Review Article

OMRF and SMRF Structures in Different Seismic Zones

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ABSTRACT

The need to compare the approaches to analysing and designing building structures has arisen from the increase in the frequency of earthquakes each year and the resulting increase in loss of life and property. Regular RC moment resisting frames (OMRF) and special RC moment resisting frames were the two categories into which building structures were split for the study (SMRF). Two comparisons have been made in these studies. The structures of the OMRF and SMRF are first contrasted. The second comparison examines how a building structure behaves in various earthquake zones in India. The four earthquake zones are designed for using STAAD Pro software. In this study, the structure was varied during design while taking into account OMRF and SMRF structures. The building structure according to the zone was studied by dividing it into two categories, namely Ordinary RC Moment Resisting Frame (OMRF) structures and Special RC Moment Resisting Frame (SMRF) structures. The building frames consist of five identical bays spaced equally along both axes. According to IS 456:2000, thirteen different load combinations are taken into account. Equivalent Static Code Method is the analysis technique used. STAAD Pro software was used to conduct the analysis using Indian standards. Additionally, IS 1893 (PART 1):2002, IS 456:2000, IS 875 (PART 1):1987, IS 875 (PART 2):1987, and IS 13920:1993 are the codes that are used as references. Shear force, bending moment, maximum deformation, and storey deformation are the variables that were computed and compared.

KEYWORDS

IS Codes, SMRF structures, OMRF structures, RC Moment Resisting Frame, Equivalent Static Code Method , STAAD Pro software

1. INTRODUCTION

India has experienced some of the major earthquakes in history, and the nation was a pioneer in the development of earthquake engineering. Following the Assam earthquake in 1987, a new earthquake-resistant housing design was created, and it is still widely used in northeast India. Following the baluchistan's earthquakes of the 1030s, the first seismic zone map and novel earthquake-resistant building techniques were developed. The establishment of institutions begins in the delayed 1950s, and many significant projects in the nation's seismically active regions have used earthquake engineering principles. Despite these early gains, the country's earthquake risk has been alarmingly rising, as evidenced by the extensive damage during moderate earthquakes.[6]

The need to compare the approaches to analysing and designing building structures has arisen from the rise in the frequency of earthquakes each year and the resulting rise in loss of both lives and property. The choice of a building configuration, one of the most crucial elements of the overall design, may severely restrict the structure's ability to serve as a seismic barrier. The zones in India are divided based on the power of an earthquake. The Indian codes divided the country into four seismic zones based on the seismic risk (II, III, IV, and V).

Under seismic loads, regular buildings are thought to perform far better than irregular buildings. This is what the codes have been urging us to do all along. In the construction of buildings, irregularities are unavoidable. As competition has intensified, so have aesthetic demands. It is preferable to combine strength and beauty. As a result, a thorough investigation into the structural behaviour of irregular structures subjected to seismic loading is required for proper design and improved performance.

2. LITERATURE REVIEW

Abhishek Tiwari, Kanhaiya Kumar Yadav, Mahesh Chandra Jan 2021 Staad Pro software is used to examine a G+18 construction in seismic zone III with medium soil in India and determine the severity of an earthquake. Various aspects of this study utilize different parameters, such as the damping ratio is set at five percent, the importance factor I is 1.5 for an important building, the building's height is set at 3.2 m, the floor thickness is 3.2 cm, the beam thickness is 650 mm by 650 mm, the column thickness is 650 mm by 650 mm, and the shear wall thickness is 150 mm. These two techniques are applied to determine the maximum deformation, maximum bending moment, maximum shear force, maximum axial forces, and other variables such as storey-wise deformation.

Payal P. Khobragade, Prof. Sushant M. Gajbhiye Feb 2020 The OMRF building has much heavier confinement than the SMRF structure because of splicing and the use of several ductile reinforcement with stirrups. The OMRF building has a base shear capacity that is 7 to 28 percent higher than the SMRF building. To endure seismic loads, the building's stiffness and strength must be increased. Designing a ductile detail structure is safer than designing a non- ductile detailed structure. In the incidence of SMRF, additional steel was identified than in the scenario of OMRF.

Faisal Najeeb N.M, Fasna T, Sivakumar B, May 2018

A plan-irregular RC building is of interest to this project. Three G+5 building models and one symmetric plan are under research. In the estimation of lateral forces, storey drift, base shear and storey shear, ETABS 9.5 is utilized. Using four different cross-sectional shapes in columns, it is possible to perform an evaluation of lateral force resistance. Under the authority of an intense earthquake, IS 1893–2002 (part 1) has received dynamic responses. Responsive spectrum is employed in dynamic analysis. In adding up, the CQC technique was used for each model for estimation of dynamic response for 5%, 10%, 15%, and 20% damping.

