MORRISON HERSHFIELD

SOPREMA / ACS Composite Systems Split Insulated 2x4 Wood Frame Wall Thermal Analysis

Presented to:

Jean-Francois Cote
Director, Standards & Scientific Affairs

Soprema Inc.
1688 Jean-Brechmans-Michaud
Drummondville, QC J2C 8E9

and

Danny White

ACS Composite Systems Inc.
35-7450 Butler Road
Sooke, BC V9Z 1N1

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TABLE OF CONTENTS

1. INTRODUCTION

Morrison Hershfield (MH) was retained by Soprema Inc. (Soprema) to evaluate the thermal performance of the ACS-S Thermal Clip system for a variety of clip spacings, insulation types, insulation thicknesses, and a variety of backup wall configurations. This report is a summary of the analysis performed for split insulated 2x4 wood frame wall assemblies.

The ACS-S Thermal Clip is made of stainless steel with a 1/2 inch Extreme Pad rigid urethane foam thermal isolator. The girt is attached to the ACS-S Thermal Clip such that the girt is outboard of the exterior insulation, resulting in no girt penetration of the exterior insulation. The ACS-S Thermal Clips were evaluated to determine the clear field U-values and effective R-values for a variety of clip spacings and exterior insulation types.

For all configurations, the smallest ACS-S Thermal Clip was selected for the exterior insulation thickness as shown below in Table 1.1.

Table 1.1: Exterior Insulation Thickness for the ACS-S Thermal Clip System

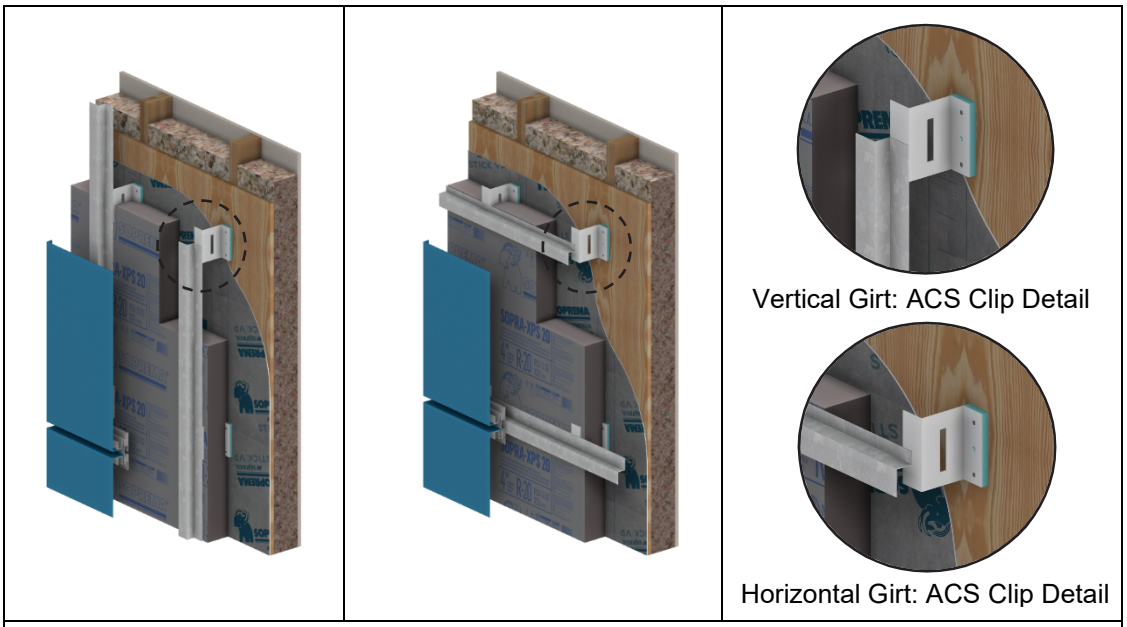
ACS-S Thermal Clip Size (in)	**Exterior Insulation Thickness** in (mm)
2	1 (25)
2	2 (50)
3	3 (76)
4	4 (102)
5	5 (127)
6	6 (152)
7	7 (178)
8	8 (203)

Table 1.2 below summarizes the evaluated wall configurations, and Figure 1.1 illustrates a representative wall assembly using SOPRA-XPS 20 exterior insulation. The geometry of the ACS-S Thermal Clips were based on the drawings provided by ACS Composite Systems Inc. and Soprema, and are provided in Appendix A.

Table 1.2: Evaluated ACS-S Thermal Clip Assemblies: Split Insulated 2x4 Wood Frame Wall

Exterior Insulation Type	Nominal R-Value/in	Exterior Insulation Thickness (inches)	Stud Spacing (in)	Horizontal Clip Spacing (in)	Vertical Clip Spacing (in)
SOPRA-XPS 20	R-5/in	1, 1.5*, 2*, 3, 4*, 5, 6*, 7	16, 24	16, 24	24, 36, 48
SOPRA-SPF 202	R-6.2/in	1, 2*, 3, 4*, 5, 6*,7	16, 24	16, 24	24, 36, 48
SOPRA-ISO V PLUS	R-6/in	1, 1.5*, 2*, 2.5*, 3, 3.5*, 4*, 4.5*, 5, 5.5*, 6*, 6.5*, 7	16, 24	16, 24	24, 36, 48
Mineral Wool	R-4.3/in	1, 2*, 3, 4*, 5, 6*, 7*, 8	16, 24	16, 24	24, 36, 48

*Indicates interpolated value



- 1/2 inch (13 mm) gypsum
- 2x4 (89 mm x 38 mm) wood studs with R-13 cellulose insulation in stud cavity
- 1/2 inch (13 mm) plywood sheathing
- SOPREMA SOPRASEAL STICK VP membrane
- ACS-S Thermal Clip System
- Exterior insulation
- Z-girt

Figure 1.1: Schematic of Evaluated ACS-S Thermal Clip with Split Insulated 2x4 Wood Frame Assemblies

2. MODELLING PROCEDURES

The thermal performance of the different assembly scenarios was evaluated by 3D thermal modelling using the Nx software package from Siemens, which is a general purpose computer aided design (CAD) and finite element analysis (FEA) package. The thermal solver and modelling procedures utilized for this study were extensively calibrated and validated to within +/- 5% of hotbox testing for *ASHRAE Research Project 1365-RP Thermal Performance of Building Envelope Details for Mid- and High-Rise Construction and for the Building Envelope Thermal Bridging Guide*[1]. The thermal analysis utilized steady-state conditions, published thermal properties of materials and information provided by Soprema and ACS Composite Systems Inc. Additional assumptions for the thermal analysis are listed in Appendix B. Further assembly information, including dimensions and materials, is provided in Appendix C.

1 https://www.bchydro.com/thermalguide

3. THERMAL RESULTS

The clear field U- Values and effective R-values for all ACS-S Thermal Clip assembly configurations are shown below in Table 3.1 to Table 3.4. Example temperature profiles for each configuration are shown in in Appendix D.

Table 3.1: U-Value and Effective R-Value for ACS-S Thermal Clip with **SOPRA-XPS 20** Exterior Insulation: Split Insulated 2x4 Wood Frame Wall Assemblies

Horizontal Clip Spacing	Exterior Insulation Thickness in (mm)	Exterior Insulation 1D R-value[2] (RSI)	24" Vertical Spacing		36" Vertical Spacing		48" Vertical Spacing	
			R_o ft²·hr·°F / Btu (m² K / W)	U_o Btu/ft² ·hr ·°F (W/m² K)	R_o ft²·hr·°F / Btu (m² K / W)	U_o Btu/ft² ·hr ·°F (W/m² K)	R_o ft²·hr·°F / Btu (m² K / W)	U_o Btu/ft² ·hr ·°F (W/m² K)
16	1.0 (25)	R-5.0 (0.88)	R-19.1 (3.36)	0.052 (0.30)	R-19.1 (3.37)	0.052 (0.30)	R-19.1 (3.37)	0.052 (0.30)
	1.5 (38)	R-7.5 (1.32)	R-21.4 (3.77)*	0.047 (0.27)*	R-21.5 (3.79)*	0.047 (0.26)*	R-21.5 (3.79)*	0.046 (0.26)*
	2.0 (51)	R-10.0 (1.76)	R-23.7 (4.17)*	0.042 (0.24)*	R-23.9 (4.20)*	0.042 (0.24)*	R-23.9 (4.22)*	0.042 (0.24)*
	3.0 (76)	R-15.0 (2.64)	R-28.2 (4.97)	0.035 (0.20)	R-28.6 (5.03)	0.035 (0.20)	R-28.7 (5.06)	0.035 (0.20)
	4.0 (102)	R-20.0 (3.52)	R-32.6 (5.75)*	0.031 (0.17)*	R-33.1 (5.84)*	0.030 (0.17)*	R-33.4 (5.88)*	0.030 (0.17)*
	5.0 (127)	R-25.0 (4.40)	R-36.9 (6.51)	0.027 (0.15)	R-37.7 (6.63)	0.027 (0.15)	R-38.0 (6.70)	0.026 (0.15)
	6.0 (152)	R-30.0 (5.28)	R-41.2 (7.26)*	0.024 (0.14)*	R-42.2 (7.43)*	0.024 (0.13)*	R-42.7 (7.51)*	0.023 (0.13)*
	7.0 (178)	R-35.0 (6.16)	R-45.4 (8.00)	0.022 (0.13)	R-46.6 (8.21)	0.021 (0.12)	R-47.2 (8.32)	0.021 (0.12)
24	1.0 (25)	R-5.0 (0.88)	R-19.6 (3.45)	0.051 (0.29)	R-19.6 (3.45)	0.051 (0.29)	R-19.7 (3.47)	0.051 (0.29)
	1.5 (38)	R-7.5 (1.32)	R-21.9 (3.86)*	0.046 (0.26)*	R-22.0 (3.88)*	0.045 (0.26)*	R-22.1 (3.90)*	0.045 (0.26)*
	2.0 (51)	R-10.0 (1.76)	R-24.3 (4.27)*	0.041 (0.23)*	R-24.4 (4.30)*	0.041 (0.23)*	R-24.6 (4.32)*	0.041 (0.23)*
	3.0 (76)	R-15.0 (2.64)	R-28.9 (5.08)	0.035 (0.20)	R-29.2 (5.15)	0.034 (0.19)	R-29.4 (5.18)	0.034 (0.19)
	4.0 (102)	R-20.0 (3.52)	R-33.5 (5.90)*	0.030 (0.17)*	R-34.0 (5.98)*	0.029 (0.17)*	R-34.2 (6.02)*	0.029 (0.17)*
	5.0 (127)	R-25.0 (4.40)	R-38.1 (6.71)	0.026 (0.15)	R-38.6 (6.80)	0.026 (0.15)	R-38.9 (6.86)	0.026 (0.15)
	6.0 (152)	R-30.0 (5.28)	R-42.6 (7.50)*	0.023 (0.13)*	R-43.3 (7.62)*	0.023 (0.13)*	R-43.7 (7.69)*	0.023 (0.13)*
	7.0 (178)	R-35.0 (6.16)	R-47.0 (8.29)	0.021 (0.12)	R-47.9 (8.43)	0.021 (0.12)	R-48.4 (8.52)	0.021 (0.12)

