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# Analysis of G+5 Commercial Building Using ETABS and STAAD.PRO Software

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***Abstract*—The rapid growth of multi-storey buildings has increased the importance of accurate structural analysis for ensuring safety and serviceability under lateral loads. Various structural analysis software are widely used in the construction industry; however, differences in modeling techniques and result interpretation may lead to variations in structural response. This study presents a comparative analysis of a G+5 reinforced concrete commercial building using ETABS and STAAD.Pro. The primary objective of the study is to evaluate and compare the structural behavior of the building based on storey displacement, storey drift, and base shear obtained from both software. Although minor variations were observed due to differences in software modeling and output procedures, both software produced comparable results. The study concludes that ETABS provides more efficient storey-wise outputs and easier interpretation for building analysis, while STAAD.Pro offers flexibility and detailed member-level analysis. Therefore, both software are reliable for structural analysis, with ETABS being more suitable for multi-storey building drift evaluation.**

***Index Terms*—ETABS, STAAD.Pro, Reinforced Concrete Building, Equivalent Static Analysis, Seismic Analysis, Storey Displacement, Storey Drift, Base Shear.**

## I. INTRODUCTION

The rapid development of urban infrastructure has resulted in a significant increase in the construction of multi-storey reinforced concrete buildings. These structures are continuously subjected to gravity loads, wind loads and seismic forces throughout their service life. Among these loading conditions, earthquake forces are highly dynamic and can induce considerable lateral displacements, inter-storey drift and base shear, which directly influence the safety and stability of a structure. Therefore, accurate structural analysis is an essential requirement for achieving safe, economical and durable building designs. With the advancement of computer-aided structural engineering, sophisticated software packages have replaced conventional manual calculations for the analysis and design of complex structures.

ETABS and STAAD.Pro are two of the most widely used structural analysis software in the construction industry. Both software employ finite element analysis techniques; however, they differ in modelling philosophy, element formulation, numerical algorithms and post-processing capabilities. ETABS is specifically developed for multi-storey building analysis, offering efficient storey-based modelling and response evaluation. In contrast, STAAD.Pro is a versatile structural analysis software capable of analysing a wide range of civil engineering structures through general finite element modelling.

In this study, a G+5 reinforced concrete commercial building was modelled in both ETABS and STAAD.Pro using identical geometric dimensions, material properties, loading conditions and seismic parameters. Equivalent Static Analysis was carried out in accordance with IS 1893 (Part 1):2016. The results obtained from both software were compared based on storey displacement, storey drift and base shear. The comparative evaluation provides insight into the accuracy and consistency of the two software packages and highlights their suitability for seismic analysis of regular reinforced concrete buildings.

## II. LITERATURE REVIEW

1) Puneet Mittal et al., (2016): “Comparison of Analysis and Design Results of 4 Storey Building Using ETABS and STAAD Pro”. The main objective of the study was to compare the structural analysis and design results of a four-

storey reinforced concrete building modeled using ETABS and STAAD.Pro. The building was analyzed under gravity and lateral loading conditions, and important structural parameters such as bending moment, shear force, axial force, displacement, and reinforcement quantity were compared.The study observed that both ETABS and STAAD.Pro produced reliable structural analysis results with slight variations in internal forces and displacement values. These variations were mainly attributed to differences in modeling techniques, load distribution procedures, and computational algorithms used by the software.

2) Mohammad Kalim et al., (2018): "Comparative Study on Analysis and Design of Regular Configuration of Building by STAAD.Pro and ETABS". The study reported that both ETABS and STAAD.Pro produced nearly similar results with minor numerical differences. These variations occurred due to differences in modeling assumptions, solution methods, and analysis algorithms adopted by the software. The study highlighted that ETABS provides a more user-friendly interface and efficient storey-based modeling process, whereas STAAD.Pro requires comparatively detailed setup procedures but provides reliable analytical outputs. The study concluded that both software can be effectively used for regular building analysis and design.
3) Surender Kumar et al., (2020): "Analysis of Residential Building with ETABS and STAADPro." The study found that ETABS and STAAD.Pro produced comparable results for most structural parameters with slight variations in displacement and internal force values. These differences were mainly due to variations in computational methods and modeling procedures adopted by the software. ETABS was found to provide a more organized and efficient environment for analyzing multi-storey buildings, especially for visualizing lateral load effects and storey response. STAAD.Pro also provided reliable results but required more detailed manual interpretation of outputs.
4) Ramanand et al., (2017), "Comparative Study of G+10 Storied Building Using ETABS and STAAD." The Study considered structural parameters such as storey displacement, storey drift, axial force, bending moment, shear force, and reinforcement quantity. The study concluded that ETABS provides better efficiency for high-rise building analysis because of its storey-based modeling system and effective handling of lateral loads. STAAD also produced accurate analytical results but required comparatively more modeling effort and manual interpretation. The study emphasized the importance of displacement and drift comparison in evaluating the seismic performance of multi-storey buildings.
5) Mallela Satish Kumar et al., (2020):"A Comparative Study on Effect of Vertical and Lateral Loads under Dynamic Analysis for Shear Walls of an RCC Structure by Using ETABS and STAADPro". The main objective of the study was to evaluate the seismic performance of RCC buildings with shear walls under dynamic loading conditions and compare the analytical results obtained from both software platforms. The study reported that the overall lateral displacement reduced by approximately 25% to 35% due to the inclusion of shear walls. Similarly, storey drift values were reduced by nearly 30%, indicating improved lateral stiffness and seismic resistance of the structure. Base shear values were found to increase slightly because of the increase in overall structural stiffness. ETABS provided better storey-wise visualization and easier interpretation of displacement and drift results, whereas STAAD.Pro offered detailed member force outputs and flexible modeling capabilities. The study concluded that shear walls play a significant role in improving earthquake resistance of RCC buildings and that both ETABS and STAAD.Pro are suitable for dynamic analysis of multi-storey structures.