Amit Kumar Yadav, February 2017

The focus of this research is to explore different building systems and the roles of Moment Resisting Frames in resisting forces. Structural Frames (SMRF and OMRF) are defined in this report as special moment resisting frames. Every type of building arrangement is included, including normal and atypical ones. When building frames are compared, their behaviour in relation to varying elevation irregularities and the resulting reduction in response is examined. Three buildings have structural systems modelled to emulate SMRF and OMRF. When it comes to building design, three different options are being considered: a bare-frame block structure, a stepped structure, and a plaza structure.

3. PROBLEM DISCRIPTION

1. The results are then put side by side in terms of moments, shear force, deformation s, and storey deformation. The analysis is carried out in accordance with IS 1893 (PART 1):2002.

- Learn how the displacement of the special RC Moment Resisting Frame Structures differs from that of the regular RC Moment Resisting Frame Structures.
- Calculate the seismic response of the structure in various zones and with various building and structure heights. Different codes used for the designing are Indian standard 875 (I & 2), Indian standard 1893:2002 (I), Indian standard 456:2000 and Indian standard 13920:1993.

4. METHODS OF SEISMIC ANALYSIS

4.1 General

Seismic analysis has recently seen a major growth in both research and practice because of the increased availability of reliable and user-friendly software, in addition to fast computers. Flowchart illustrating some of these structural building analysis techniques:

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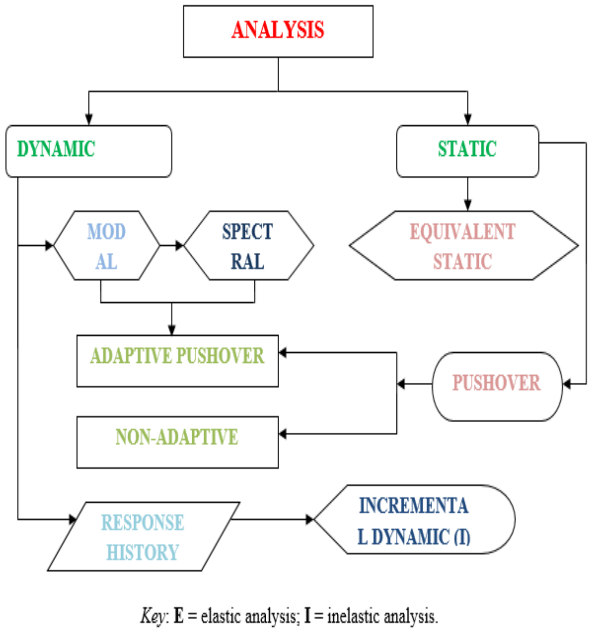


Fig.1 Flowchart illustrating some of these structural building analysis techniques

LOAD CASE NO.	LOAD CASE DETAILS
1.	E.Q. IN X_DIR.
2.	E.Q. IN Z_DIR.
3.	DEAD LOAD
4.	LIVE LOAD
5.	1.5 (DL + LL)
6.	1.5 (DL + EQ_X)
7.	1.5 (DL - EQ_X)
8.	1.5 (DL + EQ_Z)
9.	1.5 (DL - EQ_Z)
10.	1.2 (DL + LL + EQ_X)
11.	1.2 (DL + LL - EQ_X)
12.	1.2 (DL + LL + EQ_Z)
13.	1.2 (DL + LL - EQ_Z)

4.2 Method adopted in the analysis work

- Method of Dynamic Analysis
- Method of Static Analysis
- We prepared a G+8 storey building challenge.
- We use a reduced coding way to perform equivalent static analysis .
- In order to analyse the structures using the simplified code method, the following procedures were taken:
- Geometry, bays, and storey are of building (3 geometries).
- Model selection for response reduction factors (OMRF and SMRF) according to IS 1893 (PART 1):2002 Table 7.
- Using Table 2 of IS 1893 (.PART 1):2002, select four seismic zones (II, III, IV, and V).

- Importance factor selection according to IS 1893 (PART 1):2002 Table 6.
- Based on IS 456:2000 and IS 1893 (PART 1):2002, consider thirteen load combinations.

4.3 OMRF & SMRF

A moment-resisting frame that doesn't adhere to specific detailing requirements for ductile behaviour is known as an ordinary moment resisting frame (OMRF). A moment-resisting frame known as an SMRF is one that has been specifically designed to exhibit ductile behaviour and adhere to the specifications outlined in IS-4326, IS-13920, or SP6.

