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EARTHQUAKE ANALYSIS OF MOMENT RESISTING FRAME

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Abstract : Seismic activity engineering in India has been crucial for over 35 years, but recent earthquakes have shown less satisfactory performance of normal structures due to lack of awareness among practicing engineers about earthquake-resistant design and construction. This report presents the pre requirements for earthquake resistance in construction and suggests techniques to improve building resistance economically. This paper examines seismic analysis of a residential building in zone III, focusing on the response reduction of ordinary moment resisting frames and special moment resisting frames. The study uses equivalent static and response spectrum analysis methods and reveals that the special moment of resisting frame is effective in resisting seismic loads, highlighting the importance of seismic analysis in designing earthquake-resistant structures

***Index Terms* – SMRF, OMRF, Earthquake Analysis, Staad Pro.**

I. INTRODUCTION

Due to land scarcity and population growth, multi-storied buildings are becoming inevitable for residential and office purposes. However, these structures are not designed for lateral forces resistance, potentially leading to failure. Earthquake resistance structures are designed based on factors like natural frequency, damping factor, foundation type, building importance, and ductility. High-performance buildings are designed as SMRFs, designed for lesser forces. This article discusses about the importance of seismic activity engineering in India, highlighting the need for earthquake-resistant design and construction. Special moment resisting frames effectively resist seismic loads in earthquake-resistant structures.

1.1 SMRF & OMRF:

IS 1893 (Part 1), 2002 provides the criteria for earthquake resistant design of structures. Part 1 specifically focuses on general provisions and buildings. The Bureau of Indian Standards (BIS) classifies RC frame buildings into two categories: Ordinary Moment Resisting Frames (OMRF) and Special Moment Resisting Frames (SMRF). These categories have response reduction factors of 3 and 5 respectively. In order for a structure to remain elastic during its response to the Design Basis Earthquake (DBE) shaking, the design lateral force response needs to be reduced. This reduction is achieved by applying the Reduction Factor (R), which determines the generation of actual base shears.

II. LITERATURE REVIEW

1. Km Priyanshu et.al (2023): Earthquakes are a natural disaster caused by tectonic plate movement and crust excitation. Many buildings lack seismic provisions, leading to collapse and disintegration. This research examines earthquake-resistant building design for sloping terrain or hilly areas. It considers 8-, 12-, and 16-story frames on plain and sloping ground, with slopes and zones V. Frames are designed and analyzed using ETABS v-19 software, and response reduction factors are calculated.
2. Akanksha Adarsha et.al (2023): Over the past few years, India has experienced numerous devastating earthquakes, resulting in the loss of thousands of lives. With the advancements in technology, it is now possible to reduce the damages caused by earthquakes. Therefore, it is imperative for government authorities to enforce strict adherence to the prescribed guidelines for constructing earthquake-resistant high-rise buildings. It is crucial to prioritize the development of structures that can withstand seismic activities. By adhering to the recommended guidelines for structural design, we can significantly minimize the loss of human lives.
3. Shubham Tripathi et. al (2022): This study explores performance-based design in earthquake resistance design, focusing on low to medium-rise buildings. It analyzes deficient RC frames using static and non-linear analysis, installing energy dissipation devices. The study uses CSI ETABSv18 software for analysis. Results show that structures with lead-rubber bearing isolators perform well during earthquakes, satisfying minimum performance objectives. Viscous fluid dampers may not achieve desired performance, but they help reduce floor acceleration.

