

# Seismic Analysis of G+10 building with and without Rubber Bearing using E- TABS

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**Abstract** - Bracings, shear walls, dampers, base isolation etc are the earthquake resistant techniques adopted to the building to safeguard it from the hazardous effects of earthquake. The main purpose of this project is to analyze the G+10 residential building with and without Rubber bearing. Two models of the building were created one with rubber bearing and other with fixed support subjected to Dead load, live load and Earthquake load in combination as per IS 875 (part 1&2) and IS 1893-part1. The building considered to be located in zone V. Both the models were analysed and are compared on the basis of storey displacement, storey shear, storey drift, and base shear and are illustrated in the form of chart. The results show that storey displacement, storey shear, storey drift, and base shear values were much less in case of model with rubber bearing when compared with model with fixed support.

**Key Words:** Earthquake resistant techniques, Rubber bearing, base isolation, earthquake load, seismic load

## 1. INTRODUCTION

Earthquakes are the most destructive of natural hazards. Earthquake occurs due to sudden transient motion of the ground as a result of release of energy in a matter of few seconds. The impact of the event is most traumatic because it affects large area, occurs all of a sudden and unpredictable.

Vibrations induced in the earth's crust due to internal or external causes that virtually shake up a part of the crust and all the structures and living and non-living things existing on it they can cause large scale loss of life, property and disrupts essential services such as water supply, sewerage systems, communication, power and transport etc.

Software used are AutoCAD Software and ETABS Software. ETABS software used in the project stands for Extended Three-Dimensional Analysis of Building Systems.

As per IS 1893-part1, India is divided into five zones based of severity in occurrence of earthquake.

Zone II: A low seismic hazard zone with Zone factor (Z) = 0.10.

Zone III: A moderate seismic hazard zone with Zone factor (Z) = 0.16.

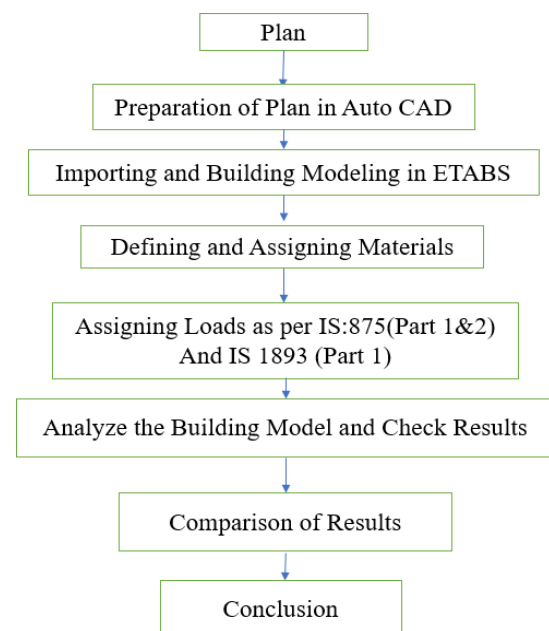
Zone IV: A high seismic hazard zone with Zone factor (Z) = 0.24.

Zone V: A very high seismic hazard zone with Zone factor (Z) = 0.36.

In Base isolation techniques, superstructure is separated from foundation using flexible interfaces such as elastomeric bearings, lead rubber bearings, Sliding systems etc. which allows the building to move independently during earthquake thus reducing force transmitted from ground to the building during earthquake.

## 2. METHODOLOGY

### 2.1 Flow chart



### 2.2 Building specifications

In this work following building details are considered

No. of stories = 10

Height = 37

each bay @3m

Site Plan dimensions- 100'X50'-8.4"

Location = Bengaluru

Concrete grade M25

Steel grade HYSD500

### 2.3 Plan and column layout

Importing architecture plan from Auto CAD and generate the grids; after getting opened with ETABS we select a new model, and a window appears where we had entered the grid dimensions and story dimensions of our building.

