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Comparative Study on Effectiveness of Lead Rubber Bearing(LRB) and High Damping Rubber Bearing(HDRB) as Base Isolation System for Regular and Irregular RC Framed Structures

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ABSTRACT

Earthquakes are one of nature's greatest hazards; throughout historic time they have caused significant loss of life and severe damage to property, especially to man-made structures. On the other hand, earthquakes provide architects and engineers with a number of important design criteria foreign to the normal design process. From well established procedures reviewed by many researchers, seismic isolation may be used to provide an effective solution for a wide range of seismic design problems. The application of the base isolation techniques to protect structures against damage from earthquake attacks has been considered as one of the most effective approach and has gained increasing acceptance during the last few decades. This is because base isolation limits the effects of the earthquake attack, a flexible base largely decoupling the structure from the ground motion, and the structural response accelerations are usually less than the ground acceleration. In this dissertation work Regular Building and Plan Irregular Building Models are considered for seismic analysis in addition to the base isolation which is favorable, cost effective and damage control aspect in earthquake design. High damping rubber bearing (HDRB) and Lead rubber bearing (LRB) is considered as a base isolator and designed as per the standards. Modal, equivalent static, and response spectrum analyses are performed on a typical 3D RC structure models of Regular Building, Building with plan irregularity, and these models are subjected to base isolation with High damping rubber bearing (HDRB) and Lead rubber bearing(LRB).

Keywords—*Response spectrum analysis*, *time period, storey displacement, Storey drift, Storey shear and Storey accelaration.*

I. INTRODUCTION

A natural calamity like an earthquake has taken the toll of millions of lives through the ages in the unrecorded, and recorded human history. A disruptive disturbance that causes shaking of the surface of the earth due to underground movement along a fault plane or from volcanic activity is called earthquake. The nature of forces induced is reckless, and lasts only for a short duration of time. The Indian subcontinent is a region that is prone to earthquakes. Between 1990 to 2006, more than 23,000 lives were lost due to six major earthquakes in India. The most notable being the 2001 Bhuj earthquake and the 2005 Kashmir earthquake. These earthquakes have caused significant loss of life and severe damage to property. Many seismic construction designs and technologies have been developed over the years in attempts to mitigate the effects of earthquakes on buildings and their vulnerable contents.

The technique of base isolation has been developed in an attempt to mitigate the effects on buildings and their contents during earthquake attacks and has been proven to be one of the more effective methods for a wide range of seismic design problems on buildings in the past three decades. Seismic isolation consists essentially of the installation of mechanisms which decouple the structures and their contents from potentially damaging

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earthquake-induced ground motions. This decoupling is achieved by increasing the flexibility 'of the systems, together with providing appropriate damping. Careful studies have been made of structures for which seismic isolation may find widespread application. In seismic isolation, the fundamental aim is to reduce substantially the transmission of the earthquake forces and energy into the structure. This is achieved by mounting the structure on an isolation system with considerable horizontal flexibility so that during an earthquake, when the ground vibrates strongly under the structure, only moderate motions are induced within the structure.
Attenuating the effects of severe ground motions on the buildings and their contents is always one of the most popular topics in the area of civil and structural engineering and attracts the attention of many researchers and engineers around the world.

II. OBJECTIVES

A. Modelling and analysis of fixed base and base isolated buildings by using ETABS and the effects of earthquake ground motions on these buildings has been studied.

B. Linear static analysis and Response spectrum analysis has been carried out to identify the effectiveness of LRB and HDRB and the performance level of the regular and irregular building are considered and results are noted.

C. Comparison between fixed base and base isolated building on the basis of their dynamic properties like, base shear, storey displacement, Storey drift and Storey acceleration.

III. MODEL STUDIES

The structural model used in the present study of regular plan and irregular plan shape has (G+7) stories having each Storey height of 3m.Sesmic analysis has done according to IS 1893:2002 and building is designed according to IS 456:2000.The design is carried by using Etabs. The bay width has been kept as 5m in X and Y directions in both regular and irregular plan.

