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EARTHQUAKE RESISTANT BUILDING WITH BASE ISOLATION, BRACING AND SHEAR WALL

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ABSTRACT
In the case study of earthquake resistant building we use Base Isolation mainly to resist seismic forces generated by earthquake. In India, there are four earthquake seismic zones area in which zone v (North-east India, Kashmir, North and middle Bihar) is highly affected when earthquake strikes. So our motive is to minimize the effect of earthquake as much as possible in heavy hazardous area. However the recent earthquakes have shown the performance of normal buildings has been less satisfactory. As we know, earthquakes constitute one of greatest hazards to life and property and also effect the development of that region. So in this paper, a model of earthquake resistant building is presented and few techniques to improve normal buildings to stand against earthquake.
KEYWORDS: Earthquake, base isolation, bracing, and shear wall.

INTRODUCTION
Earthquake-resistant structures are those structures designed to protect buildings from seismic effects. Whereas no structure can be entirely stand against damage from earthquakes caused by seismic waves, the main motive of earthquake resistant structures is to build structures that fare better during seismic activity than their conventional counterparts. Earthquake resistant structures may intended to withstand the largest earthquake of a certain probability that is likely to occur at their location. This means the loss of life and economy should be minimized by preventing failure of the buildings for rare earthquakes whereas the loss of the functionality maybe limited for more frequent ones.

In modern building construction, there are several design philosophies in earthquake engineering, making use of experimental results, computer simulations and observations from past strikes earthquakes to offer the required performance for the seismic activity at the site of interest. These range from appropriately sizing the structure to be strong and ductile enough to withstand the shaking with an minimum damage, to equipping it with base isolation or using structural vibration control method to reduce any forces and deformations. Whereas the prior methods typically applied in most earthquake-resistant structures, important facilities, landmarks and cultural heritage buildings use the more advanced (and expensive) techniques of base isolation or control to withstand strong shaking with minimum damage.

OBJECTIVES
The main principle to design earthquake-resistant building has two main objectives:
1. The building should withstand against almost no damage of moderate earthquake which have probability of occurring several times during life of a building.
2. The structures should not fail or harm human lives during earthquake activity which have a probability of occurring less than once during the life of the structures.

CLASSIFICATION OF EARTHQUAKE:
1. Slight: Magnitude up to 4.9 on the Richter Scale
2. Moderate: Magnitude 5.0 to 6.9
3. Great: Magnitude 7.0 to 7.9

4. Very Great: Magnitude 8.0 and above

MATERIALS

1. Woods for beams, columns and bracing
2. Ply board for slab and shear wall
3. Rubber balls for base isolation
4. Motor for shake table
5. Nails and glue