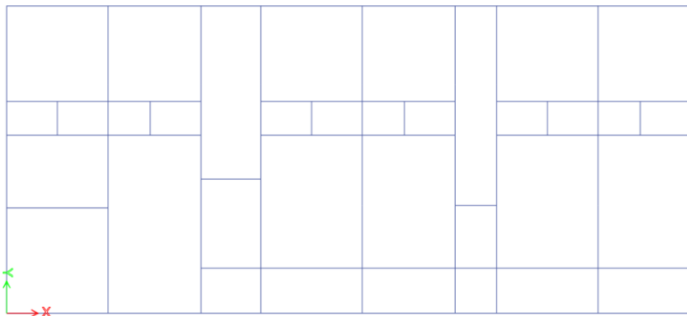


Fig-1: Grid generated in Etabs

### 2.4 Specifying Member Property

The member properties are taken as given  
 Thickness of slab = 125mm  
 Beam = 300x200 mm Column = 300 X 750 mm

The member properties are first defined and then assigned to the respective members in Etabs software.



Fig-2: Assigning the Beam and Column properties

### 2.5 Defining of rubber bearing properties

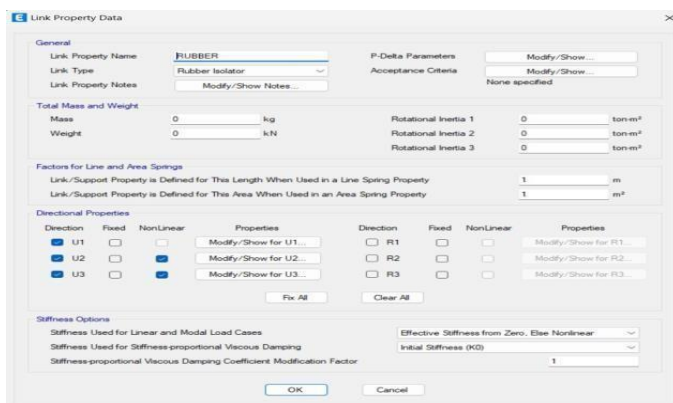


Fig-3: Defining the Rubber Bearing property

### 2.6 Assigning of Supports

For the G+10 storey 3D model created, Fixed supports were assigned to one model and rubber bearings were assigned to another model instead of fixed support

