

A Performance Study of the (G+15) Storey RCC Structure by Installation of the Base Isolators System under the Effect of Seismic Loads

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ABSTRACT: In the present study by analysing the (G+15) storey RCC structure with fixed base and Base isolated structures is studied using E-TABS software. The analysis of the structure is carried by applying response spectrum analysis method. The fixed base structure is analysed in the software and highest reaction load is considered and design of above mentioned base isolators is carried out as per UBC-97 code book. The lead rubber bearing isolator is injected as support to structure by replacing the fixed base support. After extracting the result for fixed base structure as well as base isolated structure, we can conclude that there is increase in storey displacement, time period and decrease in storey base shear and storey drifts when compared to base isolator structure, which increases the lateral stability of structure.

KEYWORDS: Base isolator, Lead Rubber Bearing, Response Spectrum Analysis, Base shear, Modal period, Story shear and Story displacement.

I. INTRODUCTION

The main aim of providing the base isolators to the earthquake prevention is applying to the structure for safety and comfort by controlling the seismic response of the civil engineer. The very common method to distractive effect of the earthquake is to damping the seismic energy forces to the structural elements, to protecting against the earthquake forces. Sometime normal construction methods are some certain time to the building will be getting safe but damaging the structural elements. So we have another one method that using the base isolator's structure by replacing the fixed supports from the foundation. In simple that divide the structure in two parts are like one superstructure and sub structure between the base isolators we going to provide. The base isolation system is giving to protection against to the earthquake vibration to the structure. The base isolator structures are in demand because of the earthquake. To comparing base isolators method to fixed support structure is far better performing to against the earthquake vibration to the building. Some providing the vertical isolators is very much less workable and also complicated to the improve work. In generally the earthquake ground motions are very greater results when acceleration response acts on the structure at a shorter period comparing to the longer period. . The seismic forces act after installing the isolators system it will be change the ground motion at a shorter period also changes the fundamental natural time period of the building.

The main strategy of the base isolators to protect from the coming seismic sources, to get understand the some major few elements' sources are the written below:

- 1. Period-shifting element of the structure:** The base isolation is more flexible device comparing from the flexibility buildings. After we going to use these isolators are giving more flexibility to the superstructure.
- 2. Mode of vibration:** The mode of vibration is also get increasing by above the superstructure and so us getting different modes on different floor by using the base isolator's structure.
- 3. Damping & reducing the load transmission path:** The purpose of the dampers is used for absorbed the energy force to get reduced the similar deflection of the building with respective ground vibration sources.
- 4. Minimum rigidity of structure:** The base isolators are providing a minimizing the rigidity to reduce the service loads such as seismic earthquake force or lateral loads coming from the structure.

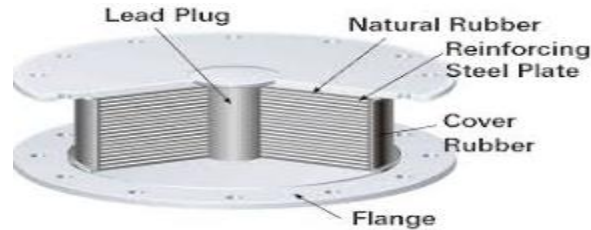


Fig 1.1 Lead Rubber Base Isolator

II. METHODOLOGY

RCC structure planning is done in AutoCAD software. After that the AutoCAD file plan has export in the EATABS 2013 software for further analysis and design will be carried out by using response spectrum method. G+ 15 storeys RCC structure is modelled in EATABS, after that lateral loads are applied as per code provisions. The firstly results are seen as per the higher vertical load for which load combination the note down the results in tabular column. Once the maximum vertical reaction is noted, after that the data may require for design the LRB base isolators. Then we get the input values for base isolated structure we directly apply the values in EATBS software by applying as link properties. The structure fixed base support replacing by the base isolators system. Once the model is analysis done after where check the base isolated structural behaviour. Then where results values are noted in table and values are shows in graph.

