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Study on Seismic Demands of Different Asymmetrical RCC Buildings Using Rubber Base Isolator

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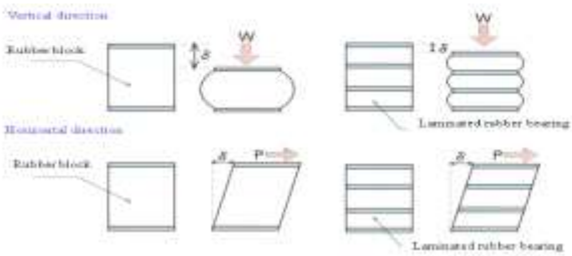
ABSTRACT

In the present study three structures such as regular and irregular shapes (L and T) with base isolation devices are considered such as lead rubber bearings (LRB) are considered in modeling of buildings of height G+10 RCC structures having material properties M35 grade for concrete and Fe500 for reinforcing steel and structures dimensions are length = 7.5x10 m = 75m, width = 4.5x10 = 45m and heights of G+10 is 36 m from the foundation level, the support conditions are chosen to be fixed base and foundation depth is considered as 3.0m below the ground level structures are modeled using ETABS in seismic zones II, III, IV, V as per IS 1893-2002 method used for seismic load generation linear static .the base isolation devices are arranged in storey1 or plinth level in the structures, The results are shown in terms of graphs and tables.

INTRODUCTION

Buildings are termed as the irregular structures when the load path is non uniform and the dimensions such as plan, elevation and mass of the structure within the storey level change suddenly; irregular buildings are unsymmetrical structures along the three mutually perpendicular directions. Irregular building configuration is mostly adopted in residential, commercial and industrial structures. Base a part that supports from beneath or serves as a foundation for an object or structure. Isolation is the state of being separated, and is that of decoupling a structure from its foundation, separating the superstructure from the columns or piers.

Load transferring between bearings:



Advantages of base isolation

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[1] Reduced the seismic demand of structure, thereby reducing the cost of structure.
[2] Lesser displacements during an earthquake.
[3] Improves safety of Structures
[4] Reduced the damages caused during an earthquake. This helps in maintaining the performance of structure after event.
[5] Enhances the performance of structure under seismic loads.

LITERATURE SURVEY

Junji TOYAMA1, Yozo SHINOZAKI1, Tetsushiro INOUE1, Ryota MASEKI2, Ichiro NAGASHIMA2, Masayoshi TAKAGI2 Yoshikazu KITAGAWA3 made an advanced base-isolation system for irregular building design. The system was developed to improve habitability by reducing acceleration during small and medium-level earthquakes. However, this is the first semi-active base isolation system in Japan to be certified as a highly reliable system that offers continued control even in the event of a major earthquake. In the event of an earthquake, the damping coefficient of the variable oil damper is changed as needed, based on an advanced control algorithm, to reduce the acceleration response of the building. Base-isolated structure is a technology that not only reduces seismic force and improves structural stability but can also improve the freedom of architectural planning.

Fu Lin ZHOU1, Zheng YANG2, Wen Guang LIU3 and Ping TAN4 investigated new seismic isolation system for irregular structure with the largest isolation building area in the world A very large platform (2 stories RC frame) with plane size 1500m wide and 2000m long was built to cover the city railway communication hub area. About 50 isolation house buildings (9 stories RC frame) with 480,000 M2 were built on the top floor of platform. A new advanced isolation system named Storied-Isolation was used to ensure the seismic safety for this irregular structure with the largest isolation house building area in the world. This new isolation system has been used widely in China. A great number of testing and researches for rubber bearings have been done for keeping high quality and wide application with low prices in China.

MODELLING & METHODOLOGY

In the present study three structures such as regular and irregular shapes (L and T) with base isolation devices are considered such as lead rubber bearings (LRB) are considered in modeling of buildings of height G+10 RCC structures having material properties M35 grade for concrete and Fe500 for reinforcing steel and structures dimensions are length = 7.5x10 m = 75m, width = 4.5x10 = 45m and heights of G+10 is 36 m from the foundation level, the support conditions are chosen to be fixed base and foundation depth is considered as 3.0m below the ground level structures are modeled using ETABS in seismic zones II, III, IV, V as per IS 1893-2002 method used for seismic load generation linear static .the base isolation devices are arranged in storey1 or plinth level in the structures, The results are shown in terms of graphs and tables.

