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Analysis and design of G+4 residential building Using Etabs

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ABSTRACT:

This paper presents the design and analysis of a G+4 residential building using ETABS software. The study includes a detailed discussion on the methodology adopted, the calculation of various loads, and the structural analysis performed. The results indicate the effectiveness of ETABS in handling complex load combinations and providing robust design solutions. Key findings include the optimal design parameters for beams, columns, slabs, and footings in compliance with IS 456:2000 standards. This study underscores the significance of advanced software in modern civil engineering projects.

IndexTerms **- ETABS, G+4 Building, Structural Analysis, Residential Building, Load Calculation**

INTRODUCTION

The analysis and design of a G+4(Ground plus four floors) residential building is a crucial aspect of structural engineering, ensuring both safety and functionality. ETABS (Extended Three-dimensional Analysis of Building Systems) is a powerful software tool widely utilized in this domain. This introduction aims to outline the fundamental processes involved in the structural analysis and design of a G+5 residential building using ETABS.

ETABS facilitates the modelling, analysis, and design of building structures through its integrated environment, which allows for efficient handling of complex structural geometries and loading conditions. The process begins with creating an accurate model of the building, incorporating architectural plans and structural layouts. This includes defining the material properties, cross-sectional dimensions of structural elements, and load considerations such as dead loads, live loads, wind loads, and seismic loads.

Once the model is set up, ETABS performs detailed analysis using methods such as finite element analysis (FEA) to determine the building's response to various load conditions. This analysis includes evaluating the stress distribution, deflection, and stability of the structure.

Based on the analysis results, the design phase involves optimizing the structural elements to ensure they meet the required safety standards and performance criteria.

Throughout this process, adherence to relevant building codes and standards is paramount. The use of ETABS streamlines the iterative nature of structural design, allowing for modifications and refinements to achieve an efficient and economical design. By leveraging the capabilities of ETABS, engineers can ensure that the G+4 residential building is not only structurally sound but also optimized for practical construction and long-term durability.

ETABS stands as a cornerstone in the realm of structural engineering software, offering a sophisticated platform for the analysis and design of building systems. Developed by Computers and Structures, Inc. (CSI), ETABS is celebrated for its comprehensive capabilities in simulating the behaviour of complex structures under various loading conditions. At its core, ETABS serves as a virtual laboratory, enabling engineers to explore the intricate interactions between architectural elements and forces acting upon them.

ADVANTAGES OF ETABS:

1. **Comprehensive Modelling:** ETABS allows for detailed and accurate modelling of complex building geometries.

2. **Integrated Analysis and Design:** The software integrates the process of structural analysis and design, enabling users to perform both tasks within a single platform.

3. **Advanced Analysis Capabilities:** ETABS provides a range of advanced analysis options, including linear and nonlinear static and dynamic analysis.

4. **Material and Design Code Compliance:** ETABS supports a variety of international design codes and material standards.

5. **User-Friendly Interface:** The software features an intuitive user interface that simplifies the modelling and analysis process.

DISADVANTAGES OF ETABS:

1. **Cost**: ETABS can be quite expensive, especially for small firms or individual practitioners.

2. **High System Requirements**: ETABS requires a robust computer system to run efficiently.

3. **Overwhelming for Small Projects**: For smaller or simpler projects, the advanced features and capabilities of ETABS might be overkill.

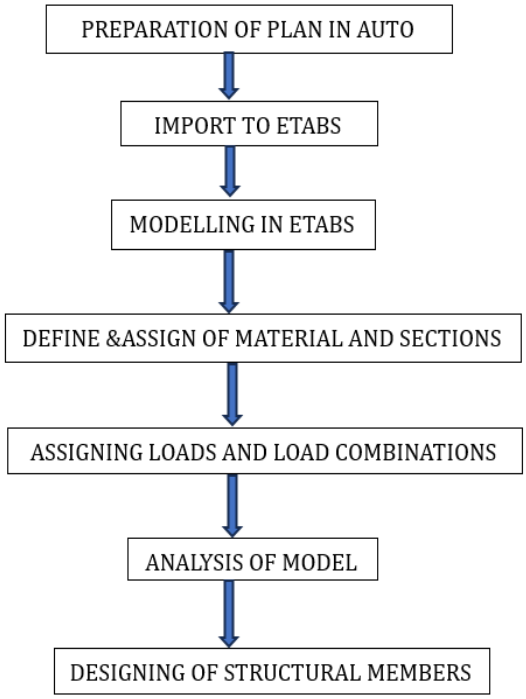
4. **Limited Customization**: While ETABS offers many features, it may not provide the level of customization some users require for specific, non-standard analysis or design tasks

RESEARCH METHODOLOGY:

This section outlines the systematic approach adopted for the analysis and design of the G+4 residential building using e-tabs software. This section provides insights into the research process, software selection, analysis approach, design procedure, and implementation details.