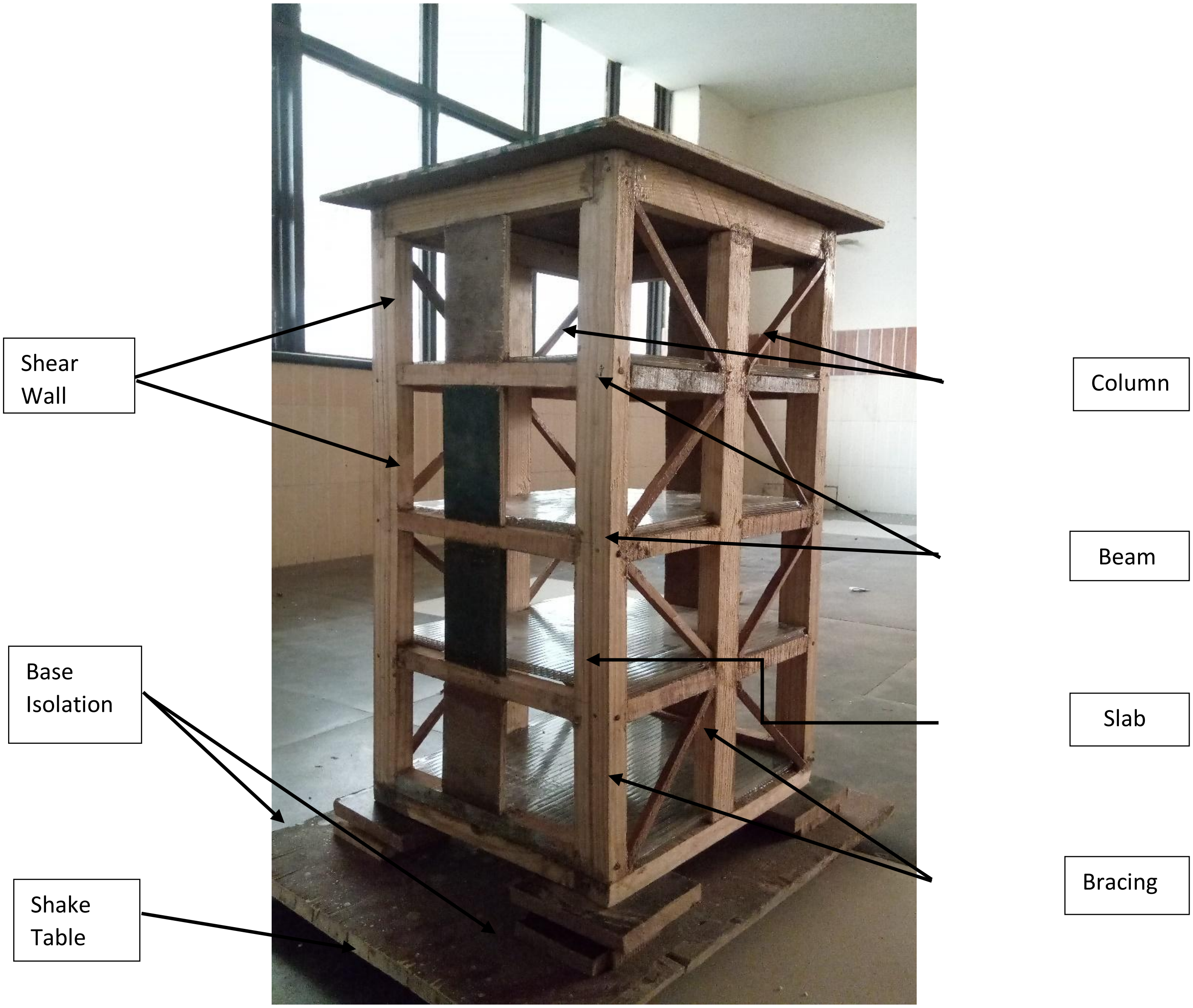
METHODOLOGY

We construct a model/prototype of earthquake resistant building of 4 storey using woods to get the result that the technique is adoptable or not. For proving isolation we use rubber balls which separate the sub-structure and superstructure. When there is shake in the ground waves generate and it moves from ground to the superstructure directly which may results in the failure of the building and loss of life and property. To prevent the building from this base isolation comes into action and in our model we used rubber balls which is separating the substructure and superstructure and absorb the seismic waves generated by the earthquake.

For seismic wave we made a shake table using motor and rubber balls and using shake table we shake our structure which we consider as earthquake force.

For preventing the building from other horizontal forces like wind force, sway we use cross bracing and shear wall to withstand against these type of forces.

To test the building either it is earthquake resistant or not first we put our building(without base isolation) on shake table with half full bottle with water in the model and shake is provided to the building by shake table we observe that there is huge deflection in the water surface. Then, we put our building with base isolation in the shake table and the same process is repeated for test and we observe there is almost no deflection in the surface of the water. We found that building with base isolation can be withstood against earthquake and there be less loss of life and property.



Picture of the model

Various Techniques for Earthquake Resistant Building:

1. Base Isolation
2. Shear wall
3. Bracing
4. Dampers

1. Base Isolation

Base isolation is also known as seismic base isolation or base isolation system, is one of the most popular methods of protecting structures against seismic forces. It is a 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 structures integrity.

Base isolation is one of the most powerful techniques of earthquake engineering pertaining to the passive structural vibration control technologies. It is meant to enable a building or non-building structures to survive a potentially devastating seismic impact through a proper initial design or subsequent modifications. In some cases, application of base isolation can raise both a structures seismic performances and its seismicsustainability considerably. Base isolation does not make a building totally earthquake proof.

Base isolation system includes isolation units with or without isolation components, where:

a) Isolation units are the basic elements of a base isolation system which are used to reduce decoupling effect to a building or non-building structures.
b) Isolation components are the connections between isolation units and their parts having no decoupling effect of their own.

