



Analysis and Design of Steel Hospital Building with and Without Base Isolation

N.Sumega¹, I.Oviya², Dr.V.Selvan³

P.G. Student, Department of Structural Engineering , Kumaraguru College of Technology, Coimbatore, India¹

P.G. Student, Department of Structural Engineering , Kumaraguru College of Technology, Coimbatore, India²

Associate Professor, Department of civil engineering, Kumaraguru College of Technology, Coimbatore , India³

ABSTRACT: The purpose of this project is to describe the structural system, analysis and design criteria for the hospitals and related facilities in Assam which comes under Zone V criteria. It is an Ordinary moment resisting frame structure and also Base Isolation techniques is recommended as per Assam Local Authority code. ETABS is used for Modelling and Analysing for the structure. The design shall generally be in accordance with Indian Standard IS 800:2007 codes. The design report consist comparative study on seismic behavior of steel building with and without base isolation technique.

KEYWORDS: Ordinary Moment Resisting Frame, Base Isolation

I. INTRODUCTION

The traditional method, i.e., strengthening the stiffness, strength and ductility of the structures, has been in common use for long time, therefore, the dimensions of structural members and the consumption of material are expected to be increased, which leads to higher cost of the buildings as well as larger seismic responses due to larger stiffness of the structures. Thus the efficiency of the traditional method is constrained. To overcome these, many vibration- control measures called structural control, have been studied and remarkable advances in this respect have been over recent years. Structural control is the one of the areas of current research aims to reduce structural vibrations during loading such as earthquakes and strong winds. In terms of different vibration absorption methods, structural control can be classified into active control, passive control, hybrid control, semi-active control and so.

Base isolation is a passive vibration control system that does not require any external power source for its operation and utilizes the motion of the structure. 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 medium- rise buildings. 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.

II. BUILDING CONFIGURATION

| | |
|------------------------|----------------------------|
| Number of storey | G+3 |
| Type of Building | Hospital Building |
| Location | Assam |
| Zone | V |
| Height of Building | 20.1m |
| Width of the Building | 48m (along X direction) |
| Length of the Building | 36.39m (along Y direction) |
| Total floor area | 6421.68 m ² |
| Each floor area | 1605.42 m ² |
| Maximum Grid Spacing | 8.4 m |
| Minimum Grid Spacing | 3.3 m |

III. LOADING DATA

DEAD LOAD:

Floor finish = 1kN/m²

Terrace water proofing = 1.5kN/m²

LIVE LOAD:

Roof = 1.5kN/m²

Live load on floor = 3.5kN/m²

WIND LOAD

Basic wind speed $V_b = 47\text{m/s}$

Design wind speed = $V_b * K_1 * K_2 * K_3 * K_4$

Terrain category = 1

Probability / risk factor $K_1 = 1.07$

Topographic factor $K_3 = 1.00$

Importance factor $I = 1.00$

Height of structure = 20.1 m

$K_d = 1$

$K_a = \text{height of structure} * \text{tributary width}$
 $= 135.5 \geq 100$, SO, 0.8

EARTHQUAKE DATA

Zone (Z) = V

Response reduction factor (R) = 3

Importance factor (I) = 1.5

Zone factor = 0.36

Damping ratio (DM) = 0.05

Base shear $V_b = A_h * W$

Design Horizontal seismic coefficient, $A_h = [(Z/2) (S_a/g)] / (I/R)$

IV. RESULTS AND DISCUSSION

STOREY DISPLACEMENT

Storey displacement is important when structures are subjected to lateral loads like earthquake and wind loads. Displacement depends on height of structure and slenderness of the structure because structures are more vulnerable as height of building increases by becoming more flexible to lateral loads.

