AENSI Journals

Advances in Environmental Biology

ISSN-1995-0756 EISSN-1998-1066

Journal home page: http://www.aensiweb.com/AEB/

Laboratory Studies for Determining the Ultimate Strength of Cold Formed Steel Frames with Foamed Concrete

[1]Nazari S.J. and [2]Javaheri Tafti M.R.

[1]MSC student, Department of Civil Engineering, Islamic azad University, taft, Iran
[2]Assistant professor, Department of Civil Engineering, Islamic azad University, taft, Iran

ARTICLE INFO

Article history:
Received 12 October 2014
Received in revised form 26 December 2014
Accepted 1 January 2015
Available online 18 February 2015

Keywords:
Cold formed steel frame, light concrete shear wall, ultimate strength, cyclic behavior.

ABSTRACT

The technology of building systems so-called CFS, which stands for Cold-formed steel frame structures, gradually became much more scientifically studied, after acquiring a suitable position among engineers and architects in the 20th century, in Great Britain and especially in America. The rapid implementation and efficiency, increasing the resistance and high stability, building lighter and reducing the mass of the buildings and increasing the amount of recycled materials are all the advantages of this system. In this paper, the cyclic behavior of three types of lightweight foam concrete shear walls with Cold formed steel frame, in full scales of 2.4 × 1.2m based on the method of ASTM-E2126-07 Standard B, can be examined by using the laboratory frame to determine the ultimate strength. Finally we come to the conclusion that the average strength is 42 percent higher in frame (A) with no studs and noggin, in comparing with the two other frames with "noggin" and with "noggin and interiorstud".

To Cite This Article: Nazari S.J. and Javaheri Tafti M.R., Laboratory Studies for Determining the Ultimate Strength of Cold Formed Steel Frames with Foamed Concrete. ***Adv. Environ. Biol., 9(2),*** *488-492, 2015*

INTRODUCTION

By stabilizing the position of topics and construction management, construction and housing in bulk and Residential Estates and in this process, prefabrication in construction industry, has assigned a major part of the housing investment in economically developed countries, like America, Canada, and Western European states especially Great Britain, France, Belgium, Norway, Switzerland, Sweden and West Germany in the early 60. Concrete prefabricated walls found a special place in construction projects. At this point, the position of cold formed steel frame was raised as a perfect option because of having an ideal condition for prefabrication and particular advantages.

Manifold speed rather than concrete in the production sector and increase the transport capacity, lightness and comfort in construction, were all early reasons which led to the construction of empirical residential apartment complexes in 1966, Florida America. After that, bring up topics such as environmental protection and forest in America caused to an ideal replacement of using this type of construction instead of wooden materials and the use of cold formed steel as a way of achieving these goals has a special importance. The use of concrete to fill the walls of these structures is a new way of building this kind of structures.

Movahed [5] have done studies on how doubling up the middle studs can affect on the coefficient behavior and ultimate strength of cold formed steel walls. In this study, the highest behavior coefficient is 7.866 and highest ultimate strength is 23 kN.

Movahed [6] have studied the effects of Structural members on the behavior coefficient changes and ultimate strength of cold formed steel frames with unilateral bracing by using laboratory tests. Consequently, we can see better results from seismic behavior of CFS frames by reinforcing the structural members instead of increasing the thickness of the shear wall plate.

Ahmadi Fard, [1] have performed laboratory studies which deals with how doubling up the side studs can affect on behavior coefficient and ultimate strength of cold formed thin steel walls. In this survey, the highest behavior coefficient is 7.804 and highest ultimate strength is 14.74 kN.

Corresponding Author: Nazari S.J., MSC student, Department of Civil Engineering, Islamic azad University, taft, Iran.
E-mail: jalal.nazary@gmail.com

Advances in Environmental Biology, 9(2) January 2015, Pages: 488-492

Hagi Soltani [2] have examined a simple nonlinear method for evaluating the Seismic characteristics of cold formed thin steel walls and it was concluded that generated forces in the frame is increased about 11% by applying the condition of rigid support and using Hold down modeling.

Javaheri, [3] have done studies on the seismic effects of thin metal shear walls on cold formed steel frames by using laboratory tests. They examined the behavior coefficient and ultimate strength of theses frames. 16 to 18 percent reduction in the ultimate shear strength was observed in frames with a single stud.

