

Earthquake Resistant of RCC Structures

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ABSTRACT

Earthquake is a series of vibrations on the earth surface caused by seismic waves due to rupture during this accumulated strain energy released. By this shaking of the ground caused by sudden breaking in the sections. It may cause great damage and collapse of the buildings and other manmade structures etc. so, the design of the earthquake resistant structures is very important to save the lives and economy of the country. To reduce the risks and damages to the RCC structures. The main cause for the earthquake is breaking between the two rocks. Earthquakes occur due to sudden movement of tectonic plates which creates a gap between the two sections. It is also responsible for various other disasters like landslides, avalanches, tsunamis and volcanic eruptions etc. the common cause of earthquakes are due to volcanic cause and another one is tectonic cause. These are the most common cause for the earthquakes.

In this paper the author is explaining about earthquake and resistance and various retrofitting strategies used.

KEYWORDS: Earthquake resistant, Seismic zones, Retrofitting techniques

INTRODUCTION

There are two dynamic factors subjected to RCC structures. They are one is wind forces and another is earthquakes. The analysis and design of earthquake forces and wind forces are completely different. The design of earthquake structures is based on type of loading and forces and pressure subject to exposed area. During earthquake random motions or forces are subjected at the base of the structures. The movement of inertia forces causes stresses in the structures. Which causes the building to get damaged. The action of earthquake forces are more at the bottom and the action of the wind forces are more at the top of the building structures. The action of both forces are reverse.

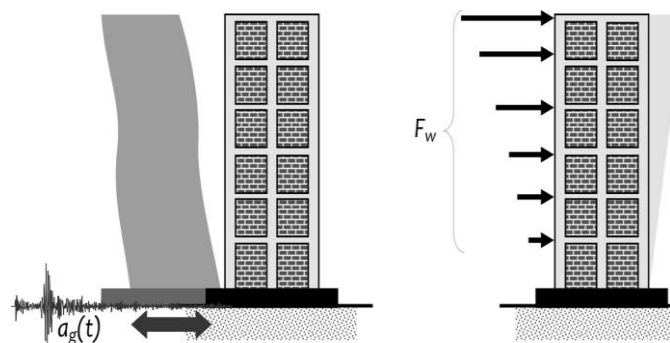


Fig. Earthquake Ground Motion at Base & Wind Forces acting on the buildings respectively.

Basically earthquake forces are random in nature and which are unpredictable. The main parameters of seismic analysis of structures are load carrying capacity, ductility, stiffness, damping and mass.

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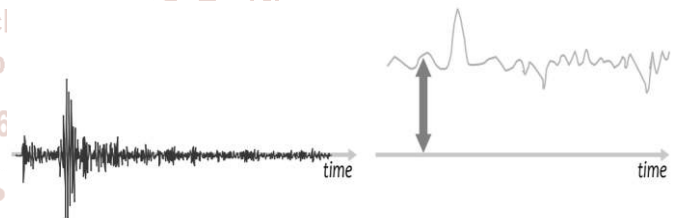


Fig. Variation of Earthquake ground motion and wind pressures respectively.

Generally earthquake ground motions are cyclic in nature and time variant and wind forces are oscillatory in nature and time invariant.

SEISMIC ZONES OF INDIA

There are mainly four types of earthquake or seismic zones in India. They are as follows;

1. Zone II: Zone of intensity is Low
2. Zone III: Zone of intensity is Moderate
3. Zone IV: Zone of intensity is Severe
4. Zone V: Zone of intensity is Very severe

