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Effect of Steel Plate Shear Wall on Behavior of Structure

Ugale Ashish B.[1] and Raut Harshalata R.[2]

[1]Research scholar, Department of Civil Engineering,
Govt. College of Engineering, Amravati (M.S).
[2]Department of Civil Engineering, RSCOE, Tathawade, Pune-33(M.S).

Abstract

Steel plate shear walls have been used more and more in the steel structures to resist earthquake and wind forces. This system offers several advantages as compared to the other usual lateral load resisting systems. Steel saving, speed of erection, reduced foundation cost, and increased usable space in buildings are some apparent advantages of the steel plate shear walls. Steel plate shear walls also provide major stiffness against building drift for the hi-rise buildings.

This paper describes the analysis and design of high-rise steel building frame with and without Steel plate shear wall (SPSW). In this paper equivalent static analysis is carried out for steel moment resisting building frame having (G+6) storey situated in zone III. The analysis of steel plate shear wall and the building are carried out using Software STAAD PRO. The main parameters consider in this paper is to compare the seismic performance of buildings such as bending moment, shear force, deflection and axial force. This paper also focused on the effects comes on the steel structure with and without shear wall.

1. Introduction

1.1 General

Since 1970's, steel shear walls have been used as the primary lateral load resisting system in several modern and important structures. Initially, and during 1970's, stiffened steel shear were used in Japan in new construction and in the U.S. for seismic retrofit of the existing buildings as well as in new buildings. In 1980's and 90's, un-stiffened steel plate shear walls were used in buildings in the United States and Canada. In some cases, the steel plate shear walls were covered with concrete forming

a somewhat composite shear wall. In the following a brief summary of the applications of steel plate shear wall.

The main function of steel plate shear wall is to resist horizontal story shear and overturning moment due to lateral loads. In general, steel plate shear wall system consists of a steel plate wall, two boundary columns and horizontal floor beams. Together, the steel plate wall and two boundary columns act as a vertical plate girder as shown in Figure 1.1. The columns act as flanges of the vertical plate girder and the steel plate wall acts as its web. The horizontal floor beams act, more-or-less, as transverse stiffeners in a plate girder.

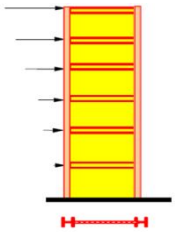

Figure1.1: A typical steel plate shear wall.

There are three different SPSW systems:

- Un-stiffened, thin steel plate shear wall
- Stiffened steel plate shear wall
- Composite concrete steel plate shear wall

1.2 Necessity

- Shear walls are not only designed to resist gravity / vertical loads (due to its self-weight and other living / moving loads), but they are also designed for lateral loads of earthquakes / wind.
- The walls are structurally integrated with roofs / floors (diaphragms) and other lateral walls running across at right angles, thereby giving the three dimensional stability for the building structures.
- Shear wall structural systems are more stable. Because, their supporting area (total cross-sectional area of all shear walls) with reference to total plans area of building, is comparatively more.

2. Methods of Study

2.1 Material Properties

The LYP steel plate is used for steel panel and conventional A36 structural steel is used for boundary frame. The mechanical properties of steel used in this study are listed in Table I. The assumed stress–strain relationships of conventional steel and LYP-100 steel used is shown in Fig. 1. The Von Mises yield theory, which is known to be the most suitable for mild steel, is used for the material yield criterion. An multi-

linear model and combined isotropic and kinematic hardening is used to simulate the behavior of steel materials under cyclic loads.

Table 2.1: Mechanical Properties.

Material	Fy (MPa)	Fu (MPa)	Fu/Fy
LYP Steel	100	260	2.6
A36 Steel	250	400	1.6

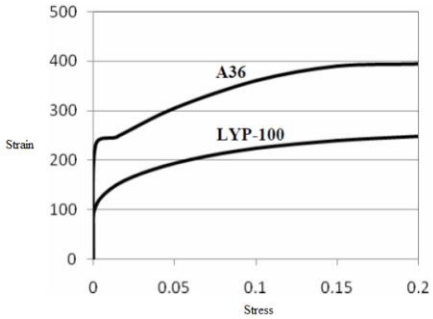

Fig. 2.1: Stress strain curve of A36 and LYP-100 steel.

2.2 Analytical Model

Design of steel building with and without SPSWs carried out as per the specification given in IS 800- 2007 by using design software Staad pro.

