



MORRISON HERSHFIELD

# SOPREMA / ACS Composite Systems CMU 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

Report Number: 203501500  
February 25, 2021

# TABLE OF CONTENTS

	<b>Page</b>
1. INTRODUCTION	1
2. MODELLING PROCEDURES	3
3. THERMAL RESULTS	4

APPENDIX A: DETAIL DRAWINGS

APPENDIX B: MODELLING PARAMETERS AND ASSUMPTIONS

APPENDIX C: BUILDING ENVELOPE THERMAL BRIDGING GUIDE DATA SHEETS

APPENDIX D: BUILDING ENVELOPE THERMAL BRIDGING GUIDE RESULT SHEETS



# 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 the CMU 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)

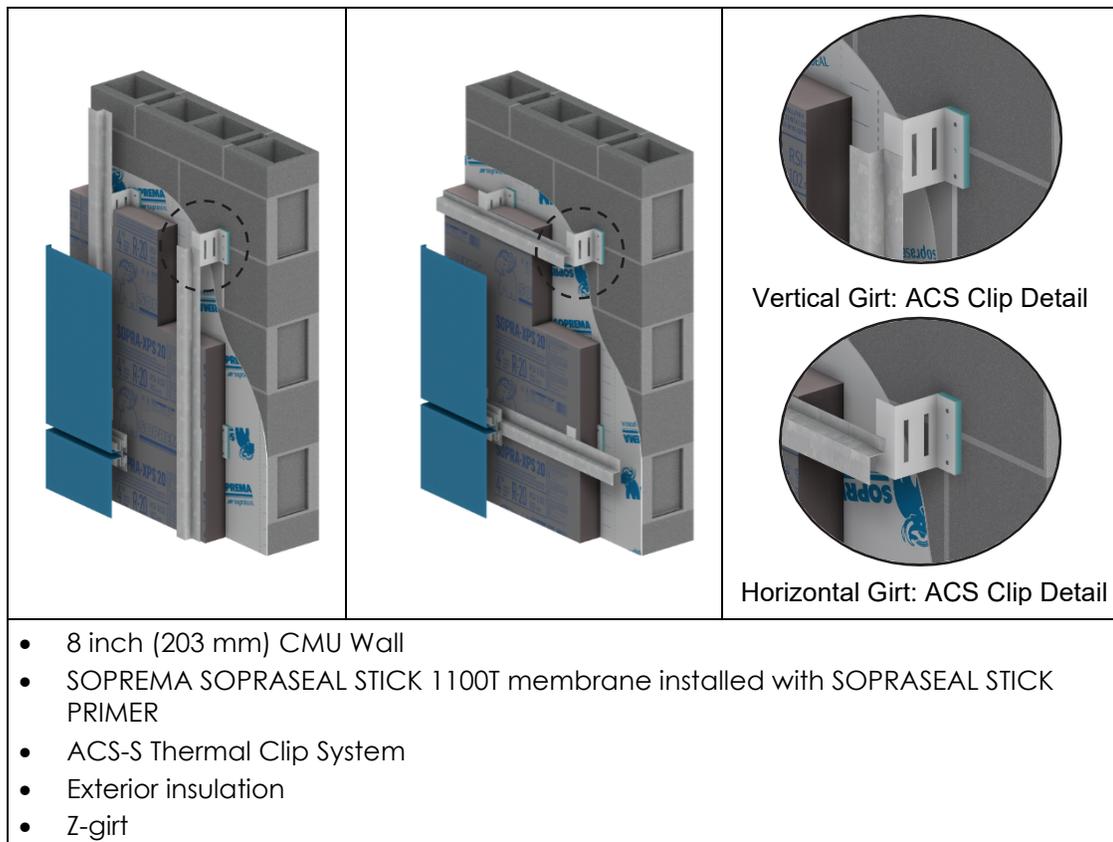
Table 1.2 below summarizes the evaluated wall configurations, and Figure 1.1 illustrates a representative wall assembly using SOPRA-XPS 20 exterior insulation. The geometry of the ACS-S Thermal Clips were based on the drawings provided by ACS Composite Systems Inc. and Soprema, and are provided in Appendix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

**Table 1.2:** Evaluated ACS-S Thermal Clip Assemblies: CMU 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	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	16, 24	16, 24	24, 36, 48
SOPRA-ISO V ALU	R-6.5/in	1, 2*, 2.5*, 3, 3.5*, 4, 4.5*, 5, 5.5*, 6	16, 24	16, 24	24, 36, 48
Mineral Wool	R-4.3/in	3, 4*, 5, 6, 7, 8	16, 24	16, 24	24, 36, 48

\*Indicates interpolated value





**Figure 1.1:** Schematic of Evaluated ACS-S Thermal Clip with CMU Wall 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*<sup>1</sup>. 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 are shown in the BETB Data Sheets 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 the BETB Result Sheets provided in Appendix D.

