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Review on Effect of Position of Steel Plate Shear Wall with R.C. Frame

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Abstract —*Structure design and analysis is necessary to produce the capability of resisting all the applied load without failure its intended life. The design of high rise buildings is governed by lateral loads mainly due to earthquake. The present study describes the analysis and design of G+20(story)high rise building with Steel Plate Shear Wall(SPSW).Steel Plate Shear Wall have been used as lateral-load resisting system with formation of tension field action. The design and analysis of R. C. building with Steel Plate Shear Wall is carried out using software ETABS. The properties of Steel Plate Shear Wall system include the stiffness for control of structural displacement, story shear and overturning moment.*

Keywords-Structural displacement, Story Shear, Overturning moment, Steel plate Shear Wall

I. INTRODUCTION

Shear walls have been long used as lateral load resisting systems. The main function of steel plate shear wall is to resist horizontal story shear and overturning moment due to lateral loads. Steel plate shear walls (SPSW) can be used as lateral load resisting system for buildings. A typical SPSW (Fig.1) consists of stiff horizontal and vertical boundary elements (HBE and VBE) and infill plates.[1] Recent researches have demonstrated that steel plate shear walls, SPSWs, can act as effective and economic seismic load resisting systems in the high risk zones. SPSWs have high elastic stiffness, large displacement ductility, and stable hysteretic behavior and high energy dissipating capacity.[2] There are two types of SPSW system,(1) Standard system used sole lateral load resisting system and pin type beam to column connection.(2) Dual system is a part of a lateral load resisting system and installed in a moment resisting frame. Force are resisted by frame and SPSW.

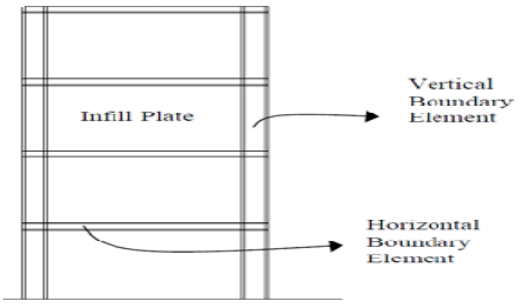


Fig.1:Typical Steel Plate Shear Wall

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, unstiffened steel plate shear walls were used in buildings in the United States and Canada. Earlier designs used stiffeners to prevent buckling of infill plates undershear stresses. On the other hand, more recent approaches rely on post buckling strength. Based on the work of Wagner, it has been known that buckling does not necessarily represent the limit of structural usefulness and there is considerable post buckling strength possessed by restrained unstiffened thin plates.[1].Design recommendations for SPSW systems are newly introduced into the AISC Seismic Provisions for Structural Steel Building. These provisions basically present guidelines on the calculation of lateral load capacity of SPSW as well as recommendations on the seismic characteristics. Lateral load resisting capacity of SPSW systems has been studied experimentally and numerically in the past and procedures for computing the nominal capacity are developed. These experimental and analytical studies led to the development of code provisions.Steel plate shear walls possess properties that are fundamentally beneficial in resisting seismically induced loads. These include superior ductility, a resistanceto degradation under cyclic loading, high initial stiffness inherent redundancy and a capacity for significant energy dissipation.[1]

A. TYPES OF STEEL PLATE SHEAR WALL

There are two types of steel plate shear wall:-
(1) Stiffened steel plate shear wall
(2) Unstiffened steel plate shear wall

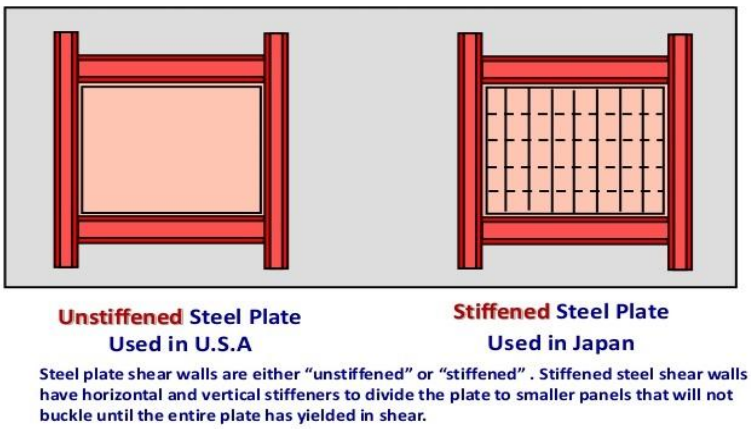


Fig.2:Types of Steel plate Shear Wall [2]

In Stiffened SPSW shear strength capacities based on the plate girders requirements to the shear buckling in the web plate. Shear strength of Un-Stiffened SPSW depends on relative stiffness and strengths of the boundary element.

