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SEISMIC CONTROL OF SYMMETRIC AND ASYMMETRIC FRAMED STRUCTURES BY BASE ISOLATION METHOD

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Abstract – In recent years considerable attention has been paid to research and development of structural control devices with particular emphasis on mitigation of wind and seismic response of buildings. Many vibration-control measures like passive, active, semi-active and hybrid vibration control methods have been developed. Passive vibration control keeps the building to remain essentially elastic during large earthquakes and has fundamental frequency lower than both its fixed base frequency and the dominant frequencies of ground motion. Base isolation is a passive vibration control system. Free vibration and forced vibration analysis was carried out on the framed structure by the use of computer program SAP 2000 v15.0.1. The results of the free vibration analysis like time period, frequency, mode shape and modal mass participating ratios of the framed structure were found out. Forced vibration analysis (non-linear time history analysis) was done to determine the response of framed structures and to find out the vibration control efficiency of framed structures using lead rubber bearing. Isolation bearings in this study are applied to the symmetric and asymmetric buildings. Introduction of horizontal flexibility at the base helps in proper energy dissipation at the base level thus reducing the seismic demand of the super structure to be considered during design.

Key Words: *Passive vibration control, Base isolation, Time history analysis, rubber bearing*

1. INTRODUCTION

Earthquakes are the most unpredictable and devastating of all natural disasters, which are very difficult to save over engineering properties and life, against it. Hence in order to overcome these issues we need to identify the seismic performance of the built environment through the development of various analytical procedures, which ensure the structures to withstand during frequent earthquakes. The main types of earthquake protective systems[1] include passive, active and semi-active systems. In passive control systems the devices do not require additional energy source to operate and are activated by the earthquake input. The passive control[2] is more studied and applied to the existing buildings than the others. Base isolation[5] is a passive vibration control system that does not require any external power source for its operation and utilizes the motion of the structure to develop the control forces. Performance of base isolated buildings in different parts of the world during earthquakes in the recent past established that the base isolation technology is a viable alternative to conventional earthquake-resistant design of buildings.

1.1 Concept of Base Isolation

The basic concept in seismic isolation is to protect the structure from the damaging effects of an earthquake by introducing a flexible support isolating the building from the shaking ground. The base isolation system introduces a layer of low lateral stiffness between the structure and the foundation. With this isolation layer the structure has a natural period which is much longer than its fixed base natural period. This lengthening of the period can reduce the pseudo-acceleration and hence the earthquake induced forces in the structure. In buildings, the base isolator protects the structure from earthquake forces in two ways by deflecting the seismic energy and by absorbing the seismic energy. The seismic energy is deflected by making the base of the building flexible (instead of fixed) in lateral directions, thereby increasing the fundamental time period of the structure.

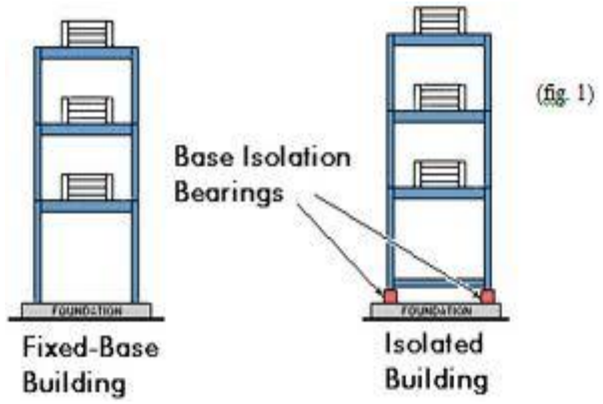

Fig-1: Function of Base Isolation

1.2 Non-Linear Time History Analysis

NLTHA is one of the methods and the most accurate method available to understand the behavior of structures subjected to earthquake forces[6]. As the name implies, it is the process of finding out the history of responses throughout the life span of the dynamic loading like an earthquake ground acceleration record until the structure reaches a limit state. The dynamic loading consists of applying a earth-quake ground acceleration Record of lateral loads to a model which captures the material non-linearity of an existing or previously designed structure, and monotonically increasing those loads which vary with time so that the peak response of the structure is evaluated.

For this purpose two earth-quake ground acceleration records namely N-E Bhuj and N-W Bhuj components of the Bhuj Earthquake record have been selected. Bhuj is a place located in the state of Gujarat which is a high intensity earthquake zone of zone factor 0.36 which comes under the Zone-V according to the classification of seismic zones[3] by IS 1893-2002 part-1.The records are defined for the acceleration points with respect to a time-interval of 0.005 second.

1.3 Objective and Scope

The main objective of this work is

- Study of Seismic demands of regular R.C buildings using the Non-linear time history analysis.
- To illustrate the effects of base isolators, on the response of the High-rise Symmetric & Asymmetric Buildings.
- To study the free vibration response of the high rise building with and without base isolator.

