



“Comparative Analysis of Multi-Storey Building with Base Isolation Under Seismic Loading.”

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ABSTRACT

The main objective of this work is to compare different base-isolation methods i.e Rubber base isolation in order to evaluate their effects on the structural response and to compare the effect of earthquake forces. An analysis is carried out by the ETABS Software on G+9 storey building with and without base isolation method. The building is designed as per provisions in IS 456:2000 and IS 1893: 2002 which is an Indian standard code for Earthquake design. A bare frame model and a model with Rubber base isolator was prepared and analysis was carried out in the ETABS software and the results such as Bending moment, Shear force, Torsion, Base shear & various Storey forces were evaluated by the system. These results are then analyzed and are compared in graphical as well as in tabular form.

I. INTRODUCTION

This paper gives a comparative result of seismic analysis of a multi-storey building models with and without base isolation. The properties of base isolated structures are highlighted. The aim of base isolation technique is to retard the earthquake forces which is coming through the base of the building and increase the strength and ductility of structure. Earthquakes are considered as one of the most dangerous natural hazard. From the old times it causes loss of human lives as well as property. From many researches it is found that base isolation is an optimum solution for seismic problems. The base isolation technique is considered as the most suitable method because it stops the effect of earthquake attack. The flexible base helps to de couple a superstructure from its substructure built on a

seismic ground and results in protecting the structure against collapse due to lateral forces. This paper gives the comparison of models based on the effect of axial forces, moment, deflection and base shear in tabular and graphical forms.

II. BASE ISOLATION SYSTEM

Lead Rubber isolation

Lead Rubber Bearing (LRB) is a type of base isolation employing a heavy damping. It was invented by William Robinson. It is mainly used in heavy damping structures in vibration control technologies and particularly in base isolation techniques. It is used as a valuable source of controlling vibrations thus enhancing a building's seismic performance.

The rubber in an isolator which acts as a spring. It is laterally very soft but vertically very stiff. These two characteristics allow the isolator to move laterally with relatively low stiffness yet carry significant axial load due to their high vertical stiffness.



Figure 1

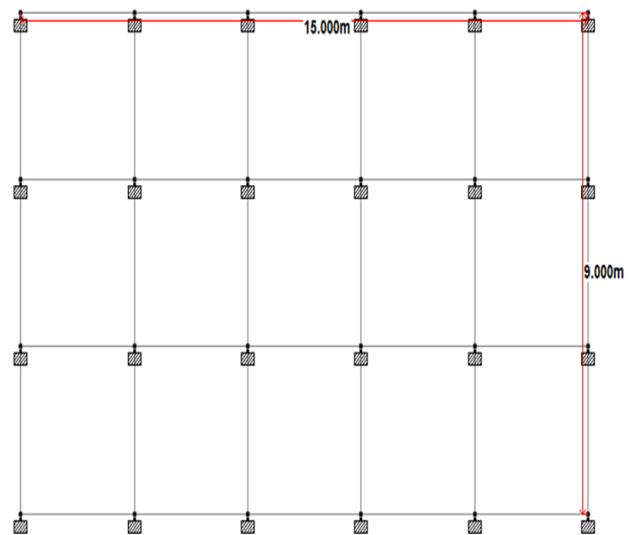


Figure 2. Plan of building

III. METHODOLOGY

Modelling and Analysis

This chapter deals with the mathematical modeling of building with different base isolating units. In order to compare the seismic response various models has been prepared using STAAD-PRO V8i. For each case, seismic analysis has been discussed. Complete analysis is carried out for dead load, live load & seismic load. All combinations are considered as per IS 1893:2002.

Description of the building

- The typical framing plan of G+9 storey building is shown in figure the building is rectangular in plan.
- Size of the building is taken as 15mX9m
- Each storey height is considered as 3m.
- Total Height of the building is 30m.
- Spacing of frame along length and width is 3m.
- Materials grade of M20 & Fe415 were used for the design.

