Analysis of A Composite Structure Considering Using Different Tools: A Review

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Abstract- *Building static force analysis is now a common practice due to the accessibility of reasonably priced computers and specialised software. However, dynamic analysis takes a lot of time and necessitates extra information on the structure's mass as well as knowledge of structural dynamics in order to evaluate the analytical results. In metropolitan India, reinforced concrete (RC) frame buildings are the most prevalent style of construction. Throughout their life, these structures are subjected to a variety of factors, including dynamic forces from earthquakes and static forces from dead and live loads.*

Keywords- Composite buildings, Storey drift, Shear connectors, Seismic performance, Equivalent Static Analysis, Response Spectrum Analysis and Cost Analysis.

I. INTRODUCTION

An earthquake is a natural disaster that has claimed millions of lives throughout history, both documented and unrecorded. Earthquakes are disruptive disturbances caused by volcanic activity or subterranean movement along a fault plane that shake the earth's surface. When it comes to the number of fatalities and the destruction of infrastructure during the past century, the earthquake is among the most catastrophic occurrences in Indian history. Due to the world's growing urbanisation and population growth, there is a strong demand for tall building construction worldwide, and tall buildings are particularly vulnerable to earthquake damage. Engineering technologies must be improved in order to analyse structures under the influence of seismic forces, which are unexpected and random in nature. The primary goal of structural analysis is to ascertain how a structure will behave under various conditions. Over the course of three to four decades, reinforced concrete structures have been meeting increasing demands in the civil and structural engineering sector. The numerous structural and architectural uses of R.C.C. serve as evidence of its adaptability and effectively illustrate its versatility. When two heterogeneous materials are successfully fused together, they function as a single unit from a structural perspective, creating a composite construction. It is referred to as composite action when this happens. The majority of building constructions in developing nations like India are classified as low rise structures. These traditional reinforced cement concrete and pure sectional steel structures are therefore frequently employed worldwide because they are practical and cost-effective. However, medium- to high-rise structures appear as a way to meet the demand for vertical building construction brought on by a shortage of land and a fast population growth.

II. LITERATURE REVIEW

The assessment of seismic performance is an essential part of high-rise building design and safety studies, particularly in seismically active areas. The seismic resilience of high-rise buildings has been the subject of several studies throughout the years, especially in response to abnormalities in shape and design. In addition to affecting human safety, tall structures' structural integrity under seismic forces also affects the building's viability both economically and functionally after the earthquake. For these structures to be safe under dynamic stresses, sophisticated techniques and instruments that go beyond conventional seismic codes are required due to the complexity of their design and analysis.

REVIEW OF LITERATURE SURVEY

Ahmed Mohiuddin et.al (2025) Analysing and designing a G+9 residential building utilising ETABS software, with an emphasis on forces, stress, strain, deflection, and bending moment within the structural system, was the aim of the study. The structure's beams, slabs, columns and footings were all painstakingly planned in compliance with Indian Standard Codes, and a 3D model of the building was created for in-depth examination. The study focused on ensuring performance against shear and bending moments, evaluating stability and workability under varied loading and external situations, and comprehending the fundamentals of structural behaviour. Three basic goals had to be met during the design process: serviceability to maintain proper stiffness, reinforcement, deflection control, and vibration limitations under service load circumstances; strength to withstand generated stresses; and stability to avoid overturning, sliding, or buckling.

ETABS 2015 was used for the seismic analysis and design of a G+9 residential building in Hyderabad. The results showed that the program is an effective and user-friendly FEM tool for 2D and 3D modelling of RCC structures. In accordance with IS 456:2000 and IS 800:2007, structural components such as beams, columns, slabs, and footings were designed after gravity, wind, live, dead, and seismic loads were examined. In order to improve stability in the high-rise system, shear walls were added, and reinforcement was described in accordance with codal requirements. All structural elements met the standards for both the limit state of serviceability and the limit state of collapse, according to the results.

Vedika Patil and Savita Patil (2025) The seismic performance of G+20-story irregular (C and L-shaped) structures built using steel-concrete composite systems and traditional RCC was investigated in this study using ETABS software. In compliance with Indian Standard standards, both structural types were examined in seismic zones II–V and in soft, medium, and hard soil conditions. To compare their dynamic behaviour, important seismic characteristics were assessed, including storey drift, lateral displacement, and base shear. The study demonstrated the superior structural performance of steel-concrete composite structures over their RCC counterparts in a variety of seismic and soil situations, and it corroborated its findings with previous research.

