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Seismic Isolation Devices

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Abstract—*When the Earthquake comes there is a huge force acts on the earth surface. The soil influences the motion of structure and the motion of structure influences the response of soil. Due to the earthquake forces, displacement occurs in the structure which consequently causes the huge damage to the structure. In order to minimize the damage which is caused by the earthquake we use seismic isolation devices. Seismic isolation devices absorbs or minimize the shock in the structure arises from earthquake. Seismic isolation devices reduce the stiffness or damping in the structure. Seismic isolation devices mounted between the foundation and floor of the structure. Seismic isolation device decreases the base shear and displacement but increases the floor acceleration and interstorey drift. In this research paper we study about different type of seismic base isolator and its mechanism. There are two basic type of isolator (Elastomeric bearing and Friction pendulum bearing) and some supplementary devices. The main goal of this research paper is to minimize the damage which occurs due tothe earthquake with the help of seismic isolation devices.*

Keywords*: Seismic Isolation, Base Shear, Displacement, Floor Acceleration, Interstorey Drift, Seismic Isolator.*

1. INTRODUCTION

In recent years there was huge damage occurs due to earthquake. Due to earthquake forces, displacement occurs in the structure which consequently causes huge damage to the structure. In order to minimize the damage we use seismic isolation technique. For protection of structure against the earthquake to install seismic energy dissipating elements at the appropriate places of the building. Seismic isolation devices increase the capacity of structure to resist the earthquake load effects or increase the dynamic stiffness. Seismic isolation devices increase the frequency and reduce forces applied to the floors. Isolators reduce the energy of structure too. Seismic isolation devices decrease the earthquake energy acting on the structure. A seismic isolation device reduces the stiffness or damping in the structure.A seismic isolation device reduces response of the superstructure by decoupling the building from the ground.A seismic isolation device reduces the base shear and interstorey drift in the superstructure. A seismic isolation device reduces the acceleration in the structure although amount of reduction depends on the force deflection characteristics of the isolators and may not be as significant as the reduction of drift.Lessening of drift in the superstructure secures structural components and also non-structural components. Acceleration reduction protects non-structural components that are sensitive to acceleration induce damage.

2. LITERATURE REVIEW

Frank (1921) firstlyimplements idea of base isolation**.** He applied the concept of base isolation in foundation design for the Imperial Hotel in Tokyo, under the site was an eight feet layer of fairly good soil and below that a layer of soft mud. From this idea of floating structure came into picture for the resistance of earthquake shock.

Luis Andrade and **John Tuxworth (2002)** comparedbetween LRB and FPB for a five storey Rc framed structure. Base isolators improved the performance of structure during earthquake. Isolators reduced the roof level acceleration, shear, and inter- storey drift.

Chandak N. R (2013) compared between the RC building with fixed and isolated base with rubber bearings and Friction isolators using response spectrum method and finite element method. In case of friction type isolator base shear and relative drift decreases. The value of relative drift is inversely properly to no. of stories. Is code giving the maximum displacement value where Euro code give the minimum displacement value for the building with fixed base.

Ashish R. Akhare (2014) didcomparison between the effects of high density rubber bearing and friction pendulum system on a hospital building. Non-linear time history analysis done by SAP2000. He concluded that the base shear reduced in case of isolated structure.

The storey displacement has very little variation. Value of storey drift, acceleration, displacement shows very little variation when storey height changes in case of high damping rubber bearings.

Alaa Barmo et al (2015) gave theeffect of hybrid isolation technique on the response of a multi storey building under seismic loads. He used Base isolation and seismic dampers to minimize inter-story drifts and floor acceleration. He concluded that displacement and base shear is inversely

proportional to storey height when combined isolation was used.

Azin Shakibabarough (2016)studiedthe position of Friction dampers and Base isolator. The structure with triple pendulum base isolator has very less drift. Floor displacement is highest in case of base isolated type frame. The frame which has base isolator reduced bending moment of the frame significantly.

