COMPARISION OF BUILDING FOR SESMIC RESPONSE BY USING BASE ISOLATION

Sonali Anilduke[1], Amay Khedikar[2]

[1]Tulsiramji Gaikwad Patil College of Engineering and Technology[1], RTMNU, Nagpur University, Nagpur
[2]Asst. Prof Tulsiramji Gaikwad Patil College of Engineering and Technology [2], RTMNU, Nagpur University, Nagpur

Abstract

Throughout historic time Earthquakes are one of the natural hazards that occur due to sudden violent movement of earth's surface which causes damage to property, especially to man-made structures . Base isolation is one of the most powerful tools of earthquake engineering pertaining to the passive structural vibration control technologies. The application of the base isolation techniques to protect structures against damage from earthquake attacks has been considered as one of the most effective approaches and has gained increasing acceptance during the last two decades. This paper present three dimensional nonlinear time history analysis is performed on r/c building by the use of computer program SAP 2000 v12.0.0. The dynamic analysis of the structure has been carried out and the performance of the building with and without isolator is studied. The main objective here is to make seismic response control by providing Isolators and comparing between the fixed based and isolated base building. Rubber bearing and Friction pendulum bearing are used

Keywords: *Base Isolation; Seismic Response; Time History*

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1. INTRODUCTION

Seismic base isolation is a well-defined building protection system against earthquakes. Earthquakes are one of nature 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. Seismic isolation is a structural design approach that aims to control the response of a structure to horizontal ground motion through the installation of a horizontally flexible and vertically stiff layer of structural isolation hardware between the superstructure and its substructure. The dynamics of the structure is thus changed such that the fundamental vibration period of the isolated structural system is significantly longer than that of the original, non-isolated structure, leading to a significant reduction in the accelerations and forces transmitted to the isolated structure and significant displacements in the deformable, structural base isolation, layer.

Time History Method shall be used on as approximate ground motion and shall be performed by using accepted principles of Dynamics. Response Spectrum Method of analysis shall be performed by using design spectrum specified in 6.4.2 as per I.S. 1893(Part1):2002

Fig.1 C/S of Lead Rubber Bearing

Fig.2 Friction Pendulum Bearing

1.1 Concept of Base Isolation

The basic concept of base isolation is to protect the structure from the damaging effects of an earthquake by improving dynamic response of structure. When base isolation is used, special bearings are installed between the bottom of the building and its foundation. The bearings are flexible in the horizontal direction and reduce the natural frequency of a building. The first dynamic mode of the isolated structure involves deformation only in the isolation system, and the structure above remains almost rigid. An isolated system does not absorb the vibrating energy, but rather deflects it through the dynamics of the system. It lengthens the natural period of vibration of the structure so that the responses are greatly reduced. In some cases a passive damper may also use to control excessive displacement. Figure 3 represents the shifting of period by the isolator and the resulting reduction in the acceleration response.

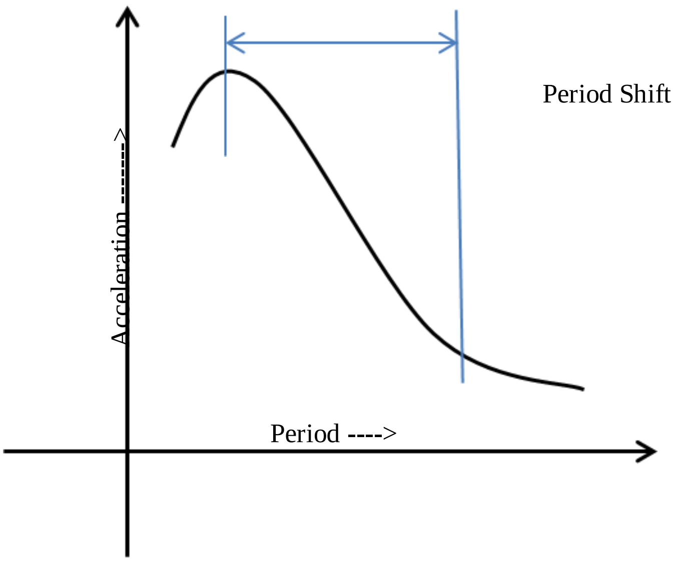

Fig 3 Period shift induced by an isolator

The main objective of this work is

- To illustrate the basic concept and behavior of the base isolated structures.
- To Analyze a building by providing rubber bearing and friction pendulum bearing.
- To study and compare total base shear force, maximum absolute acceleration, velocity ,displacement with respect to the fixed base and isolated base structure.

