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COMPARATIVE STUDY OF BASE ISOLATION IN MULTISTORIED R.C IRREGULAR BUILDING

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Abstract—*Now a days architects and engineers are required to plan and design the structures , which can withstand against the seismic loads. Therefore it became necessity to provide passive control device "base isolation" to resist large horizontal and vertical load which leads the structure to collapse.Base isolation is one of the promising and widely accepted passive control device to resist these forces by isolating the super structure from the sub structure, in this research paper the response of Base isolated building and fixed base building are evaluated for high rise building having irregularity in plan at Storey level. Response spectrum analysis and time history analysis carried out in terms of Storey Displacement, Base shear, Time period and Storey drift using ETABS software.*

Keywords:-*Base isolation, Irregular building. Time history analysis, Response spectrum analysis, Base shear, Time period, storey drift, storey displacement, Etabs*

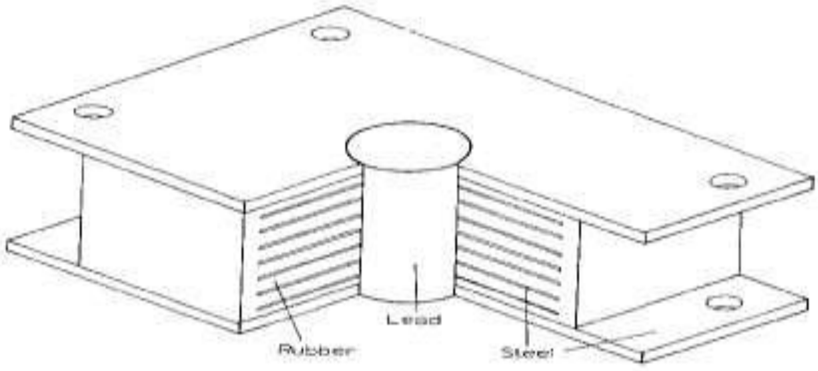
I. INTRODUCTION

An earthquake is a sudden tremor or movement of the earth's crust, which originates naturally at or below the surface. The word natural is very important here, since it excludes shock waves caused by nuclear tests, man-made explosions, etc. The entire world is made up of plates. The junction between the two plates is called as the fault. This fault in the Indian Context is the main boundary fault extending through the terrain region all the way from west along Himachal Pradesh through Uttaranchal, Bihar, Assam to Burma. That plate comes down through Andaman-Nicobar Islands and Bay of Bengal and into Indonesia. As the plate moves, the rocks are subjected to stress, suddenly a fracture develops and this fracture is called as an earthquake.
Many structures constructed with utmost techniques which have undergone severe damages due to Earth quakes lead to enormous loss of life and property. This emerging problem all over the world made engineers to develop innovative systems onEarth Quake Resistant Systems. The major criterion of a structure is to enhance the structural safety economically against severe damages caused due to natural calamities such as Earth quakes. If a building is said to withstand a considerable displacement, without any structural damage and had inbuilt with a suitable elasticity, then the structure is said to be a Ductile one.In this approach less importance is given to non-structural components. Hence because of many uncertainties we develop an alternative approach called **Base Isolation.**
The basic concept in seismic isolation is to protect the structure from the damaging effects of an earthquake by introducing a flexible support isolating the building from the shaking ground. In the literal sense, the structure is separated from its foundations. In practice, a full separation of the structure from its foundations is impossible, as large relative horizontal displacements have to be avoided either during the earthquakes or when other horizontal loads such as wind are present. Hence, the common solution is to use a layer, usually between foundation and superstructure, which is more flexible than the other structural elements and is able to transmit the vertical load when undergoing lateral displacements without critical damages.
The low stiffness bearings and damper between foundation and superstructure is introducing by base isolation. This in the reduction of inertial forces and accelerations several times. Again and again Base isolation has been proposed for at least a century. Kawai in 1891, proposed a base isolated structure with timber logs placed in several layers in the longitudinal and transverse direction (Jurkovski, 1995). Variety of dampers but due to one reason or other none could be used as frequent as the isolation system comprising of elastomeric laminated rubber bearings. Earlier the elastomeric bearings were made up of natural rubber, which possess very low energy dissipating capacity resulting in unacceptably high displacements at isolation level.