3. DESIGN PRINCIPLE

For protecting the structure against the earthquake we use seismic isolators and thus we provide security and comfort condition under service load. Many type of devices are used in the structure for the purpose of seismic isolation. The working principle of seismic isolation is very simple. Isolation devices are generally used to reduce seismic force introduce base shear. The main concept of designer behind the earthquake resistance structure is to increase the vibration period that will reduce the magnitude of spectral value and thus reduce the base shear accordingly. An equation of motion of the structure which is related to the ground motion depends on mass, stiffness, energy damping nature of structure and external seismic forces which affects the structure. When we change the stiffness of building then the characteristics of response forces are controlled. The response acceleration can be decreased, by decreasing the stiffness of structure. The displacement can be increased, by decreasing the stiffness of structure. When the damping effect of structure is increased, the response of acceleration as well as displacement will be decreased. When we change the total mass and the distribution of mass within the system then the dynamic characteristics of the structural system can be change. Seismic isolation devices in the structure fixed in that manner the foundation of the structure is separated from its superstructure like isolating the main building from its roof. A seismic isolation device usually works on energy dissipating mechanism. A seismic isolator device which is installed outside the structure usually installed into the foundation is known as external seismic isolator device. A seismic isolator device which is installed inside the structure is known as internal seismic isolator device.

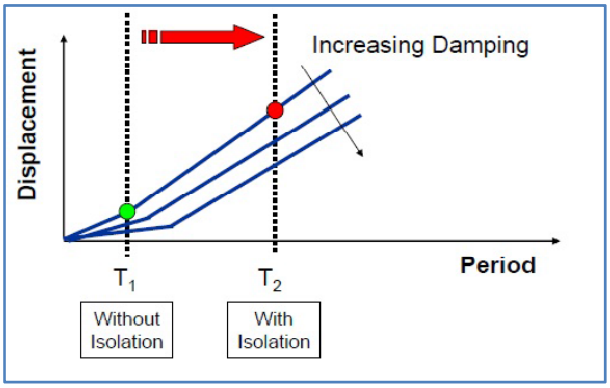


Fig. 1: Graph between Displacement and Period

Fig. 1 illustrate that the base isolator structure have larger displacement as they are separated from ground.

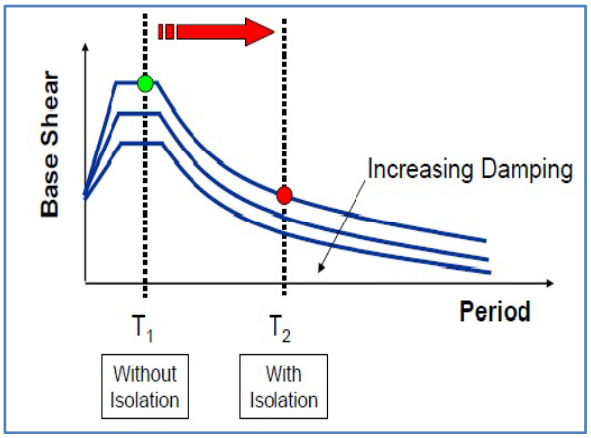
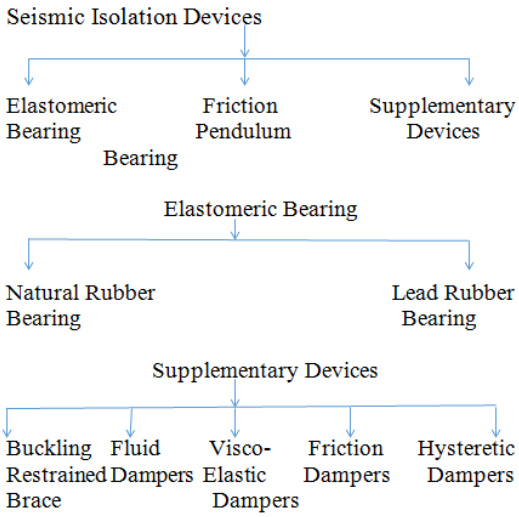


Fig. 2: Graph between Base shear and period.

Fig. 2: illustrate that non-isolated structure has larger shear force than isolated structure.

4. TYPES OF SEISMIC ISOLATION DEVICES



4.1 Elastomeric Bearing

Elastomeric bearing devices have been used, before applied in civil engineering, to isolate vibrating machine. We provide a layer of horizontal stiffness between the structure and foundation for decoupling the structure from ground motion. Elastomeric bearing are of two types according to their properties.