3.1 Modelling and Analysis

3.1.1 Properties Of Building Elements

1. Beam on 1 st to 5 th floor	= 0.30X0.50m
2. Beam on 6 th to 10 th floor	= 0.30X0.50m
3. Beam on 11 th to 15 th floor	= 0.25X0.50m
4. Column on 1 st to 5 th floor	= 0.35X0.80m
5. Column on 6 th to 10 th floor	= 0.30X0.60m
6. Column on 11 th to 15 th floor	= 0.30X0.50m
7. Slab thickness	= 0.15m
8. Main wall thickness	= 0.23m
9. Shear wall thickness (Lift)	= 0.23m

3.1.2 Material Properties

Grade of Concrete	= M35
Grade of Steel	= Fe500

3.1.3 Earthquake parameters for structure according to UBC 1997

1. Seismic zone (Z)	= Zone III
2. Soil profile type	= S _D
3. Seismic coefficient C _a	= 0.36
4. Seismic coefficient C _v (C _{VD})	= 0.54
5. Importance factor (I)	= 1
6. Response reduction factor (R)	= 8.5 (SMRF)
7. Seismic source type	= B
8. Near source factor N _a	= 1
9. Near source factor N _v	= 1
10. Damping coefficient (B _D)	= 1
11. Effective Damping (β _{eff})	= 5%

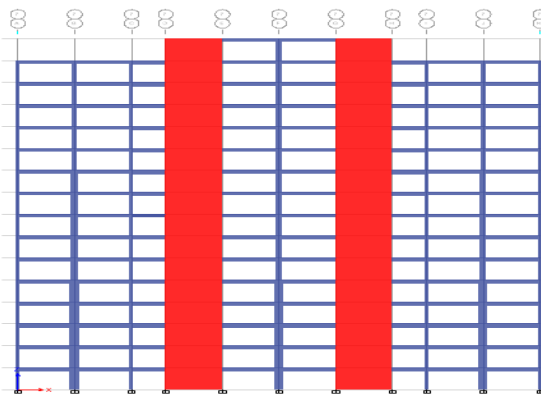


Fig 3.1 Elevation of fixed base

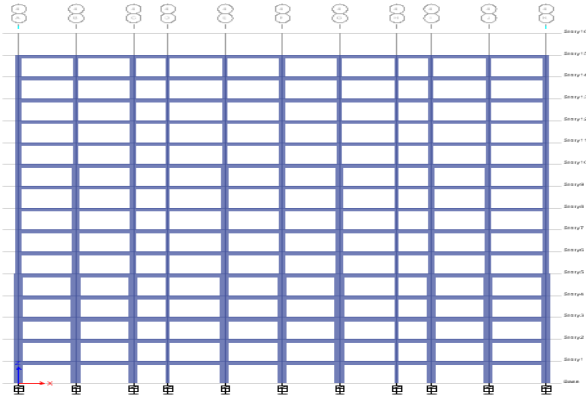


Fig 3.2 Elevation of base isolated

After the study of rigid support building the maximum vertical reaction is taken to design the lead rubber bearing. For rigid support analysis there are two higher reactions. For the outer building block reaction is 7635 kN and middle of the building where open terrace with stair-case where providing where coming higher vertical reaction is 13805 kN.

