SEISMIC ANALYTICAL STUDY OF RC AND STEEL STRUCTURES WITH LEAD RUBBER BEARING IN DAMPERS USING ETABS

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Abstract - *The efficiency of lead rubber bearings in dampers in lowering the seismic response of both reinforced concrete (RC) and steel structures is compared in this study. The main goal is to use ETABS to compare how constructions with LRBs and fixed base buildings behave. Based on the ground vibrations of the El-Centro earthquake, non-linear analysis was used to analyse the dynamic reaction of the structures. Storey displacements and storey drifts were among the seismic reaction metrics for the constructions. Time history analysis was used to analyse the buildings, and the results were taken as storey displacements and storey drifts values for unmanaged constructions ranging from 35 to 65 percent. It is also acknowledged that the aspect has a significant impact on the best location for the dampers.*

Key Words: *Base Isolators, Lead Rubber Bearing, Fixed Base, Time History Analysis, Storey Drifts, Storey Displacements*

1. INTRODUCTION

Earthquakes are one of the natural occurrences that most building engineers must cope with. Buildings need to be built to withstand seismic forces. The topic of research for many years has been seismic protection for large, tall constructions. Because of their intrinsic dampening capacity, buildings are generally more susceptible to earthquake forces. Earthquakes are caused by dynamic forces brought about by fault movement in the crust of the planet. Seismic waves are created when faults move, releasing energy. The foundation of the structure is where seismic waves first cause movement. Building's experience horizontal and vertical vibrations known as reactions because of these complex movements. Examples of these reactions include displacements, velocities, and accelerations.

Excessive vibration may occur when structures are strengthened to withstand earthquake forces. Extreme vibrations may result in the loss of the building's functional requirements, as well as human life. As a result, energy dissipation-based devices minimise vibrations more effectively. The dampening devices will function similarly to automotive shock absorbers. As a result, the building's lifespan will be extended, and vibration frequency will be reduced.

The structure is isolated from the foundation and shock is absorbed using the base isolation method. The base isolator absorbs more energy when seismic energy approaches a structure, forcing the structure to vibrate slowly.

The seismic performance of reinforced concrete and steel structures with lead rubber bearings was studied by **Mathkar and Patil in 2021**. Lead Rubber Bearing (LRB) system was used to create the frame, and its characteristics were used to model LRB for the RC frame. Results from static and push over studies reveal a consistent pattern in the frame's behaviour. **A.B.M. Saiful Islam, et al**. (12) investigated the analytical nonlinear seismic response of a ten-story building isolated by the Lead Rubber Bearing (LRB) and Friction Pendulum System under the Natore Earthquake record (FPS). The best decision between HDRB and LRB should be based on floor displacement reduction and rigid body displacement amplification. The superstructure's dynamic behaviour was examined using SAP2000. **Donato Cancerllara** and colleagues (3) studied the seismic behaviour of a multi-story reinforced concrete building with two base isolation systems. The results showed that LRB isolators had a 15% to 30% higher dissipative capacity than HDRB isolators. The influence of soil structure interaction on the response of a base isolated building was explored by **Bahkear et al (2019).** Numerical results reveal that when the flexibility of the soil is addressed, the seismic response of a structure sitting on an inelastic base isolation system may be higher than the corresponding response obtained by disregarding the effects of soil structure interaction. According to **Ahmet Hilmi Deringol** and **Esra Mete Guneyisi (2020)**, base isolations are recognised as an effective seismic protective technique for building structural systems. It was discovered that by using LRB, the seismic response of regular and irregular frames in elevation may be enhanced to some extent.

The significance, necessity, and application methodologies for analysing multi-story buildings were examined in the current study. The base's primary benefits the reduction of the structural and non-structural effects of isolation damage to the structure's components, which increases the lowering the seismic risk will increase the building's component safety forces in design. RC and steel structures with ten stories both fixed base and base isolation models and analyses utilising ETABS to create structures.

The comparison findings there were separate constructions between the base and the permanent base studied for a ten-story structure. In El Centro the non-linear earthquake ground motion record is taken analysis.

2. LEAD RUBBER BEARING

Lead rubber bearings, which are employed in building and bridge structures, are a practical and affordable choice for seismic isolation. A laminated elastomeric bearing pad, top and bottom sealing and connecting plates, a lead plug put in the centre, and these components make up the bearing.