2. DETAIL EXPERIMENTAL

For comparing a fixed base and isolated base building a Seven-storied building is modeled in the SAP 2000 software . An open frame building model with3 and 4 bays in each X and Y directions, the height of each storey as 3.2 m are modeled. Height .of building is 22.4m,Width of building in X direction is 11m and Width of building in Y direction is 14 m. The material properties of the frame elements and the area element are defined and M25 concrete grade and Fe-415 is used. The rebar material properties are also given. The beams and columns of dimensions b1 300x300,b2 300x350,c1 230x350,c2 230x400,c3 230x450 mm are given as frame elements. The slab in the building is assigned as a shell element with a thickness of 120mm. Live load is taken as 3kn/m2 .Interior and Exterior wall thickness is taken as 150mm and 230mm.Soil type is taken as 1,Zone factor is V, Response reduction factor is taken as 5.And Importance factor is 1.. The support condition at the bottom is made as fixed and the fixed-base analysis is performed considering the combination of 1.5(DL+LL).All other data is referred from I.S.1893-2002. The period for the fixed base is identified. Then the calculated rubber properties are given as link/ support properties in the software and the base-isolation model analysis is performed. The response of the structure with the rubber isolator and friction pendulum isolators are determined. The parameters selected to define the utilized Isolators in the SAP2000 program are as follows:

ForRubber Bearing: Nonlinear Link Type: Rubber, U1 Linear Effective Stiffness: 1500000 kN/m, U2 and U3 Linear Effective Stiffness: 800 kN/m, U2 and U3 Nonlinear Stiffness : 2500 kN/m, U2 and U3 Yield Strength : 80 kN, U2 and U3 Post Yield Stiffness Ratio: 0,1.For Friction Pendulum Bearing: Nonlinear Link Type: Friction Isolator, U1 Linear Effective Stiffness: 15000000 kN/m, U1 Nonlinear Effective Stiffness: 15000000 kN/m, U2 and U3 Linear Effective Stiffness: 750 kN/m, U2 and U3 Nonlinear Stiffness:15000 kN/m, U2 and U3 Friction Coefficient, Slow: 0,03,U2 and U3Friction coefficient, Fast : 0,05, U2 and U3 Rate Parameter: 40, U2 and U3 Radius of Sliding Surface: 2,23.(Referred from. Torunbalci1 and G. Ozpalanlar2 octo.12-17(2008))

3. RESULTS AND DISCUSSION

Analysis is done for both X and Y direction for fixed base and isolated base and is also carried for different storey heights of the building for the same building plan i.e. each floor. The isolator in each case varies in its total height and its single layer thickness depends on the vertical loads on the columns. The corresponding increase in time verses displacement by using time history analysis is done. represented by graph for fixed, rubber and friction beraring base fig.4a,4b,4c in X and 5a,5b,5c Y direction.