A. *TYPES OF BASE ISOLATORS:-*

a) *Lead rubber bearing*
b) *High damping rubber bearing*
c) *Friction pedulum system*

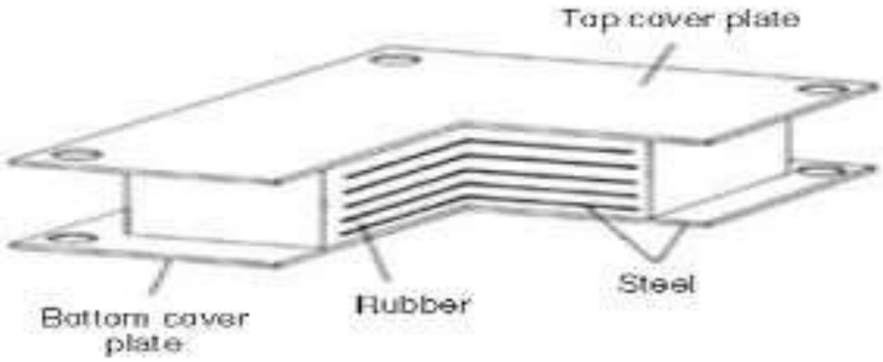
Lead rubber bearing



1.1 Lead Rubber Bearing

Lead Core Rubber Bearings (LRB) contains laminated rubber and steel bearing with steel flange plates for supporting the structure. Ninety percent of our isolators have an energy dissipating central portion. The rubber in the isolator works as a spring. It is very soft laterally but very stiff vertically. The high vertical stiffness is achieved by having thin layers of rubber reinforced by steel covers. These two characteristics allow the isolator to move laterally with relatively low stiffness yet carry remarkable axial load due to their high vertical stiffness. The lead core provides damping by deforming plastically

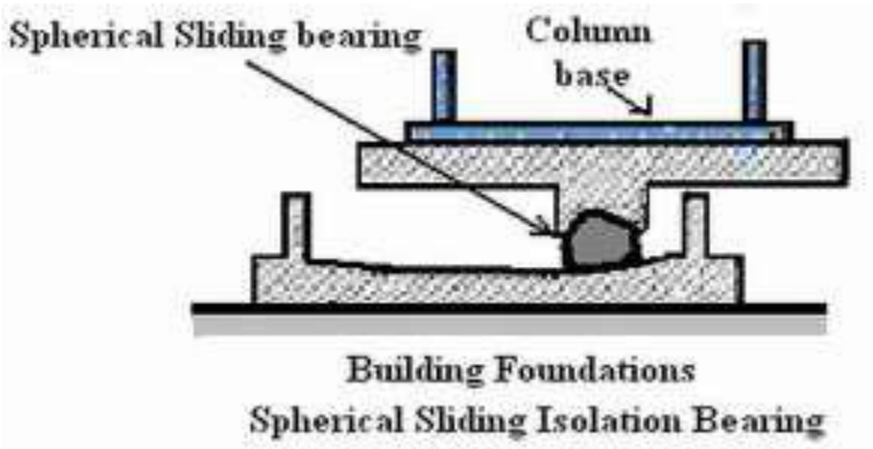
High damping rubber bearing



1.2 High Damping Rubber Bearing

HDRB is one type of elastomeric bearing. This type of bearing consist of thin layers of high damping rubber and steelplates built in alternate layers as shown in Figure Horizontal stiffness of the bearing is controlled by the low shear modulus while steel plates provides high vertical stiffness as well as prevent swell of rubber. High damping rubber bearing provides damping in the range of 10% to 20%.

friction pendullum system



1.3 Friction Pendulum System

The FPS consists of a round stainless steel surface and a slider, covered by a Teflon-based composite material. During severe ground motion, the slider moves on the spherical surface lifting the structure and dissipating energy by friction between the spherical surface and the slider. This isolator uses its surface curvature to generate the restoring force from the pendulum action of the weight of the structure on the FPS.

