SEISMIC RESPONSE OF BASE ISOLATED IRREGULAR BUILDINGS

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Abstract: Base isolation is a technique is used to protect the building structure from earthquake motion. The installation of isolator in building at base level significantly increases the fundamental time period of the structure, which means it reduces the possibility of resonance of the structure giving rise to better seismic performance of the building. Base isolation is a technology to protect different structures like building, water tanks, bridges, airport terminals and nuclear power plants etc. from earthquake motions. The study aims to compare the effectiveness of base isolation in plan irregularity and vertical irregularity building. In the present study a G+15 building is considered and response spectrum analysis is carried out using ETABS software. The study was made with use of IS: 1893(Part 1) and Lead Rubber Bearing (LRB) is used for the base isolation system. The response of the buildings in terms of time period, storey shear, storey drift and storey acceleration are compared between plan irregular and vertical irregular structures**.**

IndexTerms **– Base Isolation, Seismic analysis, Vertical Irregular Buildings**

I. INTRODUCTION

Earthquake is a natural phenomenon caused due to the moment of tectonic plates relative to each other both in magnitude and direction, earthquake cause considerable loss of life and property every year. The seismic base isolation is recent and growing technology it will decouples the structure from horizontal component of ground motion and decreases the possibility of resonance. The decoupling can be achieved by enhancing flexibility of system along with proper decoupling by providing isolator at foundation level. The goal of this system is to decrease floor acceleration and inter storey drift there by avoiding damage and also this system is cost effective. The main Qualities of this system are 1) Reduce the spectral demand by increase in the time period 2) Reduce the isolator displacement by energy dissipation technique 3) adequate stiffness at small displacements to provide sufficient rigidity for service-level environmental loadings.

The concept of base isolation can be explained by considering an example of structure resting on frictionless rollers. When earthquake is occurs it will cause the ground motion, on that time rollers roll freely but super structure will not move hence there is no forces are transmitted to the super structure. When a same structure is provided with adjustable pad it has resistance against seismic forces, then some amount of ground moments transferred to the structure. The forces induced by seismic forces will few times lesser than the building constructed directly on the ground, the fixed base building when proper adjustable rod is chosen, these pads are called base isolators.

The important characteristics of this technology is to introduce the flexibility to the structure, the isolators such as high damping rubber bearing, lead rubber bearing are designed to absorb some amount of energy by introducing damping to the system, it will reduce the earthquake response of the structure. Many brand isolators are available in the market; a proper study is required top pick the suitable type of device for specific structure.

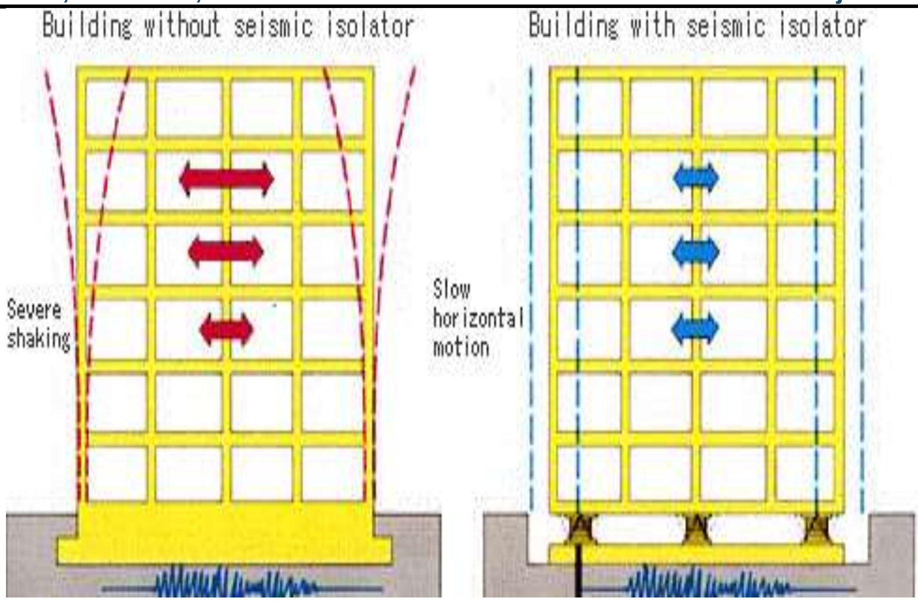

Fig 1. Building without seismic isolator and with seismic isolator

From the earlier literature, It is found that various types of reinforced cement concrete structure with different types of base isolation systems have been studied. It was concluded that the base isolation is the best method to protect the structures from strong earthquake motion. by reducing the storey drift, storey acceleration and storey shear and increases the fundamental time period. The steel consumption reduces by adopting this method when compare to that of conventional method. In the present study an attempt is made to understand the behavior if horizontal and vertical irregular buildings considering base isolation.