B. CONNECTION BETWEEN R. C. FRAME AND SPSW

The RC frame is preferred to be "special" ductile moment frame. However, intermediate RC moment frames may also be used along with appropriate R factor. Ordinary moment frames are not recommended. Following two connections are suggested to connect the steel shear wall to RC moment frame. In the left detail, a continuous plate is placed on the interior face of columns and beams with shear studs behind the plate embedded inside concrete. In the detail to the right, the boundary beams and columns are composite with steel columns and beams embedded inside the RC boundary elements. The beams and columns have "fin" plates which later will be used to weld the steel plate to them.
All connections, including the welds and shear studs, should be designed to develop the strength of connected part. The governing failure mode of all elements should be yielding of steel and not fracture of steel or crushing of concrete. As a system, the governing failure mode of the system should be yielding of steel plate shear wall, followed by formation of plastic hinges in ductile special moment frame. Failure of columns should be avoided throughout the loading up to failure of the system.[13]

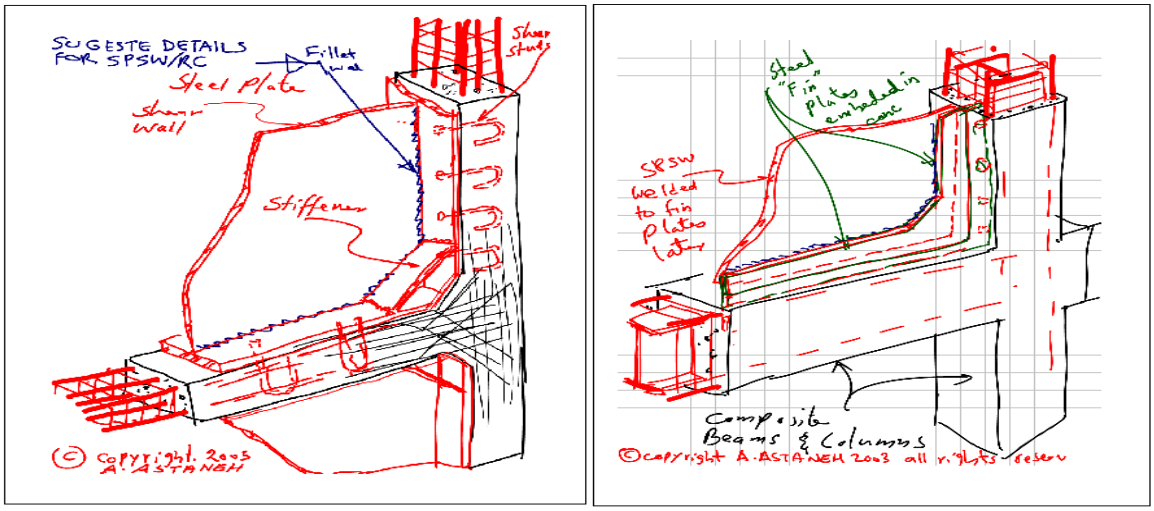


Fig.3 Connection between R. C. Frame and SPSW[13]

C. ADVANTAGE OF SPSW

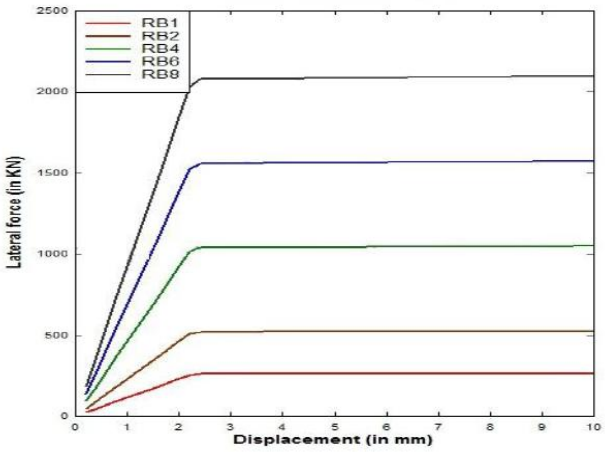
1. Steel shear walls are very efficient and economical lateral load resisting systems.
2. The steel shear wall system has relatively high initial stiffness, thus very effective in limiting the drift.