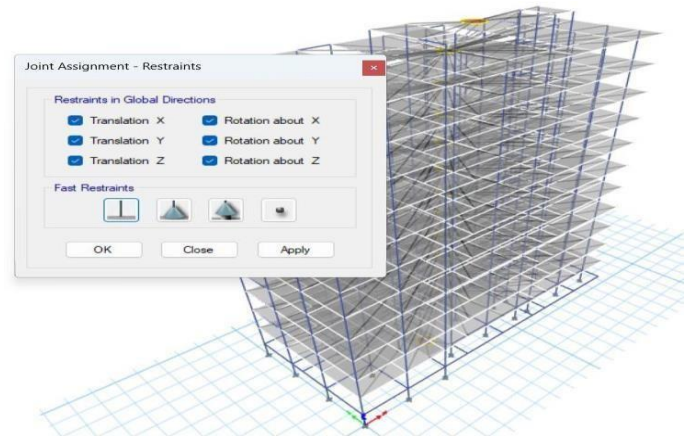


Fig-4: Assigning the Fixed Support

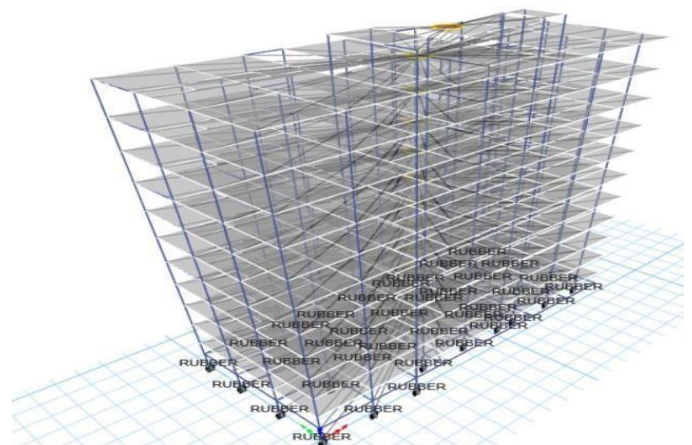


Fig-5: Assigning the Rubber Bearing

### 2.7 Defining and Assigning of loads

Dead load, live load and earthquake loads were defined and assigned to both the models, load calculations are as shown below

Dead load

Based on the beam and column dimensions assigned deadload is automatically calculated by etabs software itself

Floor finish load

Weight of mortar bed = 1.02 KN/m<sup>2</sup>  
 Weight of granite = 0.475 KN/m<sup>2</sup>  
 Therefore Floor finish = 1.5 KN/m<sup>2</sup>

Live load

As per IS 875(Part 2)-1987 for residential building live load intensity is considered as 2 kN/m<sup>2</sup>

Wall loads

Main Wall loads – 11.45 KN/m  
 Partition Wall loads - 6.25KN/m  
 Parapet wall load on terrace beam-3.12KN/m

Earthquake load was defined and assigned in both X and Y directions considering following parameters as per IS 1893-part1

- Zone: V
- Seismic Factor: 0.36
- Soil Type: II (safe soil)
- Importance Factor: 1
- Response reduction factor : 5

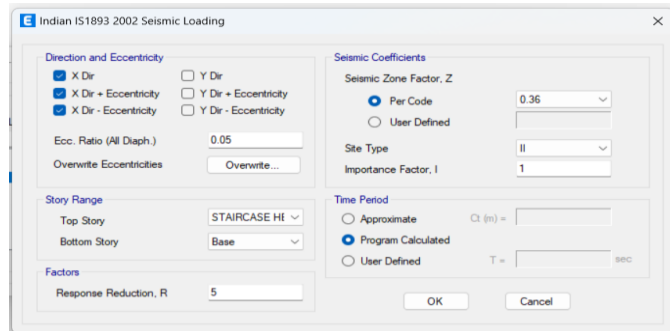


Fig-6: Defining the Earthquake load in X direction

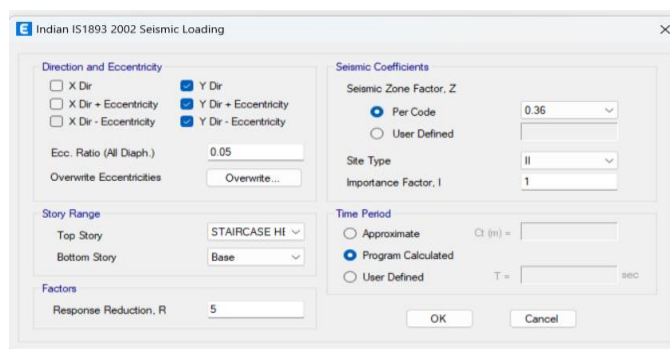


Fig-7: Defining the Earthquake load in Y direction

### 2.8 Load combination

Dead load, live load and earthquake load were applied in combination on model with fixed support and also model with rubber bearing considering scale factor of 1.2.