*Indicates interpolated value

[2] This value is the nominal R-value of the exterior insulation ONLY. Additional components, such as the sheathing, cellulose insulation, and air films all contribute an additional R-15.5 towards the nominal R-value of the entire assembly.

Table 3.2: U-Value and Effective R-Value for ACS-S Thermal Clip with **SOPRA-SPF 202** Exterior Insulation: Split Insulated 2x4 Wood Frame Wall Assemblies

Horizontal Clip Spacing	Exterior Insulation Thickness in (mm)	Exterior Insulation 1D R-value[3] (RSI)	24" Vertical Spacing		36" Vertical Spacing		48" Vertical Spacing	
			R_o ft²·hr·°F / Btu (m² K / W)	U_o Btu/ft² ·hr ·°F (W/m² K)	R_o ft²·hr·°F / Btu (m² K / W)	U_o Btu/ft² ·hr ·°F (W/m² K)	R_o ft²·hr·°F / Btu (m² K / W)	U_o Btu/ft² ·hr ·°F (W/m² K)
16	1.0 (25)	R-6.2 (1.09)	R-20.2 (3.56)	0.050 (0.28)	R-20.2 (3.56)	0.049 (0.28)	R-20.2 (3.56)	0.049 (0.28)
	2.0 (51)	R-12.4 (2.18)	R-25.8 (4.55)*	0.039 (0.22)*	R-26.0 (4.59)*	0.038 (0.22)*	R-26.2 (4.61)*	0.038 (0.22)*
	3.0 (76)	R-18.6 (3.28)	R-31.4 (5.52)	0.032 (0.18)	R-31.8 (5.60)	0.031 (0.18)	R-32.0 (5.64)	0.031 (0.18)
	4.0 (102)	R-24.8 (4.37)	R-36.7 (6.46)*	0.027 (0.15)*	R-37.4 (6.58)*	0.027 (0.15)*	R-37.8 (6.65)*	0.026 (0.15)*
	5.0 (127)	R-31.0 (5.46)	R-41.9 (7.37)	0.024 (0.14)	R-42.9 (7.55)	0.023 (0.13)	R-43.4 (7.65)	0.023 (0.13)
	6.0 (152)	R-37.2 (6.55)	R-47.0 (8.28)*	0.021 (0.12)*	R-48.4 (8.52)*	0.021 (0.12)*	R-49.1 (8.64)*	0.020 (0.12)*
	7.0 (178)	R-43.4 (7.64)	R-52.0 (9.16)	0.019 (0.11)	R-53.7 (9.46)	0.019 (0.11)	R-54.6 (9.62)	0.018 (0.10)
24	1.0 (25)	R-6.2 (1.09)	R-20.7 (3.65)	0.048 (0.27)	R-20.7 (3.65)	0.048 (0.27)	R-20.8 (3.66)	0.048 (0.27)
	2.0 (51)	R-12.4 (2.18)	R-26.5 (4.66)*	0.038 (0.21)*	R-26.7 (4.70)*	0.037 (0.21)*	R-26.8 (4.72)*	0.037 (0.21)*
	3.0 (76)	R-18.6 (3.28)	R-32.2 (5.66)	0.031 (0.18)	R-32.6 (5.73)	0.031 (0.17)	R-32.8 (5.77)	0.031 (0.17)
	4.0 (102)	R-24.8 (4.37)	R-37.8 (6.65)*	0.026 (0.15)*	R-38.4 (6.76)*	0.026 (0.15)*	R-38.7 (6.81)*	0.026 (0.15)*
	5.0 (127)	R-31.0 (5.46)	R-43.3 (7.63)	0.023 (0.13)	R-44.1 (7.76)	0.023 (0.13)	R-44.5 (7.84)	0.022 (0.13)
	6.0 (152)	R-37.2 (6.55)	R-48.8 (8.59)*	0.020 (0.12)*	R-49.8 (8.76)*	0.020 (0.11)*	R-50.3 (8.86)*	0.020 (0.11)*
	7.0 (178)	R-43.4 (7.64)	R-54.2 (9.54)	0.018 (0.10)	R-55.4 (9.75)	0.018 (0.10)	R-56.1 (9.87)	0.018 (0.10)

*Indicates interpolated value

[3] This value is the nominal R-value of the exterior insulation ONLY. Additional components, such as the sheathing, cellulose insulation, and air films all contribute an additional R-15.5 towards the nominal R-value of the entire assembly.

Table 3.3: U-Value and Effective R-Value for ACS-S Thermal Clip with **SOPRA-ISO V PLUS** Exterior Insulation: Split Insulated 2x4 Wood Frame Assemblies