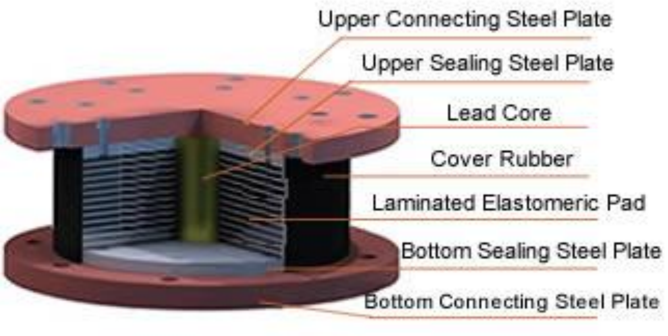


Fig -1: Lead Rubber Bearing

Among the many base isolation approaches, lead-rubber bearings (LRB) were frequently used. One or more lead plugs are inserted into the holes, and it is composed of alternating layers of rubber and steel plates. The lead core deforms in shear, providing initial stiffness against weak earthquakes and strong winds as well as a bilinear response (i.e., hysteretic damping in the isolated structure). The steel plates in the elastomeric bearing create substantial plastic deformations. As a result, a lead plug was used in place of an elastomeric bearing, and it was tested. The yield force of the lead insert can be calculated using the yield stress of the lead in the bearing.

2.1 FEATURES:

The rigid and strong in the vertical direction, but flexible in the horizontal. Modify the bearing's form to better withstand the force produced by earthquakes. Rubber's strong elastic force enables structures to maintain their original placements and shapes. To alter the dampening, alter the number of lead plugs.

It is simple to install without a separate damper. Stable, low-maintenance bilinear behaviour.

2.2 WORKING MECHANISM:

The un-isolated building will move back and forth and in different directions during the earthquake as a result of inertial forces, which will distort and harm the structure.

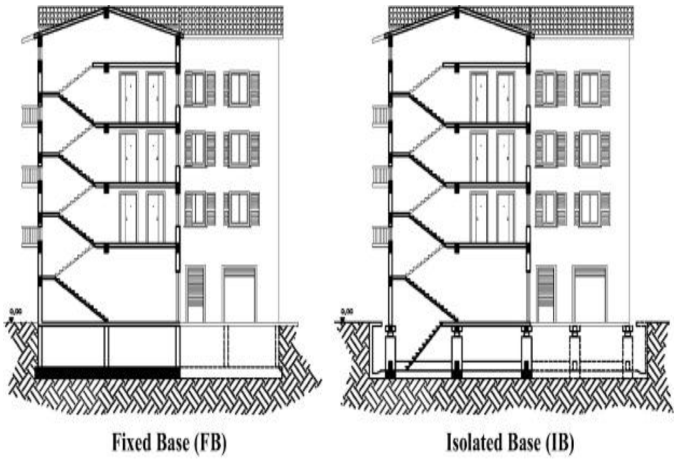


Fig -2: Fixed Base Building and Isolated Base Building

The lead plug will slide with the laminated rubber during an earthquake, but it will convert the energy of the movement into heat, lowering the inertial force on the structure and minimising vibration. The rubber component will keep its original shape in the meantime due to its great elasticity.

3. Methodology

3.1 Modelling of Isolators

The base isolator is modelled using ETABS using the connection/support property data that needs to be defined in order to add the necessary features. Buildings were initially given fixed supports, and each support of the column at the base of the structure was given a link. Calculations based on the base isolation design were used to establish the link's specifications.

3.2 Method of Analysis

In this work, nonlinear time history analysis was the methodology used. It is a nonlinear dynamic analysis, which is a methodical way to ascertain how the structure will react as it adapts to seismic loads for the particular earthquake. The analysis will use the seismic record that shows the design earthquake. The data is subsequently converted to digital form in time intervals of 1/40 to 1/25 seconds. The structure is then assessed to identify the responses of each lumped mass to acceleration, velocity, and displacement at each interval. The experiment utilised an average acceleration approach with values of 0.5 and 0.25, respectively.

Modelling and analysis of RC and steel structures: The structure was examined both with and without LRB.

