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Comparative Study of Seismic Performance of Fixed and Base Isolation of Multi-Storey Building

[1] Avinash V. Ingole, [2] D. S. Wadje, [3] Dr. G. R. Gandhe
[1] Student, M.E. Structural Engineering, [2] Asst.Professor,Civil Engineering, [3] Professor& HOD,Civil Engineering
[1][2][3] DIEMS Aurangabad, 431001, Dist. Aurangabad (M.S), India.

***Abstract*— Earthquake is one of major natural disaster in which many structures damage and collapse due to improper design against seismic forces. Earthquakes are affect the economy of the nation, so essential proper measures of prevention must be developed. There are many concepts of designing a building as earthquake resistant structure; the concept used in this paper is base isolation. There are many types of base isolation systems, lead rubber bearing (LRB) is used as base isolation system in this paper, LRB is most widely used as isolation system for buildings. In this paper, study of 8 storey building with regular floor plan of 20 m × 25 m size with fix at base and LRB at base is carried out. These building models are analysed using E-TABS 2015 software, to the action of lateral forces employing response spectrum method as per IS 1893 (Part I): 2002. The comparison of analysis of results in terms of story displacement, story drift, story shear and stiffness is presented here.**

***Index Terms*— Base isolation, lead rubber bearing (LRB), story displacement, story drift, story shear, stiffness etc.**

I. INTRODUCTION

Earthquake is causes great destruction by sudden movement of the ground shaking leading to huge loss of the life and properties. Sudden release of energy from the earth surface is known as earthquake. Interaction between interior of the crust and the earth is the main cause for earthquake. Earthquake Ground Motions are the effective natural hazards which tends to loss of lifes & properties. Most of the earthquake losses are structures collapse. It is most considerable step to be considered while designing the structures to resist against earthquake ground motion. If the existing building is not designed for earthquake then some alternative measures should be consider in terms of retrofitting. [1]. Base isolation device reduces the stiffness and increases the flexibility in the structure as shown in figure no. 1.

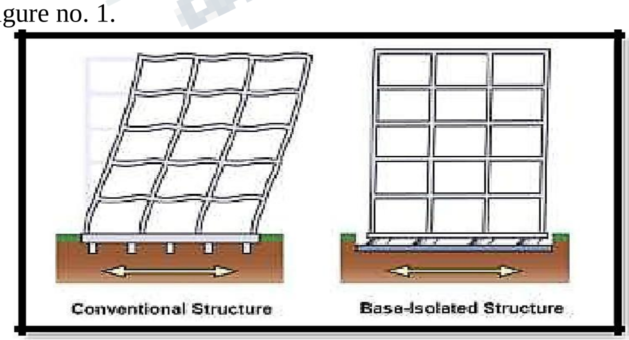

Fig.1 Effect of Base Isolation

The basic concept of base isolation technique is "to increase time period and reduce acceleration of fixed base structure" from this, reduction of the seismic effect on building. Base isolation, otherwise called seismic base disconnection or base detachment framework, is a standout amongst the most famous method for securing a structure against earthquake forces. In the base isolation building, the base isolation device or dampers is introduced between foundation and super structure of the building. Idea behind this technique is to detach the building from ground by providing lead rubber bearing, by doing so the energy induced by earthquake is not transmitted up through building and and it is act as safety and prevention. [2]. As shown in figure no. 2. Lead-rubber bearings provide in a single unit the combined features of vertical load support, horizontal flexibility and energy absorbing capacity required for the base isolation of structures from earthquake attack and also Lead rubber bearings are elastomeric bearings that contain one or more lead plugs inserted into their preformed holes. The lead provides significant stiffness under service loads and low lateral loads as compare to elastomeric bearings. Advantage of lead rubber bearing Simple manufacture ,Easy to modal and installation, Economic design ,The more and more safety and disadvantage is Need additional damping system. Lead rubber bearing is a system that is comprised of rubber and stiffening plate layers with a mechanism at the centre of the isolators made of lead to dissipate energy. the lead rubber elastomeric bearing system performed effectively in reducing acceleration in the horizontal direction.