II. IRREGULAR BUILDINGS

A regular building generally happens to be an idealized concept since real buildings have numerous discrepancies or variations in mass, stiffness or strength distributions along the height or the planar directions. Multi-storey buildings with complicated geometry and structural systems are common due to various possibilities offered by advanced construction methods. Further buildings constructed are also inherently irregular in nature due to various constraints like the implementation of various architectural schemes, space constraints, functional demands so on and so forth. Various seismic damage surveys and analyses conducted on modes of failure of building structures during past severe earthquakes have concluded that asymmetric buildings are the most vulnerable building structures. The structural configurations of modern asymmetric buildings possess very complex lateral load paths. A building when subjected to lateral loads like wind or earthquakes undergoes damage which is generally initiated at the location of the structural weak planes in the building systems. These weaknesses originate due to the presence of any kind of structural irregularities in stiffness, strength or mass and cause further structural deterioration leading to the collapse of the building. For a building to be classified as symmetric it must possess, a coincident centre of mass and centre of stiffness lying on a common vertical axis, at each floor level. This criterion is rarely achieved in reality and most buildings are unsymmetrical to different extents along the plan, elevation and orientation of structural members or mass distribution on the floors. Major seismic codes classify the structural irregularities into irregularities in plan and elevation, but quite often structural irregularity is present in buildings as a combination.

Basically, there are 2 types of irregularities

a) Plan irregularity
b) Vertical irregularity

Further the plan irregularity is classified into

i. Re- entrant irregularity
ii. Extreme torsional irregularity
iii. Diaphragm discontinuity
iv. Out of plan of offset

Further the vertical irregularity is classified into

i. Geometric irregularity
ii. Mass irregularity
iii. Stiffness irregularity
- Soft storey
- Extreme storey

iv. Discontinuity in capacity

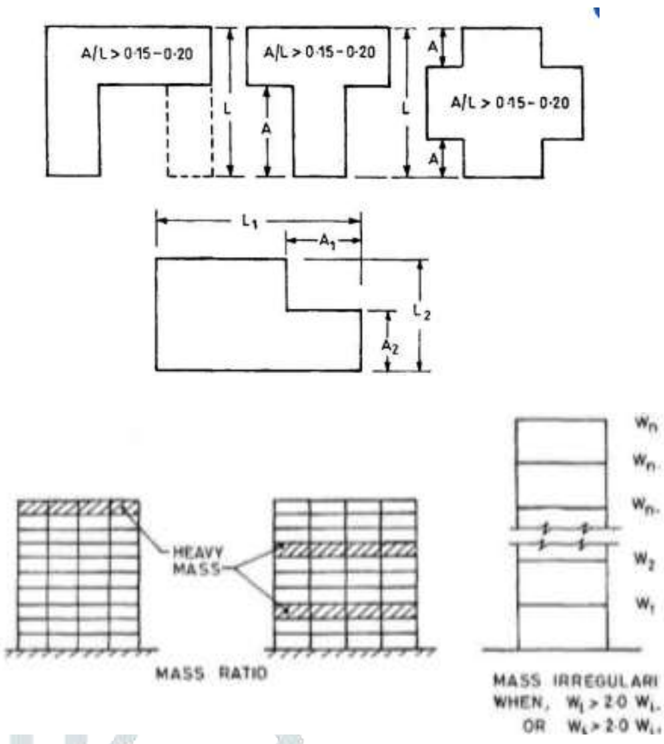

Fig 2. Re- entrant irregularity and Vertical Irregularity

In the present work, re-entrant building plans are considered in case of plan irregularity, geometric, mass and stiffness irregularity are considered in case of vertical irregularity

III. SEISMIC ISOLATORS

Base isolation is one of the most powerful tools of earthquake engineering pertaining to the passive structural vibration control technologies. The isolation can be obtained by the use of various techniques like rubber bearings, friction bearings, ball bearings, spring systems and other means. It is meant to enable a building or non-building structure to survive a potentially devastating seismic impact through a proper initial design or subsequent modifications. In some cases, application of base isolation can raise both a structure's seismic performance and its seismic sustainability considerably. Contrary to popular belief base isolation does not make a building earthquake proof. There are two fundamental sorts of base isolator devices

- Elastomeric Bearing
- Friction Pendulum Bearing System

Elastomeric bridge bearing, also known as a pot bearing or elastomeric bearing, is a commonly used modern bridge bearing. The two major types of elastomeric bearings are Natural and Synthetic Rubber Bearings and Lead Rubber Bearings. In the present study Lead Rubber Bearings (LRB) are used for the analysis.

