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Dynamic Behavior of RC Framed Irregular Building Using Lead Rubber Bearing

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***Abstract* - Base isolation (BI) is a method that has been applied around the world to safe the structures from the disaster effects of earthquake. The establishment of isolator at substructure considerably greater the mode period of building, it minimizes the prospect of vibration giving rise to quality seismic accomplishment of the building. The study is carried out to compare the performance (effectiveness) of base isolation in multistoried RC frame plan irregular and vertical irregular building. A RCC irregular building with 13(G+12) of plan irregular building with fixed and isolated base and 13(G+12) of Vertical irregular building with fixed and isolated base of dimension 33m X 42m and 39.5m height has been taken for seismic analysis. Base isolation effectiveness using Lead Rubber Bearing (LRB) is studied by Time history analysis (THA) method taking Bhuj earthquake data. The design of LRB is done manually. Four models are considered for analysis. The obtained results such as Time period, Base shear have been compared between building with fixed base and building with base isolation.**

Index Terms - **Base isolation, Lead rubber bearing, Time history analysis, Irregular building.**

I. Introduction

Earth quake is one of the natural events that can be easily felt and noticed with the senses. It is defined as movements of earth surface this results creation of large seismic waves due to sudden release of large amount of strain energy in the earth crust. This may leads to destruction of whole cities, loss of life and severe damage to rigid structures, buildings and bridges etc. Based on the survey on past earthquake shows most of the buildings with irregular shape collapsed due to uneven distribution of load compared to building with regular shape and also these buildings are not designed by considering the earthquake loads that's why these buildings are easily vulnerable to collapse. In recent days earthquake loads should be considered will be mandatory and compulsory in the region of earthquake prone areas. Several technologies are also introduced to reduce the seismic activity on buildings, bridges etc. Base isolation is one of the new and growing technologies of this kind.

Base isolation is described as an extensible (flexible) material which is fitted at base to minimize the earthquake forces of any structure. The reason of providing base isolation at the basement level is to minimize the ground movement transferred to the upper structure above the isolator, diminish the response of a conventional structure and the equivalent loading. The buildings are designed to lesser the frequency and magnitude of earthquake shock tolerated to move into the building by providing base isolator between the sub-structure and the super-structure. They implement both energy dissipating and spring features. Figure 1: illustrates the change of behavior incorporating (a) without isolator and (b) with isolator.

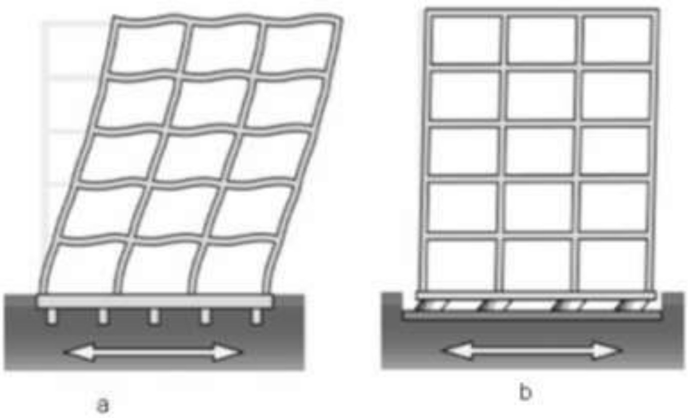

Fig.1: Illustrates the change of behavior incorporating (a) without isolator and (b) with isolator.

Lead rubber bearing (LRB)

The Elastomeric bearing is equipped in to already formed hole by lead plug force, composed the LRB. This lead core provides toughness against serviceability loads and energy absorption under large loads. The internals shrinks is less thick than the upper and lower plate, which are used to place the mounting hardware. For the sake of environmental protection provide the entire LRB is enclosed in a rubber case. During major and minor earthquakes, the plastic deformation of the lead absorbs the energy through hysteric damping.

The first LRB was introduced by New Zealand in 1975 and that has been widely used in Japan, US and New Zealand. The Lead plug was forced in to the steel plates in the bearing deforms the shear. Required amount of damping can be produced by selecting the appropriate size of lead plug and also bearing provides elastic restoring force. Typical diagram of Lead rubber bearing can be shown in Figure 2. With proper durability and reliability performance of LRB is maintained during repeated strong earthquakes.

