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Dampers as seismic energy dissipator and principles for EQ resistant building

J. Saileela
juturusaileela@gmail.com
JNTUH College of Engineering, Hyderabad, Telangana

D. Ganesh Chandra
dasganesh451@gmail.com
JNTUH College of Engineering, Hyderabad, Telangana

ABSTRACT

Earthquake is one of the major disasters since they cause damage to human life in various ways. Mostly, the world population lives within the range of 50miles away from the ocean. So, these earthquakes can cause destruction to human life and also to property. The process of releasing the huge amount of energy during an earthquake is done by DAMPERS, these are Energy Dissipating Devices. This paper briefly explains the definition and types of dampers, principles for EQ resistant building.

Keywords— *Dampers, Seismic dampers, Dissipation, Structure, Friction dampers, Viscous dampers, Yielding dampers, Magnetic dampers and tuned mass dampers*

1. INTRODUCTION

In seismic structures, the reduction of lateral force to the building caused by an earthquake is by the use of dampers. A large amount of energy is released during an earthquake. This seismic energy can be either absorbed or transferred to the structure. The forms of seismic energy are Kinetic energy and Strain energy.

2. SEISMIC DAMPER

The damper is a device which dissipates energy released during earthquakes. It is a type of Active Control Device for the resistance of earthquake. Dampers do not isolate the substructure from the superstructure. The device which is mounted in structures used to reduce the vibrations caused during earthquakes is called Seismic Damper. Usage of this dampers can prevent the damage to the building, discomfort to humans.

2.1. Types of Seismic Dampers

Commonly used Seismic Dampers are,
(a) Friction Dampers
(b) Viscous Dampers
(c) Yielding Dampers
(d) Tuned Mass Dampers
(e) Magnetic Dampers (Magnetorheological damper)
Thus, the seismic energy entering into the building can be greatly reduced by equipping building or a structure with additional devices which have high damping capacity.

(a) Friction Dampers: Frictional Dampers are designed in a manner that moving parts will slide over each other during earthquakes in turn results in rubbing action. When they slide, it results in friction which uses some of the energy from an earthquake that goes to the building.

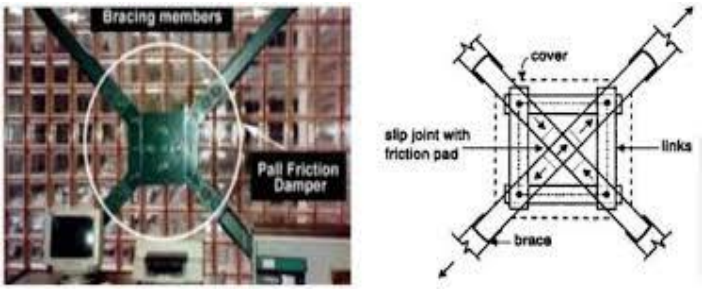

Fig. 1: Friction Damper

The principle used in this type of dampers is friction brake, which translates kinetic energy into heat by friction, caused by moving parts. Introducing frictional dampers steel bracing in rigid concrete frames, the EQ resistance is tremendously increased. There is no need for replacement after EQ. These are low cost and no maintenance is required. It shows very less effect on velocity, temperature.

(b) Viscous Dampers: In Viscous Dampers, the energy released during earthquakes is absorbed by viscous fluid which passes between the piston and cylinder. Viscous fluid or damping fluid is Silicone oil. It is inert in nature, non-toxic, non- inflammable and stable for long periods. Viscous Damper dissipates seismic energy by pushing the viscous fluid through an orifice, results in producing damping pressure which creates force. This decreases the effect of seismic energy onto the structure significantly. These dampers can be used in both situations where vibrations are induced by strong winds and earthquakes because they can reduce horizontal floor accelerations and lateral deformations by half or sometimes more

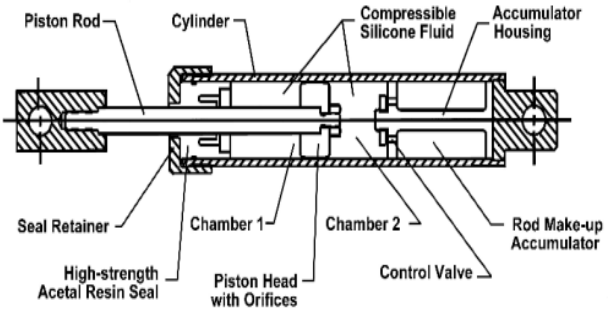

Fig. 2: Viscous Damper

(c) Metallic Yield Dampers: In Metallic Yield Dampers (MYD), the energy released during earthquakes is absorbed by metallic components. These can be made of steel or lead. The effective mechanism for seismic energy dissipation is the inelastic deformation metallic dampers. As the components of dampers are having high elastic stiffness, good ductility and high potential in the post-yield region, these became popular. When the structure is encountered with earthquake, MYD is very easy to be yielded and dissipate energy. These can prevent the primary structure being damaged by seismic events because of its high elastic stiffness.

