

Base Isolation with the Help of Spring System for Earthquake

Prasunn Yadav, Vijay Chauhan, Rohit Kumar, Yogender, Deepak Kumar

Department of Civil Engineering, Dronacharya college of engineering,
Khentawas, Farrukhnagar, Gurgaon-123506, India

Email: dpcoolboy1000@gmail.com, prasunnyadav.rao.15@gmail.com,
vijay.chauhan930@gmail.com, rohithpu2009@gmail.com, yogibhateria36@gmail.com.

ABSTRACT

Base isolation by spring system for earthquake prevention. this idea deals with the prevention of the structure from the earthquake waves or seismic waves by isolating the base of the structure by using high tension springs. Usually the structure is laid on the ground with proper foundations. But in this technique the base of the structure i.e., just above the foundation is being isolated. So that it might not be effected by seismic waves. This technique utilizes high tensile, high stiffness springs which can be made according to the tensile force they need to hold from the structure. This spring unit is attached to the base of the structure and by this way base of the structure is being isolated. Isolation with the help of a spring system can be effective in many ways as it can reduce upto 80 to 85% of the risk, i.e. being developed by the seismic waves and prevent the structure from damage. In this paper, the present behavior of the spring isolation system is being analyzed and the advancement in this system is also being discussed. On the basis of authors study the modernization of the whole picture has been described in the paper. The results of the extensive mathematical and scientific analysis, minimizes the damage from the disaster and protecting the superstructure from the heavy damage and saving many lives.

Keywords:

Base isolation; Spring System; P- waves;
Plate tectonics; Seismic waves; Retrofit

1. INTRODUCTION

In the field of civil engineering; the earthquake is the major cause of the damage of the structure. Mostly the structures which lie in the seismic zone areas are usually affected by the earthquake due to the seismic waves which are being developed at the time of the natural disaster which further leads to the seismic deformation in the earth crust or follows some deformation in the tectonic plates. The seismic waves are the energy waves that travel through the earth's layer, and are a result of an earthquake, exploration or a volcano that imparts low frequency acoustic energy. The energy waves when produced demolish the structure or weakens its foundation which would further lead to the failure of the structure[1]. For this, base isolation also known as seismic base isolation or base isolation system is one of the most popular means for protecting a structure against the seismic waves or the earthquake forces. It is the collection of the structure elements which should substantially decouple a

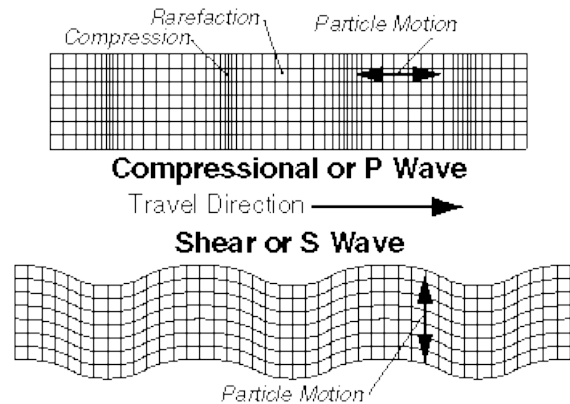
structure from its base on which it is resting thus protecting a building a non-building structure integrity. Base isolation is one of the most powerful and advanced tool of the civil engineering pertaining to the passive structural vibration control technologies. In this paper we will go through the advanced technology of isolating the base and preventing the structure from the demolition. The basic idea of working of the isolation unit is to restrain all the inertial forces which the building undergoes. Major working of this whole unit has been explained further in the paper.

2. SEISMIC FUNDOLGY

2.1 Introductory nature of seismic wave

Seismic waves are waves of energy that travel through the Earth's layers, and are a result of an earthquake, explosion, or a volcano that imparts low-frequency acoustic energy. Many other natural and anthropogenic sources create low amplitude waves commonly referred to as ambient vibrations. Seismic waves are studied by geophysicists called seismologists. The second type of deformation, dynamic motions, are essentially sound waves radiated from the earthquake as it ruptures. While most of the plate-tectonic energy driving fault ruptures is taken up by static deformation, up to 10% may dissipate immediately in the form of seismic waves. The mechanical properties of the rocks that seismic waves travel through quickly organize the waves into two types. Compression waves, also known as primary or P waves[2], travel fastest, at speeds between 1.5 and 8 kilometers per second in the Earth's crust. Shear waves, also known

as secondary or S waves, travel more slowly, usually at 60% to 70% of the speed of P waves. P waves shake the ground in the direction they are propagating, while S waves shake perpendicularly or transverse to the direction of propagation (shown in fig1).



Earthquakes create various types of waves with different velocities; when reaching seismic observatories, their different travel time help scientists to locate the source of the earthquake hypocenter. In geophysics the refraction or reflection of seismic waves is used for research into the structure of the Earth's interior, and man made vibrations are often generated to investigate shallow, subsurface structures.

Figure1. S Wave

2.2 Seismic Deformation

When an earthquake fault ruptures, it causes two types of deformation: static; and dynamic. Static deformation is the permanent displacement of the ground due to the event. The earthquake cycle progresses from a fault that is not under stress, to a stressed fault as the plate tectonic motions driving the fault slowly proceed, to rupture during an earthquake and

a newly-relaxed but deformed state. Typically, someone will build a straight reference line such as a road, railroad, pole line, or fence line across the fault while it is in the pre-rupture stressed state[3]. After the earthquake, the formerly straight line is distorted into a shape having increasing displacement near the fault, a process known as elastic rebound. Shown in figure2.

