

Analysis and Design of G+10 Building by Injecting Base Isolator System in Structure using ETAB 2013 Software

Akshay C.Umare ¹, Priyanka D.Shirawadekar ²

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

P.G. Student, Department of Civil Engineering, S.G.Balekundri College of Engineering, Belagavi, Karnataka, India²

ABSTRACT: The main principle of this project is to protect the buildings by constructing them as earthquake resistant structure; therefore important preventive measures need to be established. Lead rubber isolator is used as base isolator. Project includes (G+10) storey building in which we prepare model providing fixed base using UBC97 and IS 1893 codes, using response spectrum method. By considering the maximum vertical reaction obtained from the fixed base, is used to design above mentioned base isolator. The obtained stiffness used in modelling by replacing the fixed base joints to base isolators. Base reaction, time period, story forces, and displacement are noted down. Both fixed base and base isolator are to be compared and the results are to be noted, we conclude that this type of base isolator are provided for earthquake resistant structure.

KEYWORDS: Base isolator, seismic forces, UBC97 code, Rubber base isolator, ETABS 2013, storey force, storey displacement

I. INTRODUCTION

Base isolation is the process of installing the base isolators in between the super structure and foundation. This is the method of making the structure safe against the seismic forces. Base isolated structures are the one which are constructed using number of base isolators. Usually base isolated structure controls the vibrations generated by the earthquake forces. The idea of base isolation can be explained through an example, where the structure which rests on the friction less rollers. When the earthquake takes place, the ground shakes then the rollers move freely, but the superstructure does not move. Because the seismic forces generated are not transferred to the structure so the above structure does not experience any movement.

If the same building is tested by keeping it on the flexible joints that offers resistance to sideways movements then the force due to earthquake is carried to the building. The force generated by the shaking of ground will be less, if we choose flexible pads of fixed base structure. The base isolation system in general consist of bearing allowing horizontal movement which provides the members proper rigidity under the horizontal loads and controls the displacement. The members which are provided have behaviour of being rigid enough to pass the load vertically as well as horizontally. This helps in changing the period of the base isolation system along with structure above the ground level. It helps in decreasing the inertia forces. When the seismic isolation system is compared with fixed base the displacement of the base isolation system causes big displacements in the super structure. There are different types of base isolators are used in the base isolation system. Which are made of different material and their behaviour vary depending on the material used.

II. METHODOLOGY

Two methods of Structural Analysis may be employed for structural analysis of Base Isolated Buildings to arrive at the Design Lateral Force and the Design Lateral Displacement of the Components of The Isolation System and the Superstructure, are as follows:

- Linear Equivalent Static Single Mode Method, and

• Linear Equivalent Static Multi-Mode Method (or Linear Response Spectrum Method).
 And, Nonlinear Response History Analysis (Nonlinear Time History Analysis) is used for the checking of adequacy of base isolated building design.

- a) Type of structure : Special moment resisting frame
- b) Building type : Residential
- c) Earthquake zone : Belgaum region (zone III)(IS 1893-2000)
- d) Number of storey: G+10
- e) Height of the floor : 3.00m
- f) Live load : 3kN/m²
- g) Soil type : Hard
- h) Damping : 5%
- i) Depth of slab: 150mm
- j) Size of Column : 230mmX 350mm
- k) Size of Beam : 250mmX 300mm
- l) Thickness of wall : 230mm
- m) Grade of Concrete:M35
- n) Grade of Steel: Fe500

III.MODELLING AND ANALYSIS

Planning of G+10 RCC structure using AutoCAD. Software used for analysis and design of structure is ETABS. The analysis carried out by using Response Spectrum Analysis. Structure is modelled, after that loads are applied as per code provisions. Calculation of a Dead load for different members using IS:875(Part I). Calculation of Live load using IS: 875(Part II). For response spectrum analysis method, spectrum used from UBC 1997. Firstly, analysis of fixed support building is done; from that maximum vertical reaction is noted from support reactions results. Once maximum vertical reaction is taken, and then LRB is designed. Properties of LRB are calculated. For base isolation structure, the LRB properties are used as link properties. Then analysis of isolated base structure. Checking behaviour after analysis. Then results are tabulated and represented in terms of table and using graphical representation.