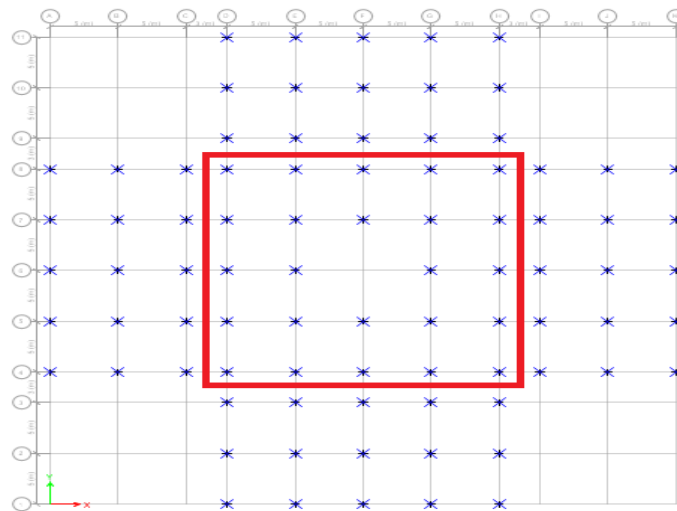


Fig. 3.3 Plan Shows the Locations of providing the Base Isolator in the Building

3.1.4 Input values in ETABS after the Design of the LRB

SL.NO	Parameters	LRB 1	LRB 2
1	Maximum vertical load W	7635 kN	13805 kN
2	Rotational inertia I	0.33960 kN/m	1.13877 kN/m
3	For U1 effective stiffness (Linear)	1611318.377 kN/m	2913668.83 kN/m
4	For U2 and U3 effective stiffness (Linear)	4917.364 kN/m	8891.831 kN/m
5	For U1 and U2 effective damping	5%	5%
6	For U1 and U3 distance from end-J	0.003177 m	0.003177 m
7	For U2 and U3 stiffness (Non-linear)	4531.105 kN/m	8193.3776 kN/m
8	For U2 and U3 yield strength	188.190 kN	426.011 kN

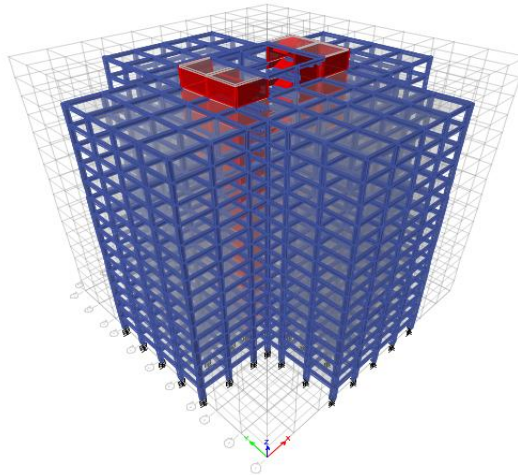
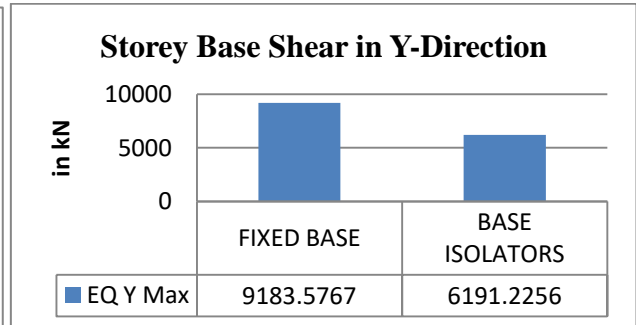
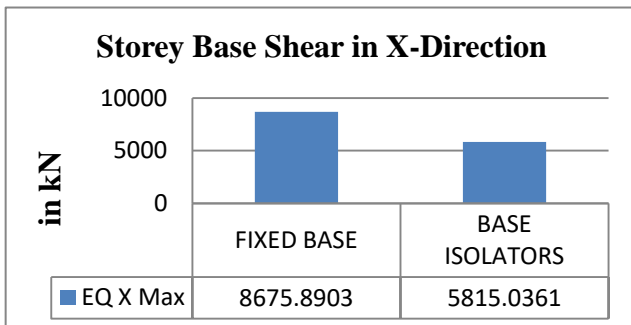