II. LITERATURE REVIEW

A. Seismic Analysis of Fixed Base and Base Isolated RC Buildings Having Diaphragm Discontinuity;Indian Journal Of Research In Engineerin And Technology: 1966 – 1970, 2017.

Dona Meriya chacko,Akhil Eliyas:-In this paper,The building having irregular opening L shaped opening at the centre is more vulnerable to earthquake than rest of the models considered. It is found that when placing lead rubber bearing (LRB) as an isolator in building which is more vulnerable to earthquake, displacement is increased drastically in comparison with fixed base building due to the presence of isolators in between foundation and superstructure.

The Fixed base building have zero displacement at base of building whereas, all base isolated building models shows increase in amount of storey displacements at base.It is found that the time period is increased in base isolated building due to the presence of flexible interface.

The Base shear is also reduced by 40 % after providing LRB in G+4 storey building which makes structure stable during earthquake when compared to fixed base building. In Base isolated building story drift is reduced by 60 % at the top storey when compared to fixed base building by the use of LRB as an isolator. Hence the damages for structural and non structural elements are greatly reduced.From the study it shows that, the buildings having diaphragm discontinuity gives better performance by the use of isolators as compared to fixed base building for regions having severe seismicity.

B. Seismic Analysis Of Fixed Base And Base Isolated Building Structures;International Journal of Advanced Technology In Engineering And Science,volume-4,issue-8,277-288,2016G.Mounika,Dr.,B.L.Agarwal:-The building having irregular opening (L shaped opening at the centre, Type 4 is more vulnerable to earthquake than rest of the models considered. It is found that when placing lead rubber bearing (LRB) as an isolator in building which is more vulnerable to earthquake, displacement is increased drastically in comparison with fixed base building due to the presence of isolators in between foundation and superstructure.

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C. Seismic Performance of RC Structure Using Different Base Isolator; International Journal Of Engineering Sciences&Research,volume-3,issue-5,724-729,2014. Ashish R. Akhar, Tejas R.Wankhade:-Base isolation method has proved to be a reliable method of earthquake resistantdesign.The results of the research shows that the response of the structure can be reduced by the use of High Density Rubber Bearing (HDRB) and Friction Pendulum System (FPS) isolators.

The base shear in X-direction is reduced by70% in HDRB & it is reduced by 94% by the use of FPS. Also in Y-direction it is reduced by 71% in HDRB & in FPS it is reduced by 85%. Time period of both the base isolated structures i.e. HDRB and FPS increases as compared to the fixed base structure. The storey displacement is more in both directions, in both the cases of base isolated structure using HDRB & FPS. Results shows that storey drift both in X & Y directions considerably reduced by using base isolation devices over the conventional structure. Results shows that storey acceleration both in X & Y directions considerably reduced by using base isolation devices over the conventional structure.

D. Earthquake Performance of RCC Frame Structure using different Types of Bracings with LRB Isolation Technique;International Research Journal of Engineering and Technology,2715-2721,Volume-4, No-6, 2017 Praveen J V, Govardhan B R, Naveen K:-In this dissertation work an attempt has been made to check the performance of RC frame building with and without Bracings under fixed base and isolated base for medium soil conditions for seismic zone V. static and dynamic analysis is carried out to compare the results.

Totally 8 different models of 20 storey are considered for the analysis. The analysis results are tabulated and compared. Following are the major conclusions drawn from those results , in which Storey displacement is increased for the isolated base models compared to fixed base Storey drift is reduced for the isolated base models compared to fixed base Structural response of the building is reduced in isolated base models compare to fixed base models.

