

## A REVIEW PAPER ON DESIGN OF STEEL BUILDING AND ITS ELEMENTS WITH DUCTILE DETAILING IN ZONE IV

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### ABSTRACT

The aim of the project is to Analyze and design seismic resistant multi-storied reinforced cement concrete building. According to the numerical results, the building frame designed by IS456-2000 where earthquake load is considered as per IS1893-2016 and ductile detailing by 13920:2016 provides the inelastic behavior and response intended by the code and satisfies the inter-story drift and maximum plastic rotation limits suggested by FEMA. The major factors distinguishing the two frames are its response reduction factor which depends on the structure over strength, ductility and redundancy. To see the response of the two moment frame two seismic zone were taken zone III and zone V. when the two structures was analyzed by using response spectrum method it was found that SMRF structure had better response to the earthquake loading with the minimum drifting and lateral loads in all two cases i.e., for two seismic zones.

### 1. INTRODUCTION

Earthquake is the moment of the earth's lithosphere resulting from the sudden dissipation of energy from the crust which is usually generated due to the movement of the tectonic plate's i.e. When the two plates move away or towards or grind against one another. Thus the lateral force generated due to earthquake is distributed by the flexure rigidity of the structure component. Moment frame are load resisting skeletal system consisting of rectilinear beams and columns, where columns are rigidly connected to the beams. Steel moment frame selection depends on two specific factors: seismic zone and response factor of the frame. The seismic force resistance system or moment frame is provided to resist lateral forces. Steel moment resistant frame without bracing are of two types ordinary moment resistance frame (OMRF) and special moment resistance frame (SMRF). When moment frame is provided with specified details which increase the ductility and energy consuming capacity of the building it is called special moment resisting frame otherwise it is known as ordinary moment resisting frame. Indian codes have divided India into FOUR seismic zones (II, III, IV &V) depending on the seismic damage. OMRF is most commonly adopted frame system in lower seismic zones, however with increase in the seismic risk, OMRF become inadequate and SMRF has to be designed. With regard to this, this entails the seismic analysis of building consisting of G+ 7 storey with Special moment resistance frame of dimension 83.5 x 24.16 m for seismic zones III and V.

### 2. MOMENT RESISTING FRAME SYSTEM

There are several systems available that may be utilized to effectively withstand lateral seismic stresses. Moment resistant frames, braced frames with horizontal diaphragms, and shear walls are the systems that are most often utilized. However, these moment-resisting frames are only cost-effective for buildings of 30 stories or less. It is crucial to comprehend how an earthquake affects a building since the level of damage will directly effect how much it will cost to rebuild the structure. A structure with a more successful seismic design is not only inexpensive but also absorbs reduced damage during low post earthquake. Less damage experienced by the building means less money will be spent on repairs, and larger damage means more money will be spent. Depending on the kind of earthquake, how long it lasts, and the type of soil, a structural system will respond in a different way. So both the economical and stability requirements will be satisfied by a structural system with excellent energy dissipation, regulated interstory drift, and stable cyclic behavior. The table below contrasts several seismic system implementation methods

#### SPECIAL MOMENT FRAME (SMF)

- According to IS 800 table 23, the steel special moment resisting frame's response reduction factor is set at 5, and when it is exposed to design-level ground motion, it is anticipated to maintain an inelastic response. SMF may have a significant overstrength because:
- Beams and columns with moment of inertia and area that are more than intended
- To fulfill the strong column/weak beam criterion, the column is oversized.
- larger section sizes are used to provide drift more control
- The material's strength might vary.

### ORDINARY MOMENT FRAME (OMF)

As per clause 12.10 of IS 800:2007 ordinary moment frame should not be used in seismic zones of IV and V and for structure having an importance factor of 1.5 or greater than. As per the IS 800:2007 moderate ductile member in the frame are expected to undergo plastic rotation of 0.02 radians without demeaning of stiffness and strength below the yield value (M). For ordinary moment frame it is desirable to have rigid joints but in clause 12.10 of IS code 800:2007 semi rigid moment connection is permitted. The response reduction factor of a ordinary moment frame for steel is given as (R=4) which is greater than of reinforced concrete cement structure (R=3).

### 3. STRONG COLUMN AND WEAK BEAM CONCEPT

When seismic loads are applied on a structure, formation of plastic hinges are seen at the ends of the members due to heavy bending moments and collapse of the structure is seen when the plastic hinges are not enough to form a mechanism. Thus if a structure has weak or long columns the structural drift will be concentrated in those storey's containing the weak or long columns. These are usually known as soft storey column which needs to be avoided for a better and wholesome performance of a structure. As per IS 1893 clause 7.10 states that the columns and beams of soft storey should be designed for 2.5 times the storey shears and moment's calculated under seismic loads.

**Seismic Behavior-** The size of the earthquake, focal depth, distance from the epicenter, soil layers of the structure, and travel characteristics of the seismic waves all affect the seismic characteristic of ground vibration at any given place. The ground motion caused by earthquakes is often resolved into three perpendicular directions, with the horizontal direction being more significant. When compared to other loads such as dead loads or live loads, earthquake loading is distinct. Since a structure is only intended to withstand gravity loads, when an earthquake's lateral load acts on it, it sustains significant damage that might cause it to collapse. Axially loaded members must withstand the cyclic loading brought on by earthquakes. Beams under tension and compression must be constructed for both positive and negative bending moments.