Horizontal Clip Spacing	Exterior Insulation Thickness in (mm)	Exterior Insulation 1D R-value[4] (RSI)	24" Vertical Spacing		36" Vertical Spacing		48" Vertical Spacing	
			R_o ft²·hr·°F / Btu (m² K / W)	U_o Btu/ft² ·hr ·°F (W/m² K)	R_o ft²·hr·°F / Btu (m² K / W)	U_o Btu/ft² ·hr ·°F (W/m² K)	R_o ft²·hr·°F / Btu (m² K / W)	U_o Btu/ft² ·hr ·°F (W/m² K)
16	1.0 (25)	R-6.0 (1.06)	R-20.1 (3.53)	0.050 (0.28)	R-20.1 (3.54)	0.050 (0.28)	R-20.1 (3.54)	0.050 (0.28)
	1.5 (38)	R-9.0 (1.59)	R-22.8 (4.02)*	0.044 (0.25)*	R-22.9 (4.04)*	0.044 (0.25)*	R-23.0 (4.05)*	0.043 (0.25)*
	2.0 (51)	R-12.0 (2.11)	R-25.5 (4.50)*	0.039 (0.22)*	R-25.7 (4.53)*	0.039 (0.22)*	R-25.9 (4.55)*	0.039 (0.22)*
	2.5 (64)	R-15.0 (2.64)	R-28.2 (4.97)*	0.035 (0.20)*	R-28.5 (5.03)*	0.035 (0.20)*	R-28.7 (5.05)*	0.035 (0.20)*
	3.0 (76)	R-18.0 (3.17)	R-30.9 (5.44)	0.032 (0.18)	R-31.3 (5.52)	0.032 (0.18)	R-31.5 (5.55)	0.032 (0.18)
	3.5 (89)	R-21.0 (3.70)	R-33.5 (5.90)*	0.030 (0.17)*	R-34.0 (6.00)*	0.029 (0.17)*	R-34.3 (6.04)*	0.029 (0.17)*
	4.0 (102)	R-24.0 (4.23)	R-36.1 (6.36)*	0.028 (0.16)*	R-36.8 (6.48)*	0.027 (0.15)*	R-37.1 (6.54)*	0.027 (0.15)*
	4.5 (114)	R-27.0 (4.76)	R-38.7 (6.81)*	0.026 (0.15)*	R-39.5 (6.95)*	0.025 (0.14)*	R-39.9 (7.02)*	0.025 (0.14)*
	5.0 (127)	R-30.0 (5.28)	R-41.2 (7.25)	0.024 (0.14)	R-42.1 (7.42)	0.024 (0.13)	R-42.6 (7.50)	0.023 (0.13)
	5.5 (140)	R-33.0 (5.81)	R-43.7 (7.70)*	0.023 (0.13)*	R-44.8 (7.89)*	0.022 (0.13)*	R-45.4 (7.99)*	0.022 (0.13)*
	6.0 (152)	R-36.0 (6.34)	R-46.2 (8.13)*	0.022 (0.12)*	R-47.4 (8.35)*	0.021 (0.12)*	R-48.1 (8.47)*	0.021 (0.12)*
	6.5 (165)	R-39.0 (6.87)	R-48.6 (8.56)*	0.021 (0.12)*	R-50.1 (8.81)*	0.020 (0.11)*	R-50.8 (8.95)*	0.020 (0.11)*
	7.0 (178)	R-42.0 (7.40)	R-51.1 (8.99)	0.020 (0.11)	R-52.7 (9.27)	0.019 (0.11)	R-53.5 (9.42)	0.019 (0.11)
24	1.0 (25)	R-6.0 (1.06)	R-20.6 (3.62)	0.049 (0.28)	R-20.6 (3.63)	0.049 (0.28)	R-20.7 (3.64)	0.048 (0.27)
	1.5 (38)	R-9.0 (1.59)	R-23.4 (4.11)*	0.043 (0.24)*	R-23.5 (4.14)*	0.043 (0.24)*	R-23.6 (4.15)*	0.042 (0.24)*
	2.0 (51)	R-12.0 (2.11)	R-26.1 (4.61)*	0.038 (0.22)*	R-26.4 (4.64)*	0.038 (0.22)*	R-26.5 (4.67)*	0.038 (0.21)*
	2.5 (64)	R-15.0 (2.64)	R-28.9 (5.09)*	0.035 (0.20)*	R-29.2 (5.15)*	0.034 (0.19)*	R-29.4 (5.18)*	0.034 (0.19)*
	3.0 (76)	R-18.0 (3.17)	R-31.6 (5.57)	0.032 (0.18)	R-32.1 (5.65)	0.031 (0.18)	R-32.3 (5.68)	0.031 (0.18)
	3.5 (89)	R-21.0 (3.70)	R-34.4 (6.06)*	0.029 (0.17)*	R-34.9 (6.14)*	0.029 (0.16)*	R-35.1 (6.19)*	0.028 (0.16)*
	4.0 (102)	R-24.0 (4.23)	R-37.1 (6.54)*	0.027 (0.15)*	R-37.7 (6.64)*	0.027 (0.15)*	R-38.0 (6.69)*	0.026 (0.15)*
	4.5 (114)	R-27.0 (4.76)	R-39.8 (7.01)*	0.025 (0.14)*	R-40.5 (7.13)*	0.025 (0.14)*	R-40.8 (7.19)*	0.024 (0.14)*
	5.0 (127)	R-30.0 (5.28)	R-42.6 (7.50)	0.023 (0.13)	R-43.3 (7.62)	0.023 (0.13)	R-43.7 (7.69)	0.023 (0.13)
	5.5 (140)	R-33.0 (5.81)	R-45.2 (7.96)*	0.022 (0.13)*	R-46.0 (8.10)*	0.022 (0.12)*	R-46.5 (8.19)*	0.022 (0.12)*
	6.0 (152)	R-36.0 (6.34)	R-47.8 (8.43)*	0.021 (0.12)*	R-48.8 (8.59)*	0.021 (0.12)*	R-49.3 (8.68)*	0.020 (0.12)*
	6.5 (165)	R-39.0 (6.87)	R-50.5 (8.89)*	0.020 (0.11)*	R-51.5 (9.07)*	0.019 (0.11)*	R-52.1 (9.17)*	0.019 (0.11)*
	7.0 (178)	R-42.0 (7.40)	R-53.1 (9.35)	0.019 (0.11)	R-54.2 (9.54)	0.018 (0.10)	R-54.9 (9.66)	0.018 (0.10)

*Indicates interpolated value

[4] This value is the nominal R-value of the exterior insulation ONLY. Additional components, such as the sheathing, cellulose insulation, and air films all contribute an additional R-15.5 towards the nominal R-value of the entire assembly.

Table 3.4: U-Value and Effective R-Value for ACS-S Thermal Clip with **Mineral Wool** Exterior Insulation: Split Insulated 2x4 Wood Frame Assemblies

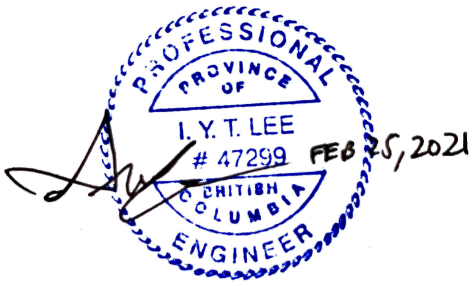
Horizontal Clip Spacing	Exterior Insulation Thickness in (mm)	Exterior Insulation 1D R-value[5] (RSI)	24" Vertical Spacing		36" Vertical Spacing		48" Vertical Spacing	
			R_o ft²·hr·°F / Btu (m² K / W)	U_o Btu/ft² ·hr ·°F (W/m² K)	R_o ft²·hr·°F / Btu (m² K / W)	U_o Btu/ft² ·hr ·°F (W/m² K)	R_o ft²·hr·°F / Btu (m² K / W)	U_o Btu/ft² ·hr ·°F (W/m² K)
16	1.0 (25)	R-4.3 (0.76)	R-18.4 (3.24)	0.054 (0.31)	R-18.4 (3.25)	0.054 (0.31)	R-18.4 (3.25)	0.054 (0.31)
	2.0 (51)	R-8.6 (1.51)	R-22.4 (3.94)*	0.045 (0.25)*	R-22.5 (3.97)*	0.044 (0.25)*	R-22.6 (3.98)*	0.044 (0.25)*
	3.0 (76)	R-12.9 (2.27)	R-26.3 (4.64)	0.038 (0.22)	R-26.6 (4.68)	0.038 (0.21)	R-26.7 (4.70)	0.037 (0.21)
	4.0 (102)	R-17.2 (3.03)	R-30.2 (5.31)*	0.033 (0.19)*	R-30.6 (5.38)*	0.033 (0.19)*	R-30.8 (5.42)*	0.033 (0.18)*
	5.0 (127)	R-21.5 (3.79)	R-34.0 (5.98)	0.029 (0.17)	R-34.5 (6.08)	0.029 (0.16)	R-34.8 (6.13)	0.029 (0.16)
	6.0 (152)	R-25.8 (4.54)	R-37.7 (6.65)*	0.026 (0.15)*	R-38.5 (6.77)*	0.026 (0.15)*	R-38.8 (6.84)*	0.026 (0.15)*
	7.0 (178)	R-30.1 (5.30)	R-41.5 (7.30)*	0.024 (0.14)*	R-42.4 (7.46)*	0.024 (0.13)*	R-42.8 (7.54)*	0.023 (0.13)*
	8.0 (203)	R-34.4 (6.06)	R-45.1 (7.95)	0.022 (0.13)	R-46.2 (8.14)	0.022 (0.12)	R-46.8 (8.24)	0.021 (0.12)
24	1.0 (25)	R-4.3 (0.76)	R-18.9 (3.33)	0.053 (0.30)	R-18.9 (3.33)	0.053 (0.30)	R-19.0 (3.34)	0.053 (0.30)
	2.0 (51)	R-8.6 (1.51)	R-22.9 (4.04)*	0.044 (0.25)*	R-23.1 (4.07)*	0.043 (0.25)*	R-23.2 (4.08)*	0.043 (0.24)*
	3.0 (76)	R-12.9 (2.27)	R-26.9 (4.74)	0.037 (0.21)	R-27.2 (4.79)	0.037 (0.21)	R-27.4 (4.82)	0.037 (0.21)
	4.0 (102)	R-17.2 (3.03)	R-31.0 (5.45)*	0.032 (0.18)*	R-31.3 (5.51)*	0.032 (0.18)*	R-31.5 (5.55)*	0.032 (0.18)*
	5.0 (127)	R-21.5 (3.79)	R-35.0 (6.16)	0.029 (0.16)	R-35.4 (6.23)	0.028 (0.16)	R-35.6 (6.27)	0.028 (0.16)
	6.0 (152)	R-25.8 (4.54)	R-38.9 (6.84)*	0.026 (0.15)*	R-39.4 (6.94)*	0.025 (0.14)*	R-39.7 (7.00)*	0.025 (0.14)*
	7.0 (178)	R-30.1 (5.30)	R-42.8 (7.53)*	0.023 (0.13)*	R-43.4 (7.65)*	0.023 (0.13)*	R-43.8 (7.72)*	0.023 (0.13)*
	8.0 (203)	R-34.4 (6.06)	R-46.7 (8.22)	0.021 (0.12)	R-47.4 (8.35)	0.021 (0.12)	R-47.9 (8.43)	0.021 (0.12)

*Indicates interpolated value

We believe that this report meets your objectives for evaluating the thermal performance for the ACS-S Thermal Clip system with split insulated 2x4 wood frame assemblies. If you have any questions or comments related to the above, please do not hesitate to contact the undersigned.

