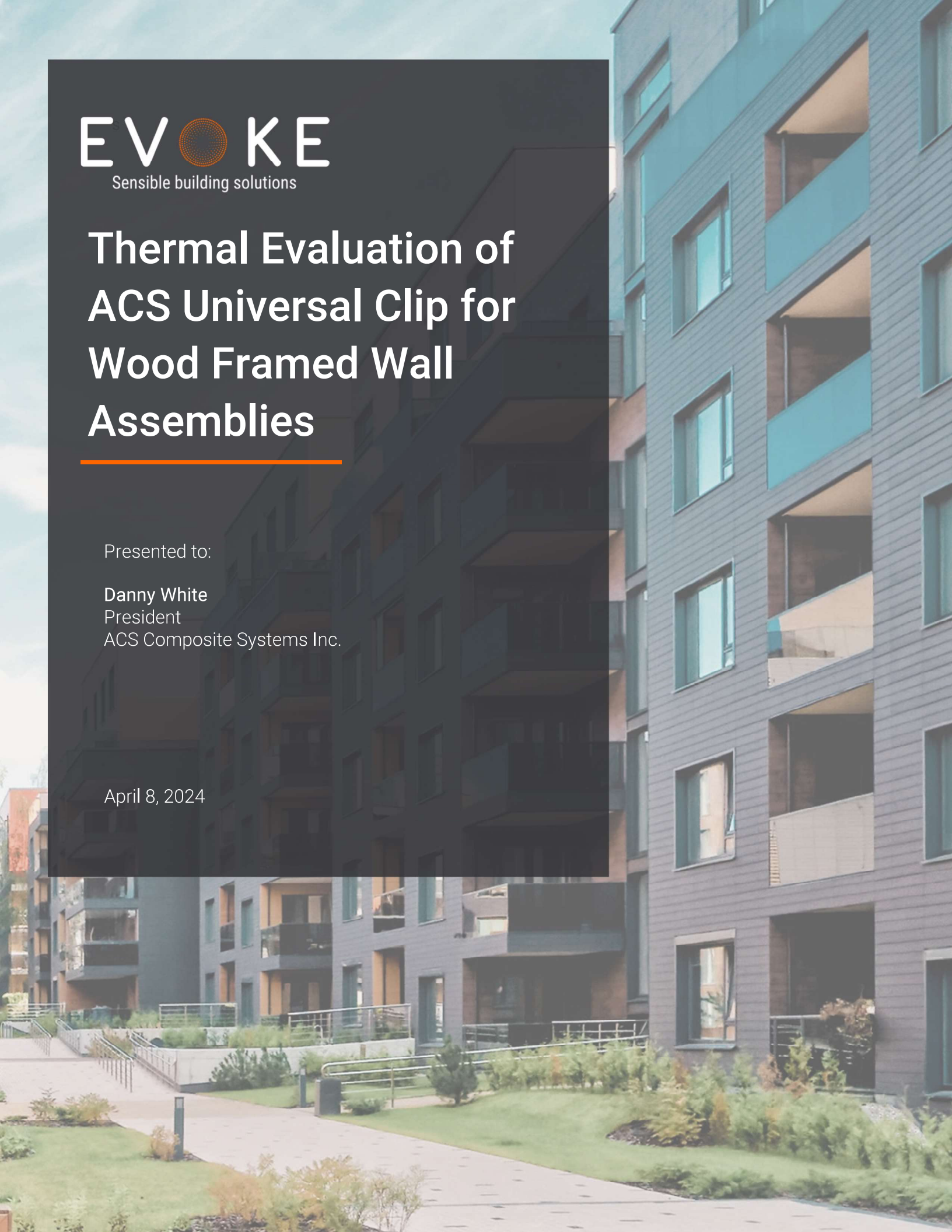


EVOKE
Sensible building solutions

Thermal Evaluation of ACS Universal Clip for Wood Framed Wall Assemblies

Presented to:

Danny White
President
ACS Composite Systems Inc.

