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Comparative Study Of Vibration Control Of Multi Storey Building With And Without Isolation System

Mustafa Lokhandwala[1], Vishal B Patel[2], Anshu Arya[3]

[1] *Post-graduation Student, Department of Civil Engineering, Parul Institute of Technology, Vadodara.*
[2] *Assistant Professor, Department of Structural Engineering, BVM Engineering College, V.V.Nagar, Gujarat*
[3] *Assist. Professor, Department of Civil Engineering, Parul Institute of Technology, Vadodara.*

Abstract — *Multi-storey reinforced concrete (RC) structures can have a weak structural experience when it is subjected to a dynamic action, in such cases Isolation technology is a very well strategy to protect structures from seismic and dynamic loading. In the present work a multi-storey reinforced concrete building which has mass irregularity is analyzed with four different base isolation systems, in order to defend the reinforced concrete structures with regards to bi-directional ground motions. The considered base isolation systems are Lead rubber bearing (LRB), Friction pendulum isolator (FPI) and parallel system of LRB and FPI with different locations.Time history analyses are performed for base isolated multi-storey RC structures. In the analysis the input of BHUJ seismic events are adopted which can be considered as extreme events in terms of peak ground acceleration.The purpose of the analysis is to highlight the structural response offered by the proposed combination of Lead rubber bearing and Friction pendulum isolator in building having mass irregularity and compare it with their individual behaviour in the seismic protection of structure.*

Keywords- *Mass irregularity, Base Isolation, Lead rubber bearing, Friction pendulum, Time history, ETABs.*

I. INTRODUCTION

In the context of various vibration absorption methods, structural control can be sorted into active control, passive control, hybrid control, semi-active control and so on. Passive control method mostly applicable to existing buildings as compared to other building. Base isolation is a passive vibration control system, which does not require an external source for its operation and uses the inert mechanism of the structure to develop control force. During the recent earthquake, the performance of separate buildings in different parts of the world established that base segregation technology is a viable option for traditional earthquake-resistant design of medium-growth buildings. Using this technique can essentially keep the building in order to be elastic and thus ensure safety during large earthquakes. Since the basic frequency of a base-separate structure is less than the main frequencies of its fixed base frequency and ground motion, the only mode of vibration of the separate structure involves distortion in the isolation system whereas superstructure is almost rigid. In this way, isolation becomes an attractive approach where the cost of sensitive equipment and internal non-structural components is required. It was interest to see the difference between the framework of a fixed base building and the reactions of separate-base building frames under seismic loading. This was the primary motivation of the current study.

In the present analysis the seismic behavior of a multi-storey Reinforced Concrete (RC) building having mass irregularity is evaluated in presence of two different base isolation systems LRB and FPI. The application of this technology may keep the building to remain essentially elastic and thus ensure safety during large earthquakes as they decouples the structure from the horizontal components of the ground motion and reduces the possibility of resonance. This decoupling is achieved by increasing the flexibility of the system, together with appropriate damping by providing isolator at the basement level of the structure.

When we incorporate both LRB and FPI in the building it provide better flexibility to the structure due to which time period elongation happens. According to L.Landi [1] The friction pendulum isolation system combines two fundamental mechanisms: the frictional sliding of steel surfaces ,which is separated by a Teflon layer, and the pendular motion of the slider on a perfectly spherical surface, Through these mechanisms, the device is able to recenter by itself and can dissipate a large quantity of energy through the sliding on a curved surface.. The specific objective of the present study are : (1) To investigate the response of the building under the combination of isolation system over the individual isolation system (2) To analyse the effect of isolation period on structural response.

II. REGULAR AND IRREGULAR STRUCTURES:

According to the Indian standard, the structure is structurally specified in regular or irregular form. In a regular structure there is no significant imbalance in planning, vertical configurations, or lateral force resistance systems. In irregular structure, according to IS-1893 (Part 1) 2002 has such important constraints like plan irregularities and vertical irregularities. To perform well in the earthquake, there are few main features in a building, i.e simple and regular configuration, and sufficient lateral strength, stiffness and ductility.The failure of the structure mainly depends on the discontinuity in the mass of the structure, stiffness and geometry of the building. Mostly due to vertical

irregularity structure possesses failure. To overcome this failure we use isolation system in the building which decouples the superstructure from substructure by which the structure resist the lateral force and gain adequate stability.