**Table 3.1:** U-Value and Effective R-Value for ACS-S Thermal Clip with **SOPRA-XPS 20**  
Exterior Insulation: CMU Wall Assemblies

Horizontal Clip Spacing	Exterior Insulation Thickness in (mm)	Exterior Insulation 1D R-value <sup>2</sup> (RSI)	24" Vertical Spacing		36" Vertical Spacing		48" Vertical Spacing	
			R <sub>o</sub>	U <sub>o</sub>	R <sub>o</sub>	U <sub>o</sub>	R <sub>o</sub>	U <sub>o</sub>
			ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	Btu/ft <sup>2</sup> ·hr ·°F (W/m <sup>2</sup> K)	ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	Btu/ft <sup>2</sup> ·hr ·°F (W/m <sup>2</sup> K)	ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	Btu/ft <sup>2</sup> ·hr ·°F (W/m <sup>2</sup> K)
16	3.0 (76)	R-15.0 (2.64)	R-16.7 (2.94)	0.060 (0.34)	R-17.0 (2.99)	0.059 (0.33)	R-17.1 (3.02)	0.058 (0.33)
	4.0 (102)	R-20.0 (3.52)	R-21.1 (3.71)	0.047 (0.27)	R-21.6 (3.80)	0.046 (0.26)	R-21.8 (3.85)	0.046 (0.26)
	5.0 (127)	R-25.0 (4.40)	R-25.3 (4.46)	0.039 (0.22)	R-26.0 (4.59)	0.038 (0.22)	R-26.5 (4.66)	0.038 (0.21)
	6.0 (152)	R-30.0 (5.28)	R-29.6 (5.22)	0.034 (0.19)	R-30.6 (5.39)	0.033 (0.19)	R-31.1 (5.48)	0.032 (0.18)
	7.0 (178)	R-35.0 (6.16)	R-33.8 (5.94)	0.030 (0.17)	R-34.9 (6.16)	0.029 (0.16)	R-35.6 (6.27)	0.028 (0.16)
24	3.0 (76)	R-15.0 (2.64)	R-17.0 (2.99)	0.059 (0.33)	R-17.2 (3.03)	0.058 (0.33)	R-17.3 (3.05)	0.058 (0.33)
	4.0 (102)	R-20.0 (3.52)	R-21.6 (3.80)	0.046 (0.26)	R-21.9 (3.86)	0.046 (0.26)	R-22.1 (3.89)	0.045 (0.26)
	5.0 (127)	R-25.0 (4.40)	R-26.0 (4.59)	0.038 (0.22)	R-26.6 (4.68)	0.038 (0.21)	R-26.8 (4.72)	0.037 (0.21)
	6.0 (152)	R-30.0 (5.28)	R-30.6 (5.39)	0.033 (0.19)	R-31.2 (5.50)	0.032 (0.18)	R-31.6 (5.57)	0.032 (0.18)
	7.0 (178)	R-35.0 (6.16)	R-35.0 (6.16)	0.029 (0.16)	R-35.8 (6.30)	0.028 (0.16)	R-36.2 (6.38)	0.028 (0.16)

**Table 3.2:** U-Value and Effective R-Value for ACS-S Thermal Clip with **SOPRA-SPF 202**  
Exterior Insulation: CMU Wall Assemblies

Horizontal Clip Spacing	Exterior Insulation Thickness in (mm)	Exterior Insulation 1D R-value <sup>2</sup> (RSI)	24" Vertical Spacing		36" Vertical Spacing		48" Vertical Spacing	
			R <sub>o</sub>	U <sub>o</sub>	R <sub>o</sub>	U <sub>o</sub>	R <sub>o</sub>	U <sub>o</sub>
			ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	Btu/ft <sup>2</sup> ·hr ·°F (W/m <sup>2</sup> K)	ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	Btu/ft <sup>2</sup> ·hr ·°F (W/m <sup>2</sup> K)	ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	Btu/ft <sup>2</sup> ·hr ·°F (W/m <sup>2</sup> K)
16	1.0 (25)	R-6.2 (1.09)	R-8.7 (1.53)	0.115 (0.65)	R-8.7 (1.54)	0.115 (0.65)	R-8.7 (1.54)	0.115 (0.65)
	2.0 (51)	R-12.4 (2.18)	R-14.3 (2.52)*	0.070 (0.40)*	R-14.5 (2.56)*	0.069 (0.39)*	R-14.6 (2.57)*	0.068 (0.39)*
	3.0 (76)	R-18.6 (3.28)	R-19.8 (3.49)	0.051 (0.29)	R-20.2 (3.56)	0.049 (0.28)	R-20.5 (3.60)	0.049 (0.28)
	4.0 (102)	R-24.8 (4.37)	R-25.1 (4.42)	0.040 (0.23)	R-25.8 (4.55)	0.039 (0.22)	R-26.2 (4.61)	0.038 (0.22)
	5.0 (127)	R-31.0 (5.46)	R-30.2 (5.32)	0.033 (0.19)	R-31.2 (5.50)	0.032 (0.18)	R-31.8 (5.61)	0.031 (0.18)
	6.0 (152)	R-37.2 (6.55)	R-35.4 (6.23)	0.028 (0.16)	R-36.7 (6.47)	0.027 (0.15)	R-37.5 (6.60)	0.027 (0.15)
24	1.0 (25)	R-6.2 (1.09)	R-8.7 (1.53)	0.115 (0.65)	R-8.7 (1.54)	0.114 (0.65)	R-8.7 (1.54)	0.114 (0.65)
	2.0 (51)	R-12.4 (2.18)	R-14.5 (2.56)*	0.069 (0.39)*	R-14.7 (2.58)*	0.068 (0.39)*	R-14.7 (2.59)*	0.068 (0.39)*
	3.0 (76)	R-18.6 (3.28)	R-20.2 (3.56)	0.049 (0.28)	R-20.5 (3.62)	0.049 (0.28)	R-20.7 (3.64)	0.048 (0.27)
	4.0 (102)	R-24.8 (4.37)	R-25.8 (4.55)	0.039 (0.22)	R-26.3 (4.63)	0.038 (0.22)	R-26.6 (4.68)	0.038 (0.21)
	5.0 (127)	R-31.0 (5.46)	R-31.2 (5.50)	0.032 (0.18)	R-32.0 (5.63)	0.031 (0.18)	R-32.4 (5.70)	0.031 (0.18)
	6.0 (152)	R-37.2 (6.55)	R-36.7 (6.47)	0.027 (0.15)	R-37.7 (6.64)	0.027 (0.15)	R-38.2 (6.73)	0.026 (0.15)