3. Compared to reinforced concrete shear walls, the steel shear wall is much lighter which can result in less weight to be carried by columns and foundation as well as seismic load due to reduced mass of the structure.
4. Due to relatively small thickness of steel plate shear walls compared to reinforced concrete shear walls, from architectural point of view, steel plate shear walls occupy much less space than the equivalent reinforced concrete shear walls. In high-rises, if reinforced concrete shear walls are used the walls in lower floors becomes very thick and occupy large area of the floor plan.
5. Compared to reinforce concrete shear walls. Steel plate shear walls can be much easier and faster to construct when they are used in seismic retrofit of existing building.
6. Steel plate shear wall systems that can be constructed with shop welded-field bolted elements can make the steel plate shear walls more efficient than the traditional systems.

II. REVIEW OF LITERATURE

(1) STRENGTH:-

Wangeris the first researcher who used to complete and uniform tension to determine the shear strength of panel with rigid flange and very thin web. [1]
Anjana R K Unnithan et al. in, studied steel plate increase stiffness of the structure. They were found that the displacement increases with the story height and decrease as the thickness of steel plate shear wall increases. They obtained minimum displacement in 80mm thick steel plate shear wall. [5]
Basler et al. in, relative stiffness and strength of the boundary element in the shear capacities and non-linear behavior of the system. [1]
Ricky Chan et al. in, demonstrated that under loading perforations reduce strength and stiffness of the system. [2]
Ugale Ahish B.et al.in, observed that due to use of SPSW in building there is decrease in value of bending moment, shear force, deflection and axial force for some columns and also quantity of steel is reduced. [7]
Abhishek Verma, et al. studied three SPSW having length1500mm height 1000mm having plate thickness 1mm , 2mm , 4mm , 6mm , 8mm. The load displacement curve for these all model is presented in graph1 [11]



Graph 1: lateral load v/s displacement [11]

(2) HEIGHT TO THICKNESS RATIO:-

Anjana R K Unnithan et al. in, They were found that the displacement increases with the story height and decrease as the thickness of steel plate shear wall increases. They obtained minimum displacement in 80mm thick steel plate shear wall. [5]
Fariborz Nateghi et al. in, studied 4-shear walls of type SPSW (a) with 6mm infill plate thickness (b) with 3mm thickness infill plate, the VBE and HBE between the column clear span. They got different height to thickness ratio and also different value of all parameters. [1]
Dr. S. Karthiyaini studied on G+9 story building. He oversexed that story drift varies for different thickness, maximum drift occurs at 6th story. Story overturning moment decreases with increase in thickness of the plate and story shear varies for different thickness of plates. It is remain zero at the base and the top story [5]

(3) MODELING OF SPSW:-

Anjaana R K Unnithan et al. in used for design and analysis of the high rise building with steel plate shear wall is carried out using software ETBS.[5]

Ugale Ashish B. et al. the analysis of steel plate shear wall and the building are carried out using software STAAD PRO.[7]

Berman and Bureau presented a plastic analysis method for analysis and design of SPSWs based on the strip models assumption. In this model assume that boundary elements have enough strength for complete tension which develop in infill steel plate.[1]

Farizborz Nateghi et al. in, analytical method to evaluate the shear resistance of un-stiffened SPSWs with thin steel plates using strip model assumed that beams are rigid enough for developing the complete tension field in infill plate.[1]

Ricky Chan. et al. Finite element models with different height to thickness of steel plate used for non-linear large displacement analysis under loading has carried out by ANSYS. [2]

