STUDY ON SELF CENTERING STEEL PLATE SHEAR WALL

Varun K M[1], Er Milu Mary Jacob[2]

[1] *UG Scholar, Department of Civil Engineering, SAINTGITS College of Engineering, Kerala, India*
[2]*Assistant Professor, Dept. of Civil Engineering, SAINTGITS College of Engineering, Kerala, India*

---***---

Abstract – *Walls are one of the most efficient lateral force resisting elements in buildings. In the seismic design of buildings, shear walls act as major earthquake resisting members. In the self-centering steel plate shear wall (SC-SPSW) system, thin steel web plates provide the primary lateral strength and energy dissipation, while post-tensioned connections in the boundary frame provide recentering and mitigate frame damage. In most steel plate shear walls (SPSWs), web plates are connected to the beams and columns; however, connecting the web plates to the beams only has been proposed as a means of reducing boundary frame demands and mitigating web plate damage. In this mini project. (1) SC-SPSWs are designed with fully-connected web plates. (2) Different patterns of web plates are introduced and the effect is analyzed and compared with effect of the conventional web plates for its displacement, drift and base shear.*

***Key Words*: Self-centering, Post-tensioned connection, Steel plate, steel plate patterns, storey displacement, storey drift , storey stiffness.**

1. INTRODUCTION

Shear walls are vertical elements of the horizontal force resisting system. Shear walls are constructed to counter the effects of lateral load acting on a structure. In residential construction, shear walls are straight external walls that typically form a box which provides all of the lateral support for the building. When shear walls are designed and constructed properly, and they will have the strength and stiffness to resist the horizontal forces. In building construction, a rigid vertical diaphragm capable of transferring lateral forces from exterior walls, floors, and roofs to the ground foundation in a direction parallel to their planes. Examples are the reinforced-concrete wall or vertical truss. Lateral forces caused by wind, earthquake, and uneven settlement loads, in addition to the weight of structure and occupants; create powerful twisting (torsion) forces. These forces can literally tear (shear) a building apart. Reinforcing a frame by attaching or placing a rigid wall inside it maintains the shape of the frame and prevents rotation at the joints. Shear walls are especially important in high-rise buildings subjected to lateral wind and seismic forces.

Seismic waves reasons arbitrary ground motions in all possible directions, transmitting from the epicentre. If the structure has not been designed to resist these additional forces it may fail causing loss of life and property. In this way the impacts of sidelong loads like wind loads, quake forces & impact loads, etc. are achieving growing significance and every design engineer will face the issue of giving sufficient strength & stability for the structures against the imposed total lateral loads. Shear walls can be divided into three groups based on the ratio of height to width. When the height to width ratio is greater than 2.0, they are called high-rise shear walls; when the height to width ratio is less than 1.0, they are called low-rise shear walls; when the height to width ratio is between 1.0 and 2.0, they are called medium-rise shear walls. For high-rise shear walls, the failure is mainly governed by flexure. In contrast, for low-rise shear walls, the failure is mainly governed by shear. For medium-rise shear walls, the failure is governed by both flexure and shear.

2. AIM

To evaluate the performance of self-centering steel plate shear wall with various web plates

3. OBJECTIVES

1. To study the performance Of SC-SPSW designed web plates.
2. To find out optimum pattern for web plate.
3. To analyse the steel plate shear wall using ETABS

4. SCOPE OF STUDY

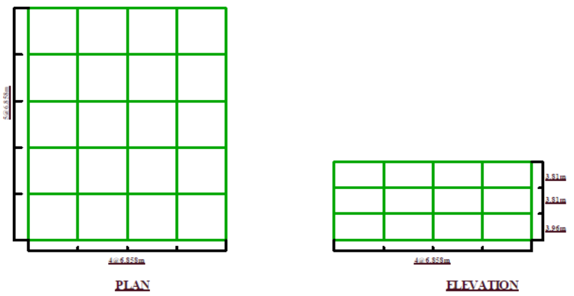
- SC-SPSW designed using beam-only-connected web plates.
- SC-SPSW designed using column-only-connected web plates.
- High rise buildings.

5. MODELING

5.1 Prototype Building

This prototype building is representative of a standard office building with structural steel frame construction and assumes a total of six lateral force resisting frames in each primary building direction.The building site location was assumed to be in Los Angeles, California situated on stiff soil (Site Class D per ASCE 7-10 definition).

The earthquake spectral response acceleration parameters used were based on the 2009 NEHRP seismic hazard maps, with a 5% viscous damping design spectral response acceleration at short (SDS) and 1 s (SD1) periods of 1.598 g and 0.842 g, respectively.



