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Shear walls – A review

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Abstract: Shear walls are structural systems which provide stability to structures from lateral loads like wind, seismic loads. These structural systems are constructed by reinforced concrete, plywood/timber unreinforced masonry, reinforced masonry at which these systems are sub divided into coupled shear walls, shear wall frames, shear panels and staggered walls. The present paper work was made in the interest of studying various research works involved in enhancement of shear walls and their behaviour towards lateral loads. As shear walls resists major portions of lateral loads in the lower portion of the buildings and the frame supports the lateral loads in the upper portions of building which is suited for soft storey high rise building, building which are similar in nature constructed in India, As in India base floors are used for parking and garages or officers and upper floors are used for residential purposes.

Keywords: walls, steel plate shear walls, plywood shear walls, cyclic loading test.

I. INTRODUCTION

Vibrations which are caused under the earth's surface generate waves which disturb the earth's surface, termed as earthquakes. It was said that earthquakes will not kill human but structures which are not constructed in considering the earthquake forces do. 60% of India lying in earthquake prone zone at which there is a need of increase of understanding the behaviour of earthquake, constructing and developing earthquake resistant structures. Shear walls to resist the lateral forces produced during earthquake. Shear walls behaviour depends upon the material used, wall thickness, wall length, wall positioning in building frame also.

II. LITERATURE REVIEW

Shear walls are more efficient in resisting lateral loads in multi storied buildings. Shear walls are made with steel, reinforced concrete are kept in major positions of multi storied buildings which are made in consideration of earthquake forces, wind forces. A significant amount of research work was done in various aspects of shear walls such as

Yamaguchi et al (1), Conducted monotonic, cyclic tests with various loading rates, pseudo dynamic test, El Centro shake table tests for wood framed shear walls, the tests with more load cycling and high amplitudes corresponded together post peak strength degradation. The fast reversed cyclic test results are close to shake table tests. Compared with pseudo dynamic tests and shake table test, similar amplitudes load cycles were observed but results were different.

Mc mullin and merrick (2), conducted force controlled cyclic tests on walls sheathed on both sides with oriented strand board (OSB), 3 ply plywood, 4 ply plywood, gypsum wall board (GWB). The stiffness of GWB was found to be greater than OSB and ply wood.

Salenikovich and Dolan (3), tested walls by various aspect ratios and overturning restraints with both statically and cyclically. Walls ductility and wall stiffness were same as result of two protocols. Capacity and corresponding displacement were 13% and greater than 30% respectively were found for walls tested monotonically and having aspect ratios less than or equal to 2:1.

Ni and Karacabeyli (4) studied the performance of shear walls anchored with hold downs, without hold downs and with dead loads and no hold downs. Static and reverse cyclic loading as per ISO (1998) protocols were used. Comparison to displacement of walls without hold downs to with hold downs and no vertical load were observed 50% corresponding displacement of walls without hold down or vertical load was found to that of walls with hold downs and no vertical load.

Kevin B.D.White (6), Conducted monotonic earthquake loadings fully and partially restrained wood frame shear walls. It was found that partially anchored subduction zone earthquake tests caused wall failure modes consistent with monotonic and cyclic tests. Fully anchored subduction zone tests caused wall failure modes consistent with cyclic tests. Fully anchored monotonic tests did not cause screw fracture or nail withdrawal and therefore did not have failure

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modes consistent with subduction zone earthquake tests. Energy dissipation was most similar to cyclic tests rather than monotonic tests.

H.Veladi et al (7), conducted cyclic tests with varying aspect ratio of shear walls and infilled panels on steel shear walls. Height reduction in shear panels results in descrease of drift and enhancement of shear strength. Increase in height of panel improves drift of panel and causes significant plastic energy absorption which leads to reduction in shear strength. Use of wide panel with cyclic tests and varying aspect ratio increase of shear strength and reduction of drift was found.