\*Indicates interpolated value

<sup>2</sup> This value is the nominal R-value of the exterior insulation ONLY. Additional components, such as the CMU wall and air films all contribute an additional R-2.9 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  
ALU Exterior Insulation: CMU Wall Assemblies**

Horizontal Clip Spacing	Exterior Insulation Thickness in (mm)	Exterior Insulation 1D R-value <sup>3</sup> (RSI)	24" Vertical Spacing		36" Vertical Spacing		48" Vertical Spacing	
			R <sub>o</sub>	U <sub>o</sub>	R <sub>o</sub>	U <sub>o</sub>	R <sub>o</sub>	U <sub>o</sub>
			ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	Btu/ft <sup>2</sup> ·hr ·°F (W/m <sup>2</sup> K)	ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	Btu/ft <sup>2</sup> ·hr ·°F (W/m <sup>2</sup> K)	ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	Btu/ft <sup>2</sup> ·hr ·°F (W/m <sup>2</sup> K)
16	1.0 (25)	R-6.5 (1.14)	R-9.0 (1.59)	0.111 (0.63)	R-9.1 (1.60)	0.110 (0.63)	R-9.1 (1.60)	0.110 (0.63)
	2.0 (51)	R-13.0 (2.29)	R-14.9 (2.62)*	0.067 (0.38)*	R-15.1 (2.66)*	0.066 (0.38)*	R-15.2 (2.68)*	0.066 (0.37)*
	2.5 (64)	R-16.3 (2.86)	R-17.8 (3.13)*	0.056 (0.32)*	R-18.1 (3.19)*	0.055 (0.31)*	R-18.3 (3.22)*	0.055 (0.31)*
	3.0 (76)	R-19.5 (3.43)	R-20.6 (3.63)	0.048 (0.28)	R-21.1 (3.72)	0.047 (0.27)	R-21.3 (3.76)	0.047 (0.27)
	3.5 (89)	R-22.8 (4.01)	R-23.4 (4.12)*	0.043 (0.24)*	R-24.0 (4.23)*	0.042 (0.24)*	R-24.3 (4.29)*	0.041 (0.23)*
	4.0 (102)	R-26.0 (4.58)	R-26.2 (4.61)	0.038 (0.22)	R-26.9 (4.75)	0.037 (0.21)	R-27.4 (4.82)	0.037 (0.21)
	4.5 (114)	R-29.3 (5.15)	R-28.9 (5.09)*	0.035 (0.20)*	R-29.8 (5.25)*	0.034 (0.19)*	R-30.3 (5.34)*	0.033 (0.19)*
	5.0 (127)	R-32.5 (5.72)	R-31.5 (5.55)	0.032 (0.18)	R-32.6 (5.75)	0.031 (0.17)	R-33.3 (5.86)	0.030 (0.17)
	5.5 (140)	R-35.8 (6.30)	R-34.3 (6.03)*	0.029 (0.17)*	R-35.5 (6.26)*	0.028 (0.16)*	R-36.2 (6.38)*	0.028 (0.16)*
	6.0 (152)	R-39.0 (6.87)	R-36.9 (6.50)	0.027 (0.15)	R-38.4 (6.76)	0.026 (0.15)	R-39.2 (6.90)	0.026 (0.14)
24	1.0 (25)	R-6.5 (1.14)	R-9.1 (1.59)	0.110 (0.63)	R-9.1 (1.60)	0.110 (0.63)	R-9.1 (1.60)	0.110 (0.63)
	2.0 (51)	R-13.0 (2.29)	R-15.1 (2.66)*	0.066 (0.38)*	R-15.3 (2.69)*	0.065 (0.37)*	R-15.4 (2.70)*	0.065 (0.37)*
	2.5 (64)	R-16.3 (2.86)	R-18.1 (3.19)*	0.055 (0.31)*	R-18.4 (3.23)*	0.054 (0.31)*	R-18.5 (3.25)*	0.054 (0.31)*
	3.0 (76)	R-19.5 (3.43)	R-21.1 (3.72)	0.047 (0.27)	R-21.4 (3.77)	0.047 (0.26)	R-21.6 (3.80)	0.046 (0.26)
	3.5 (89)	R-22.8 (4.01)	R-24.0 (4.23)*	0.042 (0.24)*	R-24.5 (4.31)*	0.041 (0.23)*	R-24.7 (4.34)*	0.041 (0.23)*
	4.0 (102)	R-26.0 (4.58)	R-27.0 (4.75)	0.037 (0.21)	R-27.5 (4.84)	0.036 (0.21)	R-27.8 (4.89)	0.036 (0.20)
	4.5 (114)	R-29.3 (5.15)	R-29.8 (5.25)*	0.034 (0.19)*	R-30.5 (5.37)*	0.033 (0.19)*	R-30.8 (5.43)*	0.032 (0.18)*
	5.0 (127)	R-32.5 (5.72)	R-32.6 (5.75)	0.031 (0.17)	R-33.4 (5.88)	0.030 (0.17)	R-33.8 (5.96)	0.030 (0.17)
	5.5 (140)	R-35.8 (6.30)	R-35.5 (6.26)*	0.028 (0.16)*	R-36.4 (6.41)*	0.027 (0.16)*	R-36.9 (6.50)*	0.027 (0.15)*
	6.0 (152)	R-39.0 (6.87)	R-38.4 (6.76)	0.026 (0.15)	R-39.4 (6.93)	0.025 (0.14)	R-40.0 (7.04)	0.025 (0.14)