Morrison Hershfield Limited

Katie Hay, P.Eng.
Building Science Consultant



Ivan Lee, P.Eng.
Building Science Consultant

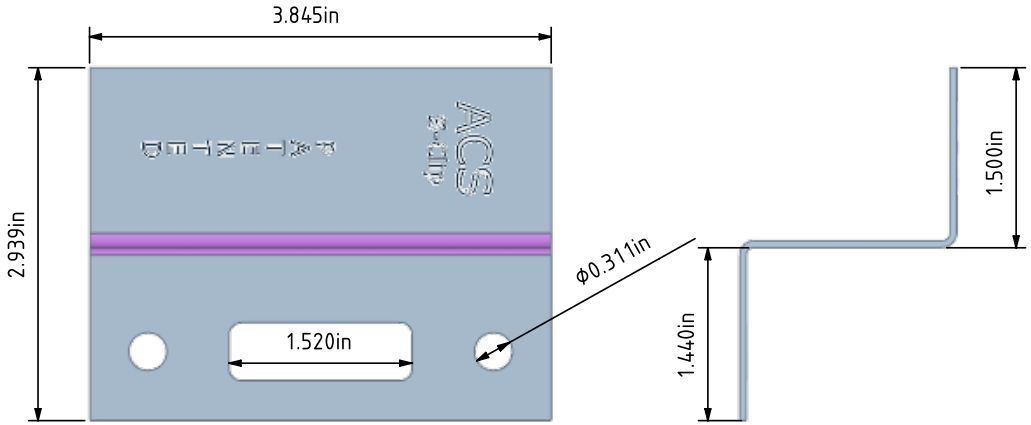
[5] This value is the nominal R-value of the exterior insulation ONLY. Additional components, such as the sheathing, cellulose insulation, and air films all contribute an additional R-15.5 towards the nominal R-value of the entire assembly.

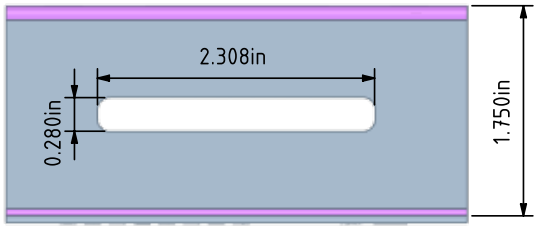
APPENDIX A:
DETAIL DRAWINGS

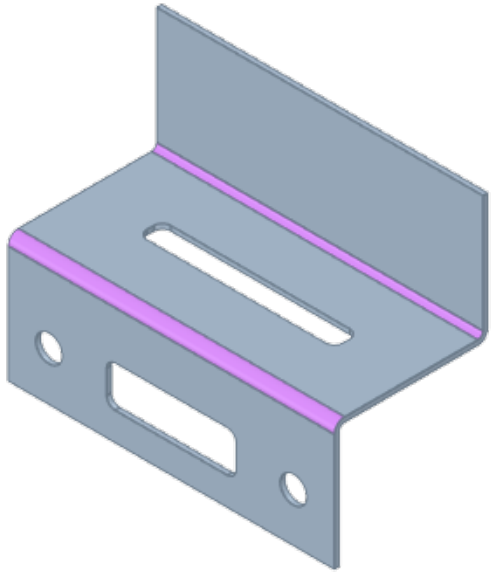
REVISION HISTORY

REV	DESCRIPTION	INCORP BY	DATE	CHECKED

NOTES:







-2 QTY REQD	-1 ITEM NO.	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION

PARTS LIST

INIT	APPROVALS	DATE	INIT	APPROVALS	DATE

CONTRACT NO.		MATERIAL
		FINISH
THIRD ANGLE PROJECTION		TREATMENT
NEXT ASSY	USED ON	SIMILAR TO
APPLICATION		

ACS Composite Systems

TITLE

2in Solid Clip

SIZE	CAGE CODE	DWG NO.	REV
B			2
SCALE		SHEET	

REVISION HISTORY

REV	DESCRIPTION	INCORP BY	DATE	CHECKED

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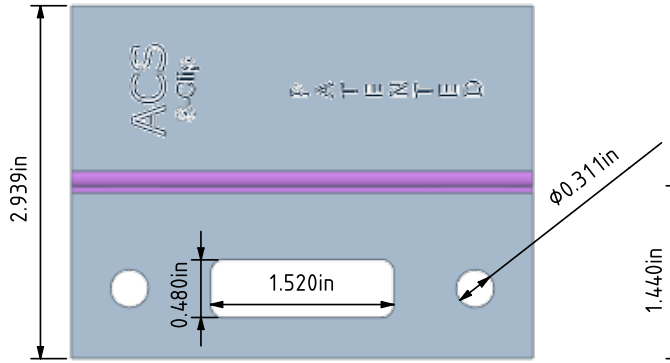
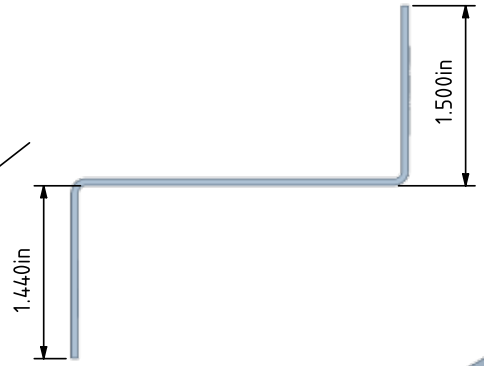
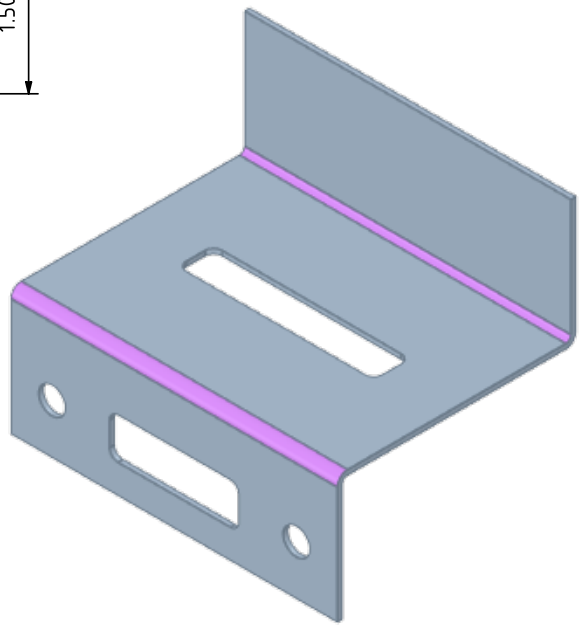
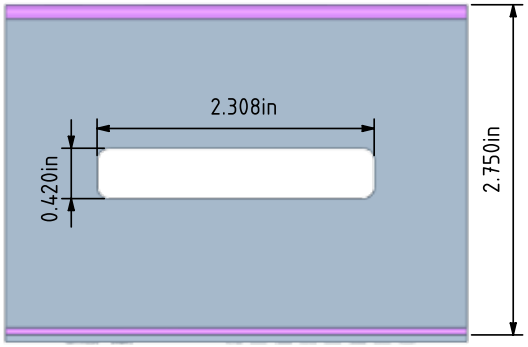








