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Seismic isolation of high-rise RC building using lead rubber isolator

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ABSTRACT

Severe damage is caused to property by earthquakes, especially to necessitate architects and manmade structures. Seismic isolation is the better solution as many researchers studied and reviewed for the earthquake resistant design of the structures. This is because base isolation confines the effects of the earthquake strike, a workable base isolating structure largely separating the structure from the ground motion, and the isolated structural counter accelerations are usually less as compared to the regular structural counter acceleration in response to ground acceleration. The present work is intended to provide a systematic procedure to assess the behavior of a structure during the seismic excitation. In this work, a lead rubber bearing isolator is used to high-rise RC buildings by doing Response Spectrum Analysis using ETABS software. The fundamental goal of base isolation is to reduce substantially the absorption of the earthquake-induced force and energy by the structure. Base isolation system significantly reduces the superstructure lateral stiffness and ductility compared to the un-isolated structure which is demonstrated by the results of this work. This allows cost saving from less material being spend on the lateral system and implication of structural detailing.

Keywords— *Base isolation, Lateral stiffness, Response spectrum analysis, Seismic excitation, Un-isolated structure*

1. INTRODUCTION

The multi-storey structures are unsafe when they are subjected to earthquakes. The multi-storey structures are generally subject to failure due to seismic forces at the location where there is a weakness. The weakness of structures is due to the presence of irregularities in stiffness, strength and mass.

In this case, we are studying mass irregular buildings. Excess mass leads in the reduction of ductility of vertical load resisting elements and increase inertia forces and thus increase the tendency towards collapse. Thus there is a necessity of designing a structure that can sustain seismic forces. In this study, multi-storey buildings are protected against earthquake forces by installing structural isolation devices.

The use of lead rubber base isolator for symmetric buildings for low rise and high rise structures in the present work aims to demonstrate the effect of base isolation techniques. The buildings studied in this section are 5 and10-storey with mass irregularity Space Frames Designed for Gravity and Seismic Loads Using Linear Static Analysis. Using Response Spectrum Analysis in accordance with seismic code IS-1893:2002, the structure is evaluated with the help of the ETABS2016 software (CSI Ltd) analysis engine.

2. RESEARCH SIGNIFICANCE

Ground vibrations during earthquakes cause forces and deformations in structures. Designed structures should have the ability to withstand such forces and deformations. Seismic codes help to improve the behavior of structures so that they may withstand the earthquake effects without significant loss of property and life. The first Indian earthquake design code was published in the year 1962 as IS 1893:1962. In view of this, the present work aims at the following objectives:

- To Study the Seismic demands of regular R.C buildings.
- To illustrate the effects of base isolators, on the response of the low rise to High-rise Symmetric Buildings.
- To develop displacement and drift curves for the considered buildings.

3. METHODS AND MATERIAL

3.1 Linear static analysis

This method of finding lateral forces is also known as the linear static method or the seismic coefficient method. The static method is the simplest one and it requires less computational effort and is based on formulae given in code of practice. In all the

methods of analyzing a multi-storey building recommended in the code, the structure is treated as a discrete system having concentrated masses at floor levels which include the weight of columns and walls in any storey should be equally distributed to the floors above and below the storey. In addition, the appropriate amount of imposed load on this floor is also lumped with it. It is also assumed that the structure is flexible and will deflect with respect to the position of foundation the lumped mass system reduces to the solution of a system of second order differential equations. These equations are formed by the distribution of mass and stiffness in a structure, together with its damping characteristics of the ground motion

3.2 Response spectrum method

It is based on the idea that the response of a building is the superposition of the responses of individual modes of vibration, each mode responding with its own particular deformed shape, its own frequency, and with its own modal damping.

According to IS 1893(Pamt-11:2002, high rise and irregular buildings must be analyzed by the response spectrum method using design spectra. The method involves only the calculation of the maximum values of the displacements and member forces in each mode using smooth spectra that are the average of several earthquake motions. However, in this method, the design base shear (V_B) shall be compared with a base shear (V_b) calculated using a fundamental period. If design base shear is less than base shear all response quantities are (for example member forces, displacements, storey forces, storey shears and base reactions) multiplied by V_B/V_b.