4.1.1 Natural and Synthetic Rubber Bearing (NRB)

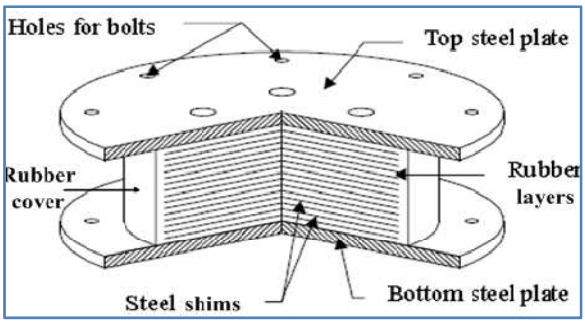


Fig. 3: Natural and Synthetic Rubber Bearing.

NRB is made of alternating elastomeric layers and steel shims vulcanized together. Elastomeric layers are made of natural rubber or neoprene. Lateral flexibility and elastic restoring force is provided by elastomeric layers. The steel plates implement vertical load capacity and prevent lateral bulge. NRB are of low damping as well as high damping. The low damping bearings are utilized as a part of conjunction with supplemental damping devices. The high damping bearings provide sufficient inherent damping.

4.1.2 Lead Rubber Bearing (LRB)

Fig. 4: Lead Rubber Bearing

LRB is similar to NRB but LRB contains a lead core. The steel shims restrict the lead plug and therefore it deforms in shear. When the deformation occurs the dissipation of energy takes place.

4.2 Friction Pendulum Bearing

Friction pendulum bearing devices works on friction between stainless steel and Teflon. Friction pendulum bearing are of two types (1) Flat Slider Bearing and (2) Curved Slider Bearing.

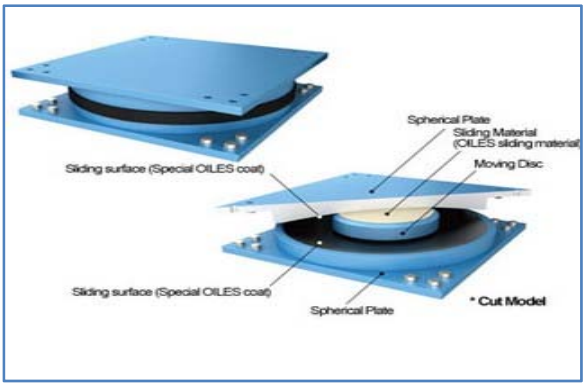


Fig. 5: Flat Friction pendulum section cut

When horizontal forces acts and there is no restoring ability then we use flat slider bearing.

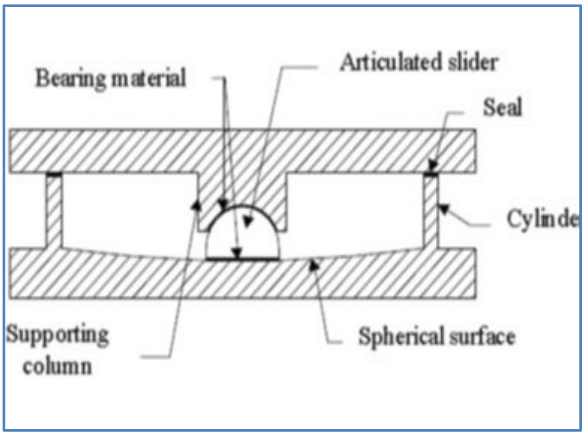


Fig. 6: Curved Friction pendulum section cut

Curved friction pendulum have spherical surface at bottom. Curved slide bearing acts like flat slider bearing.

4.3 Supplemental Damping Devices

Supplemental damping devices combined with other isolators to resist the lateral forces.

4.3.1 Buckling Restrained Brace (BRB)

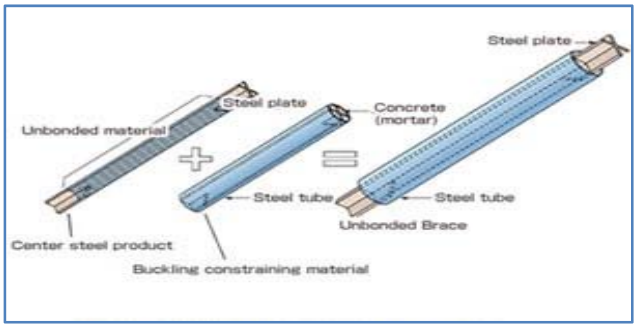


Fig. 7: BRB Material and parts

When we provide bracing for bearing of seismic load then BRB is very useful. BRB are designed to yield under loads without buckling and BRB has high ductility. BRB has ability to yield both in compression as well as tension without buckling. The steel core provides resistance against buckling by restraining mechanism.