Building Data	
Plan Dimension	20x20m
Grade of Concrete	M 25
Grade of Steel	Fe 500
Earth quake Zone	Zone V
Response Reduction Factor	5
Structure Type	SMRF
Seismic Zone Factor	0.36
Damping Ratio	0.05
Importance factor	1
Soil type	Type II, Medium soil
Number of storeys	G+7
Height of typical floor	3 m
Height of Building	24m
Slab thickness	150 mm
Beam size	0.230 x 0.450 m
Column size	0.500 x 0.500 m

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Live Load on Floor	2.5 kN/m^2
Live load on Roof	1.5 kN/m^2
Floor finish	1.5 kN/m^2
Floor finish on Roof	1.0 kN/m^2

IV. LOAD CASES

1) 1.5(DL+ lL)
2) 1.2(DL+IL ± EL)
3) 1.5(DL ± EL)
4) 0.9DL ± 1.5EL

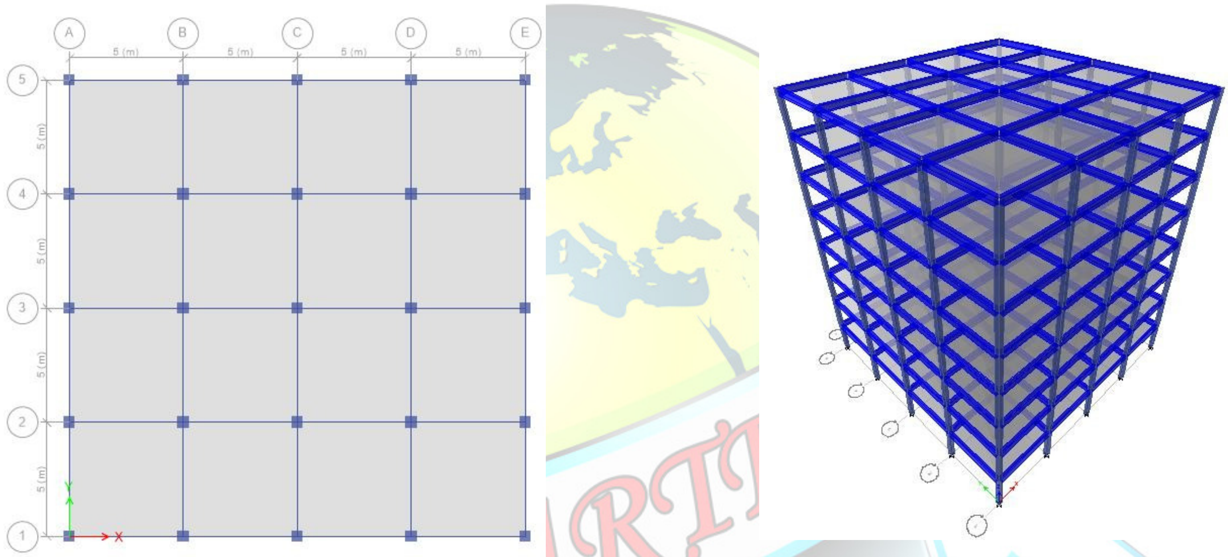

Figure 1: Plan and 3D Model of Regular Building

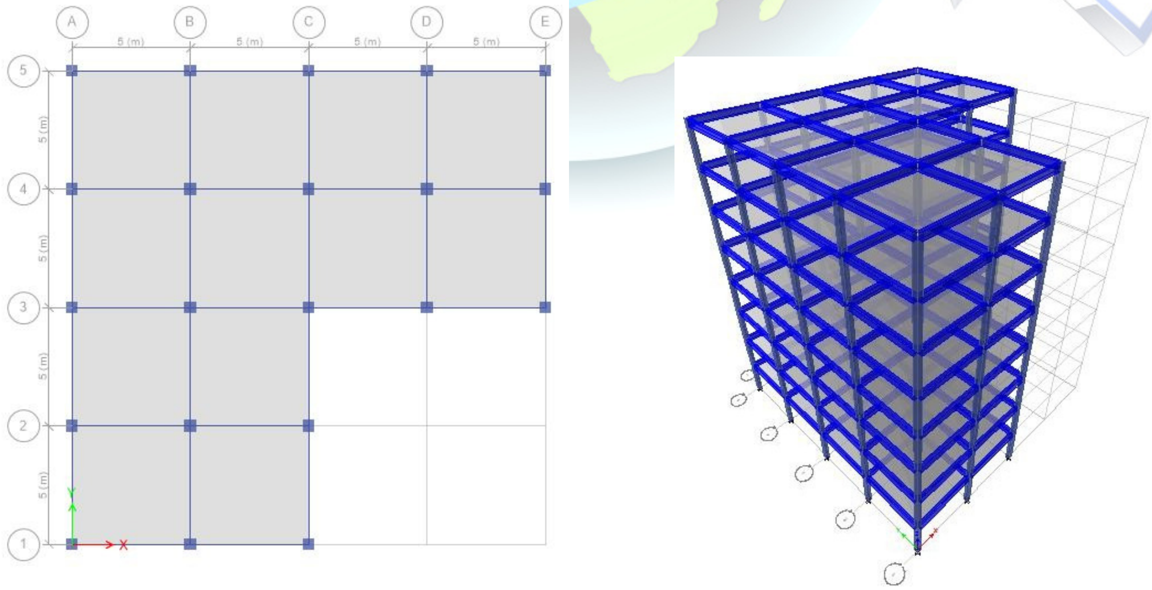

Figure 2: Plan and 3D Model of Plan Irregular Building

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Table 1: MODELS CONSIDERED FOR THE ANALYSIS

MODELS	DESCRIPTION
Model-1A	Regular Model with fixed based
Model-1B	Regular Model base isolated with HDRB
Model-1C	Regular Model base isolated with LRB
