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Earthquake Analysis of Top Storey Isolated Building using Rubber Isolater

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Abstract

The seismic isolation reduces the earthquake forces by increasing period of vibration of the structure. In this paper investigation regarding seismic response of top story isolated building and fixed-base building is performed with a similar structural system above the ground for soft soil as per IS 1893-2002 using Response spectrum

Keywords: *Fixed Base building, top storey Isolation Soft storey etc.*

1. Introduction

The earthquake is the sudden release of some stored energies in the earth's crust and upper mantle that causes sudden shaking in part of earth's crust. Due the ground motion there is large amount of damage caused to the structures. From last few years the earthquake resistant design of structures has been largely based on a ductility design concept. The performances of the ductile structures during major earthquake have been proved to be unsatisfactory. Now a day's there is most widely implemented an accepted seismic protection system is isolation. Seismic isolation is a technique that reduces the effects of an earthquake by isolating the structure from dangerous ground motion due to earthquake. The objective of is isolation to prevent the superstructure of the building from absorbing the earthquake energy. The basic idea behind the isolated structure is to increase the period of vibration of a structure.

2. Mathematical modeling

The mathematical modeling of building structure, superimposed load and combination of earthquake loads is as per IS-1893.The typical framing plan of 5-story building is shown in Fig. 1.Each storey height is considered as 3.0m.The building in plan is 24x16 m^2 area, with 6m span in the X direction and 4m in the Y direction. The column cross-section used in the structure is 500x500mm; beam cross-section used is 300x600mm.analysis is performed using SAP2000 with live load 3 kN/m2.

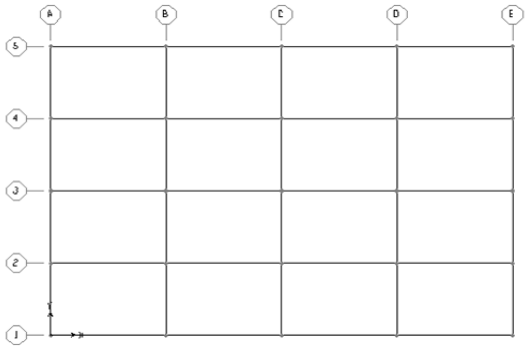

Fig.1 Plan of building

3. Rubber isolator

The seismic isolators in the system are defined as Nllink components 0.2 in length placed at the bottom of Top Storey columns. i.e. between column top of storey four and base of column at storey five.

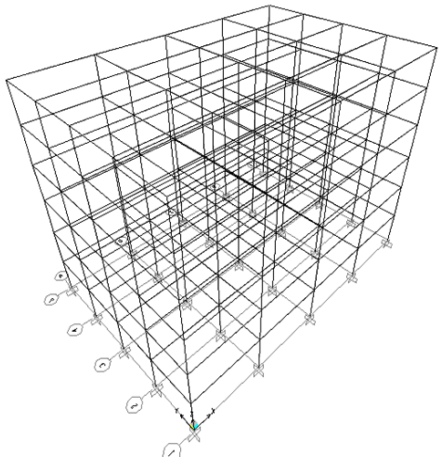

Fig.2 Perspective view Building Model

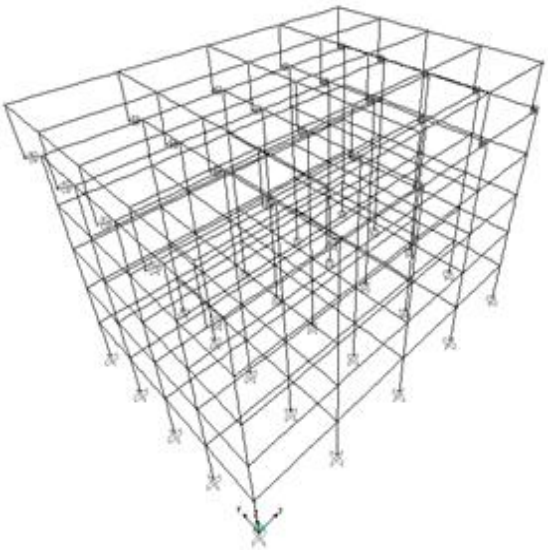

Fig. 3 Perspective view of TI Building Model

The parameters selected to define isolators in the SAP2000 program are, 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.