4. Ruchi, Kusum Choudhary et. al. (2022): Earthquakes indicate a shift in the internal structure of the Earth. Seismic activity is a common occurrence worldwide, but its frequency is influenced by the tectonic configuration of a particular region. Previous earthquakes have had devastating consequences, causing significant loss of life and property, and impacting a nation's social and economic well-being. While it is impossible to prevent earthquakes, efforts can be made to minimize damage by constructing earthquake-resistant buildings. As our understanding of earthquakes has grown, most countries now mandate the incorporation of seismic requirements in building design and architecture. The objective of this paper is to conduct a comprehensive review of earthquake-resistant tall buildings in different seismic zones across India. This study aims to explore the various techniques employed in constructing these tall buildings to enhance their earthquake resistance. The research approach involves analyzing multiple case studies and literature sources, and subsequently comparing their findings in relation to earthquakes.
5. Anurag Verma et.al (2020): The G+3 multi-storey residential building underwent thorough planning, analysis, and design. This building consists of three floors above ground level, with a basement dedicated to parking. The apartments occupy the remaining floors. The structural components were meticulously designed and detailed using AutoCAD. The analysis and design process adhered to standard specifications, utilizing STAAD.Pro for both static and dynamic loads. The dimensions of the structural members were specified, and various loads such as dead load, live load, floor load, and earthquake load were taken into account. To ensure the structural integrity, deflection and shear tests were conducted on beams, columns, and slabs. These tests confirmed that the building meets safety standards. Extensive theoretical work was carried out, leading to the conclusion that practical experience provides a deeper understanding compared to theoretical knowledge.

III. MODELING AND ANALYSIS

The study focused on analyzing a 3BHK residential building with 15 floors for self-weight, dead load, live load, wind load values, and seismic load calculations. The structure was evaluated based on IS 875 part-1 and part-2 specifications, STAAD.PRO for wind load values, and IS 1893-2002 part-1 for seismic load calculations.

The G+15 RCC structure was specifically examined due to its vulnerability to collapse during earthquakes, leading to its design as an Earthquake resisting structure in accordance with IS 1893: 2002. The study involved modeling and analyzing two frames of the G+15 RCC building under seismic effects. One frame was analyzed as an SMRF frame (Special Moment Resisting Frame) while the other was analyzed as an OMRF (Ordinary Moment Resisting Frame). Both models had a foundation depth of 3 meters, a basic plan area of 7.6 x 10.15 meters, a floor to floor height of 3 meters, and a column spacing of 3 meters in the X and Z directions. The total height of the structure was 46 meters, including 15 floors and a 1-meter plinth height.

The structure was analyzed using STAAD PRO V8i software, ensuring the absence of duplicate nodes or members and providing beam and column parameters. All column bases were assigned as fixed support, and earthquake loads were applied based on IS 1893: 2002 guidelines for Zone III earthquakes. The frames were then analyzed, and the results were compared, focusing on different Response reduction factors (R) and examining parameters such as maximum bending moment of beams, axial forces on columns, drift in X and Z directions, and lateral force distribution on each floor.

Table No. 1, "Structural Details"

Sr. No.	Description	Dimension
1	Size of Plan	7.6 meter x 10.15 meter
2	Size of Beam	450mm x 300mm
3	Size of Column	800mm x 600 mm
4	Storey Height	3meter each
5	Total Building Height	46 meter
6	Zone Factor	III
7	Wind Speed	44 meter/sec
8	Importance Factor	1
9	Soil Type	Medium Stiff
10	Grade of Concrete	M25
11	Grade of Steel	Fe415
12	Response Reduction Factor	SMRF =3
		OMRF=5

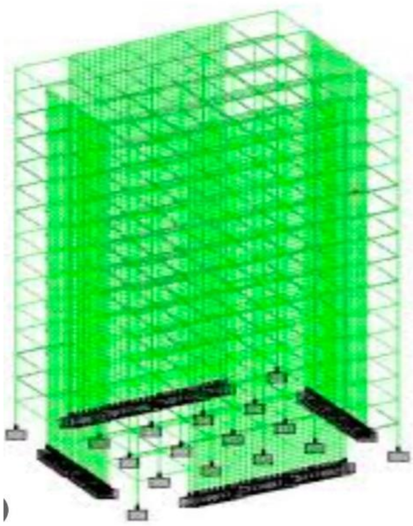

Figure No.1, "vStaad Pro Model of Building"

