International Journal of Civil and Structural Engineering Research ISSN 2348-7607 (Online)
Vol. 3, Issue 1, pp: (170-176), Month: April 2015 - September 2015, Available at: www.researchpublish.com

Seismic Analysis of Base Isolated Building in RC Framed Structures

[1]Anusha R Reddy, [2]Dr. V Ramesh

[2]Proffessor and HOD of Civil Engineering Department, East Point College of Engineering and Technology, Bangalore, India

***Abstract*: An earthquake is the shaking of the surface of the Earth, which may be dangerous enough to destroy major buildings and kill thousands of people. To protect the structures from earthquake effects there is a system known as base isolation systems. Base isolation is the technique is most widely accepted and used for seismic protection of the building in earthquake prone areas. The aim of this research is to study the mode period of different structures under fixed condition and base isolated condition. In this study, two building's are considered first structure is G+13 storey building and second is G+5 storey building which is designed and analyzed in E TABS 13.2.1 software. Lead rubber isolator are provided to both the structures and then linear response spectrum and time history analysis are carried out for both fixed base and base isolated buildings under zone v and soil type II i.e. medium soil (according to IS 1893(part 1):2002). After analysis, the mode period, base shear, acceleration and displacement are compared for response spectrum and time history analysis for fixed base and base isolated buildings.**

***Keywords:* Base isolation, response spectrum analysis, time history analysis, lead rubber bearing, E TABS.**

1. INTRODUCTION

The first step in understanding earthquake risk is to dissect the earthquake risk or loss process into its constituent steps. Earthquake risk begins with the occurrence of the earthquake, which results in a number of earthquake hazards**.** The most fundamental of these hazards is faulting, that is, the surface expression of the differential movement of blocks of the Earth's crust. To avoid the consequences of earthquake there is a technique known as base isolation.

Seismic isolation is a simple structural design approach to mitigate or reduce earthquake damage potential. Seismic isolated structures are currently difficult to analyze, design and implement, however, due to complex code requirements. Seismic isolation is an approach to earthquake-resistant design that is based on the concept of reducing the seismic demand rather than increasing the earthquake resistance capacity of the structure. Proper application of this technology leads to better performing structures that will remain essentially elastic during large earthquake.

Base isolation is now a mature technology and is used in many countries, and there are a number of acceptable isolation systems, the construction of which is well understood. Conventionally, seismic design of building structures is based on the concept of increasing the resistance capacity of the structures against earthquakes by employing.

A seismic base isolator is a flexible support of the building, which should fulfil the following requirements:

- ✓ The material is stiff under low service loads like wind and small tremors.
- ✓ Period of vibration of the system is increased sufficiently so as to reduce the seismic force response.
- ✓ It should have the ability to with stand the large displacement and pulse-type base motions from near-fault earthquakes.
- ✓ It should have a parallel damping mechanism such that the relative deflection between the building and the ground is reduced.

1.1 Types of base isolators:

The most common types of base isolators used in buildings are

1. Elastomeric (rubber) bearings.
2. Lead rubber bearing.
3. High damping rubber bearing (HDRB)
4. Friction pendulum system bearing.

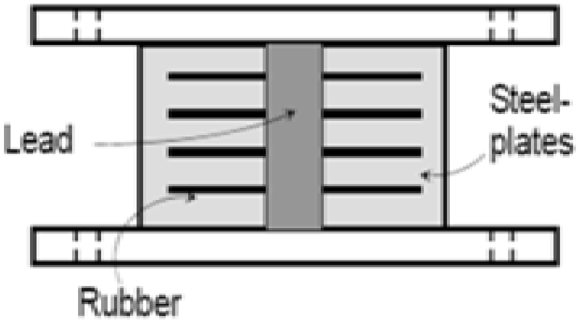

Figure 1. Lead rubber bearing

2. METHODOLOGY

Two 3D RC frames structures in which first building with 3 bay by 3 bay and 14(G+13) storey of dimension 15mx15mx49m and second building with 3 bay by 3 bay and 6(G+5) storey of dimension 15mx15mx21m has been taken for seismic analysis. four building models are considered for comparison

Model 1: fixed base building for G+13 storey's

Model 2: lead rubber isolated building for G+ 13 storeys

Model 3: fixed base building for G+5 storey's

Model 4: lead rubber isolated building for G+ 5 storeys

After modeling of structures in ETABS software, their response is studied under response spectrum and time history analysis.