This approach permits the multiple modes of response of a building to be taken into account (in the frequency domain). The response of a structure can be defined as a combination of many special shapes (modes) that in a vibrating string correspond to the "harmonics". Computer analysis can be used to determine these modes for a structure. For each mode, a response is read from the design spectrum, based on the modal frequency and the modal mass, and they are then combined to provide an estimate of the total response of the structure. In this, we have to calculate the magnitude of forces in all directions i.e. X, Y and Z and then see the effects on the building. Combination methods include the following:

- Absolute – peak values are added together
- Square Root of the Sum of the Squares (SRSS)
- Complete Quadratic Combination (CQC) – a method that is an improvement on SRSS for closely spaced modes

The result of a response spectrum analysis using the response spectrum from a ground motion is typically different from that which would be calculated directly from a linear dynamic analysis using that ground motion directly since phase information is lost in the process of generating the response spectrum

3.3 Base isolation

Base isolation is the concept of protecting a building from the damaging effects of an earthquake by introducing some type of support that isolates it from the shaking ground is an attractive one, and there are many mechanisms to achieve this result have been proposed. Base isolation is a passive control device that is installed between the foundation and the base of the building.
Base isolation system consists of isolation units with or without isolation components, where:

(a) Isolation units are the basic elements of a base isolation system which are intended to provide the aforementioned decoupling effect to a building or non-building structure.
(b) Isolation components are the connections between isolation units and their parts having no decoupling effect of their own.

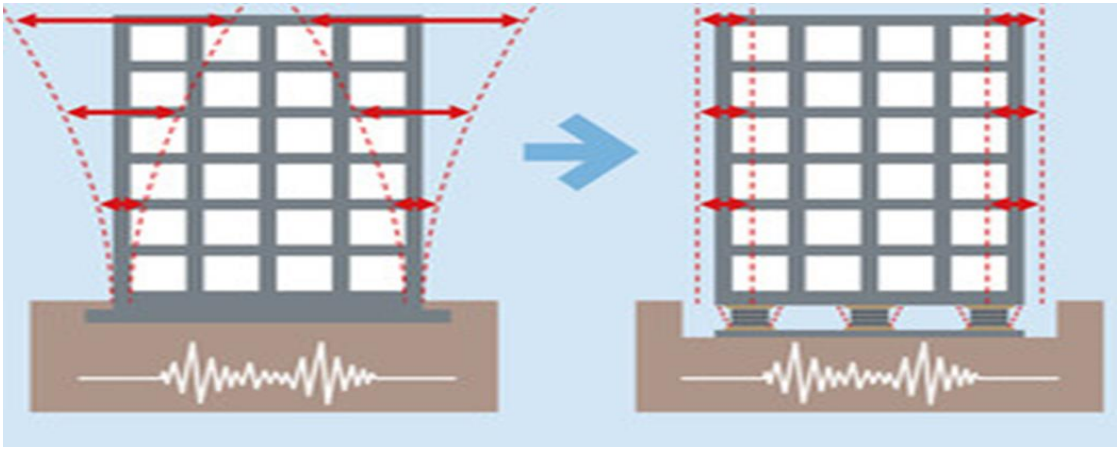

Fig. 1: Seismic Isolation with and without Base Rubber Isolator

3.5 Step by step process to perform the response spectrum analysis in ETABS software

Following are the general sequence of steps involved in performing NLTHA using ETABS in the present study:

- A three-dimensional model that represents the overall structural behaviour is create
- For reinforced concrete elements the appropriate reinforcement is provided for the cross section
- Frame hinge properties are defined and assigned to the frame elements
- Gravity loads composed of dead loads and a specified proportion of live load is assigned as a seismic weight to the structure
- The linear model with design spectrum modes are defined by assigning the ground acceleration time history function as loading in x and y directions and by assigning proportional damping

- After the completion of the analysis, the displacement pattern of the structure is studied and inter-storey drifts are calculated
- The other responses such as base shear, member forces, and response spectrum curves are noted

4. RESULTS AND DISCUSSION

The Results obtained for different parameters such as storey drifts, base shear and deflections are presented in this section. Firstly the result obtained by the linear static analysis and response spectrum base isolation techniques for symmetric buildings and for 5and10th storeys with mass irregularities is presented.

