Short communication on EARTHQUAKE RESISTANT CONSTRUCTION TECHNIQUES

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ABSTRACT

The paper presents the techniques used in the modern world for Earthquake due to improper construction techniques. In the past decades, countries around the world face various disasters like volcanic eruptions and manmade explosions with increasing efficiency. These have a more prominent effect on developing countries. This paper also reviews various methods adopted in the construction industry to minimise the effect of the Earthquake. It is concluded that during the process of process design and construction earthquake resistant measures are necessary to counter the effect of this type of natural calamity which would raise the chances of survival of the buildings and lives of people.

Keywords*: process design and construction earthquake resistant.*

INTRODUCTION

Disasters have always caused huge destruction to humans ever since their existence. They are unexpected, unpredictable. There have been several attempts to alleviate the catastrophic effects of the disaster. Among all natural calamities, an earthquake is one of the most dangerous calamities that has happened on the earth's surface and caused serious damage to the property and lives of the people. Earthquake is the vibration of the earth's surface caused by waves coming from a source of disturbance inside the earth. Tectonic earthquake occurs when the earth crust breaks due to geological forces on rocks and adjoining plates. Most earthquakes are tectonics in nature. Volcanic earthquakes result from tectonics forces in conjunction with volcanic activity. Collapse earthquakes occur in underground caverns and mines due to explosion of rock on the surface. Explosion earthquakes are due to detonation of nuclear and chemical devices. Induced seismicity occurs in many ways. Injecting or extracting from the earth such as oil and gas extraction and geothermal energy development has been found to cause seismic events. Sometimes earthquakes are classified as interplate and intraplate earthquakes.

- Interplate earthquakes occur at the boundary of two tectonic plates. Examples: Himalayas and Japan.
- Intraplate earthquakes occur in the interior of the tectonic plate. These are relatively rare compared to interplate. Examples: Bhuj and Indian ocean earthquake, 2012.

BASIC TERMINOLOGY

FOCUS: It is a point in the earth from where seismic waves generate.
FOCAL DEPTH: Vertical distance between focus and epicentre.
EPICENTRE: It is the point on the surface of earth from vertical upwards from focus.

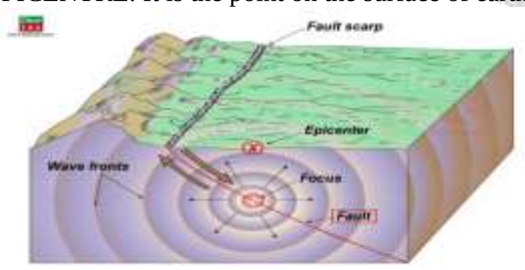


Fig.1 Engineering Terminology

Fig.2 Collapsing of Building

EARTHQUAKE EFFECT ON BUILDING STRUCTURE

A. Inertia Forces in Structures:

The generation of inertia of forces in the structures is one of the seismic effects that has harmful effects on structure. When the ground shakes during an earthquake the base of the building will move but the roof will be at the rest. Since the wall and columns are attached to it, the roof is pulled with the base of the building. When the ground moves the building is thrown backward and the roof experiences a force called inertia force. The walls and columns are flexible because the motion of the roof is different from the ground. Inertia forces can cause shearing of the structure which causes concentrated stresses on the weak walls and joints in the structure resulting in total collapse. More mass means higher inertia. Therefore, lighter buildings sustained the earthquake shaking better.

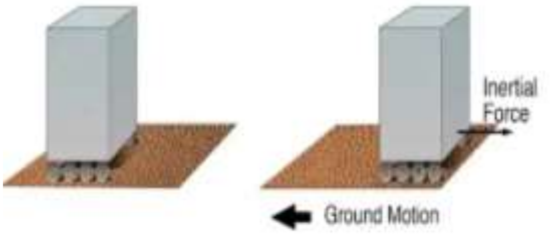
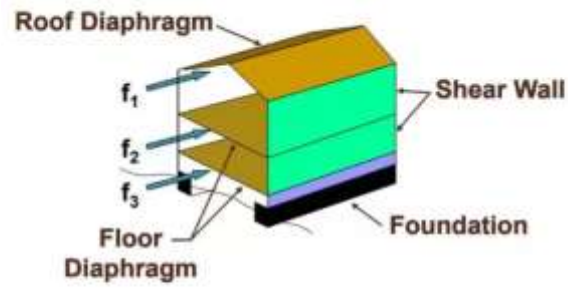


