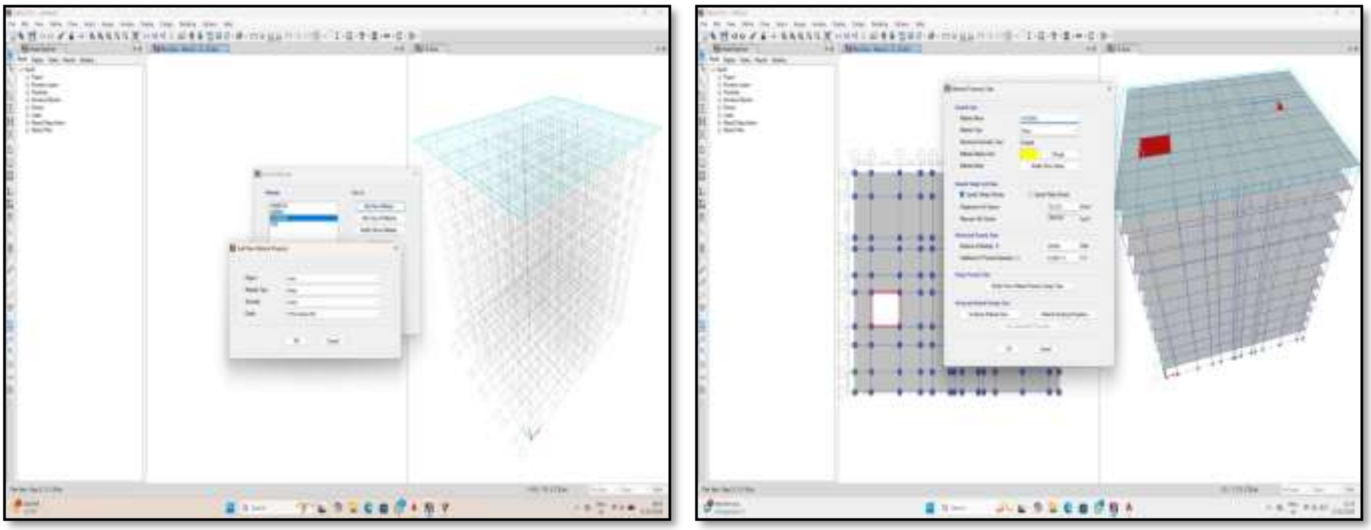

Fig 4.2 Column Marking Modeling of G+10 Structures in ETABS

V. Result and Analysis

The structural analysis of the proposed G+10 Grand Avenue Residency building was carried out using ETABS to evaluate the behavior of the structure under various loading conditions. The analysis considered different load cases including dead load, live load, and seismic load combinations as specified in IS 875 and IS 1893 (Part 1):2016. The results obtained from the analysis were used to study important structural response parameters such as storey displacement, storey drift, base shear, and internal forces in beams and columns.

Storey Displacement

Storey displacement represents the lateral movement of each floor level of the building due to applied loads, particularly seismic and wind loads. The ETABS analysis showed that the lateral displacement gradually increases from the base of the building to the top storey. The maximum displacement was observed at the roof level, which is expected because the upper storeys experience higher lateral deflections due to reduced stiffness compared to the lower levels. The results indicated that the displacement values remained within the permissible limits specified in the seismic design provisions, ensuring that the building maintains adequate stability under lateral loading conditions shown in Fig.5.2.

Storey Drift

Storey drift is defined as the relative displacement between two consecutive storeys and is a critical parameter for evaluating the seismic performance of a structure. Excessive drift may lead to structural damage or non-structural failures such as cracks in walls and partitions. According to the guidelines provided in IS 1893 (Part 1):2016, the storey drift should not exceed 0.004 times the storey height. The ETABS results showed that the maximum storey drift occurred at the intermediate storeys of the building, while the drift values near the base and roof levels were comparatively lower. All the calculated drift values were found to be within the permissible limits, indicating satisfactory seismic performance of the building.