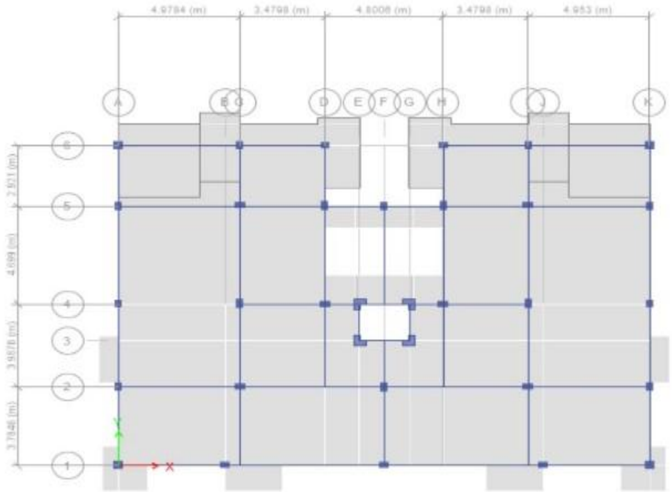


Fig -3: RC and Steel Building Plan

Fig.- 4: 3D View of the RC and Steel Building

The slab's thickness is assumed to be 0.15 m. The building's boundary condition is used as fixed support. A live load of 3 kN/m2 is applied to all floors. The earthquake loads and load combinations are defined by IS 1893 – 2016. The dampers are positioned in four different configurations to determine the optimum positioning of the dampers (Figure 5 & 6)

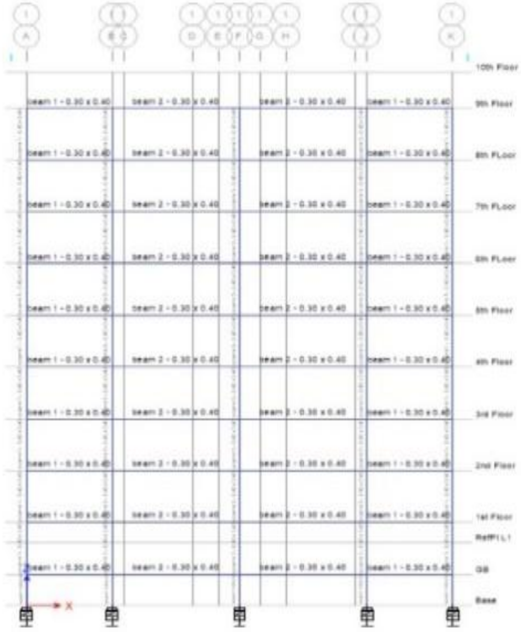


Fig.- 5: Elevation of RC Building

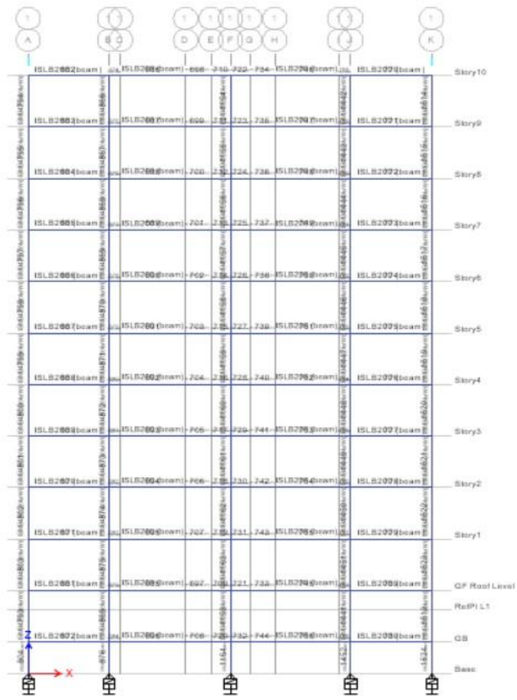


Fig.- 6: Elevation of Steel Building

For this study, El-Centro time history records were employed. ETABS was used to analyse the structures using Non-Linear Time History Analysis.

4. RESULTS AND DISCUSSION: -

In this study, a ten-story RC and steel structure was modelled and examined using ETABS. Non-linear time history analysis was utilised for both fixed base and base isolation, and the results were compared and examined for bidirectional seismic ground motion recordings. The performance and efficacy of the base isolation were examined using non-linear dynamic analysis, and the results were contrasted with fixed base structures. the RC Structure's displacement and interstorey drifts with and without base isolators.

