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Analysis of an Irregular Building with Stiffened Steel Plate Shear Wall

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Abstract - *Steel plate shear wall (SPSW) is widely used in the lateral load resisting structures. Steel plate shear wall has high initial stiffness and very effective in reducing the lateral displacement of structures. The properties of steel plate shear walls provide sufficient resistance to seismically induced loads. These include superior ductility, a resistance to degradation under cyclic loading, high initial stiffness and a capacity for significant energy dissipation. The present study describes the modeling and analysis of G+15storey high rise building with diagonally stiffened steel plate shear wall(SPSW). The design and analysis of R. C. building with Steel Plate Shear Wall is carried out using software ETABS-2015. The properties of Steel Plate Shear Wall system include the stiffness for control of storey displacement, storey drift and storey stiffness.*

Key Words: **SPSW, Degradation, Energy dissipation, Superior ductility, Stiffness, Diagonally stiffened, ETABS-2015.**

1. INTRODUCTION

Recently there has been larger increase in number of tall buildings because of the scarcity of land. However, during the time of seismic loading, a structure may actually be subjected to forces. Thus the effects of lateral loads are greater importance during the time of construction. There is a number of lateral load resisting systems are used but shear walls is commonly adopted in building. Seismic and wind loads are the most common lateral loads that the shear walls are designed to withstand.

By introducing, steel plate shear wall in high rise buildings we can avoid the lateral deformation and achieve economy in the design. This system will give sufficient strength and stiffness to control the deformation of the entire structure and will have good energy absorption capacity.

The SPSW consists of three components- stiff horizontal boundary element, stiff vertical boundary element and infill plate. If the infill plates are provided with stiffeners are called stiffened steel plate shear wall. Mainly the stiffeners are provided vertically, horizontally or diagonally. The weight of steel shear wall is less than that of reinforced concrete shear wall. SPSW have superior ductility to resist seismic loading. Moreover, the low mass of a steel plate shear wall as compared with an equivalent reinforced concrete shear wall reduces both the gravity loads and the seismic loads transmitted to the foundation. This can lead to considerable cost savings in construction.

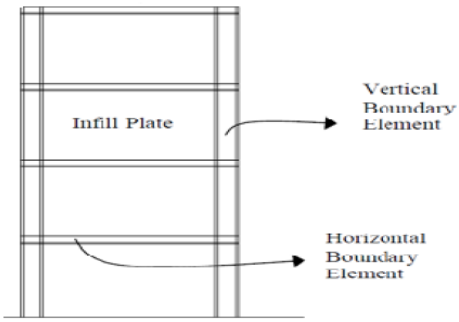

Fig -1: Typical steel plate shear wall

2. SCOPE

Recently there has been a greater increase in number of tall building, thus the effect of lateral loads like wind loads and earthquake loads are attaining increasing importance. Due to these reasons greater care should be provided. Shear wall systems are mainly used as lateral load resisting system in high rise buildings. SPSW is frequently used in these days and much efficient than R.C shear walls and have high stiffness and large energy dissipation capacity. In this paper, analysis of an irregular R.C building with diagonally stiffened SPSW.

3. OBJECTIVES

- To analyses G+15storey R.C building with diagonally stiffened SPSW at centre.
- To analyses G+15storey R.C building with diagonally stiffened SPSW at edges.
- To find out storey drift, storey displacement and storey stiffness.

4. MODELING

4.1 Model Type

- Model 1- Diagonally stiffened SPSW at Centre of the building.
- Model 2- Diagonally stiffened SPSW at edges of the building.

4.2 Model Data

Building details are shown in Table -1.

Table -1: Details of Building

Plan dimension	23m*22m
Thickness of wall	230mm
Thickness of slab	120mm
Thickness of shear wall	48mm, 64mm, 80mm
Height of floor	3m
Grade of concrete	30
Grade of steel	415
Seismic zone	IV
Type of soil	II (Medium soil)