IV. RESULT

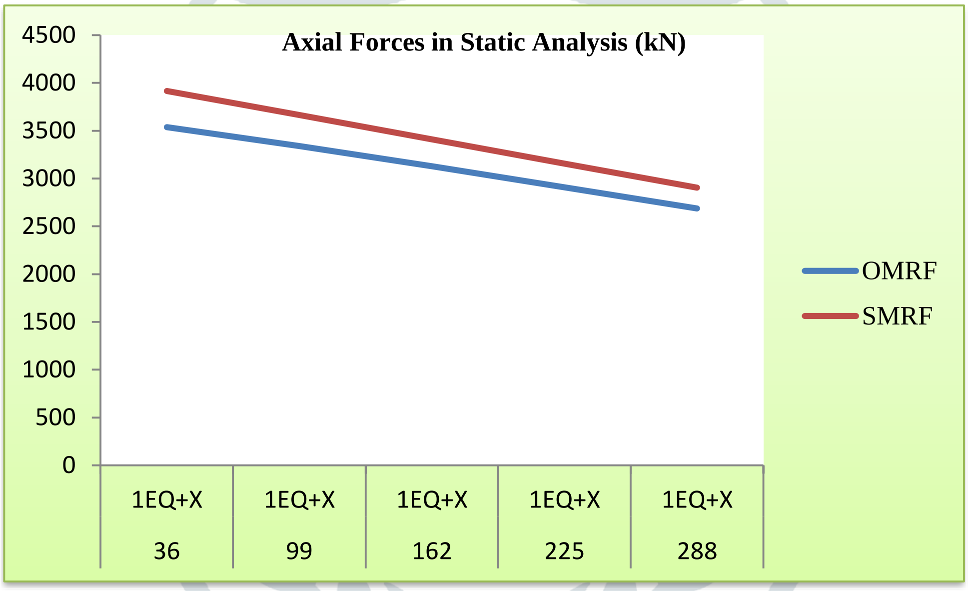

Figure No. 02, "Axial Forces in Static Analysis (kN)"

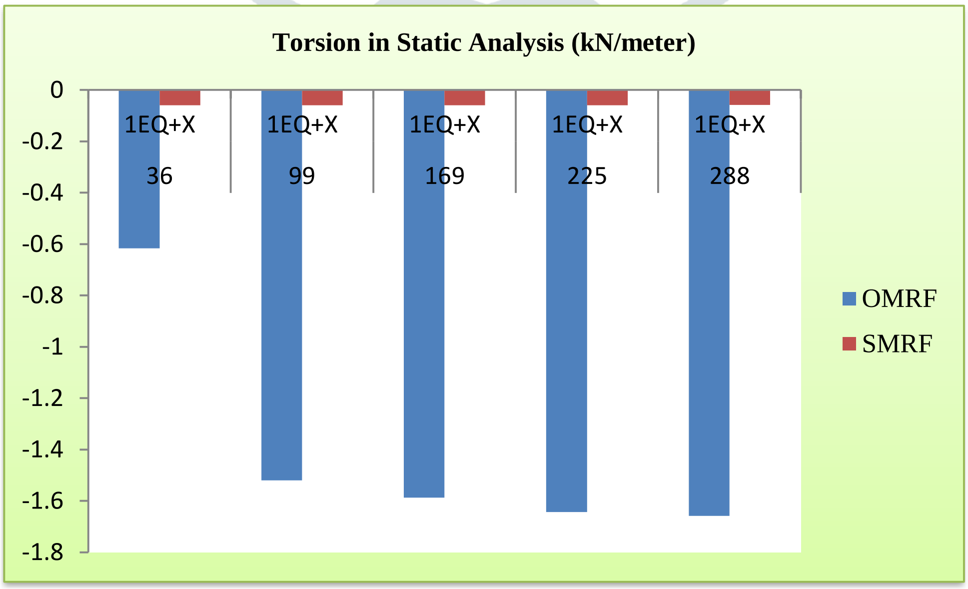

Figure No. 03, "Torsion in Static Analysis (kN/meter)"