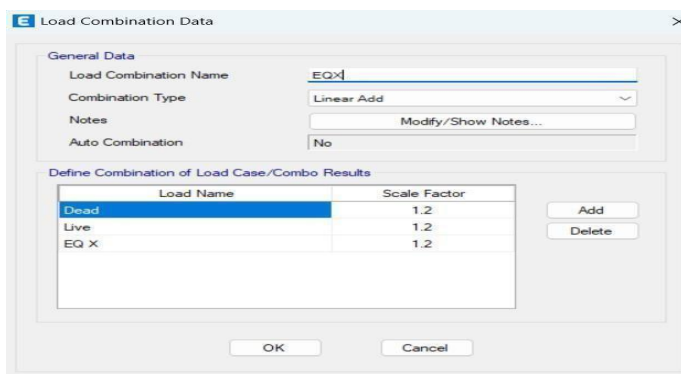


Fig-8: Defining the load combination in X direction

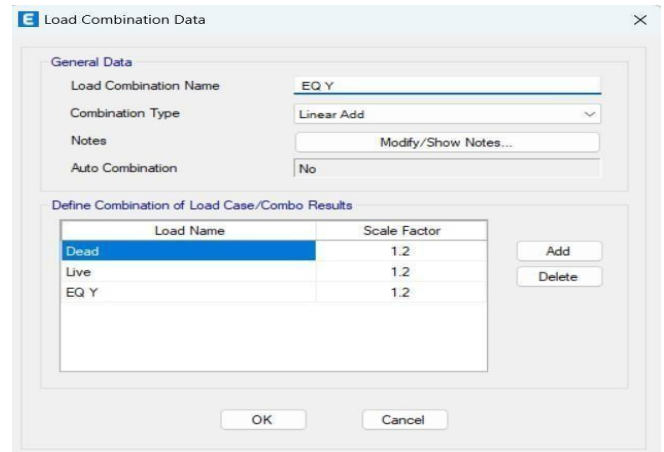


Fig-9: Defining the load combination in Y direction

### 2.9 Analysing the models

Models are checked for errors and analysed. After the completion of analysis, results of storey shear, storey drift, storey displacement and base shear in both the models were compared.

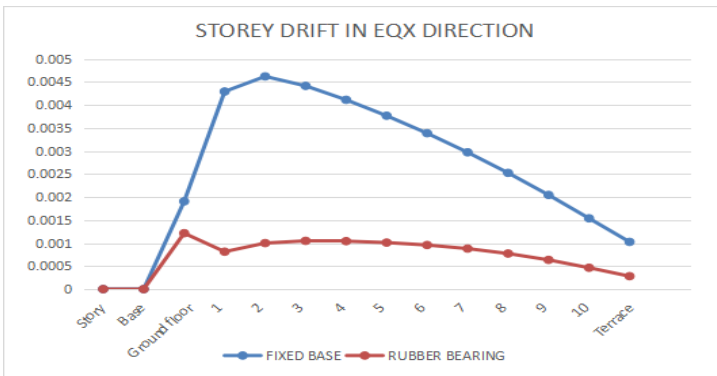
### 3. RESULTS AND DISCUSSION

The comparison of results obtained are represented below both in table format and graphs. It can be observed that the Storey drifts, Storey shear, storey displacement and base shear values for model with rubber bearing is much less when compared to model with fixed support when subjected to combined loading.

#### 3.1 Storey Drift

Table-1: Storey Drift along X-Direction for Fixed Base Model and Rubber Bearing base Model.