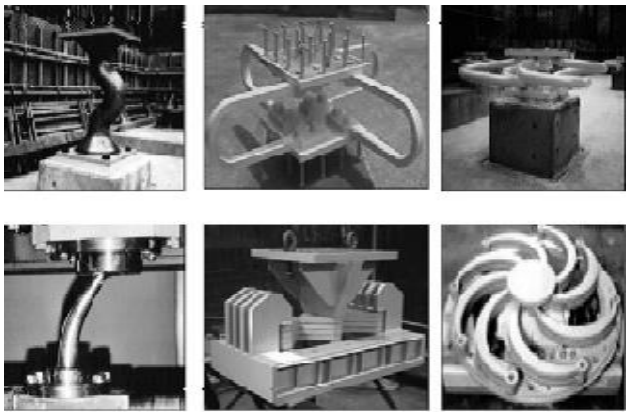

Fig. 3: Samples of Metallic Yield Dampers

(d) Tuned Mass Dampers

Tuned Mass Dampers (TMD) works in a manner that the seismic vibrations caused during earthquakes can be reduced by resisting resonance frequency. TMD works on the principle of frequency (harmonic motion). The components of TMD are,

(i) Spring

(ii) Large Oscillating Mass

These are very light in weight, which acts as spring. They reduce the amplitude of large vibrations of a building during EQ.

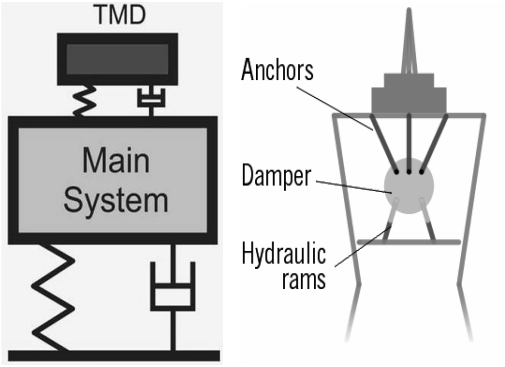

Fig. 4: Tuned Mass Dampers

(e) Magnetic Dampers (Magnetorheological Dampers): Magnetorheological (MR) damper is a damper which is filled with magnetorheological fluid. It is controlled by a magnetic field by using electro-magnet. As the intensity of electro-magnet increases, fluid viscosity in damper increases. Damping of electro-magnet with Neodymium (NdFeB) results in less expensive and temperature independent. It is very easy to adjust.

The components of MR damper are two opinions, two racks, rare earth magnet, a copper disk. Because of the pinions and racks, the copper disk rotates. The rotation of the copper disk is due to relative linear motion between ends of two rods.

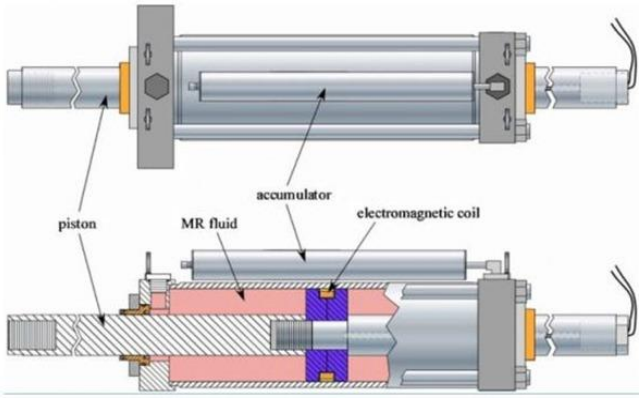

Fig. 5: Magnetic Dampers

3. PRINCIPLES FOR EARTHQUAKE RESISTANT BUILDING

- Fully earthquake resistant structure will be huge and it is highly expensive also
- Making the structure, which is absolutely earthquake resistant that will not suffer any damage during EQ cannot be possible
- Buildings which are located in the zones 3,4,5 should be designed for earthquake also
- Moderate earthquakes which occur once during the lifetime of the structure called Design Basis Earthquake (DBE). The structure should be designed that it is able to resist DBE
- Major earthquakes called Maximum Considered Earthquake (MCE) have intensity greater than DBE. Structures designed for MCE can be able to resist the collapse of structure and loss would be limited

4. CONCLUSION

- The performance of the structure can be significantly improved by incorporating damping elements
- The ratio of performance to cost is more, where the structure is provided with dampers
- Stress on concrete and reinforcement can be reduced by damping technique
- Regular maintenance of dampers is required

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