Minor differences from the literature were observed in the validation of the G+15 model, with composite column buildings displaying 5.16% higher values and RCC buildings displaying 14.06% lower floor shear. For both structural types, ETABS's storey displacement and drift were higher than those found in the literature. While storey displacement and drift decreased with stiffer soil conditions, base shear increased for G+20 irregular C and L-shaped buildings. Although they showed lower displacement and drift percentages than RCC, steel-concrete composite buildings showed similar patterns, suggesting better seismic performance under a range of soil conditions.’

Bhuvnesh K. Goyal and Mahendra Saini (2024) The study's goal was to assess and contrast the strength, stiffness, and general stability of brick and composite walls built to withstand wind loads. The study looked at how different wall types' structural behaviour was affected by openings of various sizes and configurations, including windows and doors, and how these openings affected safety, structural integrity, and load distribution. Furthermore, taking into account elements like material deterioration, upkeep requirements, and long-term performance, the study contrasted the resistance and durability of brick and composite walls in the presence of apertures.

In comparison to conventional brick infill walls, the analysis shows that the use of FRP panels as infill wall material greatly lowers base shear, bending moment, shear force, storey displacement, and storey drift across all levels of wall openings. The most significant decreases were seen in bending moments and storey drift, demonstrating how well FRP panels work to improve structural performance, especially when it comes to lowering lateral displacements and related stresses.

Jian-cheng Zhang et.al (2024) Finite element analysis (FEA) modelling was used to examine the seismic behaviour of a steel-reinforced ultra-high-strength concrete (SRUHSC) composite frame. The seismic performance of the SRUHSC frame was then investigated using the numerical model, which included the P-skeleton curves, the stiffness degradation, the failure mode, the subsequent mechanisms of plastic hinges, and the stress-strain distribution. In order to determine how salient characteristics affected the SRUHSC frame's behaviour, a parametric analysis was finally conducted.

The horizontal load-bearing capacity and elastic stiffness of the structure were found to be enhanced with the increase of concrete strength, steel yield strength, and the linear stiffness ratio of beam to column; however, the ductility was not significantly affected. The structural steel ratio and volume stirrup ratio were increased, which enhanced the structure's ductility and horizontal load-bearing capability. The ductility and horizontal load-bearing capacity of the structure clearly deteriorated as the axial-load ratio increased; however, the elastic stiffness of the structure remained unchanged. Additionally, the FEA model was used to confirm the accuracy of a concrete constitutive model in the various degrees of constraint for the SRUHSC frame that the authors had proposed.

Rajan Suwal et.al (2024) aimed to compare the characteristics of composite and RC constructions for regular and irregular buildings of 6, 10, and 15 stories located in earthquake zone V, including storey drift, time period, deflections, etc. The linear static method, linear time history method, and static pushover approach were all carried out using ETABS software.

According to the results, composite constructions work better than reinforced concrete for multi-story buildings. In comparison to RC buildings, the study found that composite structures for both regular and irregular configurations had significantly higher lateral displacements, storey drifts, and time periods; overall displacements were higher for irregular shapes. However, compared to RC structures, composite structures showed significantly lower base shear values and overturning moments. Additionally, the pushover study revealed that composite buildings had better seismic performance despite their greater flexibility, achieving higher performance scores in both the X and Y directions.

Tushar Patidar and Dr. Savita Maru (2024) The main aim of the study was to evaluate the advanced composite structure and the traditional RCC-framed building on regular and irregular plan areas under varied soil conditions, while also comparing a number of result metrics. Using the Response Spectrum Method in ETABS, the study sought to analyse several plan configurations, such as square, L-shaped, and T-shaped structures, built on soft, medium, and hard soil conditions. To compare maximum displacements and storey drifts in the X and Y directions, as well as to compute modal participation factors, both conventional and composite constructions were evaluated. In addition, the research assessed base shear variations, maximum overturning moments, and other important seismic characteristics for various scenarios. The most cost-effective structural alternative was determined by comparing the findings in percentage terms, and suggestions and solutions were offered for cases that were not cost-effective to act as useful guidance for workable construction.

