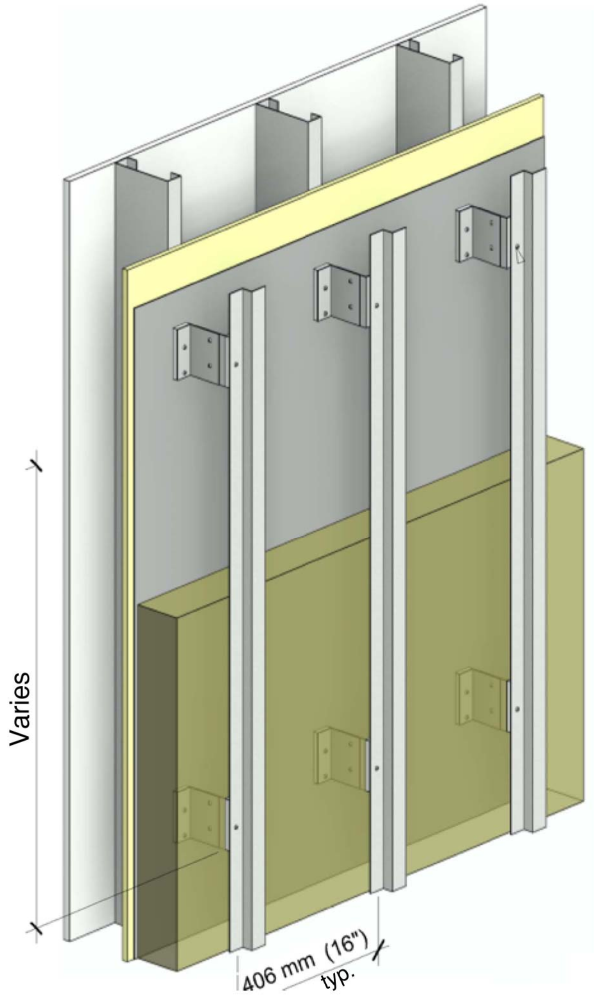
Structural Design Guide for the ACS Thermal Clip



ACS Composite Systems Inc
A2 – 6702 Rajpur Place
Saanichton, BC V8M 1Z5
T: 778-351-2288
E: sales@acscompositesysems.com

Version 3

Table of Contents

1 Introduction

This structural design guide is intended to provide assistance with properly specifying the attachment and spacing of the ACS Thermal Clips for supporting exterior cladding assemblies, and is to be used in conjunction with 'Design Guide: ACS Thermal Clips' for energy-related objectives in building codes.

The ACS clips are stainless steel z-clips that are components of a combination exterior thermal break and rain-screen cladding system. The clips are typically attached via self-drilling/self-tapping screws through exterior drywall to exterior steel stud framing, and have a Proloft™ thermal break between the clip and the drywall. Other applications may include attaching the clips to wood framing, to concrete construction, or to structural steel framing.

Typically, the outstanding leg of the clip would support a continuous z-girt spanning either vertically or horizontally between clips; this continuous z-girt would receive the specified cladding product.

The ACS A-Clip is designed to be adjustable, allowing the installer to create an accurate plane for receiving the specified cladding. Most cladding systems have little tolerance for uneven support, requiring either very accurate structural framing, or extensive shimming by the cladding contractor. With the A-Clip, after attaching the inner leg to the building, the outer leg is slid over the inner leg, to the desired plane, and then fixed by installing two screws through both the inner and outer webs.

The ACS S-Clip is a fixed (non-adjustable) z-clip thermally similar to the A-Clip, but may be used where construction tolerances are small enough in the wall plane to not be an issue for the proposed cladding assembly.

2 Structural Concept

Structurally, the clips resist gravity load (cladding assembly self weight), and transverse loads (wind/seismic). Clip length, spacing, and attachment to the substructure is determined based on the combination of thermal and structural requirements of the assembly.

Gravity load creates both a rotational force and a direct shear in each clip, while wind/seismic forces create a direct tension (or compression) force through each clip. The gravity rotational force is resisted by screw tension in the upper attachment screw and the lower compression region of the clip for the rotational force, and by both screws in direct shear/bearing in the case of direct shear, while wind/seismic forces are resisted by direct screw tension.