Base Shear

Base shear is the total horizontal force acting at the base of the structure due to seismic loading. It represents the overall seismic demand on the building. The ETABS analysis calculated the base shear based on the seismic parameters defined for the structure, including the seismic zone factor, importance factor, response reduction factor, and soil type as per IS 1893. The obtained base shear value reflects the cumulative effect of earthquake forces acting on the building. Proper distribution of lateral forces across storeys ensures that the structure can safely resist seismic loads without excessive deformation shown in Fig 5.1.

Beam and Column Forces

The analysis results also provided detailed information about internal forces such as bending moments, shear forces, and axial forces acting on beams and columns. These forces were evaluated under different load combinations to identify critical design conditions. Beams primarily resisted bending moments and shear forces due to gravity and lateral loads, while columns experienced significant axial forces along with bending moments due to the transfer of loads from upper storeys. The design of these structural elements was carried out according to the provisions of IS 456:2000 to ensure adequate strength and serviceability.

Structural Performance Evaluation

Based on the analysis results obtained from ETABS, the structural performance of the G+10 residential building was found to be satisfactory. The values of storey displacement and storey drift were within the allowable limits specified in relevant design codes. The internal force distribution in beams and columns indicated that the structural members were capable of safely carrying the applied loads. Overall, the analysis confirmed that the proposed structural configuration provides adequate stability, strength, and safety for the G+10 Grand Avenue Residency building.

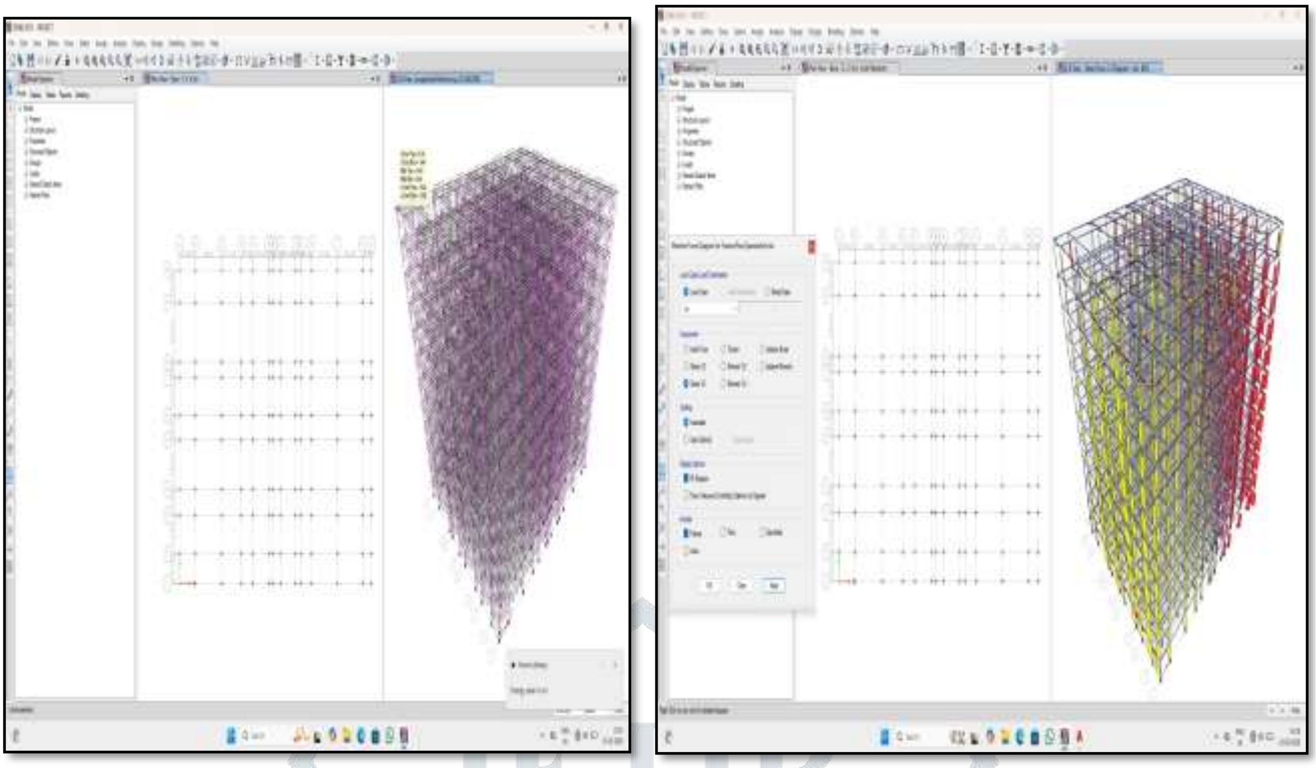

Fig 5.1 Reinforcement and Shear force of Grand Avenue Residency Building in ETABS

