

SEISMIC PERFORMANCE OF SYMMETRICAL BUILDING WITH & WITHOUT ISOLATORS

Miss. Sushma G.Sawatkar¹, Prof.M.M.Joshi²

¹Student, Dept. Of Civil Engineering, PLITMS Buldana, Maharashtra, India

²Assistant Professor, Dept. of Civil Engineering, PLITMS Buldana, Maharashtra, India

Abstract - Earthquake is one of the nature's greatest hazards, throughout historic time they have caused significant loss of life and severe damage to property, especially to Man-Made Structures. Base Isolation is an effective method for earthquake resistant design to reduce vibration transmitted from ground to the structure. Base isolation, is also known as seismic base isolation or base isolation system, Is one of the most popular means protecting a structure against earthquake forces. It is a collection of Structural elements which should substantially decouple a Superstructure from its substructure resting on a shaking Ground. In this paper, An G+6 Storey building is modeled and analyzed with and without base isolators by using Finite Element Based Software. The main purpose of this work is to study the Dynamic response of the building with fixed base and same building with Base isolation System Such as Lead Rubber Bearing isolator. In this project, the Seismic performances, Shear force, Bending moment and steel Consumptions of the fixed base building and Lead Rubber Base Isolation System is presented.

Key Words: Lead Rubber bearing Isolator (LRB), Analysis, Seismic, SAP 2000, Base Isolator

1. INTRODUCTION

Base isolation is an effective means for protection of structure during earthquake events. The concept of Base isolation is to insert a flexible layer between foundation and superstructure thus decoupling the building from damaging action of ground motion. This results in reduced frequency range and dissipates energy through damping.

In this study an attempt is made to improve the performance of symmetrical and asymmetrical buildings by incorporating lead rubber base isolators at bottom level of columns. for this, symmetrical and asymmetrical buildings models with and without base isolators are considered. The 3D analysis of building is carried out for earthquake zone III. The response spectrum analysis is carried out on all the mathematical 3D models using the software SAP 2000. The results obtain from the analysis are discussed in next sections.

1.1 Seismic Performance of Symmetrical Building with & without Isolators

There are total two symmetrical models under consideration, out of which first model is without isolator i.e. fixed base and in second models, lead rubber base isolator with all properties provided by manufacturer are used at base storey to improve seismic performance of such type of building. For comparison purpose, lateral displacements, storey drifts, base shear, time period, frequencies, maximum forces in columns at bottom are chosen.

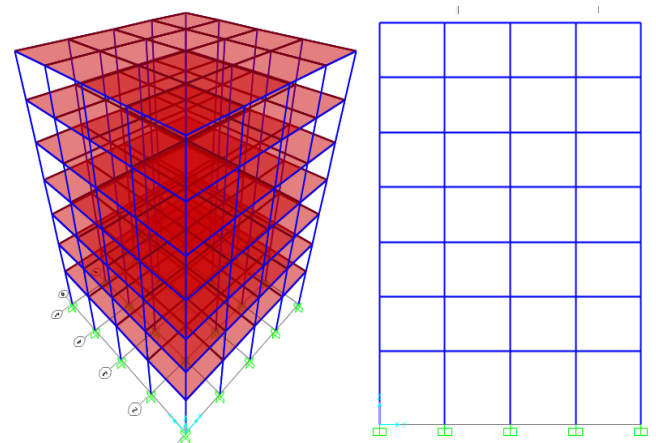


Fig -1: Symmetrical Building without Isolator

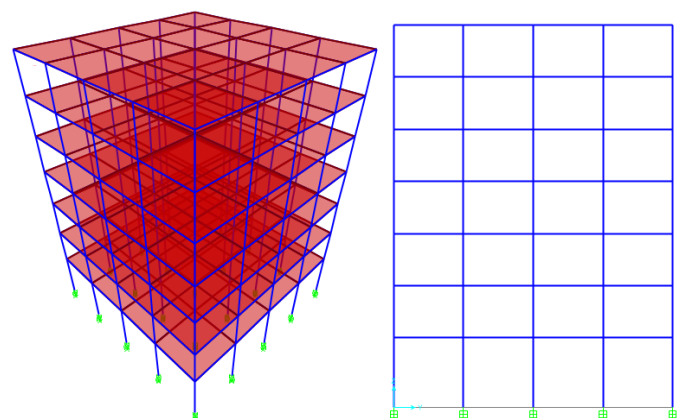


Fig -1: Symmetrical Building with Isolator

2. Comparison of results for symmetrical type buildings

Response spectrum analysis is carried out on all the models. The results are presented in the form of graphs and tables.

