Comparative Study Of RCC and Steel Concrete Composite Structure Based On Seismic Analysis Using Staad Pro Software

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Abstract – *This paper STAAD PRO is a sophisticated tool that engineers can use to precisely analyse a building's structural integrity while analysing high-rise structures. With consideration for wind, seismic loads, and other environmental factors, it can offer a thorough analysis of a structure's static and dynamic responses. Comparative evaluation of the seismic performance of a steel-concrete composite building frame located in earthquake zone IV and a (G+10) storey RCC building. First, a 3D model of the structure is created. This model may then be analysed using the robust finite element analysis programme found in STAAD Pro.*

1.INTRODUCTION

STAAD Pro is a strong tool that engineers can use to analyse high-rise structures and precisely determine a building's structural integrity. It can offer a thorough examination of a structure's static and dynamic reactions, accounting for external factors such as wind and seismic loads. Additionally, it can be applied to design and optimise the structure for optimal efficiency and safety.

The first step in the analysis is to create a 3D model of the structure, which can then be examined using the robust finite element analysis tools available in STAAD Pro. Through this analysis, the loads and forces acting on the structure are identified, and the amounts of stress and strain in various structural components are ascertained. The structure can then be designed with these findings in mind for optimal safety and effectiveness.

The examination may also be used to look into the structure's serviceability and stability. This entails evaluating the dynamic response of the structure under various loading scenarios in addition to the effects of wind, seismic loads, and other environmental variables. Additionally, STAAD Pro is capable of analysing the effects of fatigue on a structure over time as well as the buckling, cracking, and failure of structural components.

The analysis's findings can be utilised to optimise the structure's design and ensure that it complies with all relevant design codes. The study can also be used to produce reports and graphics that help guide decisions during the design and construction phases.

2. LITERATURE SURVEY

This research work aims to investigate the current state of RCC and composite building seismic performance evaluation. An analytical investigation into the structural behaviour of composite and R.C.C. high rise structures is being conducted in this work. Displacements, axial forces, base shear, and natural period are the parameters taken into account. The results, including maximum displacement values, axial forces, base shear, and natural periods, are determined by the project analysis, which was conducted using the structural analysis programme STAAD-PRO V8I.[1]

Compared to many emerging nations, India uses extremely little steel in the construction industry. Other nations' experiences show that this isn't because steel isn't a cost-effective building material[1]. There is a lot of room to grow the amount of steel used in building, particularly given India's present development requirements. The nation has suffered a great loss by not investigating steel as a substitute building material and by not utilising it when it is cost-effective. Furthermore, it is clear that composite sections made of steel encased in concrete are currently a practical, affordable, and quick fix for large civil constructions like bridges and skyscrapers. [2]

A discussion of the planning and building of a high-rise RCC structure opens the literature study. This covers an analysis of the building materials, the structure's design, and the many construction methods that were employed. A overview of the several kinds of analysis that can be done for a high-rise RCC structure is also included in the paper. This covers nonlinear analysis, finite element analysis, and static and dynamic analysis. The purpose of the study is to find any potential flaws or weaknesses in the structure and confirm that it can support the anticipated loads and stresses.

3. METHODOLOGY

3.1 Model Details:

The structure under consideration is a 10-story office building in seismic zone IV, designated as G+10. The three-dimensional isometric view is displayed in Figures 2 and 3. In Figure 4, the building plan is displayed.

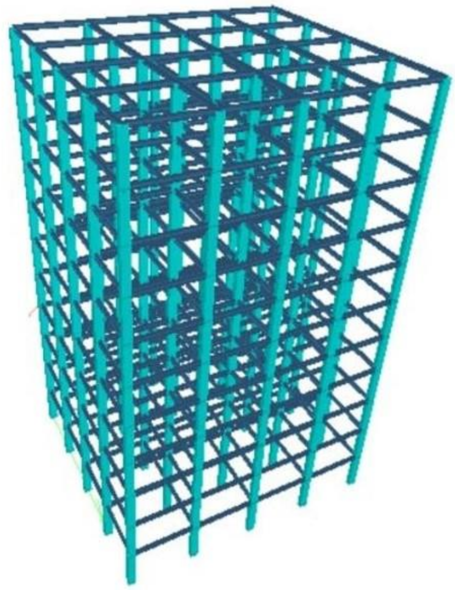

Figure : 3D Rendered view of model on STAAD-Pro

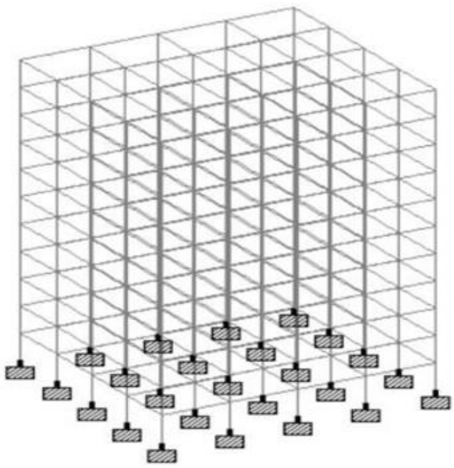

Figure : 3-D View of Model in STAAD-Pro

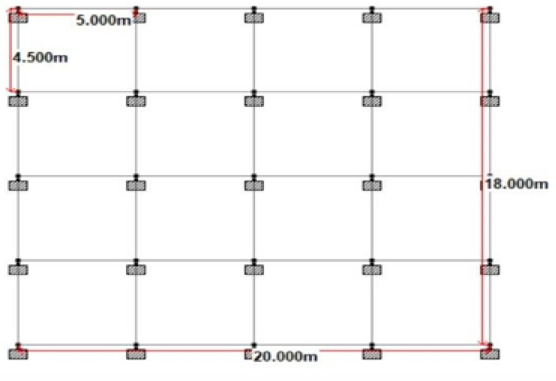

Figure 4: 3-D View of Model in STAAD-Pro

The fundamental design and loading parameters are identical for both RCC and Composite Steel Concrete structures. The slab, beam, and column structural members of an RCC structure are designed in accordance with IS456:2000, whereas the members of a Steel Concrete Composite Structure are developed in accordance with Eurocode 4.