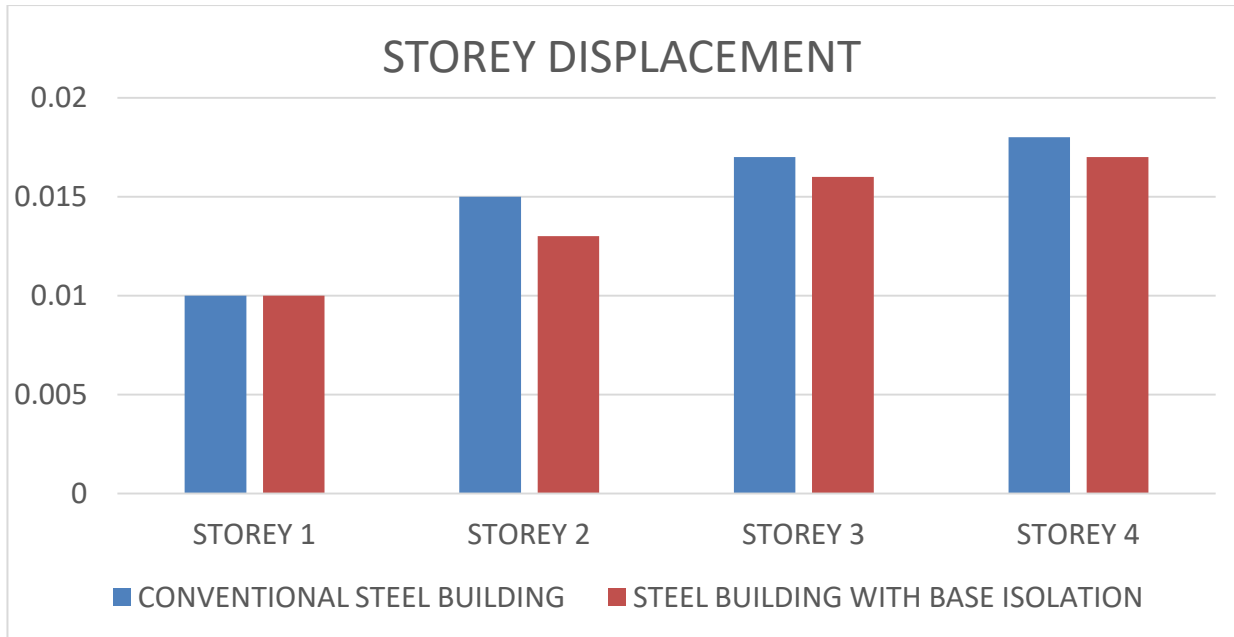


Fig. 1: Comparison of storey displacement of steel building with and without base isolation

STOREY DRIFT

Storey drift is defined as difference between lateral displacements of one floor relative to the other floor. Total storey drift is the absolute displacement of any point relative to the base. As per IS.1893-2016 cl.7.11.1 the storey drift in any storey due to the minimum specified design lateral force with partial load factor 1.00 shall not be exceeding 0.004 times the storey height.

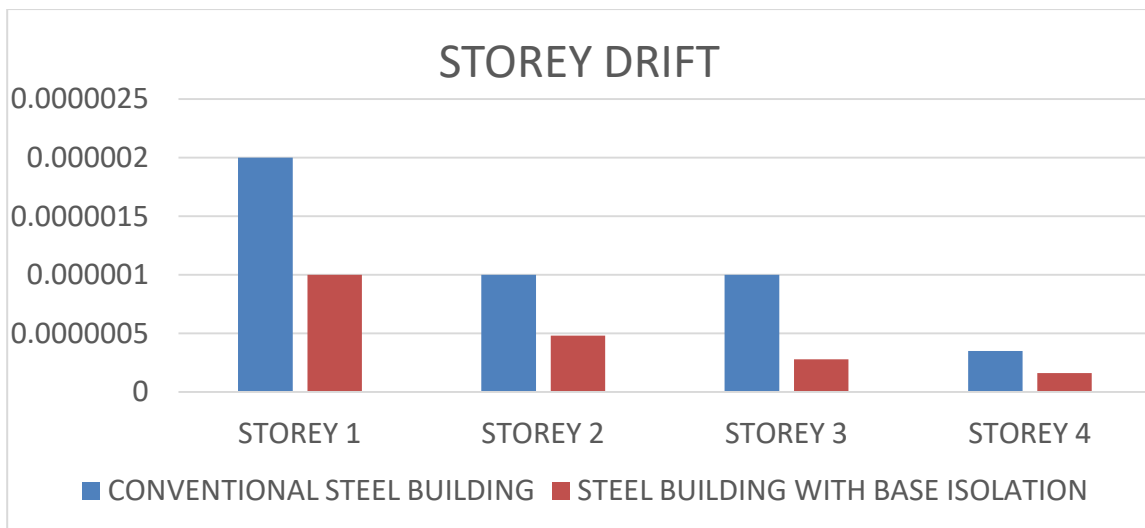


Fig.2 Comparison of storey drift of steel building with and without base isolation

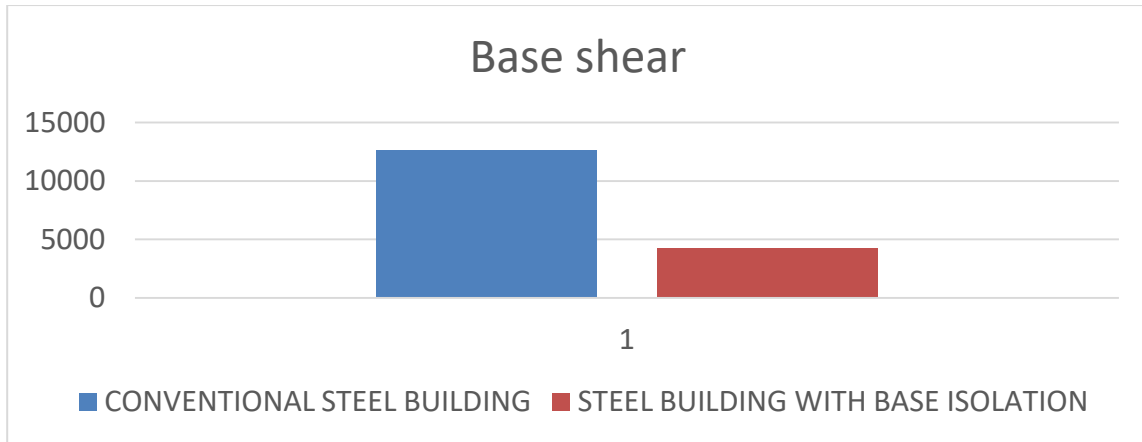


Fig.3 comparison of base shear of steel building with and without base isolation

TIME PERIOD

Time required for the undamped system to complete one cycle of free vibration is the natural time period of vibration of system in unit of second.

