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State of the Art Review on Design of Steel Plate Shear Wall

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ABSTRACT
Steel plate shear walls are rapidly becoming an appealing alternative in high seismic areas. The current research reviews the existing work on design and development of steel plate shear wall. The existing studies encompasses research on optimization of different design parameters of SPSW, materials of SPSW and various design configurations. The stability of these structures as lateral load resisting member is assessed using experimental and numerical techniques and presented in this review.
Keywords : Shear Wall, Stability

I. INTRODUCTION

A steel plate shear wall (SPSW) 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 (Figure 1).

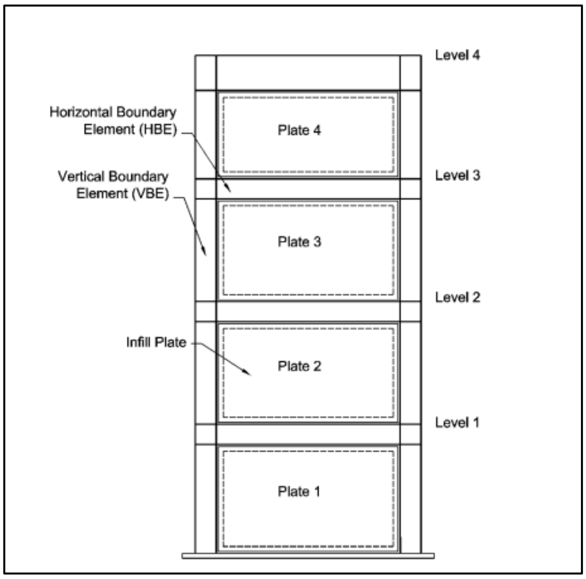

Figure 1. Typical Steel Plate Shear Wall [1]

SPSWs subjected to cyclic inelastic deformations exhibit high initial stiffness, behave in a highly tensile manner, and dissipate significant amounts of energy. These properties make them suitable for resisting and dispersing seismic loads. SPSWs can be used not only for the design of new buildings, but also, as recent research efforts show, for the modernization of existing structures [2]. In principle, beam-to-column connections in SPSWs can be either simple or moment-resisting, although, as described later, the 2005 AISC seismic design requirements allow only the latter.

II. LITERATURE REVIEW

P.P Chandurkar [3] conducted a detailed study to find a solution for a barbecue area in a multi-storied building using four different models. Model buildings with ETAB nonlinear software in 9.5.0. After analyzing the ten-story earthquake structure in Zone II, Zone III, Zone IV, and Zone V, key parameters such as lateral removal, storey displacement, and total total cost of lower storeys found on both. cases by replacing the column with a shear wall and it was concluded that the short cut wall in the corner (model 4) is economical compared to other models. It has been noted that the barber wall is economical and effective in high-rise buildings, and the placement of grill walls in appropriate areas greatly reduces earthquake migration. If the size of the shear wall is large, the shear wall takes a large amount of horizontal force

Varsha R. Harneanalysed [4] is a six story building under zone II earthquake using STAAD Pro and seismic calculation using seismic coefficient method (IS 1893 part II). Four different cases were analyzed, including a barbed wire building, an L-shaped bar structure, a near-field bar structure, and a bar-bar structure. Lateral deviation of the structural column by the shear wall near the boundary is reduced compared to other types of shear walls.

Anshuman S. et al. [5] analysis of expandable and elastoplastic materials was performed using STAAD Pro and SAP V 10.0.5 (2000) on a 15-story building located in earthquake zone IV with calculated bending moment and floor erosion in both cases. The shear strength and bending moment were greatly reduced after the formation of the shear wall. It was found that the performance point of the inelastic analysis was small and within the extension, so the results obtained by the extensional analysis are sufficient.