2.1 Lateral Displacement

The floor wise lateral displacements are tabulated in table 2.1 for both models i.e. building without isolator and building with isolator. Also a graph is plotted taking floor level as the abscissa and the displacement as the ordinate for both models in both the longitudinal and transverse direction as shown in Chart 1

Table 2.1: Displacement at Floor Levels for Both with and Without Isolator Building (Symmetrical)

Storey	Without Isolator (mm)	With Isolator(mm)
6	15.73	33.90
5	14.90	33.61
4	13.50	33.12
3	11.55	32.41
2	9.12	31.47
1	6.30	30.25
G	3.25	28.47

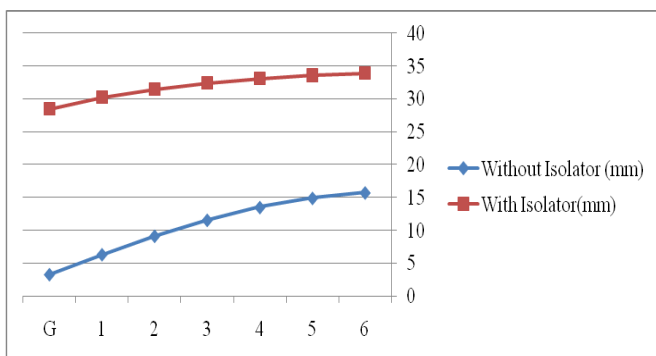


Chart -1: Displacement Profile for Both with and Without Isolator Building (Symmetrical)

From the displacement profile it is observed that there is considerable increase in displacement after incorporation of base isolator as compared to fixed base without isolator building. The maximum displacement at top level is increased 115%.

2.2 Storey Drift

The floor wise storey drift are tabulated in table 2.2 for both models i.e. building without isolator and building with isolator. Also a graph is plotted taking floor level as the abscissa and the drift as the ordinate for both models in both the longitudinal and transverse direction as shown in Chart 2

Table 2.2: Drift at Floor Levels for Both with and Without Isolator Building (Symmetrical)

Storey	Without Isolator (mm)	With Isolator (mm)
6	0.83	0.29
5	1.4	0.49
4	1.95	0.71
3	2.43	0.94
2	2.82	1.22
1	3.05	1.78

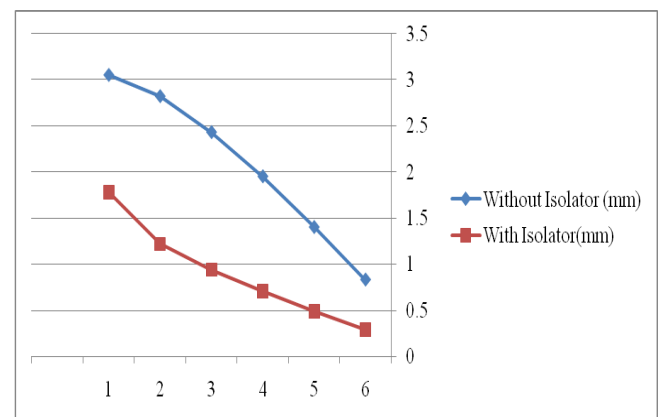


Chart -2: Drift Profile for Both with and Without Isolator Building (Symmetrical)

From the drift profile it is observed that there is sufficient decrement in drift after incorporation of base isolator as compared to fixed base without isolator building which is very beneficial from stability point of view. The drift at all the levels are decreased by 40-65%.

