

Comparative Study Analysis and Design of Base Isolated Building (HDR) with Fixed Base Building using ETABS

Prof. Girish H¹, Shubhangi Bholnekar², Shreyas Dodamani², Sudha Kamble², Sujnyani B²

Assistant Professor, Department of Civil Engineering, S.G.Balekundri Institute of Technology, Belagavi, Karnataka, India¹

U.G. Student, Department of Civil Engineering, S.G.Balekundri Institute of Technology, Belagavi, Karnataka, India²

ABSTRACT: Earthquake causes loss of life and economy every year. One can reduce it by adopting earthquake resistant design and new technologies. Base isolation is a mechanism that provides earthquake resistance to new structures. The aim of the study is the use of high damping rubber bearings (HDR) as an isolation device and compare the various parameters after analysis and design such as time period, storey displacement, and storey drift with fixed base building and base isolated building. These seismic results are carried out by static analysis method under the provision of IS 1893-2002 using zone-4 (Delhi) for 14 storied RCC structure using ETABS 2017 software.

KEYWORDS: ETABS Base isolation, High Damping Rubber, Time period, storey Displacement, Storey drift.

I. INTRODUCTION

Base Isolation: The Base Isolation is a technique wherein the structure is separated from the foundation by inserting base isolators under the building. These isolators provide adequate flexibility to allow the structure to move in the lateral direction, independent of the motion of the ground below.

High Damping Rubber: The High Damping Rubber is one of the Base isolator technique used to protect the building against earthquake forces.

- This consists of alternating layers of rubber and steel shims bounded together to form a unit. The steel plates prevent the rubber layers.
- The steel plates prevent the rubber layers from bulging and so the bearing is able to support higher vertical loads with small deformations. Base isolation minimize the need for strengthening measures of adding shear walls, frames, and bracing by reducing the earthquake forces imparted to the building.
- Base isolation can be retrofitted to suitable existing structures. Moreover, the building can remain serviceable throughout the construction.
- We adopt HDRB because; the rubber material has high damping ability, which enables it to absorb large energy of earthquake, taking advantage of its high elasticity as well as high durability.
- HDRB becomes very flexible in horizontal direction so that they can reduce the earthquake force upon the building by changing its own shape.

II. OBJECTIVES OF THE STUDY

- 1) To compare the seismic results of both Base Isolated and Fixed Base Building by using static analysis method.
- 2) The parameters to be studied are time period, storey displacement, and storey drift.
- 3) Designing of both structures which are Base isolated Building and Fixed Base Building.



III. METHODOLOGY

A. Modeling Analysis and Design:

The study includes modeling analysis and design of the models using standard ETABS software version 2017. Static method of analysis is performed on models using the earthquake data.

B. Models considered for analysis are:

- 1) Base Isolated Building
- 2) Fixed base Building

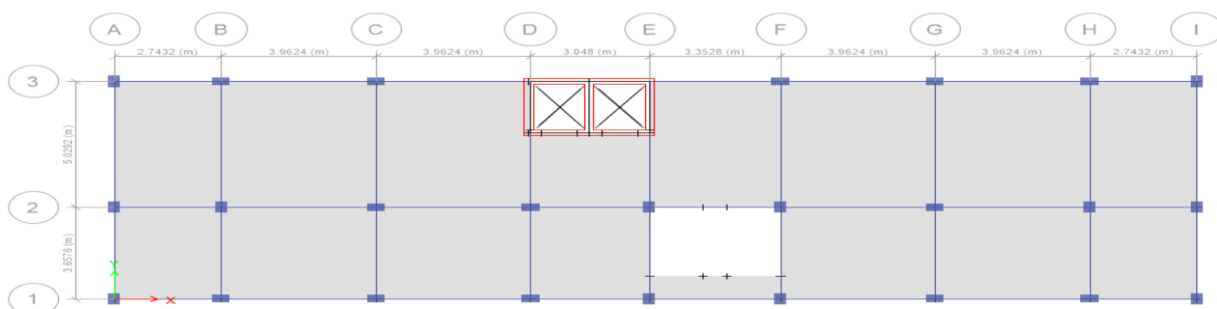


Fig 1. Plan of the building

C. Structural Specifications:

Table 1: Member Properties

No of Storey	14
Size of Beam	300 x 450mm
Size of column	300 x 450mm
Storey height	3m
Bottom storey height	3.2m
Thickness of slab	150mm
Thickness of Exterior walls	0.3m
Thickness of interior walls	0.2m
Thickness of parapet wall	0.10m
Height of parapet wall	0.9m