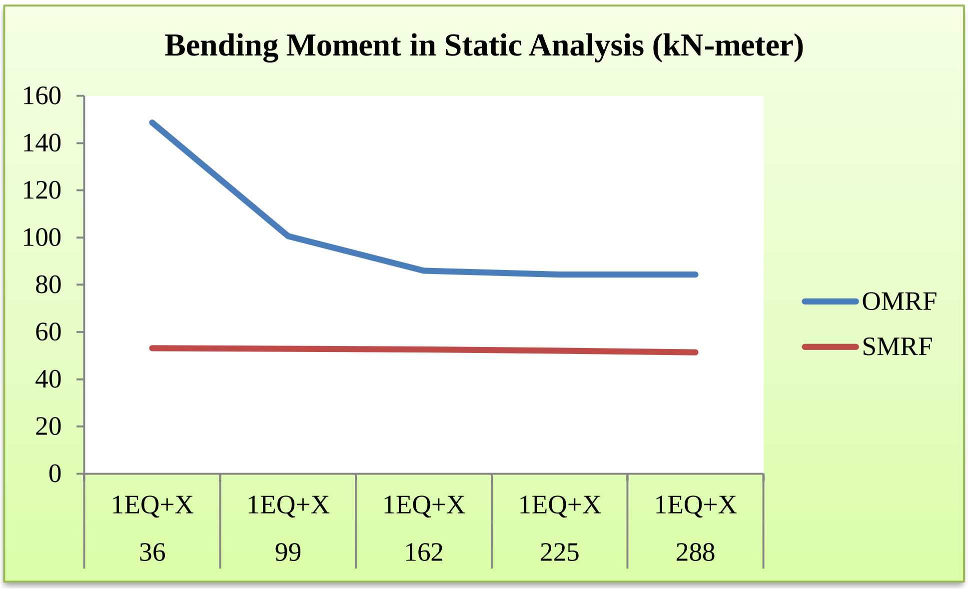

Figure No. 04, "Bending Moment in Static Analysis (kN-meter)"

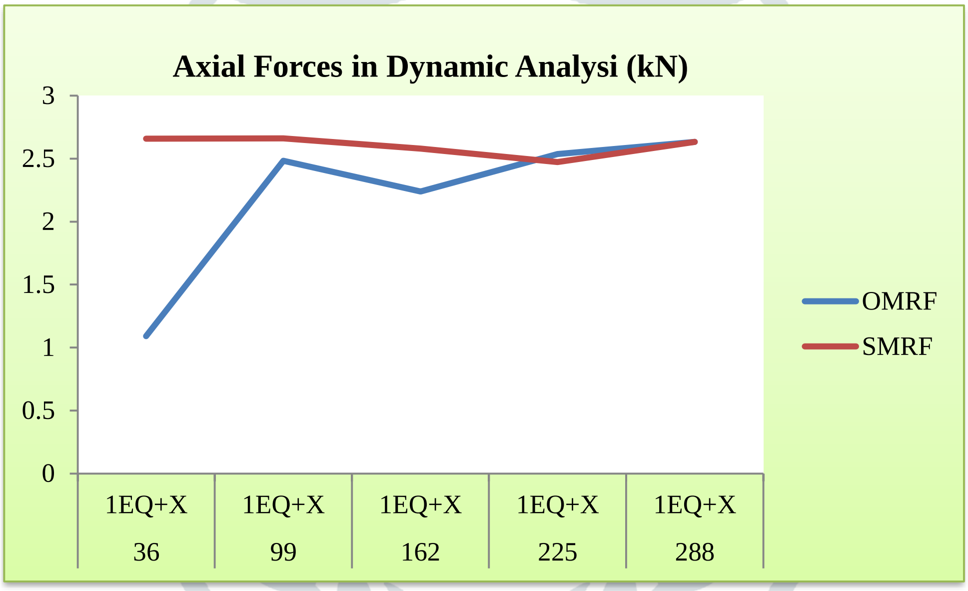

Figure No. 05, "Axial Forces in Dynamic Analysi (kN)"

