EARTHQUAKE RESISTANT CONSTRUCTION

VINAYAK KAUSHAL

Abstract: The effect of earthquake can be prevented or minimized by taking certain preventive measures as per standard scientific guidelines. In Earthquake prone areas, these measures may prevent the loss of lives and material. This is the need of hour to educate the masses to adhere to the standard measures during the process of construction in earthquake prone areas. Organization of different workshops and revision of curriculum in engineering courses from the view point of frequent earthquakes in different parts of the country may be of great help to minimize the damage.

Keywords: Active systems, Shear Walls, Seismic Isolation, Passive systems Retrofitting.

Introduction: An earthquake is a natural phenomenon, occurring with uncertainties which is the result of sudden release of energy in the earth's crust that creates seismic waves. Certain preventive measures are needed to be incorporated during the construction resulting in the Earthquake resistant structures. Earthquake resistant structures are the structures, designed to resist the effect of earthquake on them. The type of construction in which there is either no effect of earthquake or it is negligible is said to be Earthquake Resistant Construction. Although no construction can be entirely immune to the damage caused by the earthquakes. But the basic goal of earthquake resistant construction is to erect structures which can withstand seismic activities or conditions than their counterpart conventional structures so that loss of life is minimized by taking preventive measures during the construction stage. Hence in the areas which are prone to seismic effects, construction requires measures to ensure stability, serviceability, strength with considerable levels of safety.

Methodology: It has been observed that either due to conventional methods or methods not adhering to the design concepts of earthquake resistant construction, earthquake causes considerable damage. So, the aspect of earthquake has to be taken into consideration in the construction.

Principles[1] of Earthquake Resistant Design can be described under three broad categories:

- Consideration of location of rooms, walls, openings (doors, windows, and storey), site and foundation aspects must also be taken care of.
- Attention must be given to the layout and general design which furnishes lateral resistance.
- Consideration of highly loaded and critical sections with provisions of reinforcement as required.

In the methodology part, it is important to mention about the techniques[4] to resist Earthquake in the structures:

Active and Passive system: Active control systems are devices integrated with real-time processing evaluators for improved service and safety

Passive control systems are conventional devices to resist or absorb the energy produced during Earthquake. For example: Viscous Dampers.

Shear walls: Reinforced concrete shear walls in buildings are an excellent structural system for earthquake resistance and help to resist gravity loads and lateral loads.

Bracing: Bracing can be diagonal, cross, triangular, or eccentric which helps in the resistance process during the natural calamity due to seismic disturbances

Dampers: The purpose of dampers is to deaden, restrain, or depress the effect of energy or vibration produced during the earthquake

Rollers: Building on rollers for instance, parking lots at the shopping malls, without any friction results in the situation in which building will not move with ground.

Base Isolation: Base isolation is one of the means of protecting a structure against Earthquake. It is a process 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 structure. Example: building resting on frictionless rollers when the ground shakes, the rollers freely roll, but the building above does not move. Thus, no force is transferred to the building due to shaking of the ground; simply, the building does not experience the earthquake.

Light weight material: Use of light weight material can also resist the earthquake forces considerably in case of structures. Lightweight concrete is one of the most popular of the new lightweight construction materials. Lightweight concrete is made using either lightweight aggregates or with foaming agents such as aluminium powder. Lightweight aggregates include pumice, scoria, volcanic cinders, tuff, and diatomite. The aggregate can also be made by heating clay, shale, slate, diatomaceous shale, perlite,

obsidian, and vermiculite.

Another popular lightweight building material is Gyprock and its various products including walls, decorative mouldings, suspended ceilings, and finishing plasters.

Bands: Horizontal bands can be used in the masonry buildings to resist the effect of seismic forces e.g. Earthquake

Additional strength can be provided to the buildings by an art called as Retrofitting.

Retrofitting: It is an art of providing additional strength to the buildings which are weak due to original structural inadequacies &material degradation due to time effect or alteration carried out during use over the years. For Instance the Masrur Temples in Kangra have been retrofitted keeping the Earthquake effects in mind.

