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BASE ISOLATION TECHNIQUE FOR DESIGN OF EARTHQUAKE RESISTANT STRUCTURES

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ABSTRACT

An earthquake is the shaking of the surface of the Earth, resulting from the sudden release of energy in the Earth's lithosphere that creates seismic waves. The earthquake generated vertical inertial forces are to be considered in design unless checked and proven by specimen calculations to be not very significant. Special attention should be taken to the effect of such vertical component of ground motions. It is the responsibility of the structural engineer to protect the building against such vibrational forces. In practice no building can be earthquake resistant. In other words, it is impossible to make a building which can resist the earthquake completely. But, efforts can be made to reduce the damage caused by it. Many researches and studies have been done to develop such concepts that can help to minimize the structural damages to the building and thereby reducing the casualties caused during an earthquake. Base isolation is one such concept which can be employed in the buildings so as to reduce the damages caused due to earthquakes and at the same time strengthening the structure.

KEYWORDS: Base Isolation, Earthquake Lead Rubber Bearing

INTRODUCTION

Base isolation, also known as seismic base isolation or base isolation system, is one of the most popular means of shielding a structure against earthquake forces. Base isolation is one of the leading concepts of earthquake engineering, which can be described as splitting or decoupling the superstructure from its substructure. In other words, base isolation is a technique developed to prevent or diminish damage to buildings during an earthquake. “Earthquakes don't kill people, collapsed buildings do” is an old adage among structural engineers. Base isolation can be reinforced to appropriate existing structures, but we struggle the given cost-benefit analysis. The elementary belief behind base isolation is that the response of the structure or a building is adjusted such that the ground below is proficient of moving without transferring nominal or no motion to the structure above. A whole separation is possible only in an ideal system. In a reality, it is essential to have a vertical support to transmit the vertical loads to the base.

Various types of Base Isolation Devices are Elastomeric Bearings. High Damping Bearings. Lead Rubber Bearings. Flat Slider Bearings. Curved Slider Bearings or Pendulum Bearings. Ball & Roller bearings. A laminated rubber bearing (LRB) can be used as a base isolator.LRB can be defined as the bearings made up of horizontal layers of synthetic or natural rubber in thin layers bound in between the steel plates. These bearings are accomplished by supporting high vertical loads with very less deformation.

These bearings are elastic under lateral loads. Steel plates check the rubber layers from bulging. Lead cores are provided to upturn damping capacity as plain elastomeric bearings do not give significant damping. They are habitually soft in horizontal direction and hard in vertical direction.

SCOPE AND OBJECTIVES

Only practical approach left is to accept a demand and make sure the capacity is more than the demand. Base isolation takes an opposite approach, i.e. to reduce the seismic demand instead of increasing the capacity. Constructing earthquake resistant buildings is impossible, but we can provide such measures which can considerably reduce the effects of the earthquake causing the least damage to the structural components of the building.

CODAL PROVISION

The horizontal component of "EL-Centro" earthquake ground motion is chosen for time history analysis. The details of the ground motion like PGA and recording station are presented in graphs. The ground motion is applied along the X direction. The linear Time History Analysis in ETAAB 2016 was performed.

Lead Rubber Bearing

In the analysis, a laminated rubber bearing (LRB) was used as the isolator. Consisting of steel shims between the rubber layers, the LRB uses its flexibility to deflect seismic waves and, through plastic deformation, absorbs the energy from the vibrations. Additionally, its lead core assists in further dissipating the energy. Here, the steel component of the LRB was treated as an elastoplastic material, the rubber as a hyper elastic material, and the lead as an elastic perfectly plastic model. From this research, we can observe the effective nature of base isolation systems using laminated rubber bearings as a means of seismic control for structures. Simulation can help address how different parameters impact the performance of the isolator and advance its ability to stabilize vibrations within buildings.

Code Based Procedure for Seismic Analysis (IS 1893:2002)

Whenever there occurs any type of seismic attack, the seismic forces can weaken the stability of the structure. The engineers and structural designer can make use of such seismic measures like base isolation to protect the structures and at the same time can enhance the strength of the structure. This method is conservative for low to medium height buildings with regular conformation. The calculation of lead rubber bearing is carried out. The first step is to decide the minimum rubber bearing diameter depending on vertical reaction. The target period (2 seconds appears to be the desired one) and the effective damping β is assumed to be 5% for reinforced concrete structure according to IS 1893: 2002 **11** §7.8.2.1**.**

- The spectral acceleration from the response spectrum graph in relation with the desired period is found.
- Then the design displacement is calculated.
- The required stiffness to provide a period is the effective stiffness.
- Calculate *ED*= Dissipated energy per cycle at the design displacement (*dbd)*
- Calculate *Fo*= Force at zero displacement under cyclic loading
- Calculate K*Pb*= Stiffness of lead core of lead-rubber bearing

