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ANALYSIS AND DESIGN OF IRREGULAR SHAPED BUILDING USING STAAD.PRO SOFTWARE

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Abstract

The project "Analysis and Design of Irregular Shaped Building Using STAAD.Pro Software" focuses on the structural analysis and design of a building having an irregular architectural configuration. Irregular-shaped buildings can exhibit complex structural behavior because of uneven distribution of mass, stiffness, geometry, and load paths. Such buildings require detailed structural evaluation to ensure adequate strength, stability, and serviceability under different loading conditions. The study aims to develop a suitable structural model and evaluate its behavior using computer-aided structural analysis.

A three-dimensional structural model of the irregular-shaped building is developed using STAAD.Pro by defining the building geometry, storey levels, beams, columns, supports, material properties, and member sections. Appropriate dead loads, live loads, and other applicable lateral loads are considered for the analysis. The software is used to determine important structural parameters such as axial forces, shear forces, bending moments, support reactions, storey displacements, and overall structural response. The irregular geometry is carefully modeled to represent the actual structural configuration.

The analysis results are used to identify critical beams, columns, and other structural members subjected to governing forces. Structural members are designed based on the calculated forces and relevant design requirements. Storey-wise displacement and structural response are also evaluated to understand the behavior of the irregular building under applied loading conditions. Necessary modifications to member sizes or structural arrangements can be made to improve the overall performance of the building.

I. Introduction

Irregular-shaped buildings are increasingly used in modern construction to provide unique architectural forms, efficient space utilization, and functional layouts. Unlike regular buildings, irregular structures may have variations in plan geometry, stiffness, mass distribution, and structural configuration. These variations can result in uneven load distribution and complex structural behavior under gravity and lateral loading. Therefore, proper structural analysis and design are essential to ensure the safety, stability, and serviceability of such buildings.

The structural behavior of an irregular building depends on several factors, including building geometry, member dimensions, material properties, support conditions, load

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distribution, and the location of structural elements. Dead loads and live loads act vertically on the structure, while lateral loads such as wind and earthquake forces can produce additional displacement and internal forces. Irregularity in the building plan can influence the distribution of bending moments, shear forces, axial forces, and torsional effects. Hence, a detailed three-dimensional structural model is required to understand the behavior of the building under different loading conditions.

STAAD.Pro is a computer-aided structural analysis and design software used for modeling and evaluating various types of structures. It allows engineers to create three-dimensional structural models, assign material properties and member sections, define supports and loading conditions, and perform structural analysis. The software provides results such as bending moments, shear forces, axial forces, support reactions, displacements, and other structural responses. These results can be used to identify critical members and perform the required structural design checks.

II. Literature Survey

Several studies have investigated the structural behavior of irregular-shaped buildings because changes in plan geometry, mass distribution, stiffness, and structural configuration can significantly influence the response of a building. Researchers have reported that irregular buildings may experience non-uniform distribution of lateral forces and increased torsional effects when subjected to earthquake or wind loading. Plan irregularities such as L-shaped, T-shaped, U-shaped, and other non-symmetric configurations have therefore received considerable attention in structural engineering research. These studies emphasize the importance of considering building irregularity during structural analysis and design.

Research on seismic behavior of irregular buildings has shown that the position and extent of irregularity can affect storey displacement, inter-storey drift, base shear, and member forces. Comparative studies between regular and irregular buildings have generally examined how changes in plan configuration influence structural response under lateral loading. Researchers have also investigated the effects of stiffness distribution and structural member arrangement on the overall behavior of irregular structures. These findings indicate that irregular buildings require careful modeling and evaluation to identify critical structural conditions.

Several investigations have used STAAD.Pro for the analysis and design of multi-storey and irregular buildings. The software allows a three-dimensional structural model to be developed by defining beams, columns, supports, material properties, member sections, and loading conditions. Researchers have used STAAD.Pro to calculate parameters such as axial force, bending moment, shear force, support reactions, storey displacement, and member utilization. Computer-aided analysis provides a convenient method for comparing different structural configurations and identifying critical members.

Other studies have focused on the influence of wind and earthquake loading on irregular structures. Lateral loads can produce additional effects in buildings with non-uniform geometry, particularly when the center of mass and center of stiffness are not properly aligned. Researchers have evaluated parameters such as torsional

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response, lateral displacement, storey drift, base shear, and overturning effects to understand the structural performance of irregular buildings. Such studies highlight the importance of selecting suitable structural systems and appropriately distributing beams and columns.

