Comparative Analysis of a Building under Seismic Loading with Bare Frame and Base Isolator in Different Zones Using Staad Pro

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***Abstract*— The main objective of the research work is to compare seismic analysis of building under bare frame and base isolation technique i.e. Rubber base isolation and comparing the effect of earthquake forces on both models. An analysis is carried out by the STAAD. Pro Software.**

It is a well-known fact that in any code based seismic design approach, the performance objective at design bases earthquake level is preventing the inhabitants of the building and accepting a certain level of damage which may be beyond repair. On the other hand the owners of the buildings have an idea that once a building is designed based on a seismic code the building will suffer no damage. By the introduction of "performance based design philosophy" a new approach has been introduced to earthquake engineering society. In the framework of performance based design the so called performance level which is related to the response of the building is defined for different level of seismic input. The performance levels defined in seismic design approach has basically three levels namely; "immediate occupancy", "life safety" and "collapse prevention". Based on this new approach it is possible to design a building that meets the performance levels named above. In order to achieve this "target performance" there are certain design alternatives to be applied one of which is "base isolation". The basic approach in "seismic isolation design" is to provide additional damping and concentrate the nonlinear response on the isolator units and limit the seismic forces on the structural members above isolation level. This approach provides almost elastic response on the structural members and limits the floor accelerations acting on the nonstructural elements on superstructure. In recent years seismic base isolation applications are increasing especially in health complexes like hospitals which are expected to be functional after a major seismic event.

***Index Terms*—Seismic loading, Earthquake, Base isolation, Collapse prevention, Foundation, Damping, Vibration Control**

1. INTRODUCTION

To analyse, the use of base isolation is effective to how much extend, to reduce damage in the structural and non-structural component of the building, to reduce acceleration response to minimize contents related to damage and to prevent plastic deformation of the structure. Base isolation is one of the most important concepts for earthquake engineering which can be defined as separating the structure from its foundation. In other words, base isolation is a technique developed to prevent or minimize damage to buildings during an earthquake. It might be thought that structures are often shielded from the destructive forces of earthquakes by increasing the strength of the structures in order that they are doing not collapse during such events. In other words, more rigid attachment of a building to its foundation will end in less damage in an earthquake. However, if the inspiration is rigidly attached to the building or the other structure, all of the earthquake forces are going to be

Transferred directly and without a change in frequency to the remainder of the building. Providing a base isolation device between the building and therefore the ground can minimize the extent of earthquake force transmitted to the buildings.

Base isolation is one among the foremost powerful tools of earthquake engineering concerning the passive structural vibration control technologies. It enables a building or non-building structure to persist a potentially destructive seismic impact by using an accurate initial design or subsequent modifications.

In some cases, application of base isolation can strengthen both a structure's seismic performance and its seismic tolerance appreciably.

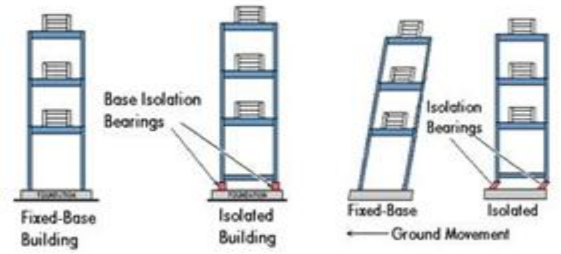


Fig: 1 Base isolation Technique

II. METHODOLOGY

The Chapter deals with the mathematical modeling of building with different base isolating units. In order to compare the seismic response various models will be prepared using STAAD-PRO. For each case, seismic analysis will be discussed. Complete analysis will be carried out for dead load, live load & seismic load. All combinations are considered as per IS 1893:2002.

III. MODELLING AND ANALYSIS

Description of the building

The typical framing plan of G+9 storey building is shown in figure the building is rectangular in plan. Length and width of the building is considered as 15m and 9m respectively. Each storey heightisconsideredas3m.Heightofthebuildingis30m.Spacingofframealonglengthandwidth is 3m. Material grades of M20& Fe415 were used for the design.