The literature review indicates that both ETABS and STAAD.Pro are widely used for structural analysis and design of multi-storey RCC buildings. Previous studies mainly focused on comparing structural parameters such as displacement, drift, bending moment, shear force, and base shear under static and dynamic loading conditions. Most researchers concluded that both software provide reliable results with minor variations due to differences in modeling procedures and computational algorithms. ETABS was found to be more suitable for storey-based analysis and lateral load evaluation, while

STAAD.Pro provided flexibility in modeling and detailed member force analysis. The reviewed studies also emphasized the importance of storey drift and displacement in evaluating seismic performance of buildings.

## III. DESCRIPTION OF BUILDING

The building considered for the present study is a G+5 reinforced concrete commercial building designed as a shopping complex. The structure is planned with a regular configuration to achieve better structural stability and efficient load distribution. The building is intended for commercial usage and includes shop spaces, circulation areas, staircase facilities, and a public elevator for vertical movement of occupants. The structural system adopted is an RCC framed structure consisting of beams, columns, and slabs designed to resist gravity and lateral loads.

### 3.1 Materail Property

The structural elements of the shopping complex were modeled using reinforced cement concrete and steel materials as per Indian Standard code provisions. M30 grade concrete was used for beams, columns, and slabs to provide adequate compressive strength and durability. Fe500 grade reinforcement steel was adopted for all structural members due to its high tensile strength and ductility.

### 3.2 Building Parameters

The building consists of reinforced concrete structural elements such as beams, columns, slabs, and foundations designed to resist gravity and lateral loads. Column Size: 450 mm × 230 mm ,Beam Size 1: 450 mm × 230 mm ,Beam Size 2: 230 mm × 230 mm ,Slab Thickness: 150 mm. The building is located in Salem, Tamil Nadu, and consists of a ground floor with five storeys (G+5). The building has a rectangular plan measuring 21.0 m × 17.61 m with a uniform floor-to-floor height of 3.75 m. A 2.0 m basement is provided below the ground level, while a 2.5 m headroom and a 1.0 m parapet wall are provided above the terrace level. The masonry walls have a uniform thickness of 230 mm, and the corridor width is maintained at 2.5 m throughout the building.

## IV. MODELLING AND ANALYSIS

### 4.1 ETABS

The building model in ETABS was developed using imported AutoCAD grid lines. Storey data and structural dimensions were defined according to the building specifications. Beams and columns were modelled as frame elements along the grid intersections, while slabs were modeled as shell elements

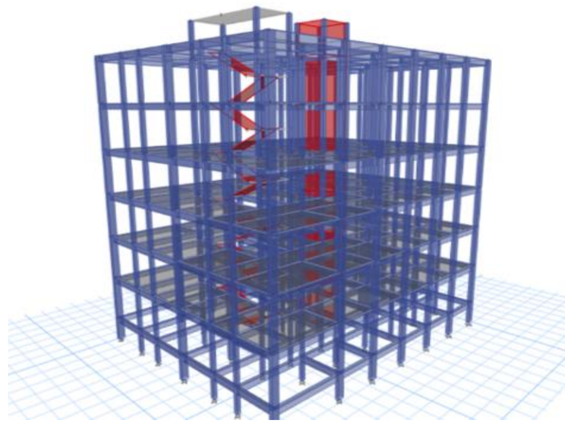

Fig.1: 3D RENDERING VIEW IN ETABS

### 4.2 STAAD.Pro

The building model in STAAD.Pro was created using grid-based node generation with reference to the AutoCAD plan layout. The geometry of the structure was developed by defining nodes and beam connectivity based on the grid system. Beams and columns were modelled using beam elements, while slabs were modelled as plate elements.