April 8, 2024

Contents

Introduction

Evoke Buildings Engineering Inc. (Evoke) was contracted by ACS Composite Systems Inc. for the thermal evaluation of the ACS U-Clip™ system for 2 x 6 wood-framed wall assemblies for 2 to 6 inches of exterior mineral wool insulation and R-22 batt insulation in the stud cavity. Figure 1 provides more details.

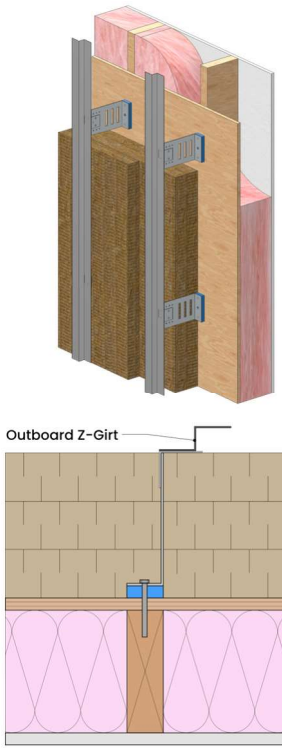
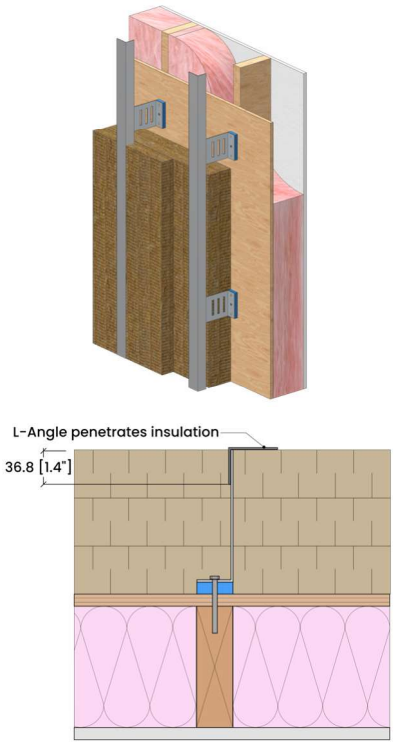
	
Cladding with rainscreen cavity (not shown)	Cladding with rainscreen cavity (not shown)
18-gauge galvanized steel vertical Z-bar (1 ½" x 1" x 1 ½") outboard of insulation	18-gauge galvanized steel vertical L-angle (2" x 1 ½") that penetrates the exterior insulation
16-gauge galvanized steel ACS U-Clip™ with ACS 1 ¾" x 1 ½" U-Angle™, vertical spacing varies 24" to 48"	16-gauge galvanized steel ACS U-Clip™ with ACS 1 ¾" x 1 ½" U-Angle™, vertical spacing varies 24" to 48"
½" ACS Thermal Pad (R-2.5) with 2 x #14 galvanized fasteners	½" ACS Thermal Pad (R-2.5) with 2 x #14 galvanized fasteners
2" (51 mm) to 10" (254 mm) ROCKWOOL Cavityrock (R-4.3/inch)	2" (51 mm) to 10" (254 mm) ROCKWOOL Cavityrock (R-4.3/inch)
1/2" (13 mm) plywood sheathing	1/2" (13 mm) plywood sheathing
2 X 6 wood-studs at 16" (406 mm) o.c. with R-22 Batt Insulation	2 X 6 wood-studs at 16" (406 mm) o.c. with R-22 Batt Insulation
1/2" (13 mm) gypsum wall board	1/2" (13 mm) gypsum wall board

Figure 1: **Evaluated Wood-Framed Wall Assembles with ACS U-Clip**

Methodology

The thermal simulation by Evoke was done using 3D thermal simulation using the Simcenter 3D software package from Siemens, which is a general-purpose computer aided design (CAD) and finite element analysis (FEA) package. The thermal solver and modeling procedures utilized for this evaluation were extensively calibrated and validated to within +/- 5% of hotbox testing[1,2].

The thermal analysis utilized steady-state conditions, published thermal data for materials, and information provided by ACS is listed in Appendix A. Additional assumptions for the thermal analysis are provided in Appendix B.

