



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

# IJRSET

International Journal of Innovative Research in  
**SCIENCE | ENGINEERING | TECHNOLOGY**



# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 13, Issue 5, May 2024

**ISSN** INTERNATIONAL  
STANDARD  
SERIAL  
NUMBER  
INDIA

Impact Factor: 8.423

 9940 572 462

 6381 907 438

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# Earthquake Resistance Structure Using Various Techniques

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## I. INTRODUCTION

An earthquake is a natural phenomenon, occurring with uncertainties which is the result of sudden release of energy in the earth's crust that creates seismic waves. Certain preventive measures are needed to be incorporated during the construction resulting in the Earthquake resistant structures. Earthquake resistant structures are the structures, designed to resist the effect of earthquake on them. The type of construction in which there is either no effect of earthquake or it is negligible is said to be Earthquake Resistant Construction. Although no construction can be entirely immune to the damage caused by the earthquakes. But the basic goal of earthquake resistant construction is to erect structures which can withstand seismic activities or conditions than their counterpart conventional structures so that loss of life is minimized by taking preventive measures during the construction stage. Hence in the areas which are prone to seismic effects, construction requires measures to ensure stability, serviceability, strength with considerable levels of safety. The Earthquake that means the earth shakes and feels the vibrations caused by these motions. Earthquakes are caused due to many reasons but most commonly the term "Earthquake" is used when shaking of earth's surface is caused due to some disturbances occurring inside the earth. Whenever the earth is disturbed, Vibration is produced. These vibrations set out in all directions from the place of their origin. Whenever these vibrations travel, an earthquake is said to have taken place. These vibrations more intense near their source. A distance increase, these become feeble and slowly die out.

## II. RELATED WORK

**Mohd Atif (2015)**, In this paper they have studied a G+15 building with shear walls and bracing members in four different earthquake zones by placing three types of bracing at different position. Some important parameters like displacement, axial force, bending moments of columns and shear moment, torsion for beams are calculated. Results obtained and published in graphical and tabular forms. Linear static analysis method was used for analysis. The conclusion of this study was that shear walls are more efficient to control lateral deflection as compare to bracings. Lateral displacement of building were reduced by using X bracing.

**Prof. Bhosale Ashwini Tanaji (2015)**, in this research they have studied different types of concrete bracings to calculate different parameters. X-type bracing, V-type bracing, K-type bracing and diagonal bracing have used and storeys drift and displacement of building have analysed. It has found that maximum displacement can be reduced by using X type bracing. The storeys drift of concrete braced system is less as compared to the RC frame building thus the overall response of the building decreases. X-type of bracing is the most efficient one in terms of storeys overturning.

**Varsha R. Harne (2014)**, by using structural analysis software STAAD-Pro V8i analysis of a building has done by using different type of models. Different type of cross sections of RC shear walls are used such as Boxed type, L-type and cross type shear wall and these walls are located at different positions of building such as along periphery, at corner and at middle position. All types of load combinations have studied and as results have found that the load combination 1.5DL +1.5EQX is the most critical among all for all models. It can be concluded that building which is having shear wall along its periphery is the most efficient one as compared to all other buildings.

### III. METHODOLOGY

#### 3.1 General

The modern construction has been replacing the traditional masonry building units with RC buildings. Concrete can be poured into any mould of desirable shape and the steel imparts the necessary tensile strength to the structure. As a result, RC buildings find wide applications and are commonly adopted in towns and cities. The RC frame is the major lateral load resisting unit in a structure. The inertial forces induced by earthquakes are proportional to the mass and these forces are transferred from one building component to another and get accumulated near the base of the building. Hence, the columns and walls at lower storey's experience higher earthquake-induced forces. The amount and location of steel in an RC member should be such that the failure of the member is by steel reaching its strength in tension before concrete reaches its strength in compression. This type of failure is a ductile failure and hence is preferred over a failure where concrete fails first in compression. The structures require additional ductile detailing in order to ensure good seismic performance. These provisions are put together in the form of a special seismic design code, IS13920-1993 for RC structures. In the methodology part, it is important to mention about the techniques to resist Earthquake in the structures:

**3.2 Active and Passive system:** Active control systems are devices integrated with real-time processing evaluators for improved service and safety Passive control systems are conventional devices to resist or absorb the energy produced during Earthquake. For example: Viscous Dampers.

**3.3 Shear walls:** Reinforced concrete shear walls in buildings are an excellent structural system for earthquake resistance and help to resist gravity loads and lateral loads.

**3.4 Bracing:** Bracing can be diagonal, cross, triangular, or eccentric which helps in the resistance process during the natural calamity due to seismic disturbances.

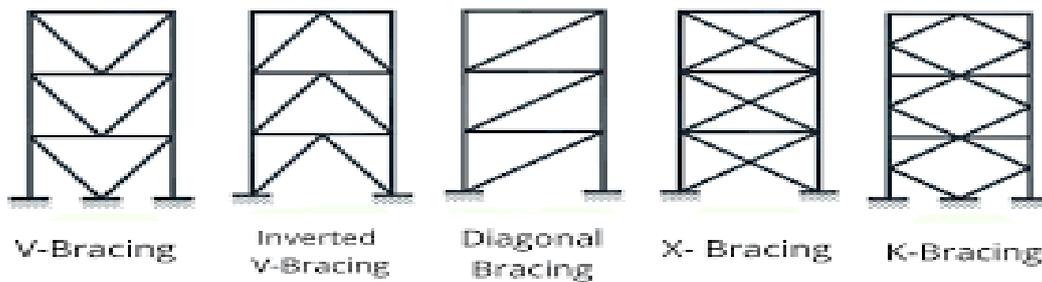


Fig.1 Different types of Bracings

**3.5 Dampers:** The purpose of dampers is to deaden, restrain, or depress the effect of energy or vibration produced during the earthquake.