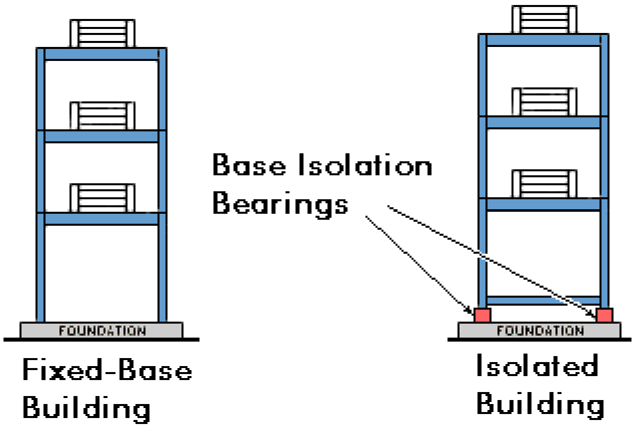
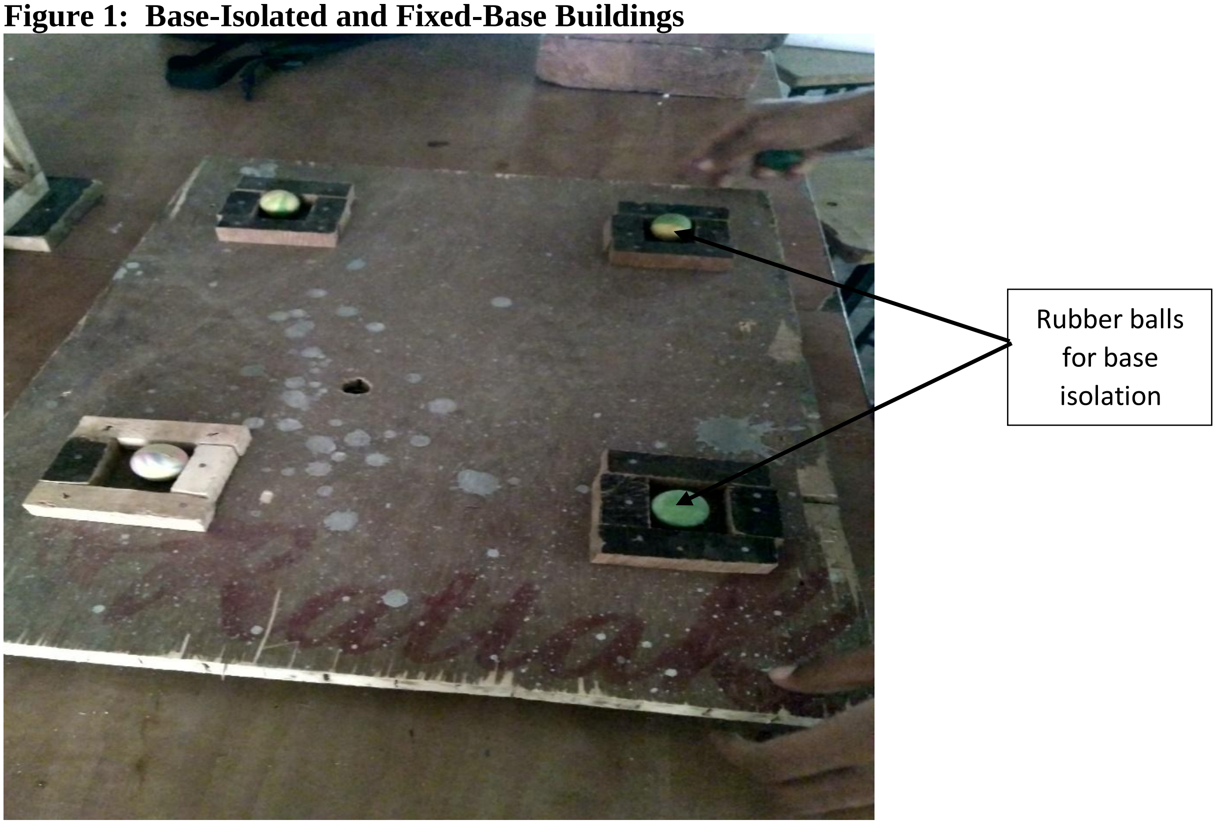
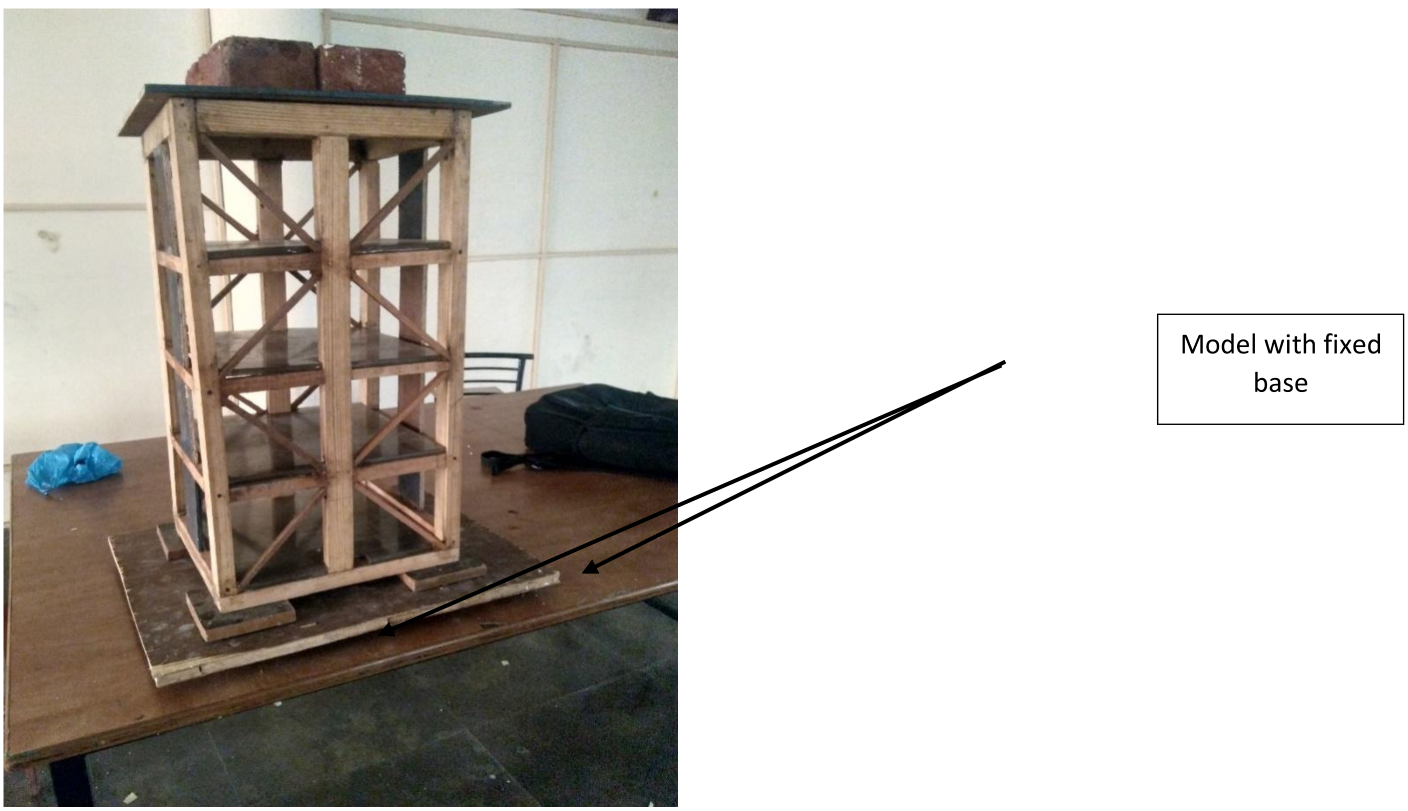