LEAD RUBBER BEARING AND FRICTION PENDULUM ISOLATOR:

Donato cancellara[2] analysed the two base isolation systems and their seismic behavior is compared with reference to a multi-storey reinforced concrete building. The base isolation systems have been designed according to the European seismic code. A base isolated building is adopted which has strong irregularity in plan and two base isolation systems have been considered in the analysis, the High Damping Rubber Bearing (HDRB) actuated in parallel with a Friction Slider (FS) and the Lead Rubber Bearing (LRB) also actuated in parallel with a Friction Slider (FS). A dynamic nonlinear analysis is performed for the three-dimensional base isolated structure. The seismic assessment and the dynamic nonlinear analysis of the base isolated structure are illustrated by presenting a comparative analysis of the behavior of the structure isolated by the two considered base isolation systems and the corresponding behavior of the traditional fixed base structure. Compared to HDRB isolators, the LRB isolators show a greater dissipative capacity, from 15% to 30% more. Another significant advantage of the LRB isolators is the robustness and stability of their hysteretic cycles when compared to the hysteretic cycles of the HDRB isolators. In present work i design the Lead rubber bearing isolator and Friction pendulum isolator according to (UBC-97) and (IBC 2000). I have taken the parallel system of Lead rubber bearing and Friction pendulum isolator in my analysis with mass irregularity in structure.

III. Structural Properties And Modeling:

A G+10 multi storey building with the plan dimensions of 30m x 30m have been adapted in the present work with 5 bays in both longitudinal and transverse directions respectively. The storey height of building up to 1st storey is 3m and above all storey is 3.5m.

SPECIFICATIONS OF BUILDING:

Grade of concrete (fck)	M-25
Grade of steel (fy)	Fe-415
Beam	350mm x 500mm
Coloumn	550mm x 550mm
Slab	150mm
Live load (1st floor)	10 kn/m2
Live load (up to 11th floor)	4 kn/m2
Floor finish	1.5 kn/m2
Soil type	II
Zone	V
Response reduction factor (R)	5
Importance factor (I)	1
Damping ratio	0.05

There are 5 models is taken in the analysis -

1) Building with Fixed base

2) Building with Lead rubber bearing isolator

3) Building with Friction pendulum isolator

4) Building with LRB at outer column and FPI at inner column

5) Building with FPI at outer column and LRB at inner column

IV. RESULTS

All figures show the response of the building such as (Time period, Base shear, Story drift, Story displacement) incorporated with the different isolators such as LRB, FPI and combination of LRB and FPI with two different locations (1. LRB at outer columns & FPI at inner columns, 2. FPI at outer columns and LRB at inner columns) under seismic event of BHUJ.

