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Seismic Behaviour of Double Steel Plate Composite Wall Under Cyclic Loading. A Review

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ABSTRACT: For high strength, durability and resistance to external forces, steel and concrete composite wall are used in construction of high-rise building. This wall consists of concrete infill and steel plate connected to each other by using tie bars. In this paper, we studied the work done by various researchers on various behavior of double steel plate composite wall under cyclic loading with different types of boundary conditions, different shapes of wall, different shear stud and tie bar spacing etc.

KEYWORDS: Steel Plate, Cyclic Loading, Monotonic Loading, Composite Wall, Strength, Various Behavior.

I. INTRODUCTION

To resist the load, construction industries has been increases the use of steel plate composite wall. The various loads acting on the high rise building due to earthquake, like monotonic loading, cyclic loading and dynamic loading. Which is prevented by using double steel plate composite wall in the high rise building to make the structure more stable. In this paper our focus is cyclic behavior of double steel plate composite wall under seismic loading.

II. LITERATURE REVIEW

Hadi kenarangi, Emre Kizilarlan, Michel Bruneau[1] (2021) investigated the cyclic behavior of C-shaped composite plate shear wall concrete filled. It was a special lateral- force resisting system made of two steel plate as sandwiched panel which is filled with concrete infill called as a composite plate shear wall/ concrete filled (C-PSW/CF). Tie bar is used as connector between steel plate. Two large-scaled C-shaped concrete filled composite plate shear core wall subjected to flexural and axial loads together for testing with same dimensions but different axial loads were applied upto 19% of axial loading capacity. The specimens were designed to have aspect ratios of cross-section ($\gamma = b/h$), web ($\beta = c/b$), and flange ($\alpha = d/h$) within $\pm 35\%$ of those from the prototype model (i.e., defined by the practicing engineers on the Project Advisory Team to be $\gamma_p = 0.33$, $\beta_p = 0.21$, and $\alpha_p = 0.07$). A572 Gr50 steel was used in construction of the flange and web plates e yield strengths of the plates were determined to be 54.6ksi (376.5 MPa) and 56.2ksi (387.5 MPa) for web and flange plates of the first specimen (which will be referred as Specimen C1 this point forward), and 52.65ksi (363 MPa) and 57.79ksi (398.4 MPa) for web and flange plates of the second specimen (which will be referred as Specimen C2 this point forward), respectively.

The walls were subjected to 19% and 15% axial loading before horizontal cyclic loads were applied as shown in figure 1 and test setup was shown in figure 2. similar buckling and fracture behaviors shown in both specimens. Ductility was more than 4 (4.02/-4.3 for positive and negative directions for both specimens) when flexural strength dropped to 80% of the peak value developed, and both specimens reached or exceeded their calculated plastic moment capacities in the positive and negative direction.

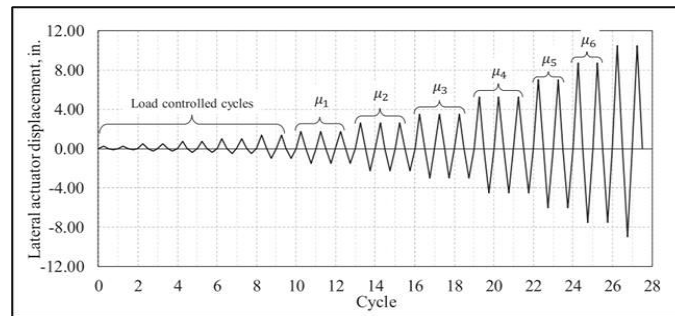


Fig. 1. Loading protocol for C-Shaped specimens.

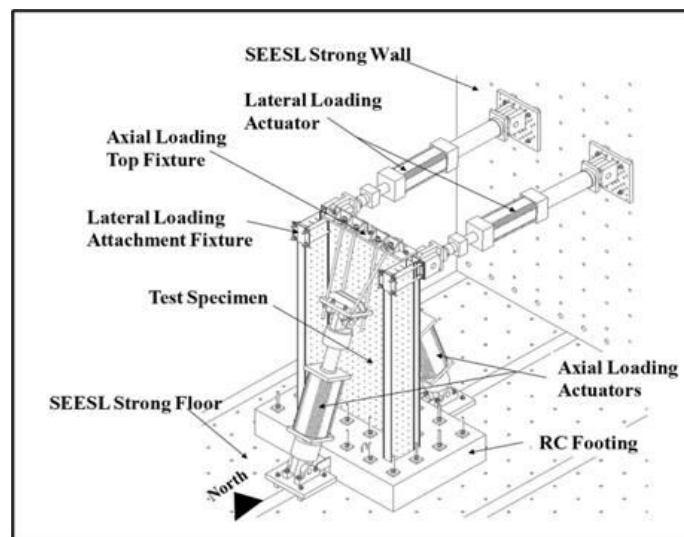


Fig. 2. 3D representation of test setup.