Zhiyuan sun, Jiliang Liu and Mingjin Chu (8), conducted cyclic loading test on a new type of adaptive slit shear wall which is introduced to improve the seismic performance of conventional shear wall structures. When compared to conventional shear walls the new wall is high ductile and failure process is progressive and is divided into two stages i.e., whole wall stage and the slit wall stage. It was found that ductile failure can be achieved and brittle shear failure can be avoided in adaptive slit shear walls with multiple seismic fortifications.

Natalino Gattesco et al (9), carried experimental study to compare with code provisions on timber shear walls with particle boards and also one opening for windows. Experimental results shown that very little differences in terms of shear capacity, ductility and dissipative capacity between perforated and solid walls with equal dimensions. And a significant increase of shear capacity observed in double number nailed panels.

S.Greeshma et al (10) conducted experiments of type 1 model comprises two joint assemblages having joint detailing of slab bars at the joints, type 2 comprises two specimens having additional cross bracing reinforcements as per IS : 13920 : 1993 for beam column joint. Experimental results showed that type 2 detailing have better performance, exhibited higher load carrying capacity with minimum cracks in the joints, enhancement in energy dissipation for type 1 and type 2 specimens were observed to be 113.58% higher than that of type 1 and are matching with analytical results.

Paulay (11) by using laws of statics, found that joint shear reinforcement is necessary to sustain the diagonal compression field rather than to provide internment to compressed concrete in a joint core.

T.Sonos et al (12) suggested the use of crossed inclined bars in joint region which is considered the most effective way to improve the seismic resistance of exterior reinforced concrete beam column joints.

Murty et al (13), suggested the practical joint detailing using hair pin type reinforcement is an alternative to closed ties in the joint region which was observed by testing the exterior beam column joint subjected to static cyclic loading by change of anchorage detailing of beam reinforcement and shear reinforcement.

Jing et al (14), suggested diagonal steel bars in the form of “obtuse Z” were suitable for joints in region of low to moderate seismicity and on interior joints by changing conventional pattern of reinforcement.

Hwang et al (15) found that the major function of joint hoop is to carry shear as tension tie and to constrain the width of tension cracks. The suggestion by author was that lesser amount of joint hoop with wider spacing could be used without no affect of the performance of joint.

Max Guendel et al (16), conducted experimental and numerical investigations on steel shear walls for seismic retrofitting tests conducted on a pure reinforced concrete (RC) frame as reference to steel shear walls with aspect ratio $\mu = 3.5$ and 5.5 with welded shear panels, shear panels made of DX56D and DX51D with excellent ductility ($\mu = 8$) SSW’S with welded shear panels and $\mu = 3.5$ and 5.5 had failure mode which separated the shear panel from the boundary elements. SSW’s with shear panels fixed with powder actuated fasteners also provide high stiffness and high strength and with limited deformation capacity due to early failure of the connection, if ordinary steel grades are used. Shear panels made with DX56D fixed by powder actuated fasteners gave improved ductility ($\mu = 8$). Strong plastifications were occurred in the shear panel before the connection fails. The advantages observed with SSW’s connection to RC frame have several advantages (i) reduction of vertical reaction forces in foundations. (ii) Additional shear forces in the RC beam are prevented and only axial forces are introduced in RC beam and RC columns with.

Arturo E.Schultz et al (17) conducted experiments on precast shear walls, to develop a calibrated experiments and accurate behavior of models and design rules of precast shear walls. Application of cyclic lateral load test was conducted of twelve 2/3 scale specimens. Vertical joint connection used are notched shear plate, slotted flexure plate, inclined flat bar, pinned tension strut, brass friction device, U-shaped flexure plate. Unlike the five connections U-shaped flexure plate performance, it was not possible to proportion the U-shaped plate to resist the shear forces. Panels made with notched shear plate and slotted flexure plate, assemblage acted as a monolithic unit and found with large initial elastic stiffness.