A) TIME PERIOD

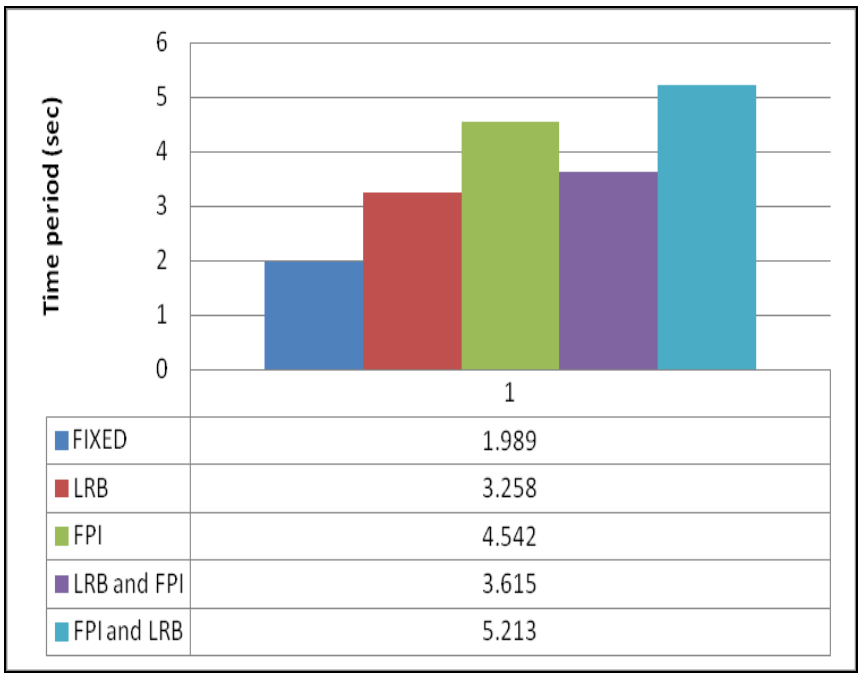

Fig -1 Time period

From Figure 5 It is observed that time period of the building increases more than 40% in all cases, but in case of FPI at outer column and LRB at inner column, time period increases 61%.

B) BASE SHEAR

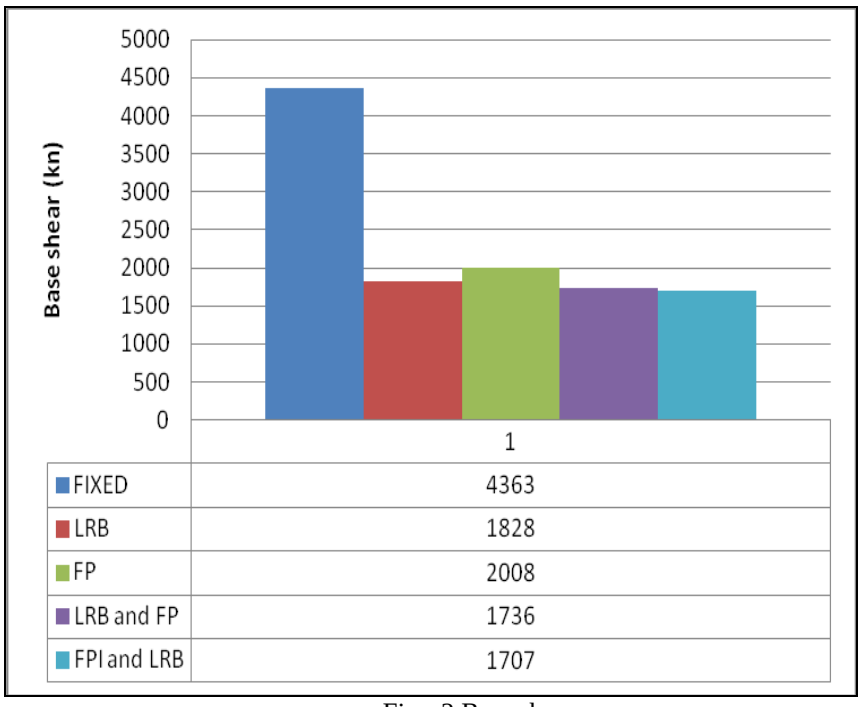

Fig - 2 Base shear

Base shear reduces in all isolation system but in case of combination of FPI and LRB it reduces enormously, as compared to fixed building base shear reduces to 60% in combination of LRB and FPI.