Fig 3.4 3D view of G+15 RCC Structure

III. EXPERIMENTAL RESULTS

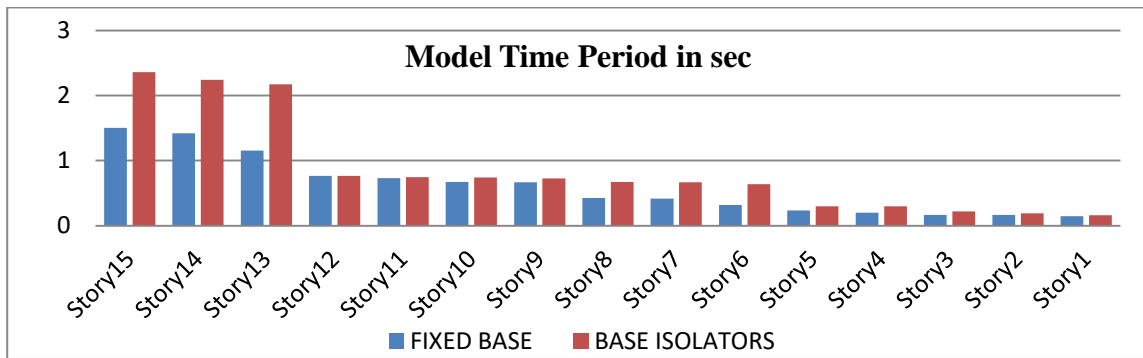
4.1 Baseshear

FLOORS	FIXED BASE IN kN		BASE ISOLATOR IN kN		DIFFERENCE IN % COMPERED WITH FIXED BASE	
	EQ-X	EQ-Y	EQ-X	EQ-Y	EQ-X	EQ-Y
BASE SHEAR	8675.89	9183.58	5815.04	6191.23	-32.95	-32.59



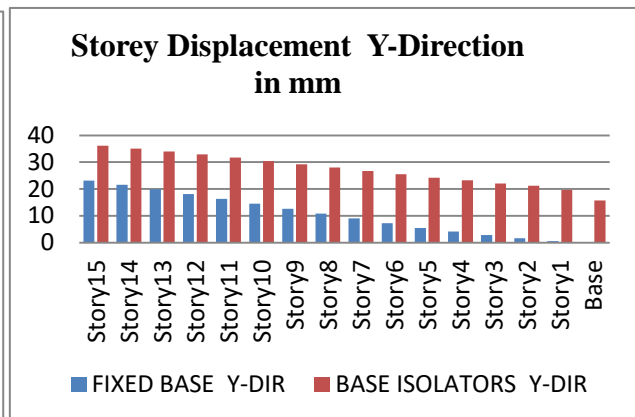
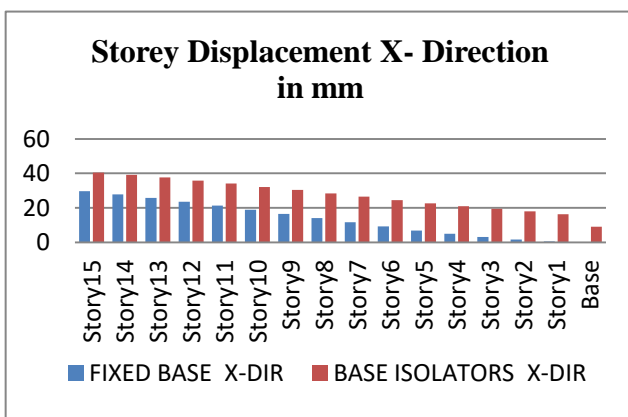
4.2 Mode period

FLOORS	FIXED BASE in sec	BASE ISOLATORS in sec	DIFFERENCE IN % COMPERED WITH FIXED BASE IS DECREASED
15 TH FLOOR	01.505	02.362	+36.23
14 TH FLOOR	01.420	02.243	+36.7
13 TH FLOOR	01.153	02.171	+46.9
12 TH FLOOR	00.765	00.660	+0.13
11 TH FLOOR	00.730	00.744	+1.88
10 TH FLOOR	00.674	00.741	+9.04
9 TH FLOOR	00.667	00.729	+8.5
8 TH FLOOR	00.427	00.674	+36.65
7 TH FLOOR	00.419	00.667	+37.18
6 ST FLOOR	00.320	00.636	+49.69
5 TH FLOOR	00.233	00.299	+22.07
4 TH FLOOR	00.200	00.299	+33.11
3 RD FLOOR	00.165	00.222	+25.68
2 ND FLOOR	00.164	00.189	+13.23
1 ST FLOOR	00.148	00.161	+8.07