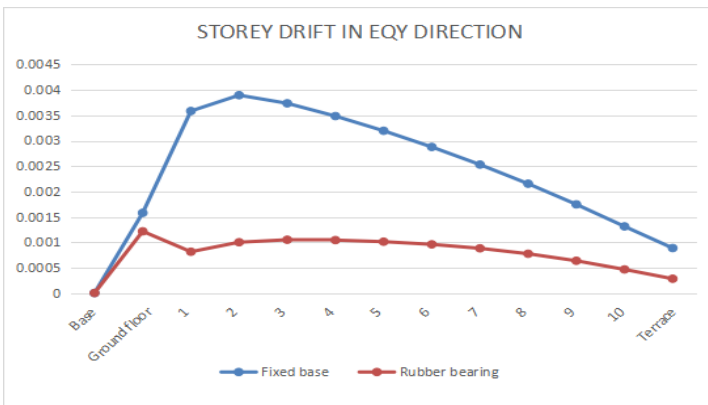
| Story        | Fixed base | Rubber bearing | % Decrease |
|--------------|------------|----------------|------------|
| Base         | 0          | 0              | 0          |
| Ground floor | 0.001907   | 0.001215       | 36.29      |
| 1            | 0.004293   | 0.000813       | 81.06      |
| 2            | 0.004621   | 0.001          | 78.36      |
| 3            | 0.004415   | 0.001049       | 76.24      |
| 4            | 0.004113   | 0.001042       | 74.67      |
| 5            | 0.003767   | 0.001011       | 73.16      |
| 6            | 0.003387   | 0.000958       | 71.72      |
| 7            | 0.002972   | 0.00088        | 70.39      |
| 8            | 0.002525   | 0.000773       | 69.39      |
| 9            | 0.002046   | 0.000635       | 68.96      |
| 10           | 0.001538   | 0.000464       | 69.83      |
| Terrace      | 0.001026   | 0.000281       | 72.61      |