Columns are thought to be composed of RCC with structural steel section in its core and reinforcement in the concrete exterior. Composite beams are constructed with structural steel section secured to the steel deck slab with the assistance of shear studs. The beam column frame is regarded as a moment-resisting frame that carries lateral stresses.

Response Spectrum Method and Equivalent Static Method are used to analyse the described 3D building model. STAAD-Pro software is then used to analyse the building models. For the seismic loads in the X-direction, several parameters are investigated, including storey stiffness, storey drift, base shear, weight of the structure, lateral pressures, mode shapes, natural time period, and frequency. A specific country's seismic codes are exclusive to that location. India's IS 1893 (PART-1) standard criteria for designing structures that are earthquake resistant: The primary code that offers an outline for figuring out seismic design force is 2002.

3.2 Structural Member sizes:

The parts of a structure that give it stability and support are called structural members. The size of these parts can vary based on the needs of the design or the application. Beams, columns, trusses, and frames are examples of common structural elements.

The size of the structural members should be carefully taken into account during the design phase in order to guarantee the structural integrity of a project. The weight that a structural part must support, the kind of material employed, and the required rigidity of the structure all have a role in determining its size. A structural member's size may also need to be modified to take other members' presence and the intended aesthetic of the structure into consideration. After the sizes of the structural members have been established, they should be verified that they comply with all criteria by comparing them to the relevant engineering standards and building regulations.

Depending on the application, structural components of composite constructions are usually constructed to have a variety of sizes. Generally speaking, the forces that must be resisted and the stiffness needed for the structure dictate the size of a structural member. The material chosen for the member's construction and manufacturing technique has an impact on its size as well. For instance, larger members might be needed for steel or concrete members than for lightweight composite members.

4. RESULT

Response Spectrum Method and Equivalent Static Method are used to analyse the described 3D building model. The STAAD PRO programme is then used to analyse the building models. For the seismic loads in the X-direction, several parameters are investigated, including storey stiffness, storey drift, base shear, weight of the structure, lateral pressures, mode shapes, natural time period, and frequency. A specific country's seismic codes are exclusive to that location. The primary code that gives an outline for determining seismic design force in India is IS 1893 (PART-1): 2002, which is the Indian standard criteria for earthquake resistant design of structures.

5. CONCLUSION & FUTURE SCOPE

5.1 CONCLUSION:

1. In composite structures, the self-weight of frame is less and therefore substantial reduction in cost of construction of foundation is observed.

2. Under seismic considerations because of the inherent ductility characteristics, steel- concrete structure will perform better than a conventional R.C.C. structure.

3. High ductility of steel material leads to better seismic resistance of the composite section. Steel component shows ductile behavior without premature failure and can withstand numerous loading cycles before fracture.

4. Steel being cost inducing construction material can pose material cost on higher side. But speedy construction, reduced dead load & various other factors can counteract overall project cost.

5. Base Shear for RCC frame is on higher side because the weight of the RCC frame is more than the composite frame.

6. Analysis of the composite building shows that the axial forces, moments and shear forces of the structure are very less for the same loadings as compared to the RCC building. The reduced moments and axial forces ultimately results in the reduced dimensions of the columns and beams of composite building. Hence one can conclude that the composite construction is more economical then the conventional RCC construction

5.2 FUTURE SCOPE:

The comparative analysis of RCC (Reinforced Concrete) and composite structures can have several future scopes. Here are some potential areas of focus:

- Performance Evaluation: Future research can delve deeper into the performance evaluation of RCC and composite structures under various loading conditions. This includes assessing factors such as strength, stiffness, durability, fire resistance, seismic performance, and long-term behavior. Comparative studies can help identify the strengths and weaknesses of each type of structure and optimize their design accordingly.

- Sustainability and Life Cycle Assessment: As sustainability becomes an increasingly important consideration, future studies can explore the environmental impact and life cycle assessment of RCC and composite structures. This involves evaluating factors such as embodied carbon, energy consumption, recyclability, and overall sustainability. Comparisons can aid in identifying which structural system has a lower environmental footprint and suggest strategies for improvement.

- Advanced Materials and Construction Techniques: Advancements in materials and construction techniques can significantly impact the design and construction of both RCC and composite structures. Future research can explore the use of innovative materials like high-performance concrete, fiber-reinforced polymers, carbon fiber composites, and hybrid systems. Comparative studies can highlight the benefits and challenges associated with incorporating these materials into each structural type.

- Structural Optimization and Design Guidelines: Comparative analysis can help in developing optimized design guidelines for RCC and composite structures. By studying their behavior and performance under different loading scenarios, researchers can establish design methodologies that ensure structural safety, efficiency, and cost- effectiveness. This can include developing code provisions, design charts, and guidelines tailored specifically to each type of structure.

- Retrofitting and Rehabilitation Techniques: Retrofitting and rehabilitation of existing structures is an important aspect of structural engineering. Future studies can explore the comparative effectiveness of retrofitting techniques for both RCC and composite structures. This involves investigating methods such as external post-tensioning, fiber wrapping, and composite jacketing to enhance the load-carrying capacity and extend the service life of these structures.

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