Figure 1: Base-Isolated and Fixed-Base Buildings




Rubber balls for base isolation


Model with fixed base

2. Shear wall

Shear wall is a structural member of the building in a reinforced concrete framed structure to resist lateral forces such as wind forces. Shear walls are generally used in multi-storey buildings subjected to lateral wind and seismic forces.

In reinforced concrete framed structures the effects of wind forces increases with the increase in height of structures.

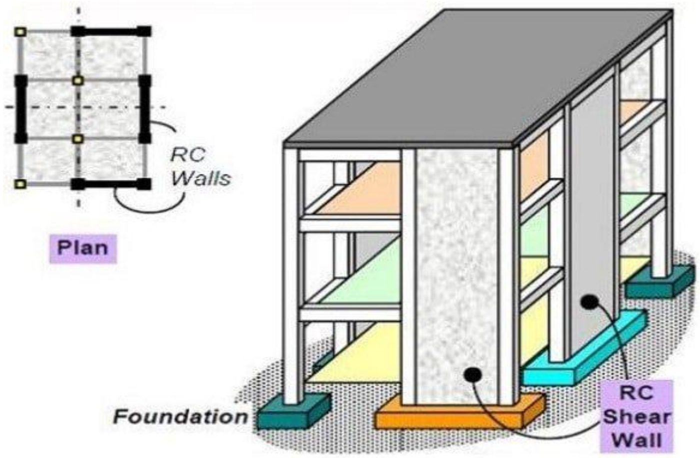


Figure2: Shear wall

The figure below shows the deflected shape for a shear wall and a rigid frame.

One way to reduce the sway of buildings and provide stability to buildings is to increase the section size of the members to create a rigid and moment resisting frame.

