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Comparative Analysis of T Shape 8 Storey Asymmetric RCC Srtucture with and Without Base Isolation

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***Abstract* – The need for design of structures to resist earthquake is to protect the human lives, infrastructures, economy and important buildings such as hospitals, military bases, etc. from the damaging effects of earthquake and reduce the hazards after seismic event. Normally seismic design of structures is based on the method of increasing the resistance capacity of structures against earthquake by using shear walls, braced frames and moment resistance frames. However, these methods are often results in high floor acceleration and inter storey drift for stiff and flexible buildings in order to minimize inter-storey drift and reduce floor acceleration the concept of base isolation is increasingly being adopted. In the present study, a T shape, G+8 storey RCC structures has been designed and analyzed for fixed and isolated base, base isolator used in this study is lead rubber bearing[LRB], analysis and design is performed in accordance with IS standards for seismic design and ETABS 2016 software using Response spectrum method of analysis. Results obtained from analysis of fixed and isolated base models clearly shows that, modal period increases for isolated base building, storey drift decreases for BI building and displacement is more for isolated base compare to fixed base model because of flexibility of base isolated building.**

Key Words*: *Earthquake, fixed base, isolated base, lead rubber bearing(LRB), response spectrum, storey drift, modal period.

1. INTRODUCTION

Earthquake generates lateral forces on the buildings and should be considered during the design of structures to resist earthquake. The purpose of the design of structures to resist earthquake is to protect human lives, economy loses and important buildings form the damaging effect of earthquake. Base isolation is a technique that helps in increasing the earthquake resistance capacity of the structure. BI separates super structure from substructure and decouple the structure from horizontal ground motion induced by earthquake and provides stiff vertical components to the base of superstructure in contact with the substructure (foundation). It results in providing more flexibility to the structure as it increases displacement and modal periods and decrease in the storey drift and base shear of the building. The building under study in this paper is a RCC beam-column framed, hospital building with number stories G+8 located in seismic zone 5. The basic wind speed is 47m/sec as per IS 875 part 3. Material used are M30 grade concrete and HYSD 500 grade steel. ETABS 2016 is used for analysis and design of frame. A typical floor plan is shown in figure 1 with a 3D view of the building in figure 2.

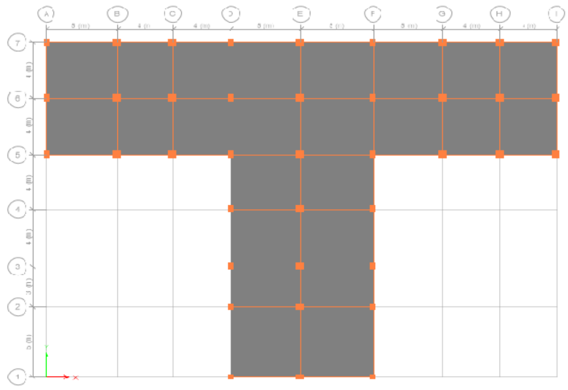


Fig. 1 A typical floor plan

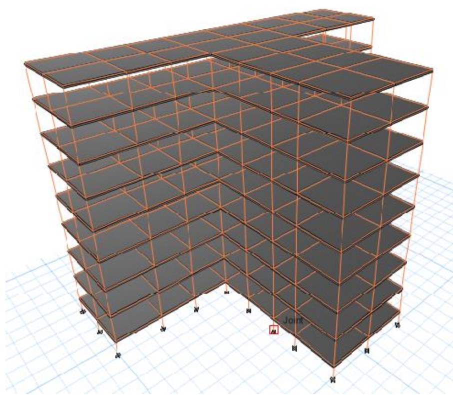


Fig. 2. 3D view

Table. 1 Data of structure.

Floor to floor height	3m
Ground floor height	4.5m
Slab thickness	150mm
Beam size	450x350mm
Column size	500x500mm
Grade of steel	HYSD500
Seismic zone	5
Structure class	B
Terrain category	2
site type	2
Wind speed	47 m/s
Response R factor	5
Dead load	$1 kN/m^2$
Live load	$3 kN/m^2$
Partition wall	150mm
Wall loads	6.12 kN/m
Seismic zone factor	0.36

II. DESIGN OF LEAD RUBBER BEARING(LRB)

Lead rubber bearing are made up of a standard elastomeric laminated rubber bearing the rubber compound can be natural or chloroprene rubber. The shape can be round or rectangular. The calculations for the design of LRB is outlined in table2, which has been performed as per the provisions of UBC-97.