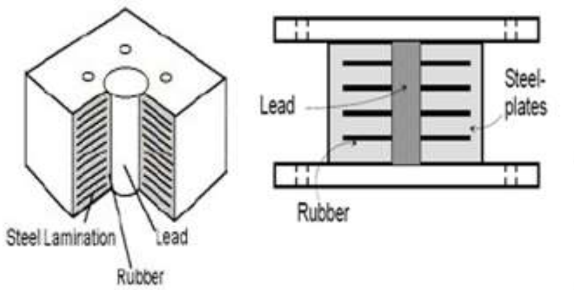

Fig.2: Typical diagram of lead rubber bearing

II. OBJECTIVE OF THE WORK

To compare the response of the building such as Time period and Base shear for 13 storied RC plan and vertical irregular buildings with and without base isolation by considering the time history analysis using Bhuj earthquake data.

III. MODELLING AND ANALYSIS

This study includes modeling and analysis of the models using standard ETABS software. Materials properties and section properties are defined and assigned. Reinforced concrete frame elements are modelled as beam and column element. Slab is modelled as area element. Modal analysis and time history analysis are performed on models.

Description of Building

In present work, 3D RC 13 storied plan irregular and vertical irregular buildings situated in zone IV, are taken for the study. Total 4 buildings have been considered for the comparison.

Models Considered for Analysis

G+12 storied building

Model 1: Plan irregular building

(A) Plan irregular with fixed base (PIFB)

(B) Plan irregular with Isolated base (PIIB)

Model 2: Vertical irregular Building

(A) Vertical irregular with fixed base (VIFB)

(B) Vertical irregular with Isolated base (VIIB)