However, this method increases building heights and thus increasing the cost of building. It is mostly used for tall buildings (more than 7 storeys).

3. Bracing:

There are different kinds of bracing systems commonly used in multi-storey steel structures between orthogonally arranged beams and columns to transfer horizontal forces imposed on the structure to the substructure.

Types of Bracing Systems

There are two major bracing systems:

I. Vertical bracing system
II. Horizontal bracing system

I. Vertical Bracing System for Multi-Storey Steel Structures:

Vertical bracings as shown in figure (below) are diagonal bracings installed between two lines of columns. It not only transfers horizontal loads to the foundations (create load path for horizontal forces) but also it withstands overall sway of the structure.

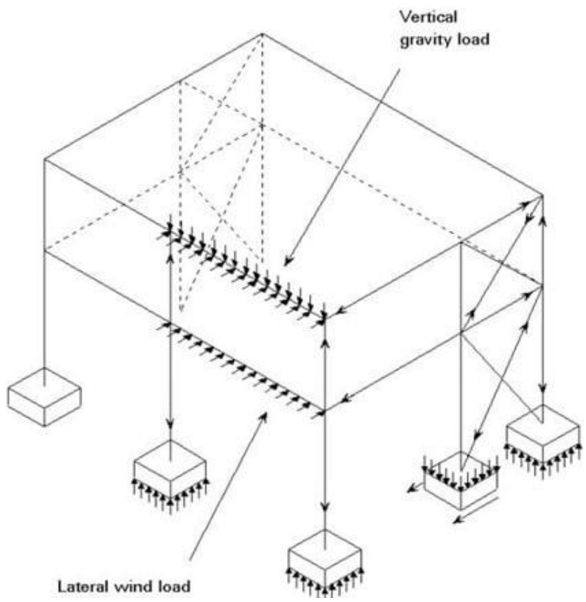


Figure 3: Vertical Diagonal Bracing Provided Between Two Lines of Columns

I. Horizontal Bracing System for Multi-Storey Steel Structures:

The main purpose of horizontal bracing system is to transfer the horizontal loads from columns at the perimeter of the structure to the planes of vertical bracing.

The horizontal forces on perimeter of the columns are generated due to wind force pressure and result in the cladding of the structure.

There are two major types of horizontal bracing systems which are used in the multi-storey braced steel structure and they are: diaphragms and discrete triangulated bracing.

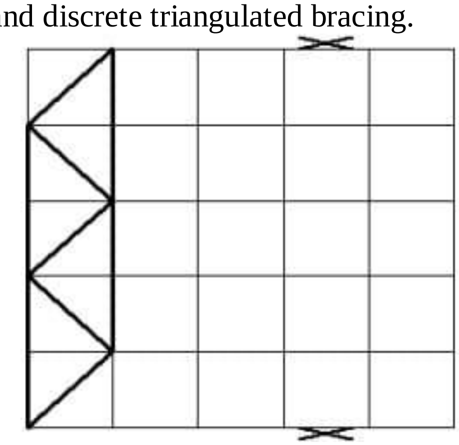


Figure 4: Horizontal Bracing Placement

4. Seismic Dampers

Seismic Dampers are used in place of structural elements, like diagonal braces for managing seismic damage in structures. It partly absorbs the seismic energy and reduces the motions of buildings.

Types of Seismic Dampers:

I. **Viscous Dampers** - Energy is absorbed by silicone-based fluid passing between piston-cylinder arrangements.

II. **Friction Dampers**- Energy is absorbed by surfaces with friction between them rubbing against each other.

III. **Yielding Dampers** - Energy is absorbed by metallic components that yield.

IV. Tuned Mass Damper (TMD):

Tuned mass damper is also called as an active mass damper (AMD) or harmonic absorber. It is a device mounted to the top of the structures to reduce the amplitude of mechanical vibrations. Its application can prevent the discomfort, damage, or outright structural failure.

They are mostly used in power transmission, automobiles and tall buildings (skyscrapers).

Taipei 101 has the largest TMD sphere in the world (shown above) and weighs 660 metric tonnes with a diameter of 5.5 metre and costs **US$4 million** (total structure costs **US$ 1.80 billion**).

RESULT

From the shake table test it has been found that building with base isolation can be withstand against earthquake and because of these there be less loss to life and property.

CONCLUSIONS

1. Earthquake resistant construction is important in earthquake prone area.
2. The building can resist earthquake forces with almost no damage.
3. The building shall not collapse or harm human lives during severe earthquake motions.

However these structures will be uneconomical.

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