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Design and Seismic Performance Analysis of Multi-Story Building

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Abstract:

This research aims to analyze and design a G+6 private residential structure using ETABS and STAAD.Pro. Traditional design methods are time-consuming and complex, whereas software-based approaches offer faster and more precise results. STAAD.Pro and ETABS employ the limit state method as per Indian Standard Codes. STAAD.Pro provides an advanced interface, visualization tools, and powerful analysis engines. This study considers dead load, live load, wind load, and seismic load combinations. The analysis includes defining structural components, applying loads, and evaluating results. A comparative study of beam and column designs between the two software programs highlights their efficiency in reinforcement detailing.

Keywords- ETABS, STAAD.Pro, G+6 Structure, Seismic Analysis, Reinforcement Design

INTRODUCTION

The construction industry has evolved significantly with the introduction of design software. Multi-story buildings require sophisticated analysis to ensure safety and stability under various load conditions. Structural analysis software like STAAD.Pro and ETABS enables engineers to model, analyze, and design structures efficiently. This study focuses on a G+6 residential building designed using these software tools. The building is located in Nepalgunj, Nepal, and consists of seven floors with 3 BHK flats

1.1 Building Specifications

- **Location:** Nepalgunj, Ward No. 06, Banke, Nepal
- **Usage:** Residential (G+6, 3 BHK flats)
- **Site Area:** 40 × 60 ft
- **Building Height:** 24 m
- **Structural Type:** RCC Framed Structure
- **Foundation Type:** Fixed Supports
- **Walls:** Brick Masonry (140 mm thickness)
- **Staircases:** Seven flights

1.2 Scope of Work This research project tests classroom concepts by developing a multi-story residential structure using STAAD.Pro and ETABS. The study evaluates their efficiency in load application, structural response, and reinforcement detailing.

I. LITERATURE REVIEW

- **Borugadda Raju et al., (2015)** Plan and investigated G+30 multi-story building taking on STAAD. Genius in limit state technique. STAAD. Expert contains a simple connection point that allows the clients to deliver the mount and the heap values and aspects are inputted. The individuals are planned with support subtleties for RCC outlines. The examination is finished for two layered casings and afterward it is finished for more multi-storeyed 2-D and three dimensional edges under different burden mixes.
- **D.Ramya, A.V.S.Sai Kumar (2015)** A comparison of the designs of STAAD. Pro and ETABS for a G+10 house. The aim of thispaper is to determine the efficacy of using a structure programmed between these two groups. They discovered that although STAAD. Pro is often useful, ETABS is often used. In this design Live, Dead and wind load is taken under consideration.
- **Aman et al., (2016)** the investigation and plan of G+5 private cum business building in view of the standards characterized by the IS codes on STAAD. Star programming. The heap forced were just dead and live burden subsequently the heap blend created was 1.5(Dead burden + Live burden) after which the investigation of the structure was finished for the Edge and the subsequent Bowing minutes and shear powers were contemplated. The detail of all the structure individuals was addressed alongside the elements of section, shaft, segment, balance and flight of stairs.
- **Viviane Warnotte (2016)** He summed up essential ideas on which the seismic beating impact happens between nearby structures. He distinguished the conditions under which the seismic Pounding will happen among structures and sufficient data and, maybe more significantly, beating circumstance examined. From his examination it was tracked down that a flexible model can't foresee effectively the practices of the construction because of seismic beating. Along these lines non-flexible investigation is to be done to anticipate the necessary seismic hole between structures.
- **Vishnu Haritha, Dr. I. Yamini Srivalli (2017)** the impact of wind gets impressive as the structure outlines stature increments. Wind burden will be dominating contrasted with dead and live loads in the event of tall slim casings.

The security and solidness of design may get basic as the tall thin structures interface with the breeze. Subsequently for the plan of tall structures an intensive investigation of wind impacts is a lot of vital. This is specific in locales where wind is morebasic than the quake.