Model-2A	Plan irregular Model with fixed based
Model-2B	Plan irregular Model base isolated with HDRB
Model-2C	Plan irregular base isolated with LRB

V. RESULTS AND DISCUSSIONS

A. *Time period*

The fundamental time period and mode shapes for all models are obtained from the modal analysis, which calculates the time period on the basis of mass and stiffness of the structure. IS 1893 (Part 1): 2002 gives the formulae for calculating the natural time period with and without brick infill panels. i.e.

$Ta = 0.09h/\sqrt{d}$ - RC frame building with brick infill panels.

$Ta = 0.075h^{0.75}$- RC frame building without brick infill panels.

Modal analysis results are tabulated in below table and the below graph showing time period versus models.

Table 2; Fundamental time period for Regular Building and Plan Irregular Building models.

TIME PERIOD(sec)		
TYPE OF MODEL	Model-1 (REGULAR PLAN)	Model-2 (PLAN IRREGULAR)
FIXED(A)	1.519	1.442
HDRB(B)	2.895	2.795
LRB(C)	3.014	2.948

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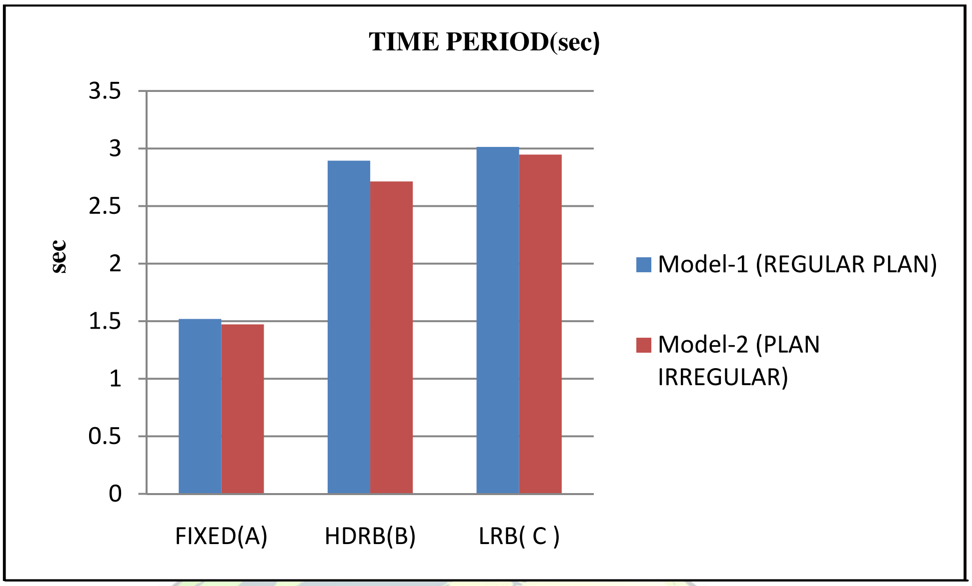