P.P.Chandurkar et al (18) present a paper in determining the shear wall location of four different types of models varying with earthquake load with zones II, III, IV, V as per IS : 1893 : 2002 and calculated lateral displacement, story drift and total cost required for ground floor are calculated by replacing column with shear wall. It was found that shear wall in short span at corner in model 4 was economical and effective in high rise buildings. Shear wall with large

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dimensions are effective in high amounts of horizontal forces and providing shear wall at suitable location, displacements can be reduced due to earthquake.

Venkatasai ram kumar.N et al (19) analyzed the reinforced concrete shear walls in multistory buildings with effect of lateral loads under flat terrain with varying seismic zones as per IS : 1893 : 2002 and wind loads as per IS : 875 : 1987 (Part : 3). In all the considered G + 2, G + 4, G + 6, building frames, the base moment varied in power equation pattern and for base shear the graphs varied linearly. With increase in base area the stability of building increased and minimum thickness to prevent buckling of shear wall also decreased as the stability increased.

Venkata Sai Ram Kumar N et al (20) analyzed behavior of reinforced concrete shear4 walls by considering increase of height of buildings from ground level to G+7 of height of each floor as 3.5m. The analysis involved in developing of capacity curves which relates wind drift, shear wall length, wind drift, wind shear, wind moment, seismic drift, seismic shear, seismic moment, base moment and base shear with increase in height the base shear of medium and soft soils have no change and varied linearly, but for rocky soils there is a slight decrease in base shear after 20mts of building height.

Ugale Ashish B. and Raut Harshalata R. (21) consider a building frame with(G+6) storey situated in seismic zone III as per Indian code 1893:2002, steel plate shear wall behavior was analyzed using STAAD PRO software, with shear wall and without shear wall also. Found steel plate shear wall enhances the stiffness of the structure. Compared without SPSW building, building with SPSW has very less deflection, bending moment, shear force, deflection and also quantity of steel is also reduced. SPSW occupies less space compared to RC shear wall which have economical and architectural aspect.

S.V.Venkatesh, H.Sharada Bai(22), conducted linear static analysis with considering internal and external shear wall performance on a 10 storey framed structure for investigation of maximum joint displacement, support reaction, column forces and beam forces and found that performance of square shear walls gave better results than rectangular column of different orientations under lateral loads. Thickness of shear forces does not have much effect on decreasing of shear stresses and performance of interior shear walls are good when compared to external shear walls. External shear walls are treated as alternative to internal shear walls in retrofitting techniques.

IV. CONCLUSIONS

From the above literature, it is seen that the research are in interest of usage of different types of shear walls in construction of tall building structures. Research was carried mainly on application of cyclic load tests and behaviour of different types of shear walls in cyclic application of loads. Researchers studied various parameters like enhancement of stiffness, drift, development forces in buildings and also to observe perfect location of shear wall location in building frame for construction. It was seen that any type of building which is tall and can be affected with lateral forces like earthquake and wind forces can be constructed with shear walls. Shear walls can be used as lateral load resisting systems and also retrofitting of structures. Internal shear walls are more efficient than external shear walls when compared with cyclic load tests by researchers.

REFERENCES

[1] Yamaguchi N.Karacabeyli E. Minowa c, KAWAI N, Watanabe K, Nakamura I seismic performance of nailed wood frame walls. Paper No 8-1-1 in Proc World Conf. on Timber Eng, , Whistler, BC, 31 July to 3 Aug 2000.

[2] Mc Mullin KM, Merrick DS (2000) Seismic testing of light frame shear walls. Paper No 5-4-1 in Proc 6th World Conf on Timber Eng, , Whistler, BC, 31 July to 3 Aug, 2000.

[3] Salenikovich AJ, Dolan JD, The racking performance of shear walls with various aspect ratios, part1,2 cyclic tests of fully anchored walls.Forest Prod J.53 (11-12), 10, 37-45, 65-73, 2003a, 2003b.