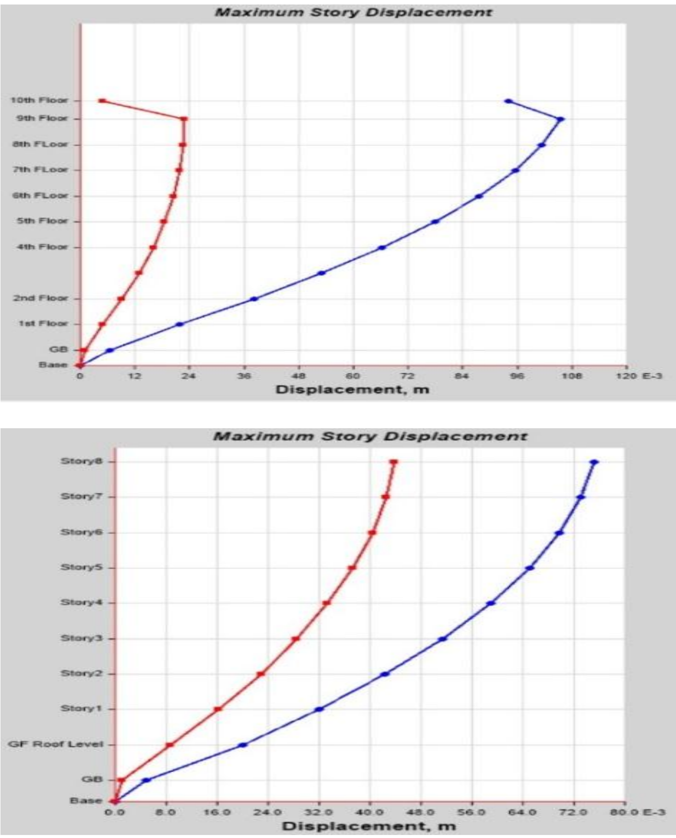
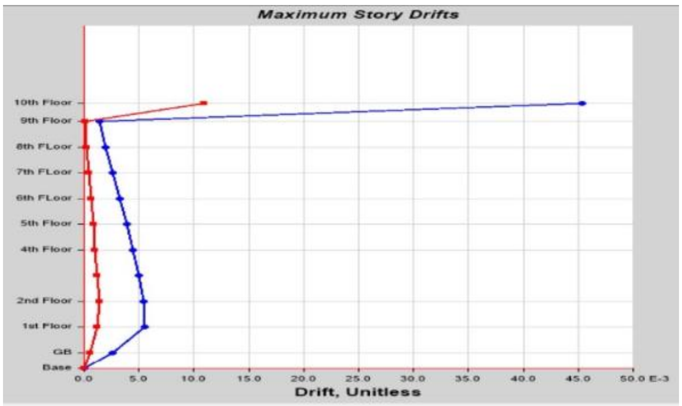


Fig.- 7: Storey Displacement of RC Building- LRB and Fixed



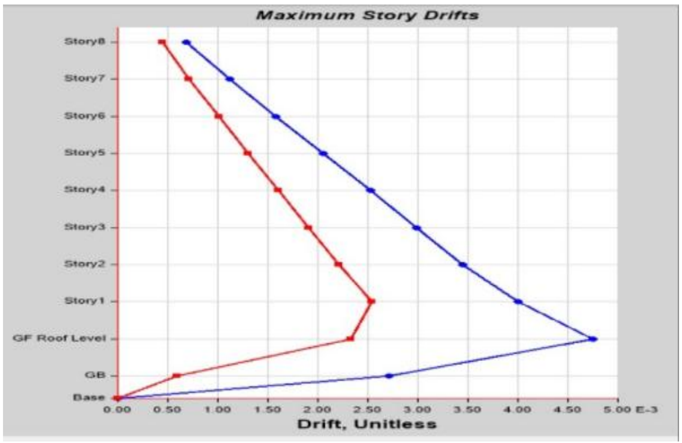


Fig.- 8: Storey Drift of RC Building- LRB and Fixed

From the examination of RC multistoreyed buildings, the Lead Rubber Bearing Isolator showed higher performance in reducing displacements and interstorey drifts. Due to LRB, the percentage of storey drifts was reduced by 61.78 percent.

The displacement and interstorey drifts of the Steel Structure with and without Base Isolator.