II. DESIGN METHEDOLOGY

3.1 STAAD.Pro Analysis Steps:

1. Generate Nodes
2. Model the Structure
3. Assign Structural Members

4. Define Restraints
5. Apply Loads
6. Run Analysis

3.2 Load Applications in STAAD.Pro

The analysis considers the following loads:

- **Dead Load**
- **Live Load**
- **Wind Load**
- **Seismic Load**

STAAD.Pro automatically calculates self-weight and applies load combinations per Indian Standards.

3.3 ETABS Analysis Steps:

- Define Grid and Story Levels
- Assign Material and Frame Properties
- Model the Structure
- Apply Loads and Load Combinations
- Run Analysis

ETABS requires manual input for self-weight calculations, but it offers enhanced flexibility in reinforcement design.

3.4 Generation of Nodes

The nodes are generated based on the dimensions of the building in X-dir., Y-dir., Z-dir. Then the coordinates are entering in Nodes geometry then the software automatically generatesgrids with specified .spacing. Unwanted nodes could be deleted. Fig 3.1 represent generated nodes in building according to dimension.

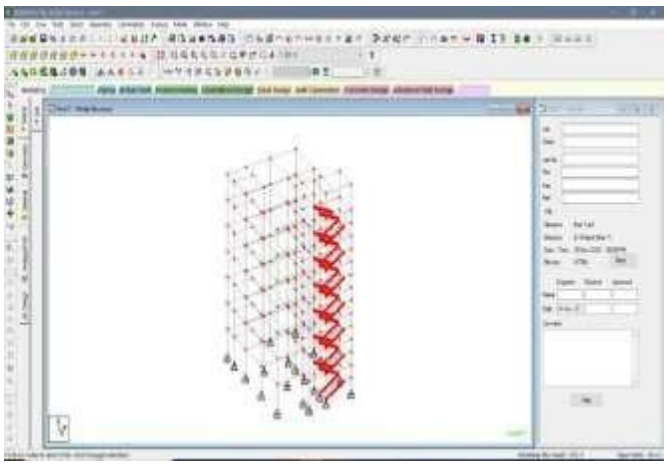

Figure 3.1 Generation of nodes

III. RESULTS AND DISCUSSIONS

A comparative study of axial force, shear force, and bending moment values obtained from STAAD.Pro and ETABS revealed minimal differences.

4.1 Reinforcement Analysis

4.1.1 Column Reinforcement:

- **STAAD.Pro:** 16 bars of 12 mm diameter with 8 mm ties @190 mm c/c.
- **ETABS:** 12 bars of 16 mm diameter with 10 mm ties @100 mm c/c.
- **Conclusion:** ETABS requires less reinforcement, making it more economical.

4.1.2 Beam Reinforcement:

- **STAAD.Pro:** 10 bars of 12 mm diameter at the top and 3 bars of 20 mm at the bottom with 8 mm ties @145 mm c/c.
- **ETABS:** 4 bars of 14 mm and 2 bars of 16 mm at the top, 4 bars of 14 mm at the bottom with 10 mm ties @150 mm (Zone A) and @175 mm (Zone B) c/c.
- **Conclusion:** ETABS provides more economical reinforcement detailing.

4.2 Software Comparison

Criteria	**STAAD.Pro**	**ETABS**
Reinforcement Detailing	Limited	Detailed
Wind Load Analysis	Basic	Advanced
Flexibility in Design	Moderate	High
Usability	More Manual Input	User- Friendly

IV. CONCLUSION

The study successfully analyzed a G+6 residential structure using ETABS and STAAD.Pro. The findings suggest that:

- STAAD.Pro is efficient for general structural analysis but lacks detailed reinforcement options.
- ETABS provides better wind and seismic analysis, making it ideal for high-rise structures.
- ETABS offers more flexibility in reinforcement detailing, leading to cost-effective designs.

While STAAD.Pro is widely used for structural analysis, ETABS provides a more comprehensive and efficient approach for reinforced concrete structures. The results indicate that ETABS is preferable for high-rise buildings and seismic assessment.

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