Simulation Results

The clear field thermal transmittances and assembly effective R-values for the galvanized steel ACS Universal Clip scenarios for split insulated wood-framed walls are presented in Table 1 and 2 below. Temperature profiles for each configuration are provided in Appendix C. Results highlighted in grey are interpolated.

Table 1. Thermal Transmittance for Split Insulated Wood-Framed Wall Assembly with Galvanized Steel ACS U-Clip with Vertical Z-Girt Outboard of Insulation

Thickness of Exterior Mineral Wool Insulation	Exterior Insulation 1D R-Value[3]	16" x 24" Clip Spacing		16" x 36" Clip Spacing		16" x 48" Clip Spacing	
		R-Value	Transmittance	R-Value	Transmittance	R-Value	Transmittance
	$ft^2 \cdot hr \cdot °F/Btu$ ($m^2 \cdot K/W$)	$ft^2 \cdot hr \cdot °F/Btu$ ($m^2 \cdot K/W$)	$Btu/ft^2 \cdot hr \cdot °F$ ($W/m^2 \cdot K$)	$ft^2 \cdot hr \cdot °F/Btu$ ($m^2 \cdot K/W$)	$Btu/ft^2 \cdot hr \cdot °F$ ($W/m^2 \cdot K$)	$ft^2 \cdot hr \cdot °F/Btu$ ($m^2 \cdot K/W$)	$Btu/ft^2 \cdot hr \cdot °F$ ($W/m^2 \cdot K$)
2" (51 mm)	8.6 (1.52)	29.1 (5.12)	0.034 (0.195)	29.6 (5.21)	0.034 (0.192)	29.8 (5.24)	0.034 (0.191)
3" (76 mm)	12.9 (2.27)	32.5 (5.72)	0.031 (0.175)	33.3 (5.86)	0.030 (0.171)	33.6 (5.92)	0.030 (0.169)
4" (102 mm)	17.2 (3.03)	35.8 (6.30)	0.028 (0.159)	36.9 (6.49)	0.027 (0.154)	37.4 (6.58)	0.027 (0.152)
5" (127 mm)	21.5 (3.79)	39.0 (6.86)	0.026 (0.146)	40.4 (7.11)	0.025 (0.141)	41.1 (7.24)	0.024 (0.138)
6" (152 mm)	25.8 (4.55)	42.0 (7.41)	0.024 (0.135)	43.8 (7.72)	0.023 (0.129)	44.7 (7.88)	0.022 (0.127)

Table 2. Thermal Transmittance for Split Insulated Wood-Framed Wall Assembly with Galvanized Steel ACS U-Clip with Vertical L-Angle Penetrating Exterior Insulation

Thickness of Exterior Mineral Wool Insulation	Exterior Insulation 1D R-Value[3]	16" x 24" Clip Spacing		16" x 36" Clip Spacing		16" x 48" Clip Spacing	
		R-Value	Transmittance	R-Value	Transmittance	R-Value	Transmittance
	$ft^2 \cdot hr \cdot °F/Btu$ ($m^2 \cdot K/W$)	$ft^2 \cdot hr \cdot °F/Btu$ ($m^2 \cdot K/W$)	$Btu/ft^2 \cdot hr \cdot °F$ ($W/m^2 \cdot K$)	$ft^2 \cdot hr \cdot °F/Btu$ ($m^2 \cdot K/W$)	$Btu/ft^2 \cdot hr \cdot °F$ ($W/m^2 \cdot K$)	$ft^2 \cdot hr \cdot °F/Btu$ ($m^2 \cdot K/W$)	$Btu/ft^2 \cdot hr \cdot °F$ ($W/m^2 \cdot K$)
2" (51 mm)	8.6 (1.52)	28.6 (5.03)	0.035 (0.199)	29.0 (5.10)	0.035 (0.196)	29.1 (5.13)	0.034 (0.195)
3" (76 mm)	12.9 (2.27)	32.0 (5.64)	0.031 (0.177)	32.7 (5.76)	0.031 (0.173)	33.0 (5.82)	0.030 (0.172)
4" (102 mm)	17.2 (3.03)	35.3 (6.21)	0.028 (0.161)	36.4 (6.40)	0.028 (0.156)	36.8 (6.48)	0.027 (0.154)
5" (127 mm)	21.5 (3.79)	38.5 (6.77)	0.026 (0.148)	39.9 (7.03)	0.025 (0.142)	40.5 (7.14)	0.025 (0.140)
6" (152 mm)	25.8 (4.55)	41.5 (7.31)	0.024 (0.137)	43.3 (7.63)	0.023 (0.131)	44.1 (7.77)	0.023 (0.129)