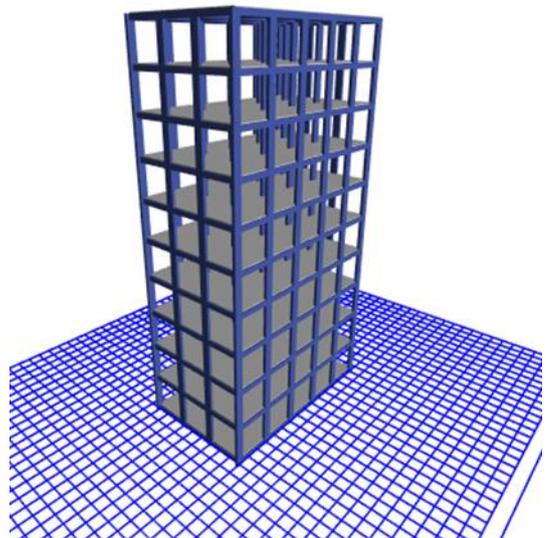


Figure 3. Rendered view

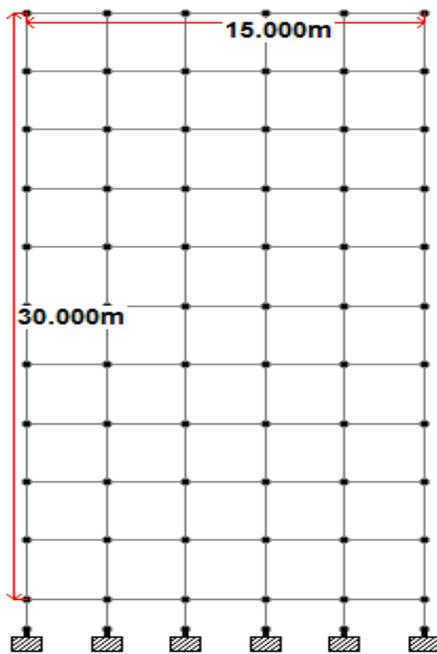


Figure 4. Elevation

Description of different Models

Model No.1 shows the model of regular building i.e. frame type.

Model No.2 shows the model of regular building with Rubber Base isolation provision.

Selection of factors

- 1) Zone II, Zone factor (Z) = 0.1 (As per IS 1893 (PART I):2002, Table 2)
- 2) I= Importance factor =1
- 3) (As per IS 1893 (PART I): 2002, Table 6)
- 4) R= Response reduction factor
- 5) (for SMRF) = 5
- 6) (As per IS 1893 (PART I): 2002, Table 7)
- 7) (As per IS 1893 (PART I): 2002, Table 7)
- 8) Table 7)

Table 1. Description of various elements

Discription	Numeric value
Total depth of slab	150 mm
Floor finish load	1KN/m ²
External wall thickness	230 mm
Internal wall thickness	230 mm
Size of external column	230 mm X 600 mm
Size of internal column	230 mm X 600 mm
Size of beam in longitudinal and transverse direction	230 mm X 400 mm
Live load	3KN/m ²

IV. ANALYSIS AND RESULTS

• **Comparison of Shear force**

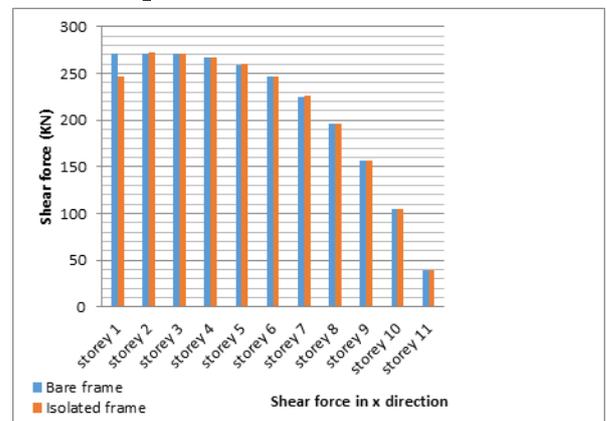


Figure 5. Shear force in X direction

Table 2. Comparison of Shear force in X Direction at base

V _x (Fix base)	V _x (Base isolated)
222.19 KN	198.37 KN

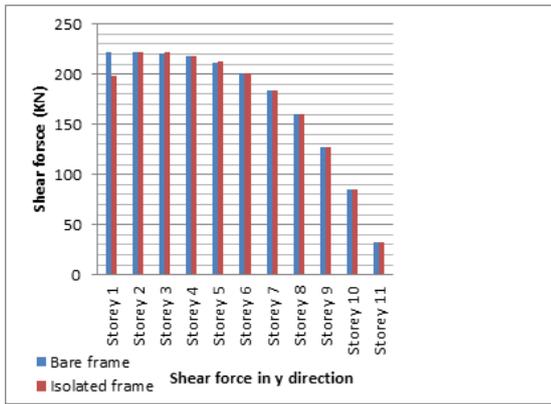


Figure 6. Shear force in Y direction

Table 3. Comparison of Shear force in Y Direction at base

V_Y (Fix base)	V_Y (Base isolation)
271.70 KN	245.94 KN

A comparison of Shear force in X & Y direction is shown in the figure where you can see that the isolated frame has a less shear force while that of fixed base structure which has more shear force acting on the base of the structure.

If the shear at base is more then the lateral displacement of the structure will be more so to overcome the lateral displacements and to minimize the effect the rubber base isolating material is bolted between foundation and plinth level, so that all the lateral forces are taken by the Rubber and the superstructure is safe against the earthquake forces.