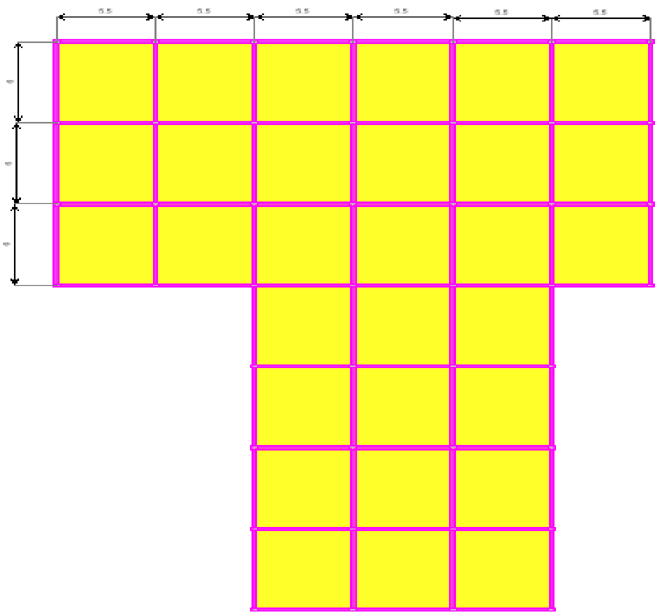

Fig.3: Plan view of Plan irregular building

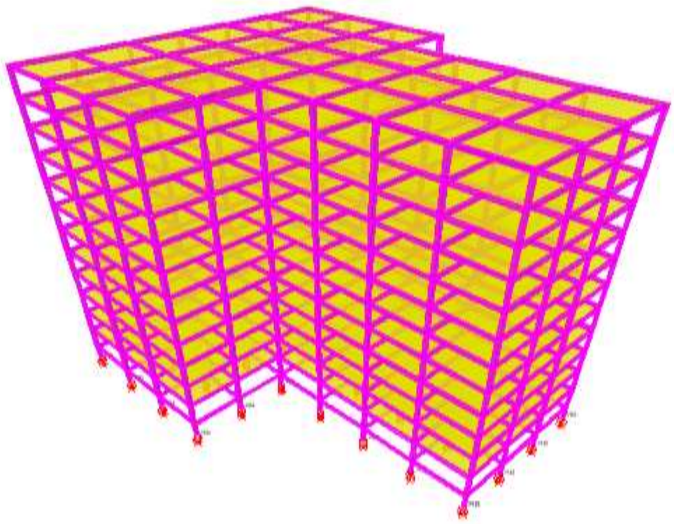

Fig.4: 3D view of plan irregular IB building

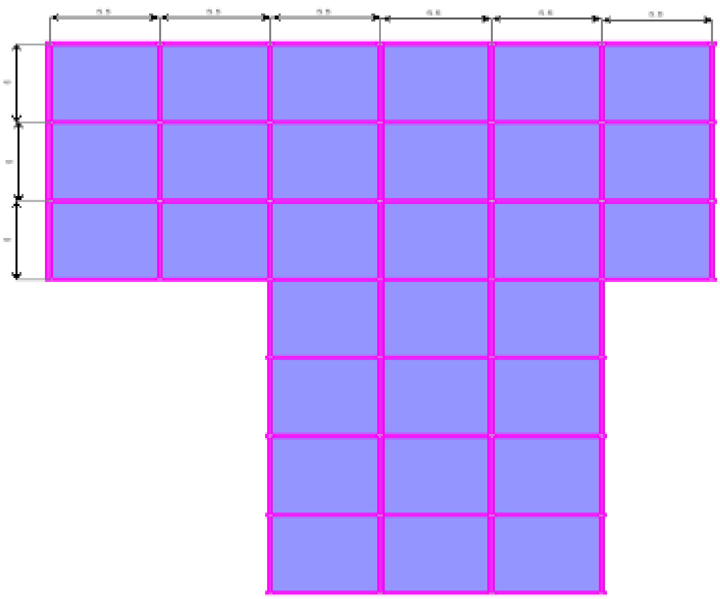

Fig.5: Plan view of vertical irregular building

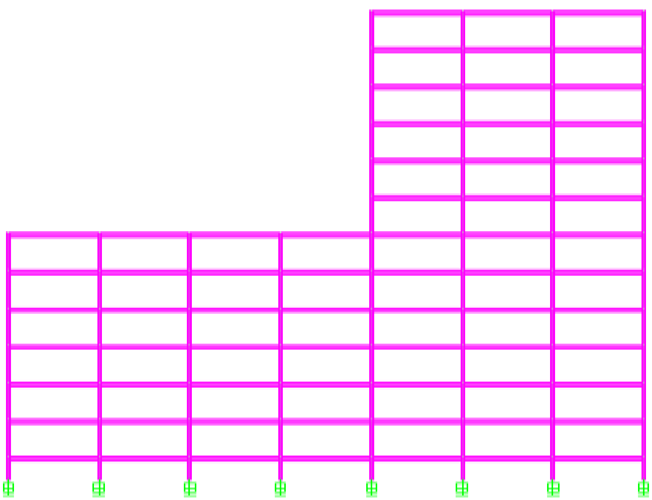

Fig.6: Elevation of vertical irregular IB Building

Description and Modeling of building

TABLE 1: DETAILS OF BUILDING

Structures	RCC(SMRF)
Plan dimension	33m x 42m
Height of building	39.5m
Building type	Commercial building

TABLE 2: MATERIAL PROPERTIES (IS456:2000)

Grade of concrete	M30 kN/m^3
Grade of steel	415 kN/m^3
Concrete density	25kN/m^3

TABLE 3: SECTION PROPERTIES

Beam sizes	230x450mm
Column sizes	300x600mm
Slab thickness	150mm
Link Elements	0.5m

Load consideration

(a) Gravity load:

TABLE 4: SHOWS GRAVITY LOAD

Live load	3 kN/m^{2}oneach floors and 1.5kN/m^{2}on roof.
Floors finish	0.75 kN/m^{2}on all floors

(b) Lateral load

TABLE 5: SHOWS LATERAL LOAD

Type of analysis	Time history analysis
Function name	N 78 E Bhuj earthquake
Local magnitude	7.6
Ground acceleration input	0.1058g
Output times steps	26706
Output time step size	0.005
Duration=26706*0.005	133.53

Properties of LRB used for Analysis

By considering the maximum gravity service load coming on the column at the base of structure, the Lead Rubber Bearing has been designed.

TABLE 6: SUMMARY OF LRB PARAMETERS FOR PLAN IRREGULAR BUILDING

Required stiffness (K_{eff})	4060 KN
Bearing horizontal stiffness(K_b)	1061.72 KN/m
Vertical stiffness(K_v)	977946.43KN/m
Yield force(F_o)	23.52
Stiffness ratio	0.1
Damping	0.05

TABLE 7: SUMMARY OF LRB 1 PARAMETERS FOR VERTICAL IRREGULAR BUILDING

Required stiffness (K_{eff})	5030.32 kN
Bearing horizontal stiffness(K_b)	1325.8 kN/m
Vertical stiffness(K_v)	1368080kN/m
Yield force(F_o)	27.02KN
Stiffness ratio	0.1
Damping	0.05

Similarly the LRB 2 parameters will be calculated for another support reaction of 2610kN obtained in analysis of vertical irregular building. The results obtained is as follows

TABLE 8: SUMMARY OF LRB 2 PARAMETERS FOR VERTICAL IRREGULAR BUILDING

Required stiffness (K_{eff})	2625.85 kN
Bearing horizontal stiffness(K_b)	676.55kN/m
Vertical stiffness(K_v)	477838.115kN/m
Yield force(F_o)	15.21KN
Stiffness ratio	0.1
Damping	0.05

IV. RESULTS AND DISCUSSION

In this study, the comparison of fixed and base isolated building is done. The totally four models are analyzed and the parameters like time period and base shear are compared using Bhuj earthquake data.