2.3 Base Shear

The base shear for both building models with and without isolator are tabulated in table 2.3 also the graphical representation of the same is shown in Chart 3

Table 5.3: Base Shear for Both with and Without Isolator Building (Symmetrical)

Storey	Without Isolator (kN)	With Isolator (kN)
Base	1050	463.19

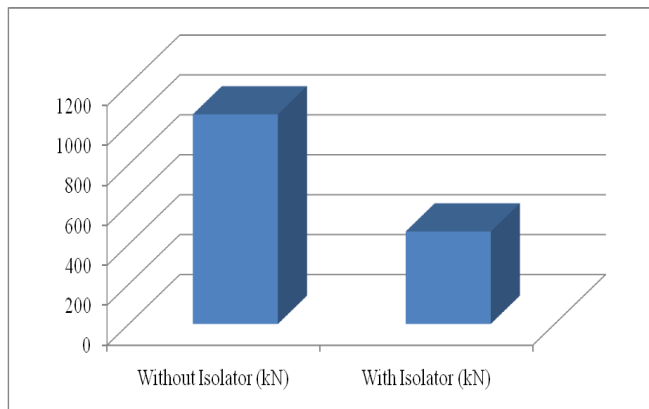


Chart -3: Base Shear for Both with and Without Isolator Building (Symmetrical)

Base shear of the building considerably decreases after incorporation of base isolator which is due to flexible behavior of building. The base shear is decreased by 56% for building with isolator.

2.4 Time Period

The time period for both building models with and without isolator are tabulated in table 2.4 Also a graph is plotted taking modes on the X axis and time period in second on Y axis for both the building models as shown in the Chart 4 below.

Table 5.4: Time Period for Different Modes for Both with and Without Isolator Building (Symmetrical)

Mode	Without Isolator (Sec)	With Isolator (Sec)
1	0.459	2.682
2	0.459	2.682
3	0.430	2.524
4	0.084	0.468
5	0.080	0.468
6	0.080	0.425
7	0.076	0.222
8	0.075	0.222
9	0.075	0.206

10	0.072	0.140
11	0.072	0.140
12	0.071	0.131

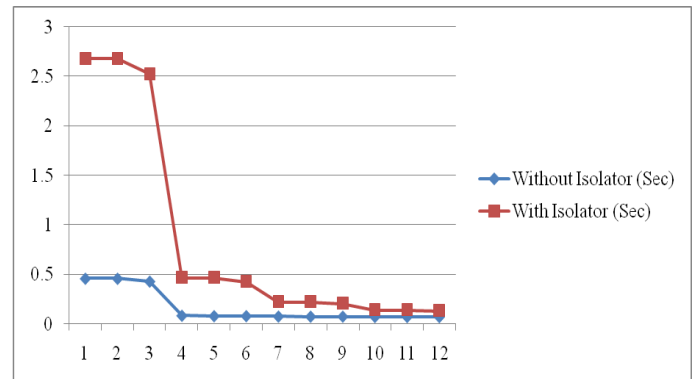


Chart -4: Time Period for Both with and Without Isolator Building (Symmetrical)

It is observed that the time period of vibration is more for building with isolator. The increment is of 484%.

2.5 Frequency

The frequencies for both building models with and without isolator are tabulated in table 2.5 Also a graph is plotted taking modes on the X axis and time period in second on Y axis for both the building models as shown in the Chart 5 below.

Table 5.5: Frequency for Different Modes for Both with and Without Isolator Building (Symmetrical)

Mode	Without Isolator (m/sec)	With Isolator (m/sec)
1	2.1773	0.3729
2	2.1773	0.3729
3	2.3248	0.3963
4	11.861	2.1362
5	12.474	2.1362
6	12.474	2.3539
7	13.106	4.4986
8	13.297	4.4986
9	13.304	4.8486
10	13.955	7.1579
11	13.955	7.1579
12	14.033	7.6190