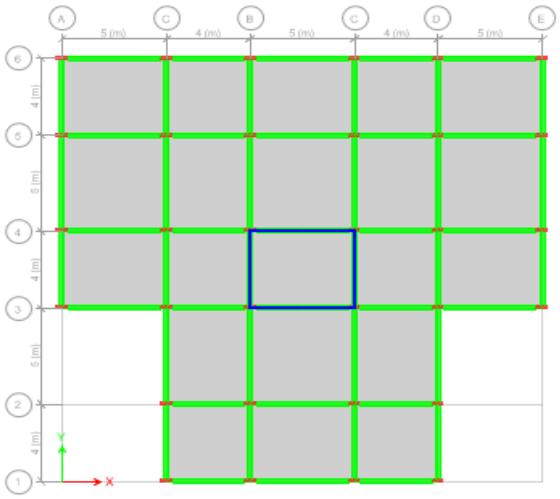

Fig -2: Plan of model 1

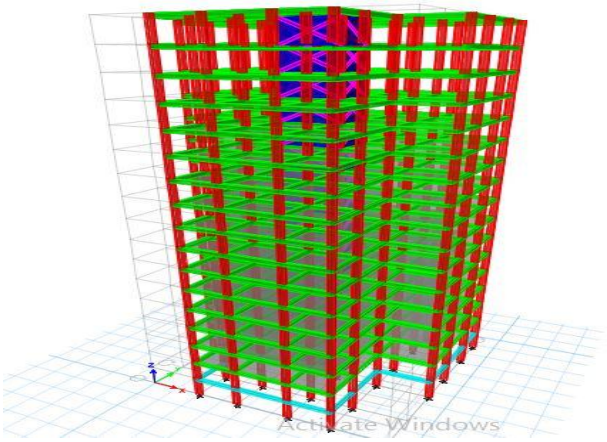

Fig -3: 3D view of model 1

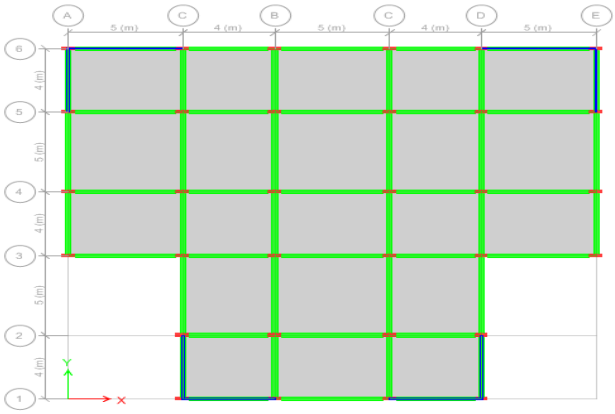

Fig -4: Plan of model 2

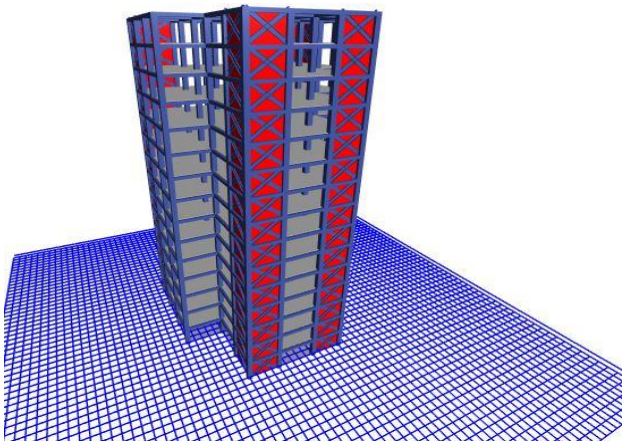

Fig -5: 3D view of model 2

5. RESULT AND DISCUSSION

5.1 Storey Drift

It is the deformation of one storey relative to storey above or below. Chart-1 shows the storey drift of model 1 and model 2.

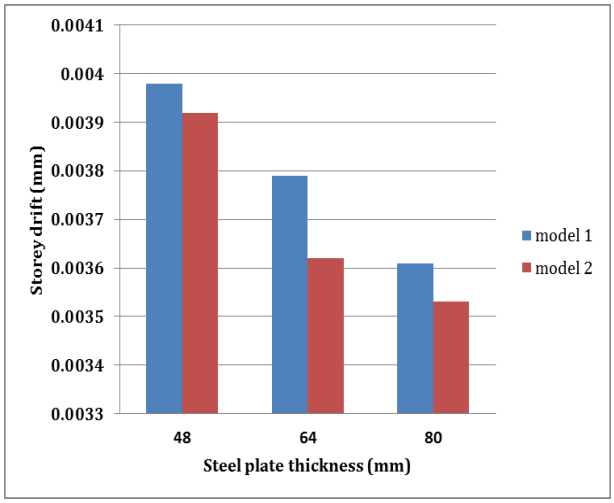

Chart -1: Maximum storey drift

From this graph

- Model 2 has comparatively less storey drift than that of model 1.
- When thickness of plate increases, storey drift decreases.
- Maximum storey drift is found to be for 48mm thick steel plate.