**Chart-1:** Storey Drift along X-Direction for Fixed Base Model and Rubber Bearing base Model

**Table-2:** Storey Drift along Y-Direction for Fixed Base Model and Rubber Bearing base Model

| Story        | Fixed base | Rubber bearing | % Decrease |
|--------------|------------|----------------|------------|
| Base         | 0          | 0              | 0          |
| Ground floor | 0.001579   | 0.001215       | 23.05      |
| 1            | 0.003585   | 0.000813       | 77.32      |
| 2            | 0.003897   | 0.001          | 74.34      |
| 3            | 0.003737   | 0.001049       | 71.93      |
| 4            | 0.003485   | 0.001042       | 70.10      |
| 5            | 0.003196   | 0.001011       | 68.37      |
| 6            | 0.002877   | 0.000958       | 66.70      |
| 7            | 0.00253    | 0.00088        | 65.22      |
| 8            | 0.002153   | 0.000773       | 64.10      |
| 9            | 0.001746   | 0.000635       | 63.63      |
| 10           | 0.001312   | 0.000464       | 64.63      |
| Terrace      | 0.000885   | 0.000281       | 68.25      |

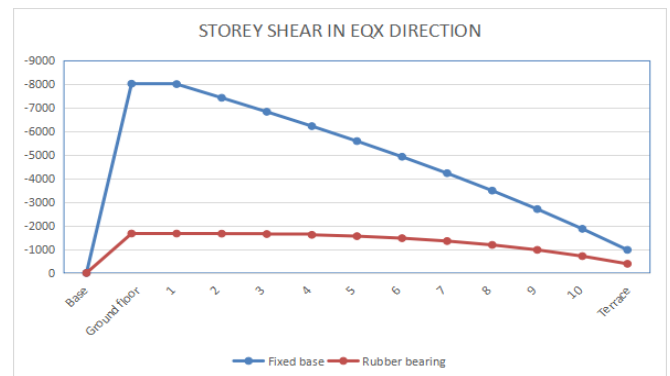


**Chart-2:** Storey Drift along Y-Direction for Fixed Base Model and Rubber Bearing base Model

### 3.2 Storey shear

**Table-3:** Storey shear along X-Direction for Fixed Base Model and Rubber Bearing base Model

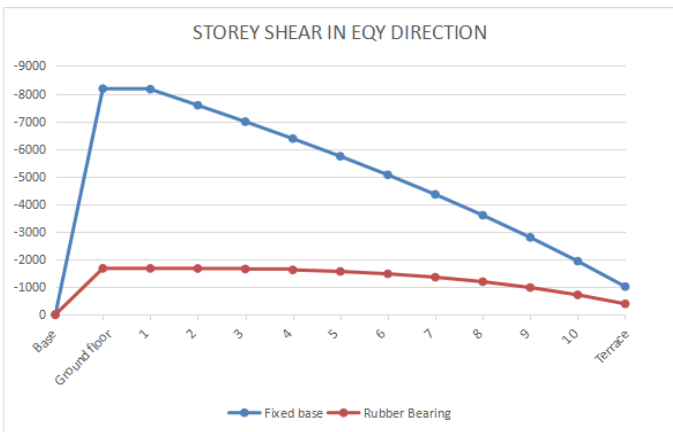
| Story        | Fixed base | Rubber bearing | % Decrease |
|--------------|------------|----------------|------------|
| Base         | 0          | 0              | 0          |
| Ground floor | -8031.15   | -1673.8        | 79.16      |
| 1            | -8014.29   | -1673.1        | 79.12      |
| 2            | -7433.69   | -1668.1        | 77.56      |
| 3            | -6840.91   | -1651.9        | 75.85      |
| 4            | -6230.28   | -1618.6        | 74.02      |
| 5            | -5596.13   | -1561.9        | 72.09      |
| 6            | -4932.81   | -1475.9        | 70.08      |
| 7            | -4234.65   | -1354.3        | 68.02      |
| 8            | -3495.97   | -1191          | 65.93      |
| 9            | -2711.12   | -980.02        | 63.85      |
| 10           | -1874.43   | -715.08        | 61.85      |
| Terrace      | -980.236   | -390.1         | 60.20      |



**Chart-3:** Storey shear along X-Direction for Fixed Base Model and Rubber Bearing base Model

**Table-4:** Storey shear along Y-Direction for Fixed Base Model and Rubber Bearing base Model

| Story        | Fixed base | Rubber Bearing | % Decrease |
|--------------|------------|----------------|------------|
| Base         | 0          | 0              | 0          |
| Ground floor | -8179.09   | -1673.79       | 79.535743  |
| 1            | -8162.17   | -1673.08       | 79.5020197 |
| 2            | -7580.89   | -1668.12       | 77.9957235 |
| 3            | -6986.37   | -1651.91       | 76.355246  |
| 4            | -6372.43   | -1618.55       | 74.600741  |
| 5            | -5732.92   | -1561.92       | 72.7552451 |
| 6            | -5061.68   | -1475.87       | 70.8422895 |
| 7            | -4352.55   | -1354.29       | 68.8851363 |
| 8            | -3599.35   | -1191.05       | 66.9093031 |
| 9            | -2795.94   | -980.023       | 64.9483537 |
| 10           | -1936.14   | -715.084       | 63.0665138 |
| Terrace      | -1013.81   | -390.105       | 61.5208964 |