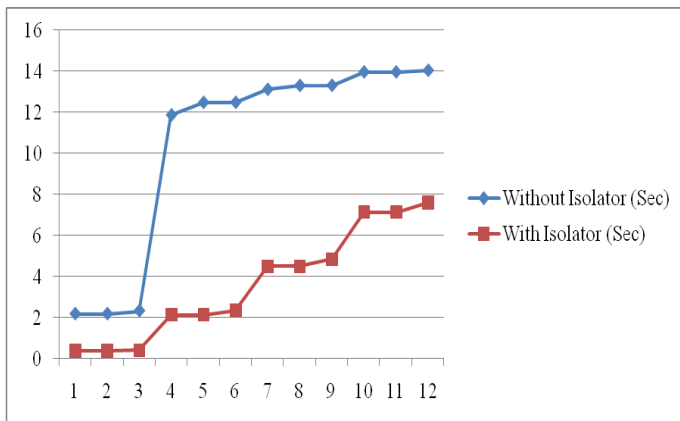


Chart -5: Frequencies for Both with and Without Isolator Building (Symmetrical)

It is observed that the frequency is reduced for building with isolator. The decrement is of 82%.

2.6 Maximum Bending Moment in Columns

The maximum bending moment in column at bottom storey for both building models with and without isolator are tabulated in table 5.6 also the graphical representation of the same is shown in Chart 6

Table 5.6: Maximum Bending Moment in Column at Bottom Storey for Both with and Without Isolator Building (Symmetrical)

Storey	Without Isolator (kNm)	With Isolator (kNm)
G	45.23	18.62

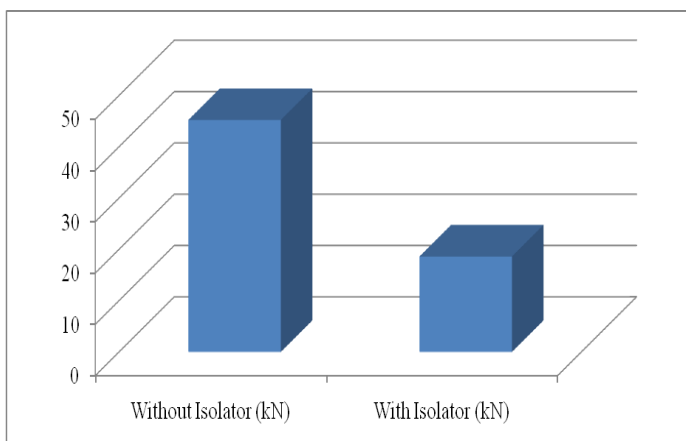


Chart -6: Maximum Bending Moment in Columns at Bottom Storey for Both with and Without Isolator Building (Symmetrical)

Maximum bending moment in bottom storey of the building significantly decreases after incorporation of base isolator which is due to flexible behavior of building. The moment is decreased by 58% for building with isolator.

2.7 Maximum Shear in Columns

The maximum shear in column at bottom storey for both building models with and without isolator are tabulated in table 2.7 also the graphical representation of the same is shown in Chart 7

Table 5.7: Maximum Shear in Column at Bottom Storey for Both with and Without Isolator Building (Symmetrical)

Storey	Without Isolator (kN)	With Isolator (kN)
G	116.87	74.47



Chart -7: Maximum Shear Force in Columns at Bottom Storey for Both with and Without Isolator Building (Symmetrical)

Maximum shear force in bottom storey of the building significantly decreases after incorporation of base isolator which is due to flexible behavior of building. The shear is decreased by 36% for building with isolator.

2.8 Maximum reinforcement in Columns

The maximum reinforcement in column at bottom storey for both building models with and without isolator are tabulated in table 2.8 also the graphical representation of the same is shown in Chart 8

Table 5.8: Maximum Reinforcement in Column at Bottom Storey for Both with and Without Isolator Building (Symmetrical)

Storey	Without Isolator (sq mm.)	With Isolator (sq mm.)
G	2000	2357

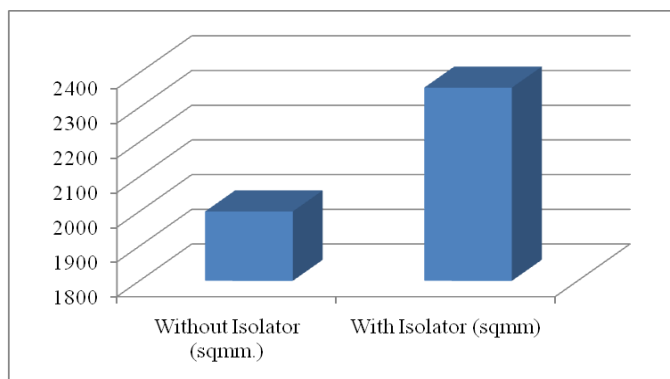


Chart -8: Maximum Reinforcement in Columns at Bottom Storey for Both with and Without Isolator Building (Symmetrical)

Maximum reinforcement in bottom storey of the building slightly increases after incorporation of base isolator which is due to flexible behavior of building. The reinforcement is increased by 17% for building with isolator.