IV. RESULTS AND DISCUSSION

To understand the behaviour of base isolated irregular buildings under the action of seismic force numerical analysis were carried out considering the different models with plan and vertical irregularity as specified in Table 1.

Table 1. Irregular Models considered for the study

Sl No	Model Name	Shape/type of Irregularity
Pan Irregularity		
1	PI-1	C shape building
2	PI-2	H shape building
3	PI-3	L shape building
4	PI-4	T shape building
Vertical Irregularity		
5	VI-1	Geometric irregularity building
6	VI-2	Stiffness irregularity building
7	VI-3	Mass irregularity building

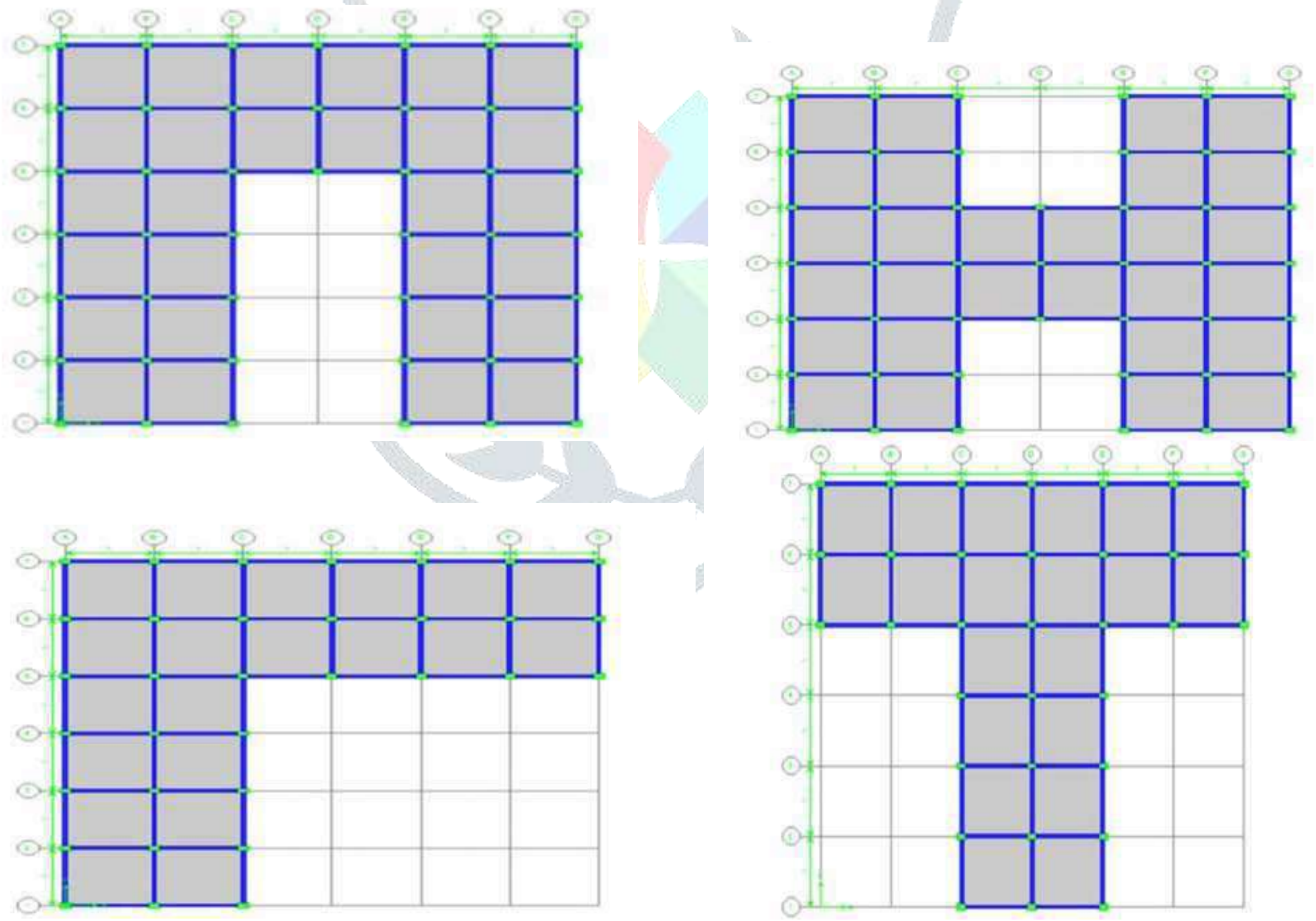

Fig 3. Top View of Plan Irregular Models (PI-1, PI-2, PI-3, PI-4)