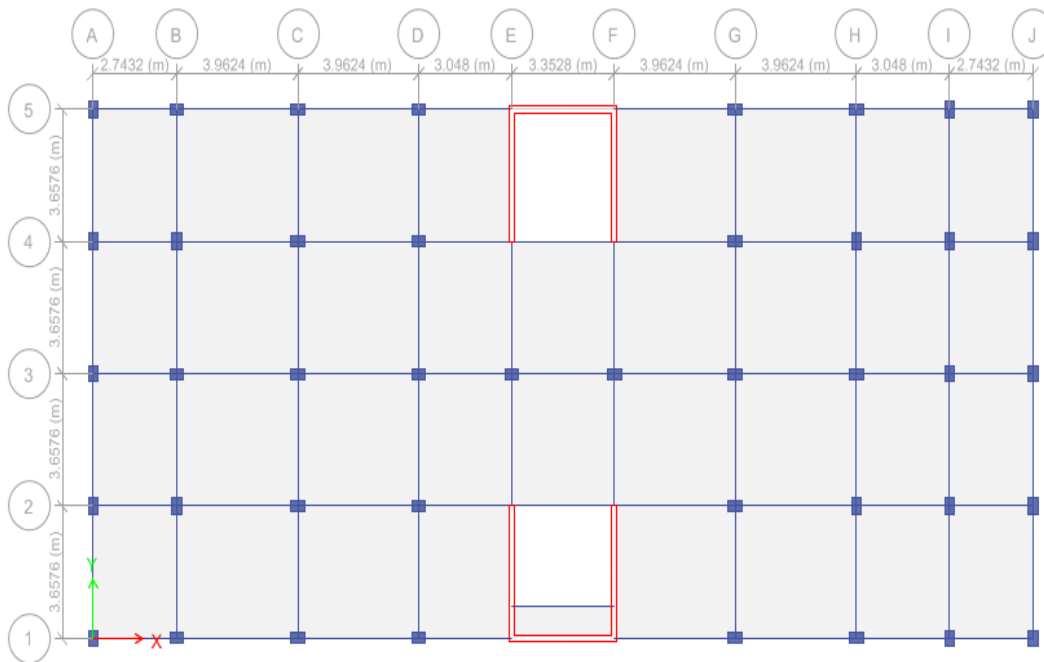


Fig.1 Plan of building(15x31mt)