Structure1: G+ 10 regular structures
Structure1: G+ 10 L-irregular structures
Structure1: G+ 10 T-irregular structures

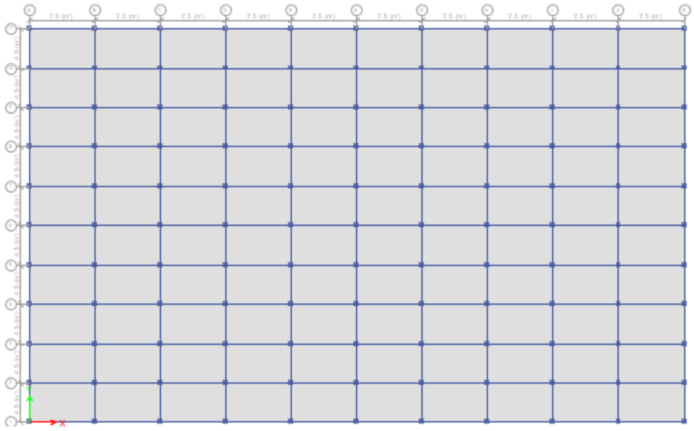

Fig: floor plan of regular structures

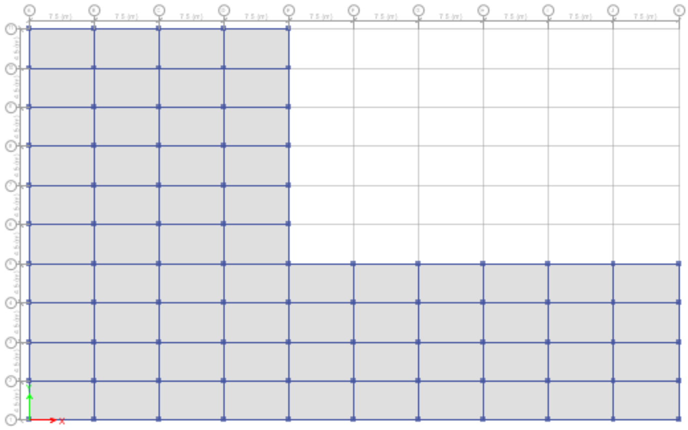

Fig : floor plan of L-shape irregular structures

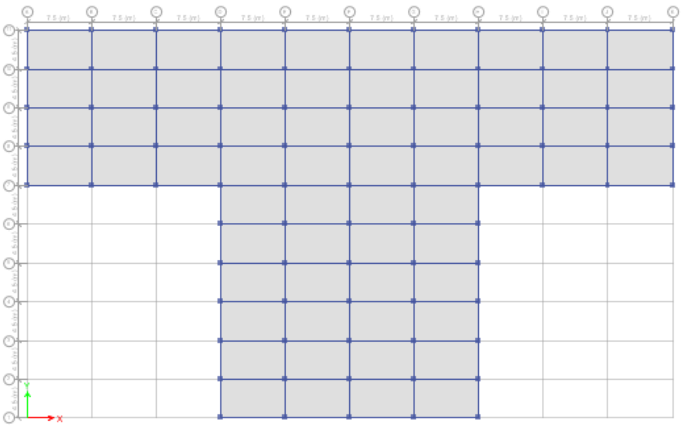

Fig : floor plan of T-shape irregular structures

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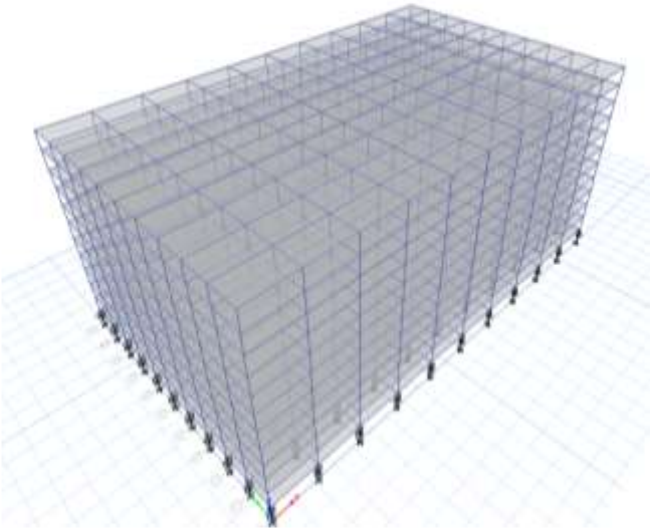

