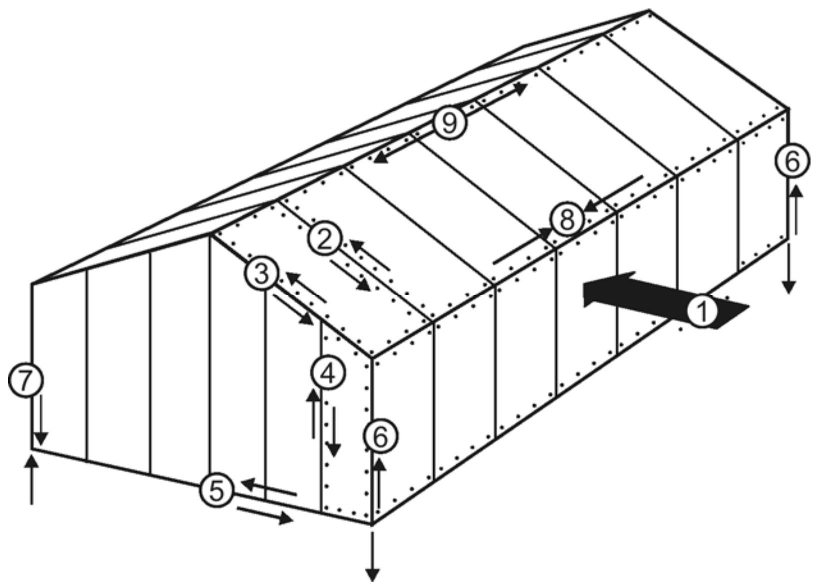
Canadian Sheet Steel Building Institute

Fact Sheet # 25: Diaphragm Design Using Lightweight Steel Cladding

Version 1: 27 August 2009

Introduction

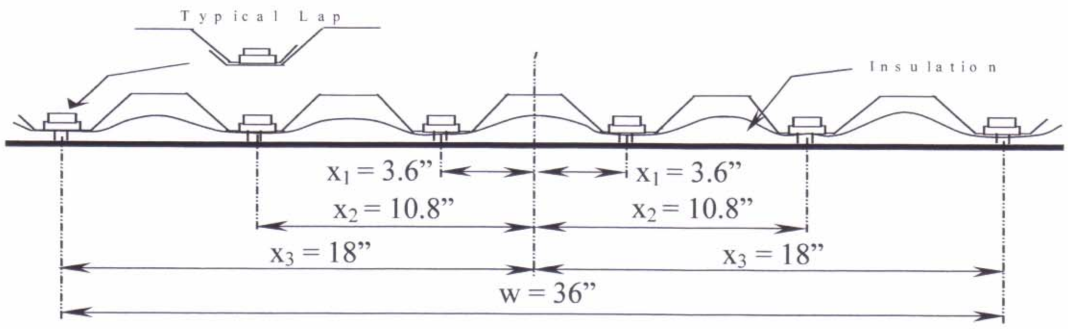
Wind blowing across a typical gable-roof building produces forces that act directly on the cladding and structural members as well as overturning forces for the building as a whole. Discrete wind bracing or rigid pole-framing are methods for resisting these forces. Another approach is to utilize the 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 the figure below.



1. Wind forces acting on the building
2. Stitch-screws at the roofing edge laps carry the wind shear forces to the ends of the roof
3. Roofing screws and blocking carry the forces into the gable trusses
4. Endwall cladding carries 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

Diaphragm Design Method

A design aid is available to assist in the in the selection and detailing of the sheet steel cladding and fasteners needed to crate 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 web site at www.metalconstruction.org. This manual provides a collection of design charts like the one re-produced below as well as worked out examples and commentary.



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
FASTENER Qs = 633.LBS. Qf = 765.LBS.

Ixg = .123 Cbl = 1.
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.

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

Insulation:

- R19 fiberglass or
- 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

Using the general design expression also included, design shear strength and stiffness values can be calculated for other configurations.

Use with Limits States Design in Canadian
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=2.356 in the sample table above) to determine the nominal resistance. The nominal resistance is 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*. This table is reproduced below.

CSA-S136-07, Table D5
Safety Factors and Resistance Factors for Diaphragms

Load Type or Combinations Including	Connection Type	Limit State					
		Connection Related			Panel Buckling		
		US and Mexico		Canada	US and Mexico		Canada
		Ω_d (ASD)	φ_d (LRFD)	φ_d (LSD)	Ω_d (ASD)	φ_d (LRFD)	φ_d (LSD)
Earthquake		2.50	0.65	0.60			
Wind	Screws	2.35	0.70	0.65	2.00	0.80	0.75
All Others		2.50	0.65	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 web site at www.cssbi.ca