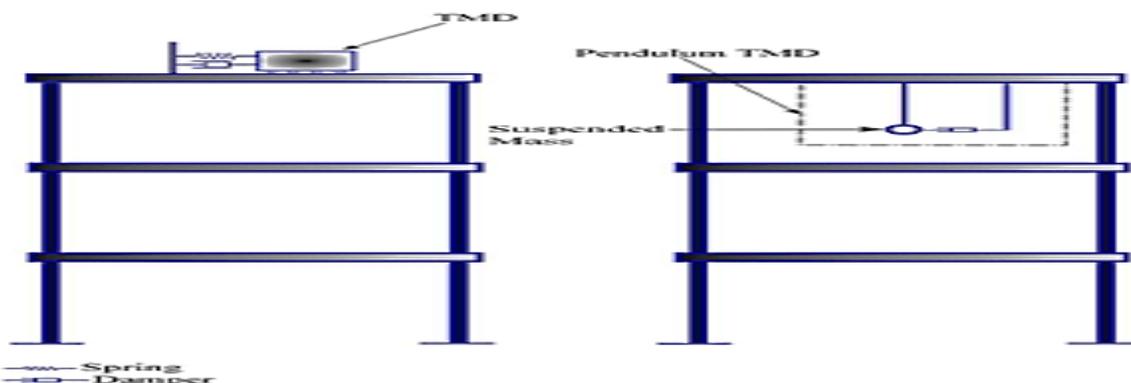


Fig.2 Damper Techniques

**3.6 Rollers:** Building on rollers for instance, parking lots at the shopping malls, without any friction results in the situation in which building will not move with ground.

**3.7 Base Isolation:** Base isolation is one of the means of protecting a structure against earthquake. It is a process collection of structural elements which should substantially decouple a superstructure from its substructure resting on a shaking ground thus protecting a building or non-building structure. Example: building resting on frictionless rollers when the ground shakes, the rollers freely roll, but the building above does not move. Thus, no force is transferred to the building due to shaking of the ground; simply, the building does not experience the earthquake.

**3.8 Light weight material:** Use of light weight material can also resist the earthquake forces considerably in case of structures. Lightweight concrete is one of the most popular of the new lightweight construction materials. Light weight concrete is made using either lightweight aggregates or with foaming agents such as aluminium powder. Lightweight aggregates include pumice, scoria, volcanic cinders, tuff, and diatomite. The aggregate can also be made by heating clay, shale, slate, diatomaceous shale, perlite, obsidian, and vermiculite. Another popular lightweight building material is Gyprock and its various products including walls, decorative mouldings, suspended ceilings, and finishing plasters. Bands: Horizontal bands can be used in the masonry buildings to resist the effect of seismic forces e.g. Earthquake Additional strength can be provided to the buildings by an art called as Retrofitting. Retrofitting: It is an art of providing additional strength to the buildings which are weak due to original structural inadequacies & material degradation due to time effect or alteration carried out during use over the years. modified. It carries lesser cost than the rebuilding. It can prevent complete collapse.

**3.9 RC Steel Frames:** RC Steel frames are a popular earthquake-resistant technique used in building construction. They are designed to resist the lateral forces that are generated by ground motion during an earthquake. Steel frames are made up of steel beams and columns, which are bolted or welded together to form a rigid structural system. One of the benefits of using steel frames is their high strength-to-weight ratio. This allows them to provide a high level of stiffness and resistance to lateral forces, without adding significant weight to the building. This is important for earthquake-resistant design, as heavier buildings are more vulnerable to the forces generated by seismic activity. Steel frames can be used in various building types, including low-rise and high-rise buildings. They are also commonly used in retrofitting existing buildings to improve their seismic performance.

#### IV. RESULT ANALYSIS

Analyzing the effectiveness of earthquake-resistant structures involves assessing their performance during seismic events. This includes examining factors such as structural integrity, material resilience, and adherence to building codes and standards. Engineers evaluate data from seismic sensors, structural simulations, and post-earthquake inspections to gauge a structure's ability to withstand seismic forces and minimize damage. Analyzing an earthquake-resistant structure with shear walls, cross-bracing, and dampers involves assessing several key results:

**Structural Stability:** Engineers evaluate the overall stability of the building during seismic events. This includes assessing how shear walls and cross-bracing contribute to resisting lateral forces and preventing structural collapse.

**Reduction in Lateral Displacement:** Shear walls and cross-bracing help reduce lateral displacement of the building during earthquakes, which is crucial for preventing damage to the structure and ensuring occupant safety.

**Dynamic Response:** Analysis includes evaluating the dynamic response of the structure under various seismic scenarios, considering factors such as natural frequencies, modal shapes, and response spectra.

**Cost-Benefit Analysis:** The effectiveness of shear walls, cross-bracing, and dampers is also assessed in terms of cost-effectiveness. This involves comparing the additional construction costs of implementing these seismic design features with the potential savings in terms of reduced damage and downtime during earthquakes.

Overall, the analysis provides insights into the performance and effectiveness of the earthquake-resistant design features in ensuring the structural integrity and safety of the building during seismic events.

## V. CONCLUSION

Based on the study conducted on earthquake-resistant Structures for implementation in various seismic zones of India, it can be concluded that there are various effective earthquake-resistant techniques available globally that can be adapted and implemented in India to reduce the impact of earthquakes on buildings and infrastructure. The study highlighted the importance of incorporating seismic-resistant design principles in the planning and construction phases of buildings, including the use of appropriate materials, foundation systems, and structural designs. The research also emphasized the significance of enhancing the building code requirements and strengthening the enforcement of seismic regulations to ensure the safety of buildings and their occupants.

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