

# International Journal of Innovative Research in Science, Engineering and Technology

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## Inelastic Seismic Analysis of RCC Framed Structure

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**ABSTRACT:** Earthquake is most extreme condition of any building may be required to survive during its lifetime. Seismic base isolation is a simple structural design approach to minimize earthquake damage. These are very stiff in the vertical direction and can carry the vertical load of the building but are very flexible in horizontally, thereby enabling the building move laterally like a rigid mass under strong ground motion. The main purpose of this study is to check the behaviour of the buildings in seismic zone by using lead rubber base isolation concept. and reduce the base shear, displacement and lengthen the period of oscillation due to earthquake ground excitation, applied to the superstructure of the G+10 and G+5 Storey building by installing lead rubber isolation (LRB) at the foundation level then compare the performance between the fixed base condition and base isolated condition by using SAP software.

**KEYWORDS:** Fixed base, base isolation, lead rubber bearing, Nonlinear Time history analysis, pushover analysis Software SAP2000

### I. INTRODUCTION

Base isolation of structures is one of the most desired means to protect it against earthquake forces. The term base isolation has two word first is 'base' its meaning is a part that supports from underneath or perform as a foundation of a structure, and second is 'isolation' its meaning of the state of being disparate. The effective reduction of inter storey drift in the floor of base isolation system can ensure the lowest damage to facilities and also human safety.

The concept of base isolation technique had been suggested in last few decades. Due to the available technologies, the knowledge of base isolation system is getting mature and well established. Seismic isolation systems are more effective when applied to high stiffness, low-rise buildings, owing to their abilities to alter the characteristic of the building from rigid to flexible.

An increasing number of structures to be isolated reflect the fact that base isolation system is gradually becoming accepted as a proven technology in earthquake hazard mitigation. Lead-plug bearings are made up of low-damping elastomers and lead cores with diameters between 15% to 33% of the bonded diameter of the bearing. By combining laminated-rubber bearings with a lead-plug insert, which provides hysteretic energy dissipation, the damping required for a successful seismic isolation system can be incorporated in a single compact component.

The fundamental principal of base isolation system is to rectify the response of the structure so that the ground can move below the structure without transferring these motions into the superstructure. In an ideal system for the supple this separation would be total. But In the existing world there is a need to have some contact between the superstructure and sub structure.

### II. RELATED WORK

#### Problem statement

G+5 and G+10 storied buildings are modelled using conventional beams, columns and slabs. The structure with plan dimension 15m x 9m. They are loaded with dead load, live load and seismic forces (According to IS: 1893(part-1)-2002). These models are then analysed using response spectrum method for earthquake zone IV zone factor (0.36). The details of modelled building are listed below. Modal damping of 5% is considered with Simple moment resisting frame

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(SMRF) Response reduction factor,  $R=3$ ) and importance factor ( $I=1$ ). The performance of the models is recorded through SAP2000 to present a brief idea about the role of base isolation in protecting the structure against earthquake hazards.

## Modelling

### Description of Models

- Model 1 = Fixed Base
- Model 2 = Base isolated (LRB)

### Building details

- Structure = RCC (OMRF)
- Structure Type = Plan Regular Structure
- Plan Diameter = 15m x 9m
- Height of Building = 15.5m (G+5)
- Height of each Storey = 3.1m
- In X-direction = 3 bay of 3m length
- In Y-direction = 3 bay of 3m length

### Material Properties

- Grade of concrete = M20
- Grade of steel = Fe415
- Density of concrete = 25KN/m<sup>3</sup>
- Density of brick infill wall = 20KN/m<sup>3</sup>

### Section Properties

- Beam size = 300mmx450mm
- Outer Column = 300mmx400mm
- Slab Thickness = 150mm
- Wall Thickness = 230mm & 150 mm

### Load Consideration

#### Gravity Load:

- Dead load = Column, Beam, Slab
- Live load = 3KN/m<sup>2</sup>
- Floor Finish = 1.5KN/m<sup>2</sup>

#### Lateral Load of Response Spectrum Analysis:

- Soil Profile type = Medium
- Seismic Zone Factor = Zone IV
- Response Reduction Factor = 5.0
- Importance Factor = 1.0
- Damping = 5.0

### Characteristics of Lead Rubber Bearing

Isolators are provided above every footing at 0.272m above base level. Properties of LRB are mentioned below:

- Vertical stiffness (linear) = 150000KN/m
- Horizontal stiffness (linear) = 150000KN/m
- Horizontal stiffness (Nonlinear) = 150000 KN/m

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### III. EXPERIMENTAL RESULTS

Below are the results of software analysis after comparison with and without Base Isolation. After observing following time periods we can see that With Base Isolation has increased time period of structure than without base Isolation. These time periods have been calculated with values from Time History Analysis.