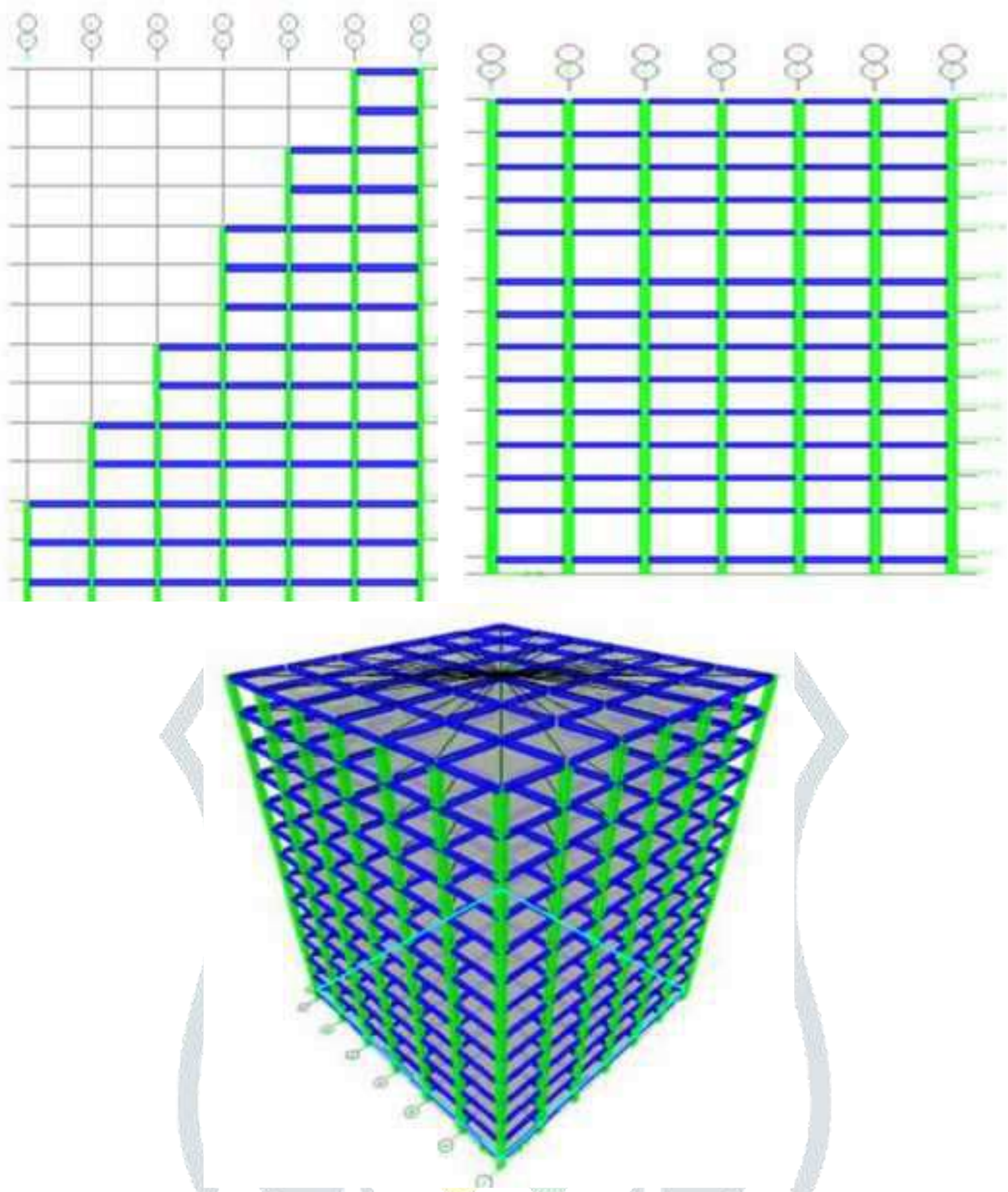

Fig 4 . Elevation and 3D View of Vertical Irregular Models (VI-1, VI-2, VI-3)

The analysis of the base isolated models were carried out by calculating the stiffness of the rubber bearing as per UBC-1997. The stiffness of LRB are tabulated in Table 2.