Mahmound REZAI ET. Al, simplified strip method in the (CAN/CSA-S16.1-M94) is based on theory of pure diagonal tension, which does not account for any shear carried by the thin plates prior to shear buckling. Each strip is assigned an area equal to the product of the strip width and plate thickness. A minimum of 10 strips, each of width equal to the strip spacing is recommended by the code. [6]

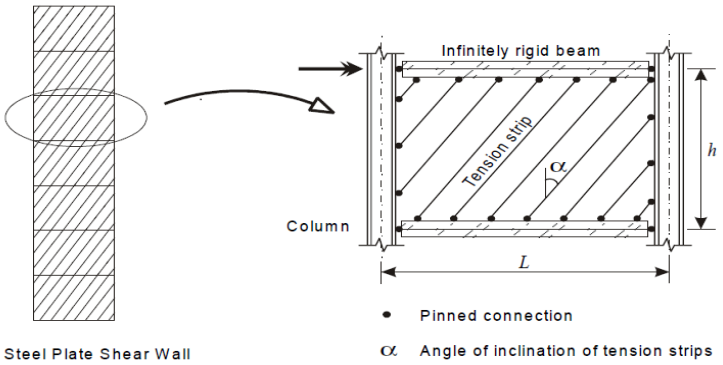


Fig.4: SPSW with tension field action [6]

Asheena Sunny et al, Geometric and material properties for the present study were collected from the journal titled investigation of the behavior of stiffened steel plate shear walls with finite element method by Masoud Ghaderi.

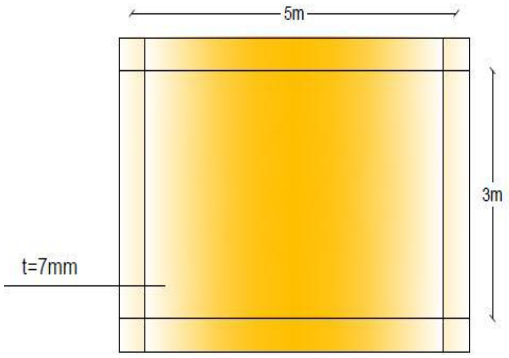


Fig.5:Geometry of the specimen [11]

Displacement was reduced around 53 % by the use of stiffeners in SPSW with cut-out. By reviewing the journal, Asheena et al. (2015) made the following conclusions, "As per FEMA 310, maximum drift limited to 51mm". From the finiteelement analysis, it is observed that displacements of diagonally stiffened steel plate shear wall with cut-outs are below 51 mm. Hence Stiffener dimensions can be suitably refined to get the displacement nearer to 51 mm. [10]

(4) DIFFERENT ANALYSIS:-

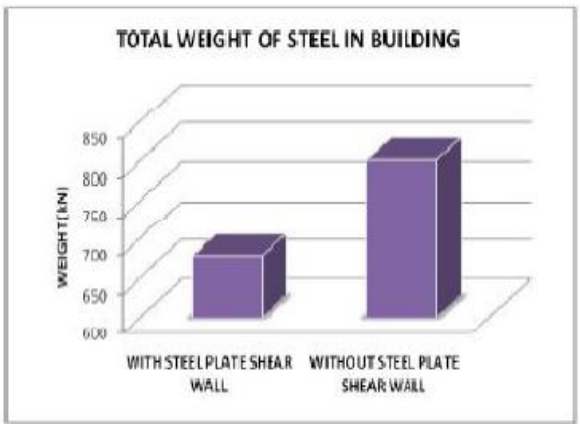
Anjaana R K Unnithan et al. their paper present study is to carry out the response spectrum analysis as per IS 1893: 2002 and all structural members are designed as per IS800:2007 considering all load combination. [5]

Asheena Sunn et al. in, analyzed their model with the time history analysis because this type of analysis was conducted the dynamic response of the structure due to the action of any time dependent loads. [10]

Fariborz Nateghi et al. in work on the push over curves of the un-stiffened specimens with enough stiffness and strength of the boundary elements have had better curves than the specimens with flexible members, shear walls with enough strong boundary elements have been able to reach the expected shear capacities based on strip model method [1]