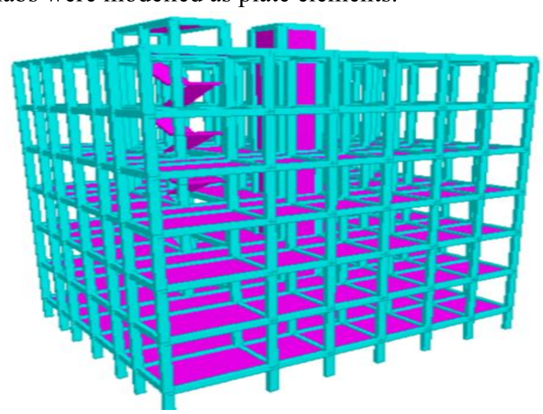

Fig.2: 3D Rendering View In STAAD.Pro

### 4.3 Load Application

The structural model was analysed by considering all major loads acting on the building, namely dead load, live load, wind load and seismic load, in accordance with the relevant Indian Standard codes. The same loading conditions were assigned in both ETABS and STAAD.Pro to ensure consistency in the comparative analysis.

Dead load consists of the self-weight of structural components, including beams, columns, slabs, walls and floor finishes. The self-weight was automatically calculated by the software, while additional dead loads were assigned as per IS 875 (Part 1):1987.Live load represents the variable load due to occupancy, furniture and movable equipment. A uniformly distributed live load of 2.5 kN/m² was assigned to all floor slabs in accordance with IS 875 (Part 2):1987. Wind load was applied in both X and Y directions based on the provisions of IS 875 (Part 3):2015 by considering the building location, height and wind parameters to evaluate the lateral response of the structure. Seismic loads were applied using the Equivalent Static Method as per IS 1893 (Part 1):2016. Earthquake load cases (EQ-X and EQ-Y) were defined using the seismic zone factor, importance factor, response reduction factor and soil type to determine the seismic response of the building.

Linear static analysis was carried out in both ETABS and STAAD.Pro after completion of modelling and load application.The analysis procedure includes: Modelling of the structure, Assignment of material properties, Application of loads, Definition of load combinations, Running structural analysis, Extraction of results. The structural response of the building was evaluated under gravity and lateral loading conditions.

## V.RESULTS AND DISCUSSION

### 5.1 Storey Displacement

Storey displacement represents the lateral movement of each floor level under seismic loading. Excessive displacement may affect structural stability and serviceability of the building. The maximum displacement generally occurs at the top storey due to cumulative lateral deformation.

Table.I Shows the Storey Displacement Comparison

| STOREY | ETABS(mm) | STAAD.Pro(mm) |
|---|---|---|
| Storey 7 | 27.86 | 29.40 |
| Storey 6 | 24.10 | 25.60 |
| Storey 5 | 20.00 | 21.30 |
| Storey 4 | 16.10 | 17.20 |
| Storey 3 | 12.20 | 13.10 |
| Storey 2 | 8.60 | 9.20 |
| Storey 1 | 5.50 | 6.00 |
| Base | 0 | 0 |

The results indicate that the displacement gradually increases from the base to the top storey in both software. Maximum displacement was observed at Story7. STAAD.Pro produced slightly higher displacement values compared to ETABS because of differences in modeling procedures and stiffness calculation.

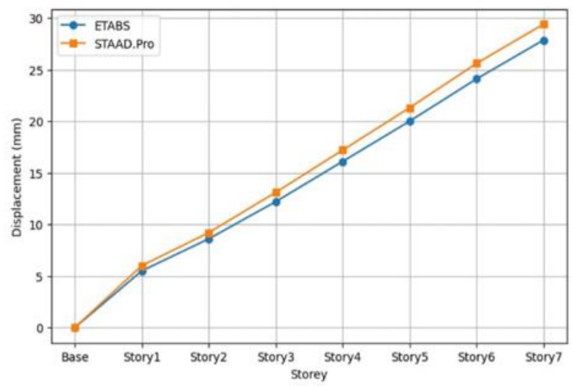


Fig.3: Storey Displacement Comparison Graph

### 5.2 Storey Drift

Storey Drift is one of the most important parameters considered in the seismic analysis of multi-storey buildings. It represents the relative lateral displacement between two consecutive floors due to earthquake or wind loading. As per IS 1893:2016, storey drift should remain within the permissible limits specified by the code to ensure adequate seismic performance of the building. In ETABS, storey drift values can be obtained directly from the software after performing the analysis. ETABS provides a separate “Storey Drift” output option under story response results. Unlike ETABS, STAAD.Pro does not provide direct storey drift output for multi-storey buildings. The software mainly provides nodal displacement values at different joints of the structure. Therefore, storey drift must be calculated manually using nodal displacement results. The storey drift is calculated using the following expression: Storey drift = $\frac{\{\Delta_{\text{current}} - \Delta_{\text{below}}\}}{h}$