[4] Ni C, Karacabeyli E, Capacity of shear wall segments without hold-downs. Wood Design Focus 12(2):10-17,2002Eftychios A. Pnevmatikakis, Petros Maragos "An Inpainting System For Automatic Image Structure-Texture Restoration With Text Removal", IEEE trans. 978-1-4244-1764, 2008

[5] Kevin B.D. White, Thomas H.Miller, Rakesh Gupta, "Seismic performance testing of partially and fully anchored wood frame shear walls". Wood and fiber science, 41(4). 2009, pp.396-413,2009.

[6] H.Veladi, A.Armaghani, A.Davaran , "Experimental investigation on cyclic behaviour of steel shear walls". Asian journal of civil engineering (Building and Housing) Vol.8, No.1 (2007) Pages : 63-75,2007.

[7] Zhijuan Sun, Jiliang Liu and Mingjin Chu, "Experimental study on behaviours of adaptive slit shear walls" The open civil engineering journal, 2013,7, PP:189-195,2013.

[8] 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).

[9] S.Greeshma, C.Rajesh, K.P.Jaya (2012) "Seismic behaviour of shear wall – slab joint under lateral cyclic loading". Asian journal of civil engineering (Building and Housing) Vol.13. No.4 .PP.455-464,2012.

[10] Paulay T. Equilibrium criteria for reinforced concrete beam – column joints, ACI structural journal, 86, pp-635-643,1989.

ISSN: 2319-8753

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(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 2, February 2014

[11] Tsonos AG, Tegos IA, Penelis GGr. "Seismic resistance of type 2 exterior beam-column joints reinforced with inclined bars, ACI structural journal, 89,. 3-12,1992.
[12] Murty CVR, Rai DC, Bajpai KK, Jain SK. "Effectiveness of reinforcement details in exterior reinforced concrete beam column joints for earthquake resistance, ACI Structural journal, 100, Pp.49-155,2003.
[13] Jing LI, Pam HJ, Francis TK. New details of HSC beam column joints for regions of low to moderate seismicity, 13th world conference on earthquake engineering, Vancouver, Canada, 449,2004.
[14] Hwang SH, Hung-JL, Ti-Fa l, Kuo-Chou W, Hsin-Hung T. Role of hoops on shear strength of reinforced concrete beam column joints, ACI structural journal, 102,.PP.578-5872005.
[15] Max Guendel, Benno Hoffmeister, Markus Feldmann, "Experimental and numerical investigations on steel shear walls for seismic retrofitting". Proc of the 8th international conference on structural dyncamics, Eurodyn, pp. 474-481,2011.
[16] Arturo E.Schultz, Maher K.Tadros and Xiaming Huo, Rafael A.Magana, "Seismic resistance of vertical joints in precast shear walls" Proc of the 12th congress vol.1 1. Federation of internationale DE la Precontrainte (FIP),1994.
[17] 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.
[18] Venkata Sairam Kumar N, Krishna sai M.L.N, Satyanarayana.S.V, : "Influence of reinforced concrete shear wall on multistorey buildings". IJESRT, Vol.2 Issue 8, pp-2055-2060,2013.
[19] Venkata Sairam Kumar.N, P.V.S.Maruthi Krishna, "Utilization of reinforced concrete flexural (shear) Wals in multistorey buildings with effect of lateral loads under flat terrain". IJESRT, Vol.2, Issue 9, pp-2467-2471,2013.
[20] Ugale Ashish B. Raut Harshalata R. "Effect of steel plate shear wall on behaviour of structure". International journal of civil engineering research, Vol.5, Number 3, PP-295-300,2014.
[21] S.V.Venkatesh, H.Sharada Bai, "Effect of internal & External shear wall on performance of buildings frame subjected to lateral load", International journal of earth science and engineering, Vol.4, No.6, SPL, (Oct, 2011), pp 571-576,2011.