The results showed that SRCCH, LRCCH, and TRCCH values are lower in the case of story displacement and drift in various plan areas when comparing all the result parameters because the stiffness of RCC members is greater than that of the composite structure. Composite values appear to be efficient in all other output result parameters, so it is advised that when this kind of construction process is used, the displacement factors for composite structures can be reduced and the use of composite structures performs well when combined with building stability techniques.

Zhang Qing Qing and Zhang Li Na (2024) Use ABAQUS software to compare multi-story reinforced concrete (RCC) and composite buildings under common and uncommon earthquake pressures using the plastic deformation (PD) approach based on concrete plasticity theory (CPT). A 15-story tall building is taken into consideration. After creating a potential building model, the novel PD approach was used to analyse plastic deformation during both frequent and uncommon earthquakes. The results of the plastic strain distribution, lateral displacement, peak acceleration, storey stiffness, shear force, storey drift, normalised shear, and top deflection of the RCC and composite buildings were then thoroughly examined by a nonlinear time history analysis.

It was determined that the RCC model's fundamental time period was 5.2 s, but the composite model's fundamental time period was 6 s. The RCC building experienced a peak acceleration that was 19% and 22% higher than composite buildings under common and unusual earthquake shocks, respectively. The composite building exhibited top deflections that were 33% and 36% higher than those of RCC buildings under common and unusual seismic loads, respectively. This study demonstrated that increased ground motion peak acceleration (PA) resulted in larger top displacement, top deflection, shear force, and storey drift for the RCC building for both ground movements. It was indicated by numerical results that using a composite structure is more durable than using an RCC structure. Additionally, it was determined that the PD approach could be applied successfully to the analysis of composite and RCC buildings under dynamic loads.

Fahad Baig et.al (2023) examined a steel-concrete composite building that was G+8 stories tall and had a shear wall in various locations. Using the structural analysis program ETABS, the overall dimensions of the 25 m x 25 m 3D structure were examined. The findings were compared for minimum displacement, storey drift, and time period.

According to the results, a composite construction with shear walls at the corners has the least amount of displacement, storey drift, and time period.

Devendra R. Hargunani and Dr S.A. Rasal (2023) centred on applying the ETABS 2017 software for numerical analysis to assess the seismic impact of high-rise structures with composite shear walls. The study examines and contrasts different composite shear wall configurations with conventional RC shear walls, such as steel-encased walls, double skin composite walls, and walls with I-sections. Response spectrum analysis, material property definition, composite shear wall incorporation, seismic loadings based on design codes, and building model creation are all part of the process. Displacements, storey drifts, storey shears, and other seismic characteristics are among the structural response metrics that are assessed in order to determine how well the composite shear wall constructions perform.

The investigation shows how well composite shear walls work to enhance high-rise structures' seismic performance. The results indicate that the use of composite shear walls, specifically DS CSW and SEI CSW designs, can lead to improved structural stiffness and reduced storey drifts, which will improve high-rise structures' overall performance and safety during seismic events.

Ande Sowmya and Dr. N. Victor Babu (2022) The Equivalent Static Analysis Method and the Response Spectrum Method in ETABS were utilised to perform linear seismic analysis on a high-rise framed structure in accordance with IS 1893-2016 (Part 1) for various seismic zones in India. A comparative study of a G+12 building was the main goal, with an emphasis on assessing the distinctions between static and dynamic techniques with respect to important characteristics, including storey displacement, storey shear, and storey drift.

Maximum displacement from Equivalent Static Analysis was 27.46% larger in the X-direction and 27.4% higher in the Y-direction than that from Response Spectrum Analysis, according to the analysis. Static analysis also showed a greater maximum storey drift in the X and Y directions than dynamic analysis, by 5.73% and 6.4%, respectively. Since both approaches rely only on structural geometry, the time duration stayed the same. According to IS 1893 requirements, base shear values were almost identical in both analyses. Overall, the results showed that static analysis produced relatively better results, highlighting the necessity of dynamic analysis for highly efficient and cost-effective high-rise structure design.