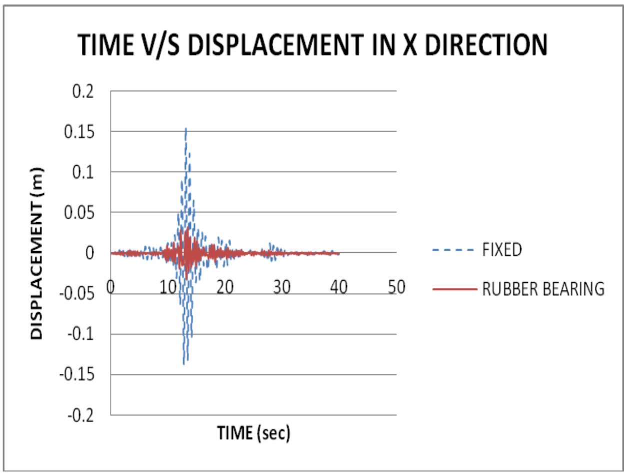

Fig 4a. For Fixed and Rubber bearing

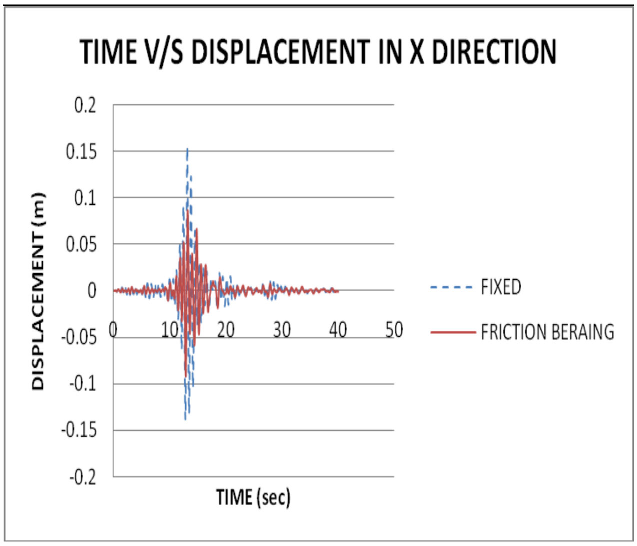

Fig 4b. For Fixed and Friction bearing

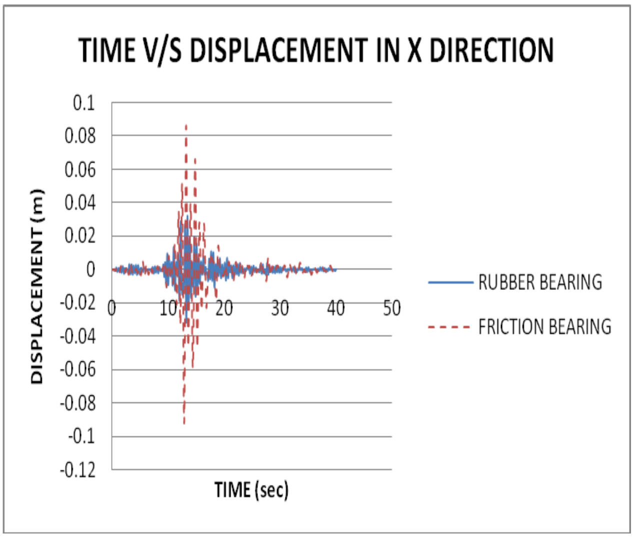

Fig 4c. For Friction and Rubber bearing

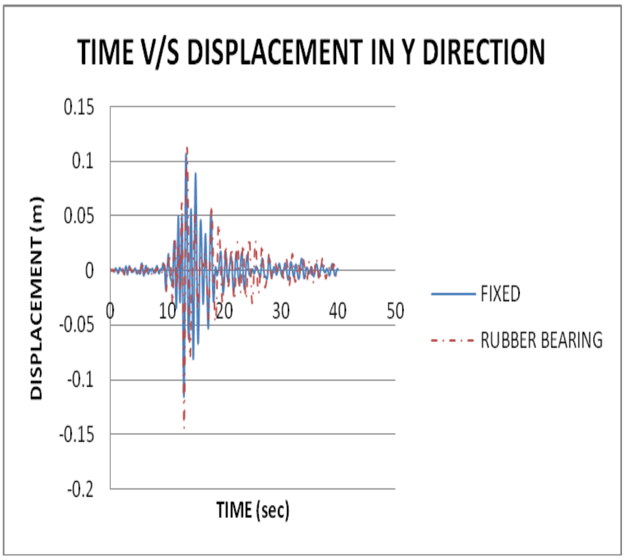

Fig 5a. For Fixed and Rubber bearing

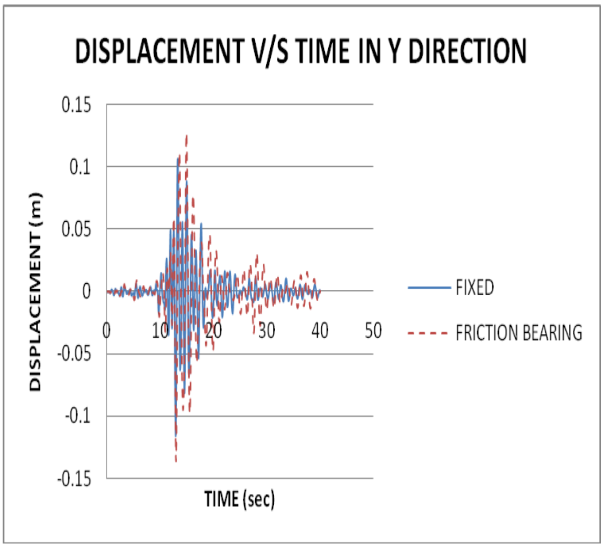

Fig 5 b. For Fixed and Friction bearing

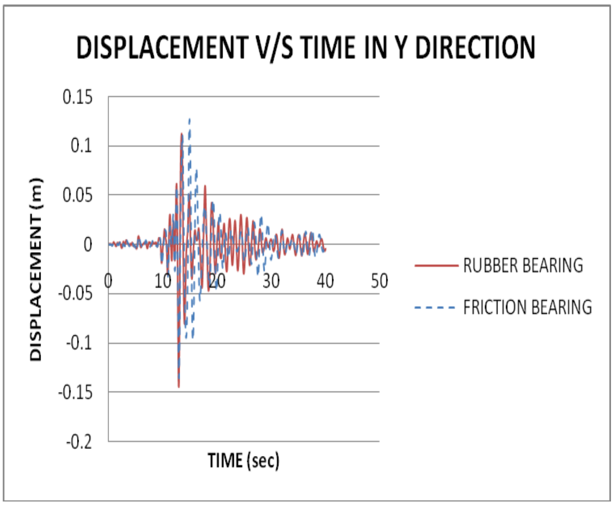

Fig 5c. For Friction and Rubber bearing

Base reaction in X and Y direction for Fixed base ,Rubber bearing and friction bearing isolators are represented byfig.6 and values are shown in table 1

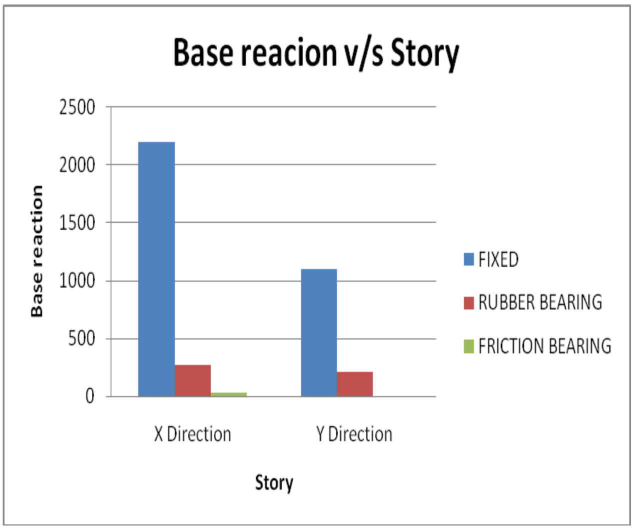

Fig 6. Base reaction v/s Story in X and Y direction

Table 1. Base Reaction