Mode period increases in Lead Rubber Bearings (LRB) when compared with fixed base building. Because, flexibility is more in Lead Rubber Bearing compared to fixed base.Building without Bracings, mode period is less when compared to building with Bracings. Because mass participates less in without Bracings when compared to with Bracing building.Even storey acceleration also reduced for the base isolated structures.

It is observed that the performance of building with base isolation technique is much better than fixed base one. The parameters such as displacement and drift have been analyzed. Hence it is seen that displacement is higher in base isolation when compared to fixed base. The main factor governing the building is its storey drift. The study shows that drift is very much reduced in base isolation.

Plan size	l24 x 24 m
No.lof bays in X direction	4
No.lof bays in Y direction	4
Storey height	13m
Beam size	l600 X 800 mm
Column size	l400 X 500 mm
Slab thickness:	150mm
Bracing	ISMB 200

.

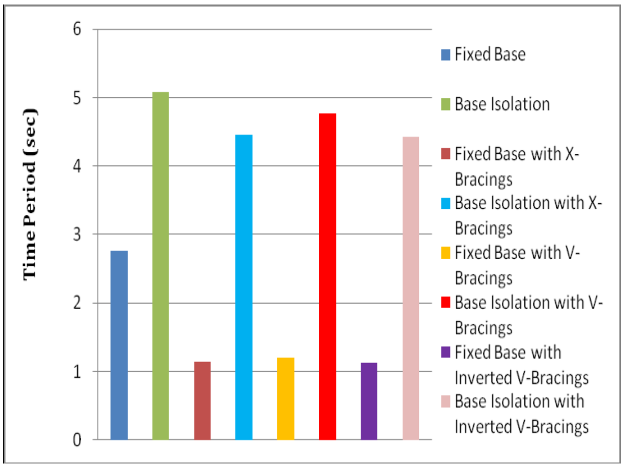
Table 1 Building Properties

Calculated Time period T	1.62 s
Earthquake Zone	V
Soil Type	: II (Medium soil)
Importance factor	I: 1
Reduction factor R	5
Damping ratio	5%

Table 2 Earthquake Load Data

Grade of Concrete for column	LM30
Grade of Concrete for beam	M30
Grade of Steel	Fel415
Grade of Steel Bracing	Fe250
Density of Concrete	l25kN/m3
Poison’s Ratio	0.2

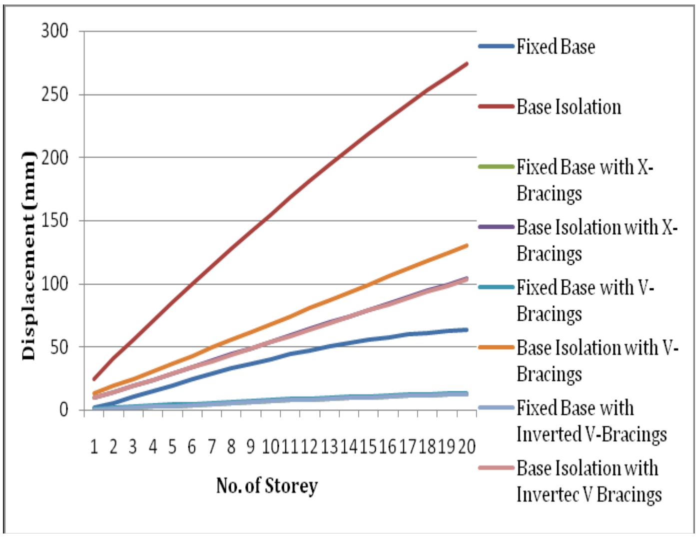
Table 3 Material Properties



2.1 Comparison between Fixed Base and Base Isolation

Models Considered	Base Isolation (sec)	Fixed Base (sec)
RCC Frame Without Bracings	5.081	2.763
RCC Frame With X-Bracings	4.455	1.138
RCC Frame With V-Bracings	4.763	1.196
RCC Frame With Inverted V-Bracings	4.434	1.127