Bhavya Upadhyay et.al (2021) examined under seismic loads the differences between reinforced concrete constructions with regular columns and those with specially shaped columns for a G+12 multi-story building with plan dimensions of 63.20 m × 29.50 m. ETABS (2018) was used to model and analyse the building, and both Equivalent Static Analysis and Dynamic Response Spectrum Analysis were used to assess the building's seismic dynamics.

According to the results, structures with rectangular columns had a larger bending moment (826.76 kN-m), while those with T-shaped and plus-shaped columns had lower values (734.17 kN-m and 566.81 kN-m, respectively), with the plus-shaped arrangement requiring less reinforcing. In the rectangular example, the unbalanced forces were again highest at 941.85 kN, but in the plus-shaped case, they dropped to 840.43 kN, indicating better stability. Decreased displacement in lightweight buildings to 66.16 mm from 88.84 mm in the bare frame, and improved lateral stability in constructions with plus-shaped columns were further benefits.

Rashmi S. Majgaonkar and Amit Mahajan (2021) Six models were examined in the study using ETABS software, and the various factors related to displacement, reaction, beam forces, storey drift, storey shear, storey stiffness, and time period were examined and contrasted.

The research revealed that the model-5, a G+3 building with 9x9 grid dimensions using steel members, had the largest resulting displacement of 25.5 mm, while the model-3, a G+3 building with 6x6 grid dimensions using composite material, had the smallest displacement of 10 mm. A G+3 building with 9x9 grid dimensions and RCC members, model-4, had the highest vertical response (Fy) of 350 kN, whereas model-6, a comparable grid plan structure made of composite material, had the lowest vertical reaction of 250 kN. In addition, the beam forces (Fy) were lowest in model-3 (23 kN) and greatest in model-4 (27 kN), suggesting that RCC members produced higher forces than composite alternatives.

Mohammed Akif Uddin and M. A. Azeem (2020) intended to compare the response parameters of conventional RCC structure models situated in seismic zone 5 with those of G+15 storey plan irregular composite structures with concrete-filled columns, plan irregular composite structures with concrete-encased columns, and stiffness, shear, moments, and axial forces.

When response spectrum analysis was done on the models, it was shown that composite structures had less stiffness than RCC structures. Although they are within acceptable bounds, the displacements and drifts are fewer in RCC constructions because of a higher stiffness value. Since composite structures have less dead weight than RCC structures, it is discovered that they have lower base shear and base moments. The two composite constructions' reaction parameters do not significantly differ from one another. A comparison of the two composite structures revealed no discernible difference between the response parameters of the structure with concrete-encased I-section columns and the structure with steel tube columns filled with concrete.

Pranita A. Maske et.al (2020) sought to assess the performance of composite columns in a residential G+11 multi-story building, with a focus on concrete-filled steel tube columns and composite encased I-section columns. Additionally, it aimed to examine how these two types of composite columns would behave structurally in buildings with different plan configurations, such as rectangular, C, L, and I shapes. ETABS is used to analyse the elastic/pushover behaviour of both RCC and composite frames.

According to the analysis, which was carried out with different parameters and contrasted with RCC frames, steel, EIS-SB, CIS-SB, and CFT-SB sections produced lower base shear and dead loads than RCC. Furthermore, it was discovered that CFT-RC outperformed RCC in terms of performance points. Consequently, it was determined that for high-rise building applications, composite sections are preferable to RCC.

Shuyun Zhang et.al (2020) evaluated a high-rise composite frame concrete tube structure's performance during different earthquake intensities by conducting a seismic vulnerability analysis utilising the Incremental Dynamic Analysis (IDA) method. Analyses of a 30-story hybrid structure were conducted using non-linear dynamic time history analysis and amplitude modulation on eight selected seismic records. Maximum inter-storey displacement angle was used as the performance index, while PGA, PGV, and Sa parameters were used to measure seismic intensity. In order to evaluate structural behaviour and any failure risks, IDA curve clusters were created, and the quantile curve approach was used to analyse the results.

The PGA strength index is more effective, according to the results. Effective evaluation of this type of structure's seismic performance is followed by the creation of the vulnerability curve and vulnerability matrix. Results of the analysis indicate that the hybrid structure has good seismic performance under 8-degree frequent, basic, and rare earthquakes and may satisfy the requirements of "three-level" seismic response.

