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Response Analysis of Mid-Story Fixed Base and Base Isolated Unsymmetrical Building under Seismic Action

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Abstract

Base isolation is design approach, which reduces the transmission of accelerations due to ground motion into structure. The seismic isolation reduces the earthquake forces by increasing period of vibration of the structure. In this paper investigation regarding seismic response of base-isolated (BI) mid-story unsymmetrical reinforced concrete buildings and fixed-base (FB) building will be performed with a similar structural system above the ground.

Keywords: *Building, Fixed Base, Base Isolation etc.*

1. Introduction

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. 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 base isolation. Seismic base isolation is a technique that reduces the effects of an earthquake by isolating the structure from dangerous ground motion due to earthquake. Base isolation is a passive control system, means that, it does not require any external force or energy for its activation. The objective of base isolation to prevent the superstructure of the building from absorbing the earthquake

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 mid-story building is shown in Fig 1. The building is unsymmetrical in plan. Each storey height is considered as 3.0m.The building in plan is 24x16 m2 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.

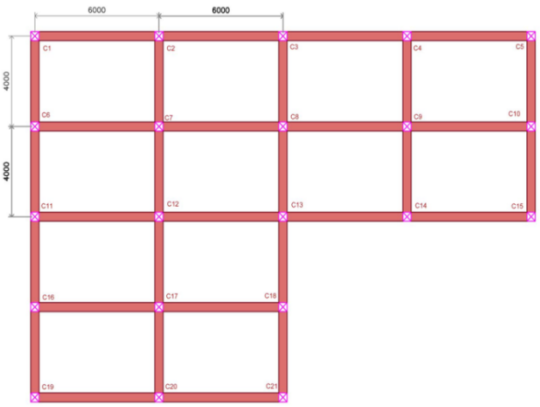


Fig.1 Plan of building

3. Rubber isolator

The seismic isolators in the system are defined as Nllink components 0.5m in length placed between the fixed base and the columns.

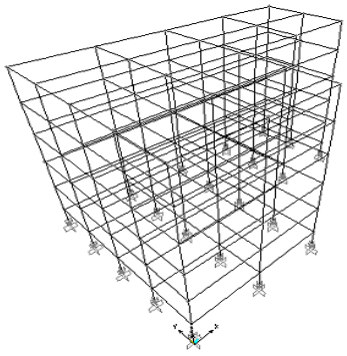


Fig.2 Perspective view Building Model

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

In the nonlinear analysis carried out for fixed base; the 1.mode period of the structure is found to be 0.68 sec. in x direction and the 2. mode period as 0.62 sec. in y direction. In the analysis, the damping ratio for all modes is assumed to be 0.05. Fig.3.

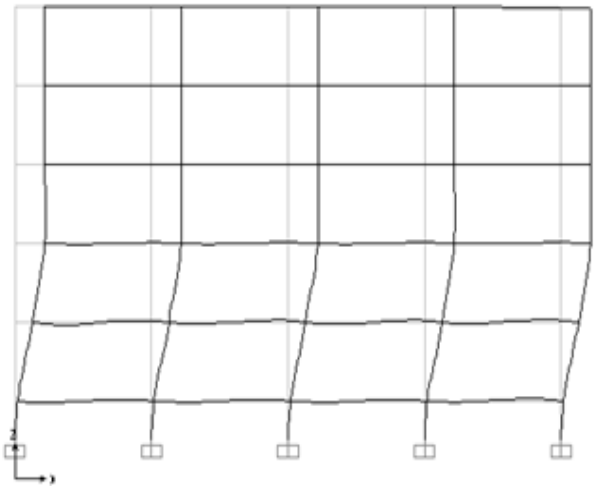


Fig.3 Mode shape 1 for FB building

In the nonlinear dynamic analysis carried out for BI building, the 1.mode period of the structure is found to be 2.71 sec in the x direction and the 2. mode period as 2.69 sec in the y direction, as shown in Fig.4.