Figure 3: Fundamental time period of two models considered in this study

B. *Storey Displacement*

In case of fixed base RC frame, displacement is zero at the base and increases as storey height increases. But in case of base isolated frames, there is a small displacement at the base and increases at a comparatively slower rate as storey height increases. It is observed that the relative displacement between stories after using isolator is much less than fixed base.

Table 3: Storey displacement of Regular and Plan irregular buildings.

STOREY DISPLACEMENT (mm)						
Story	Model-1A	Model-1B	Model-1C	Model-2A	Model-2B	Model-2C
Story7	27.83	40.44	42.29	29.93	40.82	42.77
Story6	26.61	39.97	41.83	28.53	40.34	42.31
Story5	24.48	39.13	41.03	26.19	39.49	41.49
Story4	21.42	37.84	39.81	22.84	38.2	40.26
Story3	17.51	36.11	38.17	18.61	36.45	38.61
Story2	12.88	33.92	36.09	13.62	34.25	36.52
Story1	7.76	31.22	33.54	8.14	31.53	33.94
Ground	2.79	27.73	30.23	2.88	28.04	30.62
Base	0	23.11	25.86	0	23.39	26.22

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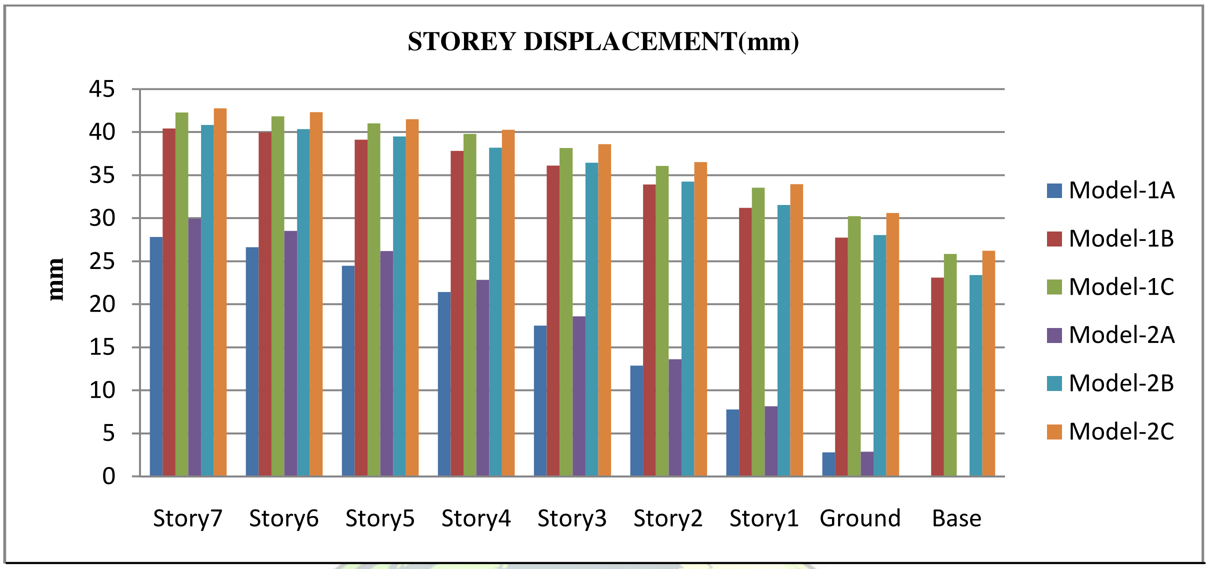

Figure 4: Storey Displacements (mm) of Regular Building and Plan Irregular Building Graphs.