-2 QTY REQD	-1 ITEM NO.	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION

PARTS LIST

INIT	APPROVALS	DATE	INIT	APPROVALS	DATE

	CONTRACT NO.	MATERIAL
		FINISH
THIRD ANGLE PROJECTION		TREATMENT
	NEXT ASSY / USED ON	SIMILAR TO
	APPLICATION	

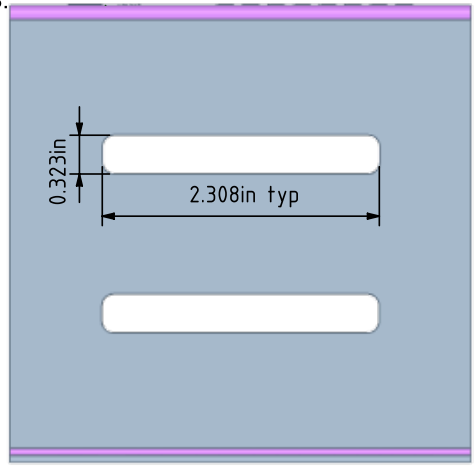
ACS Composite Systems

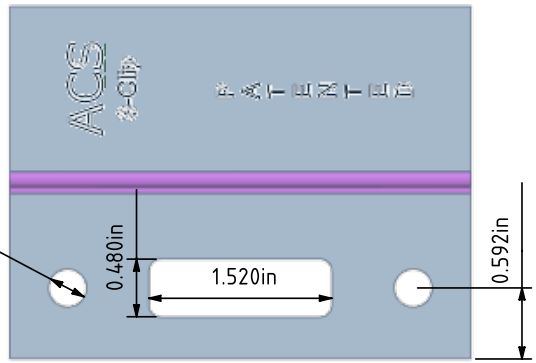
TITLE

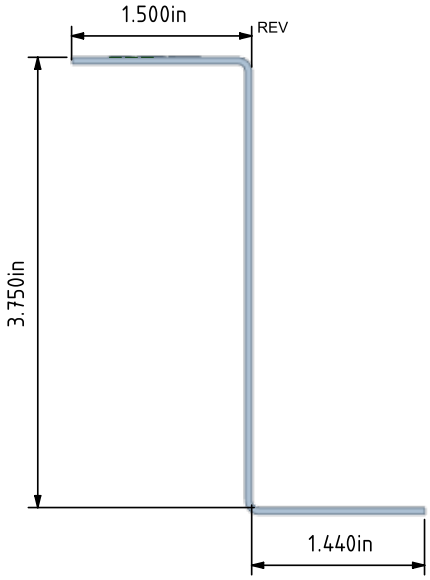
3in Solid Clip

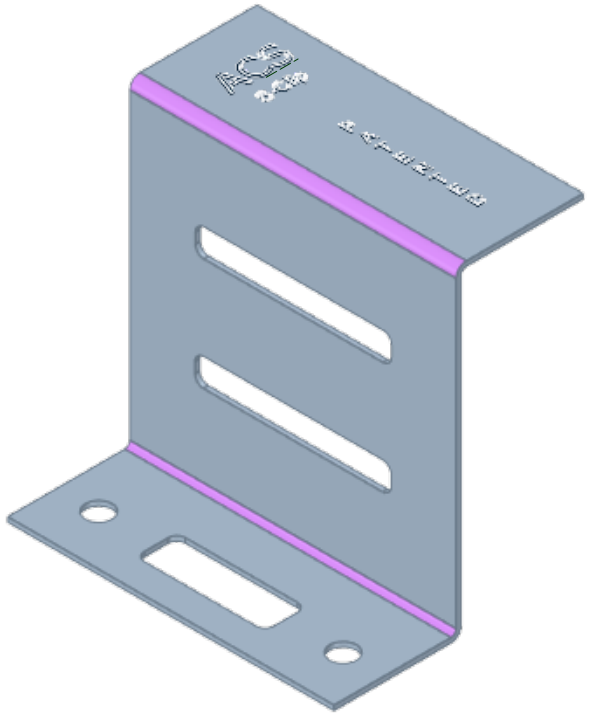
SIZE	CAGE CODE	DWG NO.	REV
B			2
SCALE		SHEET	

NOTES:









REVISION HISTORY

REV	DESCRIPTION	INCORP BY	DATE	CHECKED

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PARTS LIST

INIT	APPROVALS	DATE	INIT	APPROVALS	DATE

CONTRACT NO.

MATERIAL

FINISH

TREATMENT

SIMILAR TO

THIRD ANGLE PROJECTION

NEXT ASSY | USED ON

APPLICATION

ACS Composite Systems

TITLE

4in Solid Clip

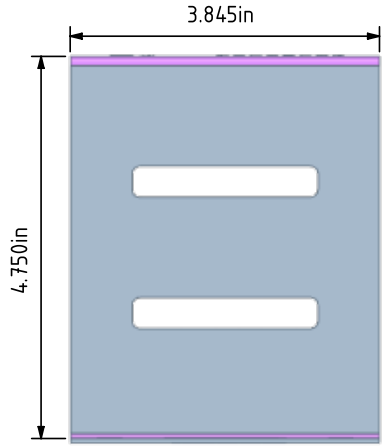
SIZE	CAGE CODE	DWG NO.	REV
B			2

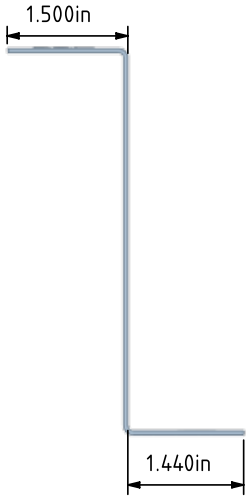
SCALE | SHEET

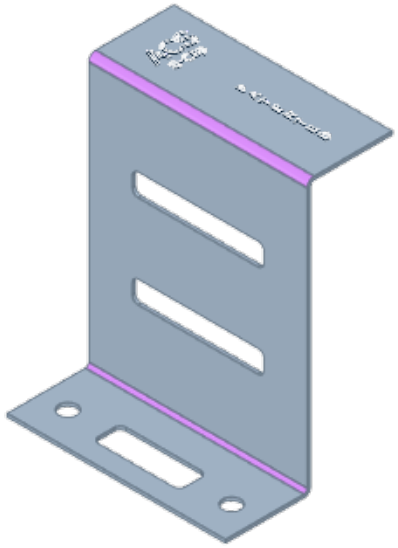
REVISION HISTORY

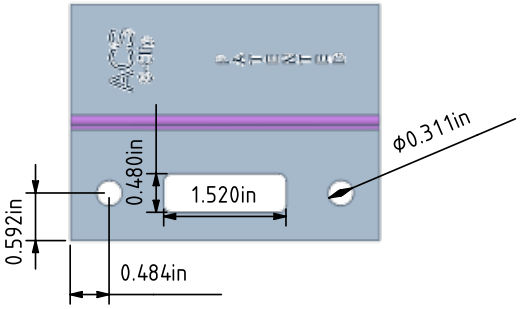
REV	DESCRIPTION	INCORP BY	DATE	CHECKED

NOTES:









-2 QTY REQD	-1 ITEM NO.	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION

PARTS LIST

INIT	APPROVALS	DATE	INIT	APPROVALS	DATE

	CONTRACT NO.	MATERIAL
		FINISH
THIRD ANGLE PROJECTION		TREATMENT
	NEXT ASSY / USED ON	SIMILAR TO
	APPLICATION	

ACS Composite Systems

TITLE

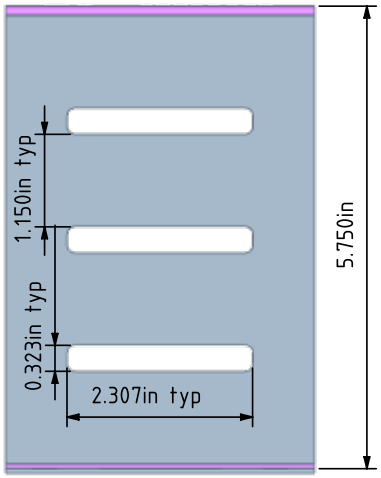
5in Solid Clip

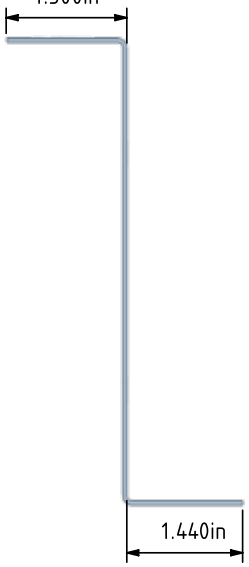
SIZE	CAGE CODE	DWG NO.	REV
B			2
SCALE		SHEET	

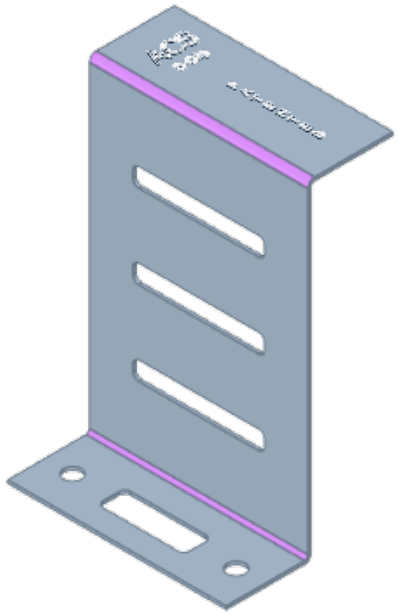
NOTES:

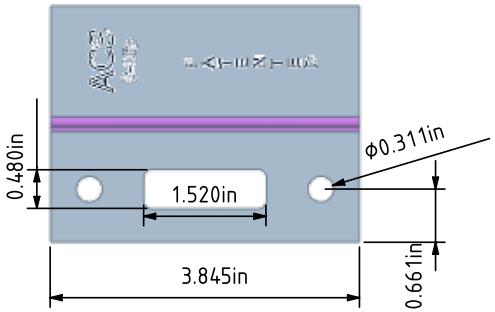
REVISION HISTORY

REV	DESCRIPTION	INCORP BY	DATE	CHECKED









-2 QTY REQD	-1 ITEM NO.	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION

PARTS LIST

INIT	APPROVALS	DATE	INIT	APPROVALS	DATE

	CONTRACT NO.	MATERIAL
		FINISH
THIRD ANGLE PROJECTION		TREATMENT
	NEXT ASSY / USED ON	SIMILAR TO
	APPLICATION	

ACS Composite Systems

TITLE

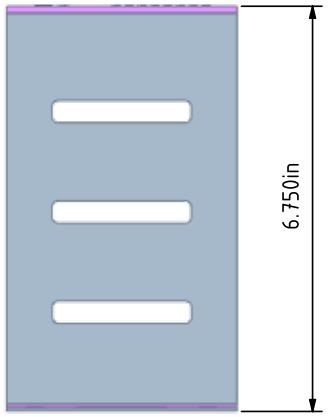
6in Solid Clip

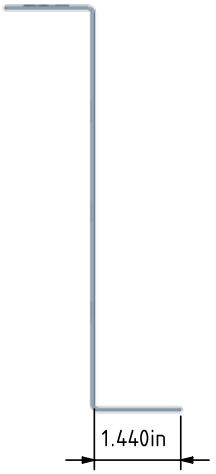
SIZE	CAGE CODE	DWG NO.	REV
B			2
SCALE		SHEET	

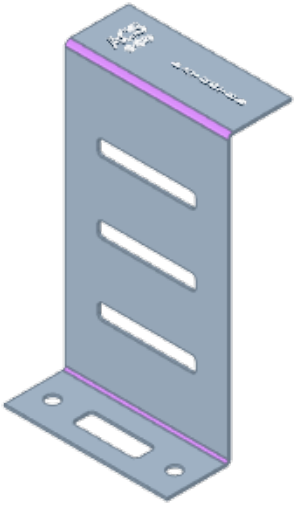
REVISION HISTORY

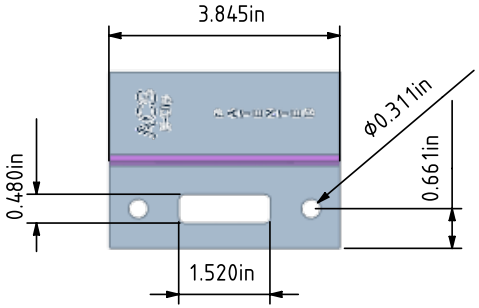
REV	DESCRIPTION	INCORP BY	DATE	CHECKED

NOTES:









-2 QTY REQD	-1 ITEM NO.	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION

PARTS LIST

INIT	APPROVALS	DATE	INIT	APPROVALS	DATE

	CONTRACT NO.	MATERIAL
		FINISH
THIRD ANGLE PROJECTION		TREATMENT
	NEXT ASSY / USED ON	SIMILAR TO
	APPLICATION	

ACS Composite Systems

TITLE

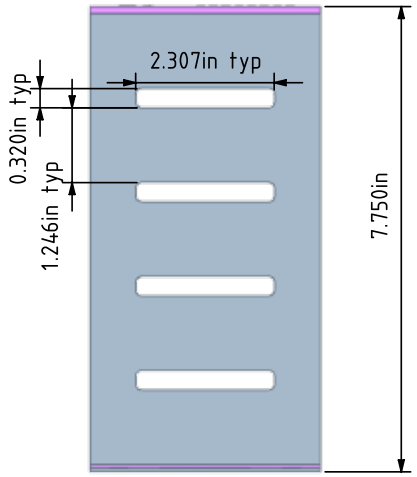
7in Solid Clip

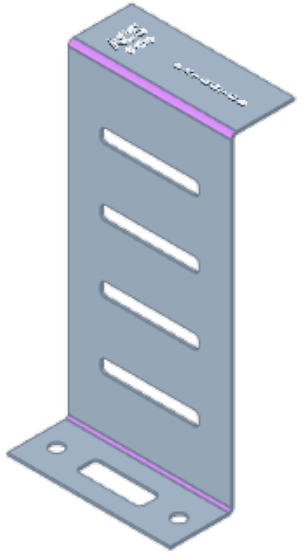
SIZE	CAGE CODE	DWG NO.	REV
B			2
SCALE		SHEET	

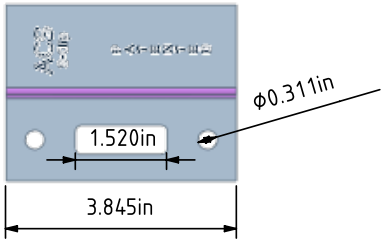
REVISION HISTORY

REV	DESCRIPTION	INCORP BY	DATE	CHECKED

NOTES:







-2 QTY REQD	-1 ITEM NO.	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION

PARTS LIST

INIT	APPROVALS	DATE	INIT	APPROVALS	DATE

	CONTRACT NO.	MATERIAL
		FINISH
THIRD ANGLE PROJECTION		TREATMENT
	NEXT ASSY / USED ON	SIMILAR TO
	APPLICATION	

ACS Composite Systems

TITLE: 8in Solid Clip

SIZE	CAGE CODE	DWG NO.	REV
B			2
SCALE		SHEET	

APPENDIX B:
MODELLING PARAMETERS AND ASSUMPTIONS

1. GENERAL MODELLING APPROACH

For this report, a steady-state conduction model was used. The following parameters were also assumed:

- Material properties were taken from information provided by Soprema Inc., ACS Composite Systems Inc., and ASHRAE Handbook – Fundamentals for common materials.
- Enclosed air spaces were modelled with an equivalent thermal conductivity of the air that includes the impacts of convection and radiation within the enclosure. Calculations for this equivalent conductivity were based on ISO 10077.
- Interior/exterior air films were taken from Table 10, p. 26.21 of 2017 ASHRAE Handbook – Fundamentals depending on surface orientation. The exterior air films were based on an exterior wind speed of 15 mph.
- In ASHRAE 1365-RP, for rain screen cavity systems, most lightweight claddings have an insignificant impact on the thermal performance other than shielding the insulation from direct wind exposure. The cladding and secondary structure outboard of the clip system were not explicitly modelled, but were incorporated into the exterior film coefficient.
- From the calibration in 1365-RP, contact resistances between materials were modelled and varied between R-0.01 and R-0.2 depending on the materials and interfaces.
- Insulation and other components were considered tight to adjacent interfaces.
- The clear field transmittances included in this analysis include uniform thermal bridges such as studs, clips, and girts.

2. TEMPERATURE INDEX

The temperature index is the ratio of the surface temperature relative to the interior and exterior temperatures. The temperature index has a value between 0 and 1, where 0 is the exterior temperature and 1 is the interior temperature. If T_i is known, Equation 1 can be rearranged for $T_{surface}$. This arrangement allows the modelled surface temperatures to be applicable to any climate.

$$T_i = \frac{T_{surface} - T_{outside}}{T_{inside} - T_{outside}} \qquad \text{EQ 1}$$

Note, these indices shown in the temperature profiles for this analysis are for general information only and are not intended to predict in-service surface temperatures subject to transient conditions, variable heating systems, and/ or interior obstructions that restrict heating of the assembly. For full limitations of this modeling approach, see ASHRAE 1365-RP.

3. BOUNDARY CONDITIONS

Table B3.1: Boundary Conditions

Boundary Location	Combined Convective and Radiation Heat Transfer Coefficient BTU/h ft^2 ^{o}F (W/m^{2}K)
Exterior Wall Surfaces with Generic Cladding	1.5 (8.3)
Interior Walls	1.5 (8.3)

APPENDIX C:
MATERIAL PROPERTIES

1. ACS-S THERMAL CLIP WITH SOPRA-XPS 20 EXTERIOR INSULATION: SPLIT INSULATED 2X4 WOOD FRAME WALL ASSEMBLIES

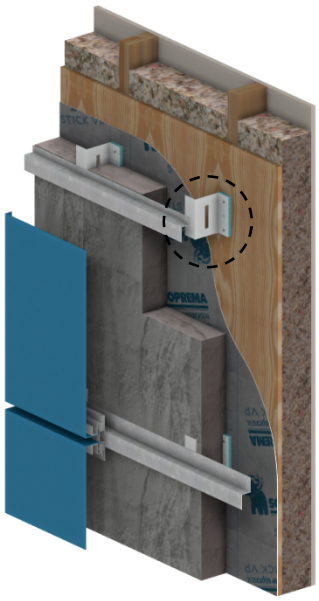
Vertical Girt: ACS Clip Detail

Horizontal Girt: ACS Clip Detail

Component	Material	Thickness in (mm)	Thermal Conductivity Btu in / ft² hr °F (W/m K)	Nominal Resistance ft² hr °F / Btu (m² K/W)
Interior Film	-	-	-	R-0.7 (0.12 RSI)
Gypsum	Gypsum	1/2 (13)	1.1 (0.16)	R-0.5 (0.08 RSI)
Stud Cavity	R-13 Cellulose Insulation	3-1/2 (89)	0.3 (0.04)	R-13.0 (2.29 RSI)
2x4 Wood Stud	Wood	3-1/2 (89)	0.69 (0.10)	-
Sheathing	Plywood	1/2 (13)	0.69 (0.10)	R-0.7 (0.13 RSI)
SOPREMA SOPRASEAL STICK VP membrane	-	-	-	-
Exterior Insulation	SOPRA-XPS 20	Varies	0.20 (0.029)	R-5.0 to R-35.0 (0.88 to 6.16 RSI)
ACS-S Thermal Clip	Stainless Steel	16 ga.	118 (17)	-
Extreme Pad	Rigid Urethane Foam	1/2 (13)	0.13 (0.019)	-
ACS Clip-Fasteners	Steel	1/4" (6.4) Ø	347 (50)	-
Vertical Girt	Galvanized Steel	18 ga.	430 (62)	-
Air Spaces[1]	Air	Varies	Varies	-
Exterior Film	-	-	-	R-0.7 (0.12 RSI)
Overall Wall Assembly 1D	-	-	-	R-20.5 to R-50.5 (3.62 to 8.90 RSI)

[1] The thermal conductivities of the air spaces were determined according to ISO 10077-2

