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An Introduction to Base Isolation in Earthquake Resistant Structures

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ABSTRACT

Earthquake by itself, is not a disaster, it is a natural phenomenon resulting from ground movements, sometimes violent. They produce surface waves, which causes vibration of ground & structures standing on top. The possible risk of loss of life adds a very serious dimension to earthquake resistant design. Now a days, various new systems have been developed to reduce the seismic energy. Base isolation also called base isolation system is one such seismic protection system in earthquake prone areas. Base isolation is one of the most important concept in earthquake resistant design which means decoupling the superstructure from its substructure. It is basically done to minimize damage to the structure during on earthquake. In this paper, the concept of base isolation for earthquake resistant design of structure is presented.

Key words : Base Isolation, Earthquakes, Design, Structure, Seismic.

I.INTRODUCTION

Base isolation or base isolation system is an important concept in earthquake resistant design of a structure. It is one of the popular techniques of protecting the structure against earthquake forces. The principle lies in the fact to decouple the superstructure from its substructure resting on shaking ground thus protecting structures integrity. Base isolation is done to enable a building to survive a potentially divasting seismic force through a proper design & subsequent modification. The base isolation system can be used from both new designing of structure as well as for retrofitting. In base isolation system, base isolators with large flexibility for horizontal motions are introduced. With such introduction of base isolators between the superstructure & substructure, the fundamental frequency of system decreases to a value lower than the predominant energy containing frequencies of earthquake ground motion. This efficient technology can be used to improve the seismic performance of various structures like schools, hospitals, multi-storey buildings etc. This technique is also referred to as passive control. The base isolation system can be used protection of new framed structures as well as for seismic retrofitting for existing ones.

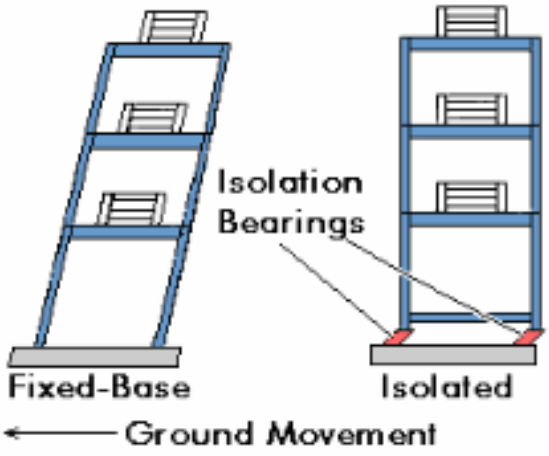
II.BASE ISOLATION TECHNIQUE

It is generally thought that structure can be protected from seismic forces by increasing the strength, so that they do not collapse during an earthquake. In other words more rigidly the superstructure is attached to the

substructure, will result in less damage in on earthquake. But, if the substructure is attached rigidly to superstructures, all the seismic forces are transmitted directly to the superstructure with same frequency. The isolation of superstructure from substructure can result in minimizing the level of seismic force transmitted to the superstructure.

During an earthquake, the soil moves laterally, the substructures moves with the soil & seismic force are transferred up to the superstructure. If the earthquake has natural frequencies of building, it will make the structure to oscillate violently. But if the natural frequencies of building can be changed to the one that does not match with the frequencies of earthquake, the structure is less likely to fail.

The base isolation works in same manner, it reduces the stiffness of structure by reducing its frequencies. In other words the base isolators lets the building move over the ground so that they have less frequency.



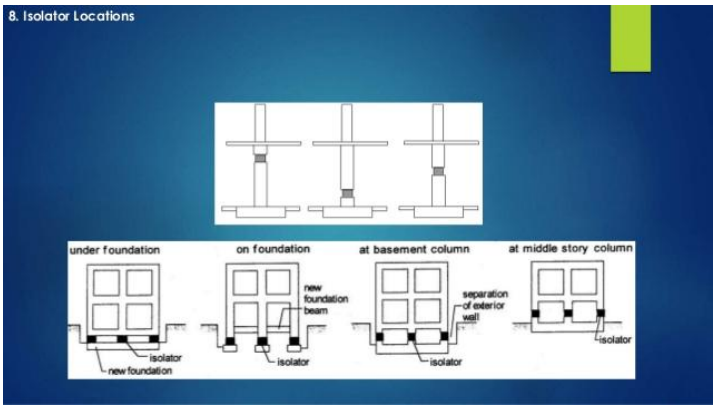
III.TYPES OF BASE ISOLATORS

The six main types of isolators are

- **Elastomeric Rubber Bearing:** Bearing formed by horizontal layers of synthetic/natural rubber in thin layers bound between steel plates. These bearings are capable of supporting high vertical loads with small deformations. These bearings are flexible under lateral loads. The steel plates prevent the rubber layers form bulging. They are usually hard is vertical direction and soft in horizontal direction.
- **High Density Rubber Bearing:** This is another type of elastomeric bearings consisting of layers of high damping rubber & steel plates in alternate layers. It do not consist of lead at centre of bearing.
- **Friction Pendulum System:** It is sliding type system of isolation. It consists of spherical stainless steel surface with a slider which is coated by teflon. It works on the principle of pendulum. The pendulum bearings are installed between substructure & superstructure to protect it from earthquake ground shaking.
- **Sliding Bearings :-** For smell vibrations, shear deformation of rubber layers provide the some isolation effect as conventional multilayer rubber bearings. For large vibration, sliding materials slide to provide same deformation performance as large scale isolators.

IV.LOCATION OF BASE ISOLATORS

- The requirement of installation of base isolation system is to make the structure to move horizontally relative to the ground, usually atleast 100mm.
- The most common configuration is to install a diaphragm immediately above the isolators.
- If the structure has basement be structure then the options are to install the isolators at top, bottom & mid-ht of the basement columns & walls.



V.ADVANTAGES OF BASE ISOLATED STRUCTURES AS COMPARED TO CONVENTIONAL STRUCTURES

- The most important advantages lies in the fact that it protects the structure from seismic activities.
- The structures with base isolators are more predictable & hence they have high reliability as compared to conventional structures.
- The use of strengthening elements such as frames, bracing, shear walls is reduced to greater extent.
- In large seismic forces, the damage is concentrated in isolation systems where the elements can be substituted easily.
- Base isolation is applicable to existing structure making then earthquake resistant.
- Mininal repairs of superstructures.

VI.DISADVANTAGES

- It can be done on the structures resting on soft soils.
- It is less efficient for high rise buildings.
- It requires highly skilled labours & engineer for its implementation.
- It can be applied partially to structures.

VII.APPLICATIONS

1. It was firstly implemented in New Zealand in 1974 & came to India in 2001 after Gujarat earthquake.
2. LA city hall in the tallest base isolated building in the world.
3. It has various applications in present era such as retrofitting it in residential, industrial, historical building, monuments bridge etc.

VIII.CONCLUSION

Base isolation comes out to be a very promising technology to protect different structure from seismic excitation. By observing and analyzing the physical phenomenon that causes the building to crumble, engineers realized the importance of keeping to superstructure stable while the substructure is being shaken by seismic activities. Base isolation is hence the best technique as it saves major amount of destruction & the maintains cost comes out to be very less. Besides, once the concept is understood it can be used to solve other engineering problems as well. The base isolation concept has created a breakthrough in structural design of earthquake resistant building and with the passage of time it will prove to be a life saving innovation.

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