International Journal of Research in Engineering, Science and Management
Volume-2, Issue-10, October-2019
www.ijresm.com | ISSN (Online): 2581-5792

Study of Importance of Seismic Safety in Architecture

Shreya Bhanupriya[1], Utkarsh Jain[2]
[1]*Fourth Year Student, Department of Architecture, SDPS Women's College, Indore, India*
[2]*Assistant Professor, Department of Architecture, SDPS Women's College, Indore, India*

***Abstract*: Natural Disasters like earthquakes are inevitable. In order to prevent the building structures from collapsing buildings need to be built with proper guidelines according to construction norms and seismic codes. In zones where the possibility of occurrence of earthquake is high, a building needs to be strong and persist over the duration of earthquake so that occupants of the building get to a safer place. Seismic safety is the most important aspect in any building design, architecturally and structurally. The damage in the structure can be reduced by following the seismic-building guidelines or else can be retrofit in a possible way. Seismic retrofitting is the modification of existing structures to make them more resistant to seismic activity, ground motion or soil failure due to earthquakes. The study of the topic helps in understanding a safe structure design approach and the prevention and strengthening of damaged structures in the seismic areas.**

***Keywords*: Earthquake, Seismic design safety, Retrofitting structures.**

1. Introduction

Earthquake: Earthquake can be described as the vibrations on earth's surface that is caused by waves coming from a source of disturbance (fault) inside the earth. Earthquake is a natural phenomenon occurring with all uncertainties of ground motions both horizontally and vertically, in all directions radiating from epicentre. These waves strike the building's foundation which results in its displacement in ground and induce vibrations in the whole structure above. These vibrations are uncomfortable for the occupants and create panic, while some weak structures may lead to collapse and structural deformations.

To avoid an earthquake disaster with its severe consequences, special consideration must be given to ensure that the construction is earthquake resistant. Building's seismic safety can be ensured by two ways; by designing new earthquake resistant structures and by retrofitting existing structures so as to reduce the loss of life during an earthquake.

Structural disturbances created by the effects of earthquake in a seismic zone cannot be resolved in a short period of time, so there must be a continuation in working to improve public safety during earthquake. The performance of the structures must be controlled in a seismic zone and it's after effects must be easily restored. To ensure seismic resistant construction, knowledge regarding seismic safety and design approach is very necessary.

2. Seismic-safe design approach

A. Fundamental properties of a seismic-safe building

Prior to designing seismic-safe buildings, it is important to have knowledge of its basic fundamental properties of seismic resistance in a building. The main properties to counter against earthquake in a seismic-safe building are as follows:

- Strength
- Stiffness
- Ductility

Strength is the ability of the material and the components of structure to bear and resist the applied forces on it under various loading conditions. Stiffness is the ability of building components to resist the displacement and deflection in the structure due to the applied force. A brittle structure with higher stiffness has lesser durability, whereas a ductile structure has more stability in the earthquake condition.

Ductility is the ability of building materials or components to bear huge inelastic deformations without serious loss of strength or stiffness. It plays a vital role in resisting damage from seismic waves in a building.

B. Seismic-safe design principles

- *Foundation:* The design of foundation depends upon the intensity of vibration due to an earthquake that could vary with different types of soil. The transmission of vibrations from the soil due to earthquake is transferred to the building through foundation. The type of foundation differs for the differing types of soil. The entire area covered by the building should be of same type of soil. Soft silt, loose fine sand and expansive clay soils should be avoided. To counter the above soils rigid raft foundations or pile foundation should be considered. To improve the soil condition for foundation of the building, sand piling and soil stabilization must be taken into account.
- *Configuration:* Configuration plays a very important role in maintaining a balance between architectural and structural requirements of a building. Buildings with certain high irregularities have higher chances of

collapsing during an earthquake. The overall building aspect ratio should be well maintained. Stiffness irregularities like soft storey and mass irregularity must be fixed.

- Buildings with simple regular and uniform geometry would have lesser damage than buildings with irregular configuration. For instance, possibility of collapsing and damage in a long and narrow building is higher due to torsion developed in the building.