The parameters considered for G+13 and G+5 storey buildings are as follows:

Beam size = 0.3 m x 0.5 m

Column size = 0.5 m x 0.5 m

Slab thickness = 0.12 m

Live load on the slab = 2.5 kN/m^2

Floor finish = 1.0 kN/m^2

Grade of Concrete = M25

Grade of Steel = Fe415

Yield Strength of Steel, f_y = 415000 kN/m^2

Compressive strength of concrete, f_{ck} = 25000 kN/m^2

International Journal of Civil and Structural Engineering Research ISSN 2348-7607 (Online)
Vol. 3, Issue 1, pp: (170-176), Month: April 2015 - September 2015, Available at: www.researchpublish.com

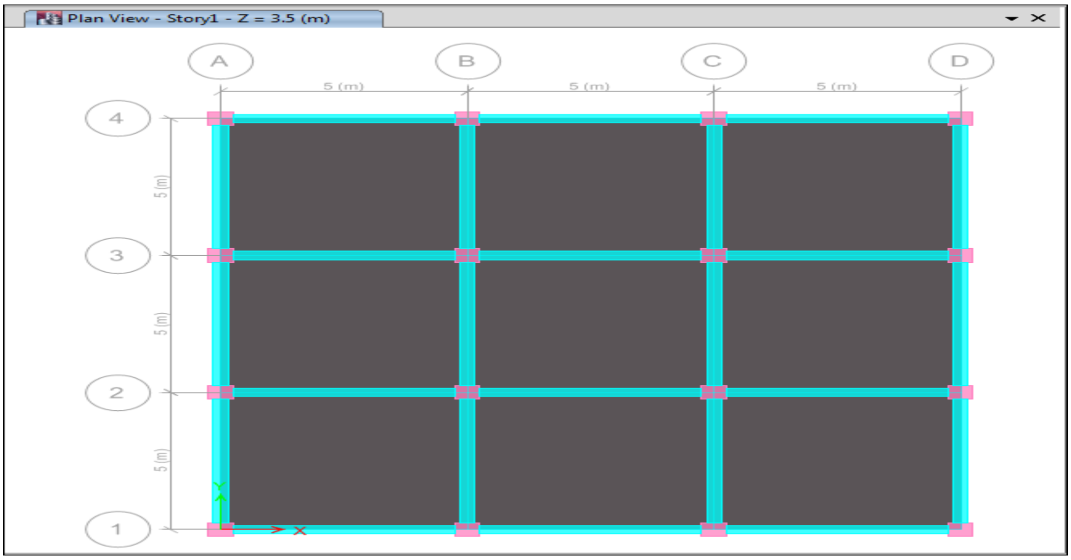

Figure 2: Building plan of G+ 13 storeys with fixed base

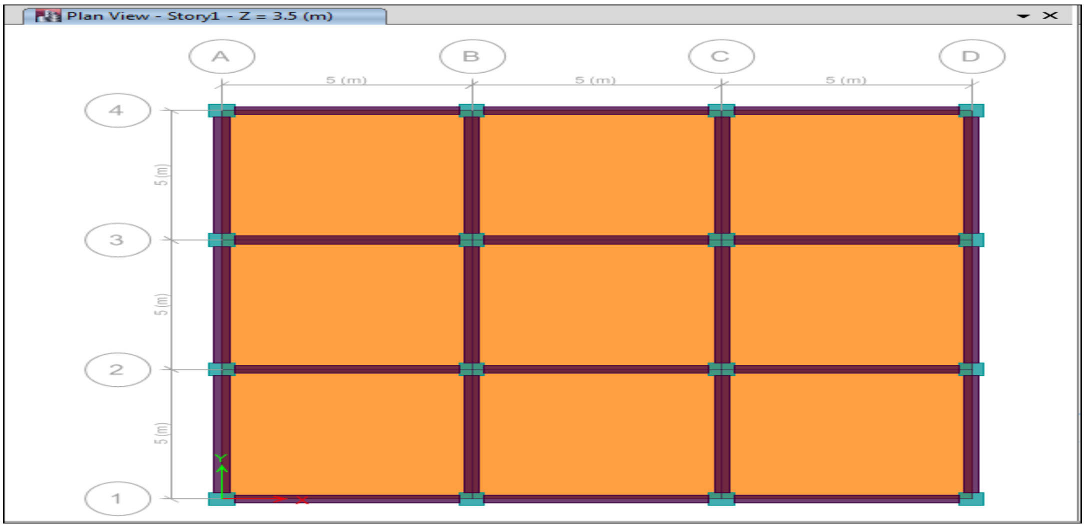

Figure 3: Building plan of G+ 5 storeys with fixed base

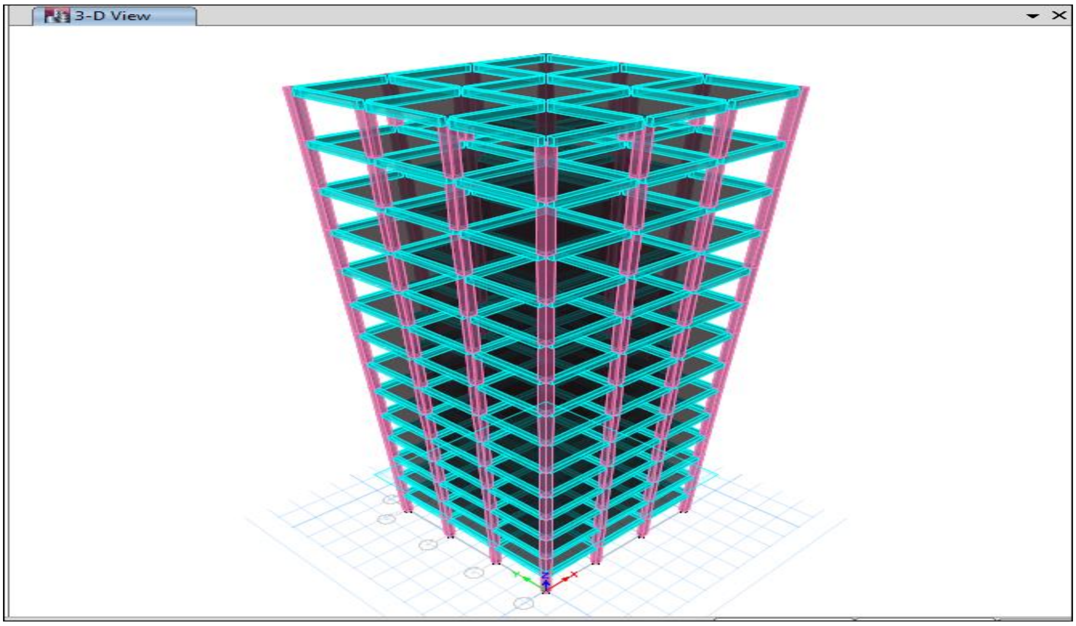

Figure 4: 3D of G+ 13 storeys with fixed base

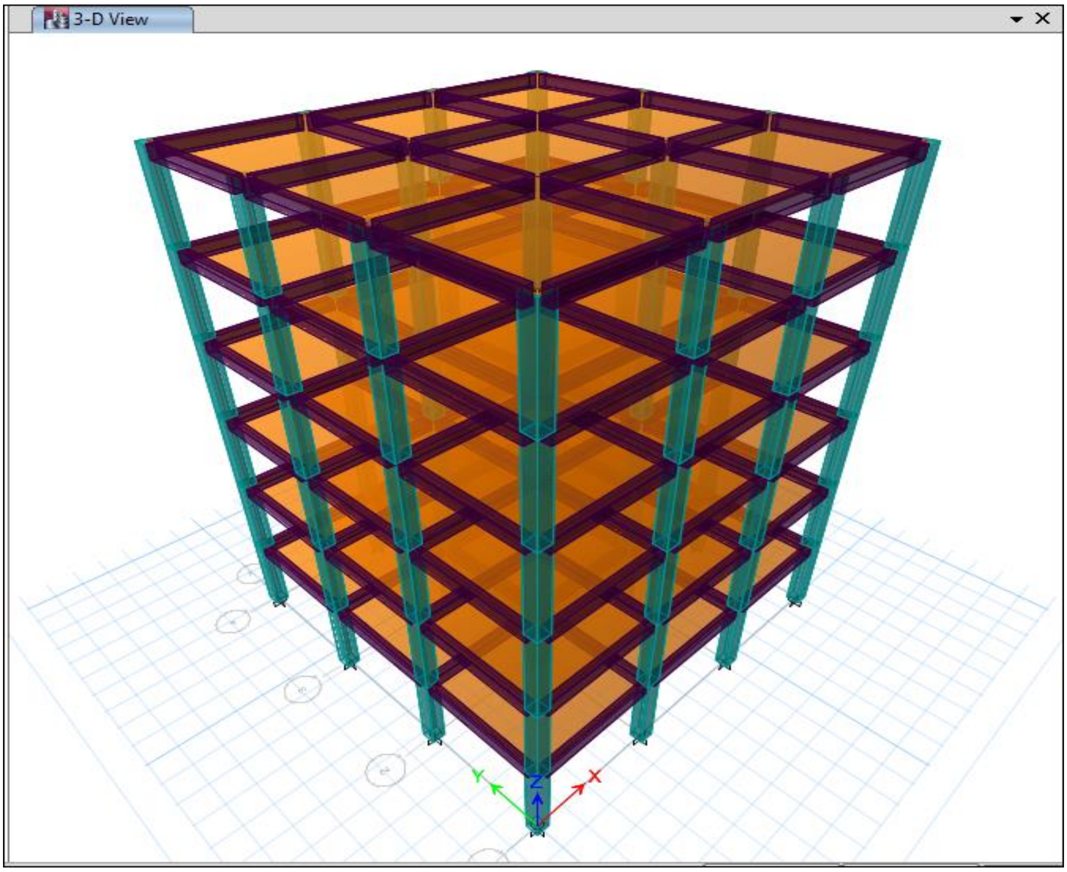