[1] ASHARE Research Project 1365-RP, Thermal Performance of Building Envelope Details for Mid- and High-Rise Construction, 2011

[2] Building Envelope Thermal Bridging Guide, Version 1.6, 2021

[3] Exterior Insulation 1D R-Value does not include the impact of the back-up wall which adds R-24.3 to the overall nominal R-Value.

Closing

We believe that this report meets your request for our evaluation of ACS U-Clip™ system for wood-framed wall assemblies. Please do not hesitate to contact us with any questions regarding this evaluation.

Evoke Buildings Engineering Inc.

Patrick Angkiriwang
Building Science Consultant

Patrick Roppel, P.Eng.
Building Science Specialist

Appendix A: Detail Drawings

THIS SECTION REMOVED TO LIMIT SHARING OF PROPRIETARY INFORMATION

Appendix B: Simulation Assumptions and Material Properties

General Assumptions

Steady-state simulations were utilized for the thermal evaluation outlined in this report with the following assumptions:

1. Material properties were taken from the 2017 ASHARE Handbook – Fundamentals for common materials, information provided by ACS for the system components, and datasheets for proprietary products.
2. Interior and exterior heat transfer coefficients were taken from table 10 on page 26.21 of the 2017 ASHRAE Handbook – Fundamentals. Lightweight claddings have an insignificant impact on the overall thermal resistance of insulated wall assemblies, other than shielding the insulation or sheathing from direct wind exposure. The cladding and secondary structure outboard of the sheathing were not explicitly modeled. The impact of lightweight cladding was incorporated into the exterior heat transfer coefficient per ASHRAE 1365-RP and CSA Z5010:21 so that the results can directly apply to any climate.
3. Contact resistances between the sheathing and insulation and steel components were simulated per ASHRAE 1365-RP and CSA Z5010:21 and varied between R-0.01 (0.002 m^2 K/W) and R-0.17 (0.030 m^2 K/W) depending on the materials and interfaces.
4. Insulation is assumed to be installed tight to the framing and sheathing.

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 per the following equation:

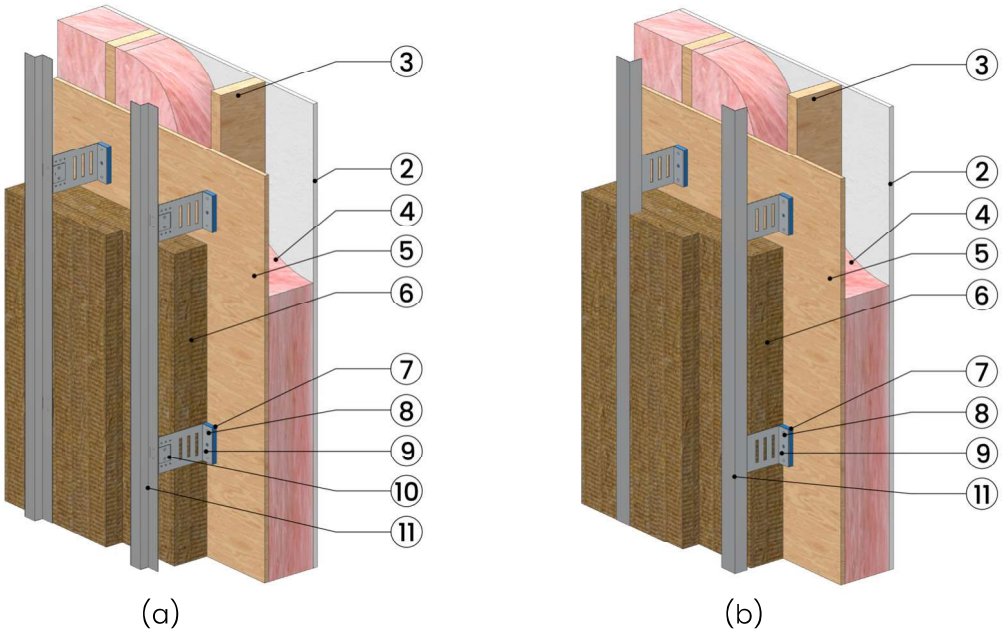
$$T_i = \frac{T_{suface} - T_{outside}}{T_{inside} - T_{outside}}$$