\*Indicates interpolated value

<sup>3</sup> This value is the nominal R-value of the exterior insulation ONLY. Additional components, such as the CMU wall and air films all contribute an additional R-2.9 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: CMU Wall Assemblies

Horizontal Clip Spacing	Exterior Insulation Thickness in (mm)	Exterior Insulation 1D R-value <sup>4</sup> (RSI)	24" Vertical Spacing		36" Vertical Spacing		48" Vertical Spacing	
			R <sub>o</sub> ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	U <sub>o</sub> Btu/ft <sup>2</sup> ·hr ·°F (W/m <sup>2</sup> K)	R <sub>o</sub> ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	U <sub>o</sub> Btu/ft <sup>2</sup> ·hr ·°F (W/m <sup>2</sup> K)	R <sub>o</sub> ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	U <sub>o</sub> Btu/ft <sup>2</sup> ·hr ·°F (W/m <sup>2</sup> K)
16	3.0 (76)	R-12.9 (2.27)	R-14.8 (2.61)	0.068 (0.38)	R-15.0 (2.65)	0.067 (0.38)	R-15.2 (2.67)	0.066 (0.37)
	4.0 (102)	R-17.2 (3.03)	R-18.6 (3.28)*	0.054 (0.31)*	R-19.0 (3.34)*	0.053 (0.30)*	R-19.2 (3.38)*	0.052 (0.30)*
	5.0 (127)	R-21.5 (3.79)	R-22.4 (3.94)	0.045 (0.25)	R-22.9 (4.04)	0.044 (0.25)	R-23.2 (4.09)	0.043 (0.24)
	6.0 (152)	R-25.8 (4.54)	R-26.1 (4.60)	0.038 (0.22)	R-26.9 (4.73)	0.037 (0.21)	R-27.3 (4.80)	0.037 (0.21)
	7.0 (178)	R-30.1 (5.30)	R-29.8 (5.24)	0.034 (0.19)	R-30.7 (5.40)	0.033 (0.19)	R-31.2 (5.49)	0.032 (0.18)
	8.0 (203)	R-34.4 (6.06)	R-33.5 (5.90)	0.030 (0.17)	R-34.6 (6.09)	0.029 (0.16)	R-35.2 (6.20)	0.028 (0.16)
24	3.0 (76)	R-12.9 (2.27)	R-15.0 (2.65)	0.066 (0.38)	R-15.2 (2.68)	0.066 (0.37)	R-15.3 (2.69)	0.065 (0.37)
	4.0 (102)	R-17.2 (3.03)	R-19.0 (3.35)*	0.053 (0.30)*	R-19.3 (3.39)*	0.052 (0.29)*	R-19.4 (3.42)*	0.052 (0.29)*
	5.0 (127)	R-21.5 (3.79)	R-22.9 (4.04)	0.044 (0.25)	R-23.3 (4.11)	0.043 (0.24)	R-23.5 (4.14)	0.043 (0.24)
	6.0 (152)	R-25.8 (4.54)	R-26.9 (4.73)	0.037 (0.21)	R-27.3 (4.82)	0.037 (0.21)	R-27.6 (4.87)	0.036 (0.21)
	7.0 (178)	R-30.1 (5.30)	R-30.7 (5.41)	0.033 (0.19)	R-31.3 (5.52)	0.032 (0.18)	R-31.7 (5.58)	0.032 (0.18)
	8.0 (203)	R-34.4 (6.06)	R-34.6 (6.09)	0.029 (0.16)	R-35.4 (6.23)	0.028 (0.16)	R-35.8 (6.30)	0.028 (0.16)

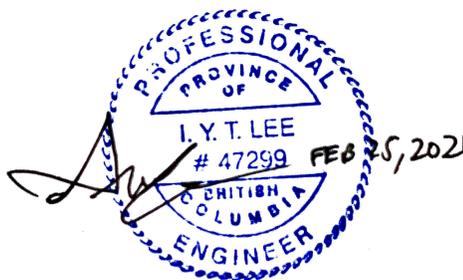
\*Indicates interpolated value

We believe that this report meets your objectives for evaluating the thermal performance for the ACS-S Thermal Clip system with CMU wall 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