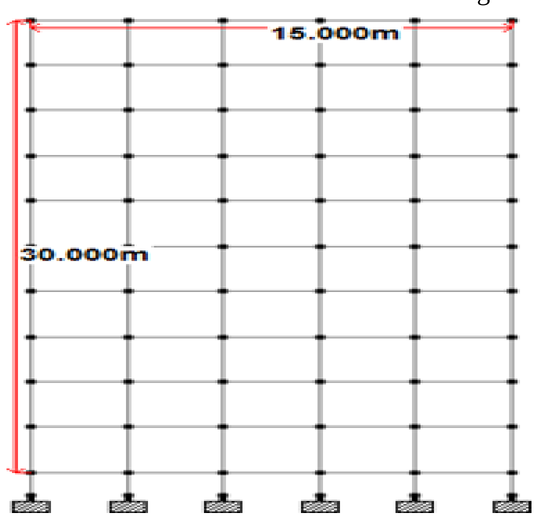


Fig 2: Model of Staad pro (Bare frame)

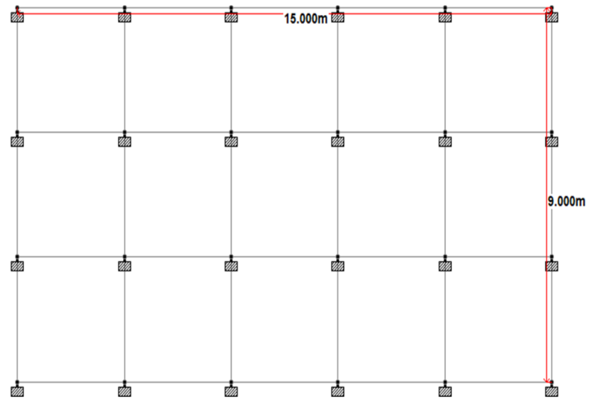


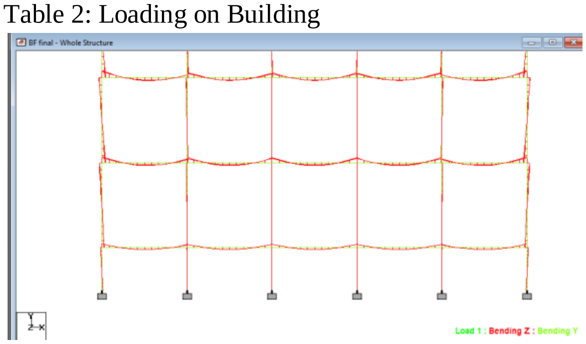
Fig 3: Plan of Building

DESCRIPTION	NUMERIC VALUE
• Total depth of slab	150 mm
• Floor finish load	1KN/m^2
• External wall thickness	230 mm
• Internal wall thickness	230 mm
• Size of external column	230 mm X 600 mm
• Size of internal column	230 mm X 600 mm
• Size of beam in longitudinal and transverse direction	230 mm X 400 mm

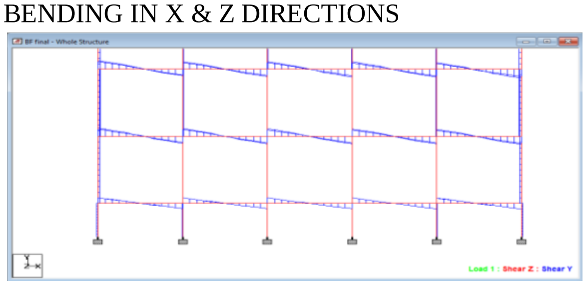
Table 1: Structural properties of the Building

LOADING ON BUILDING	NUMERIC VALUE
Dead load	3.125KN/m^2
Wall load	13.8KN/m^2
Floor load	1KN/m^2
Parapet wall load	5.75KN/m^2
Live Load	3KN/m^2
Roof load	1.50 KN/m^2