Moghimi & Ronagh [4] have examined different designs of braced frame and they found that using plaster plates by itself isn't a good idea. Also, they discovered that wall panels with strap bracing which is covered by plaster plates have higher lateral load resistance capacity rather than panels with strap bracing and using both plaster plates and wall cover especially in high lateral displacement. Also, hysteresis rings showed that plaster plates provide a lower level of force for mentioned walls. But despite this, it provides lateral resistance and desirable hardness in the range of displacement which are far from the climax of the rings.

They found that adding four brackets in the corners of the wall panel can considerably improve the side efficiency including Strength, hardness and the formability of panels even when frames have single studs. In this study, the experiments were performed on three different frame type with the size of 1200 × 2400 mm and full scale which had been filled with foam concrete.

Materials and methods of research:

As mentioned, in this research an experiment was done on three different types of frames A, B and C (Figure1), size of 1200 × 2400 mm with full scale that filled with foam concrete. Frames have been examined by a laboratory frame device (Figure 2) which generates reciprocating displacement based on the method of ASTM-E2126-07 Standard B. The results, strength value and the resulting displacement were recorded as output data. [7]. The goal of this study is to investigate the effects of frame type changes in studs and noggin on ultimate strength of the system.

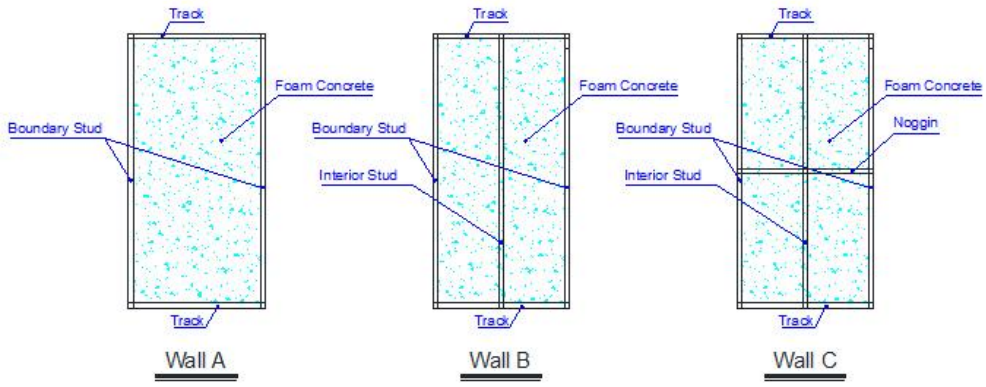

Fig. 1: Types of frames were examined.

Fig. 2: Locating the wall on the laboratory frame.

Advances in Environmental Biology, 9(2) January 2015, Pages: 488-492

How to perform the experiment:

After the frames were placed on the laboratory frame, they were examined by generating reciprocating displacement. The results, strength value and the resulting displacement were recorded as output data. Reciprocating loading regime which has been used in this experiment is based on the method of ASTM-E2126-07 Standard B. One goal of this study is to evaluate the effects of frame type changes in studs and noggin on seismic performance of this system. From each wall sample two numbers were similarly constructed and tested in order to having an ultimate strength which is closer to the reality and answers that are sufficiently accurate. Types of failure modes in these walls were observed such as the elastic local buckling of studs, screw saliency, concrete destruction, etc.

The specifications of main sections:

For estimating the seismic characteristics of cold formed frames, three types of CFS frames with full scale and all frames with size of 1200 × 2400 mm were built. All elements of the frame such as upper and lower pole, middle and side stud and noggin have been made from the same structural material. Geometrical details of sections have been illustrated in table 1 and mechanical characteristics of main sections have been illustrated in table 2 and 3. All the studs on the edge have been connected to the runners by a mushroom head screw. Tensile test experiment has been used in order to determine these specifications.

Table 1: Frames specifications.