Table 2. Summary of lead rubber bearing parameter for all models

Models	Required stiffness (KN)	Bearing horizontal stiffness(kN)	Bearing vertical stiffness(kN)	Stiffness ratio	Damping
PI-1	6432.47	1705.97	1942898.45	0.1	0.05
PI-2	6150.31	1629.42	1855780.21	0.1	0.05
PI-3	6082.49	1611.12	1834959.65	0.1	0.05
PI-4	6088.41	1612.64	1836811.85	0.1	0.05
VI-1	5892.23	1559.41	1711087.13	0.1	0.05
VI-2	5857.38	1549.96	1715843.27	0.1	0.05
VI-3	6223.74	1649.32	1878518.39	0.1	0.05

Response spectrum analysis was carried out using ETABS considering Zone V nad medium type of soil. The response of the models in both cases of fixed and isolated base were calculated interms of displacement, accelerationa and storey shear. Typical response of these models are presented

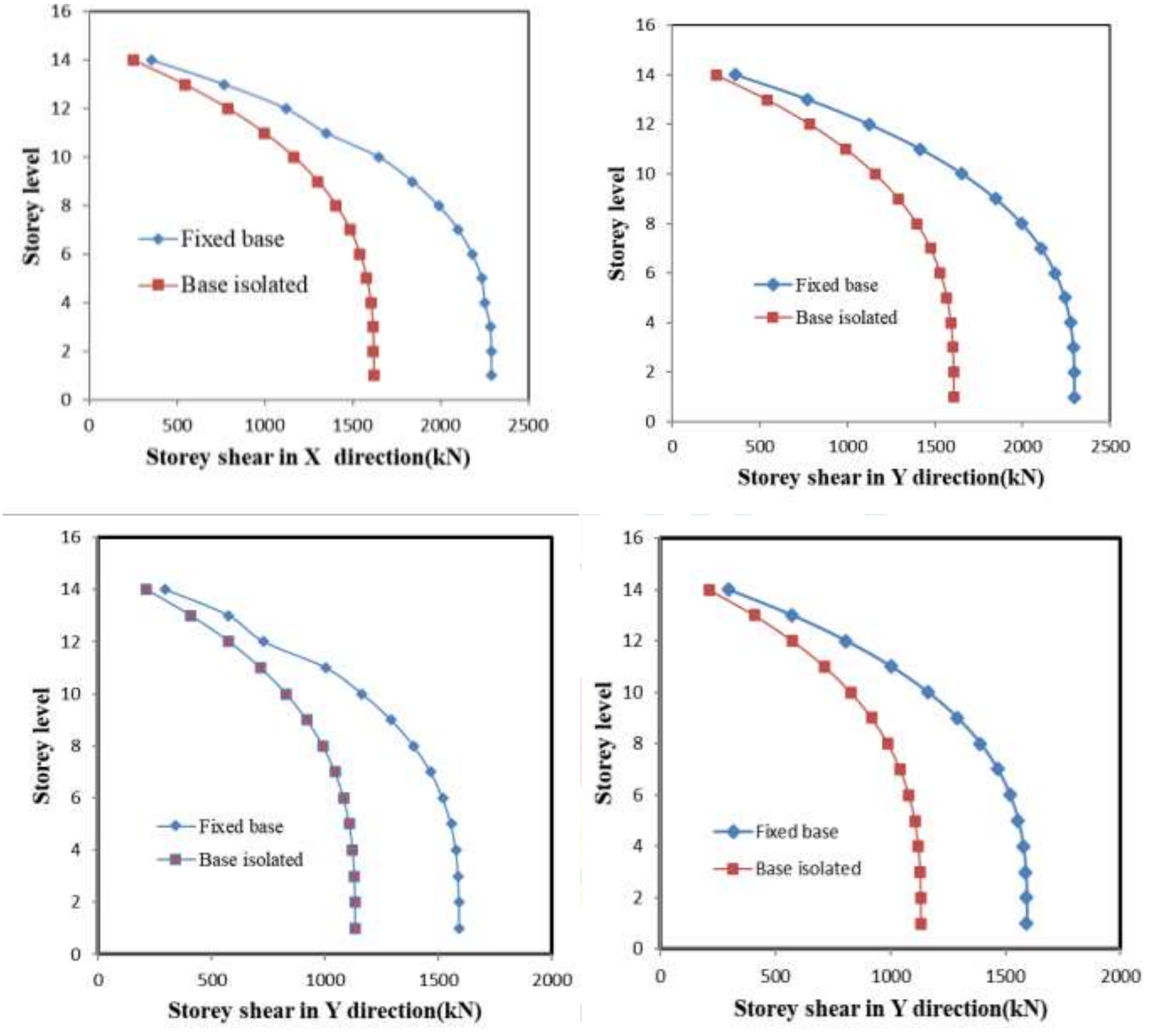

Fig 5. Storey shear of Plan Irregular Models (PI-1, PI-2, PI-3, PI-4)

Table 2. Top Storey Displacement of all Models

Models	Fixed base models displacement(mm)		Base isolated models displacement (mm)	
	Bottom storey	Top storey	Bottom storey	Top storey
PI-1	0	86	103	36
PI-2	0	84	104	31
PI-3	0	83	101	34
PI-4	0	81	98	31
VI-1	0	91	109	37
VI-2	0	81	96	30
VI-3	0	92	102	32

From the results, it is observed that the base isolated structure exhibits more storey displacement when compare to that of fixed base building. Where as the drift has considerable reduced in the case of base isolated buildings. The base shear has reduced in the case of base isolated buildings compared to fixed base condition.

V. SUMMARY AND CONCLUSION

In the present study, an attempt was made to understand the seismic behavior of different irregular buildings with base isolation (LRB). The analysis is carried out by considering plan irregularity and vertical irregularity of a G+12 storey building. In the plan irregularity C, H, L and T shape buildings and in vertical irregularity, geometric, stiffness and mass irregularity are considered. Seismic zone v and soil type II were considered for the analysis. The comparison between fixed base and base isolated models of plan irregularity and vertical irregularity buildings are done. Based on the study, following conclusions are drawn.

- It has been noted that Base shear, storey shear, storey acceleration and storey drift decreases, whereas fundamental time period and lateral displacement increases for base isolated models compare to that of fixed base models. Whereas the storey drift decreases in the case of base isolated buildings.
