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Lateral Resistance Capacity and Strengthening of Corrugated Steel Wall with Different Openings

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***Abstract*— Steel plate shear walls have been used in the construction of high-rise buildings in seismic prone countries for decades. Steel structures have great advantages compared to other systems such as reinforced concrete shear wall. With the rise in height of a building, there will be a decrease in the lateral resistance capacity of the steel shear wall. This led to the use of stiffeners in steel shear wall, which further led to an advanced study with the development of corrugations in steel shear wall. The corrugations in steel structures have a benefit of high ultimate bearing, high energy absorption capacity, appropriate stiffness and reduced structural weight. This paper deals with an analytical study of corrugated steel shear walls with openings of different sizes and comparison of force-displacement curves, stiffness, ultimate strength, shear buckling behaviour and distribution of stress in the steel shear wall.**

Keywords—Corrugation; Lateral resistance; Buckling;Ultimate bearing

I. INTRODUCTION

Steel structures are obviously one of the most common choice for residential building constructions in the world. Nowadays steel structures are very essential especially for seismic prone countries. It consists of moment resisting frames and infill panel within it. The steel moment resisting frames are susceptible to large lateral displacement during large lateral forces. By increasing height of the building the lateral resistant capacity of the steel structure will decrease. So it requires stiffeners and it is very economical. The stress concentration is higher in Diagonal stiffened steel plate shear wall so center portion will damage during higher lateral forces. After this some researchers developed Ring shaped steel plate shear wall to overcome this problem. The performance of structure during a lateral forces depends on intensity of lateral forces and the properties of the structure. In recent years, many engineers have turned to use of innovative lateral force resistant structural system for provision of stiffness and ductility and prevention of damage. The corrugated steel plate shear wall is the most economical and effective method of steel plate shear wall. It requires simple beam column connection. The steel corrugated shear walls(SCSW) are widely use in building structure to serve as lateral force resistant member. Trapezoidal shape of corrugation is adopted and the shape of corrugation will resist the lateral force. Considering the advantages of SCSW moment connections and lack of knowledge of the performance of this connection with respect to Indian profiles led to a study on this topic. Figure shows various possible configurations for the SCSW detail.

II. OBJECTIVES

- To evaluate seismic performance of corrugated shear wall
- To evaluate seismic performance of corrugated shear wall with Central cut-out and cut-out at side.

III. LITERATURE REVIEW

The studies are mainly carried out with steel plate shear wall with and without corrugations. And also with providing central openings in the shear wall. Buckling effect of steel structure is higher and stiffeners are provided to reduce buckling. Comparing the shear walls, we found that Out-of-plane displacements less in corrugated steel plate shear wall, Corrugated steel plate shear wall improves both shear resistance and ductility, Corrugated steel plate shear walls with a reduced beam section were investigated, to ensure that the plastic hinges occur at the beam ends and not within the beam span or in the columns.

IV. NUMERICAL ANALYSIS

The pushover analysis of corrugated steel plate shear wall with and without different size of openings under seismic loading were performed using ANSYS 16.1 WORKBENCH, a finite element software for mathematical modeling and analysis.

A. MATERIAL PROPERTIES

The material properties of steel domes are tabulated in Table 1.

Table 1 Material properties of CSSW

Material	Fe 415 steel
Modulus of Elasticity	2×10^5 N/mm^2
Poisson's Ratio	0.3
Density	7850 kg/m^3

B. BASE MODEL

Model comprises of steel Corrugated Steel Plate Shear wall is connected by normal weld. There is no additional cover plate or stiffener is adopted for this model. The specimen was modelled in ANSYS 16.1 WORKBENCH. The thickness of panel is 1.5mm.