$\Delta_{\text{current}}$ =Lateral displacement of current storey

$\Delta_{\text{below}}$ = Lateral displacement of storey below

H = Storey Height

Table.II Shows the Storey Drift Comparison

| STOREY | ETABS | STAAD.Pro |
|---|---|---|
| Storey 7 | 0.00074 | 0.00080 |
| Storey 6 | 0.00112 | 0.00119 |
| Storey 5 | 0.00143 | 0.00151 |
| Storey 4 | 0.00162 | 0.00171 |
| Storey 3 | 0.00155 | 0.00163 |
| Storey 2 | 0.00120 | 0.00128 |
| Storey 1 | 0.00082 | 0.00089 |

The drift values obtained from both software were found to be within the permissible limits specified in IS 1893:2016. Maximum drift occurred at the intermediate storeys due to higher lateral deformation effects. ETABS produced comparatively lower drift values because of its efficient storey-based analysis approach.

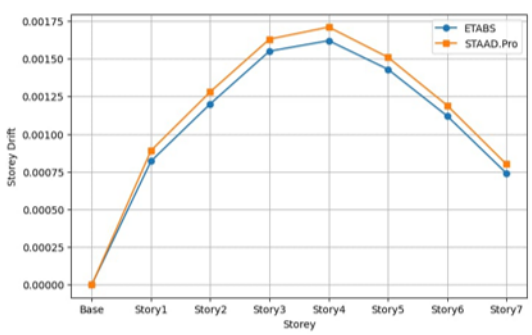


Fig.4: Storey Drift Comparison Graph

5.3 Base Shear

Base shear is the total horizontal seismic force acting at the base of the structure during an earthquake. It represents the cumulative effect of seismic forces transferred from all floors of the building to the foundation level. Base shear is one of the most important parameters in seismic analysis because it determines the lateral load that the structure must resist.

Table.III Shows the Base Shear Comparison

| DIRECTION | ETABS (kN) | STAAD.Pro (kN) |
|---|---|---|
| EQ X | 820 | 846 |
| EQ Y | 785 | 809 |

The base shear values obtained from both software were nearly similar with minor variations. STAAD.Pro produced slightly higher base shear values because of differences in computational algorithms and load distribution procedures

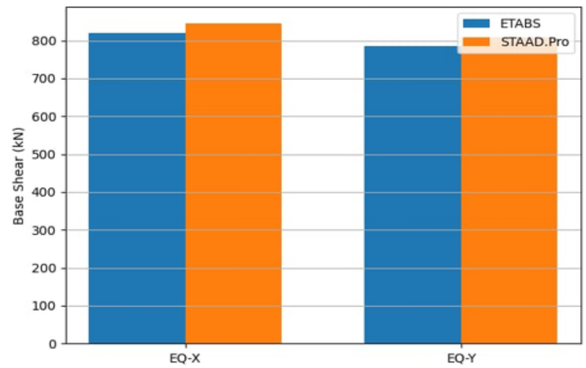


Fig.5: Base Shear Comparison Graph

5.4 Discussion

The variations observed between the software results were mainly due to differences in Structural modeling techniques, Numerical solution procedures, Stiffness calculations, Load distribution methods. Overall, both ETABS and STAAD.Pro were found suitable for the analysis of multi-storey commercial buildings.

## VI.CONCLUSION

The G+5 reinforced concrete commercial building was successfully modeled and analyzed using ETABS and STAAD.Pro software. The structural response parameters such as storey displacement, storey drift, and base shear were compared under seismic loading conditions. Both software produced nearly similar analysis results with only minor variations. ETABS generated comparatively lower displacement and drift values, whereas STAAD.Pro produced slightly higher values due to differences in modeling and computational procedures. The storey drift values obtained from both software were within permissible limits, indicating adequate structural stability and safety under seismic loading.

From the comparative study, ETABS was found to be more suitable for storey-based multi-storey building analysis and drift evaluation, while STAAD.Pro provided flexibility in detailed member analysis and modeling. Therefore, both software can be effectively used for structural analysis and design of reinforced concrete commercial buildings.

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