State Key Laboratory of Disaster Reduction in Civil Engineering
Tongji University, Shanghai, China

3rd International Conference on Advances in Experimental Structural Engineering
October 15-16, 2009 - San Francisco
Sponsors

CYCLIC TESTS OF FULL-SCALE LIGHT-FRAMED WOOD CONSTRUCTION

Principal Investigators: Prof. Xilin LU & Associate Prof. Haibei XIONG, Tongji University
Student Investigators: Jiahua KANG & Feng ZHANG, Tongji University
State Key Laboratory of Disaster Reduction in Civil Engineering, Tongji University, Shanghai 200092, China

Introduction

Lots of studies in wood frame shear wall (WFSW) research area focused on the performance of the single piece of wall. While, in the field, the wood frame shear walls always work as a component in the complete structural system, of which boundary conditions are different from that of the single piece of walls.

There were nine full-scale light-framed wood construction specimens tested to study the effects of the upper storey and the vertical load on the performance of the wood frame shear wall in the first storey, as well as to understand the performance of wood frame shear wall in the complete structure.

Test program

Test specimen

Nine symmetric specimens were divided into three groups according to different opening size in the wood frame shear wall in the first storey. In each group, the wood frame shear walls in the first storey were grouped into three types, namely, WFSW-A, WFSW-B, WFSW-C. All the test specimens are shown in fig.1.

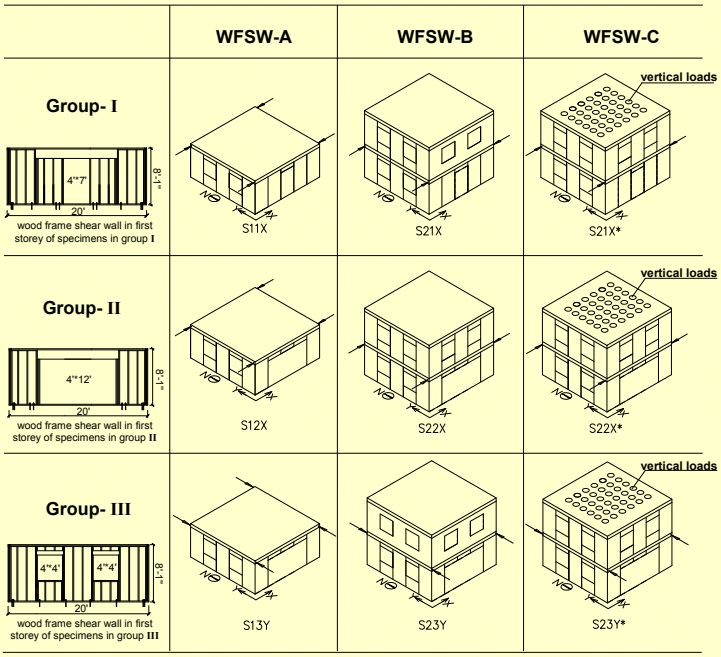

Fig.1. Sketch of the nine specimens

Load protocol and instrumentation

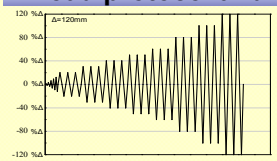

Fig.2. Load protocol

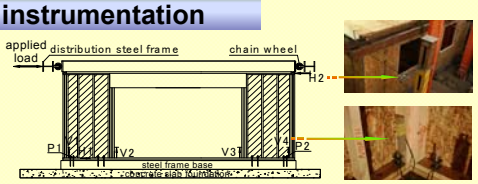

Fig.3. Instrumentation of wood frame shear wall in S12X

Test setup

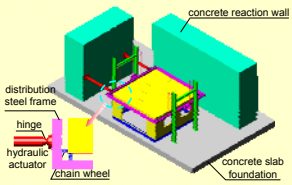

Fig.4. Sketch of the test setup

Fig.5. Photos of the specimens

Results

Failure modes

Fig.6. Nail connection failure modes

Global hysteresis response

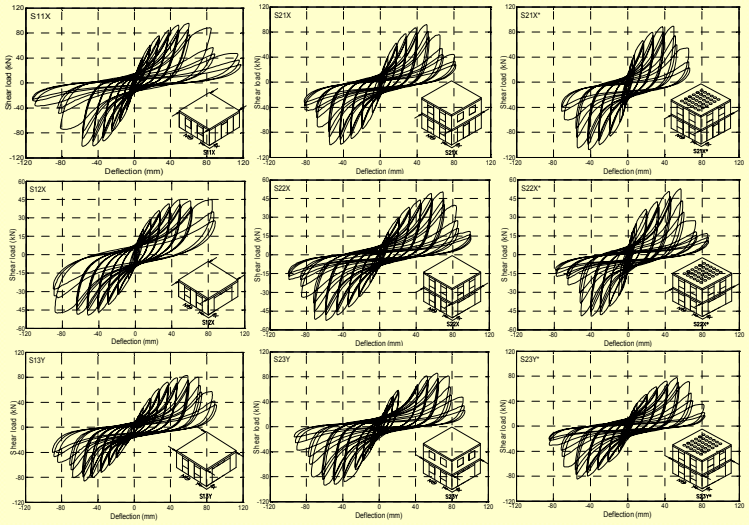

Fig.7. Hysteresis curves of the nine test specimens

Wall performance parameters

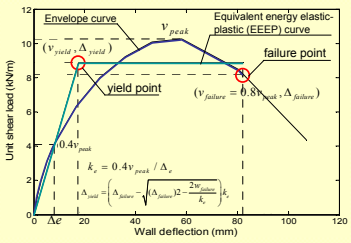

Fig.8. Performance parameters definition

Table.1. Uplift of studs (Unit: mm)