- In case of plan irregularity model like C, H, L & T, the percentage of decrease in storey shear, storey acceleration & storey shear and also percentage in increase in fundamental time period & lateral displacement is considerably same
- In case of vertical irregularity model like geometric irregularity, stiffness irregularity and mass irregularity, the percentage of decrease in storey shear, storey acceleration & storey shear and also percentage in increase in fundamental time period & lateral displacement is considerably same in stiffness and mass irregularity models but in geometric irregularity model is comparatively high. Hence geometric irregular exhibits better earthquake performance by using lead rubber bearing.
- Finally, from the study it is observed that base isolation is one of the method to design as an earthquake resistant structure.

REFERENCES

1. Manoj U. Deosarkar , S. D. Gowardhan "Seismic Performance of Combined Isolation System for Asymmetric Buildings Using Nonlinear Time History Analysis" International Journal of Innovative Research in Science, Engineering and Technology
2. Vinodkumar Parma, G.S.Hiremath "effect of base isolation in multistoried rc irregular building using time history analysis" ijret: international journal of research in engineering and technology.
3. Swathirani.K.S, Muralidhara.G.B, Santoshkumar.N.B" eatrhquake response of reinforced cocrete multi storey building with base isolation" ijret: international journal of research in engineering and technology.
4. Minal Ashok Somwanshi and Rina N. Pantawane "Seismic Analysis of Fixed Based and Base Isolated Building Structures" International Journal of Multidisciplinary and Current Research
5. Meena Noorzai, M.N.Bajad, Neha Dodal "Study Response of Fixed Base and Isolation Base "International Journal of Innovative Research in Science, Engineering and Technology.
6. B.R Anirudha, "Effect of Combined Isolation System on Low-Rised RC Structure", International Journal of Informative & Futuristic Research (IJIFR) Volume - 3, Issue -2, pp. 538-550, October 2015.
7. Ramallo J. C.,Johnson E. A.,Spencer B.F., Jr.,And Sain M.K, "Semiactive Building Base Isolation", The 1999 American Control Conference, San Diego, California, June 2–4, 1999.
8. Di Sarno, L., Cosenza, E.and Pecce, M.R., "Application Of Base Isolation To A Large Hospital In Naples, Italy,"10 th World Conference on Seismic Isolation, Energy Dissipation and active