(5) WEIGHT:-

Ugale Ashish B. & Raut Harshalata R. resulted that steel plate shear walls have a large effect on the behavior of frames under earthquake. Steel plate increase stiffness of the structure. Due the presence of SPSW total weight of steel in building is reduced than building without SPSWS. [7]



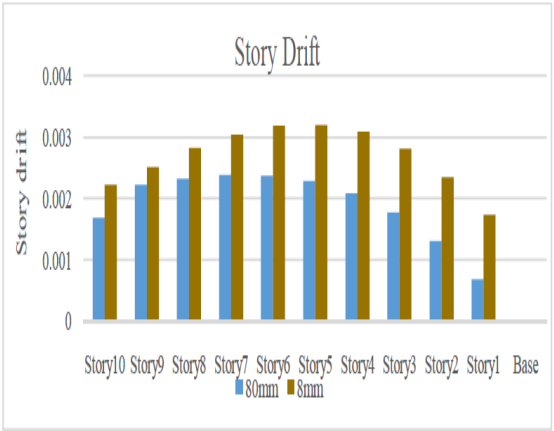
Graph 2: Weight v/s with and without SPSW

(6) OTHER PARAMETERS:-

Rocky and Skaloud found that the rigidity of the flanges has a strong upon behavior of panel and when the flanges are very light collapse mechanism is followed by first researcher Wagner but the flanges are heavy the plastic hinges from in the four corner of the panel and for intermediate flanges two no. of plastic hinges will be located at the flanges and remained two ones at corners of the panel.

Anjaana R K Unnithan et al. researched on response spectrum curve, spectrum curve, displacement, velocity and acceleration reduces as the damping increases and finally sets to zero. Maximum displacement occurs at a time period of 3.33 sec. Maximum velocity occurs at a time period of 0.416 sec. Maximum acceleration occurs at a time period of 0.4247 sec. [5]from 4.75mm to 12.75mm This structure was initially design using reinforced concrete shear wall but according to Engineering News record (1978) due to patent problem the RC walls were converted to steel shear walls. The structure consisted of moment perimeter frame and "T" shaped stiffened steel shear walls. The wall panels were about 10-ft high and 16.5 feet long and had vertical stiffeners on one side and horizontal stiffener on the other side. The panels were connected to boundary box and H steel columns using bolts. The construction contractor in this case has made a comment that "The next high-rise building we do won't likely be designed with bolted steel seismic walls" (ENR, 1978). According to ENR article, the contractor on another high-rise in Tokyo switched from bolted steel panels to welded panels after failing to achieve the required precision. [3]

Dr. S. Karthiyaini, Story drift varies for different thickness, maximum drift occurs at 6th story. For 80mm thick steel plate shear wall, maximum story drift occurs at 7th story and for 16mm thick steel plate shear wall, maximum story drift occurs at 5th story.Story overturning moment decreases with increase in thickness of the plate. [5]



Graph 3:Comparison of story drift for 8mm and 80mm thick SPSW

Siddhartha Ghosh , A four-story steel frame building with pinned beam to column connections is designed with one bay of steel plate shear walls. Initially we consider the SPSW bay to have a span equal to the story height. This span is

later varied in order to consider design scenarios with various aspect ratios of the steel plate panel. The building is assumed to have seismic weights of 4693 kN per floor, except for the roof, where it is 5088 kN. The SPSW is designed against specific earthquake records for selected target ductility ratio values. This ductility is defined in terms of the roof displacement.

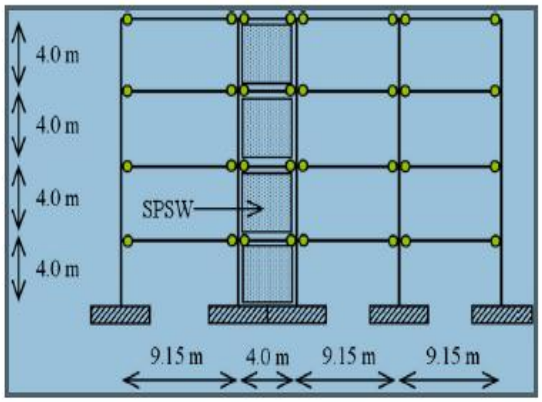


Fig.6: Plan of building [12]