Table 4 Time Period for Fixed Base and Base Isolation



2.2 Storey Displacement for Fixed Base and Base Isolation

Models Considered	Base Isolation (mm)	Fixed Base (mm)
RCC Frame Without Bracings	274.13	63.854
RCC Frame With X-Bracings	104.618	12.801
RCC Frame With V-Bracings	129.836	13.438
RCC Frame With Inverted V-Bracings	103.758	12.536

Table 5 Storey Displacement for Fixed Base and Base Isolation

E. **Effect Of Base Isolation In Multistoried RC Irregular Building Using Time History Analysis;International Journal of Research in Engineering and Technology,volume-4,issue-6,2319-1163,2015Vinodkumar Parma,G.S.Hiremath:-**By the analysis it is observed that base isolation increases the flexibility at the base level of the building. Time period of the structure increases by the use of lead rubber bearing which helps in less transfer of lateral forces at the time of earthquake. The increase in time period of the structure is found to be more in vertical irregular base isolated building compared to plan irregular base isolated building.

The base isolation has high efficiency in decreasing the base shear compared to fixed base building. Reduction in base shear is more in vertical irregular base isolated building compared to plan irregular base isolated building. From the study it shows that, the vertical irregular building gives better performance by the use of isolators at the base of the building as compared to plan irregular building at higher seismic prone area.

In present work, 3D RC 15 storied plan irregular and vertical irregular buildings situated in zone V, are taken for the study. Total 4 buildings have been considered for the comparison

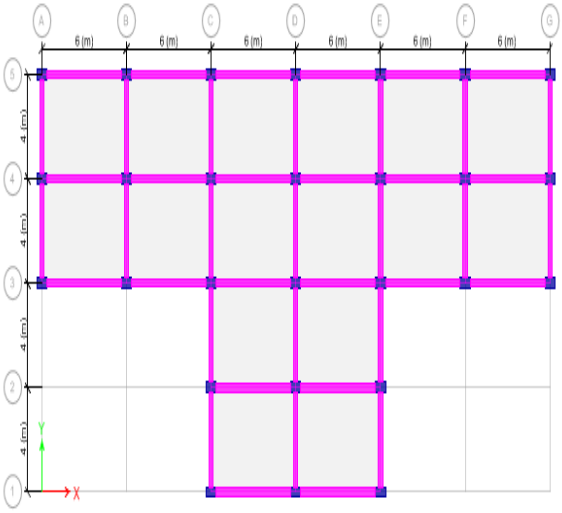
G+14 storied building
Model 1A:-Plan irregular RC building with fixed base.
Model 1B: Plan irregular RC building with Lead Rubber Bearing.
Model 2A: Vertical irregular RC building with fixed base.
Model 2B: Vertical irregular RC building with Lead Rubber Bearing.

Properties	Plan irregular building	Vertical irregular building
Axial load on column (P) kN	7750	7810
Eff. Vertical stiffness (kv) kN/m	1660250.23	1673103.78
Damping (ε)	0.10	0.10
Eff. Horizontal Stiffness (kh) kN/m	4590.82	5030.07
Pre yield stiffness (ku) kN/m	38696.08	42398.49
PYSR (Kd/Ku)	0.10	0.10
Yield force of lead plug (Qd) kN	149.30	163.59