Table 2: Material Properties

Concrete	M25
Rebar	TMT 500
Isolator used	High Damping Rubber

Table 3: Load Intensities

Live load	3KN/m
Wall loads on Exterior beams	4.59
Wall load on Interior beams	3.5
Parapet load	0.54

Table 4: Design Parameters for earthquake load

Type of Soil	Medium
Earthquake Zone	Zone 5 (Delhi)
Zone Factor, Z	0.24
Importance Factor, I	1
Response Reduction Factor, R	1
Damping Ratio	0.05

D. Properties of High Damping Rubber used for analysis:

Table 5: High Damping Rubber Bearings has been designed as per UBC-97.

Target period for Design Level earthquake TD	2 sec
Second Target period for Max. Capable Level earthquake TM	2.5 sec
Shear modulus of HDR G	550 kN/m ²
Small shear strain G	700 kN/m ²
Bulk modulus K	20,00,000 kN/m ²
Damping ratio of isolator β	15%
Shear Strain γ_{max}	1.5
Acceleration of gravity g	9.81 kN/m ²
thickness of single layer rubber	22mm
Number of layer is $10 n \times t_0$	220mm
Total Height h	281mm

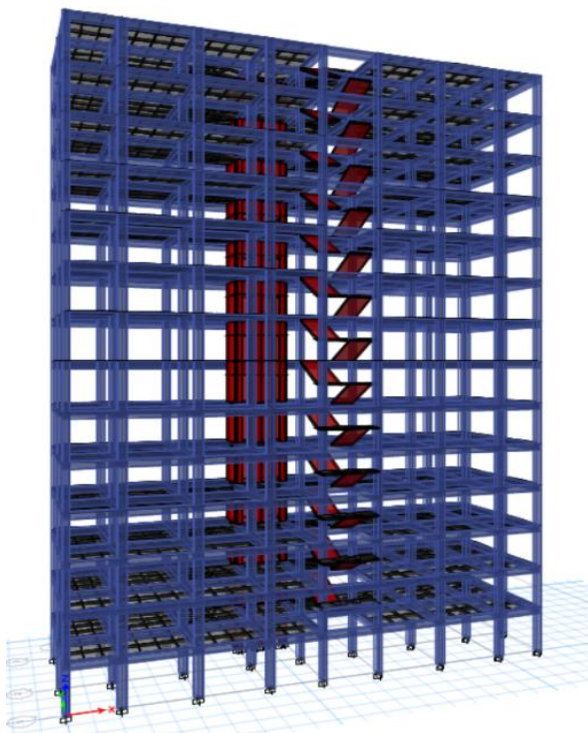