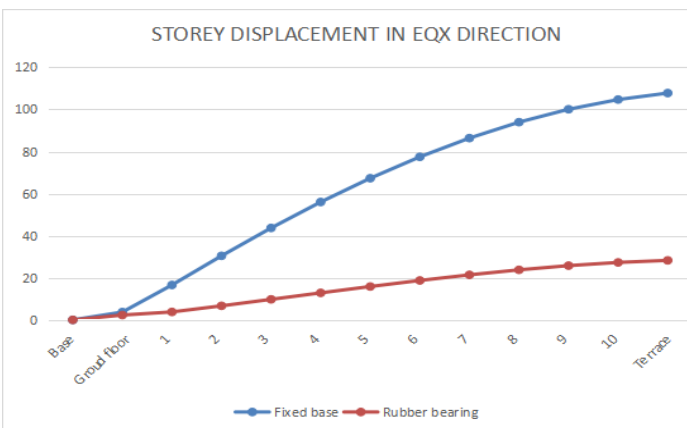


**Chart-4:** Storey shear along Y-Direction for Fixed Base Model and Rubber Bearing base Model

### 3.3 Storey Displacement

**Table-5:** Storey Displacement along X-Direction for Fixed Base Model and Rubber Bearing base Model

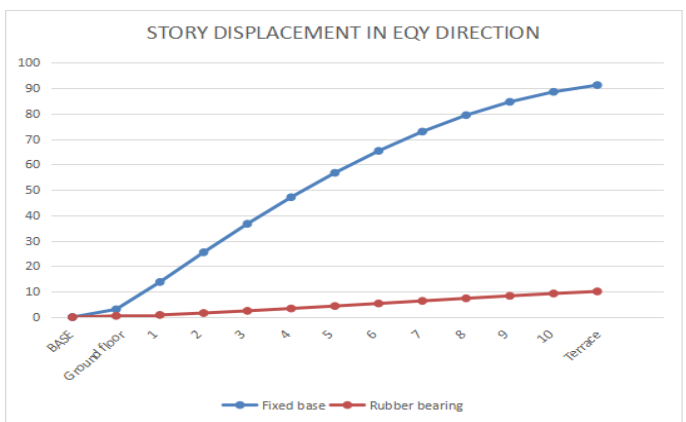
| STORY        | Fixed base | Rubber bearing | % Decrease |
|--------------|------------|----------------|------------|
| Base         | 0          | 0              | 0          |
| Ground floor | 3.723      | 2.298          | 38.28      |
| 1            | 16.591     | 3.779          | 77.22      |
| 2            | 30.453     | 6.679          | 78.07      |
| 3            | 43.699     | 9.761          | 77.66      |
| 4            | 56.039     | 12.844         | 77.08      |
| 5            | 67.341     | 15.859         | 76.45      |
| 6            | 77.501     | 18.74          | 75.82      |
| 7            | 86.418     | 21.411         | 75.22      |
| 8            | 93.992     | 23.791         | 74.69      |
| 9            | 100.129    | 25.79          | 74.24      |
| 10           | 104.742    | 27.314         | 73.92      |
| Terrace      | 107.82     | 28.29          | 73.76      |



**Chart-5:** Storey Displacement along X-Direction for Fixed Base Model and Rubber Bearing base Model

**Table-6:** Storey Displacement along Y-Direction for Fixed Base Model and Rubber Bearing base Model

| STORY        | Fixed base | Rubber bearing | % Decrease |
|--------------|------------|----------------|------------|
| BASE         | 0          | 0              | 0          |
| Ground floor | 3.079      | 0.496          | 83.89      |
| 1            | 13.809     | 0.864          | 93.74      |
| 2            | 25.5       | 1.615          | 93.67      |
| 3            | 36.71      | 2.474          | 93.26      |
| 4            | 47.165     | 3.398          | 92.80      |
| 5            | 56.752     | 4.37           | 92.30      |
| 6            | 65.383     | 5.373          | 91.78      |
| 7            | 72.973     | 6.388          | 91.25      |
| 8            | 79.432     | 7.394          | 90.69      |
| 9            | 84.67      | 8.369          | 90.12      |
| 10           | 88.605     | 9.29           | 89.52      |
| Terrace      | 91.261     | 10.111         | 88.92      |