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Table 2 Input data of CSSW

Model	Size of opening	Position of opening
Specimen 1	-	No opening
Specimen 2	1000x1600	At side
Specimen 3	1000x1600	At centre

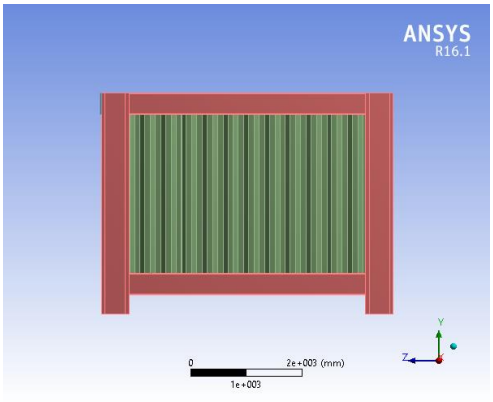

Fig 1. Corrugated steel plate shear wall

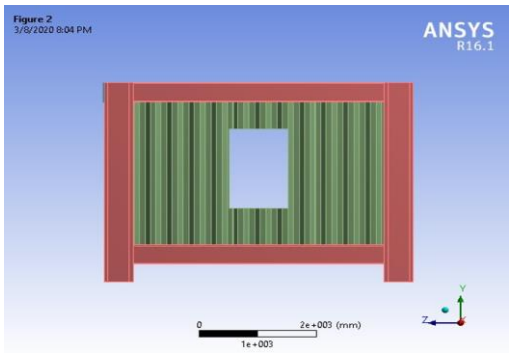

Fig 2. Corrugated steel plate shear wall

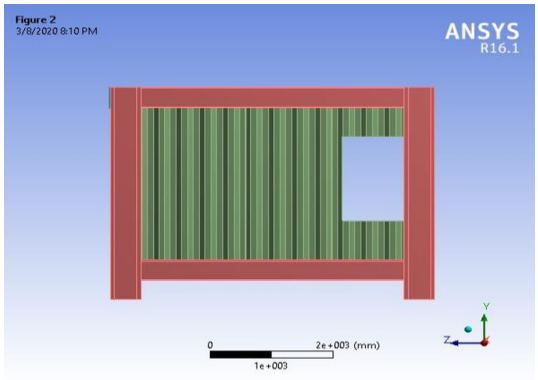

Fig 3. Corrugated steel plate shear wall

C. *LOAD DEFLECTION ANALYSIS*

Load deflection curves are plotted by maintaining the support as fixed. Load deflection curves of corrugated steel plate shear wall with and without openings are shown in fig.4.It is observed that Corrugated steel plate shear wall without opening (CSW) shows maximum load carrying capacity. Corrugated steel plate shear wall with opening at side shows minimum load carrying capacity.

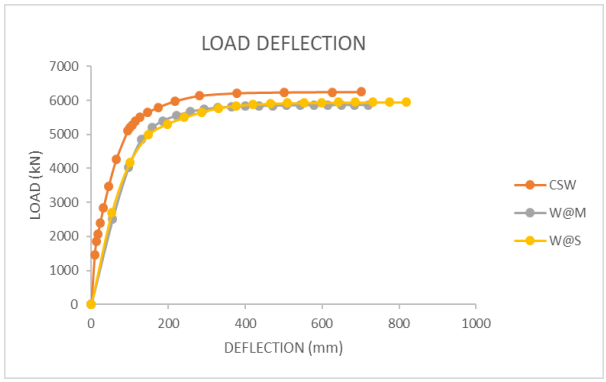

Fig 4. Corrugated steel plate shear wall with and without openings

Table 3. Load vs Deformation table for Door opening

Model	Load	Deformation
CSW	6246	702.47
C/O @M	5820	812
C/O@S	5922	949

V. RESULT AND DISCUSSION

Push over analysis was done using the software ANSYS 16.1 WORKBENCH. After analysis total deformation and Ultimate load in all models were obtained. The effect of CCSW with and without openings on each model was evaluated. The result obtained are compared to each other and inference is made. It is observed that Corrugated steel plate shear wall without opening (CSW) shows maximum load carrying capacity. Corrugated steel plate shear wall with opening at side (CSW@S) shows minimum load carrying capacity.

VI. CONCLUSION

In this study behavior of Corrugated steel plate shear wall with and without openings have been investigated. Corrugated panels postpone the ultimate strength and better performance under seismic loads. After the analysis total deformation and Ultimate load in all models were obtained. The effect of CSSW with and without openings on each model was evaluated. The result obtained are compared to each other and inference is made. It is observed that Corrugated steel plate shear wall without opening (CSW) shows maximum load carrying capacity. The deformation of Corrugated steel plate shear wall at central opening is greater than CSSW and less than CSW@M. Corrugated steel plate shear wall with opening at side (CSW@S) shows minimum load carrying capacity.

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