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Seismic Base Isolation System

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Abstract - *The study is all around the Base Isolation System, Base isolation is a technique which provide the support to the structure by placing different types of bearings between the structure and structure foundation. In this technique the structure is decouple from its ground foundation, does during an earthquake it does not transfer force and energy to structure and protect the structure. The study explains in brief what are Base Isolation System, how does it work, what are its types, what are seismic Damper and their uses. Base Isolator are of two types Elastomeric bearing and Frictional Pendulum bearing and they are further divided into different types based on the material used and shapes. The study briefly explains how types of Base Isolators differ from one another. The study also contains advantages and disadvantages of Base Isolation System. And at last, the conclusion is all about reviewing Base Isolation System and using Base Isolator, along with some limits*

Key Words: **Base Isolation System, Base Isolators, Elastomeric Bearing, Frictional Pendulum Bearing, Seismic Dampers.**

1.INTRODUCTION

Providing a Base Isolation to the structure, enhances the reliability of the structure during an earthquake. This technique basically decouples the structure from the ground motion by introducing a flexible or a sliding type interface. At the time of earthquake, the structure without the Base Isolation can move significantly when the frequency of ground motion is close to the natural frequency of structure. But the structure with the application of Base Isolation dissipates the seismic energy and lower the natural frequency of the structure and thus minimize the displacement of the structure. Thus, Base Isolation system have become a significant element of a structural system.

Most of the engineers knew what Base Isolation is, its nothing but the springs or frictional material installed at the base of the structure to protect the structure from earthquake damage (1). If the Base Isolation technique is selected, one must how those base isolator works, what are these types, how one type differs from other, which one must be selected, something needs to be added along with it or not. Therefore, one must know these things for installation of this technique.

The term base isolation is using the word isolation in its meaning of the state of being separated and base as a part that supports from beneath or serves as a foundation for an object or structure (1). Base isolation is based of the above principles.

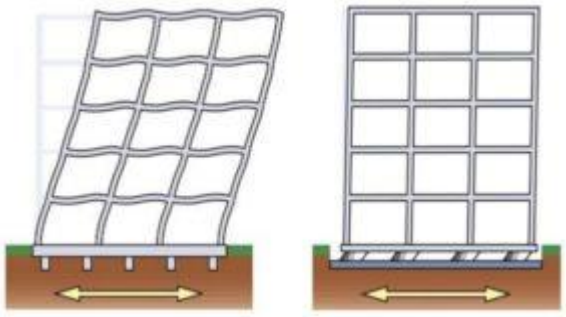

Fig. (1) Seismic Base Isolation (2)

1.1 How Base Isolation System work?

The base isolator works similar to the car suspension, which allows a car to travel over rough ground without the one sitting in the car thrown out (2). The Base Isolation system decouples the structure from the horizontal components of ground motion by interposing a low horizontal stiffness structural element between the structure and the foundation (3). Thus, by applying this isolation system the fundamental frequency of structure becomes much lower than the frequency of fixed base structure and predominant frequency of ground motion (3).

During an earthquake, a building can move around 300 mm or more, therefore there must be the way for a movement during an earthquake (2). This base isolation technology makes a medium rise building or a reinforced concrete structure to withstand the earthquake and protecting the occupants and the structure (3). Isolator reduces the energy of structure and it is also use to decrease the earthquake energy (E) acting on structure.

E=E (k)+ E (s)+ E(h)+ E(v), where E is energy induced by seismic shaking, E(k) is the kinematic energy, E(s) is the elastic strain, E(h) is the hysteric damping energy, E(v) is the viscous damping energy (3).

1.2 Types of Seismic Base Isolators

Seismic Base Isolators are divided two types, that are Elastomeric bearing and Frictional Pendulum bearing/ Sliding Isolator bearing. Depending upon material used and the intricate design further elastomeric and frictional pendulum bearings are divided.

1.2.1 Elastomeric Bearings

Elastomeric bearings consist of steel plates which are bonded to the rubber through vulcanization process and thus increase the resistance of the bearing to vertical load (4). This steel plates are fully embedded in elastomer for

protection against corrosion and the connection of the bearing with structure can be through steel and rubber both (4). The first use of elastomeric bearing to protect structure from earthquake was an elementary school in Skopje, Yugoslavia in 1969 (3). Elastomeric bearing, on basis on material used is divided into three types Natural Rubber bearing (NRB), Synthetic Rubber bearing (SRB), Lead Rubber bearing.

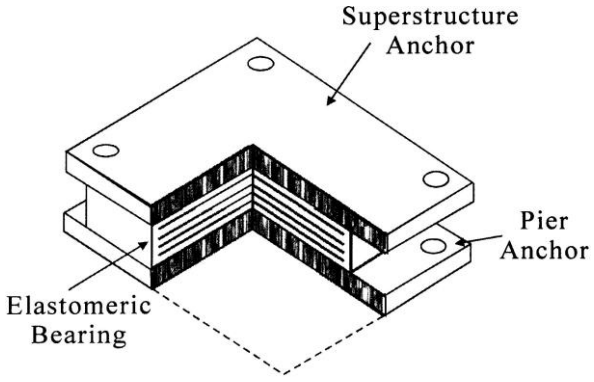

Fig. (2) Elastomeric Bearing

1.2.1.1 Natural Rubber bearing

If the alternating layer of elastomeric bearing are made up of natural rubber and steel shines, then the bearing form is Natural rubber bearing (3). The rubber provides the flexibility through its ability to move but returns to its original position and at the end of earthquake if the building or structure hasn't returned to its original position, then the rubber bearing will slowly bring it back, this might take some months but it will return to its original position (2).