Pallavi Wagh et.al (2019) conducted a comparative analysis of a G+21-story building in earthquake zone III that was planned with RCC and steel-concrete composite alternatives. ETABS software was used for structural analysis and three-dimensional modelling, and earthquake loading was assessed in compliance with IS 1893 (Part 1)-2002.

Due mainly to their higher dead weight and decreased ductility, the analysis revealed that RCC structures had higher base shear, axial forces, shear forces, and bending moments than composite structures. Axial forces varied from 11% to 28%, with the disparity growing as the number of stories grew, whereas base shear was 18% higher in RCC constructions. In a similar vein, RCC constructions had 8% to 16% higher shear force and bending moment values, with the differences being more pronounced in taller buildings.

Sunita Dahal and Rajan Suwal (2019) examined 10 multistory commercial buildings in earthquake zone V, with a total height of four to twenty stories, to determine their seismic behaviour. Conventional RCC structures, half composite structures (with only composite columns), and full steel-concrete composite structures (with composite beams and columns) were all taken into consideration. The analysis was conducted using SAP2000 software, and IS:1893 (Part 1)-2002's guidelines were used to assess seismic loading. Comparative evaluations were conducted for parameters such as time period, axial force, shear force, bending moment, deflection, storey drift, base shear, and storey stiffness using the equivalent static method of seismic analysis. An effective, cost-effective, and creative method for enhancing the seismic resistance of multistory structures was discovered to be steel-concrete composite construction.

According to the findings, RCC structures showed the least amount of flexibility and the longest time period, whereas composite buildings showed the longest and the greatest flexibility under lateral stresses. Despite being almost twice as large as RCC buildings, the maximum nodal displacement of composite structures was still within acceptable bounds because of their greater flexibility. Structures made of steel and composite materials had higher ductility than RCC, which made them better suited to withstand seismic stresses. Because of their lower seismic weight, composite buildings also faced less seismic stress than RCC structures. The results demonstrated that composite systems outperformed RCC in high-rise structures and that their lower structural weight resulted in cheaper foundation expenses. Moreover, composite buildings were shown to be a more cost-effective and efficient alternative to RCC constructions due to their shorter construction process, which enabled a quicker capital return through rental benefits.

A.S.Mahajan and L.G.Kalurkar (2016) provided the G+20 building's thorough analysis. The behaviour of axial force, shear force, bending moment, twisting moment, base shear, and displacement is explored in detail using the E-tab 2015 software.

As demonstrated by the outcome, the composite model's performance is not only safe, stable, and habitable, but it also saves money and time. Slab, beam, and FEC column structural members show a qualitative improvement, indicating less displacement, bending, twisting moment, and shear and axial force, leading to high strength, stiffness, quick erection, and effective use of the concrete and steel model of composite designing.

III. CONCLUSION

A substantial body of research has compared the structural performance of high-rise reinforced concrete (RCC) buildings with composite structures, highlighting the distinct advantages and limitations of each system. Multiple authors have investigated parameters such as seismic response, dead load, storey drift, displacement, and base shear by analyzing models of varying heights using advanced computational methods and software like ETABS and ABAQUS. Composite structures are consistently shown to possess lower dead weights, resulting in reduced foundation costs and better seismic performance due to decreased induced earthquake forces and greater ductility. Researchers such as Charantimath et al., Tushar Patidar, and others demonstrated that composite frames exhibit notable benefits over RCC frames in high-rise scenarios, including higher stiffness, lower structural member sizes, and improved resistance to dynamic loads, which contribute to enhanced resilience during seismic events.

Literature surveys also reveal that composite construction fosters faster project completion and allows more efficient vertical expansion in urban areas. Comparative analyses identify composite structures as optimal for high-rise applications while RCC is generally more suitable for low-rise buildings due to cost and procedural considerations. For instance, studies by Ankit Kumar and Mohammed Akif Uddin highlight how composite models maintain permissible drift and displacement under seismic loading, exhibit lower base shear and bending moments, and ultimately deliver higher durability and load resistance compared to their RCC counterparts. While composite systems introduce increased complexity in design and analysis, especially due to unfamiliarity and the need for precise shear connections, their superior performance under both static and dynamic loads positions them as a preferred solution for tall building structures. Overall, recent research strongly recommends composite approaches for high-rise buildings, with authors advocating their adoption for enhanced structural efficiency, earthquake safety, and economic viability.

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