Since the Proloft™ thermal break between the z-clip and the structure is a semi-rigid material, the overall system installation guidelines have been limited by permissible strain in the Proloft™ /clip rotation. Clip spacing is also limited by attachment screw capacity, steel clip capacity, and A-Clip adjustment termination screw capacity (see below for full definitions). These values were calculated and subsequently verified by an independent testing lab with the following tests:

<u>Independent Testing (Test reports available for download from ACS site):</u>

- ICC-ES AC359, *Acceptance Criteria for Exterior Wall Coverings of Steel-Backed Veneer Panels Attached to Walls Utilizing Steel Framing and Brackets,* Approved October 2008 – Section 3.8.2 *Gravity Loads*

- ASTM E330/E330M-14, *Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference*

- *2 in. and 6 in. A-Clips - Ultimate Load Testing*

- *6 in. A-Clips, Various Girt Configurations - Stress-Strain Load Testing to Failure*

<u>Clip Spacing Design Limitations:</u>

1) Clips have been limited to rotational deflection of 2L/150 (Proloft compression)

2) Screw capacity limited to factor of safety indicated for the relevant fasteners and base material. Tension/shear interaction < 1.0 based on published test data for Leland Masterdriller self-drilling/self-tapping screws

3) ASTM E330 wall assembly tests using 18-gauge studs, ACS A-Clips @ 16" H x 48" V (5.3 sq-ft/A-Clip) attached to studs with ¼"-14 x 2" x #3 drill-point screws. Test samples achieved an average test suction of 60 psf, or 320 lbs per A-Clip – assembly ultimate test mode was pull-out failure of the single #12 screw attaching the outboard vertical to horizontal girts, not attachment to outer ACS clip flange or ACS clip to wall assembly.

4) Inner/outer legs of clips are typically fastened with 2 - #10-16 x ¾" screws, providing an allowable screw shear load >320 lbs, to equal or exceed 3).

The following structural design information is provided as a convenience for the user to determine the general suitability of the clips as part of an overall cladding system. Fastener values are based on one particular manufacturer's test data and are representative of that manufacturer's fasteners, steel section used, and test apparatus. These values may not be applicable for other screw manufacturers, or to different structural support members.

Due to the number of variables inherent in the design of exterior cladding, structural review of cladding installations is required on any project. These variables include, but are not limited to, building height, building exposure, design wind pressure, cladding weight, cladding flexibility/brittleness, cladding fastening requirements, cladding assembly depth, substructure construction tolerances, and substructure material type. As a result of the large number of variables involved with cladding design, a project structural engineer (independent of ACS) is required to review and provide the necessary design/assurance that the overall system is structurally acceptable.

Additionally, cladding which is inherently prone to cracking such as stucco or some types of stone veneer, may require more onerous structural constraints or safety factors over and above those indicated here to reduce the probability of cracking during the design life of the wall assembly.

3 Recommended Clip Spacing & Fastener Data

Tabulated spacing indicated is based on lowest limit of:
1) 2L/150 deflection
2) ASD screw tension/shear/combined interaction
3) ASTM E330 wall assembly test
4) Clip adjustment termination screws (2 - #10-16 x ¾" TEKS, Vallow = 2 x 160 = 320 lbs)
Other limiting conditions such as girt strength must also be considered by the designer.

Steel Stud/Concrete Wall Substructure

Allowable ACS A-Clip/S-Clip Spacing (H" x V") based on one of:

Attachment to 18-ga. or 20 ga. steel studs with 2 - ¼" – 14 #3 Leland Master Driller or equivalent

Attachment to 4000 psi concrete – Simpson Strong-tie Titen Concrete Screws, 2 - ¼" x min. 1 ½" embed.

8" Wall Assembly – Vertical Clip Spacing (V") up to 50 psf Wind

Cladding Weight (psf)	18 Ga. Studs/Concrete				20 Ga. Studs			
	16" Horizontal Spacing		24" Horizontal Spacing		16" Horizontal Spacing		24" Horizontal Spacing	
<= 3	V"	48"	V"	32"	V"	34"	V"	22"
4	V"	48"	V"	32"	V"	30"	V"	20"
5	V"	48"	V"	32"	V"	28"	V"	18"
7.5	V"	32"	V"	21"	V"	24"	V"	16"
10	V"	24"	V"	16"	V"	22"	V"	14"
15	V"	16"	V"	10"	V"	16"	V"	10"

6" Wall Assembly – Vertical Clip Spacing (V") up to 50 psf Wind

Cladding Weight (psf)	18 Ga. Studs/Concrete				20 Ga. Studs			
	16" Horizontal Spacing		24" Horizontal Spacing		16" Horizontal Spacing		24" Horizontal Spacing	
<= 3	V"	48"	V"	32"	V"	36"	V"	24"
4	V"	48"	V"	32"	V"	34"	V"	22"
5	V"	48"	V"	32"	V"	32"	V"	21"
7.5	V"	44"	V"	29"	V"	28"	V"	18"
10	V"	32"	V"	21"	V"	24"	V"	16"
15	V"	22"	V"	14"	V"	20"	V"	13"

Steel Stud/Concrete Wall Substructure continued...