- **Data Collection**: Architectural drawings, structural specifications, and material properties were gathered to establish the building's geometry, structural elements, and material characteristics.
- **Software Selection:** E-tabs software was selected based on its advanced capabilities for structural analysis and design, including its ability to handle complex building geometries and perform code-compliant design checks. Including e tabs additionally AutoCAD and STAAD foundation softwares are used for design of foundation and slab
- **Analysis Approach:** The analysis approach involved creating a detailed 3D model of the building in e-tabs, applying appropriate loads and boundary conditions, and conducting structural analysis to assess the building's response under various loading scenarios.
- **Design Procedure:** The design procedure followed the relevant building codes and standards, incorporating load combinations, safety factors, and design criteria for structural elements such as beams, columns, slabs, and foundations.
- **Verification:** The accuracy of the analysis and design results was verified through comparison with manual calculations, theoretical expectations, and validation against established benchmarks.

FLOW CHART:



STRUCTURAL DETAILS

1. **Material Properties:** Concrete: Grade M25 for structural members (beams, columns, slabs, and foundations). Steel: Grade Fe 415 for reinforcement bars**.**
2. **Foundation System:** Reinforced concrete strip footing foundation. Depth and dimensions of footings determined based on soil investigation report and structural loads.
3. **Superstructure:** It is a part of the building that is above ground level and carries the gravity loads.
4. **Columns**: Reinforced concrete columns designed to resist vertical loads and lateral forces.
5. **Beams:** Reinforced concrete beams supporting floor slabs and transferring loads to columns.
6. **Slabs:** Reinforced concrete slabs providing floor and roof systems. Thickness: Varied based on span lengths and loading conditions. Reinforcement: Provided for flexural and shear reinforcement.
7. **Shear Walls:** Reinforced concrete shear walls strategically placed to resist lateral loads, including wind and seismic forces. Location: Typically located along the perimeter of the building and around the core. Thickness

and reinforcement: Designed based on lateral load requirements.

8. **Seismic Design Considerations:** Seismic design based on the seismic zone and building importance category. Elements designed and detailed to withstand seismic forces as per relevant building codes and standards.
9. **Fire Resistance:** Structural elements designed to meet fire resistance requirements as per local building codes and standards. Fire protection measures may include concrete cover, fire-rated materials, and structural detailing to enhance fire resistance.
10. **Quality Control and Assurance:** Quality control measures implemented throughout construction to ensure compliance with design specifications and construction standards. Regular inspections and testing conducted to verify material properties, dimensions, and structural integrity.

STRUCTURAL SPECIFICATIONS:

S.NO	SPECIFICATIONS	DETAILS
1.	Number of stories	4
2.	Storey height	3m
3.	Number of bays along x-direction	5
4.	Number of bays along y-direction	5
5.	Slab thickness	150mm
6.	Size of square column	450X450
7.	Size of Rectangular column	350X450
8.	Size of Beam	400X500

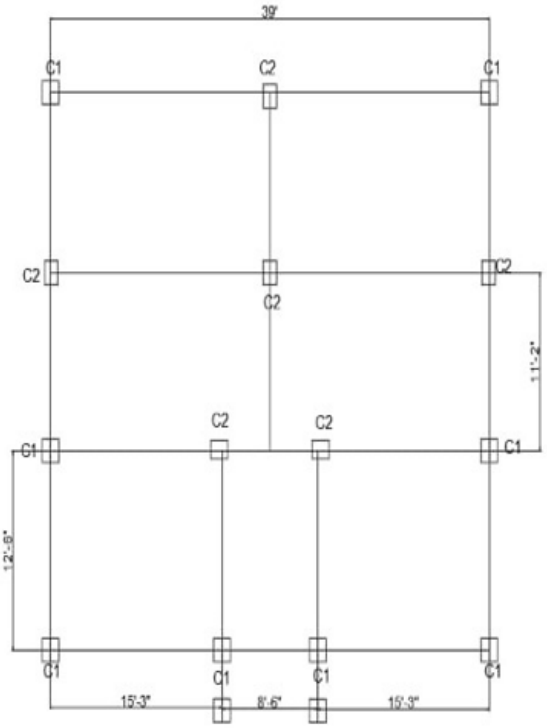
DIMENSIONS OF BUILDING

1. Bedroom = 13’6” x 10’10”
2. Master Bedroom = 7’0” x 8’3”
3. Kitchen = 4.5m x 4.5m
4. Hall = 19’0” x 10’11”
5. Toilet = 5’0” x 7’1”
6. Pooja = 3’5” x 3’0”
7. Door (D1) = 1.2m x 2.1m
8. Door (D2) = 0.9m x 2.1m