C. *Storey drift*

According to IS 1893(Part 1):2002 clause 7.11.1, the storey drift is the displacement of one level relative to the other level above or below. Storey drifts limitations are explained that the Storey drifts in any storey due to the minimum specified design lateral force, with partial load factor of 1.0 shall not exceed 0.004 times the storey height.

Table 4: Storey drift of Regular and Plan irregular buildings.

STOREY DRIFT						
Story	Model-1A	Model-1B	Model-1C	Model-2A	Model-2B	Model-2C
Story7	0.00051	0.00018	0.000168	0.00057	0.0002	0.00019
Story6	0.00085	0.00031	0.0003	0.00092	0.00034	0.00032
Story5	0.00116	0.00046	0.00044	0.00125	0.0005	0.00047
Story4	0.0014	0.00061	0.00058	0.00151	0.00064	0.00061
Story3	0.00159	0.00075	0.00071	0.00171	0.00079	0.00075
Story2	0.00172	0.00092	0.00087	0.00185	0.00095	0.00091
Story1	0.00166	0.00117	0.00111	0.00175	0.0012	0.00114
Ground	0.00093	0.00197	0.00185	0.00096	0.00205	0.00196
Base	0	0	0	0	0	0

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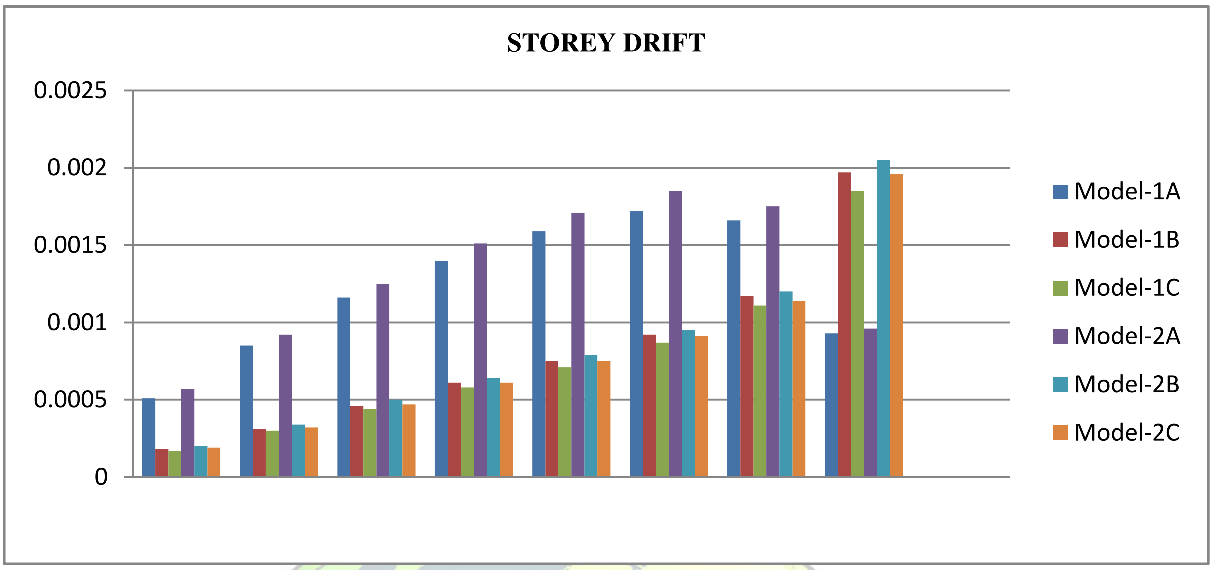

Figure 5: Storey Drift of Regular Building and Plan Irregular Building Graphs.

D. *Storey shear*

Base shear is an estimate of the maximum expected lateral force that will occur due to seismic ground motion at the base of the structure. The dynamic base shears obtained from the response spectrum analysis after substituting the relevant scale factor are tabulated .

Table 5: Storey shear of Regular and Plan irregular buildings.