Overall, the literature demonstrates that irregular building geometry has an important influence on structural behavior, particularly under lateral loading conditions. Previous research has mainly focused on plan irregularity, seismic response, wind effects, torsional behavior, storey displacement, and computer-aided structural analysis. Building on these studies, the present project develops a three-dimensional irregular-shaped building model using STAAD.Pro and evaluates its structural response under the considered loading conditions. The analysis results are used to identify critical structural members and support the design of a safe, stable, and structurally efficient irregular building.

III. System Analysis

System analysis is an important stage in evaluating the structural behavior of an irregular-shaped building using STAAD.Pro software. The project focuses on analyzing the building with respect to its irregular geometry, load distribution, stiffness, and structural configuration. The building plan, storey heights, beam and column dimensions, supports, and material properties are defined before analysis. A three-dimensional structural model is developed in STAAD.Pro to represent the irregular building accurately. Dead loads and live loads are considered along with applicable lateral loads such as wind or seismic loads. Appropriate load combinations are created to evaluate different possible loading conditions. STAAD.Pro calculates important structural responses such as axial forces, shear forces, bending moments, support reactions, and displacements. Storey-wise displacement and drift are evaluated to understand the lateral behavior of the structure. Critical beams and columns are identified based on the governing forces obtained from the analysis. The effect of irregular geometry on the distribution of structural forces is examined through the analysis results. Structural members are designed based on the calculated forces and applicable design requirements. Overall, the system analysis provides a systematic method for evaluating the safety and performance of an irregular-shaped building.

Existing System

The conventional structural design system for irregular-shaped buildings mainly depends on manual calculations, simplified assumptions, and conventional two-dimensional structural drawings. Engineers need to determine the geometry, loads, member sizes, and support conditions before performing structural calculations. Irregular building configurations make manual analysis more complicated because load paths and stiffness distribution may not be uniform. Calculating bending moments, shear forces, axial forces, and support reactions for every structural member can require considerable time. Lateral loading conditions such as wind and earthquake forces further increase the complexity of the analysis. Comparing different load combinations manually can become difficult for multi-storey irregular structures. Changes in building geometry or member dimensions may require repeated structural

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calculations. Conventional methods also provide limited visualization of three-dimensional structural behavior. Identifying critical members and evaluating storey-wise displacement can require additional calculations. Preparation of detailed structural design reports may also require significant manual effort. The possibility of calculation and data-entry errors increases when a large number of structural members are involved. Therefore, a computer-aided structural analysis approach is useful for improving the efficiency and reliability of irregular building design. STAAD.Pro provides an integrated environment for structural modeling, analysis, and design.

Disadvantages of Existing System

- Requires extensive manual structural calculations.
- Time-consuming for irregular and multi-storey buildings.
- Higher possibility of calculation and data-entry errors.
- Difficult to model complex irregular geometry manually.
- Difficult to evaluate non-uniform load distribution.
- Repeated calculations are required when geometry changes.
- Difficult to analyze multiple load combinations efficiently.
- Limited visualization of three-dimensional structural behavior.
- Difficult to identify critical members quickly.
- Manual evaluation of storey displacement requires additional effort.
- Difficult to compare different structural configurations.
- Manual preparation of structural reports is time-consuming.

Proposed System

The proposed system focuses on the analysis and design of an irregular-shaped building using STAAD.Pro software. The project begins by defining the building geometry, number of storeys, storey heights, structural layout, and support conditions. Beams, columns, and other required structural components are modeled according to the irregular building configuration. Material properties and suitable member sections are assigned to the three-dimensional structural model. Dead loads and live loads are applied to represent the gravity loading conditions of the building. Applicable wind or seismic loads are introduced to evaluate the lateral response of the irregular structure. Appropriate load combinations are generated to determine the governing structural conditions. STAAD.Pro performs the structural analysis and provides member forces, support reactions, and displacement results. Storey-wise displacement and drift are evaluated to understand the lateral behavior of the building. Critical beams and columns are identified based on the maximum bending moments, shear forces, and axial forces. The structural members are then checked and designed according to the calculated forces and relevant design requirements. Changes in member sizes or structural arrangements can be evaluated efficiently through the software. Overall, the proposed system provides an integrated approach for analyzing and designing a safe and structurally efficient irregular-shaped building.

Advantages of Proposed System

- Provides computer-aided structural analysis.
- Supports three-dimensional modeling of irregular buildings.

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- Reduces manual calculation effort.
- Handles complex building geometry efficiently.
- Allows evaluation of gravity and lateral loads.
- Supports multiple load combinations.
- Provides detailed member force results.
- Helps evaluate storey displacement and drift.
- Helps identify critical beams and columns.
- Provides graphical visualization of structural behavior.
- Makes structural modifications easier to evaluate.
- Improves efficiency of structural analysis and design.