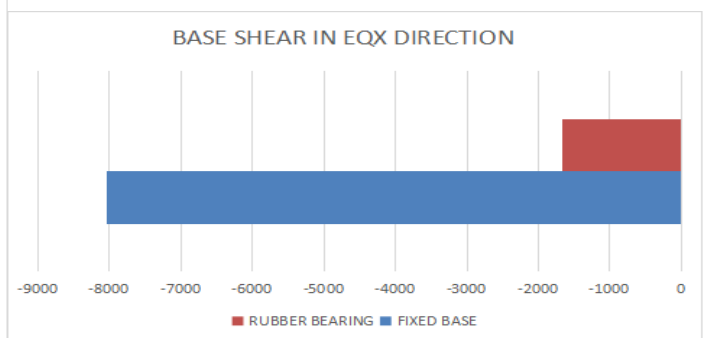


**Chart-6:** Storey Displacement along Y-Direction for Fixed Base Model and Rubber Bearing base Model

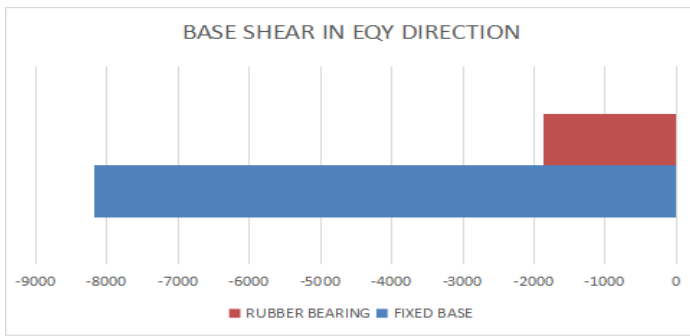
### 3.4 Base shear

**Table-7:** Base shear along X-Direction for Fixed Base Model and Rubber Bearing base Model

| Base Shear | Fixed base | Rubber Bearing | % Decrease |
|------------|------------|----------------|------------|
| EQX        | -8031.15   | -1673.7948     | 79.16      |
| EQY        | -8179.09   | -1861.7407     | 77.24      |



**Chart-7:** Base shear along X-Direction for Fixed Base Model and Rubber Bearing base Model



**Chart-8:** Base shear along Y-Direction for Fixed Base Model and Rubber Bearing base Model

#### 4. CONCLUSION

The maximum percentage decrease in the storey drift along EQX and EQY direction is 87.79 % and 77.34%

The maximum percentage decrease in the storey shear along EQX and EQY direction is 79.16% and 79.54%

The maximum percentage decrease in the storey displacement along EQX and EQY direction is 78.07% and 93.67 %

The maximum percentage decrease in the base shear along EQX and EQY direction is 79.16% and 77.24%

The storey displacement, storey drift, storey shear and base shear values of model with rubber bearing is lower when compared to model without rubber bearing, indicating the improved Lateral Stability

Based on the results, it is recommended to include rubber bearing in the design of multi-storey buildings in high-seismic zones to reduce seismic vulnerabilities and ensure adherence to safety standards

The rubber bearing improve the distribution of seismic forces, reducing stress concentrations on columns and beams, thus minimizing the risk of structural failures.

#### REFERENCES

Dr. Alok kumar jain, Dr. Manish Sakhlecha, Suman Verma, et al, "Seismic retrofitting by base isolation and analysing through E-TABS" International journal of Trend in Research and Development (IJTRD) Volume: 7(5) | Sep-Oct 2020

Cenk Alhan, et al. "Modeling of lead rubber bearings via 3d-basis, sap2000, and opensees considering lead core heating modeling capabilities" International Journal of Structural and Civil Engineering Research (IJSCER) Volume 7, No 4 | November 2018

Mr. Ankur vaidya<sup>1</sup>, Mr. Shahayajali Sayyed et al. "A Research on Comparing the Seismic Effect on Shear wall building and Without- Shear Wall Building" International Research Journal of Engineering and Technology (IRJET) Volume: 05 Issue: 12 | December 2018.

Sanket Vijay Munot, P B Autade, et al. "Design of Lead Rubber Bearing Base Isolator system for high Rise structure" International Journal of Creative Research thoughts (IJCRT) Volume: 9, Issue:7| July 2021.

P B Autade, Rohit Kokane, et al. "Comparitive study on conventional building with lead rubber bearing and Damper systems" International Journal of Creative Research thoughts (IJCRT) Volume 7 | July 2021.

IS: 875 (Part 1), for dead loads, Bureau of Indian Standards, New Delhi, India.

IS: 875 (Part 2), for imposed loads, Bureau of Indian Standards, New Delhi, India.

IS 1893 (Part 1), for seismic zone, Bureau of Indian Standards, New Delhi, India.

Radmila B SALIC, Mihail A. Garevski, Zoran V. Milutinovic, et al. "Response of Lead Rubber Bearing Isolated Structure" World Conference Earthquake Engineering (WCEE) Oct 12-17, 2008, Beijing, China.

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