Fig 2: Fixed Based Building

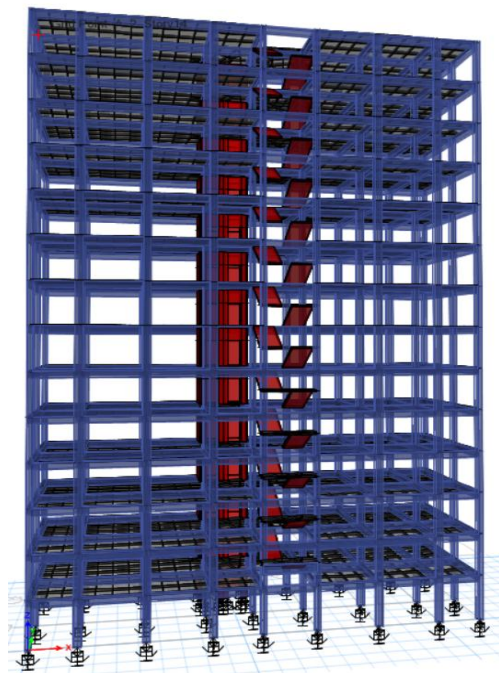


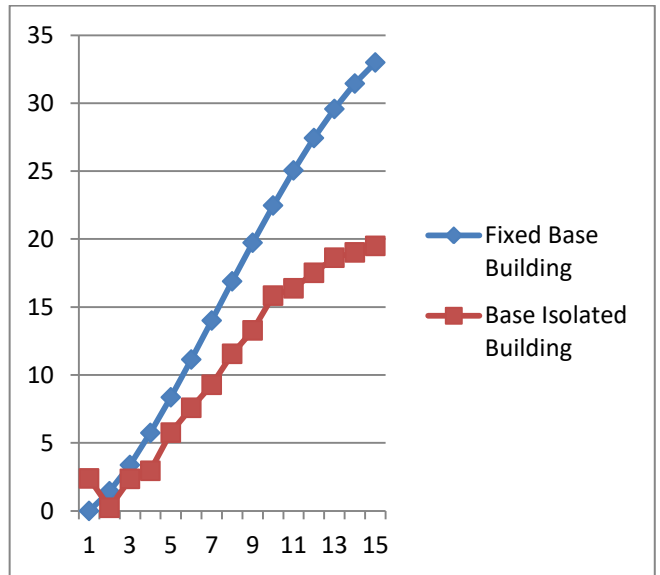
Fig 3: Fixed Based Building With Base Isolator

IV. EXPERIMENTAL RESULTS

1. Storey Displacement

Storey no	Fixed Base Building	Base Isolated Building
Base	0	2.39
1	1.449	0.23
2	3.379	2.36
3	5.741	2.952
4	8.361	5.761
5	11.141	7.588
6	14.008	9.28
7	16.893	11.56
8	19.733	13.283
9	22.472	15.84
10	25.056	16.38
11	27.436	17.52
12	29.574	18.63
13	31.446	19.02
14	32.995	19.5

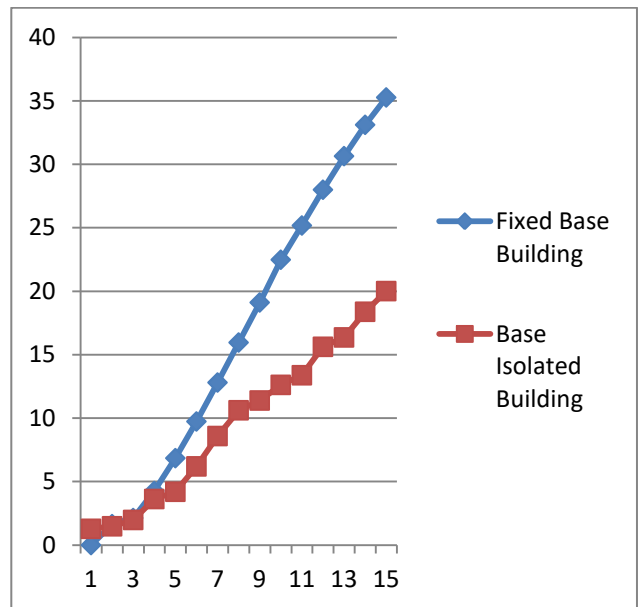
Table 6: In X Direction



Graph 1: Storey Displacement in X Direction

Storey no	Fixed Base Building	Base Isolated Building
Base	0	1.28
1	1.649	1.482
2	2.131	1.98
3	4.259	3.63
4	6.848	4.2
5	9.738	6.2
6	12.807	8.59
7	15.958	10.62
8	19.112	11.39
9	22.48	12.62
10	25.178	13.38
11	27.996	15.62
12	30.642	16.36
13	33.109	18.38
14	35.267	20.01

Table 7: In Y Direction



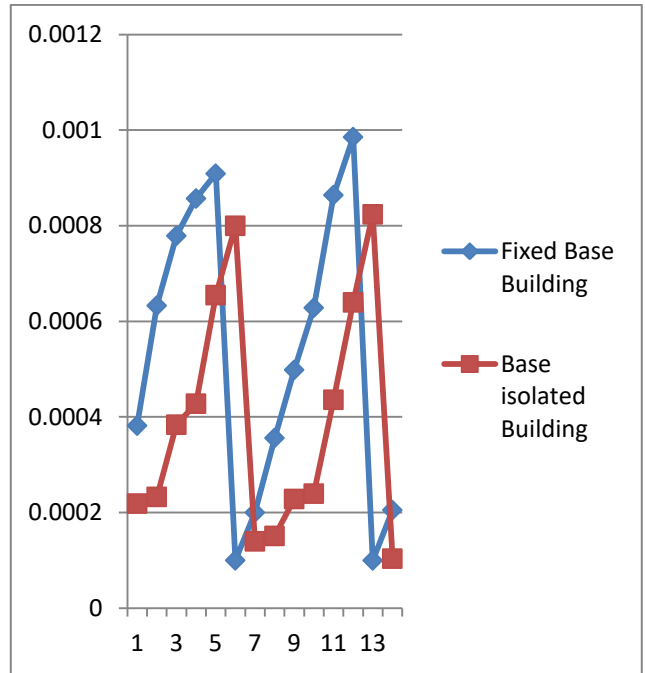
Graph 2: Storey Displacement in Y Direction