Fig: 3d view of regular structures

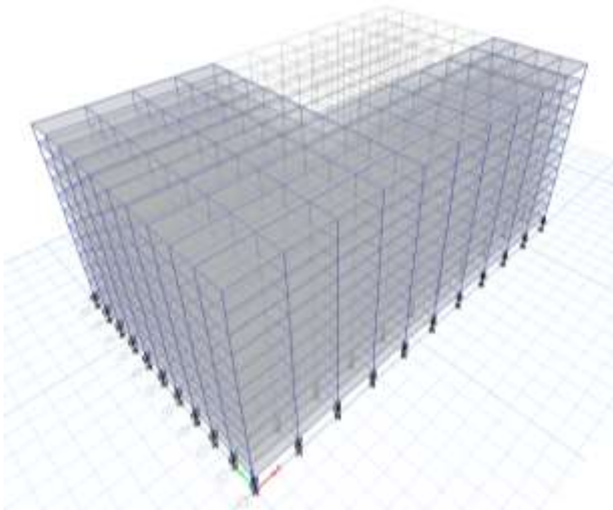

Fig: 3d view of L-shape irregular structures

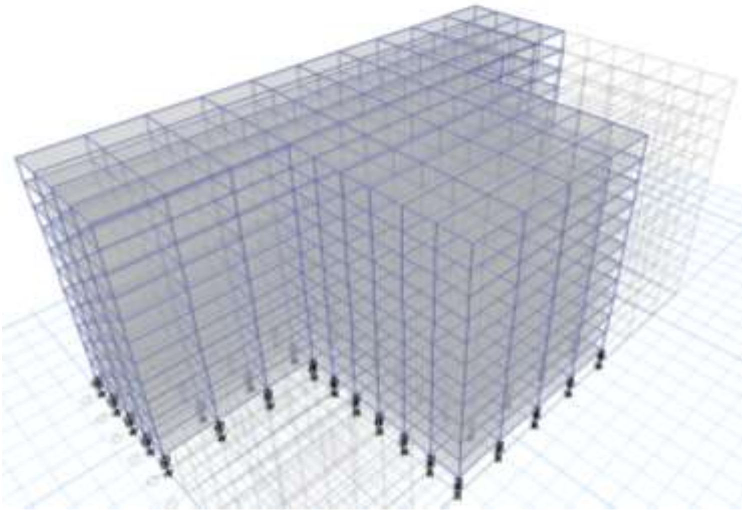

Fig: 3d view of T-shape irregular structures

Table: Design data used in modeling and analysis of structures

Materials	M35, Fe500
Beam	300x500
columns	600x600
supports	Fixed
Stories	G+10
Foundation depth	3.0m
Floor to floor height	3.0m
Length	10x7.5m = 75m
width	10x4.5m = 45m
zones	2,3,4,5
Types of bearings	Lead rubber bearings
method	Linear static analysis
software	ETABS
loads	DL,LL,EL, load combinations

IS codes used in analysis and Design of structures

[1] IS 1893:1984,"Criteria for earthquake resistant design of structures", Bureau of Indian Standards, New Delhi, India.

[2] IS 456: 2000,"Plain reinforced concrete-code of practice", Bureau of Indian Standards, New Delhi, India.

[3] IS 875-5: 1987,"Code of practice for design load combinations for buildings and structures", Bureau of Indian Standards, New Delhi, India

Table: 3.2 design parameters used in analysis and modeling

parameters	**values**
Type of building	Residential
Live load	3kN/m^2

Member load	11.5kN/m
Slab thickness	130mm
Response reduction(R)	5
Importance factor	1
Soil type	II
Slabs	Shell elements
Columns	Frame elements
Beams	Frame elements

Loads and load combination considered for analysis

In the limit state design of reinforced and prestressed concrete structures, the following load combinations shall be accounted for:

1) 1.5(DL+LL)
2) 1.2(DL+LL+EL)
3) 1.5(DL+EL)
4) 0.9DL+1.5EL

RESULTS AND DISCUSSION

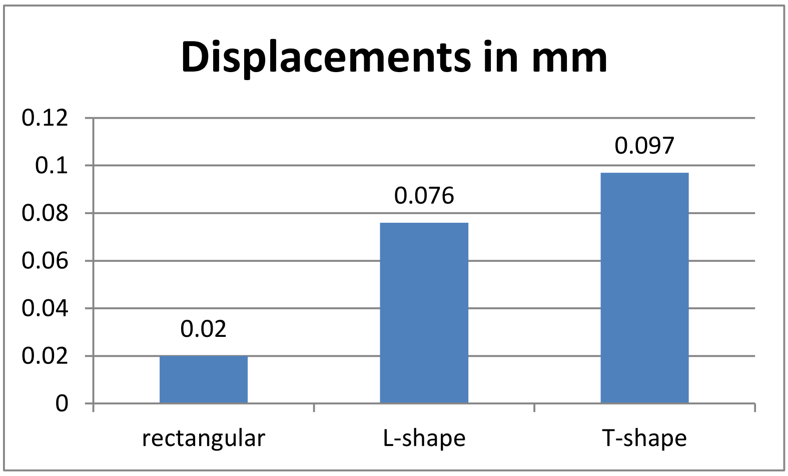

Chart: Maximum storey displacements

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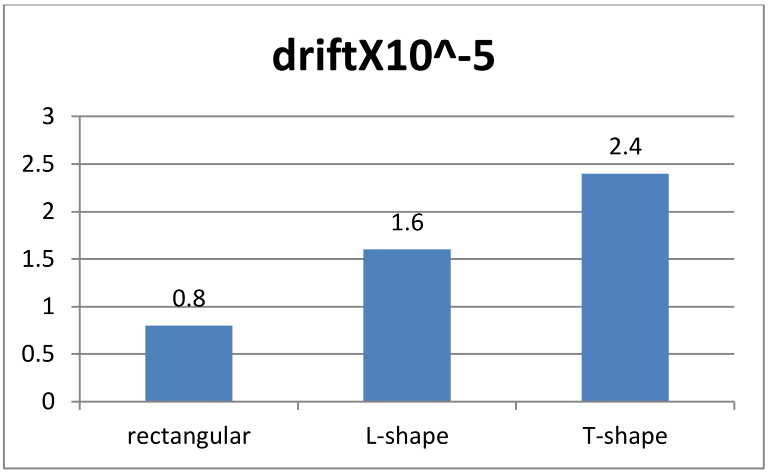