**Table 1**  
**Time periods of 5 Story building in seconds**

Mode	Time Period (Seconds)	
	Without base isolation	With base isolation
Mode-1	0.621	1.131
Mode-2	0.532	1.032
Mode-3	0.517	1.013
Mode-4	0.189	0.267
Mode-5	0.164	0.227

Below graph depicts comparison for Mode's with respect to with and without Base Isolation. Variation in time period in base Isolation model is high as compared with fixed Base Model.

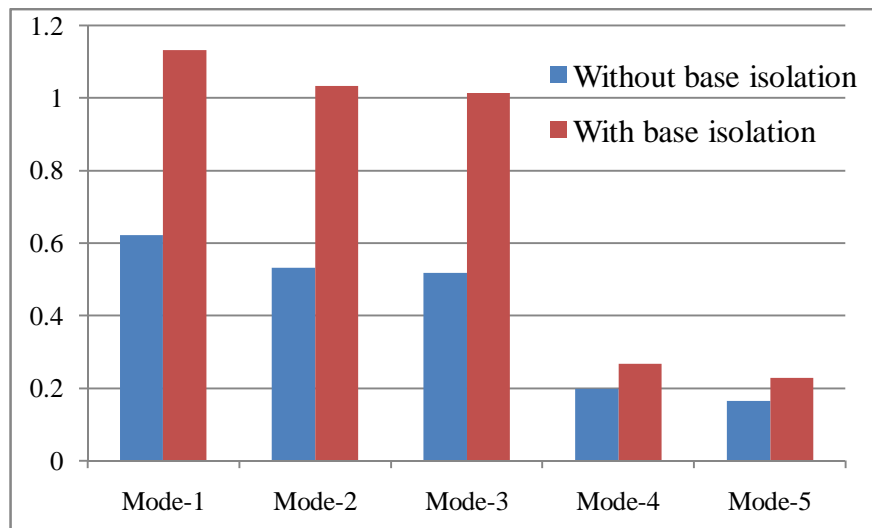


Figure 1: Comparison of time period

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Below are the results of software analysis after comparison with and without Base Isolation. After observing following time periods we can see that With Base Isolation has increased time period of structure than without base Isolation. These time periods have been calculated with values from Time History Analysis.

**Table 2**  
**Time periods of 10Storey building in seconds**

Mode	Time Period (Seconds)	
	Without base isolation	With base isolation
Mode-1	2.231	3.226
Mode-2	0.726	2.905
Mode-3	0.409	2.784
Mode-4	0.289	0.854
Mode-5	0.224	0.707

Below graph depicts comparison for Mode's with respect to with and without Base Isolation. Variation in time period in base Isolation model is high as compared with fixed Base Model.

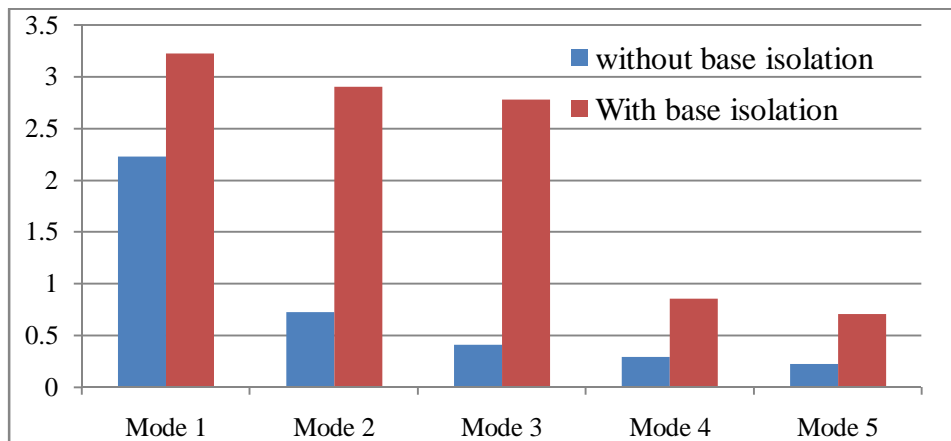


Figure 2: Comparison of time period

## IV. CONCLUSION

The two models, fixed base model and base isolated model with lead rubber bearing were analysed by response spectrum analysis from these building models following conclusion are made:

- Natural periods are increased which reduces earthquake forces during shaking.
- Time period is increased which increases reaction time of structure during earthquake.
- Storey drift is reduced in higher stories which make structure safe against earthquake.

Hence it is concluded that, by providing Lead rubber Bering (LRB) as a base isolator, structure stability against earthquake increased and also, less reinforcement is required which makes structure economical.

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