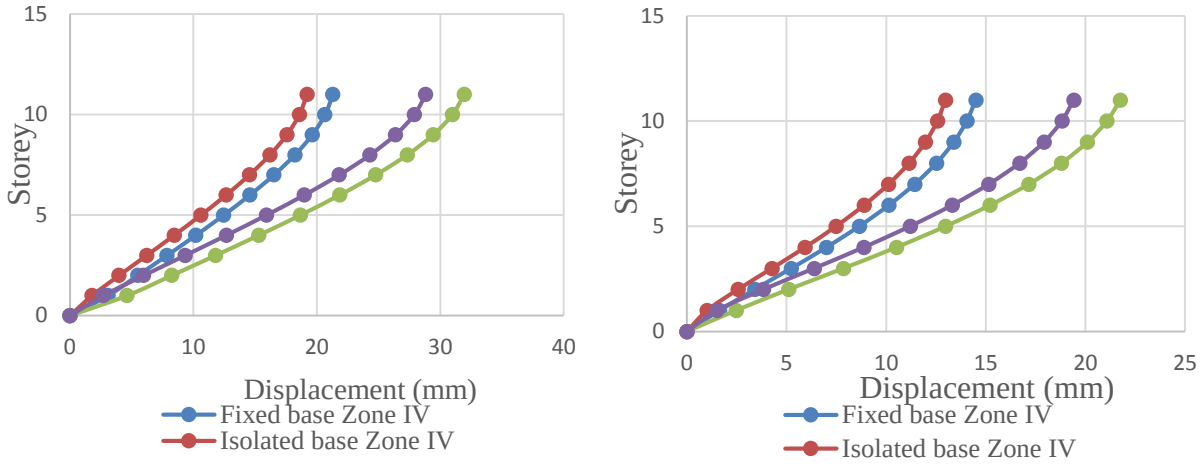

Fig. 2: Displacements (mm) of Linear Static analysis and Response spectrum analysis