- Minor earthquakes that occur often shouldn't harm the earthquake itself.
- While minor earthquakes might cause non-structural damage, they shouldn't cause structural damage.
- When there is a big earthquake, the building shouldn't collapse right away; instead, it should be able to hold up long enough for the residents to safely evacuate.

### 4. FACTORS AFFECTING STRUCTURAL RESPONSE

As seismic activity varies from place to place in India, provision was made to take into account the zone where maximum earthquake activity occurs. Thus according to IS code, India is divided into four seismic zones.

SEISMIC ZONE	SEISMIC INTENSITY	ZONE FACTOR
II	LOW	0.1
III	MODERATE	0.16
IV	SEVERE	0.24
V	VERY SEVERE	0.36

**Importance Factor-** Depending on the building's purpose or usefulness, which is determined by the effects of its collapse, post-earthquake requirements, and value in terms of its economic or historical significance. Hospitals, schools, and power plants are given a 1.5 significance factor for importance, whereas other structures, such homes, are given a 1.

**Spectral Response (Sa/G)-** The greatest response of a structure with a damped single degree of freedom is plotted against the structure's natural time period during ground motion to form a spectrum. As a result, the acceleration response spectrum may be obtained by using acceleration as the structure's highest response and plotting it against the structure's time period.

### 5. LITERATURE SURVEY

**K. K. Sangle, K. M. Bajori, V. Mhalungkar, 2012**"Seismic analysis of high rise steel frame buildings with and without bracing" was the topic of a presentation. Utilizing time history analysis, the investigation was carried out for G+ 40 steel frame buildings with and without bracing. A diagonal brace was employed as a bracing method. The outcome demonstrated that the bracing component has a significant impact on how the structure responds to earthquakes. It was determined that base shear rises significantly and bracing helps to reduce displacement at roof level. Additionally, it was observed that the modal time is shortened and that the diagonal bracing B is the most effective and cost-effective bracing type.

**SheevinayRai, Rajiv Banarjee, TabishIzhar, 2015:** performed research on the OMRF and SMRF structural systems utilizing various software, In seismic zones III and IV, G+6 story R.C.C. regular structures are analyzed for the study in accordance with Indian standard code. Etabs and Stadd.pro were the two pieces of software employed for the building's study, and they were used to assess the structure's effectiveness in terms of average storey displacement, storey drift, and time period. It was determined that the SMRF system is far more effective than the OMRF system and that the building design utilizing Etabs gave a significantly more cost-effective design than Stadd. pro.

**Ram Prasad, R. Rama Rao, 2015:** Moment resisting frames are often utilized for lateral resisting systems. The typical moment resistant frame needs extra details to have better ductile behavior in seismic zones III, IV, and V since it was seen that it performed badly in previous earthquakes. Special moment resistant frames are buildings with unique detailing. In comparison to OMRF with  $R=5$ , the response reduction factor for SMRF,  $R = 5$ , is anticipated to have greater ductility. To determine its behavior, pushover analysis of each frame's SMRF and OMRF is produced. It was observed that the R factor falls down as the structural frame's height rises.

**Anupam S. Hirapure, Ashish S. Moon, Swapnil J. Bhusari, 2017:** two moment frame structures—regular and special moment resistant frames—had their earthquake reaction examined. For the investigation, a typical R.C.C. building was used. G+7 was examined for seismic zones II, III, and IV for OMRCF and SMRCF structural configuration. One such program is called Stadd Pro. The SMRCF system outperforms the OMRCF technique, according to the study. It was found that SMRCF had a smaller percentage of base modeling than the whole framed structure based on analysis of the framed structure utilizing computer software for shear, story drift, bending moment, and torsion.

**Mohammed Idrees Khan, Khalid Nayaz Khan, 2014:** The research's goal was to assess a steel frame with bracing's pushover analysis. Steel buildings play a big part in the industry, offering stability, strength, and ductility for earthquake design. In this research, a number of concentric bracing types, including external X, V, and diagonal bracing, were used to perform push over analysis on a 15-story steel frame structure. It was found that the addition of bracing elements increased the base shear capacity of the structural frames and lowered the maximum displacement at the roof level.

**Nishant Kumar, Dr. V. Pandey, 2017:** For factors such storey shear, base shear, storey drift, bending moments, and axial force for a G+ 8 structure in seismic zone IV, the author compares ordinary moment resistant frames with special moment resisting frames in his study. Using the computer application Etabs, the structure was modeled and analysed. Based on the study, it was concluded that the shear at the storey level rises with the number of stories, base shear for SMRF is lower than for OMRF, and SMRF's column and beam sections were less than those of OMRF.

## 6. CONCLUSION

The frame model used for the dynamic analysis technique was the Ordinary Moemnt Frame And Special Moment FRAME created in accordance with the IS code. To avoid the collapse of the building, the model has to be built using the strong column and weak beam design principle. The main characteristics that set the two frames apart are their response reduction factors, which rely on the structure's ductility, redundancy, and strength above others. In order to compare the responses of the two moment frames in seismic zones III and V, the two structures were analyzed using The Response Spectrum Method. It was discovered that the SMRF structure responded better to the earth quake loading with the least amount of drifting and lateral loads in both cases, or for two seismic zones.

## 7. REFERENCES

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