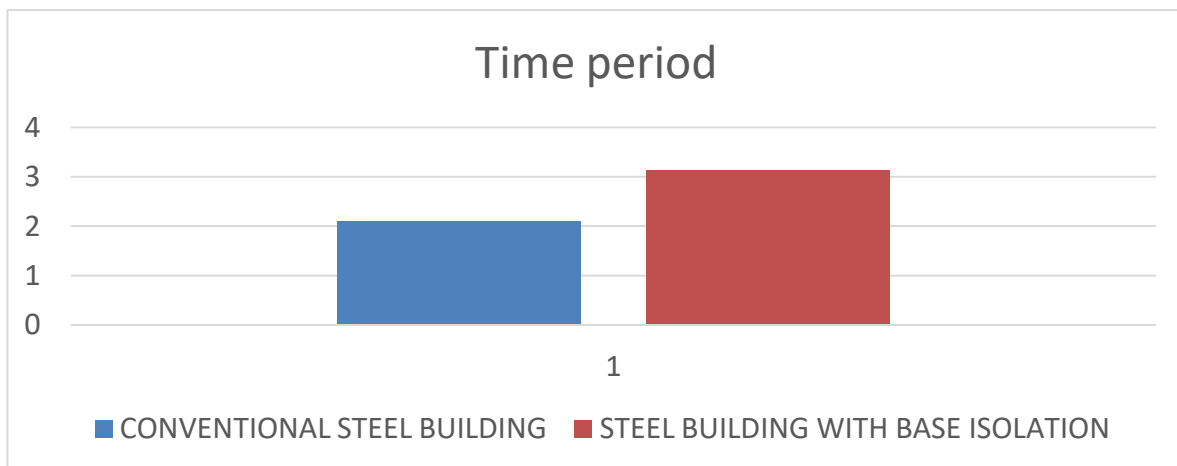


Fig.4 Comparison of time period of steel building with and without base isolation

STOREY OVERTURNING MOMENT

Overtuning moment of a object is the moment of energy capable of upsetting the object; the point where it has been subjected to enough disturbance that it ceases to be stable, it overturns, collapses.

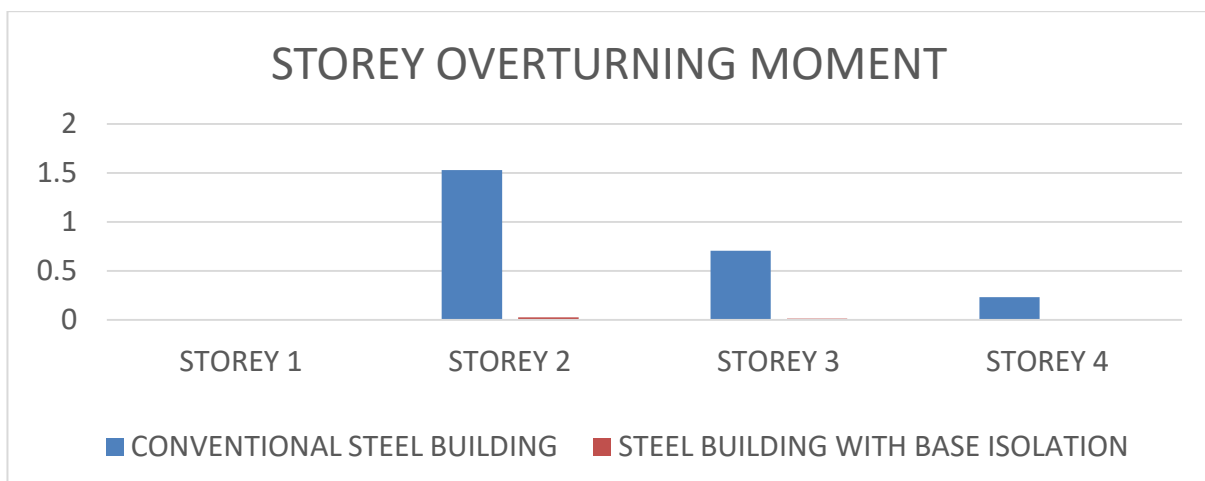


FIG.5 COMPARISON OF STOREY OVERTURNING MOMENT OF STEEL BUILDING WITH AND WITHOUT BASE ISOLATION

V. CONCLUSION

- Among these two models, steel building with base isolation has higher time period due to its high flexibility.
- Time period of the structure increases by 33% with the use of lead rubber bearing which helps in less transfer of lateral forces at the time of earthquake.
- In comparison with conventional steel building, the base shear is reduced by 66.4% in steel building with base isolation.
- The base isolation has high efficiency in decreasing the base shear compared to the conventional building.
- Base isolation decouples the building from the earthquake included load and maintain longer fundamental lateral period than that of the fixed base.

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