Table 2. Design results of LRB

Maximum vertical load w	2978.554kN
Shear modulus, G	0.7 Mpa
Design time period T_D	2.5sec
Seismic zone factor	0.36
Effective damping	5%
Damping coefficient	1
Bearing stiffness, k_{eff}	1917.857kN/m
Post yield ratio	0.1
Distance from end,j	0.0044m
Yield strength	51.143kN
Stiffness for U_2&U_3	17160kN/m

III. RESULTS AND DISCUSSIONS

Fixed and isolated base T shape structures are analyzed and designed using ETABS 2016 software and the results [displacement, modal periods, storey drift, storey shear and base shear] are computed by Response spectrum method of analysis and results are compared with fixed base structure.

1. *Displacement*

Table. 3 Maximum storey displacement.

Storey	Load case	Direction	Fixed base (mm)	Isolated base (mm)
Base	RS	X	0	43.148
Ground floor	RS	X	1.056	45.662
Storey1	RS	X	7.102	51.099
Storey2	RS	X	14.287	56.095
Storey3	RS	X	21.182	60.502
Storey4	RS	X	27.33	64.245
Storey5	RS	X	32.487	67.275
Storey6	RS	X	36.473	69.553
Storey7	RS	X	39.341	71.156
Storey8	RS	X	41.026	72.097

Table 3 shows maximum displacement for fixed base(41.026mm) and (72.079mm) for isolated base, is showing an increase of 43% in case of base isolation which is an evidence that base isolator provides more flexibility to the structures.

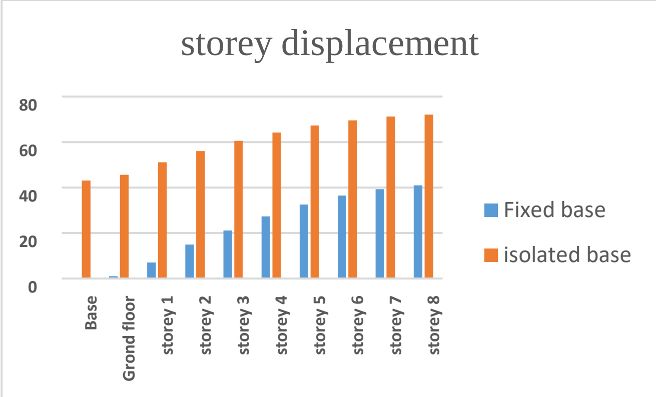


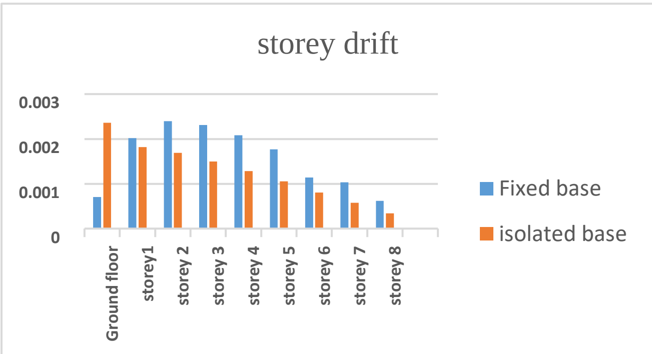
Chart.1. showing variation of storey displacement.

2. *Storey drift*

Table. 4 storey drift

Storey	Load case	Direction	Fixed base (m)	Isolated base (m)
Base	RS	X	0	0
Ground floor	RS	X	0.000704	0.00236
Storey1	RS	X	0.002016	0.001818
Storey2	RS	X	0.002398	0.001687
Storey3	RS	X	0.002312	0.001495
Storey4	RS	X	0.002079	0.001285
Storey5	RS	X	0.001769	0.001054
Storey6	RS	X	0.0011394	0.000803
Storey7	RS	X	0.001033	0.000573
Storey8	RS	X	0.000621	0.000338

Chart.2. showing variation of storey drift.