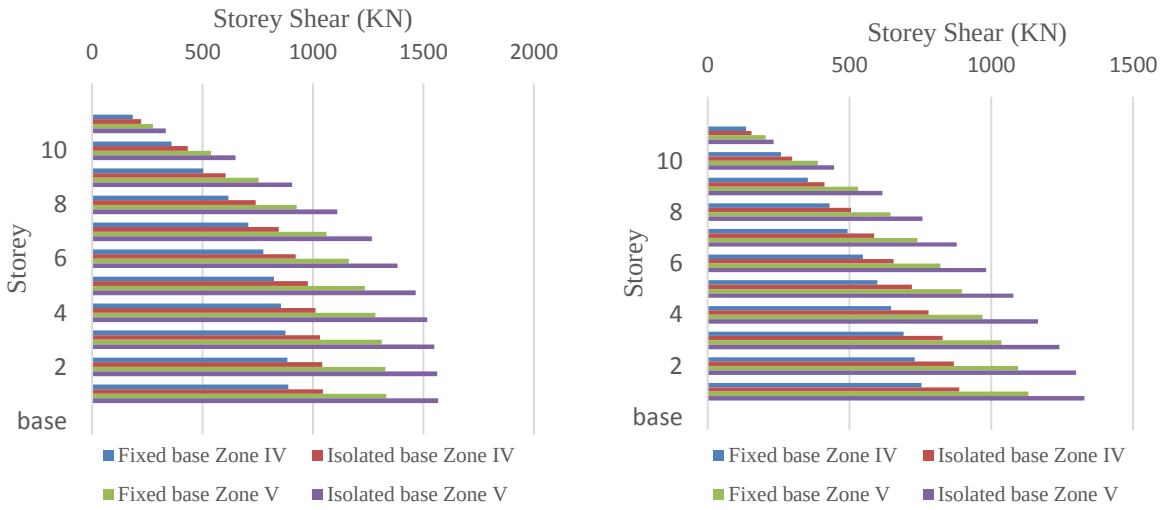

Fig. 3: Storey shear of Linear Static analysis and Response spectrum analysis

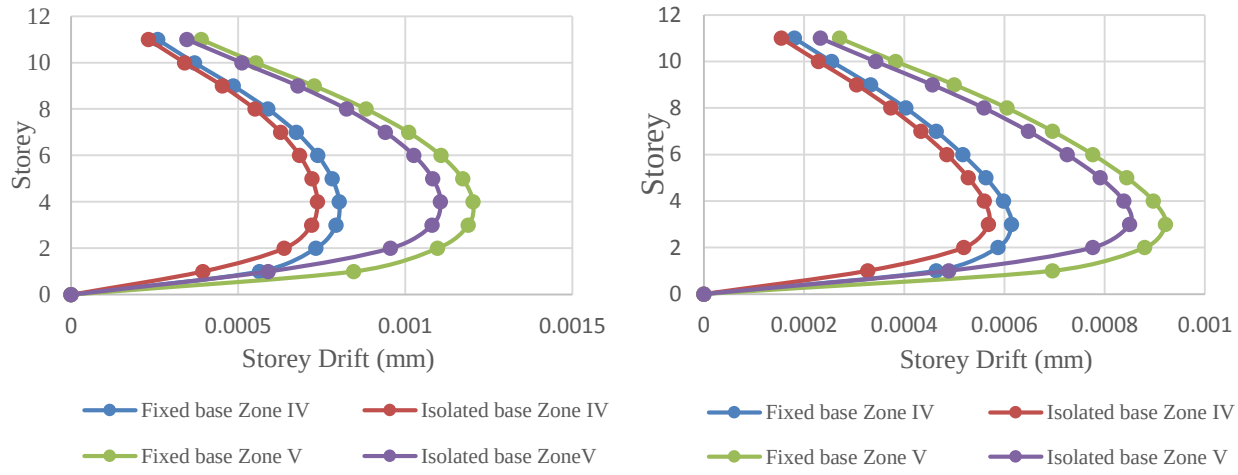

Fig. 4: Storey Drift of Linear Static analysis and Response spectrum analysis

Following observations can be made from the above results presented.

- Displacements are decreased by about 11% in building with base isolation compare to building with a fixed base. It is also decreased by about 33% for seismic zone iv compare to zone v

- Base shear is increased by 17% in building with base isolation compare to building with fixed base
- Storey drift is decreased in building with base isolation by about 4% when compared to building with fixed base

5. CONCLUSION

This study presents both theoretical investigation and modeling for building subjected to earthquake-induced load with a fixed base and with a base-isolation method using rubber bearing. The aim of this work is to contribute to the efficient design of base-isolated structure subjected to seismic ground motion. The following sections summarize the conclusions resulting from this research work. The building with base isolation, the maximum displacement is decreased by 11% compared to the building with a fixed base in both the zones considered. Base shear is increased by 20% in a building with base isolation compared to the building with a fixed base in both the zones considered. In the building with base isolation, the maximum storey drift is decreased by 5% compared to the building with a fixed base in both the zones considered. Maximum displacements are decreased by 29% in Response Spectrum method compared to Linear Static method. Base Shear is decreased by 15% in the Response Spectrum method compared to Linear Static method

6. REFERENCES

[1] Piyush Mandloi "Seismic Analysis of Vertical Irregular Building with Time History Analysis," IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684, p-ISSN: 2320-334X, Volume 14, August 2017.

[2] K. Santhosh "Deflection Analysis of Multi-Story Building G+10 in Various Seismic Zones with and Without Base Isolation Using Etabs," IOSR Journal of Mechanical and Civil Engineering, e-ISSN: 2278-1684, P-ISSN: 2320-334X, Volume 14, Issue 2, 2017.

[3] Shri. Ramkrisna V. Darji "Design of Base Isolator for R.C.C. Building and Performance Evaluation," research gate 2016.

[4] Mr Pathan Irfan Khan "Seismic analysis of multistoried RCC building due to mass irregularity," International Journal of Engineering Development and Research (www.ijedr.org), Volume 4, Issue 3, ISSN: 2321-9939, 2016.

[5] Niranjan G M "Dynamic Response of RC Frame Building with Plan Irregularity Using Base Isolation," International Journal of Innovative Research in Science, Engineering and Technology (IJIRSET) (An ISO 3297: 2007 Certified Organization) Vol. 5, Issue 6, June 2016.

[6] Ashvin G. Soni "Effect of Irregularities in Buildings and their Consequences," International Journal of Modern Trends in Engineering and Research (IJMTER) Volume 02, Issue 04, April 2015.

[7] Prof. R.B. Ghodke, Dr S. V. Admane "Effect of Base-Isolation for Building Structures," International Journal of Science, Engineering and Technology Research (IJSETR), Volume 4, Issue 4, April 2015.

[8] IS 1893 (part 1):2002 Indian Standard criteria for earthquake resistant design of structures, General provisions and buildings, Bureau of Indian Standards, New Delhi.

[9] IS 875 (part 1) 1987 "code of practice for design load (other than earthquake) for building and structures Unit weight of building materials and stored materials" B.I.S New Delhi.

[10] IS 875 (part 2) 1987 "code of practice for design load (other than earthquake) for building and structures Imposed loads" B.I.S New Delhi.