Design data:- Types of structure=M.R.S.F, Zone =III, No. of stories =G+6, Lateral load resisting system=Steel plate shear wall, Height of each storey=3m, Depth of foundation=3m, Thickness of slab=150mm,External wall thickness=230mm, Internal wall thickness=150mm, shear wall thickness=6mm width of strips=350mm, Angle of inclination of strip with vertical(α)=45 degree, Unit weight of masonary=20 KN/m2, Floor finish= 2 KN/m2, Live load= 4 KN/m2, Type of Soil= Medium, Seismic analysis= Seismic coefficient method (IS1893-2002), Design of philosophy= Limit state metod confirming to IS800-2007

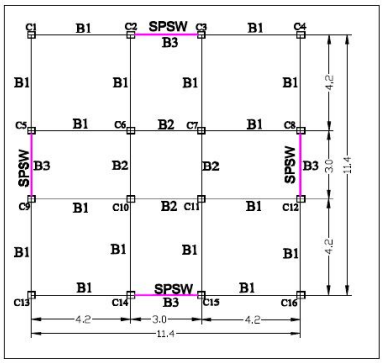

Figure 2.2: Plan of G+6 storey steel building with SPSW

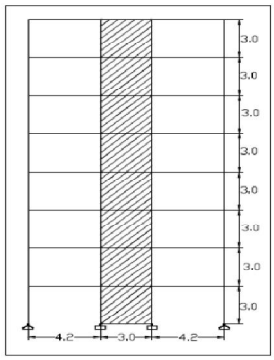

Figure 2.3: Elevation of G+6 storey stel building with SPSW

Structural detail:- The mentioned both the frame has been analysed and Design by using STAAD-PRO software. For getting results some column has been selected and they are as column nos. 1 ,7 & 9. The results found to be are shown with the help of graph for the parameters deflection, shear force, moment axial force and Ast

3. Discussion

As compare to the Reinforced cement concrete (RCC) the steel has got some important physical properties like the high strength per unit weight and ductility . The high yield and ultimate strength result in slender sections. Being ductile the steel structures give sufficient advance warning before failure by way of excessive deformations. These properties of steel are of very much vital in case of the seismic resistant design. Steel shear wall is a lateral load resisting system consisting of vertical steel plate infills connected to the surrounding beams and columns and installed in one or more bays along the full height of the structure to form a cantilever wall. Shear walls are vertical elements of the horizontal force resisting system. The main role of steel shear wall is to collect lateral forces of earthquake in a building and transfer those forces to the foundation. The web plates in steel shear walls are categorized according to their ability to resist buckling.

The web plates can be sufficiently stiffened to preclude buckling and allow the full shear strength of the web to be reached. The steel plate shear walls are mainly used in multi storied building in the foreign countries such America, Japan, Canada etc.

3.1 Comparative study

In comparison with conventional bracing systems, steel panels have the advantage of being a redundant, continuous system exhibiting relatively stable and ductile behaviour under severe cyclic loading (Tromposch and Kulak, 1987). This benefit along with the high stiffness of the plates acting like tension braces to maintain stability, strongly qualifies the SPW as an ideal energy dissipation system in high risk seismic regions, while providing an efficient system to reduce lateral drift. Thus, some of the advantages of using SPWs compared with conventional bracing systems are as follows:

- Reduces seismic force demand due to higher SPW ductility characteristics and inherent redundancy and continuity
- Accelerates structural steel erection by using shop-welded and field-bolted steel panels, and thus, less inspection and reduced quality control costs
- Permits efficient design of lateral-resisting systems by distributing large forces evenly.

3.2 Major failuare modes

The failure modes of typical steel plate shear walls are:

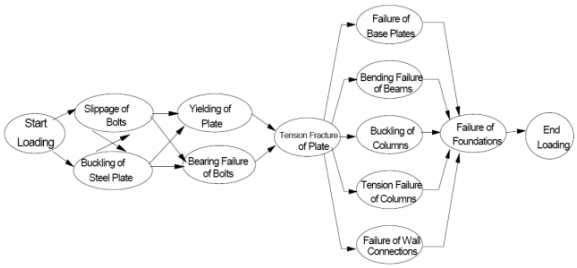

Fig. 3.1: Failure modes of steel plate shear wall.