Figure 5: 3D of G+ 5 storeys with fixed base

Building data for G+13 storey building is:

Number of Storey's = 14 Storey (G +13)

Bottom storey = 3.5 m

Other storey's = 3.5 m

Link element = 0.5 m

Building data for G+5 storey building is:

Number of Storey's = 6 Storey (G +5)

Bottom storey = 3.5 m

Other storey's = 3.5 m

Link element = 0.5 m

3. RESULT AND DISCUSSION

1. Mode period:

Table 1. Comparison of mode (time) period for G+13 storey building

Model	Time period(sec) Mode-1 (X-direction)	Time period(sec) Mode-2 (Y-direction)	Time period(sec) Mode-3 (Torsion)
Model- 1	2.146	2.146	1.805
Model- 2	2.667	2.667	2.305

Table 2. Comparison of mode (time) period for G+5 storey building

Model	Time period(sec)Mode-1 (X-direction)	Time period(sec) Mode-2 (Y-direction)	Time period(sec) Mode-3 (Torsion)
Model- 1	0.875	0.875	0.758
Model- 2	1.642	1.642	1.463

The mode period of the structure being 2.146 sec in fixed condition is increased to 2.667 sec after providing base isolator i.e. the time period of G+13 storey building almost increased by 19% after providing lead rubber isolator when compared to fixed base building in both X and Y direction.

The mode period of the structure being 0.875 sec in fixed condition is increased to 1.642 sec after installing lead rubber isolator i.e. the time period of G+5 storey building almost increased by 47 % after providing lead rubber isolator when compared to fixed base building in both X and Y direction.

2. Base shear:

Table 3. Comparison of base shear (kN) for G+13 storey building

Models	Base shear (kN)			
	Response spectrum analysis		Time history analysis	
	X-direction	Y-direction	Y-direction	X-direction
Model-1	760.774	760.774	1219.09	1219.09
Model-2	611.85	611.85	1071.65	1071.65