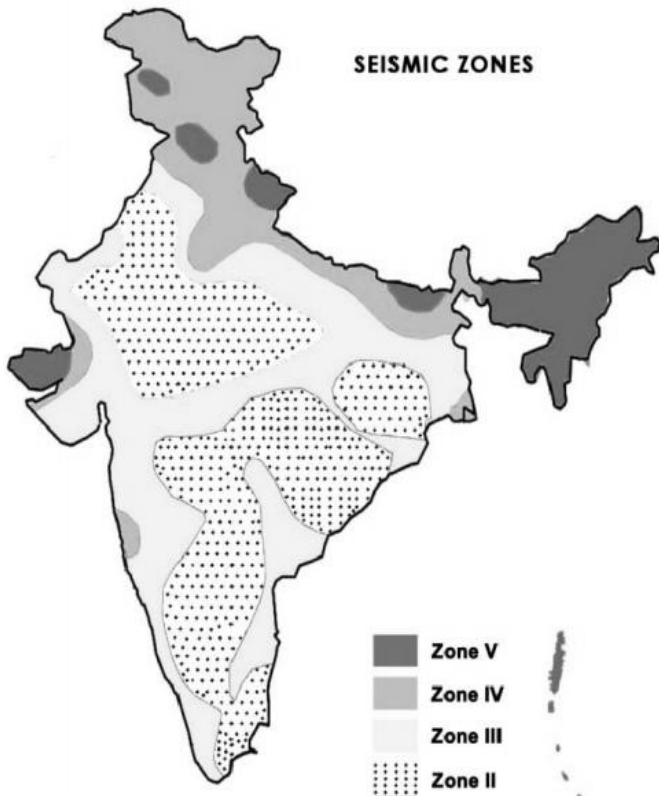


Fig. Seismic zones Map of India

BASIC DESIGN PRINCIPLES

1. Proper designing and construction of structures
2. Use of light weight materials
3. All parts are well connected to each other
4. Use of good quality materials with proper mix proportions
5. Use of Resisting elements
6. Foundation should be strong and durable
7. Use of ductile materials

EARTHQUAKE RESISTING METHODS AND TECHNIQUES

1. Shear walls
2. Bracings
3. Base isolation
4. Mass dampers
5. Infill walls
6. Mass reduction
7. Wall thickening
8. Jacketing of beams
9. Jacketing of columns
10. Jacketing of beam column joints

Shear walls

Shear walls are vertical elements or columns, which are designed to resist the wind loads and seismic loads and other loads etc. they are provided laterally to the buildings along the two directions of the buildings. It is the one of important method of the structure to improve the strength and durability of the structure.

SEISMIC ZONE FACTORS

as per IS:1893 (Part 1) – 2007 Seismic Zone Factor (Z) of Indian Buildings are as follows;

Seismic zone	II	III	IV	V
Seismic zone factor (Z)	0.10	0.16	0.24	0.36

Importance Factor of buildings as per IS:1893 (Part 1) - 2007;

Building	Importance factor I
Normal buildings	1.0
Important buildings	1.5

Response Reduction Factor R of buildings as per IS:1893 (Part 1) – 2007

Lateral Load Resisting System	Response Reduction Factor R
1. Building Frame Systems	
Ordinary RC moment resisting frame (OMRF)	3.0
Special RC moment-resisting frame (SMRF)	5.0
Steel frame with (a) Concentric braces (b) Eccentric braces	4.0 5.0
Steel moment resisting frame designed as per SP 6 (6)	5.0
2. Buildings with Shear Walls	
Ordinary reinforced concrete shear walls	3.0
Ductile shear walls	4.0
3. Buildings with Dual Systems	
Ordinary shear wall with OMRF	3.0
Ordinary shear wall with SMRF	4.0
Ductile shear wall with OMRF	4.5
Ductile shear wall with SMRF	5.0