• Comparison of Bending moment

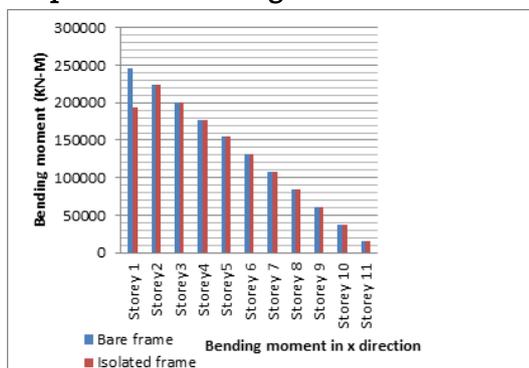


Figure 7. Bending moment in X – direction

Table 4. Comparison of Bending moment in X direction at base

M_x (Fix base)	M_x (Base isolated)
245992.28 KN-m	194274.01 KN-m

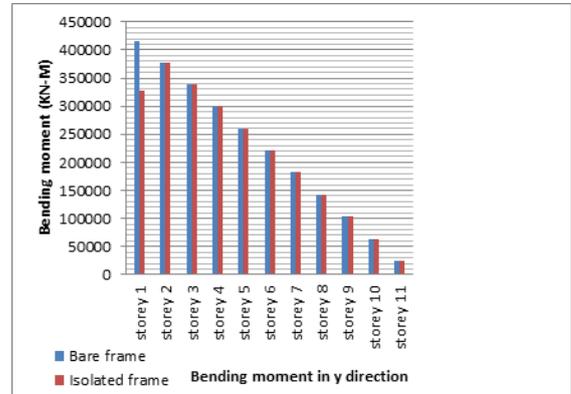


Figure 8. Bending moment in Y – direction

Table 5. Comparison of Bending moment in Y direction at base

M_Y (Fix base)	M_Y (Base isolated)
415266.00 KN-m	327958.00 KN-m

A comparison of bending moment in X & Y direction is shown in the figure where you can see that the isolated frame has a less bending moment while that of fixed base structure.

By the application of rubber base isolator in the structure the bending moment at the base is much reduced if we compare it with a fixed base structure.

• **Comparison of forces in plinth nodes**

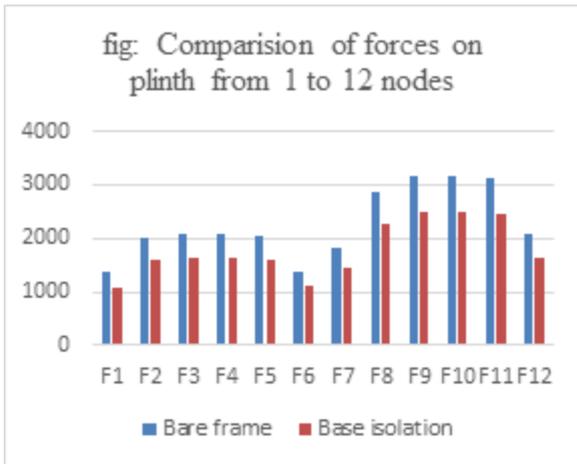


Figure 9. Graphical representation of Plinth level forces

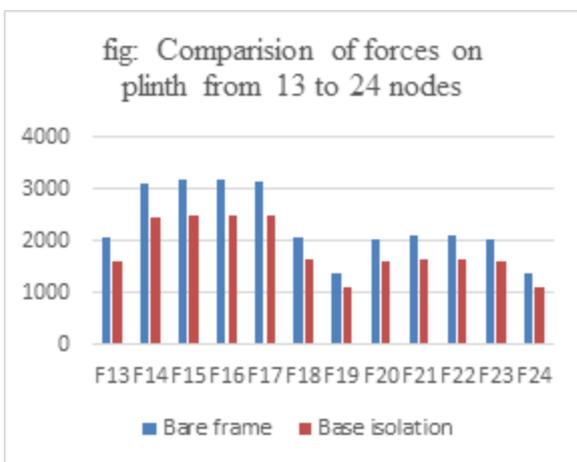


Figure 10. Graphical representation of Plinth level forces

IV. CONCLUSIONS

- ✓ Percentage reduction of shear force is found to be 10.70% by using base isolation.
- ✓ Percentage reduction of Bending moment is found to be 21.02% by using base isolation.

It is found that the base isolation technique is very effective in the control of earthquake forces. Also this technique reduces shear as well as bending moment in the base storey which is our desired result. If the forces at the base is controlled, then it is possible that the building is safe against collapse

because the earthquake forces are transferred on the foundation through the soil, and then these forces are transferred on the superstructure through the foundation.

So, if the plinth level (base) of the building is safe against the collapse then the whole superstructure can be safe against the collapse, and plinth can only be safe if the forces coming through the earthquake can be reduced from its original magnitude.

So, the Base Isolation technique proves to be much efficient in the reduction of all kind of forces and also it protects the building from the collapse.

V. REFERENCES

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