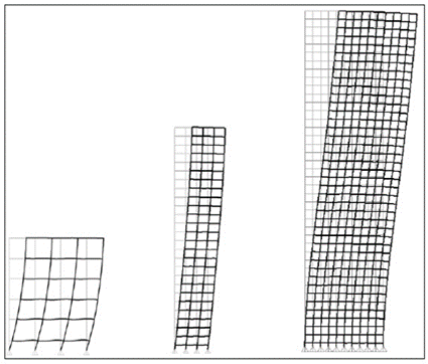

Fig. 1. Effect of building height

Shape of the building: In seismic zones of India like zones V and IV, it is suggested to build separate blocks of symmetrical rectangular shapes for better resistance from earthquake. Building should have simple, symmetrical and uniform shapes and forms in order to reduce torsion and stress generated in a building. Symmetry with respect to mass and rigidity in a building ensures the coinciding of centre of mass and rigidity of the building for earthquake resistance. Typical layout plans with L, T, E, U, Y or V shapes are appreciated with rectangular parts provided at the separation.

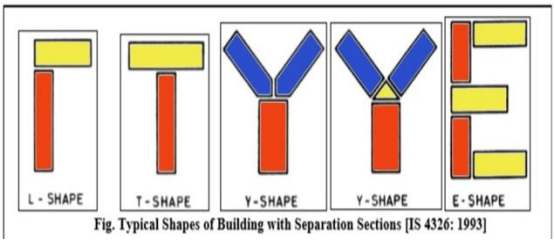

Fig. 2. Effect of building shape

- *Adjacency:* Pounding due to no space in between two adjacent building structures may result in failure of seismic-resistant design creating substantial damage to both the buildings. To avoid this, a safe gap between buildings must be provided which is dependent on the height of the building.
- *Projections and suspended parts:* To meet functional and architectural requirements of a building, suspended parts and projections are made. But these should be avoided as far as possible. If it is unavoidable it should be ensured to be properly reinforced and tied to the building as advised by the civil engineer.
- *Lightness:* To have a seismic-safe structure, it is advisable to build the structure as light as possible by providing shear walls in both the axes integrated with the frames and by building light upper storey and roofs.
- *Structural integrity:* All parts of the building should act as a single unit. Structural integrity should be well maintained between foundation, wall, roof, bonding at corners and junctions with reinforcement. Adequate ductile detailing of reinforcement in beams, columns and beam-column joint ensures structural integrity.
- *Vertical irregularity:* Due to discontinuity in the load transfer in a building vertically, the structure may collapse therefore vertical reinforcement at the corners of the building should be properly provided due to feeble masonry construction which can't easily withstand tension generated due to seismic vibrations.
- *Diaphragm discontinuity:* Horizontal resistance members such as floors and roofs transfer lateral forces between vertical resistance members such as frames and shear walls. The horizontal elements are known as diaphragm. An opening in the diaphragm or a break in the edge (lift-well, stairs, skylight and duct) may weaken the diaphragm of the existing structure. All the stresses generated around the opening in the diaphragm should continuously spread over it. As far as possible the diaphragm of the building should be continuous.

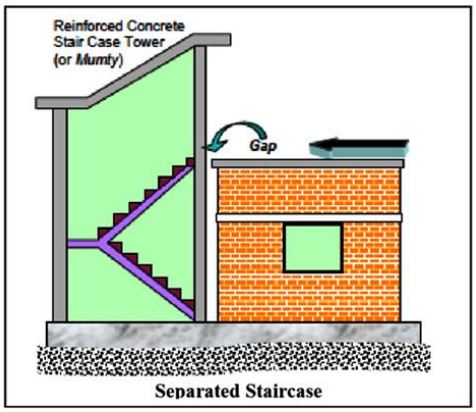

Fig. 3. Effect of gap maintained between staircase and building

- *Staircases:* As it can be concluded from the above point, staircase should be isolated from the rest of the building which reduces most of the damages by earthquake. A gap should be maintained in between the staircase slab and the roof/slab of the building
- *Openings:* Openings such as doors and windows reduces lateral load-resisting ability of masonry walls. Therefore, the size of the openings in the wall should be controlled in the zones like zone V and IV. The

location of the openings should not be at the corners but located centrally in the building along with the provision of lintel bands which ensures the top of the opening at same level. A continuous band should run over a lateral load-resisting surface i.e. wall.

3. Conclusion

The above research data concludes that earthquakes are unavoidable but its adverse effects on the building can be reduced in the seismic zones by practicing seismic-safe architecture. The above design approaches may reduce the damage and loss of lives promoting seismic-safe architecture.

References

[1] S. K. Duggal, "Earthquake Resistant Design of Structures."
[2] Pankaj Agarwal, and Manish Shrikhande, "Earthquake Resistant Design of structure."
[3] Shekhar Chandra Dutta, and Parthasarathi Mukhopadhyay, Improving Earthquake Resistance of Structures."
[4] P. K. Das, and A. R. Ramanathan. "An Introduction to seismic safe architecture."