M. Nadir Olabi, Naci Caglar, M. Hasim Kisa, S. Bahadir Yuksel[2] (2021) conducted a numerical analysis on composite shear walls with steel sheets, used the L-shaped cold-formed steel sheets under lateral cyclic forces. Actual behavior of composite shear wall was reproduced by developing a macroscale numerical model using a fiber beam-column element with shear spring model. Three composite shear wall was experimentally tested and compared with open sees-based model and showed strong simulation ability. The mechanical properties of L-shaped steel sheets were studied by considering the parameter in terms of thickness and yield strength. Figure 3 shows the loading protocol for composite shear wall.

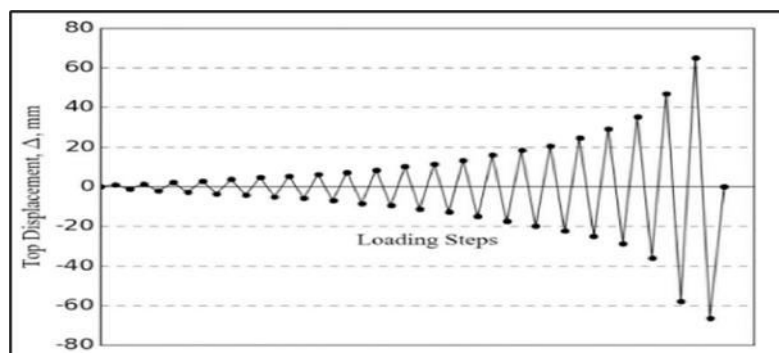


Fig. 3. Applied load protocol for CSW

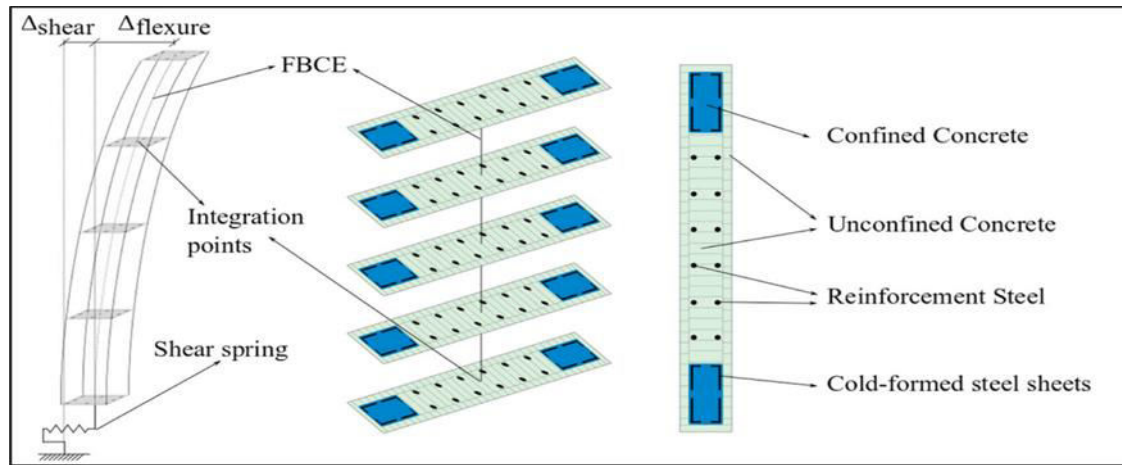


Fig. 4. Illustration of fiber beam-column element model

The mechanical properties of L-shaped steel sheets were studied by considering the parameters in terms of thickness and yield strength. Figure 4 illustrated the fiber beam column model. The lateral load carrying capacity was increased as the thickness and yield strength of steel plate increased.

Qihong Zhaoa, Yikang Lia, Ying Tianc[3] (2020) studied the cyclic behavior of double steel plate composite wall with flat and corrugated faceplate for mid to high-rise building made up of steel face plate connected with each other by tie bolts, concrete filled steel tubes and concrete .