Shear wall systems is presented in this paper. The method is applied to the design of four-story steel frame structures, with different steel panel aspect ratios. The results show very clearly that this method (along with a suitable adjustment of the beam section) is able to achieve the target displacement ductility quite satisfactorily. The primary advantage of the proposed procedure is that (conceptually) it provides a very simplistic solution for obtaining a design of SPSW systems based on a target inelastic drift and a selected yield mechanism. It does not require any complicated analysis from the designer's/practicing engineer's part. The procedure remains simple while satisfying an advanced performance-based seismic design criterion, which makes it a prospective candidate for design codes .The proposed displacement-based design procedure is validated against specific earthquake records. However, since themethod is found to work well for designs against specific earth-quake records, it should be easily extended to designs using a code-defined design spectrum. The method needs to be validated for a larger set of strong motion records with different characteristics. The proposed procedure also needs to be validated for taller structures. Where the assumption of uniform and unidirectional story drifts during the peak response may not be realistic due to a larger participation of the higher modes. Also, for high-rise structures with large drifts and increased gravity loads at lower floors, the P_1 effects may not be negligible.

III. CONCLUSION

By the reviewing above papers we can conclude that the steel plate can be used for high rise building to dynamic evaluation of lateral force resisting system. The steel plate shear wall system is depending on the steel what we use it depends on design specification of building is increases. Then we can adopt this system for multistoried building.

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REFERENCES

1. Fariborz Nateghi and Erfan Alavi Fariborz Nateghi1 and Erfan Alavi 2The 14 the World Conference on Earthquake Engineering, October 12-17, 2008, Beijing, China.
2. Ricky Chana, Faris Albermanib and S. Kitipornchai Stiffness and Strength of Perforated Steel Plate Shear Wallthe Twelfth East Asia-Pacific Conference on Structural Engineering And Construction.
3. Jadhav Manoj Babaso , Patil G. R. Review On Steel Plate Shear Wall For Tall Buildings International Journal Of Science And Research (IJSR)ISSN (Online): 2319-7064Impact Factor (2012): 3.358.
4. C. H. Li, K. C. TSAI, J. T. CHANG, And C. H. LIN Cyclic Test Of A Coupled Steel Plate Shear Wall Substructure, The Twelfth East Asia-Pacific Conference On Structural Engineering And Construction.
5. Anjana R K Unnithan, design And Analysis of High Rise Building with Steel Plate Shear Wall international Journal of Civil Engineering and Technology (IJCIET) Volume 8, Issue 4, April 2017, Pp. 1012-1025, Article ID: IJCIET_08_04_115.

6. Mahmoud Rezai, Carlos E Ventura And Helmut G L Prion3 numerical Investigation Of Thin Unstiffened Steel Plate ShearWalls
7. Ugale Ashish B. and Raut Harshalata R. Effect of Steel Plate Shear Wall on Behavior of Structure International Journal of Civil Engineering Research.ISSN 2278-3652 Volume 5, Number 3 (2014), pp. 295-300.
8. R.Esfandiar1 and M.A.Barkhordari investigation behavior thin steel plate shear walls. The 14th The World Conference on Earthquake Engineering October 12-17, 2008, Beijing, China.
9. M. Lashgari, Azad University of Kermanshah, Iran Finite Element Analysis of Thin Steel Plate Shear Walls World Academy of Science, Engineering and Technology 58 2009.
10. Asheena Sunny1, Kavitha P.E. 2, and Lija M. Paul Study on Diagonally Stiffened Steel Plate Shear Wall with Cutout*IOSR* Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684,p-ISSN: 2320334X, PP 42-46
11. Abhishek Verma, P. R. Maiti Push Over Analysis of Unstiffened Steel Plate Shear Wall International Journal of Engineering Research and Development ISSN: 2278-067X, Volume 1, Issue 12 (July2012), PP. 41-49.
12. Siddhartha Ghosh,Design of steel plate shear walls considering inelastic drift demand Journal of Constructional Steel Research 65 (2009) 1431_1437
13. Astaneh Asl, Professor, University of California, Berkeley"A Technical Note on The Use of Steel Plate Shear Wall Inside a Reinforced Concrete Moment Frame"