2. ACS-S THERMAL CLIP WITH SOPRA-SPF 202 EXTERIOR INSULATION: SPLIT INSULATED 2X4 WOOD FRAME WALL ASSEMBLIES



Vertical Girt: ACS Clip Detail

Horizontal Girt: ACS Clip Detail

Component	Material	Thickness in (mm)	Thermal Conductivity Btu in / ft² hr °F (W/m K)	Nominal Resistance ft² hr °F / Btu (m² K/W)
Interior Film	-	-	-	R-0.7 (0.12 RSI)
Gypsum	Gypsum	1/2 (13)	1.1 (0.16)	R-0.5 (0.08 RSI)
Stud Cavity	R-13 Cellulose Insulation	3-1/2 (89)	0.3 (0.04)	R-13.0 (2.29 RSI)
2x4 Wood Stud	Wood	3-1/2 (89)	0.69 (0.10)	-
Sheathing	Plywood	1/2 (13)	0.69 (0.10)	R-0.7 (0.13 RSI)
SOPREMA SOPRASEAL STICK VP membrane	-	-	-	-
Exterior Insulation	SOPRA-SPF 202	Varies	0.16 (0.023)	R-6.2 to R-43.4 (1.09 to 7.64 RSI)
ACS-S Thermal Clip	Stainless Steel	16 ga.	118 (17)	-
Extreme Pad	Rigid Urethane Foam	1/2 (13)	0.13 (0.019)	-
ACS Clip-Fasteners	Steel	1/4" (6.4) Ø	347 (50)	-
Vertical Girt	Galvanized Steel	18 ga.	430 (62)	-
Air Spaces[1]	Air	Varies	Varies	-
Exterior Film	-	-	-	R-0.7 (0.12 RSI)
Overall Wall Assembly 1D	-	-	-	R-21.7 to R-58.9 (3.83 to 10.38 RSI)

[1] The thermal conductivities of the air spaces were determined according to ISO 10077-2

3. ACS-S THERMAL CLIP WITH SOPRA-ISO V PLUS EXTERIOR INSULATION: SPLIT INSULATED 2X4 WOOD FRAME WALL ASSEMBLIES

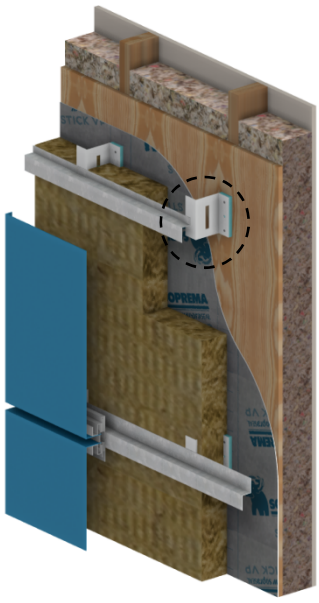
Vertical Girt: ACS Clip Detail

Horizontal Girt: ACS Clip Detail

Component	Material	Thickness in (mm)	Thermal Conductivity Btu in / ft² hr °F (W/m K)	Nominal Resistance ft² hr °F / Btu (m² K/W)
Interior Film	-	-	-	R-0.7 (0.12 RSI)
Gypsum	Gypsum	1/2 (13)	1.1 (0.16)	R-0.5 (0.08 RSI)
Stud Cavity	R-13 Cellulose Insulation	3-1/2 (89)	0.3 (0.04)	R-13.0 (2.29 RSI)
2x4 Wood Stud	Wood	3-1/2 (89)	0.69 (0.10)	-
Sheathing	Plywood	1/2 (13)	0.69 (0.10)	R-0.7 (0.13 RSI)
SOPREMA SOPRASEAL STICK VP membrane	-	-	-	-
Exterior Insulation	SOPRA-ISO V PLUS	Varies	0.17 (0.024)	R-6.0 to R-42.0 (1.06 to 7.40 RSI)
ACS-S Thermal Clip	Stainless Steel	16 ga.	118 (17)	-
Extreme Pad	Rigid Urethane Foam	1/2 (13)	0.13 (0.019)	-
ACS Clip-Fasteners	Steel	1/4" (6.4) Ø	347 (50)	-
Vertical Girt	Galvanized Steel	18 ga.	430 (62)	-
Air Spaces[1]	Air	Varies	Varies	-
Exterior Film	-	-	-	R-0.7 (0.12 RSI)
Overall Wall Assembly 1D	-	-	-	R-21.5 to R-57.5 (3.79 to 10.13 RSI)

[1] The thermal conductivities of the air spaces were determined according to ISO 10077-2

4. ACS-S THERMAL CLIP WITH MINERAL WOOL EXTERIOR INSULATION: SPLIT INSULATED 2X4 WOOD FRAME WALL ASSEMBLIES



Vertical Girt: ACS Clip Detail

Horizontal Girt: ACS Clip Detail

Component	Material	Thickness in (mm)	Thermal Conductivity Btu in / ft² hr °F (W/m K)	Nominal Resistance ft² hr °F / Btu (m² K/W)
Interior Film	-	-	-	R-0.7 (0.12 RSI)
Gypsum	Gypsum	1/2 (13)	1.1 (0.16)	R-0.5 (0.08 RSI)
Stud Cavity	R-13 Cellulose Insulation	3-1/2 (89)	0.3 (0.04)	R-13.0 (2.29 RSI)
2x4 Wood Stud	Wood	3-1/2 (89)	0.69 (0.10)	-
Sheathing	Plywood	1/2 (13)	0.69 (0.10)	R-0.7 (0.13 RSI)
SOPREMA SOPRASEAL STICK VP membrane	-	-	-	-
Exterior Insulation	Mineral Wool	Varies	0.23 (0.034)	R-4.3 to R-34.4 (0.76 to 6.06 RSI)
ACS-S Thermal Clip	Stainless Steel	16 ga.	118 (17)	-
Extreme Pad	Rigid Urethane Foam	1/2 (13)	0.13 (0.019)	-
ACS Clip-Fasteners	Steel	1/4" (6.4) Ø	347 (50)	-
Vertical Girt	Galvanized Steel	18 ga.	430 (62)	-
Air Spaces[1]	Air	Varies	Varies	-
Exterior Film	-	-	-	R-0.7 (0.12 RSI)
Overall Wall Assembly 1D	-	-	-	R-19.8 to R-49.9 (3.49 to 8.80 RSI)

[1] The thermal conductivities of the air spaces were determined according to ISO 10077-2

APPENDIX D:
SIMULATED TEMPERATURE PROFILES

As an example of the thermal profiles of the ACS-S Thermal Clip system with a split insulated 2x4 wood frame wall assembly, the following figures illustrate a typical temperature distribution for the 3 inch ACS-S Thermal Clip with 3 inches of exterior insulation and 16 inches o.c. horizontal and 24 inches o.c. vertical clip spacing. The profiles are presented as a temperature index (between 0 and 1). See Appendix B.2 for more information.

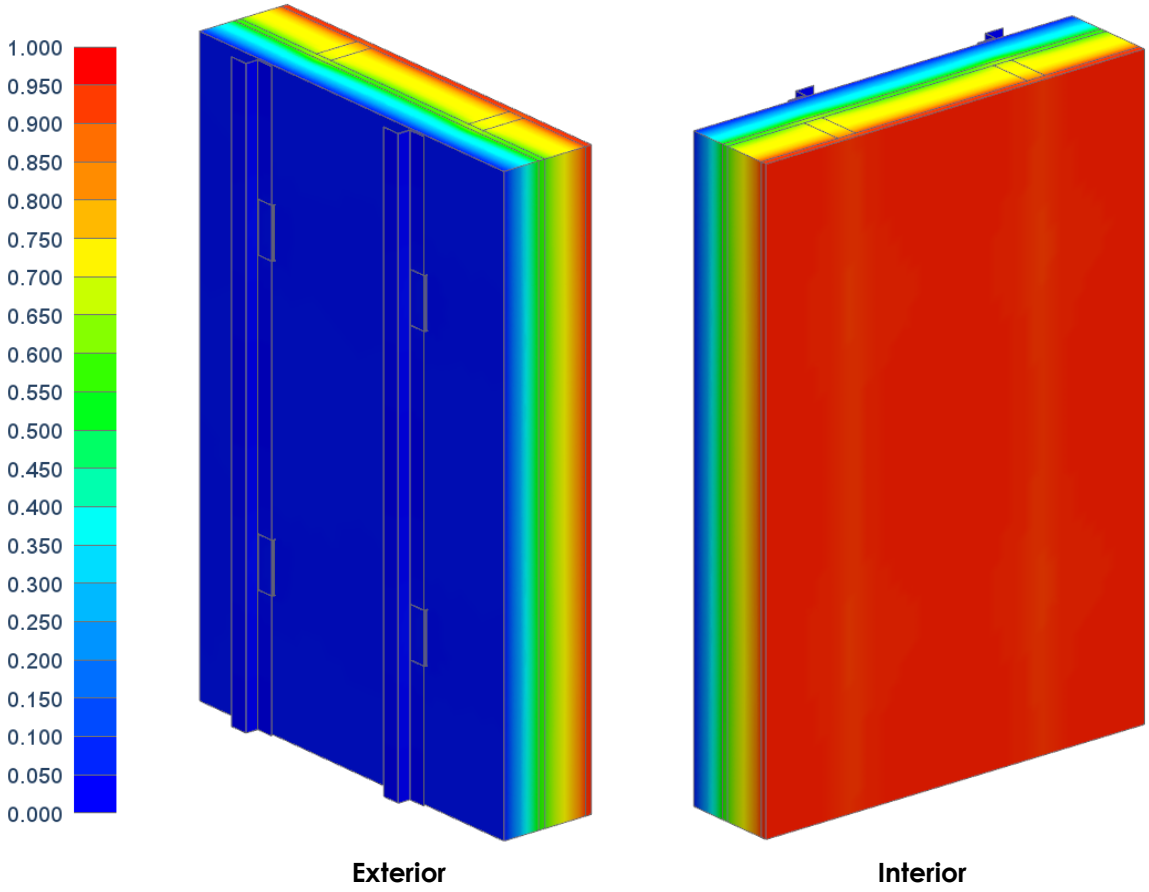


Figure D1: Temperature Profile of ACS-S Thermal Clip with **SOPRA-XPS 20** Exterior Insulation: Split Insulated 2x4 Wood Frame Assembly