Dr. B. Kameswari et.al [6] studied the drift and inter-story drift of a very tall structure made of various shear wall panels and compared them with the drift of a bare frame. Considered configurations (1) Standard shears (2) Other shears (3) Diagonal distribution of shears (4) Zigzag distribution of shears (5) Influence of lifting walls. The horizontal arrangement of the barber wall has been found to be superior to other suspensions as it increases the strength and resistance of the structure by reducing lateral and interstory erosion than other types of walls and works best in earthquake prone areas.

Qiuhong ZHAO et al [7] studied a combination of traditional barbershops and new barbershops. The solid concrete wall is in direct contact with the enclosing steel frame, while the new system has a gap in the middle. He performed cyclic tests on both systems and both showed high gravity and inelastic behavior and both were able to withstand more than 17 cycles of inelastic shear displacements and achieve a mean frequency over 0.05. Shear Wall System The new compound was found to be more ductile than the traditional integrated shear wall, but the strength and durability of the traditional system was found to be higher. By introducing a gap in the new system, damage to the concrete wall at higher cycles was significantly less than damage to the concrete wall in the traditional system.

Ugale Ashish B. and Raut Harshlata R [8] analyzed the steel plate shear wall structure of G + 6 building in seismic zone III using STAAD Pro and compared it with the building frame without shear wall. The construction with a steel shear plate wall showed a very slight deviation, an increase in shear strength and bending moment and overall stiffness was found. Steel sheet shear walls are found to occupy less space than RCC shear walls.

Shahadin. Zaregairizi [9] investigated the use of shear wall and infill to improve the seismic performance of existing buildings. When a vertical analysis was performed to compare the effectiveness of the two methods, it was found that the concrete infills exhibited greater strength than the individual brick, but the brick infill experienced greater displacement than the concrete infill. Therefore, when they are used in combination, their side effects are reduced.

Men Jinje et al [10] proposed the planned construction of RC shear wall structures after conducting research based on the conceptual design method. A 30-story building with an RC shear wall and rectangular structure was considered. research was carried out on the construction plans of shear walls and parameters such as lateral strength, slope between floors, seismic response capability, rotation rate and displacement time were calculated, and it was concluded that the arrangement of shear walls has an effect on the material and use of concrete. The use and utilization of metal increases as the aspect ratio of the structure increases.

Chun Ni et al [11] studied the operation of diagonal timber sheathing by examining 16 gauge shear walls and obtaining the results of bracket support, live load and log width in plane shear volume. The shear strength of the plane for two-story wood shavings was found to be 2-3 times higher than that of a simple diagonal rabbit grill.

T. Sonos et al [12] proposed the use of interconnected inclined bars in the joint area to improve the earthquake resistance of reinforced concrete joints of external concrete columns.

Ravi Kumar et al [13] conducted an extensive research to determine the solution of shear wall in multi-story building based on its behavior and elasticity and elastoplastic. Using ETABS, he analyzed a 10-story, 40-meter-tall building to withstand an earthquake. He concluded that shear walls are one of the most effective structures

Natalino Gattesco et al [14] performed a comparative study of code provision on chipboard shafts and individual window openings. From the experiments, it was found that there was very little difference in shear volume, swelling and dissipation force between perforated and solid walls of the same size, and there was a significant increase in shear volume on the two-pin panels.

Wen - I Liao et al [15] performed a four-dimensional wall cutter, two grill walls under the control of a moving table and two grill walls under a loaded circumferential cycle. The steel bars were placed at a 45 degree angle to the horizontal closest to the applied pressure area. The heavy loading of the two shear walls caused by the shaking table was handled and response times for acceleration and deceleration and hot loops were introduced. Moving energy loops were also provided on the shear walls during the rotation of the rotating load and it was concluded that the pressure applied to the high earthquake performance was achieved by placing the steel bars.

A.B. Karnale et al [16] analyzed different 6-dimensional wall (low height) and 14-story configurations using ETABs software. A comparison of the results observed due to building height was made and it was found that the shear wall performs better in high-rise buildings than in low-rise buildings.