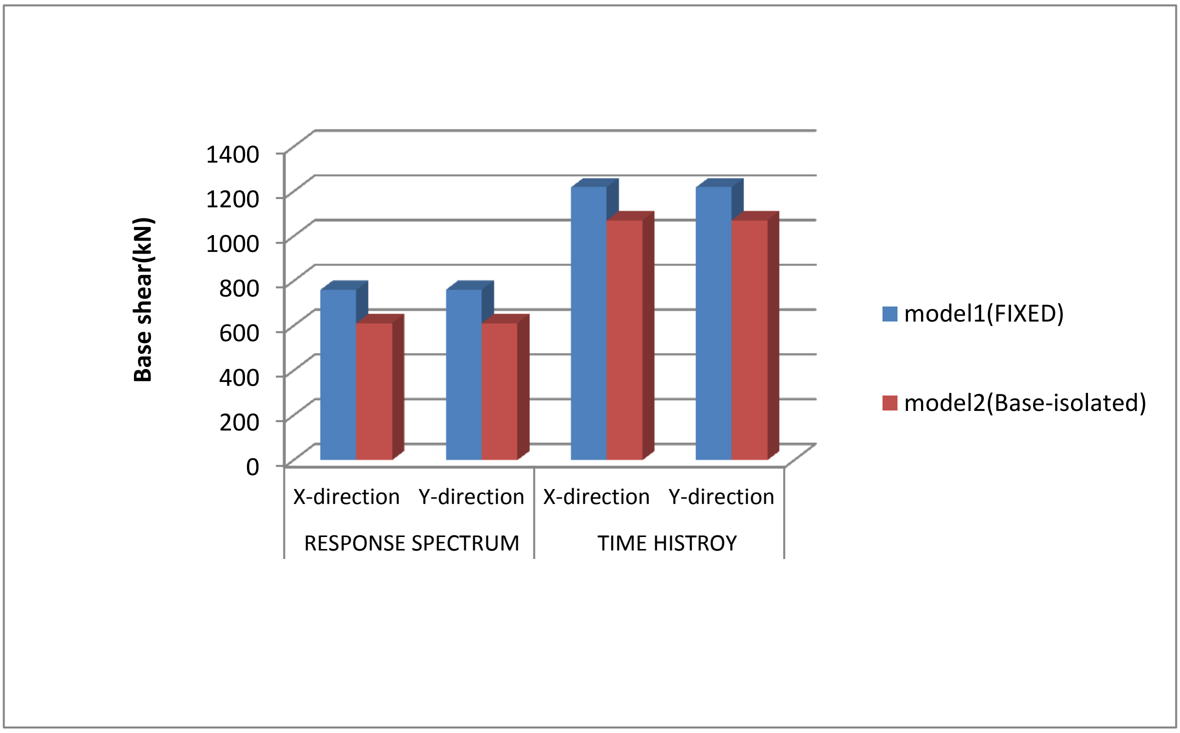

Figure: 6. Variation of base shear (kN) in G+13 storey building

Table: 4. Comparison of base shear (kN) for G+5 storey building

Models	Base shear (kN)			
	Response spectrum analysis		Time history analysis	
	X-direction	Y-direction	Y-direction	X-direction
Model-1	753.81	753.81	2266.32	2266.32
Model-2	392.77	392.77	608.18	608.18