Chart: Maximum storey drifts

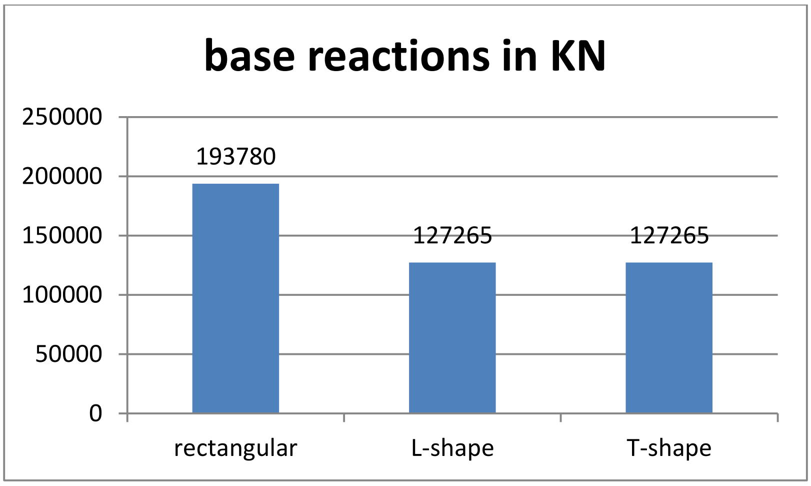

Chart : base reactions at the base

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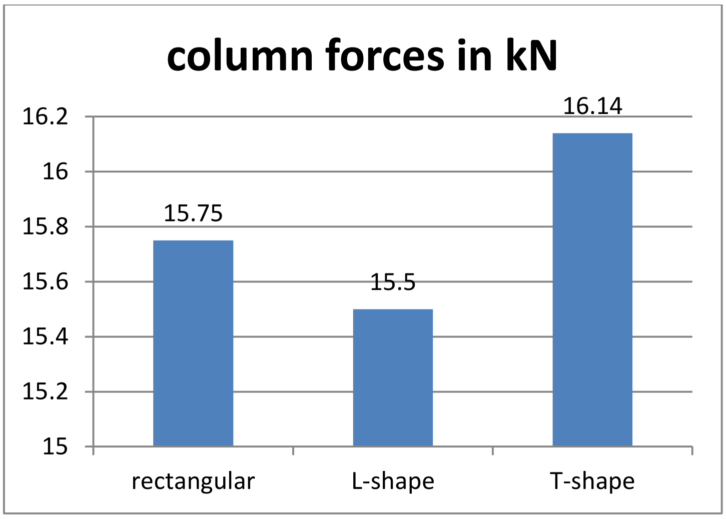