4.3 Story displacement

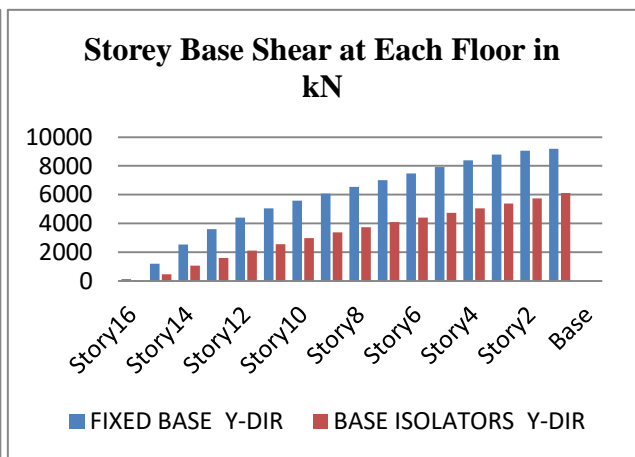
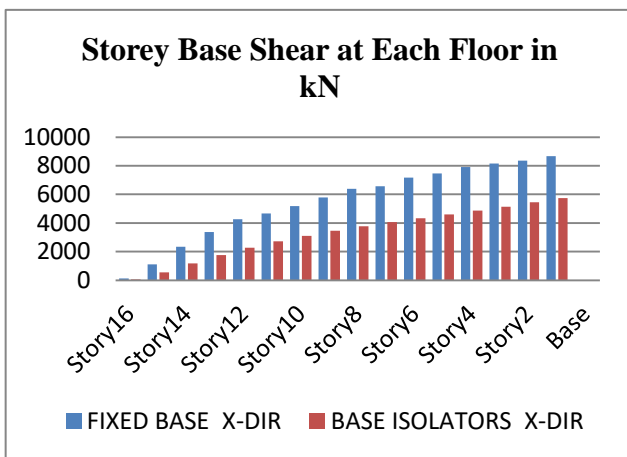
FLOORS	FIXED BASE IN mm		BASE ISOLATORS IN mm		DIFFERENCE IN % COMPERED WITH FIXED BASE IS DECREASED	
	X-DIR	Y-DIR	X-DIR	Y-DIR	X-DIR	Y-DIR
15 TH FLOOR	29.7	23.1	40.5	36.1	+26.67	+36.01
14 TH FLOOR	27.9	21.6	39.2	35.1	+28.83	+38.46
13 TH FLOOR	25.8	19.9	37.6	34.0	+31.38	+41.47
12 TH FLOOR	23.6	18.1	35.9	32.9	+34.26	+44.99
11 TH FLOOR	21.3	16.3	34.1	31.7	+37.54	+48.58
10 TH FLOOR	18.9	14.5	32.2	30.4	+41.30	+52.30
9 TH FLOOR	16.6	12.6	30.4	29.2	+45.40	+56.85
8 TH FLOOR	14.1	10.8	28.5	28.0	+50.53	+61.43
7 TH FLOOR	11.7	9.0	26.5	26.7	+55.85	+66.30
6 ST FLOOR	9.3	7.2	24.5	25.5	+62.04	+71.76
5 TH FLOOR	6.9	5.5	22.6	24.2	+69.50	+77.30
4 TH FLOOR	5.1	4.2	21.0	23.2	+75.71	+81.90
3 RD FLOOR	3.3	2.8	19.5	22.1	+83.78	+87.33
2 ND FLOOR	1.8	1.6	18.0	21.2	+90	+92.45
1 ST FLOOR	0.6	0.6	16.3	19.7	+96.32	+96.95`
GF	0	0	9.1	15.7	+100	+100