STOREY SHEAR (kN)						
Story	Model-1A	Model-1B	Model-1C	Model-2A	Model-2B	Model-2C
Story7	250.25	72.12	65.18	202.95	58.26	53.57
Story6	557.48	186.13	171.43	447.15	152.99	141.31
Story5	769.55	289.93	268.38	611.97	237.18	220.08
Story4	919.85	382.4	355.77	731.57	311.69	290.55
Story3	1047.17	465.83	435.46	833.22	378.57	354.43
Story2	1172.06	543.25	509.92	932.49	440.47	413.93
Story1	1286.47	617.19	581.25	1022.87	499.57	470.94
Ground	1351.49	688.35	650.12	1073.86	556.5	526.07

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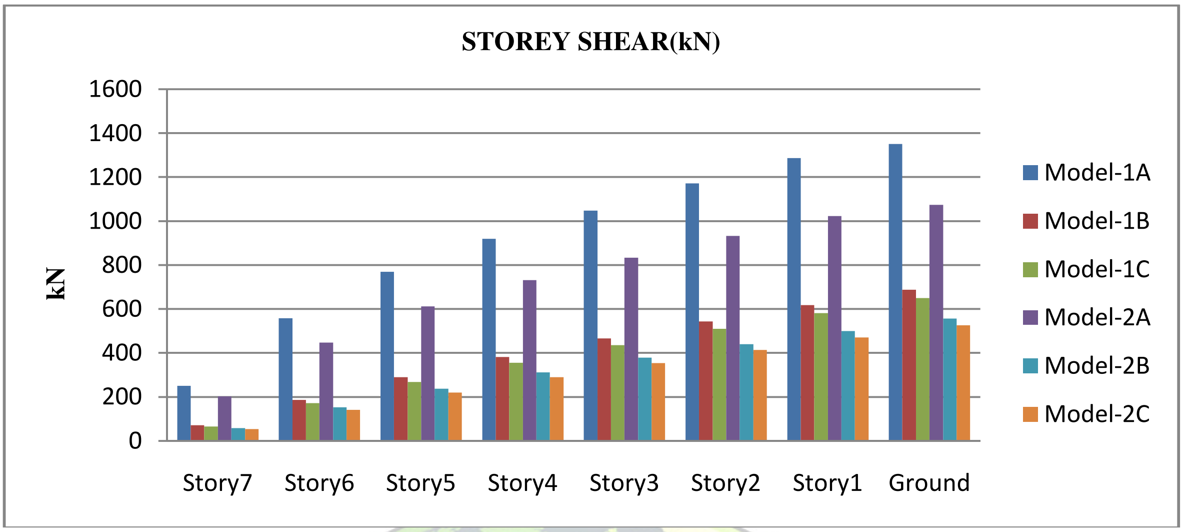

Figure 6: Storey shear of Regular Building and Plan Irregular Building Graphs.

E. *Storey Accelaration*

The acceleration or the rate of change of the velocity of the building in motion, Sa/g is a factor denoting the acceleration response spectrum of the structure subjected to earthquake ground vibrations and depends on natural period of vibration and damping of the structure. 5% Damping is considered for the analysis of the structural models.

Table 6: Storey accelaration of Regular and Plan irregular buildings

STOREY ACCELARATION (mm/sec^2)						
Story	Model-1A	Model-1B	Model-1C	Model-2A	Model-2B	Model-2C
Story7	814.59	226.1	207.22	870.41	243.17	224.55
Story6	589.03	208.76	192.73	632.1	220.93	205.47
Story5	517.95	191.44	178.11	551.53	200.71	187.2
Story4	499.35	179.03	167.43	533.61	188.2	176.41
Story3	546.83	173.21	162.1	581.17	181.91	170.7
Story2	541.97	173.4	161.78	575.72	181.39	169.99
Story1	515.68	176.13	163.86	537.22	186.64	174.56
Ground	285.22	176.41	164.35	289.06	188.83	177.16
Base	0	171.22	160.94	0	185.49	175.83