- Calculate Kr = Stiffness of rubber in the LRB
- Calculate tr= Total thickness of LRB
- Calculate D bearing = Diameter of lead rubber bearing
- Calculate Total loaded area (AL) calculation
- Calculate Bearing horizontal stiffness
- Calculate Total bearing vertical stiffness

Table 1

Summery of LRB Parameters		
Required stiffness Keff	197605.493	KN/m
Bearing horizontal stiffness	14352.4065	KN/m
Vertical satiffness	26327780.1	KN/m
Yeild Force	2290.71335	KN
Stiffness ratio	0.1	
Damping	0.05	

Experimental Investigations

Following graph shows comparative results for base shear of G+10 multistory with fixed base and LRB isolated base:-

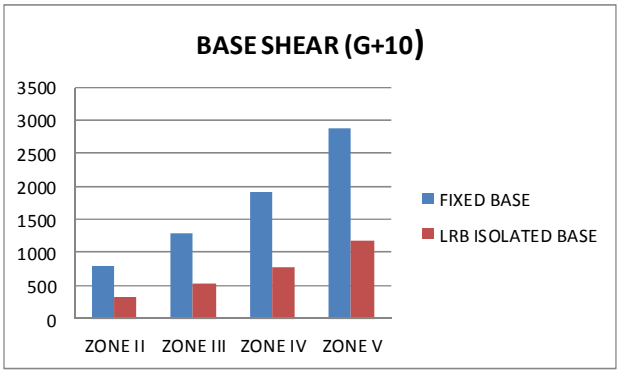

Figure 1

Following graphs shows story drift for G+ 10 structures obtained from ETAB 2016:-

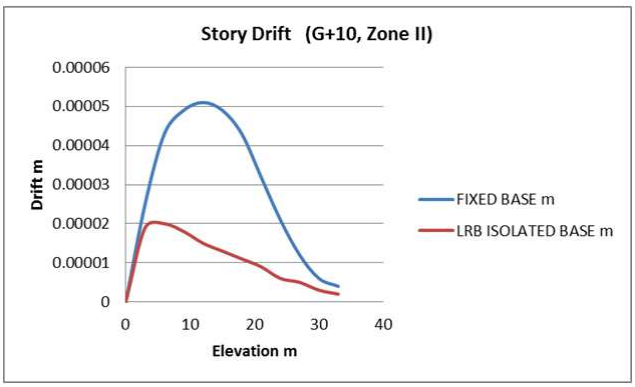

Figure 2

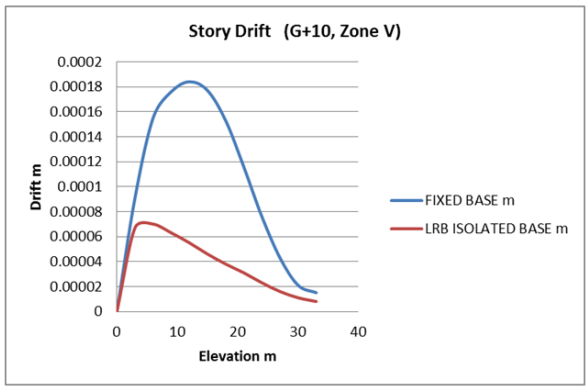

Figure 3

RESULTS

This study presents both theoretical investigation and modeling for building subjected to earthquake induced load with fixed base and with a base - isolation method using rubber bearing. The aim of this work is to contribute to the efficient design of base-isolated structure subjected to seismic ground motion. The following sections summarize the conclusions resulting from this research work.

- It is seen that the frequency has reduced due to insertion of base Isolators in a building.
- The time period was increased for the structure with base isolator compared to a fixed base.
- It is clear from the graph that spectral acceleration is lowest when the building is isolated with rubber bearing.
- It can see that base shear has a minimum value when isolated with rubber bearing.
- Displacement has decreased in the case of base isolated building as compared to the fixed base structure.
- The performance of base isolated building is better compared to the fixed base building.
- There is a 55 % reduction in base shear when isolated with LRB as compared to the fixed base building in case of 10 storey. The reduction in base shear is 40% and 20%, respectively, when isolated with LRB to the fixed base in 15 storey and 20 storey respectively.

CONCLUSIONS

- The results of this work demonstrated that base Isolators are excellent seismic control devices for high raise symmetric Buildings.
- Base isolation method has proved to be a reliable method of earthquake resistant design
- The base-isolated structure exhibit less lateral deflection, since the lateral displacement at the base never equals to zero, and less moment values than the fixed base structure.
- It has been observed that LRB Isolators are very noteworthy in reducing the seismic response of fixed base building and reduce the damages in building during strong ground motions.
- Therefore, it is concluded that building with base isolation remains strong enough during an earthquake as compared to fixed base buildings.

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