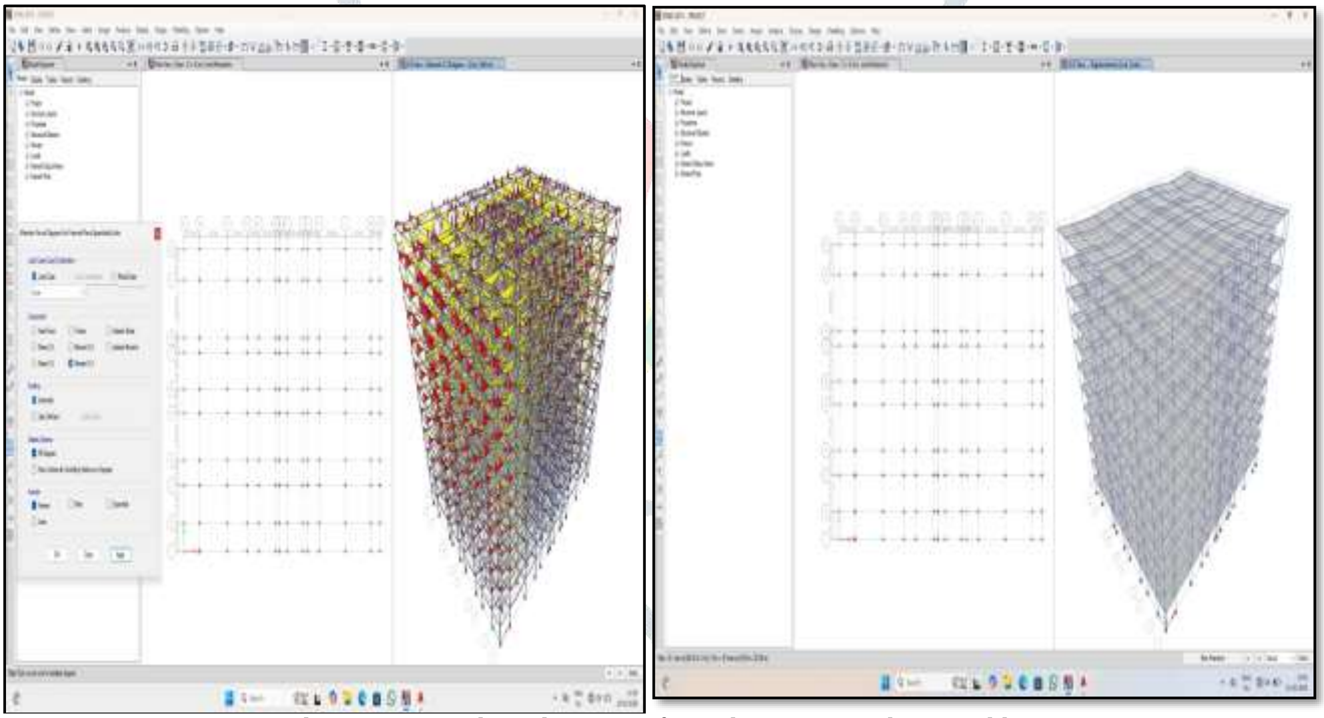

Fig 5.2 Bending Moment and Displacement of Grand Avenue Residency Building in ETABS

VI. DISCUSSION

The results obtained from the structural analysis of the G+10 Grand Avenue Residency building provide valuable insights into the behavior of the structure under various loading conditions. The architectural visualization and preliminary building modeling were developed using SketchUp shown in Fig.6.1, which helped in defining the building geometry and spatial arrangement of structural components. The structural analysis was then carried out using ETABS, which enabled a detailed evaluation of the structural response in terms of displacement, storey drift, base shear, and internal forces acting on structural members. These parameters are essential for assessing the stability and safety of multi-storey buildings.