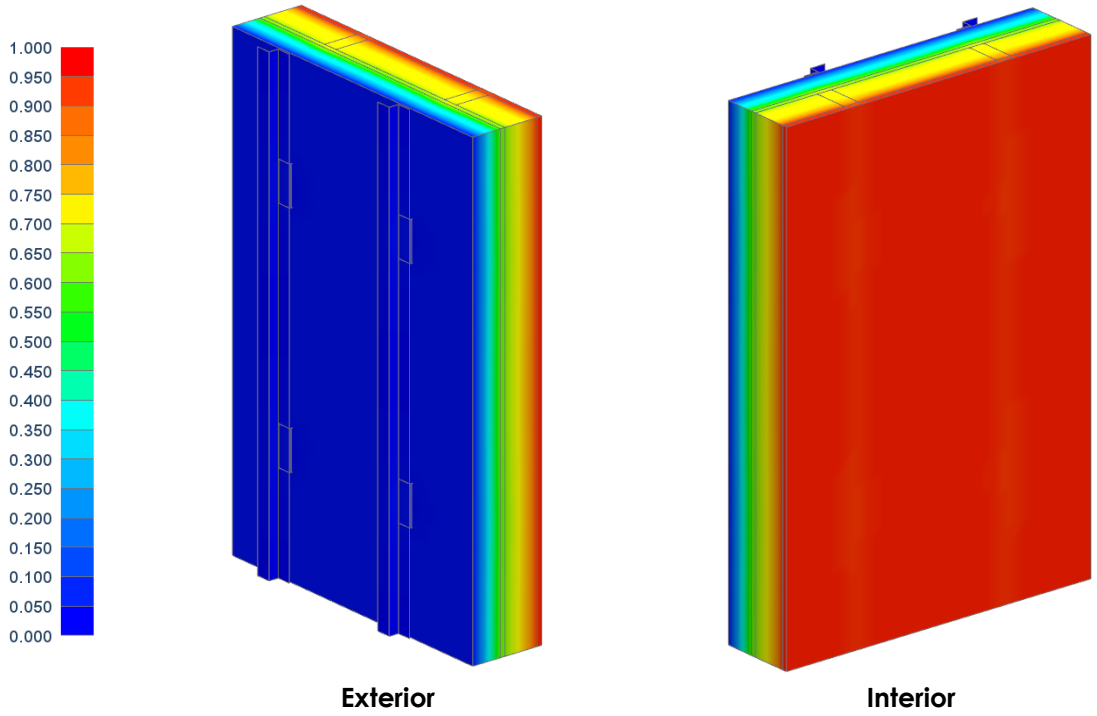


Figure D2: Temperature Profile of ACS-S Thermal Clip with **SOPRA-SPF 202** Exterior Insulation: Split Insulated 2x4 Wood Frame Wall Assembly

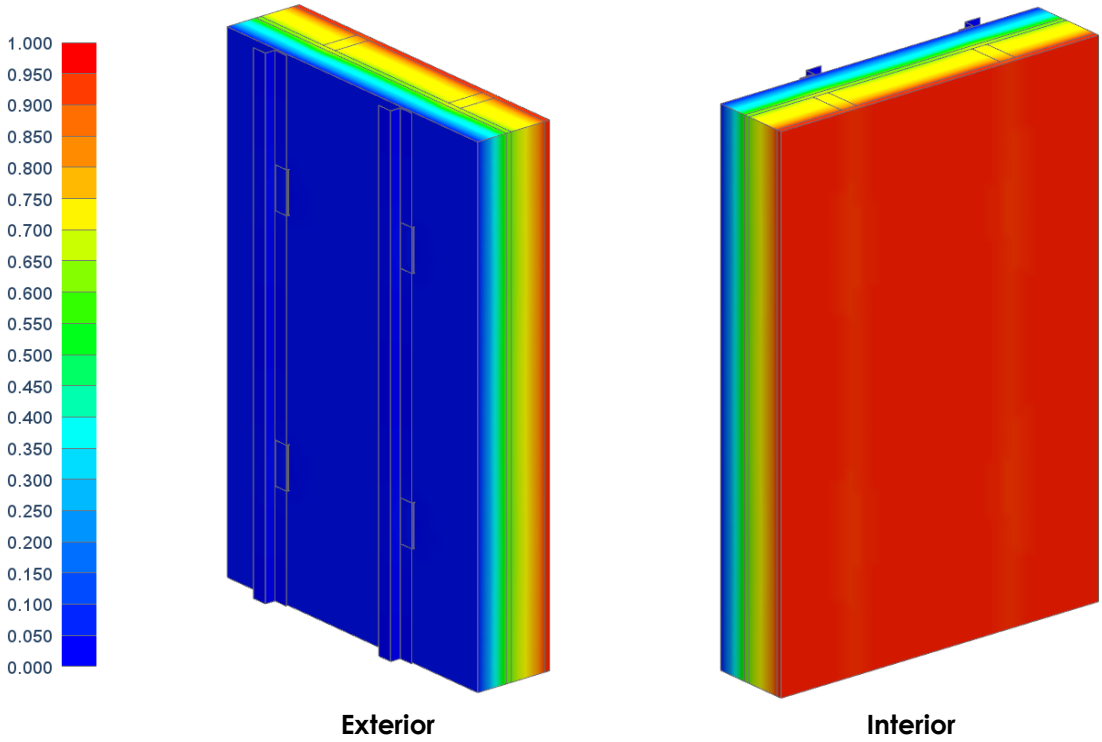


Figure D3: Temperature Profile of ACS-S Thermal Clip with **SOPRA-ISO V PLUS** Exterior Insulation: Split Insulated 2x4 Wood Frame Wall Assembly

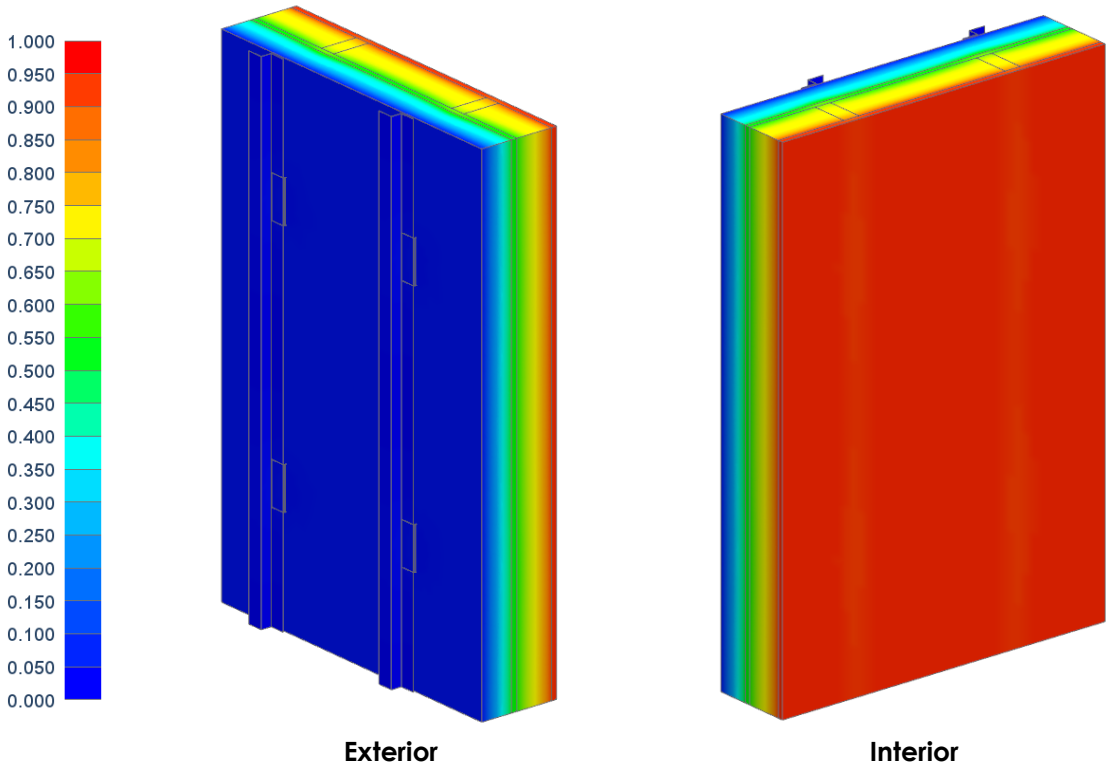


Figure D4: Temperature Profile of ACS-S Thermal Clip with **Mineral Wool** Exterior Insulation: Split Insulated 2x4 Wood Frame Wall Assembly