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A Study on Earthquake Resistant Techniques in Buildings

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Abstract: - Traditional earthquake resistant techniques are effective for mitigating earthquake consequences and are also cost friendly. Apart from these some modern techniques are developed and documented in standard codes.

Keywords: - Seismic waves, expansive soil, collapsible soil, weathering, earthquake resistant techniques, isolators, elastomers.

I. INTRODUCTION

An earthquake is the vibration in the earth's crust due to release of strain energy stored in earth's crust. These vibrations are called seismic waves. These waves travel outward from the focus of the earthquake along the surface and through the earth at different speeds depending on the material properties through which they travel. These waves are responsible for disasters on the earth's surface. Earthquake-resistant structures are designed and constructed considering some principles and techniques to withstand various types of hazardous earthquake exposures at the sites of their particular location. According to standard building codes, earthquake-resistant structures are supposed to withstand the prime earthquake of a certain frequency that is likely to occur at their location.

This means the loss of life should be minimized by preventing failure of the buildings for rare earthquakes while the loss of functionality should be restricted for more frequent ones.

II.GENERAL PRINCIPLES FOR SEISMIC RESISTANT BUILDINGS

- Structures should not be brittle or collapse suddenly. Rather, they should be tough and should have high ductility to enable them to deflect or deform in a considerable amount.
- Resisting elements, such as bracing, shear walls, seismic bands etc, must be provided evenly throughout the building, in both directions horizontal as well as vertical.
- All elements, such as walls, column, beams, roof, should be tied together so as to act as an integrated unit during earthquake shaking, transferring forces across connections and preventing disintegration.
- The building should have adequate foundation. Soft, expansive and collapsible soils should be avoided, and the foundation must be well tied together, as well as tied to the wall.
- Care must be taken that all materials used are of good quality, and are protected from weathering and other weakening actions, so that their strength lasts for long.
- Concrete and masonry have no reliable strength in tension, and are brittle in compression. Thus, they must be properly reinforced by steel or wood.

III. CAUSES OF EARTHQUAKE DAMAGE

- Heavy dead weight of structure and very stiff buildings, having large seismic inertia forces.
- Very low tensile strength, particularly with poor mortars and cement concrete.
- Low shear strength of poor mortars particularly.
- Brittle behavior of concrete and masonry in tension as well as compression.
- Weak connection
- Stress concentration at corners of doors and windows.
- Un-symmetry in plan and elevation of the building.
- Un-symmetry due to unevenness in the sizes and positions of openings in the wall.
- Poor quality control, such as use of sub standard materials.

IV. STAGES OF EARTHQUAKE DAMAGES

There are basically four stages of earthquake damage in RCC and masonry buildings.
Stage I : Diagonal tension cracks originates from corner of openings and minor cracks develops on other structural members such ason roof.
Stage II : Cracks gets widen to sizes of 10mm approximately.
Stage III : Failure of corners and connections.
Stage IV : Complete failure of structure.

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V. EARTHQUAKE RESISTANT TECHNIQUES

A. Rice Straw/Wheat Straw

Rice and wheat straw bale are cheaper and stronger, and are used in construction with easy by rural people. These are light, easily available and can be used in earthquake proof houses.

B. Bamboo & Wood as construction material

Wood is cheaper and light weight material. Now-a-days, wooden houses as a means to safer buildings against earthquake forces are in practice. Similarly, bamboo is a well known cheap construction material found everywhere. It has good seismic performance properties; it is lighter in weight and is ductile.

C. Light Weight Materials

Light weight materials reduces the dead load of material and thus reduces the effect of seismic inertia forces. Some materials are light weight aggregates, fly ash bricks, autoclaves aerated concrete, Gypsum Based Ceiling Tiles, autoclaved aerated blocks, rice husk etc.

D. Seismic bands

Seismic bands at three different heights of a building i.e. at plinth level, lintel level and roof level are provided. Nowadays, this is a common practice in various earthquake resistant housing constructions. Making reinforced cement concrete band is more reliable. Finely seasoned good quality wood or bamboo can be used for making the bands

E. Moment Resisting Frames

Since the joints or connections are rigid and transfer of moments takes place from member to member by rigid connections so, these are also called rigid frames. Connections are rigid but the horizontal and vertical members are allowed to deflect and deform during lateral ground movements. Gravity as well as lateral load both are considered while designing. The majority of moment resistive frames are made up of either steel or reinforced cement concrete.

F. Seismic Base Isolation Technique

In base-isolated systems, the superstructure is isolated from the foundation by assured devices. These devices reduce the ground motion transmitted to the structure and absorb seismic energy by providing significant damping. Moreover, even if the ground underneath vibrates violently, the building itself would remain reasonably stable.

Thus, Isolators separate the superstructure and the substructure. Examples of the common isolators being used are elastomers, spherical sliding isolators, rubber layer as foundation support and friction pendulum bearings. Base isolation is a difficult and costly process which is not preferred for low and medium rise buildings and low cost buildings.

G. Seismic Dampers

Dampers perform like the shock absorbers. They absorb a large amount of the sudden jerks in the hydraulic fluids filled in them and thus, only a little jerk is passed to structure above ground level. When seismic energy is transmitted through dampers, they absorb part of it, and thus damp the motion of the structure.

Commonly used Seismic Dampers are

1. **Viscous Dampers** which absorbs energy by silicone-based fluid passing between piston cylinder arrangement
2. **Friction Dampers** which absorbs energy by friction action between rubbing surfaces against each other
3. **Yielding Dampers** which absorbs energy by metallic components that yield.
4. **Viscoelastic Dampers** which absorbs energy by utilizing the controlled shearing of solids.

VI. CONCLUSION

In this paper, a number of traditional and modern techniques have been discussed which are adopted in construction practices for improvement in the earthquake resistance of a structure.

"Earthquake do not causes damages, it is the building which causes damages".

It is the responsibility of structural and civil engineers to design and construct the buildings according to standard codes and should ensure proper quality control.

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