This formula can be rearranged for $T_{surface}$ to determine the surface temperatures for any climate once the temperature index is known for a critical location to evaluate the condensation risk. The temperature indices shown in the temperature profiles in Appendix C are for general information and not intended to predict in-service temperatures subject to transient conditions, variable heating systems, and/or obstructions that restrict heat getting to the wall system. Refer to ASHRAE 1365-RP for a full discussion on the limitations of using steady-state temperature indices for evaluating condensation risk.

Boundary Conditions

Boundary Condition	Combined Convective and Radiative Heat Transfer Coefficient Btu/ft²· hr·°F (W/m² K)
Exterior wall surface with generic cladding	1.5 (8.3)
Interior surface	1.5 (8.3)

Material Properties



Item	Component	Material	Thermal Conductivity Btu · in/ft² · hr·°F (W/m K)
		Backup Wall	
2	Gypsum Wall Board	Gypsum	1.1 (0.16)
3	Wood Studs	Wood	69.4 (10)
4	Cavity Insulation	R-22 Batt Insulation	0.25 (0.036)
5	Exterior Sheathing	Wood	69.4 (10)
		Exterior Wall	
6	Exterior Insulation	ROCKWOOL Cavityrock	0.23 (0.0335)
7	ACS Thermal Pad	High-Density Polyiso	0.20 (0.0288)
8	Fasteners	Galvanized Steel	430 (62)
9	ACS U-Clip™	Galvanised Steel	430 (62)
10	ACS U-Angle™	Galvanized Steel	430 (62)
11a	Z-bar	Galvanized Steel	430 (62)
11b	L-Angle	Galvanized Steel	430 (62)

Appendix C: Simulated Temperature Profiles

Appendix C illustrates example temperature distribution of the 6-inch galvanized steel ACS Universal Clip system across a split insulated backup wall assembly. The following figures are provided for scenarios with a clip spacing of 16" x 24", vertical girts and 6 inches of exterior insulation. The profiles are presented as a temperature index (between 0 and 1). See Appendix B for more discussion on temperature index.