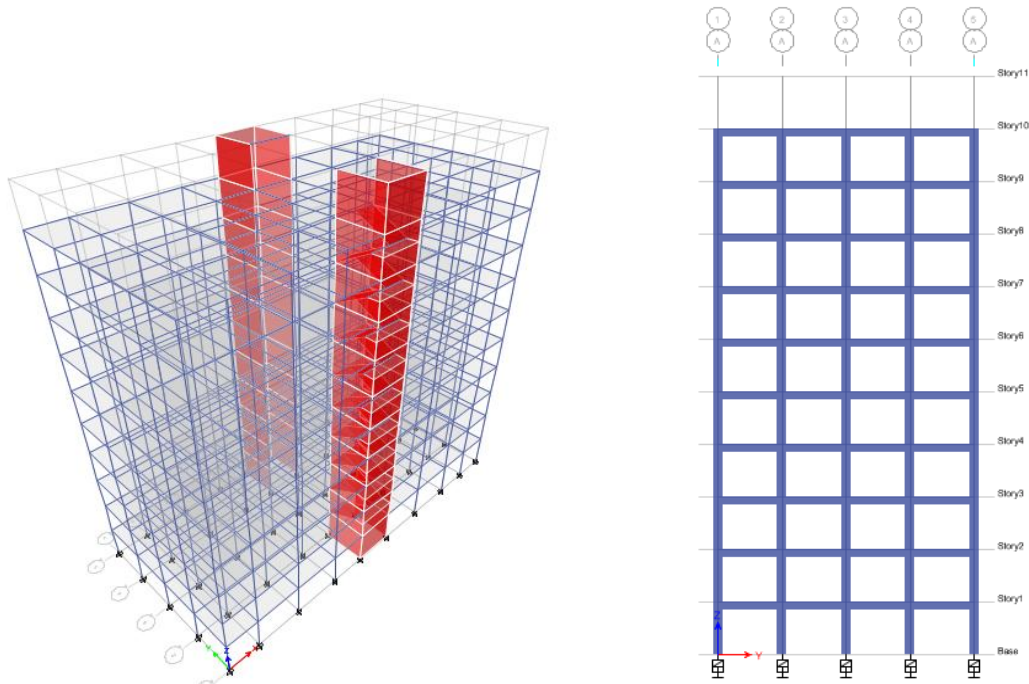


Fig 2. 3-d model and elevation

IV. BASE ISOLATOR DESIGN

For designing the base isolator following data should be input in ETABS

Rotational Inertia1	0.2180	kN/m
For U1 Effective Stiffness	1316191.49	kN/m
For U2 & U3 Effective Stiffness	4013.432	kN-m
For U2 & U3 Efficient Damping	0.05	Percent
For U2 and U3 distance from end-J	0.0032	M
For U2 & U3 Stiffness	36981.77	kN/m
For U2 & U3 Yield Strength	145.203	kN

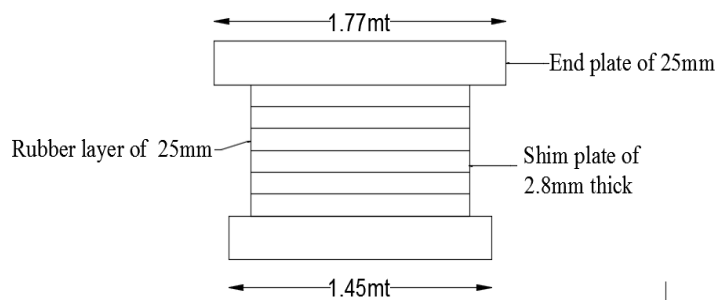
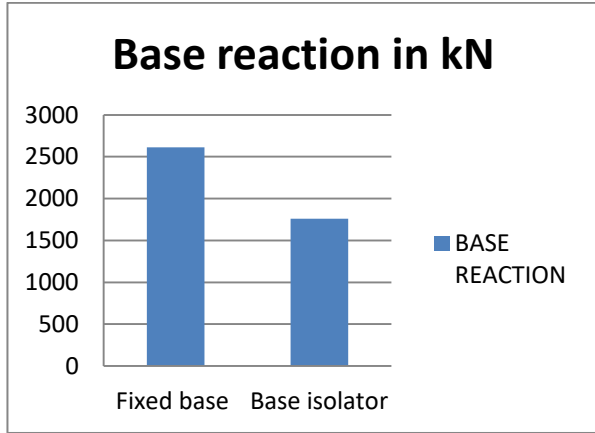


