Canadian Sheet Steel Building Institute

Sheet Steel Facts 25

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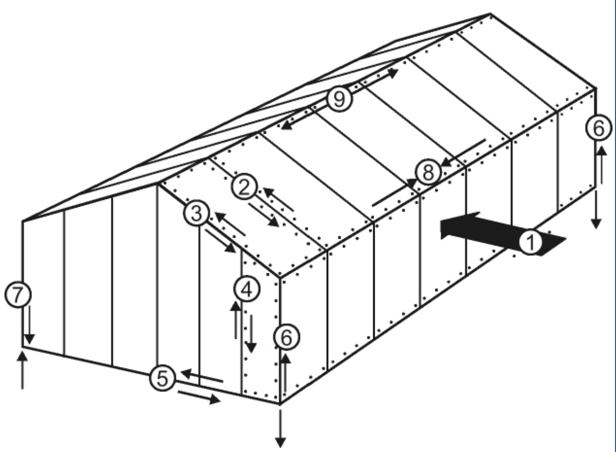
Diaphragm Design using Lightweight Steel Cladding

Introduction

Wind blowing across a typical gable-roof building produces forces that act directly on the cladding and structural members, as well as overturning forces for the building as a whole. Discrete wind bracing or rigid pole-framing are methods for resisting these forces. Another approach is to utilize the in-plane strength of the steel roof cladding to act as a shear diaphragm to transfer these loads to the foundation. The basic forces acting on the building are illustrated in Figure 1 below.



1. Wind forces acting on the building.
2. Stitch-screws at the roofing side laps transfer the wind shear forces to the ends of the roof.
3. Roofing screws and blocking transfer the forces into the gable trusses.
4. Endwall cladding transfer the forces from the gable trusses down the endwalls.
5. Cladding to foundation shear connection.
6. Uplift forces at windward foundation corners.
7. Leeward corner forces may be up or down, and are less critical than (6).
8. Roof bending causes compression at the windward edges.
9. Tension at the leeward edges of the roof planes.

Figure 1: Diaphragm Forces

Diaphragm Design Method

A design aid is available to assist in the selection and detailing of the sheet steel cladding and fasteners, needed to create a lightweight steel cladding diaphragm. This aid is a publication of the Metal Construction Association titled "A Primer on Diaphragm Design", First Edition 2004, and is available through their website at www.metalconstruction.org. This manual provides a collection of design charts like the one re-produced below (see Figure 2) as well as worked out examples and a commentary. Unfortunately the profiles used for the tabulated design values are not typical of Canadian products. However, a general design expression is included in the manual that can be used to develop design shear strength and stiffness values for other cladding profiles.

Scope

The manual provides tables for a variety of different roof and wall systems that include the following components:

Cladding profiles:

- 1.5" deep x 7.2" rib spacing x 36" panel width in 33 and 50 ksi yield strengths
- 1.25" deep x 12" rib spacing x 36" panel width in 80 ksi yield strength

Insulation:

- R19 fiberglass
- 3-1/4" polyisocyanurate or thermal spacer blocks

Fastener pattern:

- 3, 4 and 5 screws configurations across the sheet width

Fasteners:

- #12 or #14 screws

Use with Limit States Design in Canada

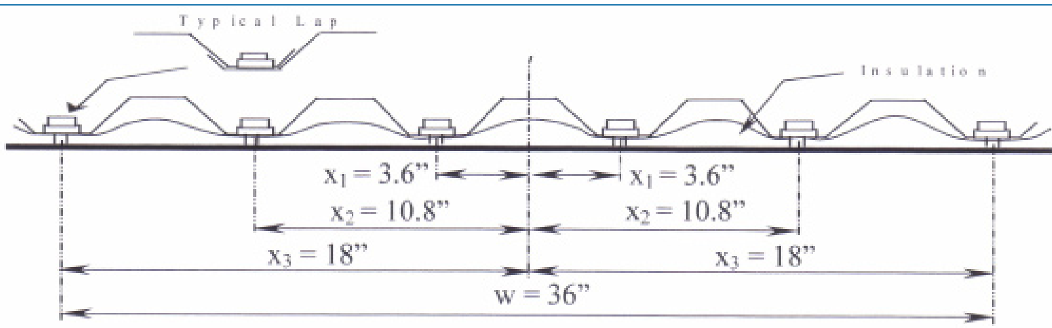
The tables provided in the MCA manual give design shear values that are allowable loads for use in the US with the Allowable Strength Design methodology. In Canada we use Limit States Design, and so the design shear values need to be converted. The tabulated allowable loads are multiplied by the appropriate safety factor (FAC=2.35 in the sample table below) to determine the nominal resistance. The nominal resistance is then multiplied by the appropriate resistance factor to get the factored resistance for use in an LSD design. The resistance factors for cold-formed steel diaphragms are given in Table D5 of CSA-S136-07 North American Specification for the Design of Cold-Formed Steel Structural Members. These values are reproduced below.

CSA-S136-07, Table D5
Canadian Resistance Factors for Diaphragms

Load Type or Combinations	Connection Type	Limit State	
		Connection Related	Panel Buckling
		ϕ_d (LSD)	ϕ_d (LSD)
Earthquake	Screws	0.60	0.75
Wind		0.65	
All Others		0.60	

For More Information

For more information on lightweight steel cladding products, or to obtain other CSSBI publications, contact the CSSBI at the address shown below or visit the website at www.cssbi.ca



Pattern = 36/6

1.5"x7.2"x36" - Lap Down,
No. 14 Screws to Structure
AP = 1.00 AE = 1.00 A2P =.50 A2E =.50
FAC = 2.35

Insulation **Fy = 33 ksi**
No. 14 Screws in Sidelaps
AN = 1.667 Ins = 1.

Steel Design Thickness = .0240 Inches Ixg = .123 Cbl = 1.
FASTENER Qs = 633.LBS. Qf = 765.LBS. A = -.0807 B = 4.0000

DESIGN SHEAR (LBS./LIN. FT.) AND SHEAR STIFFNESS (KIPS/IN.)

NO. OF SPANS = 3.0 OR MORE

STICH CONNS. SPACES, IN.	SPAN (FT) 4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0
12.	270.	286.	264.	278.	261.	273.	258.	269.	256.	266.	-244.	-219.	-198.
	60.	64.	64.	68.	68.	71.	71.	74.	73.	76.	75.	77.	76.
18.	222.	201.	226.	209.	194.	214.	201.	189.	206.	196.	186.	201.	192.
	54.	54.	59.	59.	58.	62.	61.	60.	64.	63.	62.	65.	64.
24.	167.	201.	183.	168.	153.	180.	169.	157.	147.	169.	161.	152.	145.
	47.	54.	53.	52.	51.	56.	55.	54.	52.	57.	56.	55.	54.
36.	167.	148.	132.	119.	109.	141.	130.	121.	114.	107.	101.	124.	118.
	47.	46.	45.	43.	42.	49.	48.	46.	45.	43.	42.	48.	47.

Figure 2: Example of Design Chart from "A Primer on Diaphragm Design", First Edition 2004