5" Wall Assembly – Vertical Clip Spacing (V") up to 50 psf Wind

Cladding Weight (psf)	18 Ga. Studs/Concrete				20 Ga. Studs			
	16" Horizontal Spacing		24" Horizontal Spacing		16" Horizontal Spacing		24" Horizontal Spacing	
<= 3	V"	48"	V"	32"	V"	36"	V"	24"
4	V"	48"	V"	32"	V"	34"	V"	22"
5	V"	48"	V"	32"	V"	32"	V"	21"
7.5	V"	48"	V"	32"	V"	28"	V"	18"
10	V"	40"	V"	26"	V"	26"	V"	17"
15	V"	26"	V"	17"	V"	22"	V"	14"

4" Wall Assembly – Vertical Clip Spacing (V") up to 50 psf Wind

Cladding Weight (psf)	18 Ga. Studs/Concrete				20 Ga. Studs			
	16" Horizontal Spacing		24" Horizontal Spacing		16" Horizontal Spacing		24" Horizontal Spacing	
<= 3	V"	48"	V"	32"	V"	38"	V"	25"
4	V"	48"	V"	32"	V"	36"	V"	24"
5	V"	48"	V"	32"	V"	34"	V"	22"
7.5	V"	48"	V"	32"	V"	30"	V"	20"
10	V"	46"	V"	30"	V"	28"	V"	18"
15	V"	32"	V"	21"	V"	24"	V"	16"

3" Wall Assembly – Vertical Clip Spacing (V") up to 50 psf Wind

Cladding Weight (psf)	18 Ga. Studs/Concrete				20 Ga. Studs			
	16" Horizontal Spacing		24" Horizontal Spacing		16" Horizontal Spacing		24" Horizontal Spacing	
<= 3	V"	48"	V"	32"	V"	38"	V"	25"
4	V"	48"	V"	32"	V"	38"	V"	25"
5	V"	48"	V"	32"	V"	36"	V"	24"
7.5	V"	48"	V"	32"	V"	34"	V"	22"
10	V"	48"	V"	32"	V"	30"	V"	20"
15	V"	44"	V"	29"	V"	26"	V"	17"

Wood Stud Substructure

Allowable ACS A-Clip/S-Clip Spacing (H” x V”) based on:
Attachment to wood studs (DF/SP or SPF/HF) with Simpson Strong-tie SDS Screws, 2 - ¼” x 2 ½” based on minimum of 1 ½” penetration into main member

8” Wall Assembly – Vertical Clip Spacing (V”) up to 50 psf Wind

Cladding Weight (psf)	DF/SP				SPF/HF			
	16” Horizontal Spacing		24” Horizontal Spacing		16” Horizontal Spacing		24” Horizontal Spacing	
<= 3	V”	48”	V”	32”	V”	48”	V”	32”
4	V”	48”	V”	32”	V”	44”	V”	29”
5	V”	48”	V”	32”	V”	40”	V”	26”
7.5	V”	32”	V”	21”	V”	32”	V”	21”
10	V”	24”	V”	16”	V”	24”	V”	16”
15	V”	16”	V”	10”	V”	16”	V”	10”

6” Wall Assembly – Vertical Clip Spacing (V”) up to 50 psf Wind

Cladding Weight (psf)	DF/SP				SPF/HF			
	16” Horizontal Spacing		24” Horizontal Spacing		16” Horizontal Spacing		24” Horizontal Spacing	
<= 3	V”	48”	V”	32”	V”	48”	V”	32”
4	V”	48”	V”	32”	V”	46”	V”	30”
5	V”	48”	V”	32”	V”	44”	V”	29”
7.5	V”	44”	V”	29”	V”	38”	V”	25”
10	V”	32”	V”	21”	V”	32”	V”	21”
15	V”	22”	V”	14”	V”	22”	V”	14”

5” Wall Assembly – Vertical Clip Spacing (V”) up to 50 psf Wind

Cladding Weight (psf)	DF/SP				SPF/HF			
	16” Horizontal Spacing		24” Horizontal Spacing		16” Horizontal Spacing		24” Horizontal Spacing	
<= 3	V”	48”	V”	32”	V”	48”	V”	32”
4	V”	48”	V”	32”	V”	48”	V”	32”
5	V”	48”	V”	32”	V”	46”	V”	30”
7.5	V”	48”	V”	32”	V”	40”	V”	26”
10	V”	40”	V”	26”	V”	36”	V”	24”
15	V”	26”	V”	17”	V”	26”	V”	17”

Wood Stud Substructure continued...