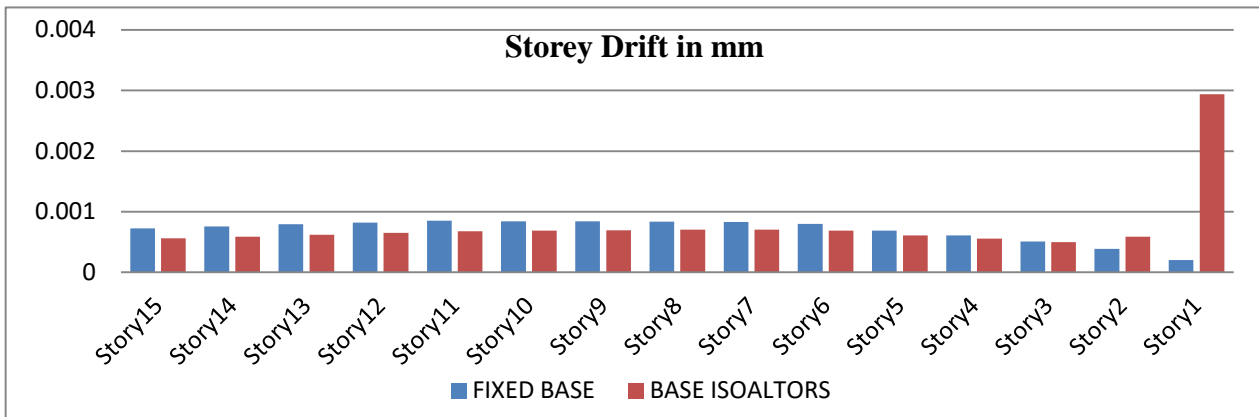
4.4 Each storey base shear

FLOORS	FIXED BASE in kN		BASE ISOLATORS in kN		DIFFERENCE IN % COMPERED WITH FIXED BASE IS INCREASED	
	X-Dir	Y-Dir	X-Dir	Y-Dir	X-Dir	Y-Dir
16 TH FLOOR	126.69	131.80	55.89	48.04	-55.89	-63.55
15 TH FLOOR	1123.82	1214.56	546.60	481.71	-51.36	-60.34
14 TH FLOOR	2354.14	2551.04	1193.22	1071.57	-49.31	-57.99
13 TH FLOOR	3367.90	3606.96	1767.94	1614.53	-47.51	-55.24
12 TH FLOOR	4276.09	4415.58	2274.03	2111.69	-46.82	-52.17
11 TH FLOOR	4679.09	5044.18	2716.85	2565.56	-41.94	-49.14
10 TH FLOOR	5189.09	5580.53	3112.86	2989.96	-40.01	-46.42
9 TH FLOOR	5790.89	6076.17	3464.16	3382.75	-40.18	-44.33
8 TH FLOOR	6389.07	6551.91	3777.06	3746.56	-40.88	-42.82
7 TH FLOOR	6575.90	7016.60	4061.92	4087.96	-38.23	-41.74
6 ST FLOOR	7165.09	7473.13	4328.85	4413.29	-39.58	-40.95
5 TH FLOOR	7456.09	7931.46	4594.03	4736.40	-38.39	-40.28
4 TH FLOOR	7908.98	8384.84	4867.91	5063.41	-38.45	-39.61
3 RD FLOOR	8145.98	8779.84	5149.93	5393.41	-36.78	-38.57
2 ND FLOOR	8348.89	9062.39	5442.78	5731.00	-34.81	-36.75
1 ST FLOOR	8675.89	9189.18	5737.47	6119.40	-33.87	-33.41



4.5 Story drift

FLOORS	FIXED BASE	BASE ISOLATORS	DIFFERENCE IN % COMPERED WITH FIXED BASE IS INCREASED
15 TH FLOOR	00.000724	00.000559	-22.79
14 TH FLOOR	00.000755	00.000585	-22.52
13 TH FLOOR	00.000791	00.000618	-21.87
12 TH FLOOR	00.000819	00.000649	-20.76
11 TH FLOOR	00.000851	00.000677	-20.45
10 TH FLOOR	00.000840	00.000688	-18.09
9 TH FLOOR	00.000843	00.000695	-17.56
8 TH FLOOR	00.000838	00.000701	-16.35
7 TH FLOOR	00.000830	00.000703	-15.3
6 ST FLOOR	00.000800	00.000690	-13.75
5 TH FLOOR	00.000687	00.000607	-11.65
4 TH FLOOR	00.000606	00.000554	-8.58
3 RD FLOOR	00.000510	00.000497	-2.55
2 ND FLOOR	00.000389	00.000587	33.73
1 ST FLOOR	00.000201	00.002941	93.167



IV. CONCLUSION

The finally we going to conclude that above expressed the analytical structure result. The experiment done by (G+15) RCC building with-out and with base isolators system are applied under the effects of seismic force, in the below we explain in detail.