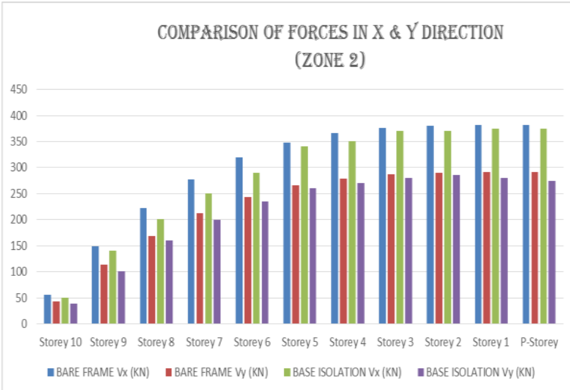
Table 2: Loading on Building

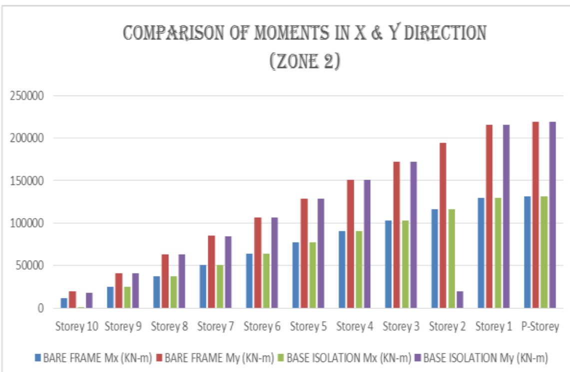


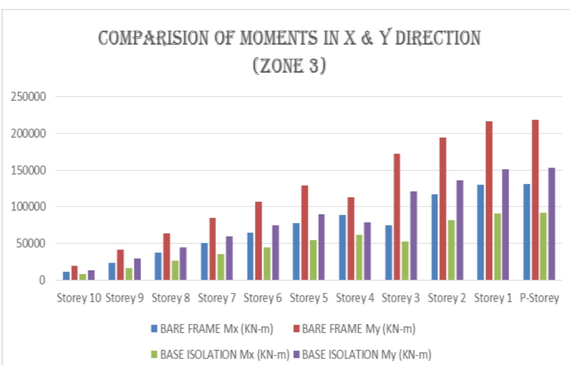
BENDING IN X & Z DIRECTIONS

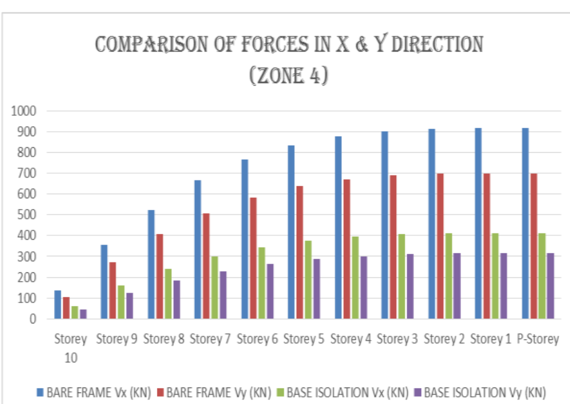


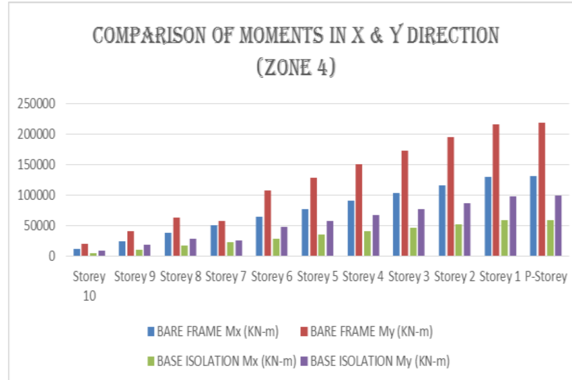
SHEAR IN THE FRAME

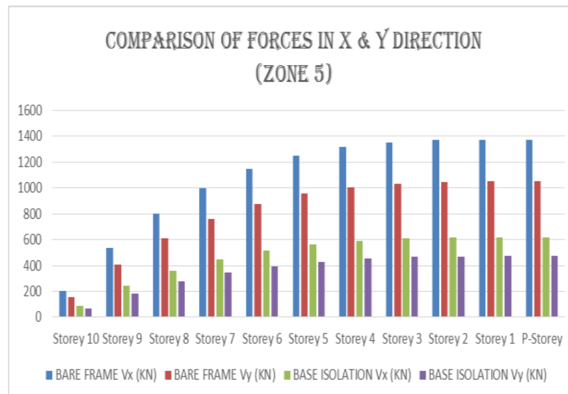












Comparison of Shear force

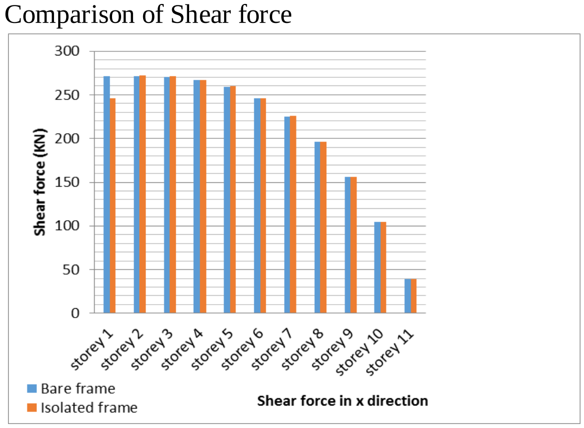


Fig 4: Shear force in X direction

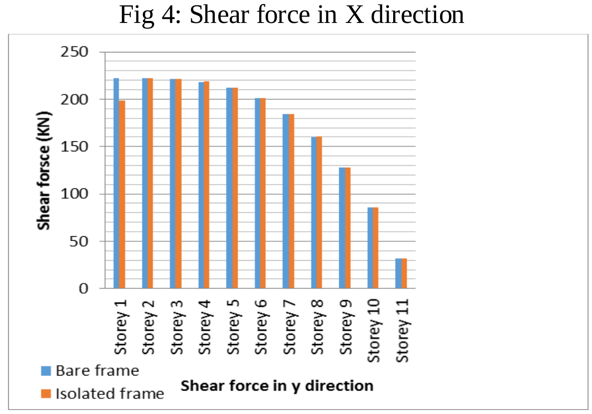


Fig 5: Shear force in Y direction

Comparison of Bending moment

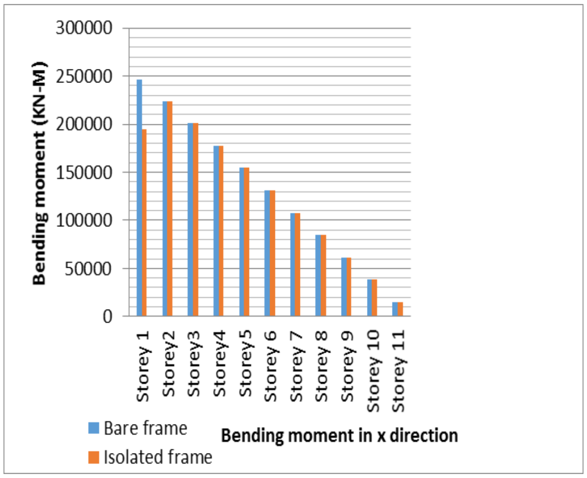


Fig 6: Bending moment in X – direction

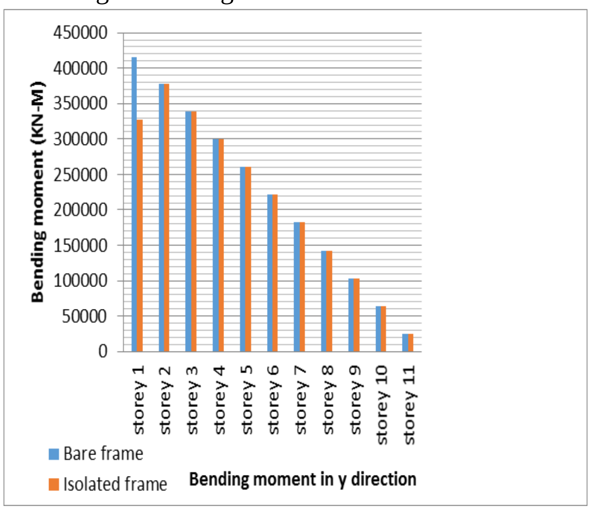


Fig 7: Bending moment in Y – direction

Comparison of forces in plinth nodes

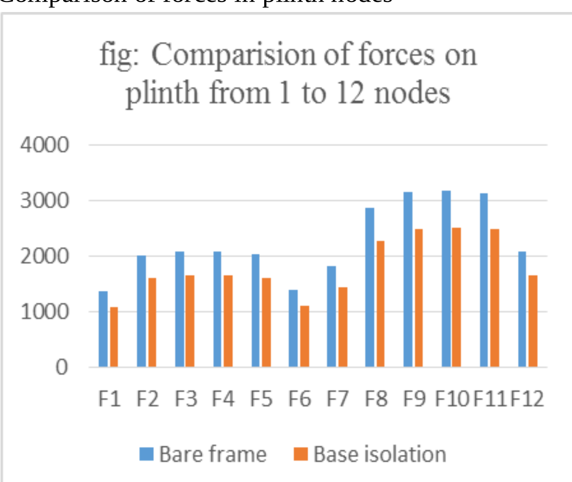


Fig 8: Graphical representation of Plinth level forces

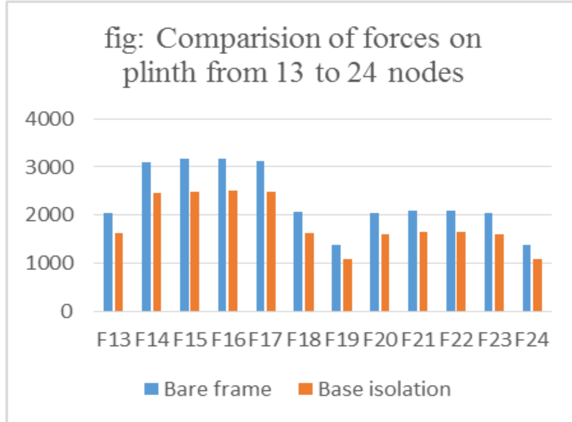


Fig 9: Graphical representation of Plinth level forces