From the above results it is observed that storey displacement decreases in case of Base isolated building when compared to fix base building.



2. Storey Drift

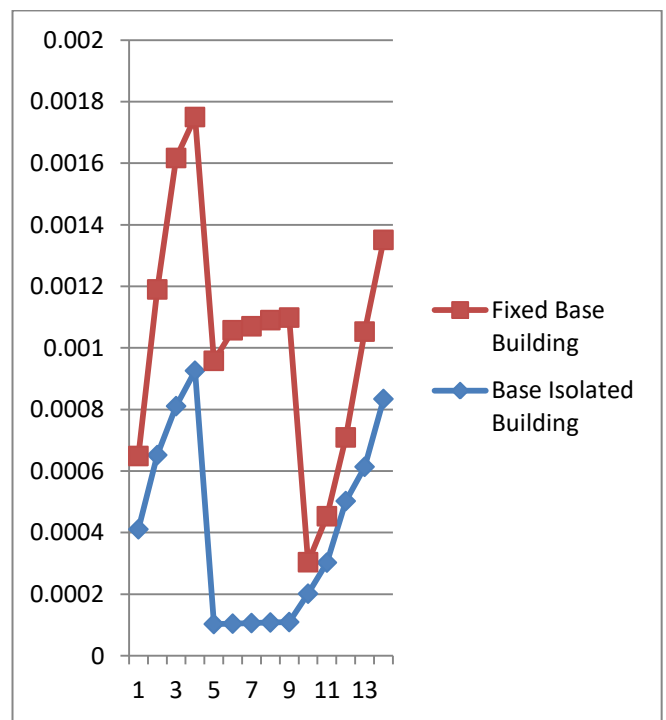
Storey No	Fixed Base Building	Base isolated Building
1	0.000382	0.000219
2	0.000633	0.000233
3	0.000779	0.000384
4	0.000857	0.000428
5	0.000909	0.000655
6	0.0001002	0.0008
7	0.0002003	0.00014
8	0.0003562	0.0001513
9	0.0004986	0.0002286
10	0.0006285	0.0002398
11	0.0008642	0.0004362
12	0.0009856	0.0006398
13	0.00010005	0.0008239
14	0.00020536	0.00010382



Graph 3: Storey Drift in X Direction

Table 8: X Direction

Storey NO	Fixed Base Building	Base isolated building
1	0.000411	0.000238
2	0.000652	0.000538
3	0.000811	0.000806
4	0.000926	0.000824
5	0.0001032	0.000855
6	0.0001045	0.000953
7	0.0001064	0.000964
8	0.0001083	0.000982
9	0.0001096	0.000989
10	0.0002018	0.0001023
11	0.0003028	0.0001506
12	0.0005026	0.0002068
13	0.0006139	0.0004392
14	0.0008342	0.0005168



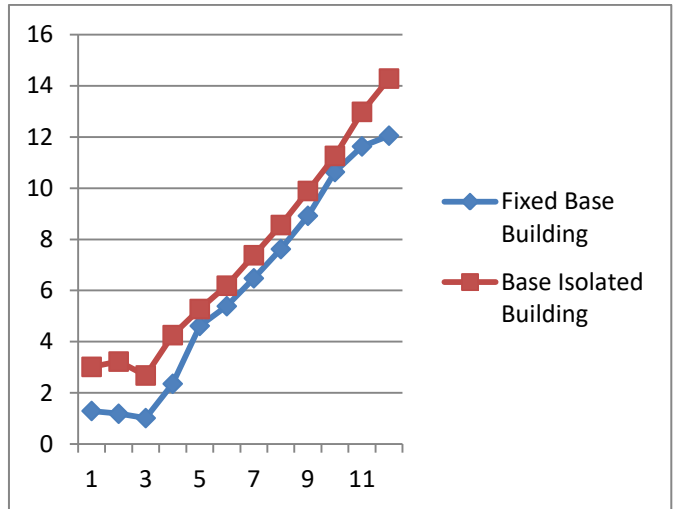
Graph 4: Storey Drift in Y Direction



From the above results it is observed that storey drift decreases in case of Base isolated building when compared to fix base building.