1 Storey Base Shear of the structure:

- I. As the extracting the results for fixed base structure as well as base isolated structure, we can conclude that there is decreased the total storey base shear by using the base isolated structure.
- II. After all the parameters are assigning on the structure, the storey base shear is around **32.58%** reduction as comparing to the fixed base structure.
- III. The total storey Base Shears of X and Y-direction in the both direction we getting reduction around **33%** reduction as comparing with the fixed base structure.

2 Storey time period of the structure:

- I. The extracting the results for fixed base structure as well as base isolated structure, we can conclude that there is increase in natural time period of the base isolated structure.
- II. As above the statement we had conclude that the natural time period getting increased as around the **36.23%** as comparing with the fixed base structure.

3 Storey displacement of the structure:

- I. After extracting the result for fixed base structure as well as base isolated structure, we can conclude that there is increase in storey displacement in the both X and Y-direction.
- II. We conclude that there is getting increased storey displacement around in X-dir **26.67%** and even Y-dir **36.01%** increased as comparing with the fixed base model.

4 Storey Drifts of Structure

- I. The extracting the result for fixed base structure as well as base isolated structure, we can conclude that there is decrease in storey drift of the structure.
- II. The storey drift we getting decreased around **22.79%** as comparing with base isolated structure.

Finally it is concluded that after LRB is provided as base isolation system it increases the structures stability against earthquake.

5.8 Remodelling of structure after conclusion

The Lead Rubber Bearing (LRB) structure is remodelled. Section properties are reduced in LRB base isolated structure and the building is remodelled and analysed. Results were compared with the fixed base and base isolated structure.

5.8.1 Section Properties

ELEMENTS	FIXED BASE	BASE ISOLATORS	REMODELING OF THE BASE ISOLATORS
Columns on 1 st to 5 th floor	800mm X 350mm	800mm X 350mm	800mm X 350mm
Columns on 6 st to 10 th floor	600mm X 300mm	600mm X 300mm	550mm X 280mm
Columns on 11 st to 15 th floor	500mm X 300mm	500mm X 300mm	450mm X 250mm
Beam on 1 st to 5 th floor	600mm X 300mm	600mm X 300mm	500mm X 250mm
Beam on 6 st to 10 th floor	500mm X 300mm	500mm X 300mm	450mm X 250mm
Beam on 11 st to 15 th floor	500mm X 250mm	500mm X 250mm	450mm X 230mm
Thickness of shear wall	200mm	200mm	175mm

5.8.2 Comparison of % variation of parameters in fixed base building with remodelled LRB base isolated building.**% variation of parameters in fixed base building with LRB base isolated models**

Parameters	Fixed base	Reduced in % variation in LRB isolated compared with Fixed base	Reduced in % variation in Remodelled LRB isolated compared with Fixed base
Base Shear	100	-32.58	-42.17
Mode Period	100	-36.23	-40.18
Story Displacement	100	-26.67	-34.87
Story Drift	100	-22.79	-36.60

Parameters	Reduced in % variation in LRB isolated compared with Fixed base	Reduced in % variation in Remodelled LRB isolated compared with Fixed base	Increase in % by directly used base isolated structure
Base Shear	-32.58	-42.17	9.59
Mode Period	-36.23	-40.18	3.95
Story Displacement	-26.67	-34.87	8.23
Story Drift	-22.79	-36.60	13.81

From above results it is concluded that the section properties can be reduced due to the application of LRB base isolator and also provides stability against seismic forces.

V.SCOPE FOR FURTHER STUDY

However, further study can be undertaken in the following areas:

1. By analysis can be done by increasing the number of storey and also height of structure.
2. By considering the different geometric shape of the buildings we can perform the project with providing the base isolators structure.
3. The study can be extended by using the different types of base isolator systems.
4. Reducing the structural dimensions by using base isolated structures.

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