Martínez and Xu (2010) [17] proposed a simplified but accurate approach to model a CFS-frame shear wall using a 16-node shell element with equivalent geometric and material properties derived from actual CFS-frame shear wall properties.

Liu P. et al (2012) [18] adopted the Pinching4 [19] model developed by Lowes and Altoontash (2003) [20] to characterize the cyclic behavior of CFS shear walls with timber cladding; this model was calibrated based on experimental test results and reproduced the hysteretic behavior with acceptable accuracy (difference below 10%).

Shamim and Rogers (2013) [21] simulated the nonlinear response history of two-story CFS frame shear walls under seismic loading using the Pinching4 model, which was calibrated based on the results of dynamic tests performed by the same authors.

Buonopane et al. (2015) [22] developed a computationally efficient bolt-based modeling protocol in OpenSees software for CFS OSB-clad shear walls. In the official version of Open Sees, two hysteretic models have been developed and implemented that take into account strength and stiffness degradation as well as clamping.

David Padilla-Llano (2015) [23] proposed a numerical framework for shear walls with a CFS frame that captures the nonlinear cyclic behavior of critical components including frame elements (chord bolts) and bolts.

More advanced modeling techniques were performed by Hung Huy Ngo (2014) [24] through the adoption of the SpringA element in ABAQUS to simulate the shear behavior of bolts connecting OSB cladding to CFS frame members.

Deverni et al. (2021) [25–26] replicated the same effort with a simplified approach to model the shear behavior of bolts between the casing and the CFS using the CONN3D2 element in ABAQUS assuming a constant angle between the bolt strain and the global horizontal axis at all levels. of the lateral shear wall requirement. Additionally, without defined release and reloading paths, Spring A and CONN3D2 elements can only be used when simulating the transverse behavior of CFS shear walls under monotonic loading.

III.CONCLUSION

The shear walls are an effective structure is reducing the lateral deformation of the building. From the existing researches it was found that the shear wall works better in high-rise buildings than in low-rise buildings. The shear wall arrangements have an impact on material and concrete use which increases with increase in aspect ratio of the structure. For large size shear walls, the maximum magnitude of horizontal force is taken by it. Out of different arrangement of shear walls (parallel and zig-zag) the zigzag arrangement is found to have higher strength as compared to parallel arrangement.

IV. REFERENCES

[1]. AISC (2004), “2005 Seismic Provisions for Structural Steel Buildings”, American Institute of Steel Construction, Chicago, IL.

[2]. Astaneh-Asl, A. (2001), “Seismic Behavior and Design of Steel Shear Walls”, Steel Tip 37, Structural Steel Educational Council, Moraga, CA.

[3]. P.P Chandurkar, DR. P.S. Pajgade, "Seismic analysis of RCC building with and without shear wall" IJMER, Vol.3, Issue 3, may- june 2013,pp- 1805 -1810,2013

[4]. Varsha. R. Harne "Comparative study of strength of RC Shear wall at different location on multistoried Residential building", International Journal of civil Engineering Research. ISSN 2278-3652 Volume5,Number 4(2014)pp 391-400

[5]. Anshuman.S, Dipendu Bhunia,Bhavin Ramjiyani,"Solution of shear wall location in multistorey building",International Journal of Civil and Structural Engineering , Volume 2, No 2,2011.