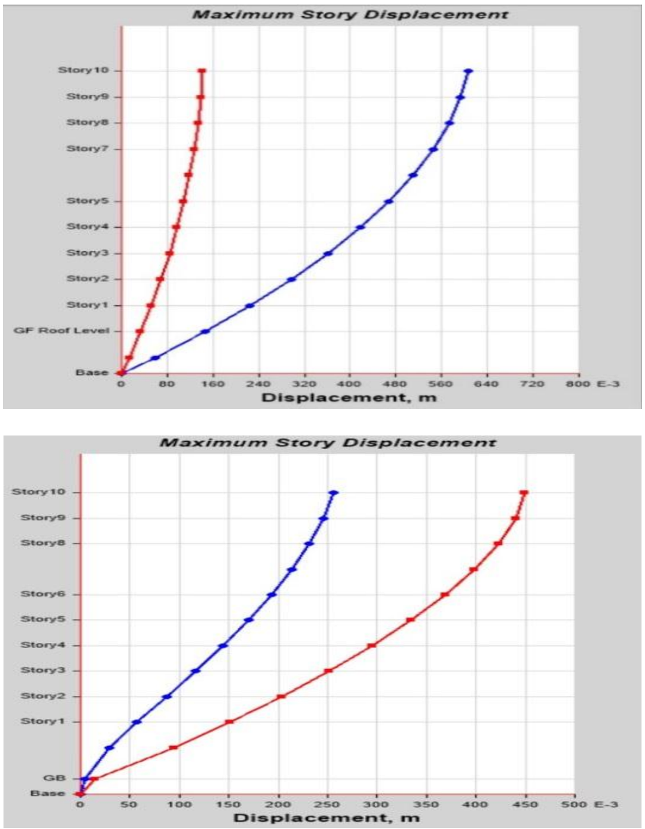


Fig.- 9: Storey Displacement of Steel Building- LRB and Fixed

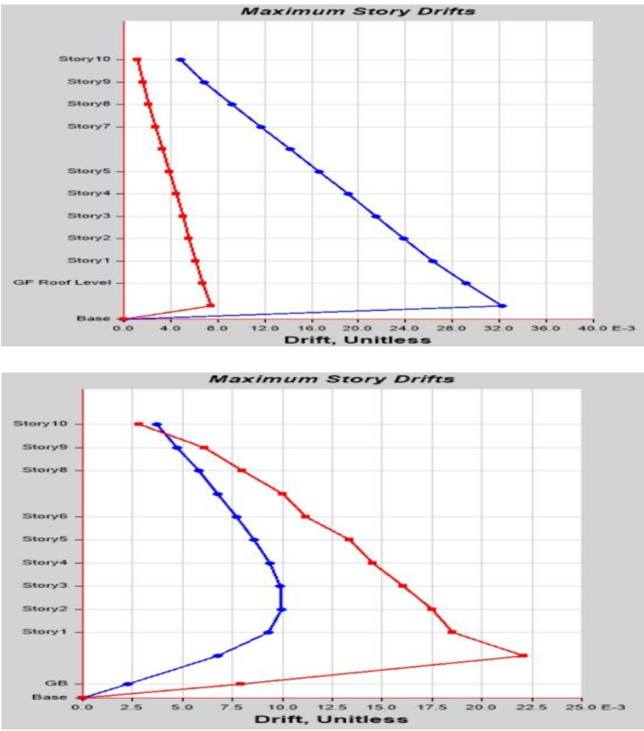


Fig.- 10: Storey Drift of Steel Building- LRB and Fixed

From the examination of steel multistory buildings, the Lead Rubber Bearing Isolator showed greater performance in reducing displacements and interstorey drifts. When compared to the permanent foundation structure, the steel construction had a 44.98 percent lower interstorey drift.

5. CONCLUSIONS

Based on the conclusions, the performance of LRB was looked at. The statistics show that the base isolation greatly minimises the seismic reaction when compared to a fixed construction. The following findings were drawn from a comparison of the results of fixed base structures with base isolated structures:

From the examination of RC multistoreyed buildings, the Lead Rubber Bearing Isolator showed higher performance in reducing displacements and interstorey drifts. Due to LRB, the percentage of storey drifts was reduced by 61.78 percent.

The examination of steel multistoreyed buildings showed that the Lead Rubber Bearing Isolator performed better in reducing displacements and interstorey drifts. When compared to the permanent foundation structure, the steel construction had a 44.98 percent lower interstorey drift.

A base separated building has a significant amount of lateral displacement at the base, whereas a fixed base building has zero displacement at the base in both RC and steel constructions. As the floor height rises, the interstorey drifts in the base isolated construction substantially diminish in contrast to the fixed base building. Base isolation is a very effective way to bring down the price of the construction and lighten its load. It is also known that the aspect ratio of the building has a significant impact on the best location for the dampers.

The buildings were analysed using time history analysis, and the results were taken in the form of storey displacements and storey drifts values ranging from 35 to 65 percent for unmanaged structures.

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