Due to Retrofitting, response of structures against earthquake gets modified. It carries lesser cost than the rebuilding. It can prevent complete collapse

The first formal seismic code[3] in India, namely IS1893, was published in 1962. Today, the Bureau of Indian Standards (BIS) has the following seismic codes:

IS 1893 (Part I), 2002, IS Criteria for Earthquake Resistant Design of Structures (5th Revision)

IS 4326, 1993, IS Code of Practice for Earthquake Resistant Design and Construction of Buildings (2nd Revision)

IS 13827, 1993, IS Guidelines for Improving Earthquake Resistance of Earthen Buildings

IS 13828, 1993, IS Guidelines for Improving Earthquake Resistance of Low Strength Masonry Buildings

IS 13920, 1993, IS Code of Practice for Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces

IS 13935, 1993, IS Guidelines for Repair and Seismic Strengthening of Buildings. The regulations in these standards do not ensure that structures suffer no damage during earthquake of all magnitudes. But, to the extent possible, they ensure that structures are able to respond to earthquake shakings of moderate intensities without structural damage and of heavy intensities without total collapse.

Research Data: The research[2] conducted on the Earthquake in Bhuj and Kutch in Gujarat to the tune of 7.7 on R-scale on Jan 26, 2001 at 08:46 AM reveals that 20,000 deaths were recorded,3, 40,000 houses were found to be destructed, 6, 00,000 people became homeless and additional 844000 houses were damaged.

This unforgettable earthquake led to devastation of structures, industrial buildings, rails bridges, highways, and monuments (Shiva Temple). Rajolati Chattri at Bhuj was partially damaged. Even RCC buildings were badly affected.

Following behavior of buildings during Bhuj Earthquake was seen:

i. Starting of diagonal and vertical cracks-Stage1 and 2
ii. Shear cracks in both directions
iii. Spalling of concrete
iv. Starting of cup-cone formation
v. Bucking of bars
vi. Drifting of upper storey

The reasons behind the failure of structures and roads during Bhuj Earthquake were due to:

i. Improper seismic design and Liquefaction of soil
ii. Structures designed only for gravity loads
iii. Soft storey system
iv. Insufficient confinement
v. Poor quality of construction materials
vi. Plan asymmetry and Soil Condition

Conclusion: It can be concluded that for the Earthquake-resistant construction, preventive measures have to be incorporated during the construction process. This includes incorporating new techniques that can be use of smart materials. These are the materials that respond to specific external stimuli and carry out particular functions as a result of their intrinsic properties. These materials have had a major impact on the field of vibration control in cases of seismic disturbances. Smart materials are most frequently used to absorb vibrations in vehicle suspensions. Attempts should be made to transfer this technology to civil engineering, where it has so far only been used experimentally. Incorporating new technologies does mean investing heavily in the infrastructure sector. But that must not be ignored at the expense of lives of people. To avoid what we have witnessed during the earthquake in Gujarat in 2001, the need of the hour is to go along with the technology.

Acknowledgment: Guidance of Prof.RL Sharma, Director-cum-Principal, SP Guleria, HOD, Civil Engineering & Tarun Goel, Assistant Professor, Civil Engineering and every assistance of the Administration of the JNGEC, Sundernagar are gratefully acknowledged.

References:

1. C.V.R Murty, "How do Earthquakes affect Reinforced Concrete Buildings"? Available: http://www.iitk.ac.in/nicee/EQTips/EQTip17.pdf.
2. Sudhir K Jain and Shashank Pathak. "Intensity Based Casuality Models: Case Study Of Bhuj and Latur Earthquake in India". Available: http://www.iitk.ac.in/nicee/wcee/article /WCEE2012_4830.pdf.
3. Earthquake Resistant Construction. Available: http://www.nicee.org/iaee/E_Chapter3.pdf
4. Earthquake Resistant Construction. Available: http://civil-resources.blogspot.in/2010/06 /earthquake- resistant-construction.html.

* * *

BTech. 3rd Year, Civil Engineering,
Jawaharlal Nehru Government Engineering College,
Sundernagar (HP)
vinayakkaushal4449@gmail.com