Fig.3 Direction of Inertia Forces

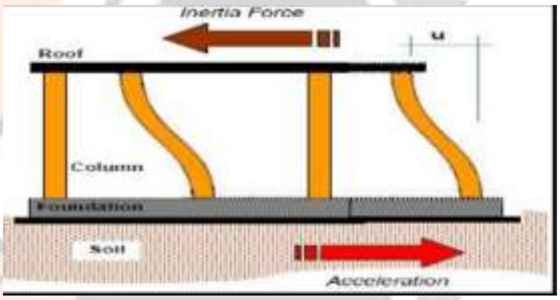
Fig.4 Development of inertia forces

B. Effect of Deformation in Structures:

When a building experiences an earthquake and the shaking of ground occurs the base of the building moves with it. The movement of the roof is different from the base. This difference in the movement generates internal forces in columns which helps them to return to its original position. The inertia force will transfer to the ground through the columns. The column undergoes relative movement between their ends. Higher horizontal displacement greater the internal force in columns. These internal forces are called Stiffness Forces. Stiffness forces will get more as the size of the column increases.



Fig,5 Lateral Force resisting system



Fig,6 Inertia force and Relative motion within the building

C. Horizontal and Vertical Shaking

Earthquakes cause shaking of the ground in all the directions X,Y,Z. Commonly, structures are designed to resist vertical loads so that the vertical shaking due to earthquakes is tackled through safety factors used in the design to support vertical loads.

However, horizontal shaking along X and Y directions is critical for the performance of the structures because it generates inertia forces and lateral displacement.

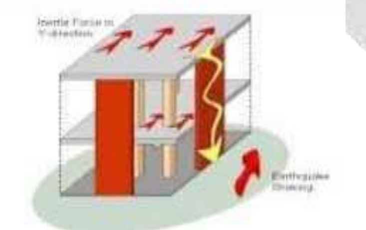


Fig6. Load path for lateral inertia forces

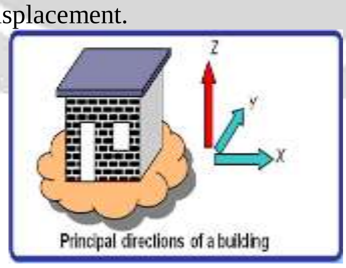


Fig.7 Principal Directions of building

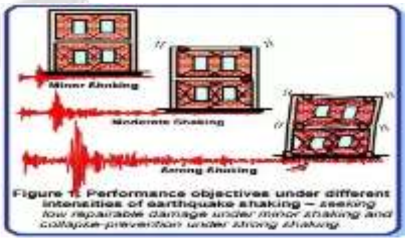


Fig.8 Performance objectives under different intensities

D. Flow of Inertia Forces to Foundation:

The lateral inertia forces are transferred by the floor slab to the walls or columns, to the foundation, and finally to the soil.

So, each of these structural elements (floor slabs, walls, columns and foundation) and the connection between them must be designed to safely transfer these inertia forces through them.

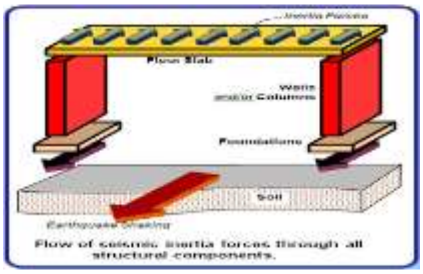


Fig.9 Flow of seismic inertia forces

MODERN CONSTRUCTION METHOD FOR EARTHQUAKE RESISTANT BUILDING

The prestressed concrete components in seismic risk resistant construction which ensures proper relationship between different elements of a structure.

A. Seismic Dampers:

These are the diagonal braces in a movement resisting frame which is used for an efficient lateral load resisting scheme. These dampers work the same as that of hydraulic shock absorbers in a car. Considerably in case the sudden jerks are engaged in the hydraulic fluids and only small are transferred to the chassis of the car. In this case the energy is transferred through it and dampers absorb a small part of it and decrease the magnitude of the force which is acting on the structure.

Generally, types of seismic dampers are included: Frictional dampers, viscous dampers, and Yielding dampers. The frictional dampers were delivered in a 18 storey RC frame structure in gurgaon, India.