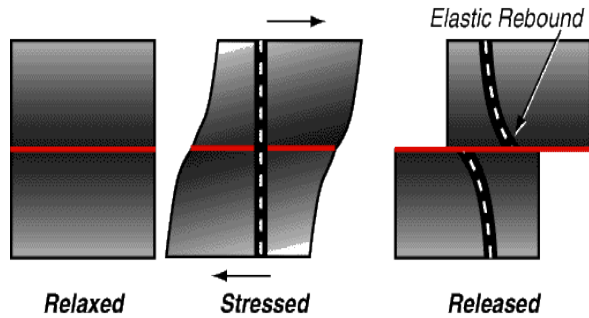


Figure2. Tectonic plates

3. BASE ISOLATION SYSTEM

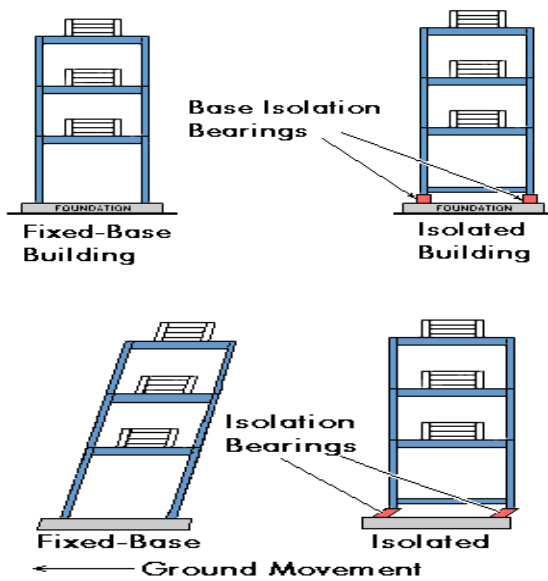


Figure3. Base isolation system

3.1 Introduction to the base isolation system

Base isolation also known as seismic base isolation or base isolation system is one of the most important means of protecting a structure (superstructure + substructure) against earthquake forces. It is a collection of various types of structural elements which should decouple a superstructure from its substructure resting on the ground which shakes due to the seismic waves, thus protecting a building integrity[4]. It is one of the most powerful tools of earthquake engineering pertaining to the passive structural vibration control techniques .[5] Base isolation includes, isolating the base by high tension coiled and collapsed springs which are being designed and installed beneath the structure which works at a time of disaster. Base isolation system consists of isolation units with isolation components where isolation units are the basic elements of a base isolation system which are intended to provide the targeted decoupling effect to building or non-building structure where the isolation components acts as the connection between isolation units and their parts. By their response to an earthquake impact, all isolation units may be divided into two basic categories: shear units and sliding units. As shown in figure3.

3.2 Present Isolation system

The present isolation system deals with the single spring system, it consists of a single high tensile collapsed spring foundationed on the ground beneath the base of the structure. Various desired numbers of the springs are placed and fixed. The reinforced concrete slab is placed on this system and structure is established on this slab. When the seismic waves originate, the tectonic plates vibrate with each other resulting in an earthquake[6]. These continuous vibrations of the ground result in activation of the

springs and the energy produced by these vibrations is resisted by the system. Hence the structure is prevented from the damage. But continuous motion of all the springs can lead to more damage the structure. So to prevent this advancement in the system is done to avoid the failure of the structure.

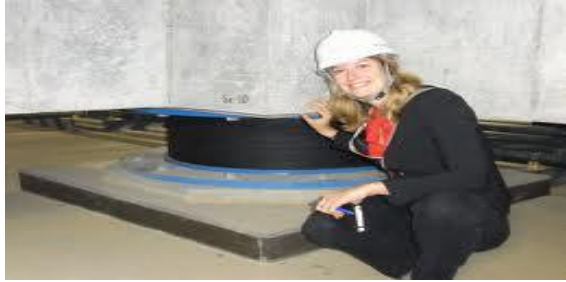


Figure4. Present isolation system

Figure5. Advanced isolation system

3.3 Advanced Isolation system

To prevent the structure from damage, lead me to research on this system and after many failures the best one which come out was the use of set of equi-stiffness unit of springs. In this system we use a set of springs that are placed with each other one with other and packed in a framework of steel. This unit is similarly placed as placed in the present isolation system. When the seismic waves effect the structure the vibrations can be uniformly distributed throughout the whole system and up to 80 to 85% of the loss of energy of the waves can be measured with this system[7]. And the

structure can be easily stabilized. As shown in figure4 and5.

4. CONCLUSION AND FUTURE SCOPE

The paper looks into a new dimension of using various base isolation techniques and also improving the futuristic vision of the society. The present status of the system of using the tension spring collapsed can be replaced by a set of equi-stiffness unit of springs that can be installed beneath the structure. This lead to the proper balance of the structure with respect to the single spring isolation system. The structure would be able to maintain its balanced form and also it would reduce the seismic waves intensity which are being produced at the time of earthquake or in other approach this system can be proved a much better way than single spring base isolation system. This system can be used for heavy loads. In future this set of equi-stiffness unit of springs would be very effective to its approach and would change the infrastructure of the whole society. Thus this paper has come up with an exhaustive research and advancement of the base isolation techniques by using set of equi-stiffness unit of springs. The technique has major potential to reduce the impact of uncertainties related tom seismic conditions and save ourself. At last “ Initial implementation of the new technology coincided with the romantic era of earthquake engineering and public relations associated with the dreams of ‘beating the quake’ ”.

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