4.4 Earthquake Magnitude and Intensity

An earthquake, thus, is literally described as an episode of intense seismic energy generation. Richter scales are commonly employed as magnitudes scales. Trace deformation of surface-wave seismograms is the most important parameter in determining the amount of an earthquake. Magnitudes estimated from body wave components of seismograms are widely used to refine magnitude estimations due to this property. But, for the purposes of reporting, the outcome is almost always reported as equivalent Richter magnitude. When it comes to measuring the magnitude of an earthquake, there is a direct correlation between the quantity of energy emitted (E) and the Richter magnitude (M).

$$\log_{10} E = 11.4 + 1.5M$$

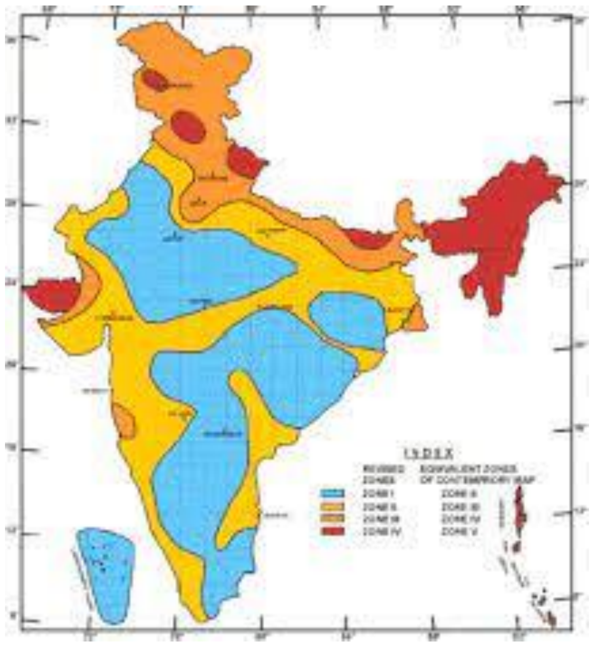
The intensity of an earthquake is a subjective assessment of its perceived local impacts, and it is determined by peak acceleration, duration, and velocity. The modified Mercalli scale (MM) is the most extensively used, having been established by Mercalli in 1902, amended by Wood and Neuman in 1931, and revised by Richter in 1958.

Destructive Effects of Earthquakes –

1. At or around the epicenter, earthquakes cause buildings, bridges and other infrastructure to collapse. Many people and animals are slain and buried beneath the surface.
2. Rails have been folded, and underground wires have been severed. In huge cities, fires are unavoidable.
3. Tsunamis are sea waves that are origin by earthquakes.
4. Earthquakes cause fractures and fissures in the ground.
5. Earthquakes generate landslides, avalanches, and landmass denudation.
6. Earthquakes can sometimes block valleys, forming undesirable lakes or rerouting river flows, resulting in catastrophic scenarios.
7. It has psychological consequences that might take years, if not a lifetime, to overcome.

4.5 List of Earthquake (Seismic) Zones in India

The Bureau of Indian Standards divided the nation into four seismic zones, namely Zones II, III, IV, and V, based on the country's seismic past. Zone-V is the seismically least active of these four zones, while Zone-II is the seismically most active.



Seismic Map of India

Seismic Zone	Intensity on M.M Scale
Zone-II (Low-Intensity Zone)	6 (or less)
Zone-III (Moderate Intensity Zone)	7
Zone-IV (Severe Intensity Zone)	8
Zone-V (Very Severe Intensity Zone)	9 (and above)

5. CONCLUSION

The OMRF and SMRF are evaluated for all seismic zones, considering various types of traditional and irregular buildings. The following concludes the work.

BENDING MOMENT

1. The special moment resisting frame is more efficient than ordinary moment resisting frame and SMRF reduces moments means reduces area of steel so it is more economical to OMRF.
2. As the seismic zone intensity rises, so does the rate of bending moment.
3. While the form of the graph is consistent throughout seismic zones, it is evident that bare frame is best, stepped is second best, and plaza buildings are critical.

SHEAR FORCE

1. The special moment resisting frame (SMRF) is more efficient than the ordinary moment resisting frame (OMRF), as it decreases shear forces and hence shear reinforcement, making it more cost effective.

2. As the seismic zone intensity rises, the rate of shear forces rises as well.
3. While the form of the graph is consistent throughout seismic zones, it is evident that bare frame is best, stepped is second best, and plaza buildings are critical

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