C) STORY DRIFT

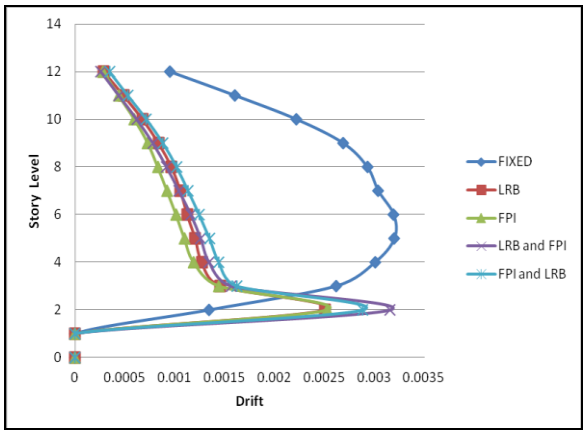

Fig - 3 Story Drift in X-direction

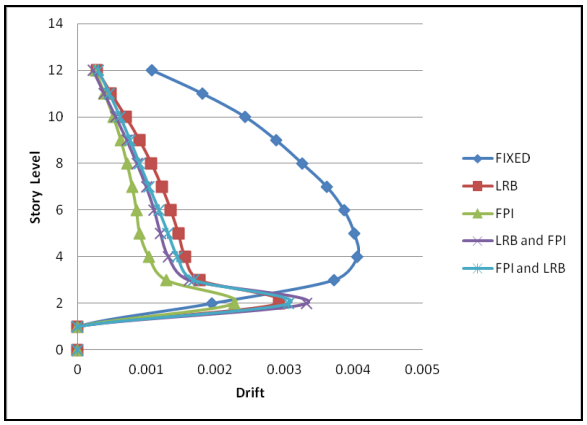

Fig - 4 Story Drift in Y-direction

From figure 5 and 6 it observed that at story level 2 story drift increases in all model because of mass irregularity exist in the building but in parallel system of FPI and LRB it decreases enormously and give very effective result.

D) MAXIMUM STORY DISPLACEMENT

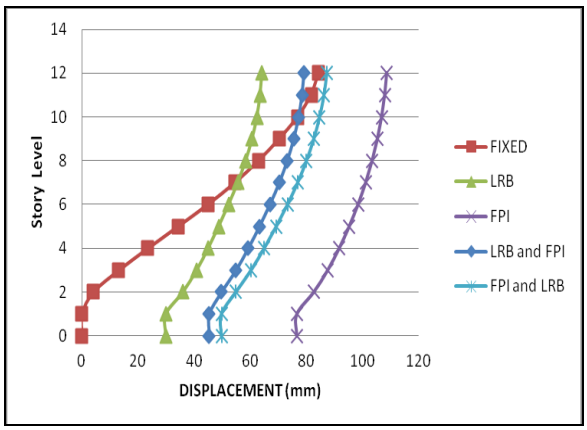

Fig - 7 Story Displacement in X-direction

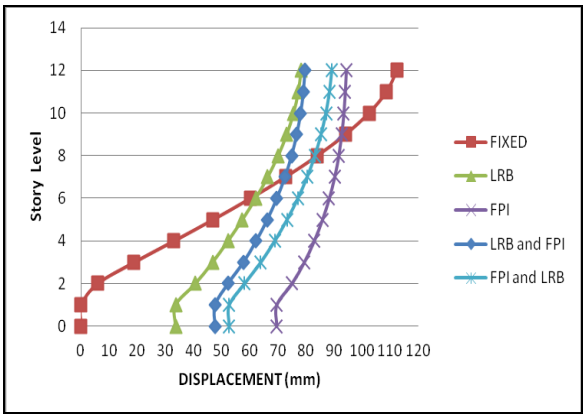

Fig - 7 Story Displacement in Y-direction

Figure 7 and 8 shows the displacement of all stories, In all models at base level displacement increases as compared to fixed base building. But at top level it goes decreasing very fairly in all system, in case of LRB system top displacement decreases from 117mm to 55mm.

V. CONCLUSION

Under the dynamic analysis of building using BHUJ seismic event, it concluded that the base isolation system proves more relevant in seismic prone areas and all isolation system possesses better stability to the structure but the parallel system of Friction pendulum isolator and Lead rubber bearing isolator (FPI at outer column and LRB at inner column) provide good rigidity to the structure specially in case of time period and base shear. In case of FPI at outer column and LRB at inner column, time period increases 61% and base shear reduces upto 60%.

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[6] Is 1893 : 2002 Criteria For Earthquake Resistant Design Of Structures