IV. CONCLUSION

- Percentage reduction of shear force is found to be 10.70% by using base isolation.
- Percentage reduction of Bending moment is found to be 21.02% by using base isolation.
- Percentage reduction of shear force is found to be 40% by using base isolation in Zone 3
- Percentage reduction of Bending moment is found to be 30-35% by using base isolation in Zone 3 .

It is found that the base isolation technique is very effective in the control of earthquake forces. Also this technique reduces shear as well as bending moment in the base storey which is our desired result. If the forces at the base are controlled, then it is possible that the building is safe against collapse because the earthquake forces are transferred on the foundation through the soil, and then these forces are transferred on the superstructure through the foundation.

So, if the plinth level (base) of the building is safe against the collapse then the whole superstructure can be safe against the collapse, and plinth can only be safe if the forces coming through the earthquake can be reduced from its original magnitude.

So, the Base Isolation technique proves to be much efficient in the reduction of all kind of forces and also it protects the building from the collapse.

REFERENCES

[1] Mazza F, Vulcano A, (2001), “Seismic response of buildings with isolation & supplemental dissipation at the base.” Proceedings of the 5th

World Congress on Joints, Bearings and Seismic Systems for Concrete Structures, Rome, Italy.

[2] Dr. R.S. Talikoti and Mr. Vinod R. Thorat, (2014), "Base isolation in seismic structural design". IJERT. ISSN: 2278-0181.

[3] Datta, T. K, (2010). "Seismic Analysis of Structures". John Wiley and Sons. p. 369. ISBN 978-0-470-82462-7.

[4] Mital Desai (2015), "Seismic Performance of base isolated multi-storeyed building". IJSER. ISSN 2229-5518.