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3. Modal periods

Table.5 modal periods of base isolated & fixed base

Case	Mode	Fixed base sec	isolated base sec
Modal	1	0.851	1.575
Modal	2	0.835	1.547
Modal	3	0.743	1.424
Modal	4	0.278	0.42
Modal	5	0.276	0.416
Modal	6	0.248	0.37
Modal	7	0.162	0.217
Modal	8	0.16	0.217
Modal	9	0.146	0.194
Modal	10	0.108	0.142
Modal	11	0.106	0.14
Modal	12	0.098	0.127

From table 5 it is evident that time periods are increases for base isolated building by 45.96% for first modal (fundamental mode).

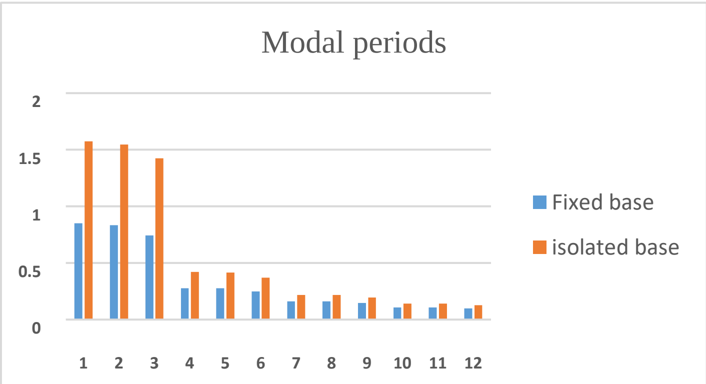

Chart.3. showing variation of modal periods.

4. storey shear

Table.6. storey shear of the structure

Storey	Load case	Direction	Fixed base kN	Isolated base kN
Base	RS	X	0	0
Ground floor	RS	X	3856.1856	2986.42
Storey 1	RS	X	3810.136	2709.5
Storey 2	RS	X	3632.24	2425.3
Storey 3	RS	X	3336.69	2122.3
Storey 4	RS	X	2946.14	1797
Storey 5	RS	X	2472.43	1444.9
Storey 6	RS	X	1910.43	1062.26
Storey 7	RS	X	1255.23	650.2
Storey 8	RS	X	658.23	314.475

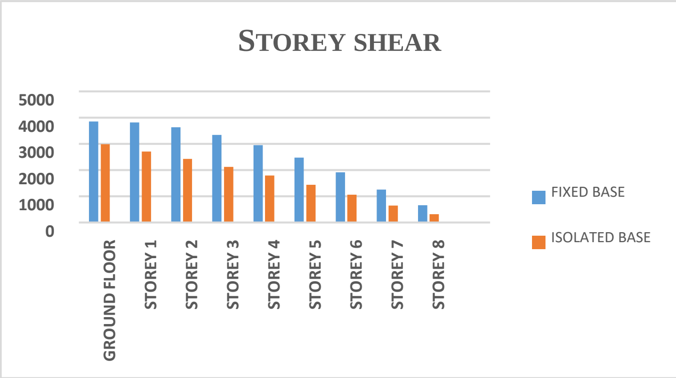

Chart.4. showing variation of storey shear.

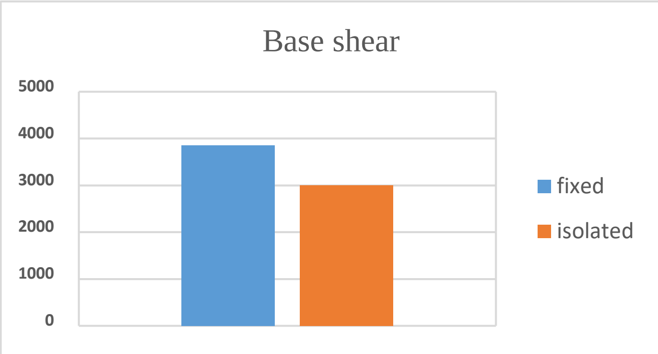

Chart.5. showing variation of base shear

5. CONCLUSION

1. Applying base isolation to a structure reduces the base shear of the building which results in reducing the earthquake effects on the structure.
2. The modal periods of the structure with LRB base isolation is more than the structure with fixed base.
3. Displacement of each storey with LRB base isolation is increased which results in high ductility and flexibility to a structure.
4. Storey drift in each storey decreases for base isolated compare to fixed building which results in an increase in storey drift.
5. Using base isolation systems increases the structural stability which results in reducing the earthquake effects on the structure.

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AUTHOR’S PHOTO