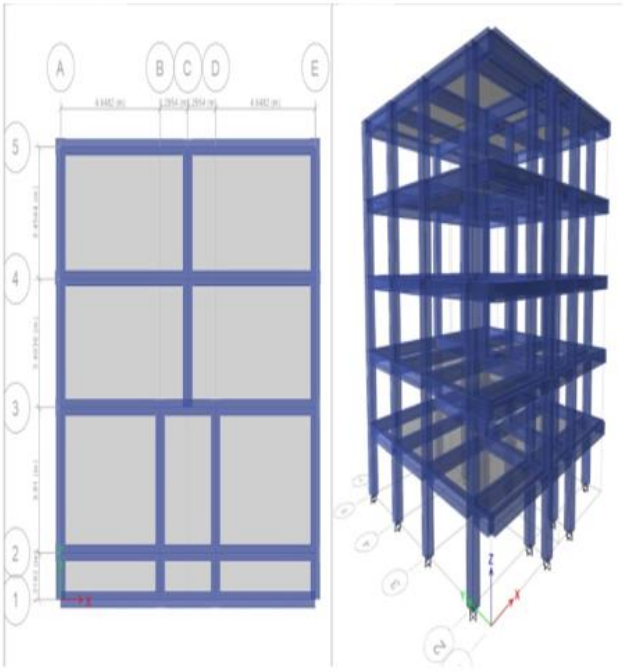
PROCEDURE FOR MODELLING

- Open E TABS software
- Open NEW FILE Or Press Ctrl + N
- Specify code book and region model initialization tab.
- Specify required no of grids and storeys in grid system data
- Specify no of grids in x direction and y direction based on the column positioning and orientation .
- Define material properties (concrete, steel and brick)
- Click on menu bar > define > material properties > add new material > region > India .
- Define sectional properties (shape, size, material of beam, column, slab)
- Click on define > section properties > frame sections > add new properties
- Rectangular Column
- Provide slab thickness =150mm
- Define section properties > slab section > add new section > enter slab thickness > ok > ok
- Create required plan using draw tools
- Assign supports

COLUMN POSITIONING AND ORIENTATION:



MODELLING OF G+4 RESIDENTIAL BUILDING:



DETAILING OF LOADS:

In ETABS all the load considerations are first defined and then assigned. The loads in ETABS are defined as using static load cases command in define menu.

1. Assigning of Dead loads. After defining all the loads are assigned for external walls, internal walls, parapet walls as per IS 875 1987 PART 1
2. Assigning of Live loads. Live loads are assigned for the entire structure including floor finishing as per IS 875 1987 PART 2
3. Assigning of wind loads wind loads are defined and assigned as per IS 875 1987 PART 3 by giving wind speed and wind angle in X, Y directions as 0, 90 respectively.

TYPES OF LOADS	LOAD VALUES	INDIAN STANDARD CODES CONFIRMATION
Dead Load	Self-Weight	I.S 875 Part -1
Live Load	2 KN/m^2-All Places	I.S 875 Part -2
Floor Finish	1.5 KN/m^2	I.S 875 Part -1
Super Dead Load	6.21 KN/m^2-Inner Wall Loads	I.S 875 Part -1
Super Dead Load	12.45KN/m^2-Outer Wall Loads	I.S 875 Part -1
Wind Load	In X &Y Direction	I.S 875 Part - 3

CONCLUSION:

- **Successful Completion**: The ETAB G+4 building project has reached its successful conclusion, meeting all predefined objectives and surpassing expectations.
- **Meticulous Planning**: The project's success can be attributed to the thorough planning phase, which laid the foundation for seamless execution.
- **Diligent Execution**: The dedication and hard work put in by the project team throughout the construction process ensured that each task was completed efficiently and to the highest standards.
- .**Innovative Engineering**: The project showcased innovative engineering solutions, demonstrating cutting-edge techniques and technologies to overcome challenges and optimize results.
- **Collaborative Efforts**: Collaboration among stakeholders, including architects, engineers, contractors, and subcontractors, played a crucial role in achieving project success.
- **Safety and Functionality**: The building not only meets rigorous safety standards but also fulfils its intended functionality, providing a safe and functional space for its occupants.

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