Time Period

TABLE 9: TIME PERIOD FOR DIFFERENT MODELS IN MODE 1, MODE 2 AND MODE 3 IN PIFB AND PIIB

Model	**TIME PERIOD**		
	Mode 1 (Y-direction)	**Mode 2 (X-direction)**	**Mode 3 (Torsion)**
PIFB	5.3264	4.1357	4.0267
PIIB	5.8802	4.6966	4.5610

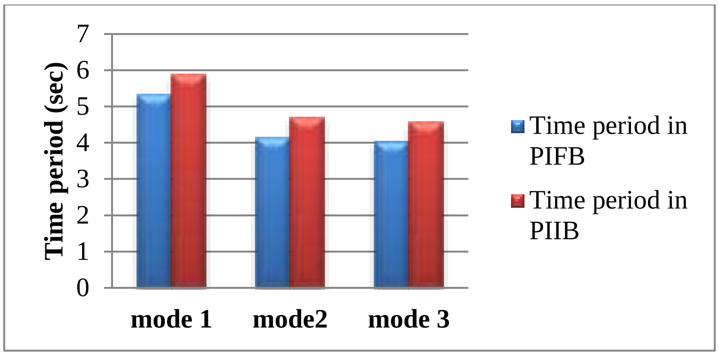

Fig.7: Comparison of Time period in mode 1, mode 2, mode 3 between PIFB and PIIB.

TABLE 10: TIME PERIOD FOR DIFFERENT MODELS IN MODE 1, MODE 2 AND MODE 3IN VIFB AND VIIB

Model	TIME PERIOD		
	Mode 1 (Y-direction)	Mode 2 (X-direction)	Mode 3 (Torsion)
VIFB	4.6417	3.9244	2.9311
VIIB	5.2471	4.5375	3.5755

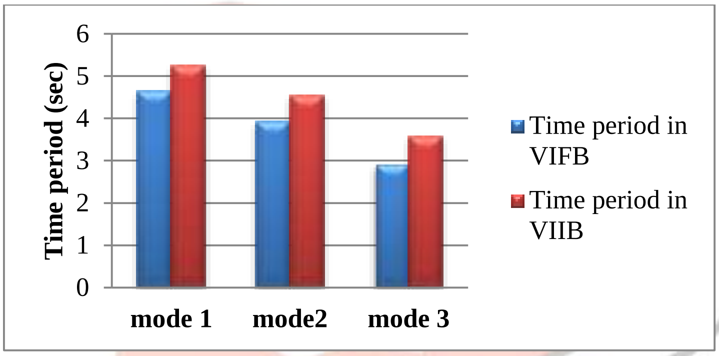

Fig.8: Comparison of Time period in mode 1, mode 2, mode 3 between VIFB and VIIB.

From figure 7 and figure 8 it is observed that, time period decreases with increase in mode number. As result of the increased flexibility of the system, time period of the structure is also increases.

From Figure 7, it is absorbed that, time period in PIIB is increased by 10% in X direction, 9% in Y direction and 13% in torsion compared to PIFB.

From Figure 8, it is absorbed that, time period in PIIB is increased by 13% in X direction, 16% in Y direction and 22% in torsion compared to PIFB.

BASE SHEAR

TABLE 11: COMPARISON OF BASE SHEAR FOR PIFB AND PIIB

Model	Base shear in kN	
	Time History Analysis	
	X-X direction	Y-Y direction
PIFB	7342.51	6245.49
PIIB	5459.77	6244

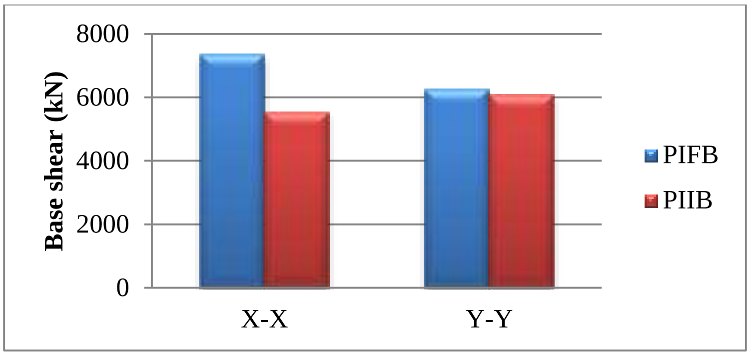

Fig.9: Comparison of Base shear for plan irregular building in both X-X and Y-Y direction between PIFB and PIIB