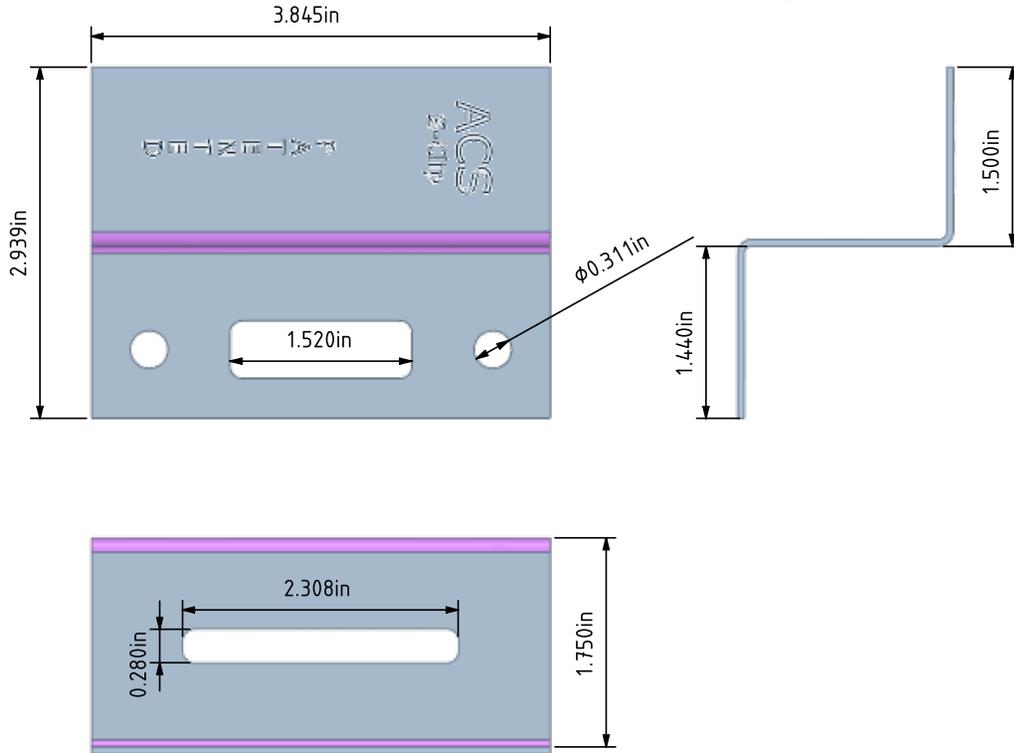
Ivan Lee, P.Eng.  
Building Science Consultant

<sup>4</sup> This value is the nominal R-value of the exterior insulation ONLY. Additional components, such as the CMU wall and air films all contribute an additional R-2.9 towards the nominal R-value of the entire assembly.



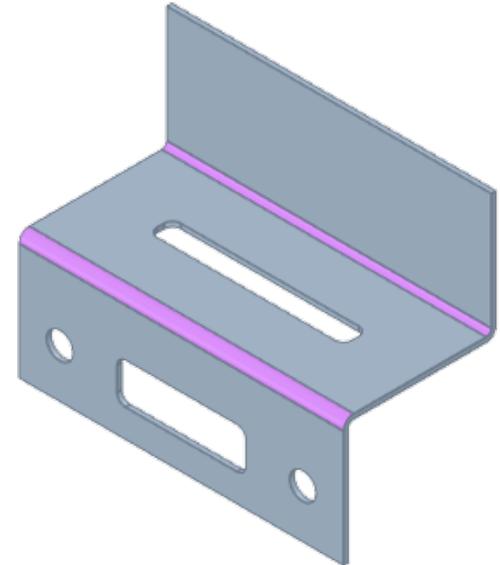
## **APPENDIX A: DETAIL DRAWINGS**

NOTES:



REVISION HISTORY

REV	DESCRIPTION	INCRP BY	DATE	CHECKED
-----	-------------	----------	------	---------

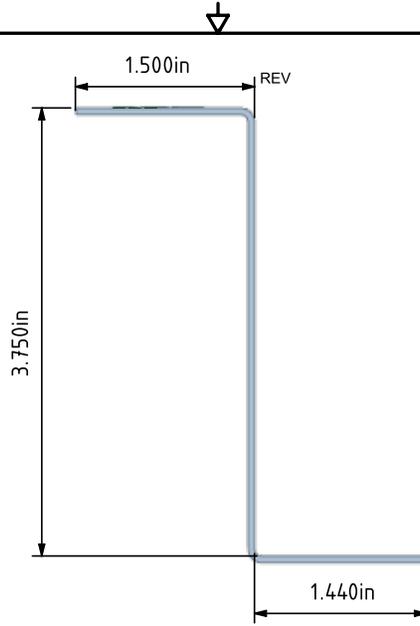
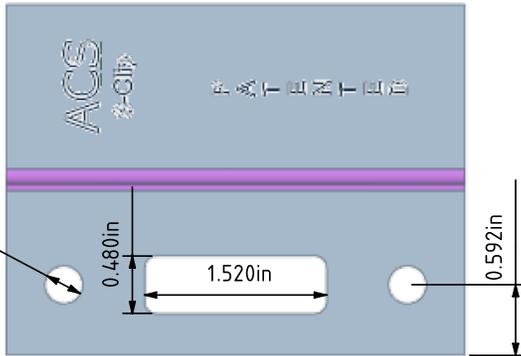
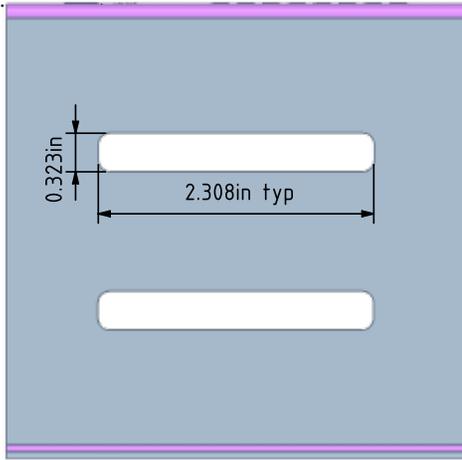