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In the Lead rubber bearing (LRB) are the laminated rubber bearing containing one or more lead plugs to deform in shear. The lead in the bearing deforms physically at a flow stress of 10 MPa, providing the bearing with bilinear response. For that reason the lead must fittightly in the elastomeric bearing, and this is achieved by making the lead plug slightly larger than the hole and applying force at the time of inserting it in the hole. The cross-sectional view of LRB is shown in Fig. 2 In this paper, comparative analysis of 8-storey without base isolation building model and with base isolation models of multi-storey building are analyzed by response spectrum method. A regular floor plan of 20m x 25m size is considered. ETABS 2015 software is used for modelling and analysis of structure. Analysis results like displacement, storey drift, story shear and mode period are presented here.

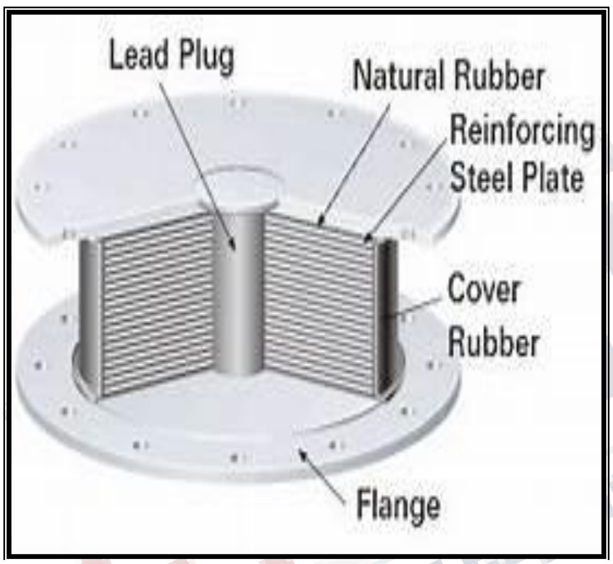

Fig. 2 Lead rubber bearing

MODELING CONFIGURATION

This study includes modeling of the models using standard ETABS 2015 software properties and section properties are defined and assigned. Reinforced concrete frame elements are modelled as beam and column element. Slab is modelled as area element fig.3 for plan view of building. Modal analysis and response spectrum analysis are performed on model fig.4 for elevation of fix at base and fig.5 for elevation of LRB at base.

Table -1 Building details

Grade of Concrete	M25
Grade of Steel	Fe415
Story Height	3.2m
Bottom story height	1.5 m
Beam Size	300x450mm
Column Size	350x500mm
Slab Thickness	150mm
Wall Thickness	150mm
Parapet Height	1m
Live load on the floor	4KN/m^2
Live load on roof	1.5KN/m^2