[6]. Dr. B.Kameswari , Dr. G Elangovan ,P. Sivabala, G. Vaisakh, "Dynamic Response of High rise

Structures under the Influence of discrete staggered shear wall", IJEST,2011
[7]. Qiuhong ZHAO, Abolhassan Astaneh -ASL ," Cyclic Behaviour of traditional and innovative composite shear walls" 13th World Conference on Earthquake Engineering.
[8]. Ashish B. and Raut Harshlata R, " Effect of steel plate shear wall on behavior of structure" International Journal of civil Engineering Research. ISSN 2278-3652 Volume5, Number 3(2014)pp 295-300.
[9]. Shahabodin. Zaregairizi, "Comparative investigation on using shear wall and infill to improve seismic performance of existing buildings", 14th World Conference on Earthquake Engineering.
[10]. Men Jinjie,Shi Qingxuan,He Zhijian,"Optimal Design of Tall Residential Building with Shear wall and with Rectangular layout" International Journal of High Rise Buildings Volume 3 Number4.
[11]. Chun Ni Erol Karacabeyli, Performance of Shear Walls with Diagonal or Transverse Lumber Sheathing, Journal of Structural Engineering 14. Mark Fintel, Performance.
[12]. Tsonos AG, Tegos IA, Penelis GGr. “Seismic resistance of type 2 exterior beam-column joints reinforced with inclined bars, ACI structuraljournal, 89,. 3-12,1992.
[13]. A. Ravi Kumar K. Sundar Kumar "Analysis and Design of Shear Wall for an Earthquake Resistant Building using ETABS"International Journal for Innovative Research in Science & Technology, Volume 4 , Issue 5, October 2017
[14]. Natalino Gatteso, Allen Dudine, Rita Franceschinis, “Experimental investigation on the seismic behaviour of timber shear walls with practicle boards”. World conference on Timber Engineering, Auckland (2012).
[15]. Wen - I Liao , Jianxia Zhong ,C.C.Lin,Y.L.Mo,Chin- Hsiung " Experimental studies of high seismic performance shear walls" 13th World Conference on Earthquake Engineering Vancouver, B.C., Canada August 1-6, 2004 Paper No. 501
[16]. A.B. Karnale and Dr. D. N. Shinde, Comparative Seismic Analysis of High Rise and Low Rise RCC Building with Shear Wall, International Journal of Innovative Research in Science, Engineering and Technology, September 2015.
[17]. Martínez-Martínez J, Xu L. Simplified nonlinear finite element analysis of buildings with CFS shear wall panels. J Constr Steel Res 2011;67(4):565–75.
[18]. Liu P., Peterman K.D., Yu C. and Schafer B.W., “Characterization of cold-formed steel shear wall behavior under cyclic loading for CFS-NEES building”, Proceedings of the 21st International Specialty Conference on Cold-Formed Steel Structures, October 24-25, 2012, St. Louis, Missouri, United States
[19]. https://opensees.berkeley.edu/wiki/index.php/Pinching4_Material.
[20]. Lowes LN, Altoontash A. Modeling reinforced-concrete beam-column joints subjected to cyclic loading. J Struct Eng 2003;129(12):1686–97.
[21]. Shamim I, Rogers CA. Steel sheathed/CFS framed shear walls under dynamic loading: Numerical modelling and calibration. Thin-Walled Structures 2013;71: 57–71.
[22]. Buonopane SG, Bian G, Tun TH, Schafer BW. Computationally efficient fastener based models of cold-formed steel shear walls with wood sheathing. J Constr Steel Res 2015;110: 137–48.
[23]. Padilla-Llano DA. A framework for cyclic simulation of thin-walled cold-formed steel members in structural systems. Blacksburg, United States: Virginia Polytechnic Institute and State University; 2015. Ph.D. thesis.
[24]. Ngo H.H., “Numerical and experimental studies of wood sheathed cold-formed steel framed shear walls”, MSc. Thesis, Johns Hopkins University, Baltimore, MD, United States, (2014).

[25]. Derveni F, Gerasimidis S, Schafer BW, Peterman KD. High fidelity finite element modeling of wood-sheathed cold-formed steel shear walls. J Struct Eng 2021;147: 04020316.

[26]. Derveni F, Gerasimidis S, Peterman KD. Behavior of cold-formed steel shear walls sheathed with high-capacity sheathing. Eng Struct 2020;225: 111280. https://doi. org/10.1016/j.engstruct.2020.111280.

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