The storey displacement results indicated a gradual increase in lateral displacement from the base to the top of the building. This pattern is commonly observed in multi-storey structures subjected to lateral loads such as earthquake forces. The maximum displacement was recorded at the roof level, which reflects the cumulative effect of lateral forces acting along the height of the structure. However, the obtained displacement values remained within acceptable limits, indicating that the structural system possesses adequate stiffness and stability to resist lateral loads effectively.

The analysis of storey drift revealed that the maximum drift occurred at the intermediate storeys of the building. This behavior is typically observed in multi-storey structures because the mid-level floors experience significant lateral movement due to load transfer between upper and lower structural elements. According to the provisions of IS 1893 (Part 1):2016, the permissible limit for storey drift is 0.004 times the storey height. The results obtained from the ETABS analysis confirmed that the calculated drift values were within the permissible limits, demonstrating satisfactory seismic performance of the building.

The base shear obtained from the analysis represents the total seismic force acting at the base of the structure. Proper distribution of this lateral force across the building height ensures that the structural members effectively resist earthquake forces. The base shear results indicate that the structure can safely transfer seismic loads to the foundation without causing excessive deformation or instability.

Furthermore, the internal force analysis revealed that beams primarily resist bending moments and shear forces due to gravity and lateral loads, while columns carry significant axial loads along with bending moments transferred from upper floors. The design of these structural members was carried out according to the provisions specified in IS 456:2000, ensuring adequate strength and serviceability. The reinforcement requirements and section capacities were found to be sufficient to resist the applied loads.

Overall, the discussion of the analysis results indicates that the structural configuration adopted for the G+10 Grand Avenue Residency building provides satisfactory performance under the considered loading conditions. The combined use of SketchUp for architectural modeling and ETABS for structural analysis facilitated accurate representation and evaluation of the building structure. The results confirm that the proposed design satisfies the safety and stability requirements specified in the relevant Indian Standard codes.

Fig 6.1 Elevation of Grand Avenue Residency Building in SketchUp software

VII. Conclusions

The present study investigates the structural modeling, analysis, and design of a G+10 Grand Avenue Residency building using the structural analysis software ETABS. The analysis considered various loading conditions including dead load, live load, and seismic loads in accordance with the provisions specified in IS 875, IS 1893 (Part 1):2016, and IS 456:2000. The analysis provided a comprehensive understanding of the structural behavior and performance of the building under different loading conditions.

- The evaluation of structural response parameters such as storey displacement, storey drift, base shear, and internal forces was carried out using ETABS analysis results. The study revealed that the maximum storey displacement occurs at the roof level of the building, which is consistent with the expected behavior of multi-storey structures subjected to lateral forces. Nevertheless, the displacement values were found to be within permissible limits, indicating adequate lateral stiffness and overall structural stability.

- Furthermore, the storey drift results were examined to evaluate the seismic performance of the building. The maximum storey drift was observed at intermediate levels of the structure; however, the calculated drift values were within the allowable limit of 0.004 times the storey height as recommended by IS 1893 (Part 1):2016. This confirms that the proposed structural system satisfies the seismic safety criteria and is capable of resisting earthquake-induced forces effectively.

- The internal force distribution within structural members demonstrated that beams primarily resisted bending moments and shear forces, while columns carried significant axial loads along with bending moments transferred from upper floors. The design verification of structural members confirmed that the selected beam and column sections are adequate and comply with the strength and serviceability requirements specified in IS 456:2000.

In conclusion, the analysis confirms that the proposed G+10 residential building structure is safe, stable, and structurally efficient. The use of ETABS facilitated accurate structural modeling and analysis, enabling effective evaluation of the building's performance under various loading conditions. The study highlights the importance of advanced structural analysis tools in achieving reliable and economical design solutions for multi-storey residential buildings.

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