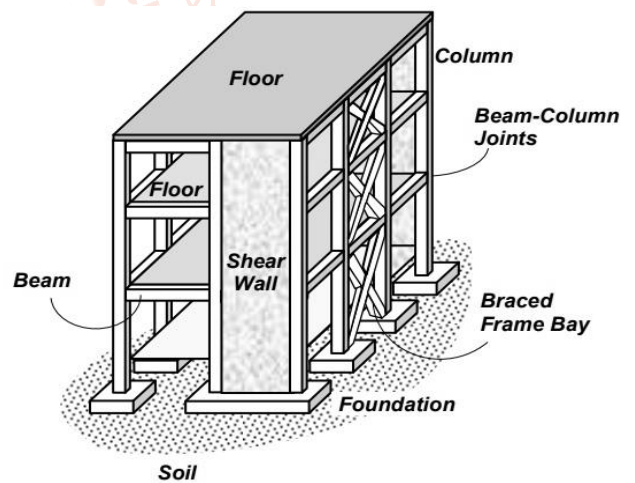


Fig. Shear wall

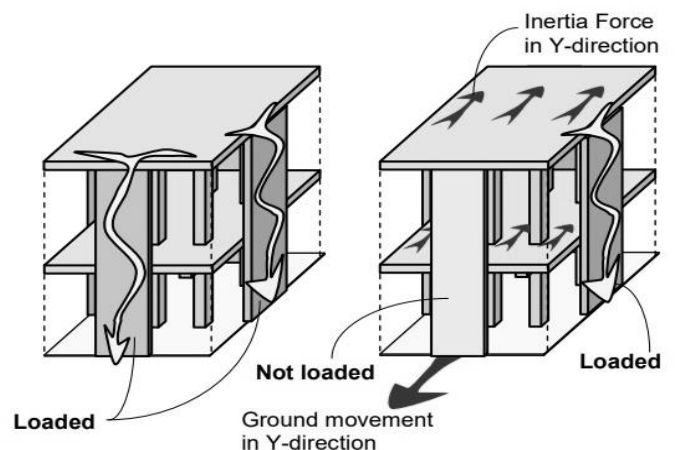


Fig. Shear walls with load paths

Bracings

Bracings are rigid steel structures. They are provided at horizontal, vertical and inclined sections. They are used to support the member of the structure and to prevent the movement of the structure. These are used to withstand the structure from wind loads and seismic loads etc. it is used to improve the strengthening of the structure.

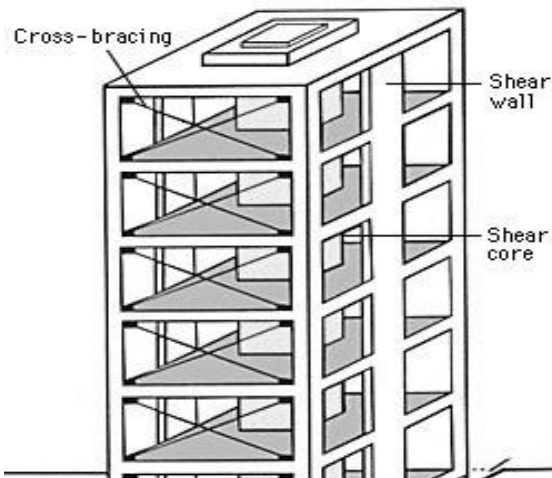


Fig. Bracings used in the building

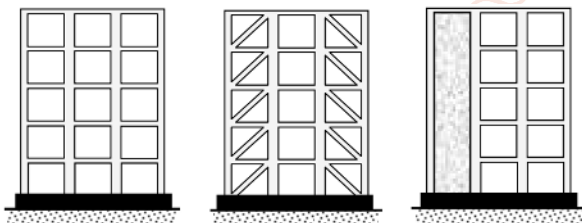


Fig. Shear walls, Bracings and combination

Base Isolation

Base isolation is a technique is placing a flexible isolation system between foundation and super structure. It is used to separate structure from the foundation and base isolators provided. They are used to increase the strength and durability of the structure. These are controls the flow from the structure to the foundation and vice versa. It is the one of the important technique used to protect the buildings from the seismic loads. it is generally used for low, medium, high rising buildings. Which absorbs the earthquake energy and reduce the energy from the super structure. During the earthquake it provides safety against collapse and reduces large damage.

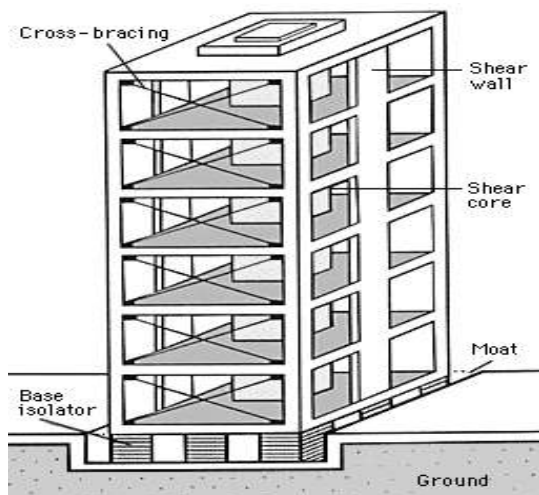


Fig. Base isolators

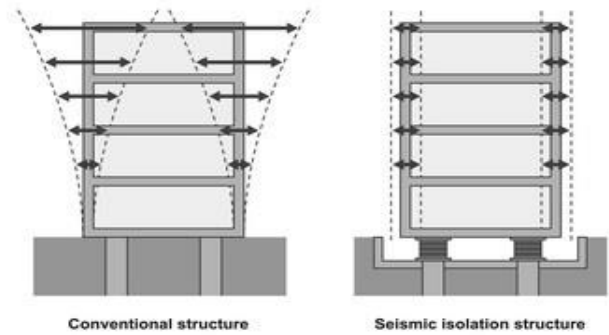


Fig. Isolation system

Jacketing

Jacketing is the one of the important method commonly used for repair of structural members. It is used for beams, columns and combination of both. Jacket is provided around the reinforcement and then concrete is filled into the jacket. It increases the section of member and load carrying capacity. To increase the structural strength.