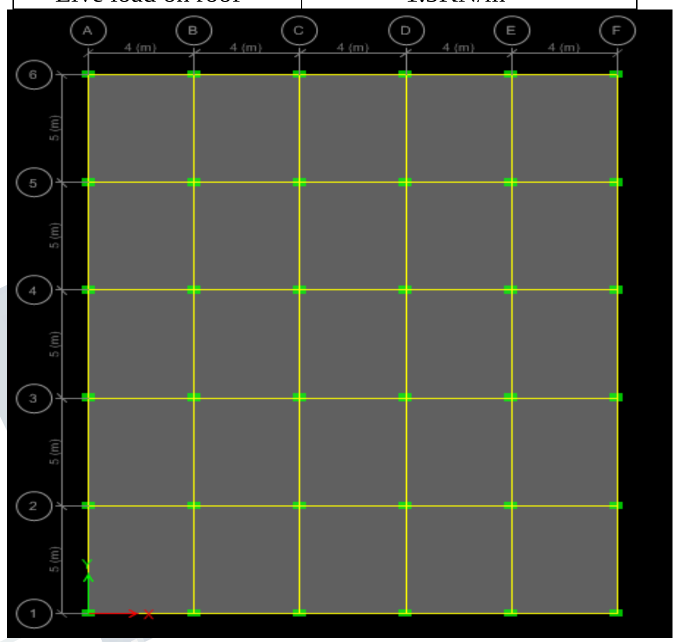

Fig. 3 Plan view of building

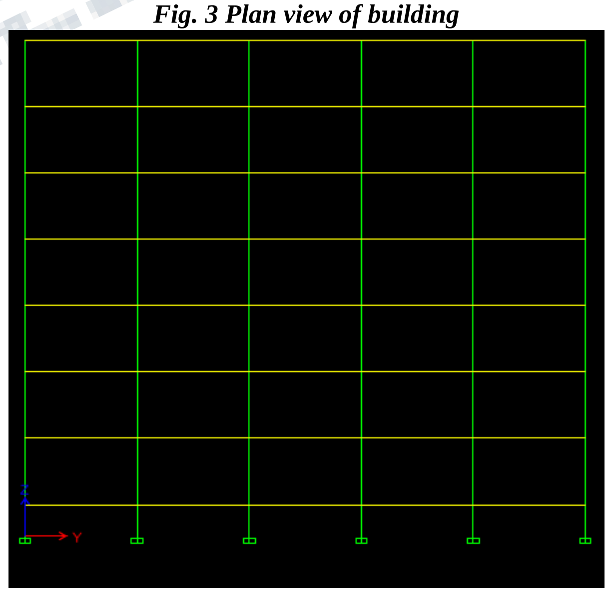

Fig. 4 Elevation on fixed at base building

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Lateral Load for Response Spectrum Analysis (according to UBC 1997)
Seismic Zone Factor (Z) Zone4
Soil Profile Type -Sc
Seismic Coefficient Ca -0.40
Seismic Coefficient Cv -0.56
Importance Factor (I) –1
Response Reduction Factor (R) –8.5(For SMRF)
Seismic Source Type –B
Near Source Factor Na–1
Near Source Factor Nv–1
Damping coefficient (BD or BM) –1
Damping (βeff) –5%

Table -2 prperties of LRB

Property type	LRB
Effective stiffnessKeff(R)	2242.41 KN/m
Horizontal Stiffness KH	2239.19 KN/m
Vertical Stiffness KV	796385.01 KN/m
Yield strength QR	67 KN
Post yield stiffness ratio	0.1
Damping	5%

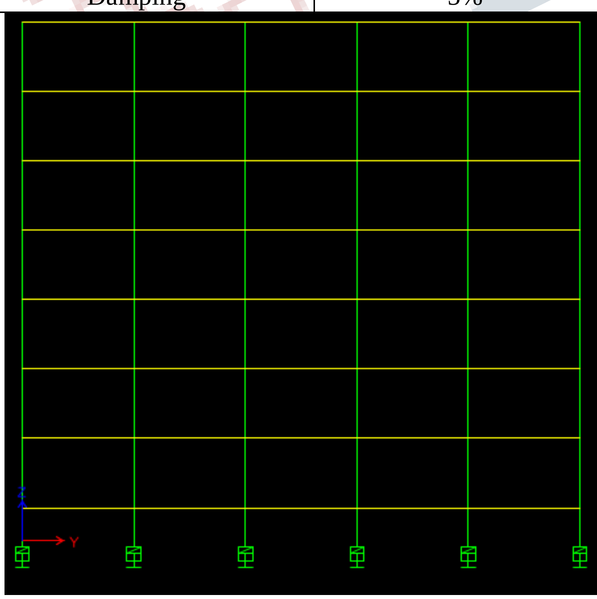

Fig. 5 Elevation on LRB at base building

II. RESULTS AND DISCUSSION

In this paper the comprasion between fix base structure and base isolated structure is done by response spectrum analysis results of the models are presented here in terms of storey displacement, storey drift, story shear and stiffness.

Lateral Displacement

The displacement for the building in X-direction are as shown in Fig.6. It is observed that displacement in base isolation building is higher as compared to the fix base building. In fix base zero displacement at base and in LRB at base 7.59mm at base. The difference between top and bottom storey displacement value is less in isolated base as compare to fix base building.

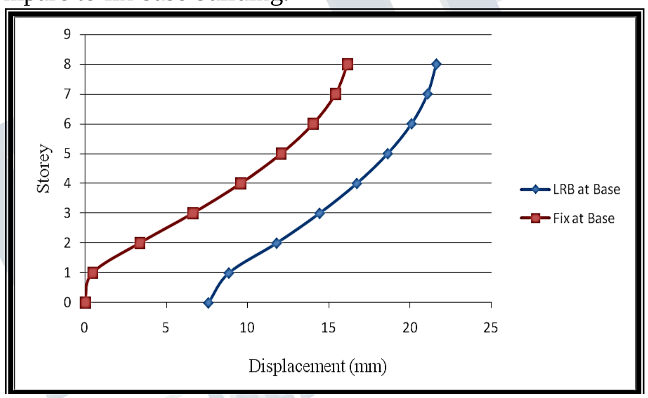

Fig.6: Displacement results

Storey drift

The storey drift X- direction of fix and base isolated building are as shown in fig.7. It is observed that fixed base less drift value at bottom storey as compare to base isolated and then in fixed base building higher compared to the base isolated building. For earthquake load, as per IS: 1893-2002, clause: 7.11.1, the storey drift in any storey due to minimum specified lateral force with partial load factor of 1.0 should not exceed 0.004 times storey height that is h/250, where h = storey height in meter. The storey drift values of all models are within the permissible limit.