4. Test Results and Discussions

4.1 Structural Time Period

Mode	Top Isolated	Fixed Base
	T (sec)	T (sec)
1	1.16	0.95
2	1.11	0.86
3	1.06	0.82

In the nonlinear analysis carried out for fixed base, the 1.mode period of the structure is found to be 0.95 sec. in x direction and the 2. mode period as 0.86 sec. in y direction.

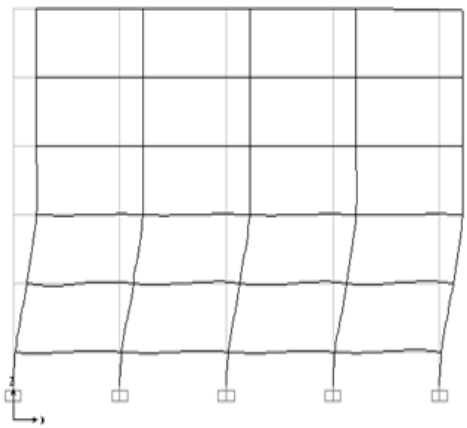

Fig.3 Mode shape 1 for FB building

In the nonlinear dynamic analysis carried out for TI building, the 1.mode period of the structure is found to be 1.16 sec in the x direction and the 2. mode period as 1.11 sec in the y direction, as shown in Fig.4.

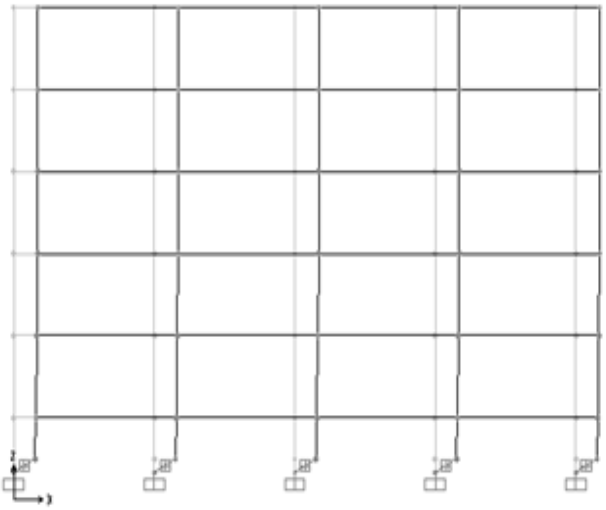

Fig.4 Mode shape 1 for BI building

4.2 Maximum Base Shear

Sr.No.	Structure.	X direction	Y direction
1.	Fixed Base	1282	1406
2.	Top isolated	1005	1115

In the base shear forces, the results of the TI building provided approximately 30% reduction in the x direction and 32% reduction in the y direction. Fig. 5.