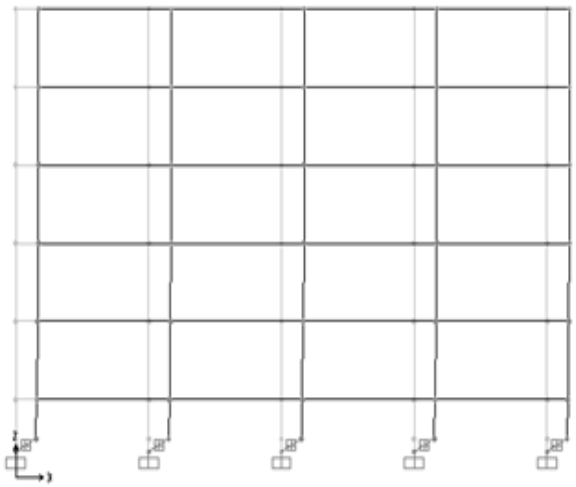
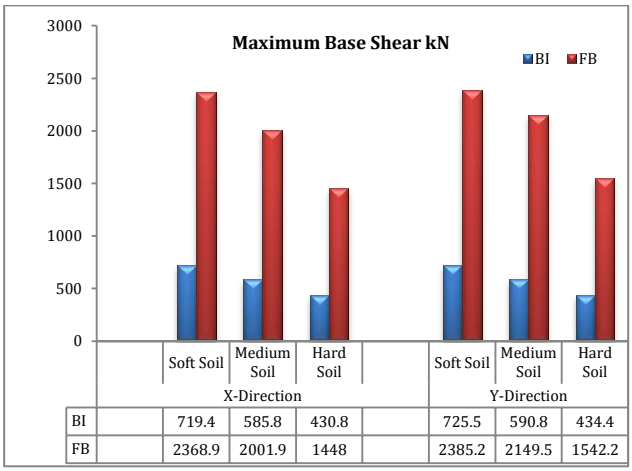


Fig.4 Mode shape 1 for BI building

4.2 Maximum Base Shear

In the base shear forces, the results of the BI building provided approximately 70% reduction in the x direction and 73% reduction in the y direction. This reduction in the forces indicates that the performance of the base isolation under the influence of earthquake is extremely good. Fig.5.0



	Soft Soil	Medium Soil	Hard Soil	Soft Soil	Medium Soil	Hard Soil
	X-Direction			Y-Direction		
BI	719.4	585.8	430.8	725.5	590.8	434.4
FB	2368.9	2001.9	1448	2385.2	2149.5	1542.2

Fig.5 Maximum base shear – x and y directions

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 base isolated buildings, storey drift is comparatively lower than fixed base buildings apart from first floor and decreases as we move to the top floors. Fig.6

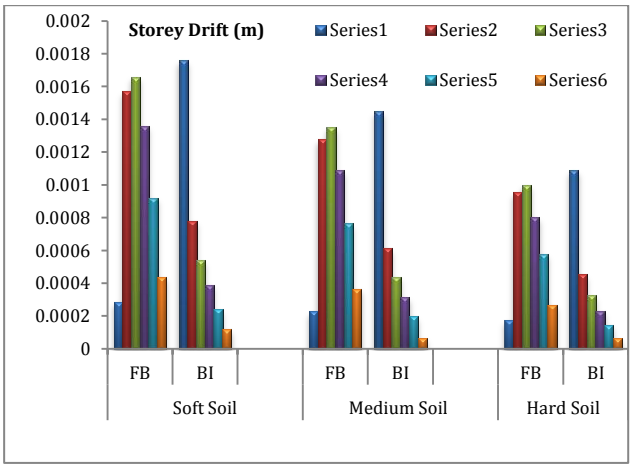


Fig. 6 Inter Storey Drift for different types of soil of FB and BI building

4.4 Moment Variation

The shear and bending moments are reduced due to the higher time period of the base isolated structure which results in lower acceleration.

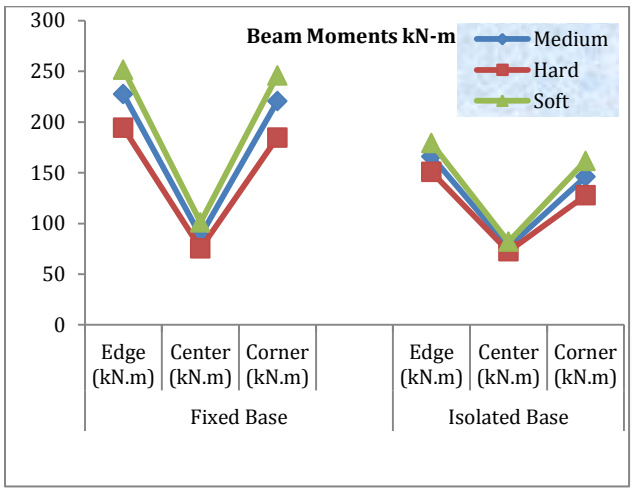


Fig. 7 Beam Moments for storey one

Conclusions

The following are the conclusions for analysis.

1. Base isolation helps in reducing the design parameters i.e. base shear and bending moment in the structural members.
2. The bending moments are reduced about 20% to 30 % for base isolated structure when compared with fixed base building.
3. In the base shear forces, the results of the BI building provided 70% reduction in the x direction and 73% reduction in the y direction.
4. Time period affects the earthquake response of the structure, as the time period increases the base shear and acceleration values found to be reducing; however the displacement increases with the same.
5. At base, more storey drift is observed for base isolated model compared to fixed base building. As storey height increases, the storey drift in base isolated building decreases drastically as compared to fixed base building.
6. The base shear, displacement and acceleration response is higher in case of soft soil than the corresponding value for hard rock.
7. 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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