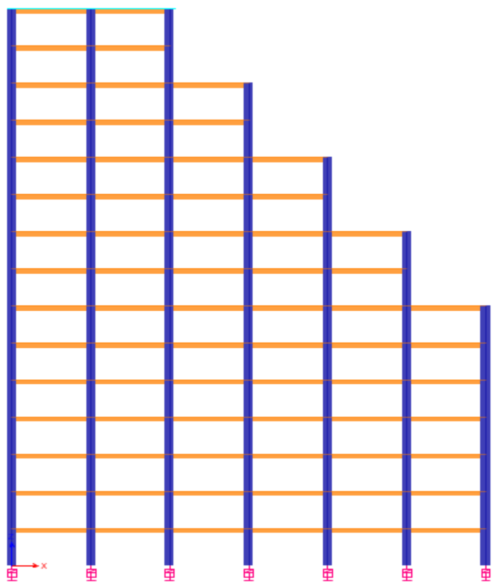
Table 6 Isolator Properties

Grade of concrete	M25 for beam
Grade of concrete	M30 for column
Grade of steel	Fe500
Story height	3.2 m
Beam size	300 × 450 mm
Column size	400 × 700 mm
Slab thickness	150 mm
Wall thickness	230 mm
Parapet height	1 m
Live load on the floor	3 kN/m2
Live load on roof	1.5 kN/m2

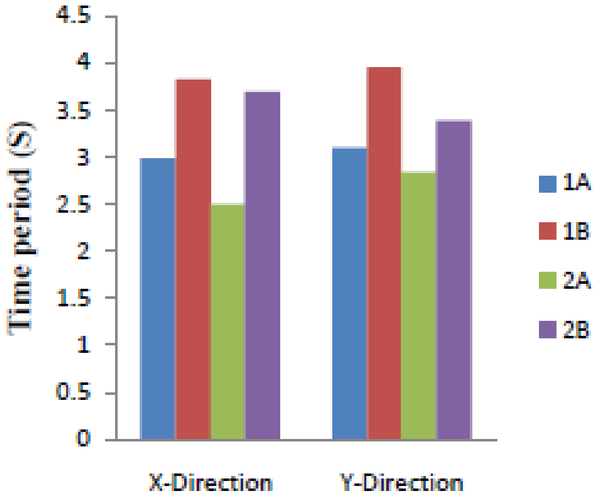
Table 7 Building Detail



1.3 Plan view of Plan irregular building



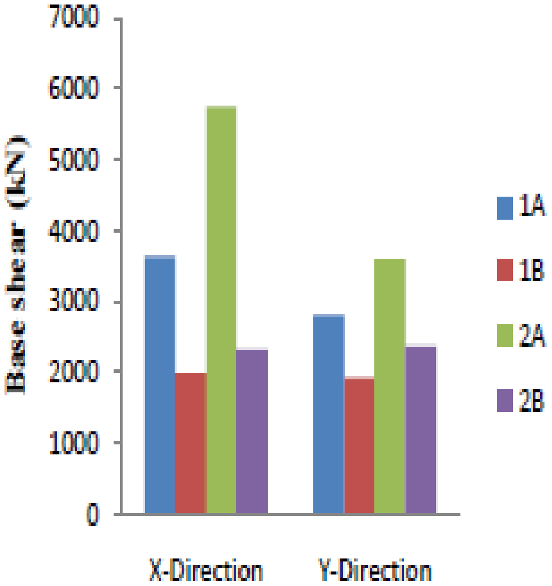
2.4 Elevation of vertical irregular BI Building



2.5 Mode period for different models along X and Y direction

Models	Time period (S)	
	X-X direction	Y-Y direction
1A	2.97	3.09
1B	3.82	3.94
2A	2.49	2.83
2B	3.38	3.68

Table 8 Time period for different models in X and Y direction



2.6 Maximum base shear (kN) along X and Y direction for different models

Models	Base shear (kN)	
	X-direction	Y-direction
1A	3629.20	2793.13
1B	1988.94	1921.50
2A	5739.24	3596. 05
2B	2312.51	2362.89

Table 9 Base Shear Along X And Y Direction

III. CONCLUSION

From the above literature we conclude that,

- By providing base isolation it reduces the inter storey drift and floor acceleration simultaneously which provides the necessary flexibility,with the displacement concentrated at isolation level.
- Capable in supporting the structure against horizontal earthquake load.
- Provide horizontal flexibility to RC structure.
- Capable of dissipating energy which reduces the acceleration transmitted to the superstructure.

REFERENCES