Fig.10 Viscous dampers

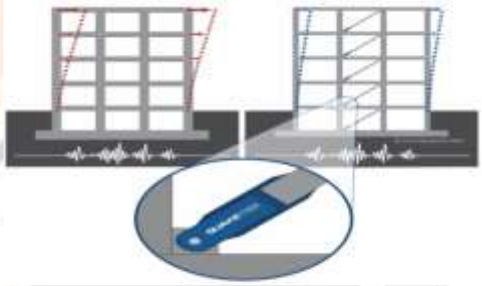


Fig.11 Frictional dampers

B. Shape Memory Alloys:

They have a capability to break up considerable energy without permanent deformation or considerable destruction. Generally, common shape memory alloys are made up of metal blends of Nickel-Titanium, Copper-Aluminium-Nickel and Copper-Zinc-Aluminium-Nickel. This is more suitable for large applications.

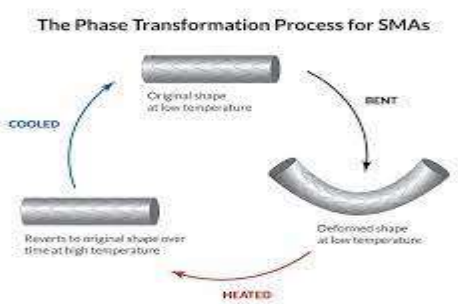


Fig.12 Phase transformation process

Fig.13 Shape memory alloys

C. Steel Plate Shear walls:

Shear walls are deemed as an important component of a lateral load resisting system and steel is known for its flexible behaviour. These walls are not needed to be cured and consequently, it leads to an increase in the speed of the construction process.

Fig.14 Steel Plate shear wall

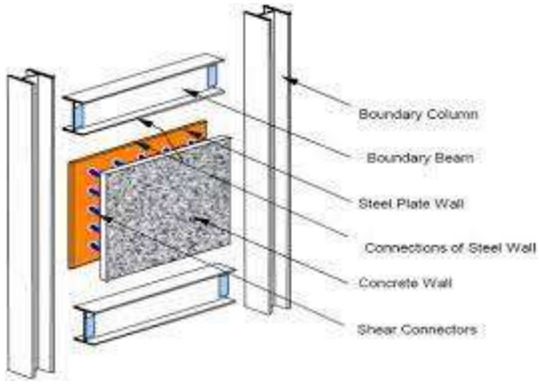


Fig.15 Concrete Stiffened Steel shear wall

D. Ecological ductile cementitious composite (EDCC) spray:

EDCC blends the fly ash, cement with polymer-based fibres, and other extracts in making it ecological and has been provided the molecular level to be malleable and strong at the same time. This material when utilised as a slim coating (10mm), was noticed to have enhanced seismic resistance of the structure by enduring a seismic risk of intensity 9 to 9.1 on Richter scale.

STRATEGIES FOR EARTHQUAKE RESISTANT CONSTRUCTION

In lodgement to the earthquake design code 1893 the Bureau of Indian Standards (BIS) has distributed to relevant earthquake design codes for Earthquake Resistant Construction masonry structures (IS-13828 1993).

- Delivering vertical reinforcement at significant locations such as internal corners, and external wall junctions as per code.
- Horizontal bands should be provided at lintel, plinth and roof levels as per code
- Proper workmanship and Quality assurance must be guaranteed for all cost without any concession In RCC framed structures (IS-13920)
- Grade of mortar should be as per codes definite for dissimilar earthquake zones.
- Asymmetrical shapes should be evaded both in vertical and plain configuration.
- In RCC framed structures the arrangement of lateral ties should be retained closer as per the code
- Whenever laps are to be offered, the lateral ties (stirrups for beams) should be at nearer spacing as per code.
- The hook in the ties should be at 135 degree as an alternative of 90 degree for better anchoragement.
- The planning of lateral ties in the columns should be as per code and must be sustained through the joint as well.

CONCLUSION

This review article concludes that earthquakes are unpredictable natural disasters. Earthquakes mainly affect buildings and destroy each other. This is due to the poor structural design of the building. To overcome these effects, civil engineers must follow good construction design practices. In this review, we analyze how to design earthquake-resistant buildings. Proper building codes, along with balanced practices, ensure safe construction for owners and occupants. Building codes specify the design of seismic structures. His intention is to strengthen the building to overcome strong earthquakes. The construction skills of civil engineers must prevent damage and collapse of buildings during unpredictable earthquakes. Structural and architectural engineering has had its own historical growth, and their interaction has resulted in several attractive and delightful modern architecture. There is still a need to model the original design of the architectural structure. Structural engineers must also collaborate during the construction process. Every civil engineer must develop new architectural design methods that can withstand earthquake-induced building collapse and ensure safe lives for people around the world.

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