IV. Methodology

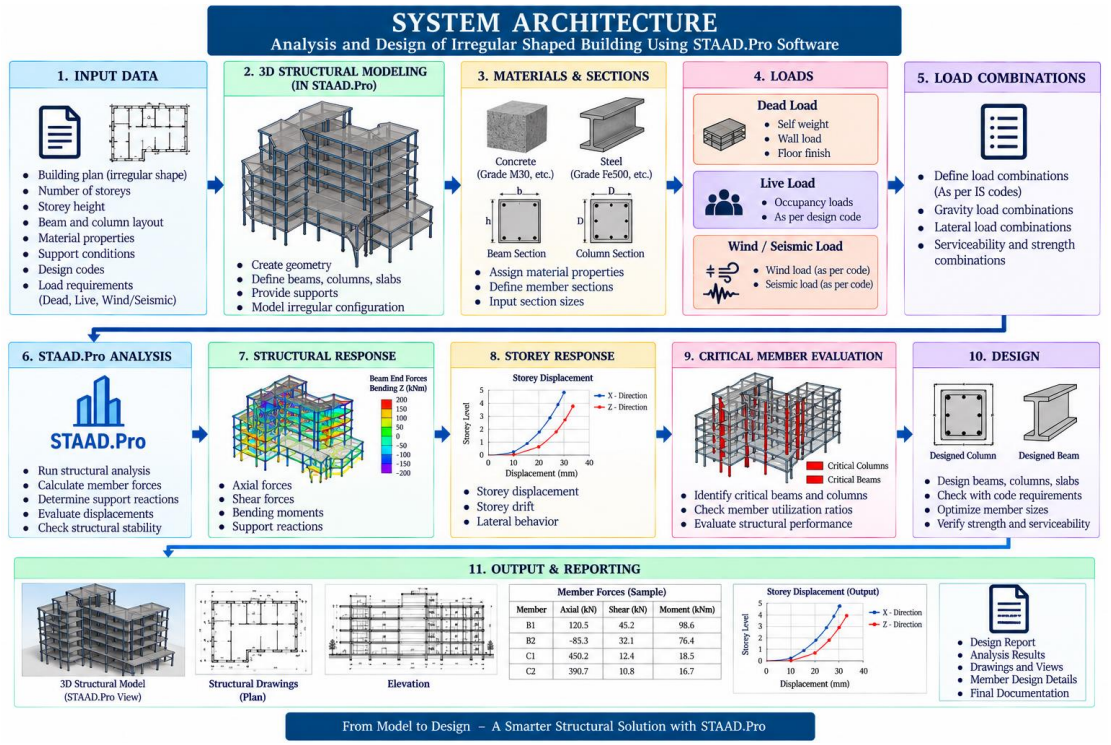
The methodology begins with collecting the architectural and structural information required for the proposed irregular-shaped building. The building plan, number of storeys, storey heights, member dimensions, material properties, and support conditions are defined. The irregular building geometry is then converted into a three-dimensional structural model using STAAD.Pro. Beams, columns, supports, and other required structural elements are created according to the proposed structural arrangement. Suitable material properties and member sections are assigned to the model. Dead loads and live loads are calculated and applied to represent gravity loading conditions. Wind or seismic loading is then defined according to the selected design requirements and building conditions. Appropriate load combinations are generated to consider different possible loading scenarios. The complete structural model is analyzed to obtain axial forces, bending moments, shear forces, support reactions, and displacements. Storey-wise displacement and drift are evaluated to understand the response of the irregular structure. Critical structural members are identified based on the governing analysis results. The members are designed and checked using the calculated forces and applicable structural design requirements. Finally, the analysis and design results are evaluated to determine the safety, stability, and structural performance of the irregular-shaped building.

System Architecture

The system architecture represents the complete workflow used for analyzing and designing the irregular-shaped building using STAAD.Pro software. The process begins with Building Input Data, including building geometry, storey dimensions, material properties, and structural requirements. The 3D Structural Modeling Module develops the irregular building model using beams, columns, supports, and other structural components. The Material and Section Module assigns concrete, steel, and suitable member sections to the structural model. The Gravity Load Module defines dead loads and live loads acting on the building. The Lateral Load Module introduces applicable wind or seismic loads based on the selected design conditions. The Load Combination Module generates appropriate combinations of gravity and lateral loads for structural evaluation. The complete model is processed through the STAAD.Pro Analysis Engine to calculate structural responses. The Structural Response Module provides axial forces, bending moments, shear forces, support reactions, and displacements. The Storey Response Module evaluates storey displacement and drift to understand the lateral behavior of the irregular building. The Critical Member