	FIXED	RB	FRB
X-Direction	2200.176	268.558	33.616
Y-Direction	1099.898	214.554	5.837

Displacement with respect to story for fixed base ,rubber beraring, friction bearing are represented by fig 7 a for X direction and 7b for Y direction and values are shown in table 2

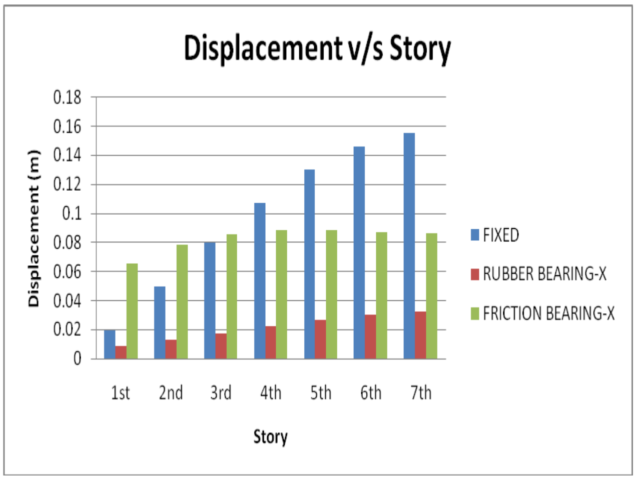

Fig 7a. Displacement v/s Story in X direction

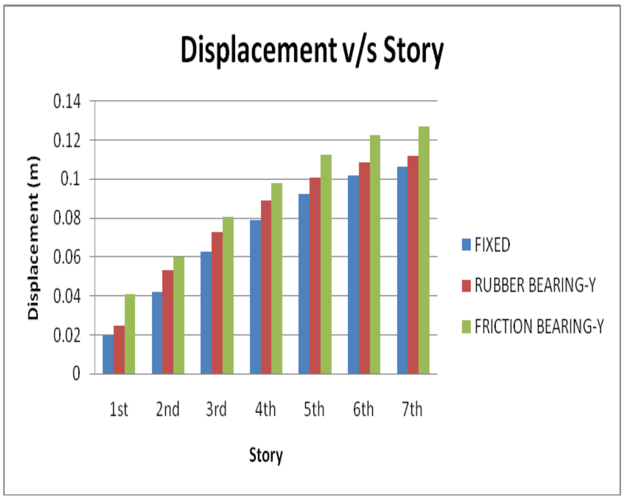

Fig 7b. Displacement v/s Story in Y direction

Table 2

	JOINT DISPLACEMENT					
	Fixed U1	Fixed U1	RB U1	RB U2	FRB U1	FRB U2
Store y	X	Y	X	Y	X	Y
	m	m	m	m	m	m
1st	0.0196 9	0.019 4	0.008 6	0.024 8	0.0657 3	0.0410 5
2nd	0.0498 1	0.042 2	0.012 6	0.052 9	0.0783 2	0.0596 8
3rd	0.0800 6	0.062 5	0.017 3	0.073	0.0857 9	0.0804 9
4th	0.0107	0.079	0.022	0.089	0.0887	0.0979