Chart: base reactions at the base

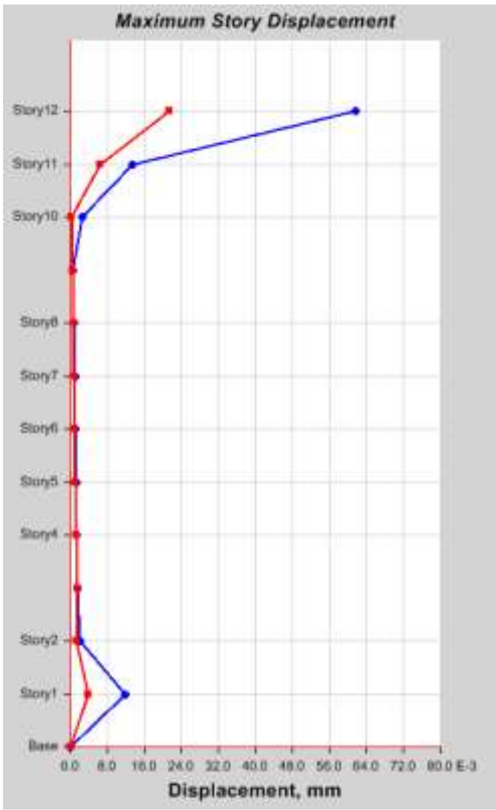

Fig: maximum storey displacements for regular structures

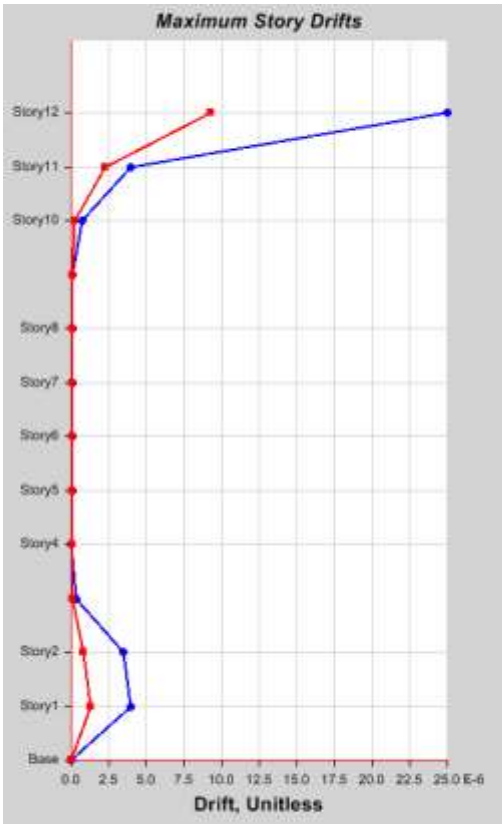

Fig : maximum storey drifts for regular structures

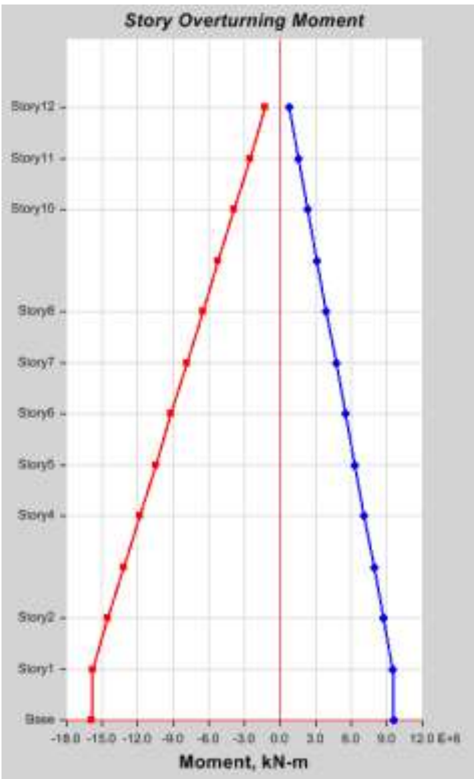

Fig: overturning moments for regular structures

CONCLUSIONS

The following are the conclusions drawn from the analysis results of three structures such as regular and irregular shapes (L and T) with base isolation devices are considered such as lead rubber bearings (LRB) are considered in modeling of buildings of height G+10 RCC structures having material properties M35 grade for concrete and Fe500 for reinforcing steel and structures dimensions are length = 7.5x10 m = 75m, width = 4.5x10 = 45m and heights of G+10 is 36 m from the foundation level, the support conditions are chosen to be fixed base and foundation depth is considered as 3.0m below the ground level. structures are modeled using ETABS in seismic zones II, III, IV, V as per IS 1893-2002 method used for seismic load generation linear static .the base isolation devices are arranged in storey1 or plinth level in the structures.

Structure-1: REGULAR: G+10 building with rubber base isolation device
Structure-2: IRREGULAR (L-SHAPE): G+10 building with rubber base isolation device
Structure-3: IRREGULAR (T-SHAPE): G+10 building with rubber base isolation device

1. The maximum storey displacements for structure-1, structure-2 and structure-3 in zone-II, zone-III, zone-IV, and zone-V are 1.72mm; 1.722mm and 1.73mm, with the increase in the seismic intensities the structures storey displacements are increased.

2. The maximum storey drift for structure-1, structure-2 and structure-3 in zone-II, zone-III, zone-IV, and zone-V are $0.8x10^{-5}$, $1.6x10^{-5}$, $2.4x10^{-5}$, with the increase in the seismic

intensities the structures storey drifts are increased.

3. The base reactions in zone-II, zone-III, zone-IV, and zone-V for structure-1, structure-2 and structure-3 are 193780kN, 127265kN and 127265kN.

4. The column forces in zone-II, zone-III, zone-IV, and zone-V for structure-1, structure-2 and structure-3 are 15.75kN, 15.5kN and 16.14kN.

5. Provision of base isolators reduces the storey drifts and displacements with the increase in the seismic intensities from zone-II, zone-III, zone-IV, and zone-V.

6. The column forces, drifts and displacements are observed to be high in structure-3 when compared with structure-1 and structure-2 for zone-II, zone-III, zone-IV, and zone-V.

7. The column forces for structure-2 are decreased when compared with structure-1 by 1.58% and structure-3 is increased when compared with structure-1 by 2.47%.

8. The base reactions for structure-2 and structure-3 are reduced by 34.33% when compared with structure-1.

9. The maximum storey drift for structure-1, structure-2 and structure-3 in zone-II, zone-III, zone-IV, and zone-V are increased by 100% and 200% for structure-2 and structure-3 when compared with structure-1.

10. when compared with T shaped irregular structures L shaped irregular structures are having lesser displacements, drifts and column forces.

REFERENCES

[1] IS 1893:1984,"Criteria for earthquake resistant design of structures", Bureau of Indian Standards, New Delhi, India.

[2] IS 1893(Part1):2002,"Criteria for earthquake resistant design of structures -General provisions and buildings", Bureau of Indian Standards, New Delhi, India.

[3] IS 456: 2000,"Plain reinforced concrete-code of practice", Bureau of Indian Standards, New Delhi, India.

[4] Dia Eddin Nassani1, Mustafa Wassef Abdulmajeed1 investigated the Seismic Base Isolation in Reinforced Concrete Structure

[5] Sameer S. Shaikh1, P.B. Murnal2 found the effects of Base Isolation at Different Levels in Building

[6] Prof.R.B.Ghodke, Dr.S.V.Admane studied the Effect of Base-Isolation for Building Structures. Base-isolation is best technique to prevent or minimize damage to buildings during an earthquake disaster