3. CONCLUSIONS

Based on the analysis results following conclusions are drawn;

1. Building becomes more flexible as compared to fixed base building which will improve the performance in earthquake excitation.
2. Base isolation system is the effective one in reducing the structural response as compared to fixed base building.
3. From the analytical results, it is observed that how effective seismic isolation works by considering various aspects such as: base shear, maximum bending moments, & column shears, etc. Analysis results of the study suggest that rubber isolators are better option to improve performance of buildings.
4. Base isolation basically reduces the demand forces by shifting the time period of the structure.
5. Storey drift also reduced from 40% to 65% for both symmetrical and asymmetrical building.
6. The Base isolation considerably increases the lateral displacement. As observed the lateral

displacement at top storey is increased up to 115% for both symmetrical and asymmetrical building as that of fixed one.

7. The Base isolation substantially increases the time period of the building & hence correspondingly reduces the base shear. As observed the time period is being increased by 484% for symmetrical building and 155% for asymmetrical building & base shear is reduced up to 55% for both symmetrical and asymmetrical building of that of fixed one.
8. By considering the bending moment values of columns, it is clearly observed that for isolated case the maximum bending moment is reduced up to 58% as that of fixed case.
9. The shear force values of columns shows that the ground storey columns are reduced up to 36% for isolated frame when compared fixed base building.
10. The reinforcement requirement of columns shows that the ground storey columns are increased up to 17% for isolated frame when compared fixed base building.

REFERENCES

- [1] Satish Nagarajaiah (Journal of Structural Engineering, Vol. 119, No. 10) October, 1993 (Torsion in base-isolated structures with elastomeric isolation systems)
- [2] J. C. Ramallo (JOURNAL OF ENGINEERING MECHANICS) OCTOBER 2002 (Smart" Base Isolation Systems)
- [3] Xi-Yuan Zhou (ISET Journal of Earthquake Technology, Paper No. 436) Vol. 40, No. 2- 4, June-December 2003,(Study on protection measures for seismic isolation rubber bearings , pp. 137-160)
- [4] Khante.S.N, Lavkesh R.Wankhade, ' , International journal of civil and structural engineering) Volume X, No X, 2010 (Study of seismic response of symmetric and asymmetric base isolated building with mass asymmetry in plan)
- [5] A. B. M. Saiful Islam , Mohammed Jameel (International Journal of the Physical Sciences) Vol. 6(11), 4 June, 2011 (Study on corollary of seismic base isolation system on buildings with soft storey, pp. 2654-2661)
- [6] KS Sable, J S Khose, V P Kulkarni (International Journal of Engineering and Innovative Technology ,IJEIT) Volume 1, Issue 4, April 2012 (Comparison of

Different Bearing Types Performance in Multistoried Building).

- [7] S.J.Patil (International Journal of Emerging Technology and Advanced Engineering) ISSN 2250-2459, Volume 2, Issue 7, July 2012 (State Of Art Review - Base Isolation Systems For Structures).
- [8] Shirule Pravin Ashok (International Journal of Civil, Structural, Environmental and Infrastructure Engineering Research and Development) ISSN 2249-6866 Vol.2, Issue 3, Sep2012 (Response spectrum analysis of multi storeyed base-isolated building, 66-75)
- [9] Chauhan Kalpesh M. (International Journal of Advanced Engineering Research and Studies) Vol. II, April-June, 2013 (Excel spreadsheet for design of lead rubber bearing uses for seismic Isolation of bridges, P.P 60-62)
- [10] Ashish R. Akhare, Tejas R.Wankhade (International journal of engineering sciences & research) 3(5) (Seismic Performance of RC Structure Using Different Base Isolator, May, 2014)