Table 2: characteristics loading responses for models

Specimen	Loading direction	K_0 (kN/mm)	P_y (kN)	d_y (mm)	θ_y (%)	P_{max} (kN)	d_{max} (mm)	θ_{max} (%)	d_w (mm)	θ_w (%)	μ
CW-F1	+	115	515	9.4	0.63	1083	36.0	2.40	54.0	3.60	5.7
	-	110	559	9.4	0.63	1036	41.6	2.77	47.8	3.19	5.1
	Avg.	113	537	9.4	0.63	1060	38.8	2.59	50.9	3.39	5.4
CW-F2	+	96	559	8.0	0.53	771	21.3	1.42	30.2	2.01	3.8
	-	121	526	8.2	0.55	997	29.8	1.99	38.0	2.53	4.6
	Avg.	109	543	8.1	0.54	884	25.6	1.71	34.1	2.27	4.2
CW-C1	+	157	584	7.5	0.50	1172	34.5	2.30	49.6	3.31	6.6
	-	180	376	6.1	0.40	1089	41.5	2.77	51.3	3.42	8.4
	Avg.	169	480	6.8	0.45	1131	38.0	2.55	50.5	3.37	7.5
CW-C2	+	124	485	9.3	0.62	1155	40.7	2.71	48.1	3.21	5.2
	-	139	397	7.3	0.49	1008	32.5	2.17	55.6	3.71	7.6
	Avg.	132	441	8.3	0.55	1082	36.6	2.44	51.9	3.46	6.4

Four 1/3 scale DSC wall specimens, varying with face plate profile and tie stud spacing. Table 2 shows the various responses of the wall. The corrugated DSC wall with standard bolt spacing were able to achieve an ultimate drift ratio around 3.4% and ductility ratio greater than 5.4. steel tube fracture, steel faceplate buckling and concrete crushing at wall bottom failure in flexure for all specimen was observed. Corrugated DSC wall with double tie bolt spacing had higher initial stiffness, ductility ratio and energy dissipation compared with flat DSC wall. On average less than 6% difference was obtained between predicted and measured capacity of lateral strength or drift.

Khandaker M.A. Hossain, Shahryar Rafiei, Mohamed Lachemi, Kamran Behdina[4] (2015) investigated the two skinned profile steel sheeting and an infill concrete composite wall system behavior under inplane cyclic shear loading. DSCW specimen with overall height 1626mm high by 720 mm wide. To generate the composite action between steel-sect-concrete, the intermediate fasteness along the height and width of wall were provided. The type of loads acting on the wall is shown in table 3. To two types of concrete used namely self-consolidating concrete (SCC) and highly ductile engineered cementitious composite concrete (ECC) with cold formed profile steel sheet with same geometry and two different yield strength were incorporated. Figure 5 showed the casting of DSCW specimen.

Table 3: test matrix, dimensions and material property.

Wall designation	Loading	Concrete properties (mean values) MPa			Steel properties (mean values) stress and modulus of elasticity in MPa				
		f_c	f_t	E_c	Yield		Ultimate		E_s
					Stress	Strain	Stress	Strain	
DSCW1-SCC-HSS	Monotonic	48.0	3.9	25,100	552*	0.00272	577	0.01	202,940
DSCW3-ECC-HSS	Monotonic	40.2	5.4	24,500	552*	0.00272	577	0.01	202,940
DSCW5-SCC-MSS	Monotonic	35.7	3.3	25,010	354**	0.00171	420	0.10	206,980
DSCW2-SCC-HSS	Cyclic	48.1	3.8	25,100	552*	0.00272	577	0.01	202,940
DSCW4-ECC-HSS	Cyclic	39.4	4.9	24,500	552*	0.00272	577	0.01	202,940
DSCW6-SCC-MSS	Cyclic	34.6	3.2	25,100	354**	0.00171	420	0.10	206,980



Fig. 5. Casting of DSCW specimens and typical DSCW specimen after casting.



Figure 6: Failure mode of steel sheet and concrete core under monotonic loading.



Fig. 7. Failure mode of steel sheet and concrete core under cyclic loading.

The benefits were demonstrated through more ductile failure when mild steel over high-strength steel was used. The failure mode of steel sheet and concrete core under monotonic and cyclic loading is shown in figure 6 and 7 respectively. As compared to SCC wall the ECC wall showed lower stiffness degradation, higher displacement ductility and higher energy dissipation.

Xiaomeng Zhang, Ying Qin, Zhihua Chen, Li Jie [5] (2016) proposed an innovative T-shaped composite wall called as bundled lipped channel concrete (BLC-C). The flange of the proposed wall consist of cold formed square hollow section (SHS) at the middle and two lipped channel through complete joint penetration (CJP) welds. The wall web was made by connecting several lipped channels through complete joint penetration weld. The steel channels and tubes enclosed into compartment filled with concrete. Five specimen was subjected under constant axial load subjected to cyclic lateral load as shown in figure 8. The parameter studied in the experiments include the wall configuration, cross section of wall, steel sheet thickness, axial force ratio, and presence of shear stud.