5.2 Test Specimens

Size of test specimen have been founded out to be W8x18, W8x15, W8x18 horizontal boundary elements, and W6x25 vertical boundary elements. Thickness for Infill web plate and strip thicknesses if founded to be, 24 GA, 22 GA welded to steel fish plates along the boundary frame. Floor was provided by a steel clevis and pin connection at the base of each VBE to allow its free rotation .Dimension for anchor beam is founded to be W6x20 bolted to the foundation plate. PT monostrands consisting of 13 mm (1/2 in.) diameter 1860 MPa (270 ksi) strands were provided, one on each side of the HBE web, with an initial PT force ranging 20% to 30% of the yield strength of the PT strands.

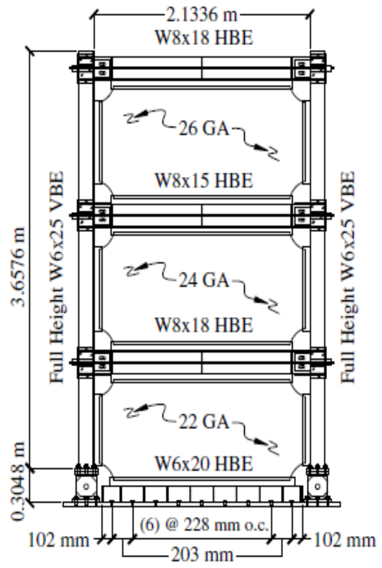


Fig 1 showing the dimension of the specimen

GM amplitude	PGA %GM	PGA g
	Test frame FRW	
WN	—	0.15
1	10	0.07
2	25	0.18
WN	—	0.15
3	50	0.36
WN	—	0.15
4	75	0.53
WN	—	0.15
5	100	0.71
WN	—	0.15
6	120	0.85
WN	—	0.15
7	140	1.00
WN	—	0.15
8	50	0.36
WN	—	0.15

Fig 2 representing loading sequence

6.0 DIAGRAMS

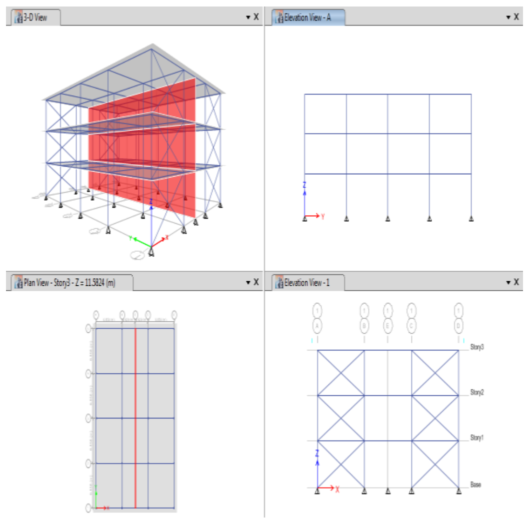


Fig 2 noticing modelling structure

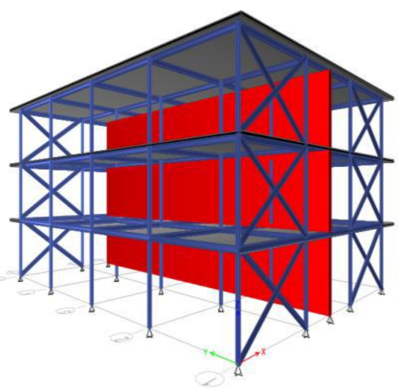


Fig 3 showing 3D view of the model

7.0 RESULTS AND DISCUSSIONS

7.1 Deformation diagrams

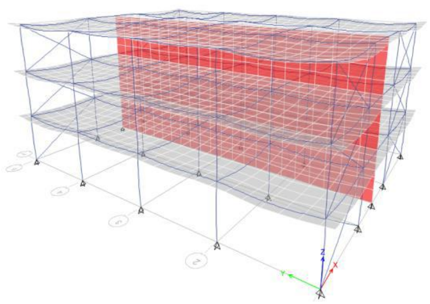


Fig 4 deformation in model 1(with slit opening)

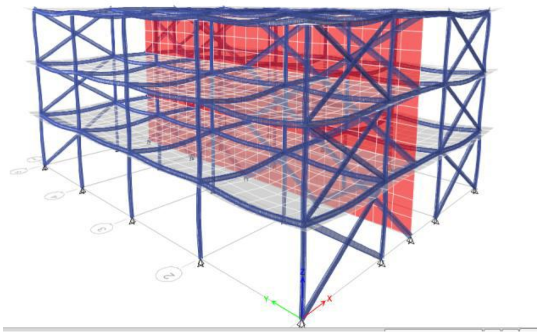


Fig 5 deformation in model 2(with low yield point)