1.2.1.2 Synthetic Rubber bearing

If the alternating layer of elastomeric bearing are made up of synthetic rubber like neoprene and steel shines, then the bearing is called Synthetic rubber bearing. This bearing is not preferred mostly as the properties of natural rubber and lead are much useful than that of synthetic rubber in base isolation system.

1.2.1.3 Lead Rubber Bearing

A structure or a building consist of large mass that is mass of the structure along with mass of occupant and if the rate of ground motion due to earthquake is strong then it will continue its back-and-forth motion due to absorption of energy from the ground motion by the structure (2). Therefore, lead cores were added to the base isolators as an energy dissipation mechanism as lead has its plastic property it will regain its original shape and during an earthquake the kinetic energy of earthquake is absorbed into heat energy as lead get deformed (2).

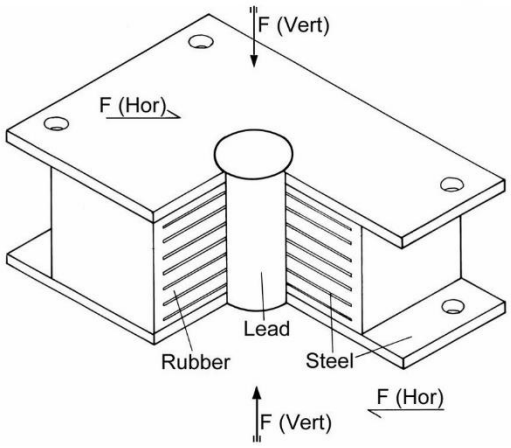

Fig. (3) Laminated Rubber bearing with Lead core (2)

1.2.2 Frictional Pendulum Bearing/ Sliding Isolator Bearing

Frictional Pendulum bearing are made up of dense chrome over steel concave or flat surface in contact with an articulate friction slider which are free to slide during lateral displacement (5). FPB works on a principal of simple pendulum, during an earthquake it gets activated and the articulate slides move along concave or flat surface which makes the structure to perform simple harmonic motion (5). The magnitude of the displacement can be varied according to the bearing just by adjusting the curvature and diameter of the bearing in case of curved slider bearing (5). Frictional Pendulum bearing is mainly divided on the basis of curvature that is Flat slider bearing and curved slider bearing.

1.2.2.1 Flat Slider bearing

It comes under the pure frictional systems and to introduce the sliding motion it uses flat stainless-steel plates as a sliding isolator, but this has some limitation due to which use of flat slider bearing is dropped and that is due to geometry of the sliding surface it produces large and residual sliding displacement (6). Therefore, instead of sliding isolator bearing frictional pendulum bearing based on principal of pendulum motion overcomes this issue.

1.2.2.2 Curved Slider Bearing

It is based on the pendulum motion, in an earthquake the slider moves along the spherical concave surface of the bearing, helping minimize the motion of the mass caused by seismic activity and at the end of earthquake, the gravitational force returns the slider to its original position, minimizing the residual displacement (6). Curved slider bearing overcome the limitations of flat slider bearing.

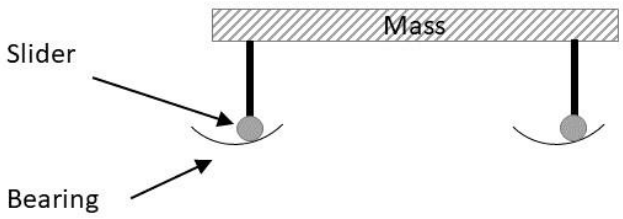

Fig. (4) Curved Slider Bearing (2)

1.3 What are Seismic Damper?

It is another method for controlling seismic damage in structure. It is based on the same principal as lead rubber bearing that is kinetic energy being converted to heat energy and preventing the structure to absorb the energy (2). With the help of base isolator our structure becomes earthquake resistant and by seismic damper it absorbs the energy produce due to ground motions. Therefore, sometimes base isolation is combined with seismic damper, which prevent the structure to absorb the energy during an earthquake (2). Thus, it provides better protection to the building or structure along with occupants. The main difference between the base isolator and seismic damper is that base isolator provides to prevent a way for structure to move and to follow the ground as the ground shakes during the earthquakes while the seismic damper absorb the energy and prevent the structure to absorb it (2).

2. Advantages and Disadvantages of Base isolators

1. Base Isolation isolates the structure from its ground motion, thus restrict the motion of structure due to earthquake and also prevent the structure from absorbing energy.
2. Base isolation system is effective for medium rise building and for hard soil strata.
3. Base isolation system is not suitable for all high-rise buildings. (3)

3. Conclusion

Every structural engineer wants their structure to persist all the natural calamities. Considering this making an earthquake resistant structure becomes an important task to serving the ground motion caused by earthquakes. Thus, base isolation is a technique which makes the structure an earthquake resistant structure. Base Isolation system isolate the structure from the ground foundation and thus not allow to pass the ground motion to the structure and seismic damper absorb the energy produce by the ground motion and not allow the structure to absorb the energy. Thus, both this technique can protect our structure and their occupants. One must also consider the limits while thinking for base isolation technique. Base isolation is most effective on medium rise building and on hard strata (3). And is not much effective on soft soil strata and high-rise buildings (3).

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