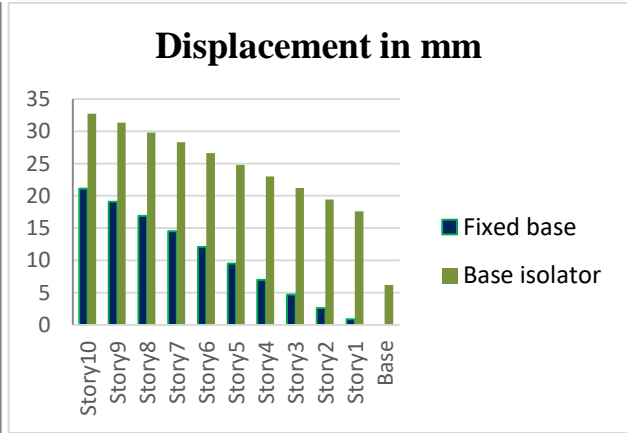
Fig 3. Base isolator



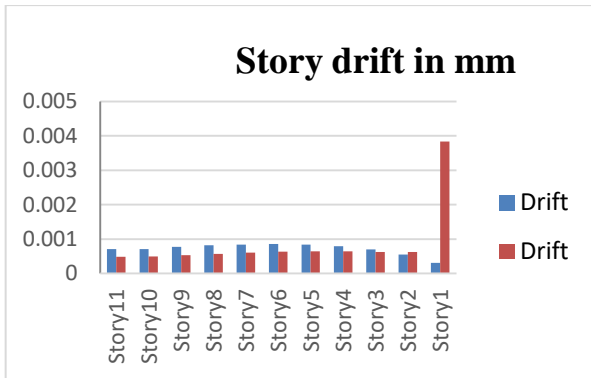
V. RESULTS AND DISCUSSIONS



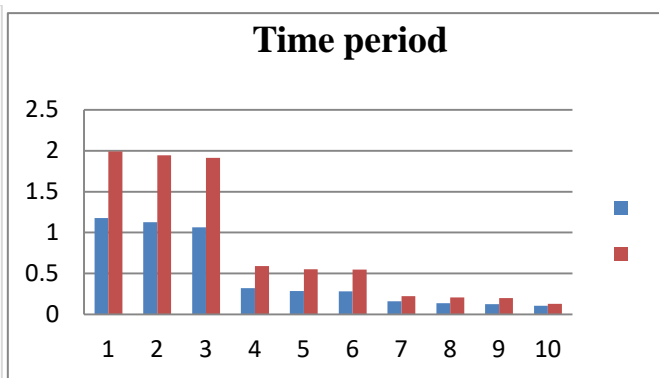
Base shear



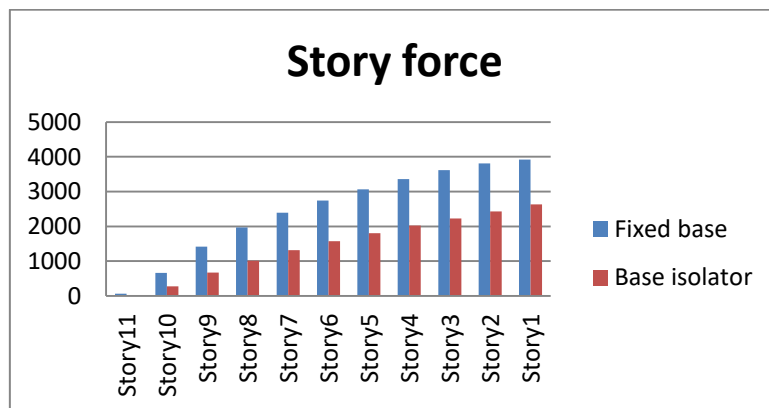
Displacement



Story drifts



Time period



Story force



Base reaction	Fixed base	Base isolator
	2610.5725	1759.0436

BASE REACTION

Story No	Displacement		% difference
	Fixed base	Base isolator	
Story10	21.1	32.7	35.47
Story9	19.1	31.3	38.98
Story8	16.9	29.8	43.29
Story7	14.5	28.3	48.76
Story6	12.1	26.6	54.51
Story5	9.5	24.8	61.69
Story4	7	23	69.57
Story3	4.7	21.2	77.83
Story2	2.6	19.4	86.60
Story1	0.9	17.6	94.89
Base	0	6.2	100.00

Storey displacement

Story No	Drift		% difference
	Fixed base	Base isolator	
Story11	0.000706	0.000486	31.161
Story10	0.000711	0.000489	31.224
Story9	0.000771	0.000531	31.128
Story8	0.000816	0.000571	30.025
Story7	0.000842	0.000605	28.147
Story6	0.000856	0.00063	26.402
Story5	0.000842	0.000641	23.872
Story4	0.000793	0.00064	19.294
Story3	0.0007	0.000626	10.571
Story2	0.000553	0.000619	-11.935
Story1	0.000306	0.003832	92.015

Storey drifts



Mode no	Fixed base	Base isolator	% difference
1	1.176	1.989	40.87
2	1.128	1.945	42.01
3	1.064	1.911	44.32
4	0.32	0.592	45.95
5	0.288	0.553	47.92
6	0.284	0.55	48.36
7	0.161	0.224	28.13
8	0.138	0.208	33.65
9	0.125	0.2	37.50
10	0.106	0.128	17.19

