Earthquake Resistance Design of Structures Using Energy Dissipation Devices

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Abstract— A number of imaginative approaches for improving earthquake response performance and damage control of buildings, bridges and other structures have been developed and other will be forthcoming in future. These can be divided into three groups: Passive systems such as base isolation and supplemental energy devices; Active systems which requires the active participation of mechanical devices and Hybrid Systems which combines the Passive systems and active systems in manner. So the safety of the system is not compromised even if the active system fails. Energy dissipation has long been recognized as an effective means of controlling excessive vibration of mechanical and structural systems under dynamic loads.
Key words: Earthquake, seismic devices

I. INTRODUCTION

Building owners and structural engineers have become increasingly aware that buildings designed in accordance with code force requirements produce buildings that behave as expected. Buildings designed and constructed in accordance with newest codes provide life safety as is their intent , but cost of damage repair and the time needed implement these repairs are greater than anticipated

Three innovative techniques have been proposed for use individual or in combination with to improve earthquake building performance: Seismic isolation, supplemental energy dissipation system and active or hybrid structural control. The protection of structures subject to the risk of earthquake really began in 20th century.

In the majority of cases the structure used passive safeguard system such as shear walls in buildings or even protection based on plasticization of elements chosen in advance for bridges. Even though this type of protection allows the structure to resist design earthquakes and ensure the protection of human lives, after a high intensity earthquake it often meant major repairs to the damaged protective elements.

In modern society the current trend is to equip the structures in seismic zones with special devices that absorb or limit the effects of earthquake on structure. These devices can be used alone or in combination to achieve the most efficient and suitable protection for the project.

Here in this paper we will emphasis upon the three different systems and some of the device which are being extensively used in the earthquake resistance buildings.

II. THE PASSIVE SYSTEMS

These contain the shear walls, base isolation systems, etc.

A. Shear Walls:

Shear walls are a type of structural system that provides lateral resistance to a building or structure. They resist "in-plane" loads that are applied along its height. They are built generally in concrete. The use of shear walls increases the rigidity of the structure and thus decreases the sway of stories of buildings. They are always used in combination of two, three, and four, but it has its own limitations.

B. Base Isolation Systems:

The principle involves isolating the structure from the movement of the ground by using flexible connectors, mainly structural elastomeric bearings or sliding devices, to increase the natural period of the structure to protect it from, and reduce the response to, the seismic acceleration. The effect of the isolation of the structure can therefore be seen in the low natural frequency, slow acceleration and significant relative movements.

C. Structural Elastomeric Bearings:

The seismic isolators are particularly suited to massive, circular structures such as liquefied gas reservoirs and nuclear power stations and act as lateral springs which re-centre the structure after an earthquake. They also have an internal damping capability which gives them an energy absorption capacity which can be augmented by dampers. Isolation achieved with structural elastomeric bearings consists of increasing the natural period of the structure by extending the dominant values liable to be produced under the seismic activity. The isolation is characterized by a reduction in seismic forces.

D. Sliding Devices:

These devices make almost perfect isolators. They are usually used in combination with lateral springs (e.g. structural elastomeric bearings) whose function is to limit overall movement during the earthquake and to return the structure to its original position. Controlled friction devices, i.e. between a μmin value and a μmax value, limit structure accelerations to the μmax.g value while the ground acceleration less than μmin.g will be filtered by the elastic function of the structural elastomeric bearings. Furthermore, it is important to construct sliding devices that guarantee sufficient friction to dissipate enough seismic energy and to reduce movements of the structure subject to the earthquake whilst maintaining an acceptable acceleration level. Providing 20% nominal friction elasto-sliding devices for the protection of nuclear power stations which guarantee nominal maximum acceleration of 0.2g.

In addition this there are few Hysteric devices also used in the buildings as energy dissipation devices.

III. ACTIVE SYSTEMS

This system requires the involvement of mechanical devices. These devices are known as dampers. Dampers are comparable to the shock absorbers of vehicle. These are installed in the buildings at suitable places to damp the vibrations of quake energy. It may be advantageous to limit the seismic movement of the structures to simplify the equipment linking them to neighboring structures (expansion joints, etc.). In these cases the designer will use either mechanical structural bearings to transmit directly and in totality the service or seismic loads from the foundations to the structures, or seismic connectors. Seismic connectors have the characteristic of only providing very low resistance to slow movements such as those due to temperature and stress-strain variations. In contrast, they provide a rigid link between the superstructure and its supports during rapid movements such as those caused by seismic events. Another advantage of connectors is the distribution of the major seismic horizontal forces between all the supports where installed. These devices react according to the speed of movement involved and act as “safety belts”: During slow movements, due to temperature variations, the connectors only provide very low resistance. However, in the event of rapid movements caused by an earthquake, the connectors are blocked and create a rigid connection between the structure and its supports. They thus transfer all the horizontal seismic forces. This system have certain advantages which is given below

1) Transfer of high-intensity loads.
2) Movements limited to the deformation of substructure in the event of an earthquake.
3) Distribution of the horizontal seismic forces to all piles provided.
4) Simplification of equipment (structural bearings and expansion joints).

IV. HYBRID SYSTEMS

The use of mechanical connector and the Passive systems together is shown up as Hybrid system. It is to insure the complete safety of the structure. If in a case one of the systems fails the other is there to compensate for it, thus insuring complete safety of the structure and lives.

V. CONCLUSION

Here we can conclude that heavy structures if equipped with the energy dissipation devices are always safer and long lasting. They present first-rate examples of structural engineering and saving lives of people and property.

REFERENCES

[1] IITK-BMTPC Earthquake tips by C.V.R. Murty.
[2] Earth quake rebuilding in Gujarat, India by C.V.R. Murty.
[3] Seismic Design with Supplemental Energy Dissipation devices by Robert D. Hanson and Tsu T. Soong.
[4] Barton A.H. (1969). Communities in Disaster. A Sociological Analysis of Collective Stress Situations. SI: Ward Lock
[5] Catastrophe and Culture: The Anthropology of Disaster. Susanna M. Hoffman and Anthony Oliver-Smith, Eds.. Santa Fe NM: School of American Research Press, 2002
[6] G. Bankoff, G. Frerks, D. Hilhorst (eds.) (2003). Mapping Vulnerability: Disasters, Development and People. ISBN 1-85383-964-7.
[7] D. Alexander (2002). Principles of Emergency planning and Management. Harpended: Terra publishing. ISBN 1-903544-10-6.