TABLE 12: VARIATION OF BASE SHEAR FOR VIFB AND VIIB

Model	**Base shear in KN**	
	Time History Analysis	
	X-direction	**Y-direction**
VIFB	9889.32	9817.84
VIIB	6788.16	6552.14

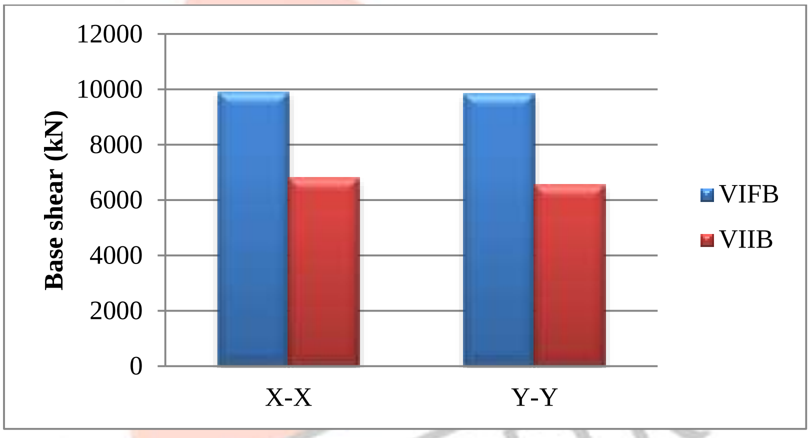

Fig.10: Comparison of Base shear in both X-X and Y-Y direction VIFB and VIIB.

From figure 9 shows that, in X-X direction the base shear in PIIB will found to be diminished by 34% than the PIFB and in Y-Y direction the base shear in PIIB will found to be only 1% less than the PIFB.

Figure10 shows comparison of base shear in both X-X and Y-Y direction between VIFB and VIIB. The graph shows that, in X-X direction base shear in VIIB will be 46% less than VIFB and base shear in VIFB will be 49% greater than VIIB in Y-Y direction.

V. CONCLUSION

In general, it is observed that in both model 1 and model 2 time period will be decreases with increase in mode number. This results increased elasticity (Flexibility) of the structure.

Time period of both models greater by the use of L R B and also helps in low transmission of horizontal force during seismic activity.

It is observed that, in both model 1 and model 2, base shear is found to be higher in fixed base compared to isolated base. This shows the effectiveness of L R B in both plan irregular building and vertical irregular building.

The base isolation has greater efficiency in diminishing the base shear compare to fixed base building.

REFERENCES

[1]. Anand.s.arya, “Concepts and techniques for seismic base isolation for structures”, Earthquake Engineering, Tenth World Conference, 1994, Balkema, Rotterdam, pp. 6639-6648.

[2]. Khante.S.N, Lavkesh.R.Wankhad, “Study of seismic response of symmetric and asymmetric base isolated building with mass asymmetric in plan”, International journal of civil & structural engineering, 2010, Vol.10, pp. 898-909.

[3]. Mr.Sohrabi, S.Etadali, (2011) “Torsional strengthening of base-isolated asymmetric structures by increasing the flexible edge stiffness of isolation system”, International journal of civil & environmental engineering IJCEE-IJEN, Apr-2011, Vol.11, pp. 46-53.

[4]. T. Subramani, J. Jothi, M. Kavitha, (2014) “Earthquake Analysis of Structure by Base Isolation Technique in SAP”, International Journal of Applied Engineering Research, Jun-2014, Vol.04, pp. 296-305.

[5]. Ganga warrier A, Balamonica K, Sathish kumar, Dhanalakshmi, “Study on laminated rubber bearing base isolators for seismic protection of structures”, IJRET: International journal of research in engineering and technology, Feb-2015, Vol.04, pp. 466-476

[6]. Mr.Pavan, D.Tikate, Prof. Dr.S.N.Tande, “Seismic isolation: Earthquake protection of buildings”, JETIR, Feb-2015, Vol.02, pp. 190-196

[7]. Pallavi wamanrao taywade, Madhevi Narayan savale , **“**Sustainability of Structure Using Base Isolation Techniques for Seismic Protection” IJIRSET, Mar-2015, Vol.04, pp. 1215-1288.

[8]. Sameer.s.shaikh, P.B.murnal, “Base Isolation at Different Levels in Building”, Journal of Civil Engineering and Environmental Technology Print, Vol.02, April-June, 2015 pp. 54-58.

[9]. Vinodkumar Parma, G.S.Hiremath, “Effect of base isolation in multistoried rcc irregular building using time history analysis”, International Journal of Applied Engineering Research, Jun- 2015, Vol.04, pp.289-292.