3.3 Comparison of result

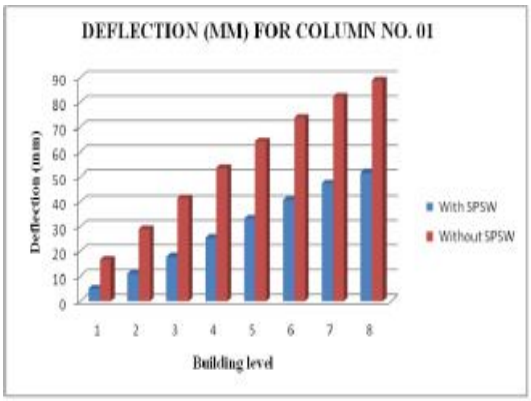

Fig 3.2: Deflection in (mm) for column no.1

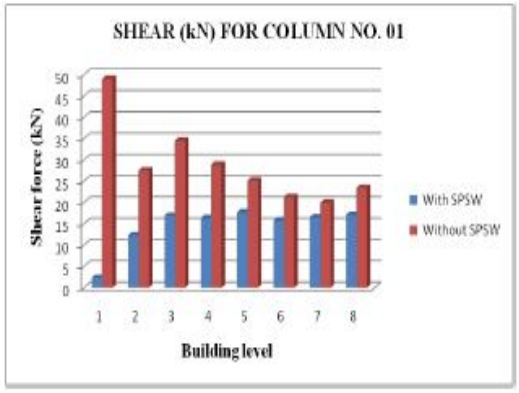

Fig 3.3: Shear force in (KN) for column no.1

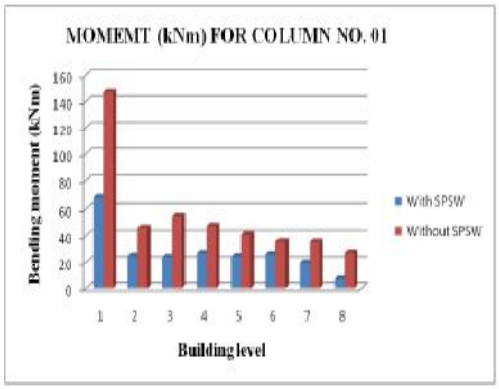

Figure 3.8: Bending moment for column no.1

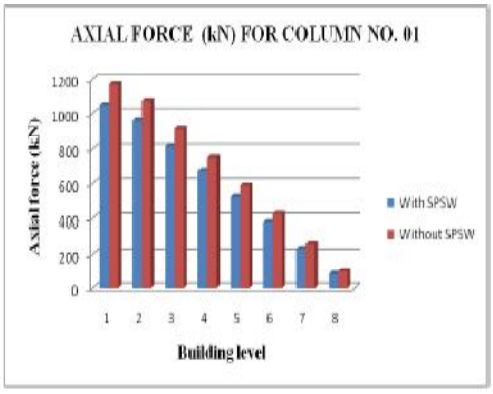

Figure 3.9: Axial force in (KN) for column no.1

Weight of steel Result:-

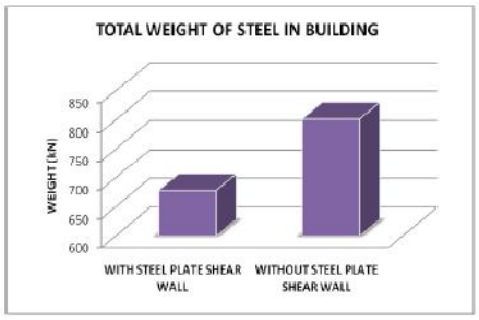

Figure 3.14: Total weight of steel in (KN).

4. Conclusions

- Results indicate that steel plate shear walls have a large effect on the behavior of frames under earthquake excitation. In general, steel plate increase stiffness of the structure.
- Deflection in case of without SPSW is very large & in case of with SPSW deflection is very less.
- With the use of steel shear walls in the buildings, the bending moments in the column are reduce.
- Due to presence of SPSW total weight of steel in building is reduced than building without SPSWs.
- From above result it is observed that, due to use of SPSW in building there is considerable decrease in value of bending moment, shear force, deflection and axial force for some columns and also quantity of steel is reduced. Hence steel building with SPSWs is economical compare to without SPSWs.
- Due to relatively small thickness of SPSW compared to reinforced concrete shear walls, from architectural point of view, steel shear wall occupy much less space than equivalent reinforced concrete shear wall .

References

[1] Astaneh, Abolhassan. “Seismic Behavior and Design of Steel Plate Shear Walls,” Structural Steel Educational Council Steel Tips. January 2001.

[2] Astaneh-Asl, A., 2000, “Seismic Behavior and Design of Steel Shear Walls” Steel Technical Information and Product Services Report, Structural Steel Educational Council, Moraga, CA, a copy can be downloaded from: www.aisc.org.

[3] AISC (1997), Seismic Provisions for Structural Steel Buildings, American Institute of Steel Construction Inc., Chicago

[4] Thorburn J.L., Kulak G.L., and Montgomery C.J. (1983). “Analysis of steel plate shear walls”, Structural Engineering Report No.107, Department of Civil Engineering, The University of Alberta Edmonton, Alberta, pp 1-167.

[5] International Journal of Scientific & Engineering Research Volume 3, Issue 6, June-2012 ISSN 2229-5518 IJSER © 2012 http://www .ijser.org