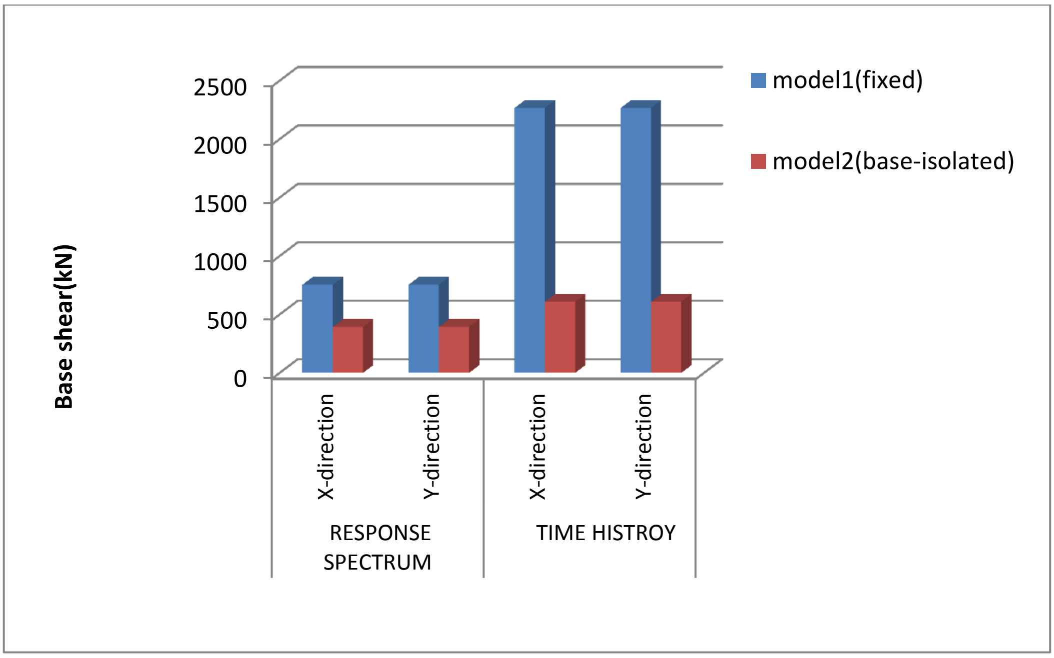

Figure: 7. Variation of base shear (kN) in G+5 storey building

In response spectrum method the base shear obtained in both X and Y direction is 760.774 kN for fixed base building and 611.84 kN for lead rubber isolated building. Thus the bases shear of the building in X and Y direction is reduced by 20% for lead rubber isolator when compared to fixed base.

In time history method the base shear obtained in both X and Y direction is 1219.09 kN for fixed base and 1071.65 kN for rubber isolated building. Thus the base shears of the building in X and Y direction is reduced by 12% for lead rubber isolator when compared to fixed base.

In response spectrum method the base shear obtained in both X and Y direction is 753.81 kN for fixed base building and 392.77 kN for lead rubber isolated building. Thus the base shears of the building in X and Y direction is reduced by 48% for lead rubber isolator when compared to fixed base.

In time history method the base shear obtained in both X and Y direction is 2266.32kN for fixed base building and 608.18 kN for lead rubber isolated building. Thus the base shears of the building in X and Y direction is reduced by 74% for lead rubber isolator when compared to fixed base.

Thus result of base shear is found to be highly reduced when lead rubber bearing is installed, and thus lead rubber bearing are more suitable for multi-storeyed building which are situated in higher zone.

4. CONCLUSION

- After providing rubber base isolator the mode period of structure is increased by 19% and 47% for G+13 and G+5 storey buildings. It is investigated that the mode period is increased after providing rubber isolator due to the flexible property of the isolator.

- For response spectrum analysis the base shear for G+ 13 storeys building in X and Y direction for fixed condition is 760.77 kN and for G+5 storey is 753.81 kN. After providing rubber isolator the base shear for G+13 storey building is 611.85 kN and for G+5 storey is 392.3 kN.

- For time history analysis the base shear for G+ 13 storeys building in X and Y direction for fixed condition is 1219.09 kN and for G+5 storey is 2266.32 kN. After providing rubber isolator the base shear for G+13 storey building is 1071.76 kN and for G+5 storey is 608.18 kN. By proving rubber isolator, the base shear is reduced to an average of 34% in response spectrum analysis and 43% in time history analysis.

- When compared with fixed base structure, the base shear is reduced in base isolated structures, thus the response of building is good in base isolated structures than fixed base structures.

REFERENCES

[1] IS 1893:2002, Indian Standard criteria for earthquake resistant design of structures, General provisions and buildings, Bureau of Indian Standards, New Delhi.

[2] IS 456-2000 Indian Standard Plain and reinforced concrete.

[3] Naeim, F. and Kelly, J.M. (1999). Design of seismic isolated structures: from theory to practice. John Wiley & Sons, Inc., New York.

[4] Kelly JM. "Earthquake Resistant Design with Rubber", Second Edition, Springer-Verlag London Ltd., Great Britain, 1997.

[5] Duggal S. K. (2010), ―Earthquake Resistance Design of Structure‖, Fourth Edition, Oxford University Press, New Delhi.

[6] Uniform Building Code UBC (1997), Chapter 16, Division IV—Earthquake regulations for Seismic-Isolated Structures.

[7] Chandak N. R.," Effect of Base Isolation on the Response of Reinforced Concrete Building", Journal of Civil Engineering Research, pp. 135-142, 2013.

[8] Mr.D.Dhandapany (2014), Comparative Study of and Analysis of Earthquake G+5 Storey Building with RC Shear Wall, Int.J. Engineering Research and Advanced Technology, Vol 2 (3),167-171.

[9] Shirule. P.A, Jagtap.P, Sonawane.K.R, Patil.T, D, Jadwanir N and Sonar. S. K "Time History Analysis of Base Isolated Multi-Storyed Building" , august 2012,p.p-809-816,vol(04)..

[10] A.B.M. Saiful Islam a, Raja Rizwan Hussain b, Mohammed Jameel a, Mohd Zamin Jumaat a "Non-linear time domain analysis of base isolated multi-storey building under site specific bi-directional seismic loading" (2012) 554–566.