Time period of the fixed base and base isolator

Story	Fixed base	Base isolator	% difference
Story11	61.1936	21.5507	64.78
Story10	660.0515	277.7119	57.92
Story9	1418.4283	670.5014	52.72
Story8	1968.1491	1014.7641	48.44
Story7	2390.7726	1314.256	45.02
Story6	2745.5658	1575.5939	42.61
Story5	3063.5913	1807.7215	40.99
Story4	3354.8827	2020.7862	39.76
Story3	3612.5489	2224.7197	38.41
Story2	3812.4886	2427.7878	36.32
Story1	3915.8588	2631.7203	32.79

Story shear of fixed base and base isolation

VI. CONCLUSION

- **Story base shear of the structure**
 - 32.61% of the base shear is decreased after providing Lead rubber base isolator due to which structure becomes stable during the earthquake.
- **Story drift of the structure**
 - 31.16% of story drift is reduced at the highest floor of the building with base isolator when compared to fixed base model.
- **Displacement of the building**
 - Displacement of structure with base isolator increase up to 35.47% than fixed base when observed at the highest storey.
- **Mode period of the building**
 - Mode period of structure with base isolator at the top floor is increased up to 40.87% when compared with fixed base structure.

- At last it is observed that installing lead rubber base as a base isolation device, it will help in increasing the stability of building against earthquake and reduces reinforcement, thus making structure cost effective.

VI.SCOPE FOR THE FUTURE STUDY

- Base isolator has a high deformation potential allows for large drift on the isolation interface.
- Extension of the structure period and increased damping resulting in a major reduction in the seismic response.
- The analysis can be done by varying the storey height and also by increasing the story number.
- For different type of geometry base isolation system can be adopted.

REFERENCES

- [1] Venkatesh et.al “Dynamic analysis of 11 storey RCC structure by providing lead rubber base isolator “International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056 Volume: 03 Issue: 07 | July-2016.
- [2] Saurabh P. Kharat, Dinesh N. Biradar et.al “Case study on lead rubber bearing isolation” International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 Volume: 05 Issue: 03 | Mar-2018.
- [3]Dr. Prof. Pravat Kumar Parhi,,May “Base Isolation of Residential Building using Lead Rubber Bearing Technique” International Journal of Engineering Research & Technology (IJERT) Published by : www.ijert.org Vol. 7 Issue 05, May-2018.
- [4] Yagnesh kumar Patel,Pradeep Kumar Pandey “Comparison of Fixed Base and Base Isolation Reinforced Concrete Structure for Seismic Response” (April 2017)
- [5] Shri. Ramkrishna V. Darji and Prof. S. P. Purohit“Design of Base Isolator for R.C.C. Building & Performance Evaluation”Conference Paper · January 2006.
- [6] Hossein Shakeri“A Survey study on design procedure of Seismic Base Isolation Systems”J. Appl. Sci. Environ. Manage. Dec, 2012 Vol. 16 (4)299 -307.
- [7] Prof. Ir. R. Bambang Budiono, M.E., Ph.D“Design And Analysis of Base Isolated Structures” Conference Paper · July 2013.
- [8]Md.Wahid Hassan “base isolation structures using lead rubber bearing” conference paper (2013)
- [9] Mr. Aravinthan. K, Dr.Venkatesh Babu. D.L, Dr. Prince Arulraj.G“Design Of Base Isolated Rcc - Framed Structure With Lead Elastomeric Bearing”Australian Journal of Basic and Applied Sciences, (20 June 2015).
- [10]Sarvesh K. Jain et.al “Application of base isolation for flexible buildings” conference paper,in the year (2004)
- [11]IS 1893-2002, Indian standards code book for Earthquake resistant design of structure.
- [12]IS 875 PART 1 and PART 2 Indian standards code book for the dead loads and live load.
- [13] James.M.Kelly and Farzad Naiem, “Design of isolated structures” from university of California.