Frame	Frame specifications	Cover specifications
A	Single side stud	Foamed concrete
B	Single side stud , single middle stud	Foamed concrete
C	Single side stud , single middle stud and with side noggin	Foamed concrete

Table 2: Mechanical characteristics of main components.

value	specifications	row
1.00 mm	Nominal thickness	1
174.82 Mpa	Yield stress Fy	2
0.25%	Yield strain	3
350.22Mpa	Ultimate stress Fu	4
2.75%	Ultimate strain	5
2	Fu/Fy	6

Table 3: Dimensions of frame components.

specifications	Frame components
ST100*50*1 mm	stud
RN 103*30*1 mm	top and bottom pole
PL 10*0.5 mm	noggin

The concrete specifications:

Using lightweight concrete is one of the bracing methods against lateral loads in CFS systems. In this study the effects of lightweight foamed concrete on the ultimate strength of the frame is tried to be investigated. All of the concretes in the frame were carried out with a thickness of 10 cm. The concrete has been made with foaming liquid, cement and water and the foam type A from the company of Atashbas Tehran, 2 liters per cubic meters of concrete and the cement of type 2 abadeh has been used.

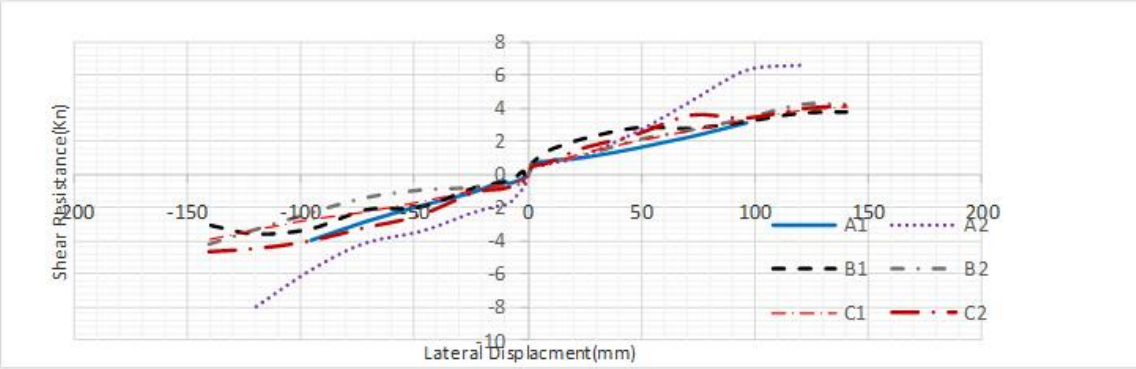

Fig. 3: Comparison diagram of force – displacement for frames A, B, C.

Advances in Environmental Biology, 9(2) January 2015, Pages: 488-492

Table 4: Specifications of foamed concrete.

amount	specifications
15*15*15 CM	dimensions of the concrete sample
$602\frac{kg}{m^3}$	specific weight
$12.4\frac{kg}{cm^2}$	compressive strength of the concrete F'c

The results of experiments:

In this part of the study, the displacement - force diagrams of the samples (Figure 3) and the hysteresis diagrams of the samples (Figures 4) were examined and their ultimate strength (Figures 5) were presented and have been evaluated.

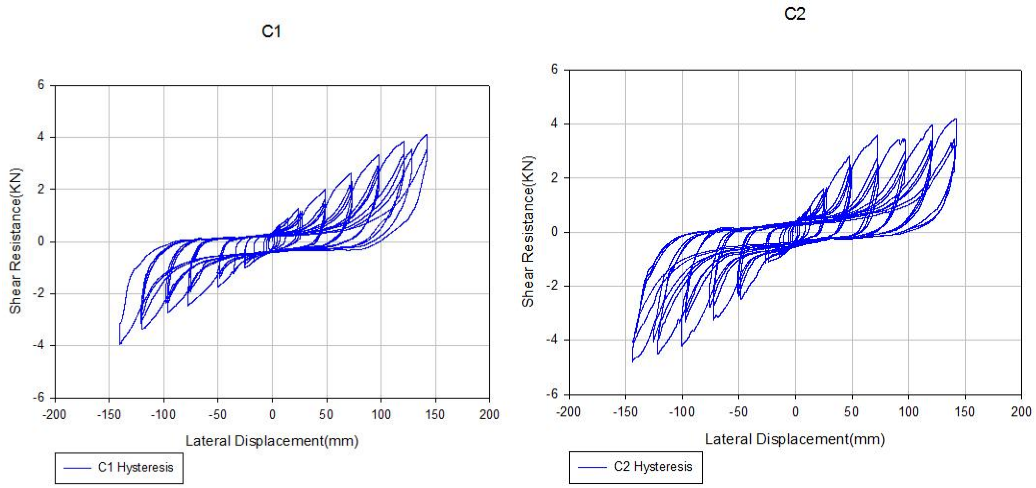

Fig. 4: Hysteresis curve of the samples.