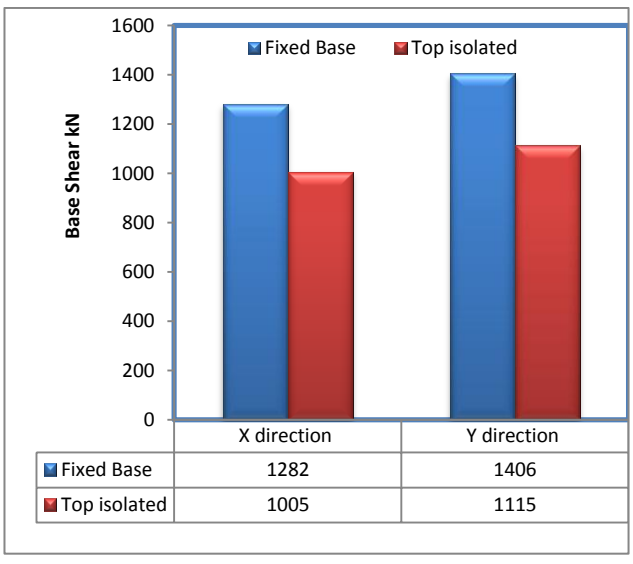

Fig.5 Maximum base shear – x and y directions

4.3. Displacement Response

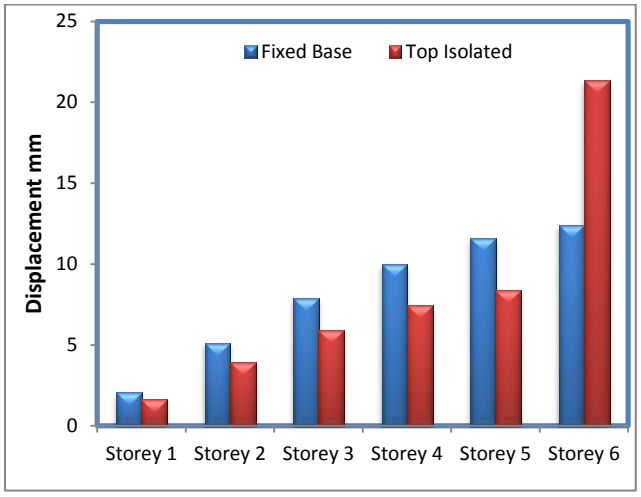

Fig. 7 Storey displacement

The fixed base and Top storey isolated model have zero displacement at base of the building. Also it has been observed that as the floor height increases, lateral displacements increases drastically in case of fixed base building. But for Top storey isolated buildings the lateral displacement variation is smaller as the height increases and increases drastically at top storey, which is isolated Fig.7

4.3 Storey Drift

In case of fixed base building, storey drift is higher at the lower floors and it decreases drastically as we move to the top floors. In case of Top storey isolated buildings, storey drift is comparatively lower than fixed base buildings apart from first floor and decreases as we move to the top floors but the isolated Storey shows drastic increase in storey drift. Fig.8

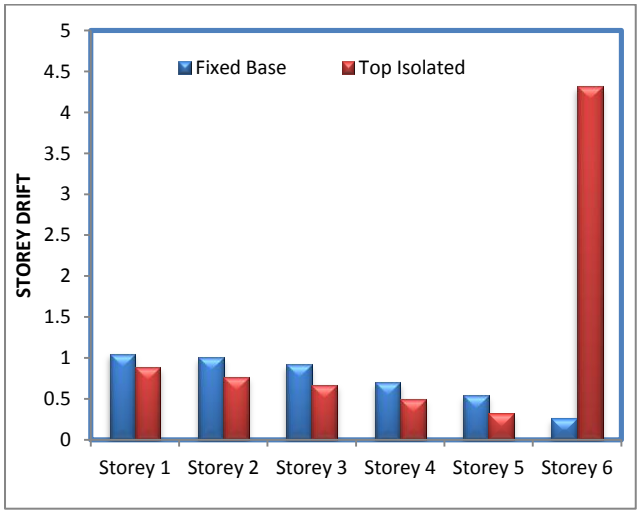

Fig. 8 Inter Storey Drift FB and TI building

Conclusions

The following are the conclusions for analysis.

1. Top storey isolated model shows reducing the design parameters i.e. base shear and bending moment in the structural members.
2. In the base shear forces, the results of the BI building provided 30% reduction in the x direction and 32% reduction in the y direction.
3. Time period affects the earthquake response of the structure, as the time period increases the base shear and acceleration values found to be reducing.
4. In the nonlinear analysis carried out for fixed base; the 1. mode period of the structure is found to be 0.95 sec. in x direction and the 2. mode period as 0.86 sec. in y direction
5. In the nonlinear dynamic analysis carried out for Top Isolated storey the 1.mode period of the structure is found to be 1.16 sec in the x direction and the 2. mode period as 1.11 sec in the y direction
6. In case of fixed base building, displacement is zero at the base and increases as storey height increases. But in case of base isolated building, there is a small displacement and increases at a comparatively slower rate as storey height increases.
7. At base, more storey drift is observed for fixed base model. As storey height increases, the storey drift in top storey isolated building decreases but there is drastically increase in drift of Top storey due to isolation, as compared to fixed base building.
8. This reduction in the forces indicates that the performance of the base isolation under the influence of earthquake is extremely good.

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