4" Wall Assembly – Vertical Clip Spacing (V") up to 50 psf Wind

Cladding Weight (psf)	DF/SP				SPF/HF			
	16" Horizontal Spacing		24" Horizontal Spacing		16" Horizontal Spacing		24" Horizontal Spacing	
<= 3	V"	48"	V"	32"	V"	48"	V"	32"
4	V"	48"	V"	32"	V"	48"	V"	32"
5	V"	48"	V"	32"	V"	48"	V"	32"
7.5	V"	48"	V"	32"	V"	42"	V"	28"
10	V"	48"	V"	32"	V"	38"	V"	25"
15	V"	32"	V"	21"	V"	32"	V"	21"

3" Wall Assembly – Vertical Clip Spacing (V") up to 50 psf Wind

Cladding Weight (psf)	DF/SP				SPF/HF			
	16" Horizontal Spacing		24" Horizontal Spacing		16" Horizontal Spacing		24" Horizontal Spacing	
<= 3	V"	48"	V"	32"	V"	48"	V"	32"
4	V"	48"	V"	32"	V"	48"	V"	32"
5	V"	48"	V"	32"	V"	48"	V"	32"
7.5	V"	48"	V"	32"	V"	46"	V"	30"
10	V"	48"	V"	32"	V"	42"	V"	28"
15	V"	46"	V"	30"	V"	34"	V"	22"

Fastener Data

Steel Stud Framing:

Leland Master Driller – ¼”-14 #3 Fastener, DT2000			
Stud Gauge	20	18	16
Nominal Thickness (in)	0.0346	0.0451	0.0566
Tensile Capacity (lbs)	375	613	883
Allowable Tensile (lbs)	125	204	294
Ultimate Shear (lbs)	993	1445	2103
Allowable Shear (lbs)	331	482	701

Note – Factor of Safety of Ultimate Values: FS = 3

Concrete Support:

Simpson Strong-Tie Titen Stainless Steel Screws 1/4" dia. x 1 1/2" embedment		
Concrete Strength (psi)	2000	4000
Tensile Capacity (lbs)	1460	2006
Allowable Tension (lbs)	365	500
Shear Capacity (lbs)	1600	1600
Allowable Shear (lbs)	400	400

Note – Factor of Safety of Ultimate Values: FS = 4
Shear values only available for f’c = 2000 psi

Wood Support:

Simpson Strong-Tie SDS Wood Screws - 1/4" dia. x 2 1/2" lg.		
Wood Species	DF/SP	SPF/HF
Allowable Tension (lbs)	258	182
Allowable Shear (lbs)	250	180

Note – Factor of Safety from Simpson Strong-Tie for 16 ga. Steel Side Plates, & assumes at least 1 ½” penetration into main member
Allowable withdrawal load for DF/SP is 172 lb/in for DF/SP, and for SPF/HF 121 lb/in.

4 Kolot Structural Engineering Ltd.

30 August 2017

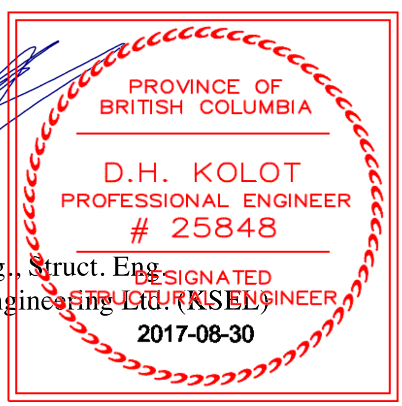
ACS Composite Systems Inc.
A2-6702 Rajpur Place
Saanichton, BC V8M 1Z5

Dear Dan-

KSEL is pleased to provide the attached ACS Structural Design Guide. This document relates to the ACS Thermal Clips (A-Clips & S-Clips) installed on steel stud walls, concrete walls, and wood stud walls.

The thermal clip design has been based on a combination of analytical design, structural verification from an accredited third party testing agency, as well as manufacturer data for fasteners for the above-mentioned structural backup assemblies. It should be noted that due to the complexity of cladding/sub-girt types, local/national building codes, wind/seismic loads due to building location, shape, and size, the design of the complete wall assembly is outside the scope of this structural manual. Each project generally requires a cladding specialty engineer (structural engineer) independent of ACS and KSEL, competent in the design of cladding/wall assemblies, and registered in the region that the cladding assembly is to be installed. KSEL is available to provide some guidance for using the thermal clips in the planning stage of individual projects should the need arise. In some instances, KSEL could also be retained to act as the cladding specialty engineer of record, although this would be limited to regions where KSEL is currently registered, and would depend on availability.

Best regards,



Doug Kolot, P. Eng., Struct. Eng
Kolot Structural Engineering Ltd. (KSEL)