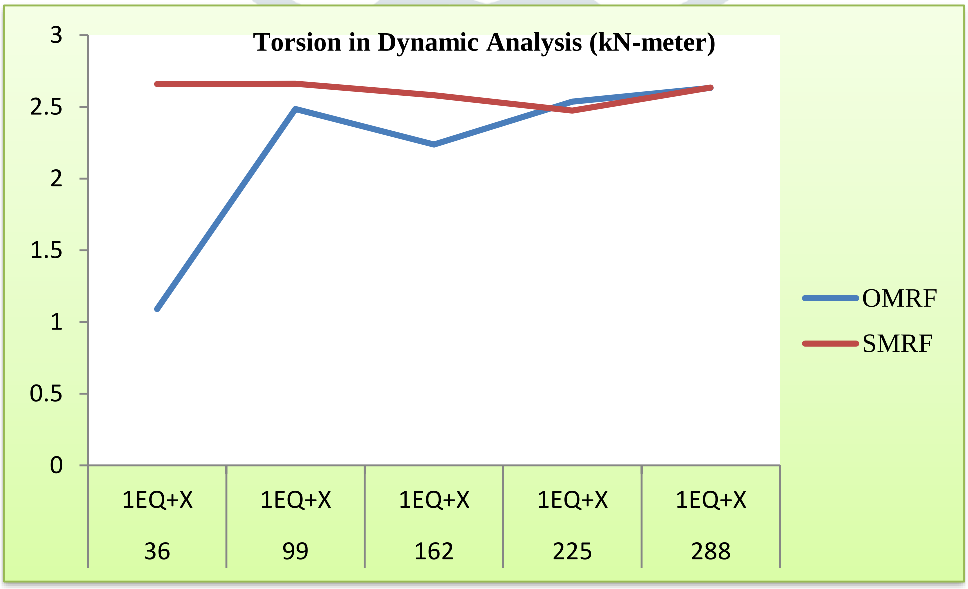

Figure No. 06, "Torsion in Dynamic Analysis (kN-meter)"

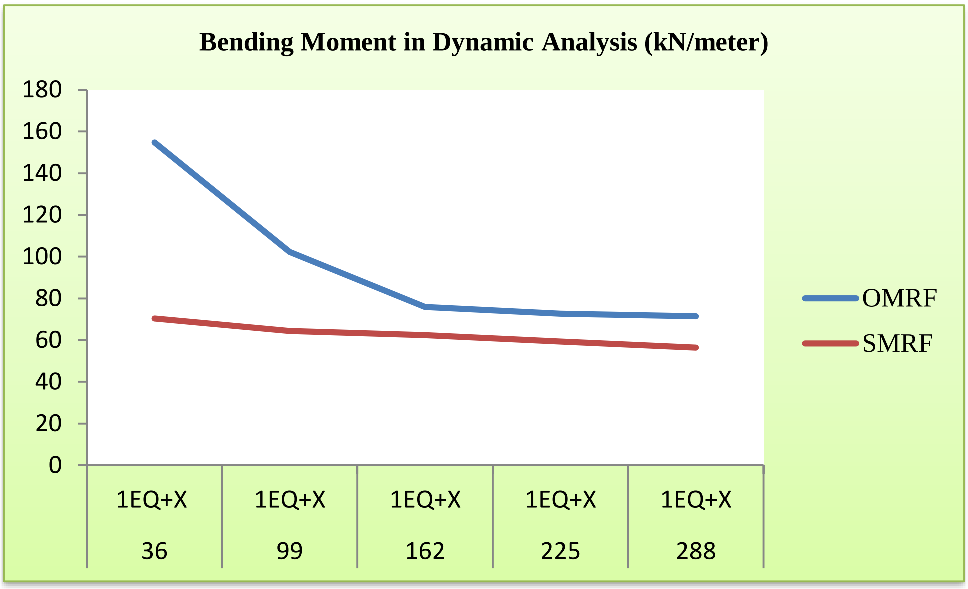

Figure No. 07, "Bending Moment in Dynamic Analysis (kN/meter)"