	54	2	2	3	2	2
5th	0.1302	0.092 4	0.026 7	0.100 7	0.0886 3	0.1124 9
6th	0.1464 1	0.101 7	0.030 2	0.108 4	0.0873 4	0.1225
7th	0.1555 8	0.106 7	0.032 2	0.112	0.0863 2	0.1273 4

Acceleration with respect to story for fixed base ,rubber bearing, friction bearing are represented by fig 8 a for X direction and 8b for Y direction and values are shown in table 3

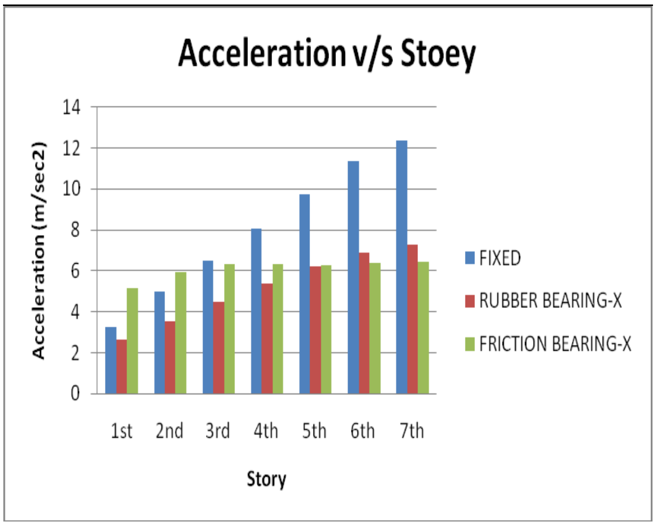

Fig 8a. Acceleration v/s Story in X direction

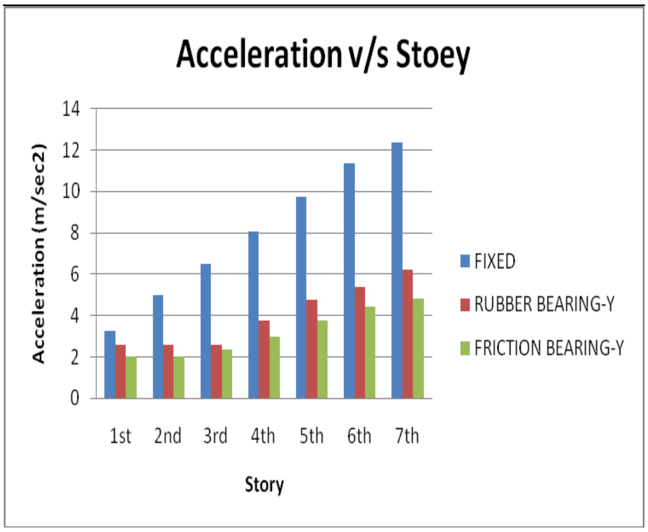

Fig 8b. Acceleration v/s Story in Y direction

Table 3

	JOINT ACCELERATION					
	Fixed U1	Fixed U1	RB U1	RB U2	FRB U1	FRB U2
Store y	X	Y	X	Y	X	Y
	m/sec 2	m/sec 2	m/sec 2	m/sec 2	m/sec 2	m/sec^2

1st	3.268	2.474	2.644	2.588	5.124	2.013
2nd	4.982	2.647	3.507	2.557	5.947	1.989
3rd	6.523	3.877	4.452	2.577	6.330	2.346
4th	8.073	4.785	5.398	3.747	6.341	2.982
5th	9.738	5.13	6.243	4.773	6.250	3.739
6th	11.369	5.138	6.885	5.400	6.362	4.405
7th	12.376	5.421	7.257	6.221	6.433	4.802

4. CONCLUSION

Basic concept of base isolation are very well studied .Base Isolators controls structural response in which the building or structure is decoupled from the horizontal component of the earthquake ground motion. A base-isolation system reduces ductility demands on a building, and minimizes its deformations. From the result, By conducting the nonlinear time history analysis it was shown that base isolation increases the flexibility at the base of the structure which helps in energy dissipation due to the horizontal component of the earthquake and hence superstructure's seismic demand drastically reduced as compared to the conventional fixed base structure.

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