5.2 Storey Displacement

It is the total displacement of storey with respect to base. Chart-2 shows the maximum storey displacement of model 1 and model 2.

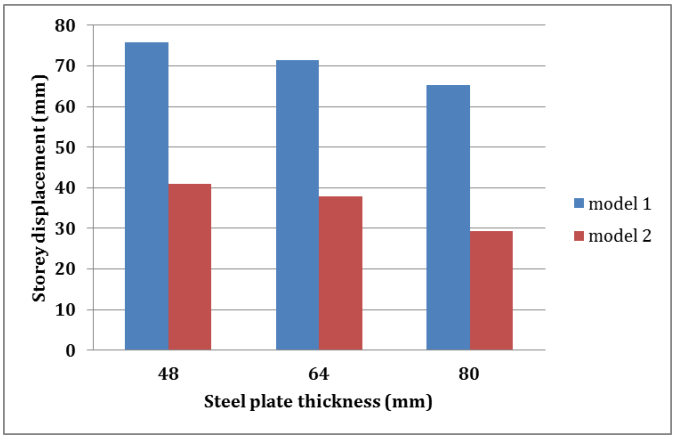

Chart -2: Maximum storey displacement

From this graph

- Model 2 has comparatively less storey displacement.
- When thickness of steel plate increases storey displacement decreases.

5.3 Storey Stiffness

It is the ability of the structure to resist deformation during the time of lateral loading. Chart-3 represents the maximum stiffness of model 1 and model 2.

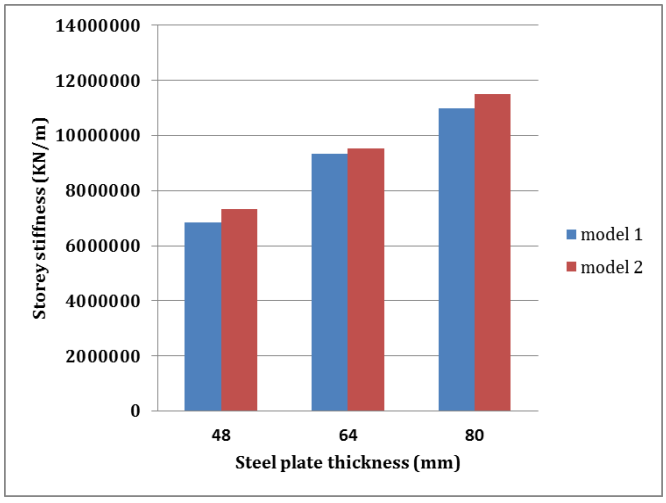

Chart -3: Maximum storey stiffness

From this graph

- Model 2 has higher stiffness compared to Model 1, as it is an irregular building.
- 80mm thick plate has more stiffness than other two plates.
- Diagonal stiffeners improve the stiffness of entire structure.

6. CONCLUSION

From the analysis of an irregular building by response spectrum method, the following general conclusions were drawn.

- From the above analysis, the diagonally stiffened SPSW has a large effect on the performance of building under cyclic loading. The introduction of diagonally stiffened SPSW increases the stiffness of whole structure.
- The displacement and drift are lesser in the case of irregular building with diagonally stiffened SPSW provided at edges of the building.
- The stiffness will be higher in the case of irregular building with diagonally stiffened SPSW at edges than that of diagonally stiffened SPSW at centre.
- The storey drift and displacement are less at 80mm thick diagonally stiffened SPSW, when compared to other two thicknesses.
- The maximum stiffness is obtained by providing 80mm thick diagonally stiffened SPSW.
- From the above analysis, it is seen that, when the thickness of diagonally stiffened SPSW increases overall performance of the structure.
- In the case of irregular building, the better placement of diagonally stiffened SPSW is at edges compared to centre because of the irregular behavior of structure under cyclic loading.

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