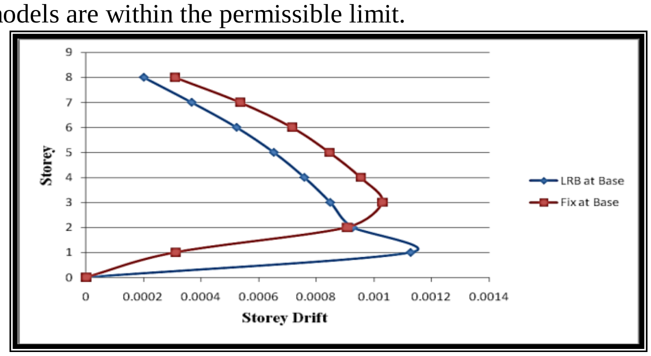

Fig.7: Storey drift results

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Storey shear

The story shear in X-direction are as shown in Fig.8. It is observed that fixed at base gives more story shear than LRB at base. Suddenly increase and then gradually decrease as increase the heightof the storey.

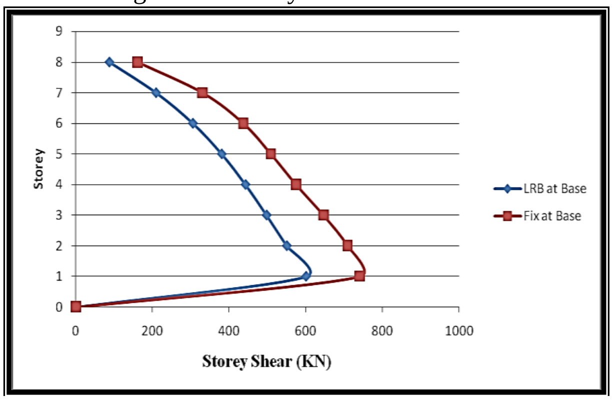

Fig.8: Story shear results

Storey stiffness

The stiffness are in X-direction as shown in fig.9. It is observed that fixed base building gives more stiffness at 1st floor as compare to LRB at base building.

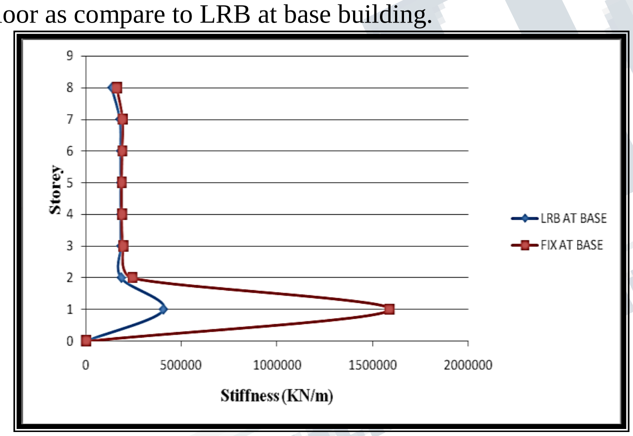

Fig.9: Stiffness results

CONCLUSIONS

In this paper, comparative analysis of 8-storey fix base building and base isolated building are analyzed by response spectrum method. A regular floor plan of 20 m x 25 m size is considered. Analysis results like displacement, storey drift, story shear and stiffness are presented. fixed base and base isolated by providing lead rubber bearing these two building were analyzed by response spectrum analysis from these building conclusions are made follows.

1. The storey displacements are increased in every stories after providing LRB which is important to make a structure flexible during earthquake.
2. Story drift are reduced in higher stories which makes structure safe against earthquake.
3. Story shear reduced after the lead rubber bearing (LRB) is provided as base isolation system which reduces the seismic effect on building.
4. Story stiffness reduced after the lead rubber bearing (LRB) is provided as base isolation system which reduces the seismic effect on building.
5. it is concluded that after LRB is provided as base isolation system it increases the structures stability against earthquake.

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