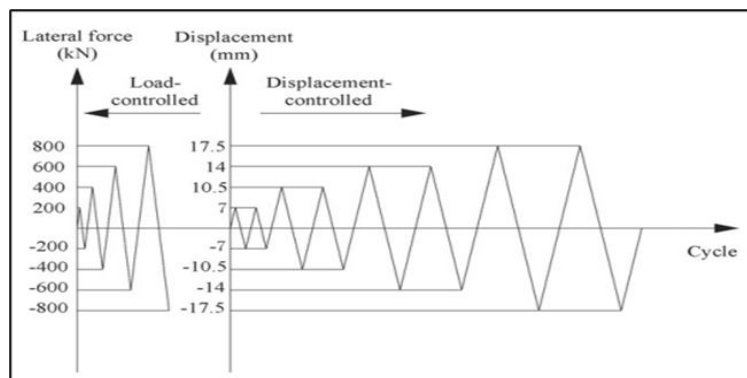


Figure 8. loading protocol

The specimen shows ductile manner and stable hysteresis behavior, local buckling was occurred at the base of the wall. The seismic behavior was evaluated as strength, stiffness, deformation, ductility and energy dissipation capacity as shown in table 4.

Table 4: test results

Specimen	Loading direction	Initial stiffness (kN/m)	Yield load P_y (kN)	Yield displacement d_y (mm)	Yield drift (rad)	Peak load P_m (kN)	Displacement at peak load d_m (mm)	Drift at peak load (rad)	Ultimate displacement d_u (mm)	Ultimate drift (rad)	Ductility μ	P_m/P_y
BLC-C-T1	(+)	71,871	1297	20.8	0.0080	1452	28.1	0.0108	48.6	0.0187	2.34	1.12
	(-)	69,239	1338	23.2	0.0089	1457	31.9	0.0123	-	-	-	1.09
BLC-C-T2	(+)	66,952	1269	22.4	0.0086	1412	29.9	0.0115	45.0	0.0173	2.01	1.11
	(-)	68,034	1364	25.5	0.0098	1528	36.5	0.0141	59.5	0.0229	2.33	1.12
BLC-C-T3	(+)	73,273	1282	19.8	0.0076	1393	26.1	0.0100	44.6	0.0172	2.25	1.09
	(-)	73,839	1435	24.0	0.0092	1584	41.0	0.0158	70.0	0.0269	2.92	1.10
BLC-C-T4	(+)	163,050	2641	18.1	0.0070	3043	40.4	0.0155	58.0	0.0223	3.20	1.15
	(-)	146,300	-	-	-	-	-	-	-	-	-	-
BLC-C-T5	(+)	152,007	2754	21.6	0.0083	3090	49.1	0.0189	67.5	0.0260	3.12	1.14
	(-)	146,374	-	-	-	-	-	-	-	-	-	-

III.CONCLUSION

In summary, researchers studied the behavior of composite shear wall of different shapes like L-shaped, C-shaped, T-shaped, flat and corrugated shear wall under cyclic loading is done. The research gap identified and the concluding remark highlights the need for further research to improve the design and construction of these structure and develop more accurate design guidelines.

REFERENCES

- [1] Hadi Kenarangi, Emre Kizilarlan, Michel Bruneau “Cyclic Behavior Of C-Shaped Composite Plate Shear Walls – Concrete Filled” engineering structure 226 (2021), <https://doi.org/10.1016/j.engstruct.2020.111306>.
- [2] M. Nadir Olabi, Naci Caglar, M. Hasim Kisa, S. Bahadir Yukse “Numerical Study On The Response Of Composite Shear Walls With Steel Sheets Under Cyclic Loading”, Journal Of Building Engineering 36 (2021) 102069, <https://doi.org/10.1016/j.jobbe.2020.102069>.
- [3] Qihong Zhao,a,b,* , Yikang Lia , Ying Tianc, “Cyclic Behavior Of Double-Skin Composite Walls With Flat And Corrugated Faceplates” Engineering Structure 220 (2020) 111013, <https://doi.org/10.1016/j.engstruct.2020.111013>.
- [4] Khandaker M.A. Hossain, Shahryar Rafiei, Mohamed Lachemi, Kamran Behdinan, “Structural Performance of Profiled Composite Wall Under In-Plane Cyclic Loading”, Engineering Structure 110 (2016) 88-104, <http://dx.doi.org/10.1016/j.engstruct.2015.11.057>.
- [5] Xiaomeng Zhang, Ying Qin, Zhihua Chen, Li Jie, “Experimental behavior of innovative T-shaped composite shear walls under in-plane cyclic loading”, journal of constructional steel research 120 (2016), <http://dx.doi.org/10.1016/j.jcsr.2016.01.008>.



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