2. MODELLING OF STRUCTURE

The Layout of plan having 3X3 bays of equal length of 4m. The buildings considered are Reinforced concrete special moment resisting space frames of 11 storeys symmetric as well as asymmetric. The unit weights of the materials adopted, have been taken according to the IS-875 (Part 1) and the live load consideration in loads according to IS-1893 (Part 1): 2002 i.e. 25% of the live load[3] has to be considered if the LL > 3.5kN/m^2 Stiffness of the infill is neglected in order to account the Nonlinear Behavior of Seismic demands. All these buildings have been analyzed by NLTHA method.

The Plan configuration consists of

1. Model 1 –Building in rectangular shape symmetry, Eleven storey-Number of bays in x-direction=3, Number of bays in y-direction=3 .
2. Model 2 -Building in L shape Asymmetry, Eleven storey.

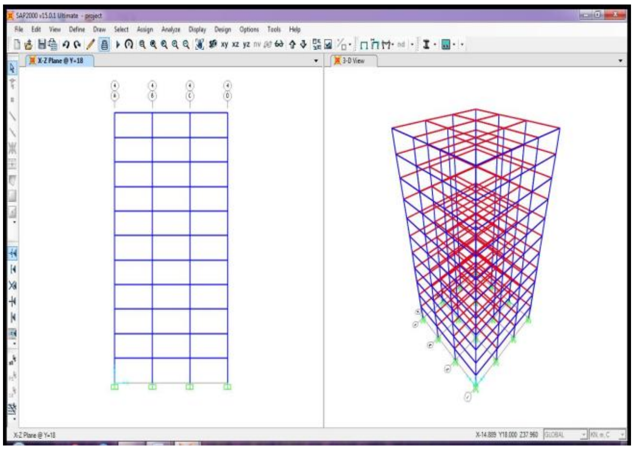

Fig-2: Isometric view and elevation of model-1

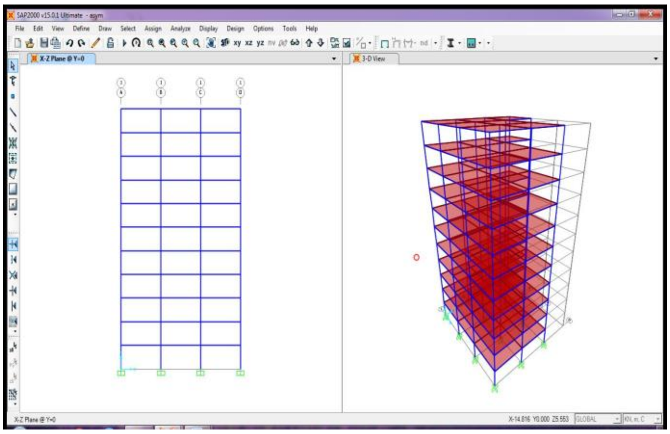

Fig-3: Isometric view and elevation of model-2

3. RESULTS AND DISSCUSSIONS

The Results obtained are of different parameters such as Storey drifts, Base shear ,Modal Periods, Torsion etc. and the results obtained by carrying out Non-Linear Time History Analysis using Base Isolation techniques for both Symmetric and Asymmetric Buildings for Eleven storey Building are listed below.

Table -1: Modal time periods of symmetric building

	With isolation	Without isolation
Mode	Time period in sec	Time period in sec
1	2.913729	0.967074
2	2.913686	0.967074
3	2.771277	0.889319
4	0.480863	0.31289
5	0.480862	0.31289
6	0.440461	0.288901
7	0.234322	0.177305
8	0.234322	0.177305
9	0.217931	0.165423
10	0.149427	0.118975
11	0.149427	0.118975
12	0.139695	0.111414

Table-2: Modal time periods of asymmetric building

	With isolation	Without isolation
Mode	Time period in sec	Time period in sec
1	2.878645	0.976877
2	2.877072	0.97408
3	2.734541	0.902086
4	0.486486	0.315207
5	0.485334	0.314438
6	0.447716	0.292427
7	0.236319	0.177825
8	0.235293	0.177323
9	0.220441	0.166618
10	0.150277	0.118874
11	0.149723	0.118675
12	0.140955	0.111853

3.1 Discussion of Results

Results for Base Isolation of Symmetric Buildings:
The reduction in storey drifts using base isolation at top storey level from 48 mm to 35.3 mm.

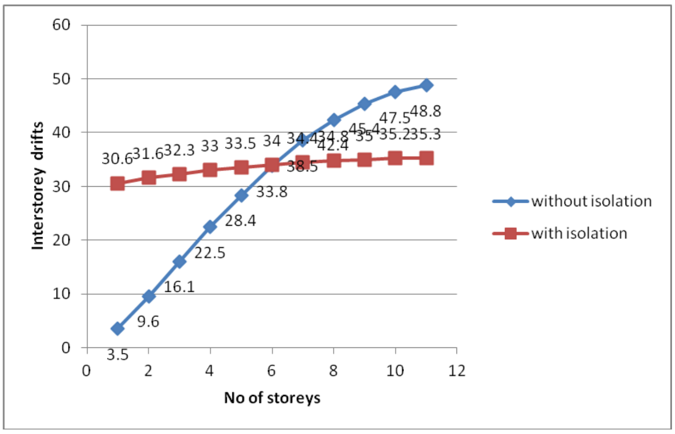

Fig-2: Interstorey drifts for symmetric building

The storey drifts on an average were reduced by 28% for the eleven storey structure as shown in figure 2.