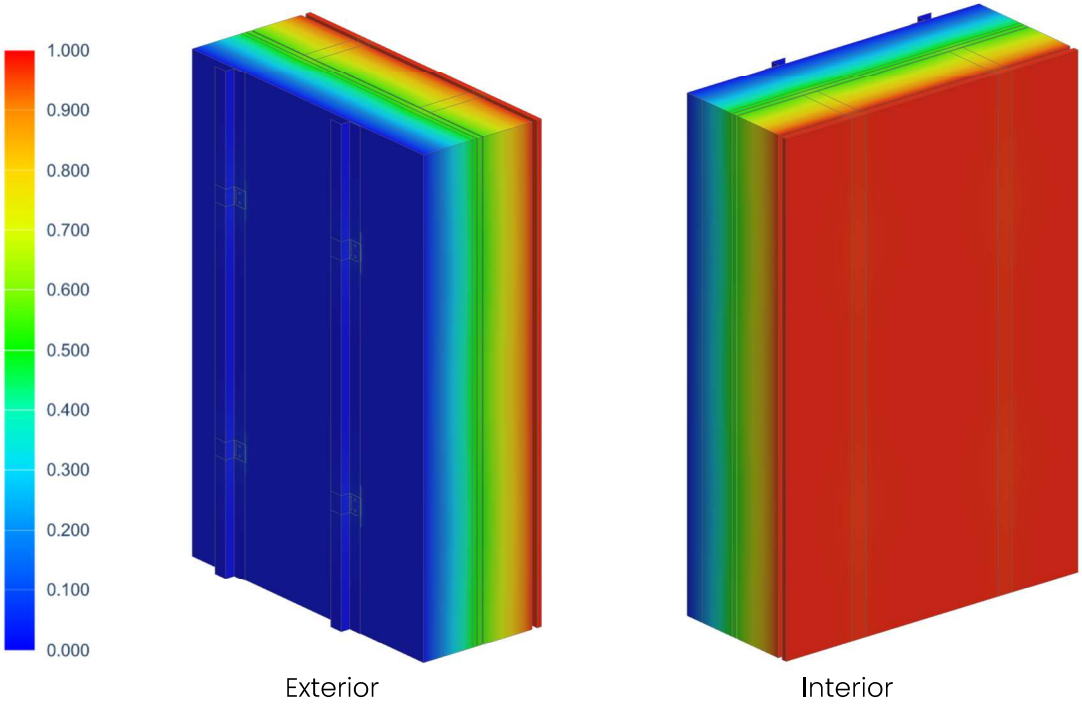


Figure C1. Temperature Profile of the 6-inch ACS U-Clip Spaced at 16"x 24" with Vertical Z-Girts

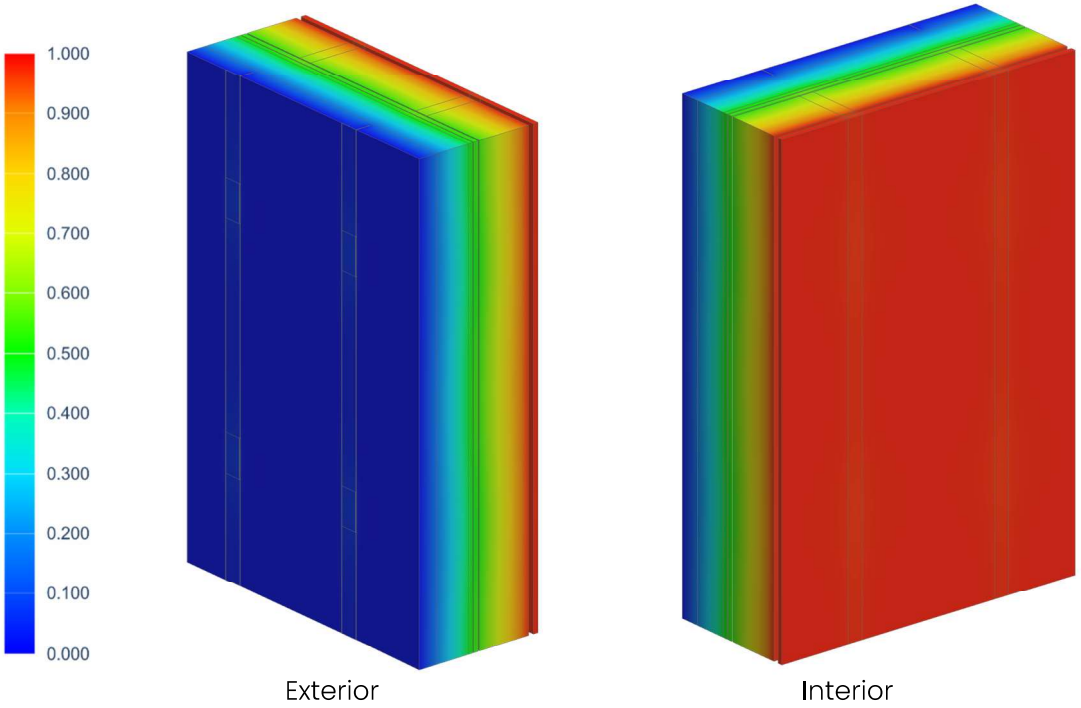


Figure C2. Temperature Profile of the 6-inch ACS U-Clip Spaced at 16"x 24" o.c. with Vertical L-Angle