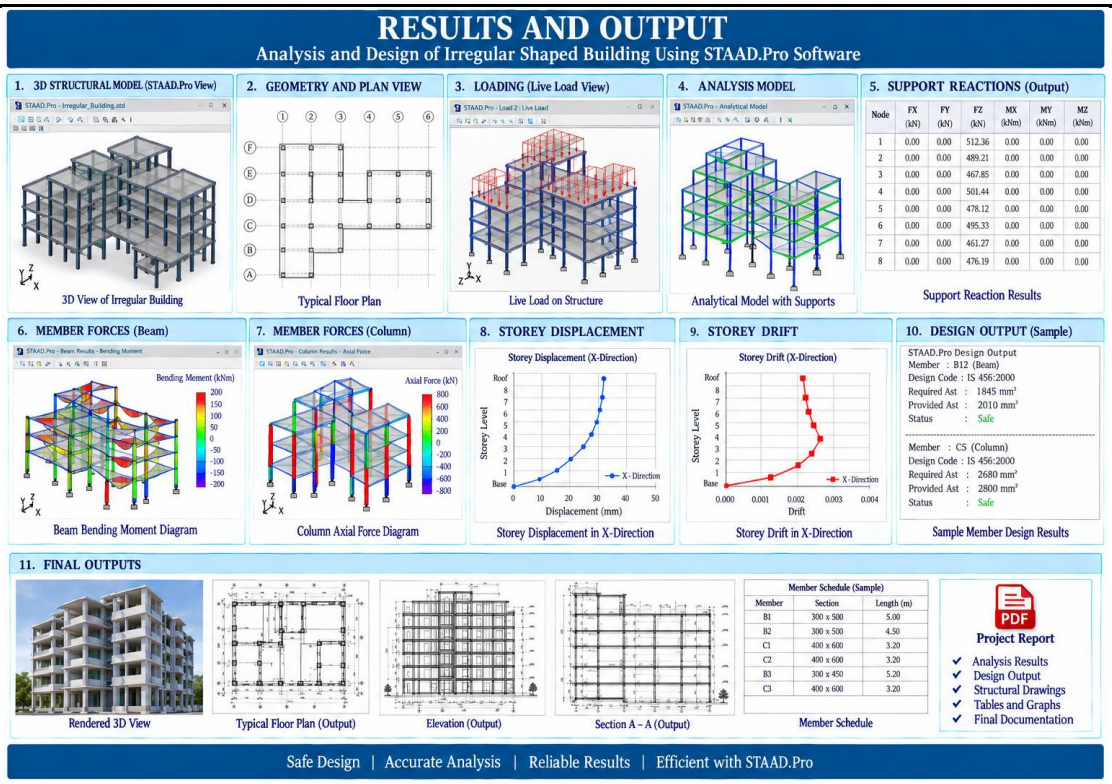
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Evaluation Module identifies governing beams, columns, and other structural members. The Design Module checks and designs structural members based on the calculated forces and applicable requirements. Finally, the **Results and Reporting Module** generates analysis results, design checks, structural views, tables, and project reports. Overall, the architecture follows the workflow **Building Data → 3D Modeling → Materials & Sections → Gravity Loads → Wind/Seismic Loads → Load Combinations → STAAD.Pro Analysis → Structural Response → Storey Evaluation → Critical Member Identification → Member Design → Final Results & Report**.



V. Result and Output

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VI. Conclusion

The project successfully analyzes and designs an irregular-shaped building using STAAD.Pro software. A three-dimensional structural model was developed by considering the irregular building geometry, storey levels, beams, columns, supports, and material properties. Dead loads, live loads, and applicable lateral loads were applied to evaluate the structural response under different loading conditions. STAAD.Pro was used to determine important parameters such as axial forces, shear forces, bending moments, support reactions, and structural displacements. Storey-wise displacement and drift were evaluated to understand the lateral behavior of the irregular structure. The analysis helped identify critical beams and columns subjected to governing structural forces. Based on the analysis results, the required structural members were checked and designed according to the applicable design requirements. The software provided clear graphical representations and detailed numerical results for evaluating the structural performance. The use of STAAD.Pro reduced manual calculation effort and improved the efficiency of the analysis and design process. The study demonstrates that proper structural modeling and load consideration are essential for irregular-shaped buildings. Overall, the project provides a systematic approach for evaluating the strength, stability, and serviceability of irregular structures. The analysis and design results can be used to develop a safer, reliable, and structurally efficient building design.

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