Mode No	Fixed Base Building	Base Isolated Building
1	1.298	3.02
2	1.19	3.227
3	1.02	2.685
4	2.36	4.26
5	4.62	5.28
6	5.39	6.19
7	6.48	7.38
8	7.62	8.56
9	8.92	9.89
10	10.63	11.26
11	11.63	12.98
12	12.05	14.28

Table 10: Time Period



Graph 5: Graph Shows the Time Period

From the above table it is observed that the time period for base isolated building increases by 57% as compared to the time period of fixed base building.

V. CONCLUSION

After observing the results from all the models following can be concluded which are as follows:

- As a result of the increased flexibility of the base isolated system, time period of the structure is increased by 57% compared with the fixed base building.
- The maximum displacement in X and Y direction of the top storey for the base isolated building is reduced by 40% and 43% respectively as compared to the maximum displacement of the top storey of the fixed base building.
- The minimum displacement in X and Y direction of the 7th storey for the base isolated building is reduced by 31.8% and 36.3% respectively as compared to the minimum displacement of the 7th storey of the fixed base building.
- The maximum storey drift in X and Y direction of the top storey for the base isolated building is reduced by 50% and 38% respectively as compared to the maximum displacement of the top storey of the fixed base building.
- The minimum displacement in X and Y direction of the 7th storey for the base isolated building is reduced by 30% and 31% respectively as compared to the 7th storey of the fixed base building.
- From the study, it shows that the building gives better performance by the use of isolators at the base of the building as compared to the fixed base building.
- Hence Base isolation method has proved to be a reliable method of earthquake resistant design.

REFERENCES

1. Hossein Monafared, AyoubShirvani, Sunny Nwaubani (2013) – “Aninvestigation into the Seismic Base Isolation”, International Journal of Civil and Structural Engineering, volume no: 3, no of pages 451-463.
2. Ashish R. Akhare, TejasR.Wakhande (2014) -“Seismic performance of RC Structure Using Different Isolator”, International Journal of Engineering Science and Research, no of pages 724-729.
3. DiaEddinNassani, Mustafa WassefAbdulmajeed (2015) -“Seismic Base Isolation in Reinforced Concrete Structures”, International Journal of Research studies in Science, Engineering and Technology, no of pages 1-13.
4. A RincyM, Er. ShwethaSaju (2015) – “Comparative study of RC Framed Building with Isolator and Dampers”, International Journal of Engineering Research and Technology.
5. IS: 875(part-1) -1987, “Indian Standard Code of Practice for Design Loads (other than earthquake) for Buildings and Structures”, Bureau of Indian Standards, New Delhi, 1987.

6. IS: 875 (part-2) -1987, “Indian Standard Code of Practice for Design Loads (other than earthquake) for Buildings and Structures”, Bureau of Indian Standards, New Delhi, 1987.
7. IS 456: 2000, “Indian Standard Plain and Reinforced Concrete- Code of Practice”, Bureau of Indian Standards, New Delhi, 2000.

BIOGRAPHY



Prof. Girish. H is working as Assistant Professor, Dept. of Civil Engineering in S.G.Balekundri Institute of Technology, Belagavi-590010, Karnataka India



Shubhangi S Bholnekar is B.E Student, Dept. of Civil Engineering in S.G.Balekundri Institute of Technology, Belagavi-590010, Karnataka India



Sudha S Kamble is B.E Student, Dept. of Civil Engineering in S.G.Balekundri Institute of Technology, Belagavi-590010, Karnataka India



Shreyas G Dodamani is B.E Student, Dept. of Civil Engineering in S.G.Balekundri Institute of Technology, Belagavi-590010, Karnataka India



Sujnyani N Biradar is B.E Student, Dept. of Civil Engineering in S.G.Balekundri Institute of Technology, Belagavi-590010, Karnataka India