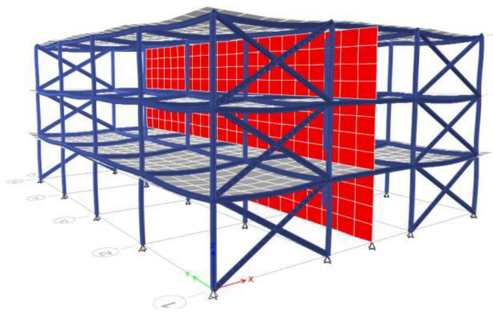


Fig 6 deformation in model 3(un-stiffened condition)

7.2 Storey height vs displacements

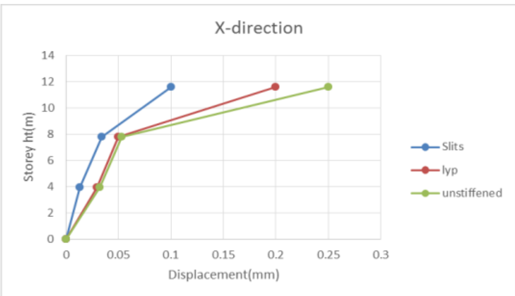


Chart 1 - storey height vs displacement

7.3 Storey height vs drift

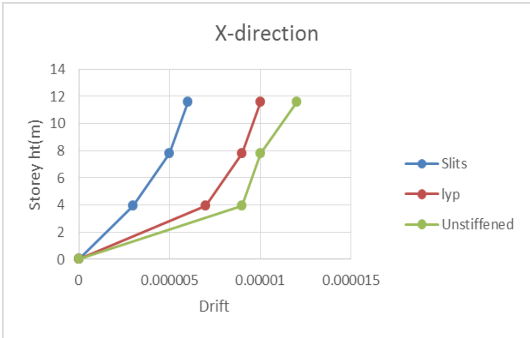


Chart 2 - storey height vs drift

7.4 Base shear vs roof drift

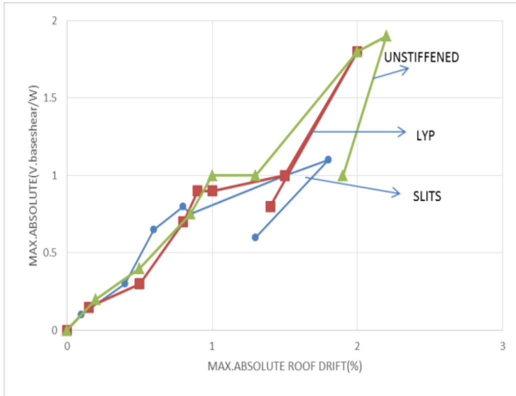


Chart 3 - base shear vs roof drift

CONCLUSIONS

Shear wall is an effective system to resist the lateral load. From the above 3 model that have been analyzed using the E tabs software for base shear, displacement and drift it was founded out that the shear wall with slit opening has better resistance to displacement drift and base shear.
At following conclusions were made

- Performance of SC-SPSW is affected by designed web plates.
- Optimum pattern for web plate is found out to be the web plate with slit opening.

As it has

1. Lesser displacement

2. Lesser drift

3. Lesser base shear

ACKNOWLEDGEMENT

I would like to thank my guide, head of department, principal, friends and family and all other who helped me in completing this thesis.

REFERENCES

[1]. **Totter, E., Formisano**, A.(2018). Strip Model Analysis for Steel Plate Shear Walls in Earthquake Resistant Structures. In Key Engineering Materials (Vol. 763, pp. 743-750). Trans Tech Publications.

[2]. **Clayton, P. M., Dowden, D. M.** (2016). Self-centering steel plate shear walls for improving seismic resilience. Frontiers of +Structural and Civil Engineering, 10(3), 283-290.

[3]. **Dowden, D. M., & Bruneau**, **M** (2016). Dynamic shake-table testing and analytical investigation of self-centering steel plate shear walls. Journal of Structural Engineering, 142(10), 04016082.

[4]. **Hashemi, A., Masoudnia, R.** (2016). Seismic performance of hybrid self-centring steel-timber rocking core walls with slip friction connections. Journal of Constructional Steel Research, 126, 201-213.

[5]. **Clayton, P. M., Berman, J. W**.(2015). Seismic performance of self-centering steel plate shear walls with beam-only-connected web plates. Journal of Constructional Steel Research, 106, 198-208.

[6]. Egorova, N., Eatherton, M. R.(2015). Experimental study of ring-shaped steel plate shear walls. Journal of Constructional Steel Research, 103, 179-189.

[7]. **Wang, M., Yang, W., Shi (**2015). Seismic behaviors of steel plate shear wall structures with construction details and materials. Journal of Constructional Steel Research, 107, 194-210.