DESIGN PROCEDURE FOR

CORRUGATED SHEET STEEL SHEAR WALLS

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REPORT TO
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Abstract

The objective of this document is to propose a structural design procedure for the Corrugated Sheet Steel Shear Wall (CSSSW) lateral bracing system. The CSSSW is an alternative lateral bracing system for use with light-framed cold-formed steel buildings. The key element of this structural system is the Corrugated Sheet Steel Shear Wall: the lateral load resistance of this structural element originates with the shear strength of the corrugated sheet steel and the shear resistance of the screws connecting the sheeting to the cold-formed steel framing. To establish a design basis, a total of 44 cyclic racking tests and 4 fire tests were conducted The results of these tests are presented in companion reports. System-level R, C_d and Ω_o values consistent with the test results are proposed for adoption into design codes. A design table listing the CSSSW nominal shear strength values and a set of design guidelines are provided. The primary users of the system would be practicing engineers who design light-framed cold-formed steel buildings.

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Introduction

The objective of this document is to propose a structural design procedure for the Corrugated Sheet Steel Shear Wall (CSSSW) lateral bracing system for inclusion into the ASCE-7 code document. The CSSSW is an alternative lateral bracing system for use with light-framed cold-formed steel buildings. The key element of this structural system is the Corrugated Sheet Steel Shear Wall: the lateral load resistance of this structural element originates with the shear strength of the corrugated sheet steel and the shear resistance of the screws connecting the sheeting to the cold-formed steel framing.

To establish a structural design basis, a total of 44 cyclic racking tests were conducted to establish the relation between CSSSW design parameters, such as gauge of the sheet steel, gauge of the cold-formed steel framing, size and spacing of the fasteners, and the shear strength of the wall. The tests were conducted in accordance with the AC 154 test protocol. The results of these tests are presented in a companion report "Structural Testing of Corrugated Sheet Steel Shear Walls".

To establish a fire design basis, a total of four 9' by 12'wall panels were fire tested in accordance with ASTM E 119-08a, Standard Test Methods for Fire Tests of Building Construction and Materials, at the Southwest Research Institute in San Antonio, Texas. The aim of this phase of the research is to confirm that corrugated sheet steel sheathing can be added to conventional one and two hour fire rated assemblies constructed with cold formed steel load bearing studs without affecting the assembly fire ratings. Testing

revealed that the addition of the corrugated sheet steel into the pre-approved conventional fire rated assemblies did in fact affect adversely the fire rating of the assembly. Additional testing of a modified assembly will be required before the wall assembly can be used commercially in a one and/or two hour fire rated assembly.

In this document, the system-level response modification factor *R*, the deflection amplification factor C_d, and the system overstrength factor Ω_o values consistent with the test results are proposed for adoption into the ASCE 7 design code. A design table listing the CSSSW nominal shear strength values as a function of the principal design parameters: sheeting gage, stud gage, screw size and screw spacing, is provided. Finally, modifications of the design guidelines of the Standard For Cold-Formed Steel Framing – lateral Design, 2004 Edition to accommodate CSSSW are provided.

The primary users of the system are practicing engineers who design light-framed cold-formed steel buildings. The proposed lateral bracing system gives engineers and contractors the ability to design and construct buildings (multifamily housing in particular) with the same flexibility that wood frame construction has. The corrugated sheet steel would take the place of plywood in providing the lateral bracing. The system also has excellent potential for use with prefabricated (panelized) walls and the modular construction of homes. The CSSSW are light (to easily transport and construct), tough (to withstand shipping and handling), strong (to resist high seismic loads), durable (to allow exposure to the elements during construction), and cost-effective.

Recommended Design Parameters

The Corrugated Sheet Steel Shear Wall (CSSSW) system shall be classified as a Bearing Wall System utilizing light-framed cold-formed steel walls sheathed with corrugated sheet steel and have the following design parameters:

Response Modification Factor (R) = 5.5

System Overstrength Factor (Ω_o) = 2.5

Deflection Amplification Factor (C_d)= 3.25

Recommended Design Values

The nominal shear strength values in Table 1 shall be used with the CSSSW system.

Recommended Design Guideline Modifications

The authors recommend that the Standard For Cold-Formed Steel Framing – lateral Design, 2004 Edition be modified as follows to incorporate the CSSSW system:

1. Modify paragraph 3 of Section C2 to include reference to corrugated sheet steel.

2. Add a section similar to C2.2.1 Sheet Steel Sheathing entitled “Corrugated Sheet Steel”. The new section would read as follows: “Corrugated steel sheets, attached to cold-formed steel framing, shall be permitted to resist horizontal forces produced by wind or seismic loads subject to the following: a. Corrugated steel sheets shall have a minimum *base metal thickness* as shown in Table –

(enclosed Table 1), and shall be of the following grade of structural quality steel: G90 galvanized steel conforming to ASTM A653, Grade 50. b. *Nominal* shear strengths, used to establish the *available* shear strengths, are given in Table – (enclosed Table 1) for wind and seismic loads. c. Corrugated steel sheets shall be applied perpendicular to framing. d. In lieu of blocking, panel edges are permitted to be overlapped and attached to each other with screw spacing as required for panel edges. e. Screws used to attach corrugated sheet steel shall be a minimum No. 12 in accordance with Table —(enclosed Table 1).

3. Add Table C2.1-4 to the document (similar to enclosed Table 1).

4. Modify paragraph 1 of Section C3 to include reference to corrugated steel sheets.

5. Modify Section C5.4 to include reference to corrugated steel sheets.

Nominal Shear Strength (R_n) for Wind and Seismic Loads for shear walls faced with corrugated sheet steel. (pounds per foot) [1, 3, 4, 7]

Assembly Description[5, 6]		20 gauge studs	18 gauge studs	16 gauge studs	
		#12 screws	#12 screws	#12 screws	#14 screws
Sheathing	Screw Spacing[2]	Shear (plf)	Shear (plf)	Shear (plf)	Shear (plf)
22 gauge	6" o.c.	1173	1505	1836	---
	3" o.c.	---	3050	3290	---
18 gauge	3" o.c.	---	4144	5164	5874

1 *Nominal* shear strength shall be multiplied by the *resistance factor* (ϕ) to determine the *design strength* or divided by the *safety factor* (Ω) to determine *allowable* shear strength as set forth in Section C2.1.

2 Screws in the field of the panel shall be installed 6 inches o.c. unless otherwise shown.

3 A *shear wall* height to width aspect ratio (h/w) greater than 2:1, but not exceeding 4:1, is permitted provided the *nominal* shear strength is multiplied by 2w/h.See Section C2.1.

4 See Section C2.1 for requirements for sheathing applied to both sides of wall.

5 Unless noted as (min.), substitution of a stud or track of a different designation thickness, per the *General Provisions* , is not permitted.

6 Wall studs and track shall be ASTM A1003 Grade 33 Type H steel for members with a designation thickness of 33 or 43 mil, and A1003 Grade 50 Type H steel for members with a designation thickness equal to or greater than 54 mils.

7 For SI: 1" = 25.4 mm, 1 foot = 0.305 m, 1lb = 4.45 N

Table 1. Nominal Shear Strength Values for CSSSW structural walls.