4.3.2 Fluid Dampers

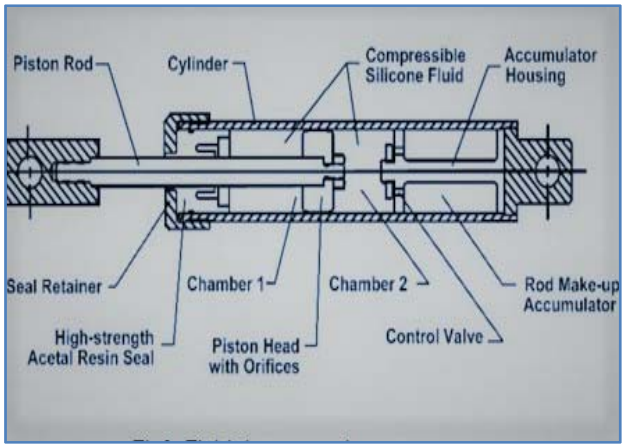


Fig. 8: Fluid Damper section cut

Fluid dampers apply restoring force over a finite displacement by which energy dissipation occurs. Energy dissipation occurs in the form of heat mainly by the convection and conduction process. When the force applied then the piston rod moves and therefore the reduction in fluid volume occurs. A restoring force developed due to reduction of fluid volume which is prevented with the help of accumulator.

4.3.3 Visco-Elastic Dampers

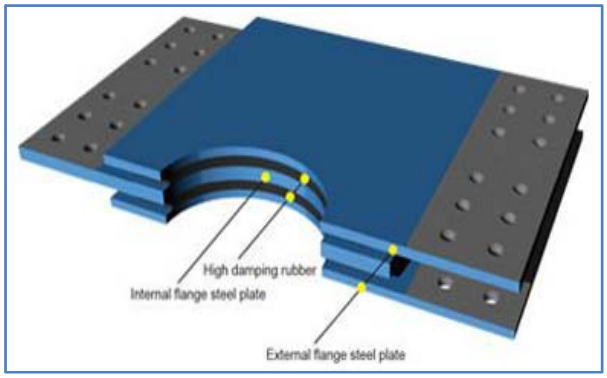


Fig. 9: Visco-Elastic Damper

Visco-Elastic dampers are designed to operate at ambient temperature and fundamental frequency of the structure. It contains a Visco-elastic material which is tied to steel plates.

4.3.4 Friction Dampers

Fig. 10: Friction dampers

Frictional dampers are most effective, economic and reliable. It extracts kinetic energy from moving body. Frictional dampers consist of series of steel plates which develops friction. The steel plates are fixed with high strength steel bolts and allowed to slip at predetermined load. Frictional dampers are suitable for all type of construction.

4.3.5 Hysteretic Dampers

Fig. 11: Hysteretic Dampers

Hysteretic dampers provide most reliable seismic performance. It is also known as yielding dampers. In this damper energy is absorbed by metallic components. In this type Of damper metallic components are allowed to reach yield point.

5. ADVANTAGE AND DISADVANTAGE OF SEISMIC ISOLATOR DEVICES

1. Seismic isolator devices are most effective and suitable for low to medium rise building.
2. Seismic isolator devices are suitable for building on hard soil.
3. Structure is safer for occupants.
4. Less ductile detailing is needed.
5. It is not suitable for building on very soft soil.
6. It is not suitable for tall high- risebuilding.

6. CONCLUSION

When we use seismic isolator in the structure the structure behaves like earthquake resistant structure. A seismic isolator device absorbs the shock and reduces the stiffness as well as damping in the structure. It is most effective for low to medium rise structure which is constructed on hard soil. Seismic isolation serves further step onward for improved seismic safety. The construction cost mainly depends on the design force level of conventional building and the location of the plane of isolation. The construction cost increases in very lesser amount to achieving a structure which will have a considerably better seismic performance during major earthquakes. The dominant problem in comparing the costs and benefits of a conventional and an isolated structure is the significant difference in their performance characteristics.

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