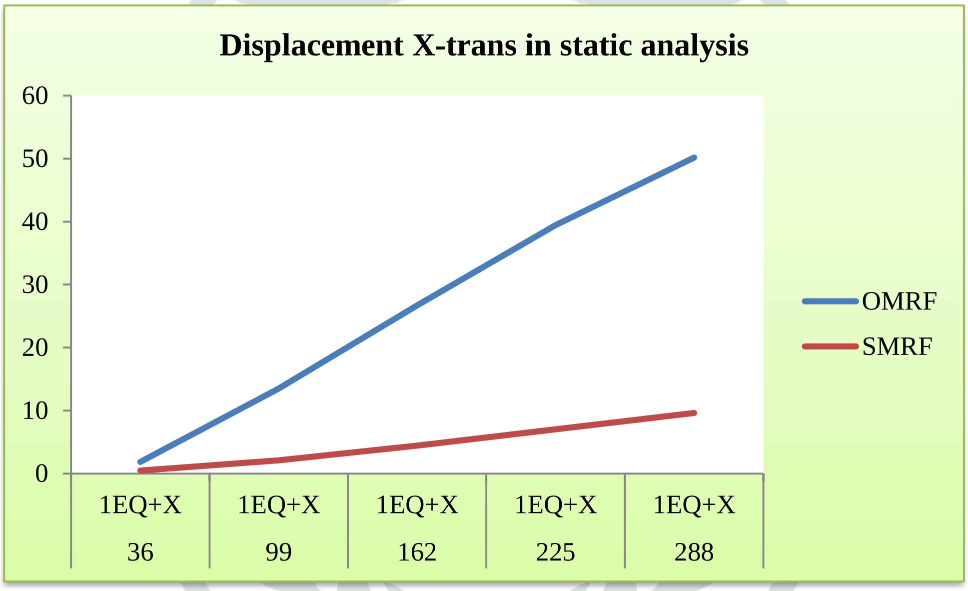

Figure No. 08, "Displacement X-trans in static analysis"

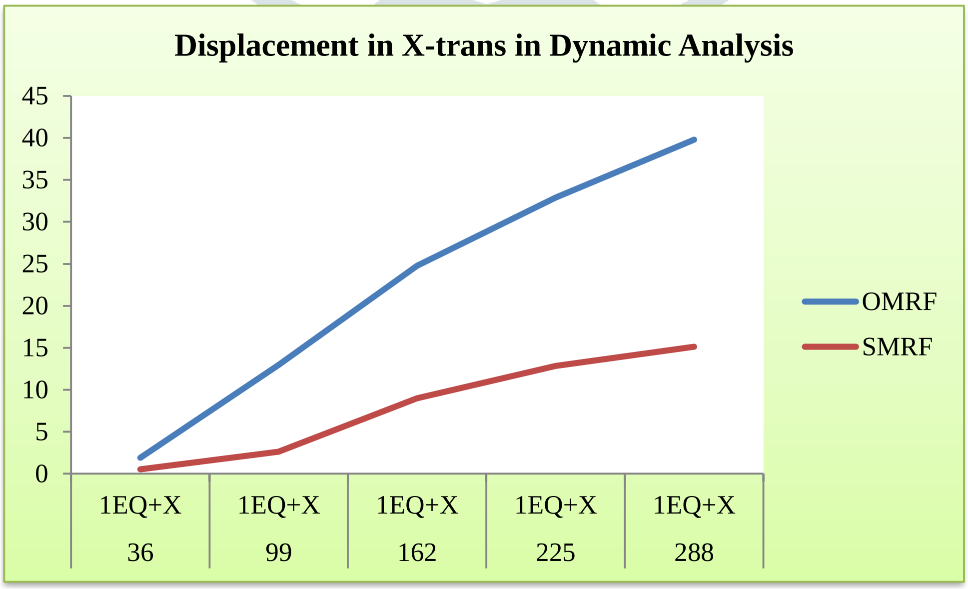

Figure No. 09, "Displacement in X-trans in Dynamic Analysis"

V. Conclusion:

The comparison between static and dynamic analysis of OMRF and SMRF structures shows that axial forces, torsion values, and bending moment and displacement values are similar. Nevertheless, dynamic analysis indicates higher values for displacement and axial forces. In static analysis, torsion values are negative, whereas in dynamic analysis, they are positive. Bending moment values are greater in dynamic analysis, and displacement values show a gradual increase. The results of static analysis suggest that the SMRF structure in dynamic analysis performs better in withstanding earthquake forces when compared to both OMRF and SMRF structures in static analysis.

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