The base shear is reduced from 59.83 KN to 30.96 KN for the eleven storey building. There is a decrease in base shear by 50% for the eleven storey symmetric building after using base isolators. There is a reduction in base torsion from 639.1 KN/m to 176.8KN/m for the eleven storey symmetric building. There is a decrease in base torsion by 72.34% for the eleven storey building after using base isolators.

Results for Base Isolation of Asymmetric Buildings:
The reduction in storey drifts using base isolators at top storey level from 42 mm to 14.7 mm.

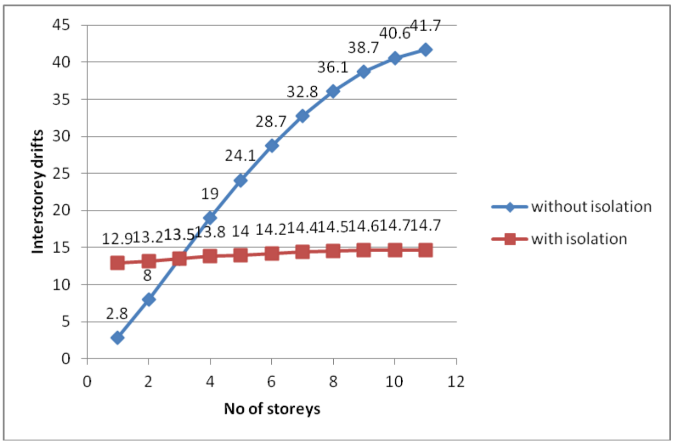

Fig-3: Interstorey drifts for asymmetric building

The storey drifts on an average decreased by 65% for the eleven storey asymmetric building as shown in the figure3.

The reduction in base shear was observed for the eleven storey building from 49.27KN to26.63KN. There is a decrease of base shear by 46% for the eleven storey asymmetric building. The base torsion moment for the eleven storey building after using base isolation is reduced from 409.1 KN/m to 138 KN/m. There is a decrease in base torsion by 66.26% for the eleven storey building.

3. CONCLUSIONS

1. The storey drifts were decreased by 28% for eleven storey symmetric building. Suggesting the effectiveness of Base Isolators for High-Rise Buildings (Symmetric).

2. The storey drifts were decreased by 65 % for eleven storey asymmetric building. Suggesting the effectiveness of Base Isolators for High-Rise Buildings (Asymmetric).

3. The Base Isolators were found to be excellent seismic control devices for eleven storey buildings in controlling forced Responses such as base shear for symmetric buildings because of the reduction in Base shear by 50% for Symmetric Buildings.

4. The Base Isolators were found to be excellent seismic control devices for eleven storey buildings in controlling forced Responses such as base shear for asymmetric buildings because of the reduction in Base shear by 46% for Asymmetric Buildings.

5. The Torsion was decreased by 72.34% for eleven storey symmetric building. Suggesting the effectiveness of Base Isolators for High-Rise Buildings (Symmetric).

6. The Torsion was decreased by 66 % for eleven storey asymmetric building. Suggesting the effectiveness of Base Isolators for High-Rise Buildings (Asymmetric).

7. The overall results suggested that base isolators were excellent seismic control devices for High-Rise Symmetric Buildings.

8. In conclusion by performing Non Linear Time-History Analysis, it can be demonstrated that base isolators are effective for High-Rise Symmetric and Asymmetric Buildings.

REFERENCES

[1] KubilayKaptan, “Seismic Base Isolation and Energy Absorbing Devices”, European Scientific Journal, Vol-9, No-18.
[2] Ian G Buckle, “Passive Control of Structures for Seismic loads”, University of Nevada-Reno, United States of America, 2000.
[3] IS 1893(Part-1) 2002 Indian Standard criteria for earthquake resistant design of structures.
[4] SAP User Manual version 15, Computers and Structures Inc.
[5] Sajal Kanti Deb, “Seismic base isolation – An overview”, Current Science, vol. 87, No. 10, November 2004.
[6] S.M.Wilkinson , R.A.Hiley "A Non-Linear Response History Model For The Seismic Analysis Of High-Rise Framed Buildings" september 2005,Computers and Structures.
[7] S.M. Kalantari, H.Naderpour and S.R.Hoseini Vaez "Nonlinear Dynamic Analysis of Multiple Building Base Isolated Structures by Investigation Of Base-Isolator Type Selection On Seismic Behavior Of Structures Including Storey Drifts And Plastic Hinge Formation." The 14th World Conference on Earthquake Engineering October 12-17, 2008, Beijing, China.