Group	Wall	Maximum uplift/Uplift under peak load			
		V1	V2	V3	V4
I	WFSW-A	5/4.3	8.5/7	13.3/7.9	4.9/2.5
	WFSW-B	3.2/1.4	10.7/8.1	8.2/5.9	1.8/0.5
	WFSW-C	2.7/0.9	2.6/2.5	6.2/4.8	3.9/0.7
II	WFSW-A	4.5/3.2	24.1/24.1	21.6/19.5	7.9/1.9
	WFSW-B	3.5/1.2	11.5/10.6	11.2/9.8	3.1/1.3
III	WFSW-A	9.9/6.8	15.8/6.3	11.1/7.1	11.3/8.9
	WFSW-B	7.9/7.1	4.4/1	3.8/1.1	3.4/1.9
	WFSW-C	5.5/3.4	5/2.6	1.4/1.4	6.1/5.2

Table.2.Performance parameters based on the definition in Fig.8

	Group I			Group II			Group III		
	WFSW-A	WFSW-B	WFSW-C	WFSW-A	WFSW-B	WFSW-C	WFSW-A	WFSW-B	WFSW-C
v_{peak} (kN/m)	10.26	9.99	10.21	9.81	10.61	10.57	11.73	12.45	11.29
$\Delta_{failure}$ (mm)	82.15	63.02	57.46	84.15[a]	78.77	59.22	76.86	77.66	67.22
v_{yield} (kN/m)	8.86	8.69	8.94	8.87	9.16	9.07	10.28	10.70	9.44
Δ_{yield} (mm)	17.48	14.25	9.28	15.59[b]	21.55	9.33	25.40	20.29	15.10
k_e (kN/m/mm)	0.51	0.61	0.96	0.57	0.43	0.97	0.40	0.53	0.63

Conclusion

Results showed that the effects of the upper storey with the vertical load on the performance of wood frame shear wall were to: (1) increase the elastic stiffness, (2) reduce the ultimate deflection and yield deflection, and (3) make the uplift of the studs at the end of walls and beside the openings small and uniform along the wall in the first storey. While the upper storey or the vertical load had little effect on the shear strength of wood frame shear wall. The test results indicated that in the lower storey the number of hold-downs can be reduced to some extent in seismic design.

Literature cited

Cheng, H. J., Ni, C., and Lu, X. L. 2006. Performance of perforated wood-frame shear walls with transverse walls and vertical load. *China Civil Engineering Journal* **39**(12): 33-40. (in Chinese)

Dolan, J., and Heine, C. 1997c. Sequential phased displacement tests of wood frame shear walls with corners. *Prepared for the NAHB Research Center, Inc.* by Virginia Polytechnic Institute and State University, Blacksburg, VA.

Dean, P. K., and Shenton, H. W. III 2005. Experimental investigation of the effect of vertical load on the capacity of wood shear walls. *J. Struct. Eng. ASCE* **131**(7): 1104-1113.

ISO. 2003. Timber structure-Joint made with mechanical fasters-Quasi-static reversed cyclic test method. *ISO 16670*, International Organization for Standard, Geneva.

Van de lintd, J. W. 2004. Evolution of wood shear wall testing, modeling, and reliability analysis: Bibliography. *Practice Periodical on Structural Design and Construction, ASCE* **9**(1):44-53.

Johnston, A. R., Dean, P. K., and Shenton, H. W. III 2006. Effect of vertical load and hold-down anchors on the cyclic response of wood framed shear walls. *J. Struct. Eng. ASCE* **132**(9):1426-1434.

Nelson E. L., Wheat D. W., Fowler D. W., 1985. Structural behavior of wood shear wall assemblies. *J. Struct. Eng. ASCE* **111**(3):654-666.

Ni, C., and Karacabeyli, E. 2002. Capacity of the shear wall segments without hold-downs. *Wood Design Focus* **12**(2):10-17.

Acknowledgements

This research is belong to the international cooperative project, Development and Demonstration of New Sustainable and Energy Efficient Green Housing Systems and Related Technologies (Grant No. 2008DFA71990), which financial supported from The Ministry of Science and Technology of People's Republic of China and FPInnovations Forintek Canada Corporation.

For further information

Please contact kangjia3721@163.com, Jiahua KANG, Ph.D. student, *State Key* Laboratory of Disaster Reduction in Civil Engineering, Tongji University, Shanghai 200092, China

This project was made possible with support from:
PACIFIC EARTHQUAKE ENGINEERING RESEARCH CENTER
UC Berkeley • Caltech • Stanford • UC Davis • UC Irvine • UC Los Angeles • UC San Diego • USC • U Washington
peer.berkeley.edu