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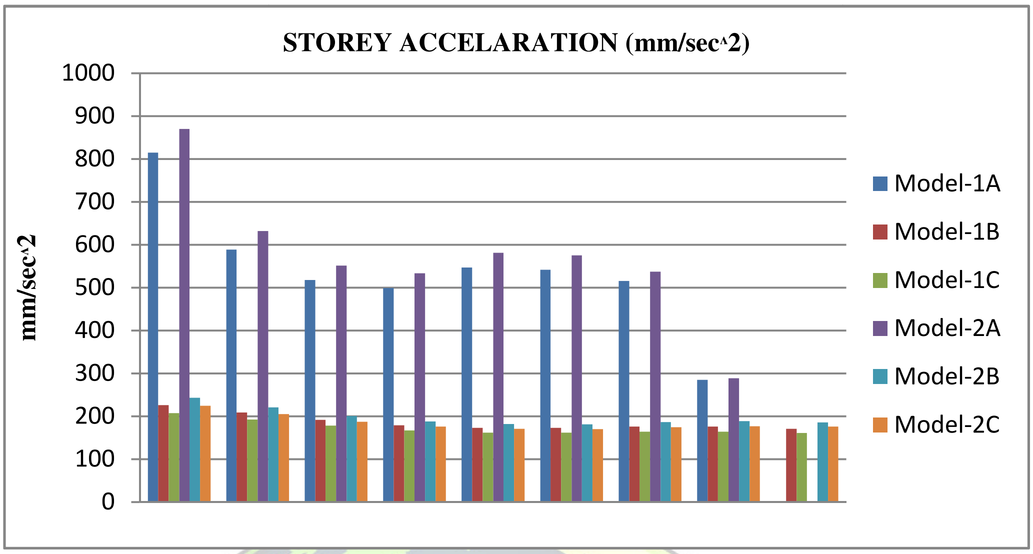

Figure 7: Storey acceleration of Regular Building and Plan Irregular Building Graphs.

VI. CONCLUSIONS

a. It is concluded that time period of the regular and plan irregular building in case of HDRB & LRB is increased by about 1.35 sec & 1.5 sec respectively as compared to fixed base

b.Displacement of base isolated models are more in all cases compared to fixed base models, this is due to reduction in stiffness of base isolated models. And the relative displacement of base isolated models is less compared to fixed base models.

c. Storey drift of Base isolated models is less compared to Fixed based models for all the stories in all the models, except first story.

d. Storey drift for LRB Base isolated models is less compared to HDRB Base isolated models for both regular and plan irregular building.

e. It is concluded that the reduction of storey shear in regular and plan irregular building is more in LRB than HDRB.

f. In all the Model cases i.e Regular and Plan Irregular Building models the reduction of base shear from fixed based models to base isolated model is almost around 50%.

g. Storey acceleration values of fixed base structures is more compared to building with base isolation. Maximum and minimum storey acceleration is observed in Plan irregular fixed base model (Model-2A) and regular base isolated model with LRB (Model-1C) respectively.

h. Base isolation system is an extraordinary and widely recognized advancement that is used to save innumerable lives and money spends in destruction made my earthquakes.

VII. REFERENCES

[1] T. Subramani, J. Jothi ,and M. Kavitha "Earthquake Analysis of Structure by Base Isolation Technique in SAP" ISSN : 2248-9622, Vol. 4, pp.296-305, June 2014.

[2] SunitaTolani and Dr. Ajay Sharma, "Effectiveness of Base Isolation Technique and Influence of Isolator Characteristics on Response of a Base Isolated Building,"AJER, ISSN:2320-0936, vol. 5, pp-198-209, 2016.

[3] G.Mounica and Dr. B.L.Agarwal, " Sesmic Analysis of Fixed Base and Base Isolated Structures'' IJATES, ISSN:2348-7550, Vol. 4, Aug 2016.

[4] "Earthquake Engineering Handbook", by W. F. CHEN and CharlesScawthorn.

[5] IS: 456-2000 – "Code of Practice for Plain and Reinforced Concrete", Bureau of Indian Standards, NewDelhi.

[6] IS:1893(Part–1)–2002-Code of Practice for Criteria for Earthquake Resistant Design of Structures, Part1:General Provisions and Buildings, Bureau of Indian Standards,New Delhi.

[7] IS:875–1987-Code of Practice for Design Loads (otherthan Earthquake) for Buildings and Structures, Part 1: Dead Loads, Part 2: Imposed Loads, Part 5: Special Loads and Load Combinations, Bureau of Indian Standards, NewDelhi.

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