Fig. Beam Jacketing



Fig. Column Jacketing



Fig. Beam column Jacketing

Mass Reduction

Reduction of mass is achieved by using light weight materials in the construction. Which cause structure is light weight. It is very useful for high rising structures. It is used for all structures to withstand the earthquake forces.

Mass Dampers

Mass dampers is a device is used to reduce the amplitude of mechanical vibrations. It is a seismic absorber. It is used to prevent the damages in the structural systems.

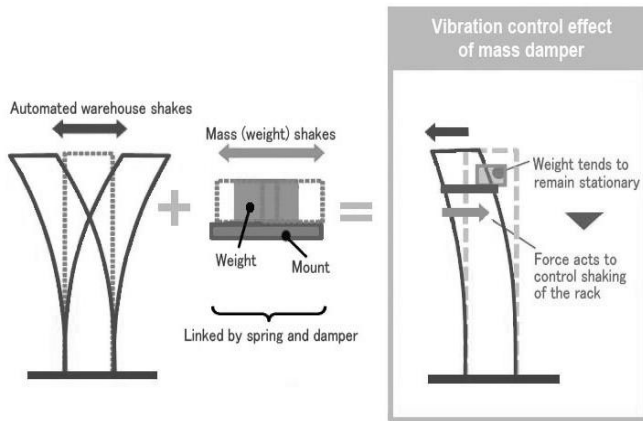


Fig. Mass dampers

Infill walls

Infill walls are supported walls in the structures. They are used to create separate space inner and outer spaces. It is different from partition wall. Infill walls are durable and economical.

Role of Responsibilities of Structural Engineers

1. Safest access to the structures
2. Monitoring the structures
3. Safety and durability of the structure
4. Investigation of structures
5. Construction management
6. Structural designing
7. Earthquake resistant construction
8. Prediction of earthquake losses
9. Safety precautions
10. Site investigations
11. Checking the performance of the structures
12. Analyzing conditions of the structure

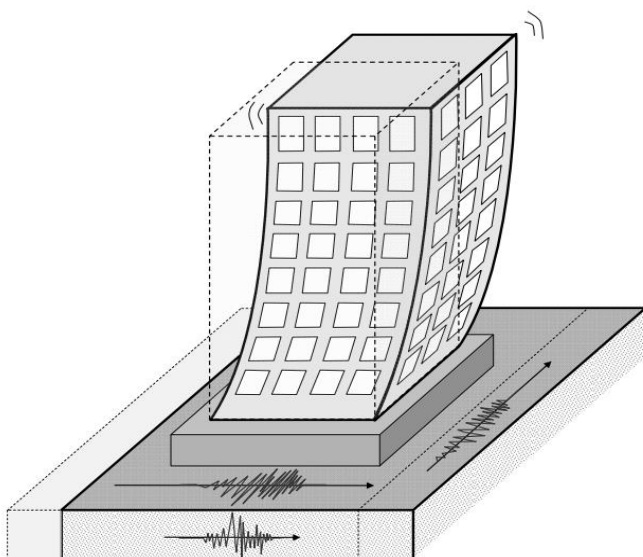


Fig. Earthquake Behaviour of a Building

CONCLUSION

Earthquake resistant structures are important now a days, to withstand the seismic effects. It cannot be avoided but by following various methods and techniques reduce the damages and risks to the structures. The role of civil/structural engineers are also plays an important to planning and design the earthquake resistant structures. So by using proper techniques mitigate the earthquake effects on the structures. To save lives and property and economy .

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Memberships

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Area of Interests

Structural Engineering, Concrete Technology, Building Materials, Retrofitting of Structures, Earthquake Engineering, Waste water treatment.

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Area of Interests

Structural Engineering, Reinforced concrete structures, Concrete Technology, Building Materials, Earthquake Engineering.

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