Table 5: Numerical results of the samples and the ultimate resistance.

frame	Test number	Maximum positive(KN)	displacement (mm)	Maximum negative(KN)	displacement(mm)	Ultimate load (Kn)	Average ultimate load of samples(Kn)
A	1	3.48	98.65	-4.3	-96.17	-4.3	6.25
	2	7.16	142.05	-8.2	-123.31	-8.2	
B	1	3.77	122.37	-4.01	-145.08	-4.01	3.34
	2	4.68	139.31	-4.32	-142.44	4.68	
C	1	4.10	141.78	-3.95	-140.45	4.10	4.44
	2	4.17	141.71	-4.78	-143.78	-4.78	

Failures:

Types of failure modes were observed in these walls like elastic local buckling of stud, screw saliency, wall concrete demolition, concrete demolition against noggin, separating concrete from side stud, the creation of diagonal and horizontal cracks in concrete. (Figure 5) are examples of failure types.

Fig. 5: Failure modes of the samples.

Advances in Environmental Biology, 9(2) January 2015, Pages: 488-492

Results:

The highest final resistance obtained is 6.25 kN which is related to the frame A. Frame B with the ultimate strength of 4.34 kN has the lowest resistance among the three types of frames. Frame C with the ultimate strength of 4.44 kN in terms of resistance amount is greater than frame B and lower than frame A. Frame A has 44 percent strength increase in comparing with frame B. Also frame A has a 40-percent increase in resistance than frame C. Frame C has a 2-percent resistance increase in comparing with frame B. The existence of noggin and connection between 2 studs causes 2- percent strength increase in comparing with the same frame without noggin. In general, the existence of middle stud and noggin causes a reduction in resistance in comparing with walls without middle stud and noggin.

REFERENCES

[1] Ahmadi Fard, 2014. Tafti & Ronagh have performed laboratory studies which deals with how doubling up the side studs can affect on behavior coefficient and ultimate strength of cold formed thin steel walls. Paper presented at the First National Conference of building materials and new technologies in the construction industry, Islamic Azad University MEYBODhttp://www.civilica.com/Paper-MTMAYBOD01-MTMAYBOD01_065.html

[2] Hagi Soltani, 2014. Roonagh & Javaheri-Tafti have examined a simple nonlinear method for evaluating the Seismic characteristics of cold formed thin steel walls. Paper presented at the First National Conference of building materials and new technologies in the construction industry, Islamic Azad University MEYBODhttp://www.civilica.com/Paper-MTMAYBOD01-MTMAYBOD01_042.html

[3] Javaheri-Tafti, M.R., H.R. Ronagh, F. Behnamfar, P. Memarzadeh, 2014. An experimental investigation on the seismic behavior of cold-formed steel walls sheathed by thin steel plates. *Thin-Walled Structures, 80*(0): 66-79. doi: http://dx.doi.org/10.1/016j.tws.2014.02.018.

[4] Moghimi, H., H.R. Ronagh, 2009. Performance of light-gauge cold-formed steel strap-braced stud walls subjected to cyclic loading. *Engineering Structures*, *31*(1): 69-83. doi: http://dx.doi.org/10.1016/j.engstruct.2008.07.016

[5] Movahed, 2014a. Javaheri-Tafti & Ronagh have done studies on how doubling up the middle studs can affect on the coefficient behavior and ultimate strength of cold formed steel walls. Paper presented at the First National Conference of building materials and new technologies in the construction industry, Islamic Azad University MEYBOD http://www.civilica.com/Paper-MTMAYBOD01-MTMAYBOD01_059.html

[6] Movahed, 2014b. Javaheri-Tafti & Ronagh have studied the effects of Structural members on behavior coefficient Changes and ultimate strength of cold formed steel frames with unilateral bracing by using laboratory tests. First National Conference on Seismology and Earthquake Engineering, Islamic Azad University MEYBOD http://www.civilica.com/Paper-MYBODIAU01-MYBODIAU01_061.html

[7] Taheri Behbahani, A.S., 1996. Philosophical attitude to the computational conditions of structures against earthquakes. Tehran building and housing research center.