-2		-1		ITEM	PART OR IDENTIFYING NO.			NOMENCLATURE OR DESCRIPTION			
QTY	REQD			NO.							
PARTS LIST											
INIT	APPROVALS	DATE	INIT	APPROVALS	DATE	ACS Composite Systems					
						TITLE					
						2in Solid Clip					
						SIZE	CAGE CODE	DWG NO.			REV
						B					2
						SCALE		SHEET			

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

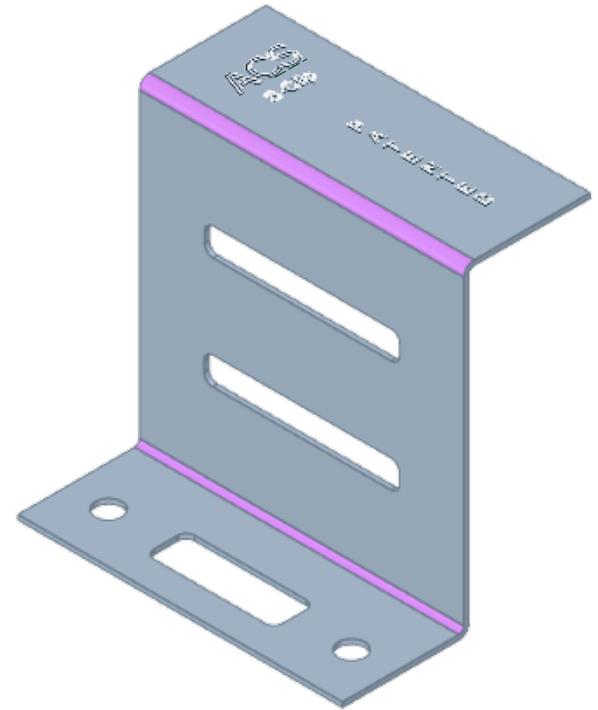


NOTES:



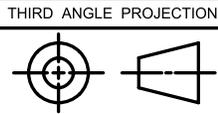
REVISION HISTORY

DESCRIPTION	INCORP BY	DATE	CHECKED



-2		-1		ITEM	PART OR IDENTIFYING NO.			NOMENCLATURE OR DESCRIPTION		
QTY	REQD	NO.	NO.	NO.						
PARTS LIST										
INIT	APPROVALS	DATE	INIT	APPROVALS	DATE	ACS Composite Systems				
						TITLE				
						4in Solid Clip				
						SIZE	CAGE CODE	DWG NO.	REV	
						B			2	
						SCALE		SHEET		

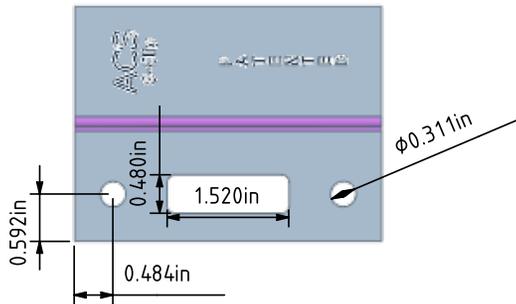
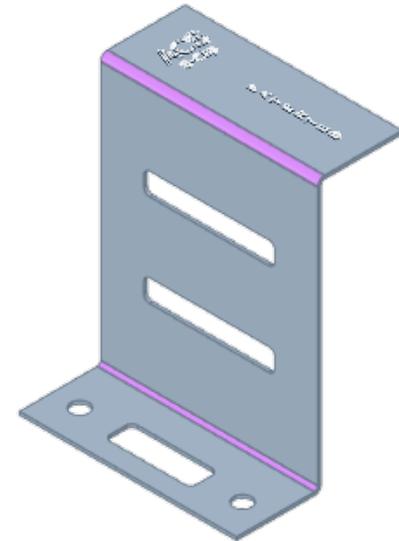
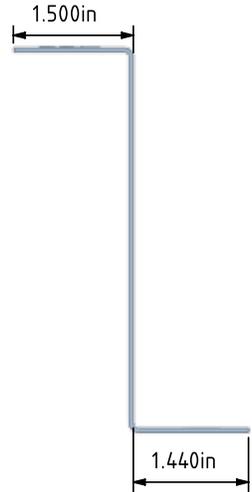
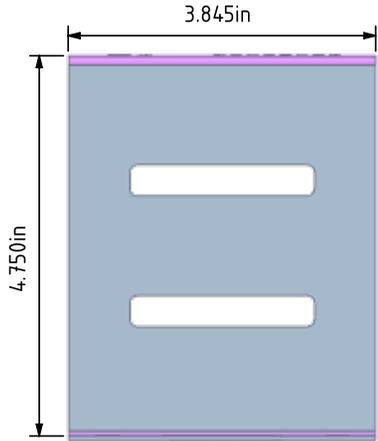
CONTRACT NO.		MATERIAL	
		FINISH	
		TREATMENT	
NEXT ASSY	USED ON	SIMILAR TO	
APPLICATION			



THIRD ANGLE PROJECTION



NOTES:

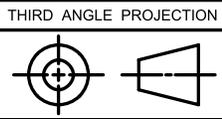


REVISION HISTORY

REV	DESCRIPTION	INCRP BY	DATE	CHECKED
-----	-------------	----------	------	---------

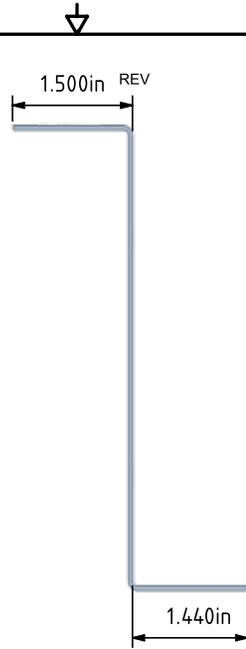
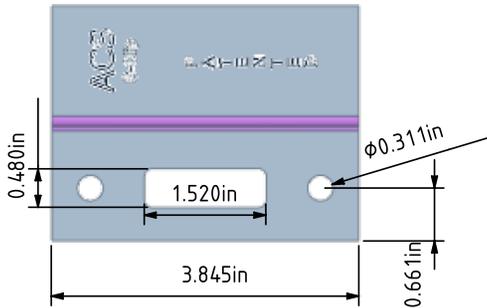
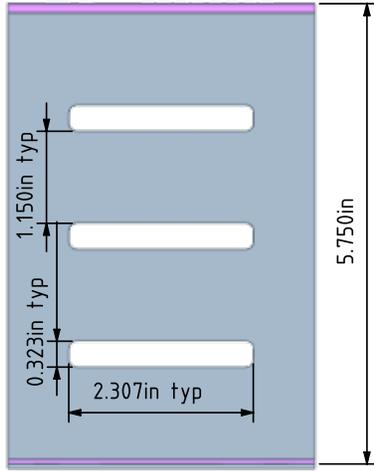
-2		-1		ITEM NO.	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	
QTY	REQD					PARTS LIST	
						ACS Composite Systems	
						TITLE	
						5in Solid Clip	
						SIZE	CAGE CODE
						B	DWG NO.
							REV
							2
						SCALE	SHEET

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



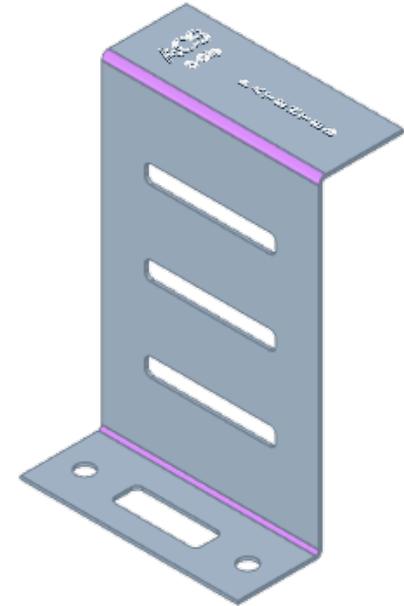
THIRD ANGLE PROJECTION

NOTES:



REVISION HISTORY

DESCRIPTION	INCRP BY	DATE	CHECKED
-------------	----------	------	---------

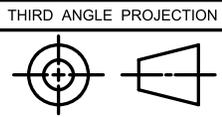


-2	-1	ITEM NO.	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION

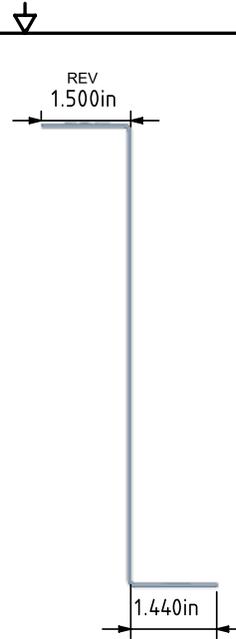
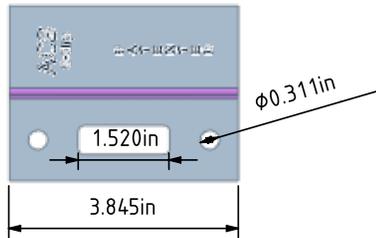
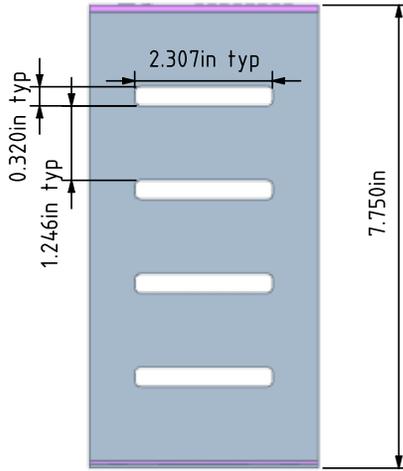
INIT	APPROVALS	DATE	INIT	APPROVALS	DATE	PARTS LIST			
						ACS Composite Systems			
						TITLE			
						6in Solid Clip			
						SIZE	CAGE CODE	DWG NO.	REV
						B			2
						SCALE		SHEET	

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



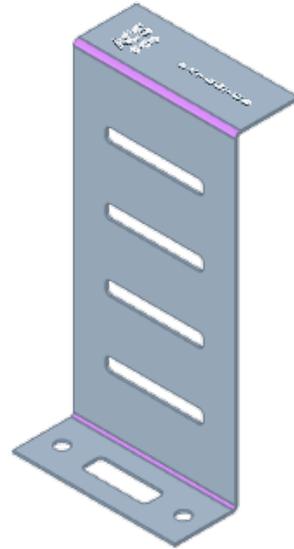


NOTES:



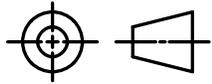
REVISION HISTORY

DESCRIPTION      INCORP BY      DATE      CHECKED



-2		-1		ITEM	PART OR IDENTIFYING NO.			NOMENCLATURE OR DESCRIPTION		
QTY	REQD			NO.						
PARTS LIST										
INIT	APPROVALS	DATE	INIT	APPROVALS	DATE	<b>ACS Composite Systems</b>  <b>8in Solid Clip</b>				
							SIZE	CAGE CODE	DWG NO.	REV
							B			2
							SCALE		SHEET	

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



## **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.

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

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

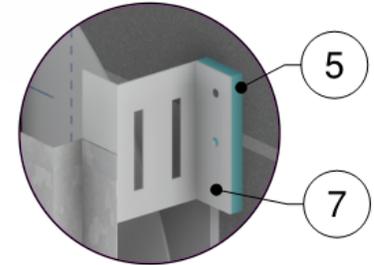
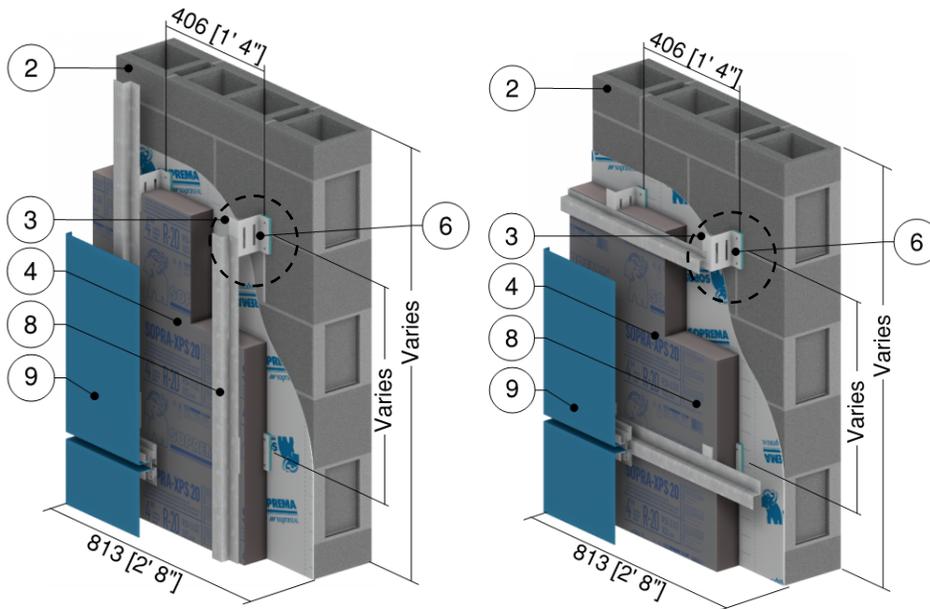
Boundary Location	Combined Convective and Radiation Heat Transfer Coefficient BTU/h ft <sup>2</sup> °F (W/m <sup>2</sup> K)
Exterior Wall Surfaces with Generic Cladding	1.5 (8.3)
Interior Walls	1.5 (8.3)

**APPENDIX C:  
BUILDING ENVELOPE THERMAL  
BRIDGING GUIDE DATA SHEETS**

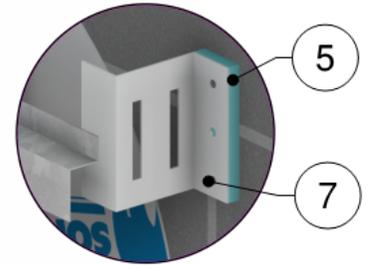


# Detail 4.1

## Exterior Insulated Concrete Block Wall Assembly with SOPREMA SOPRA-XPS 20 and ACS-S Thermal Clip (16" o.c. Horizontal) Supporting Metal Cladding - Clear Wall



Vertical Girt: ACS Clip Detail



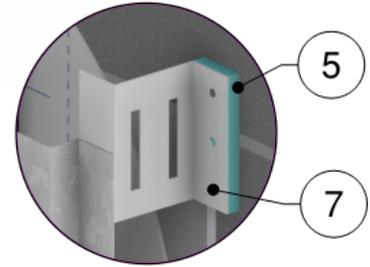
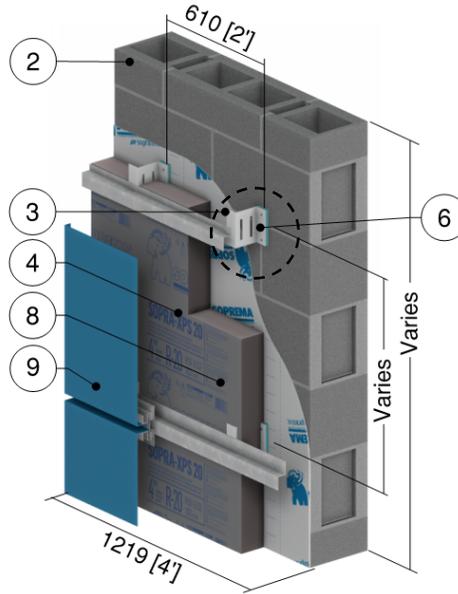
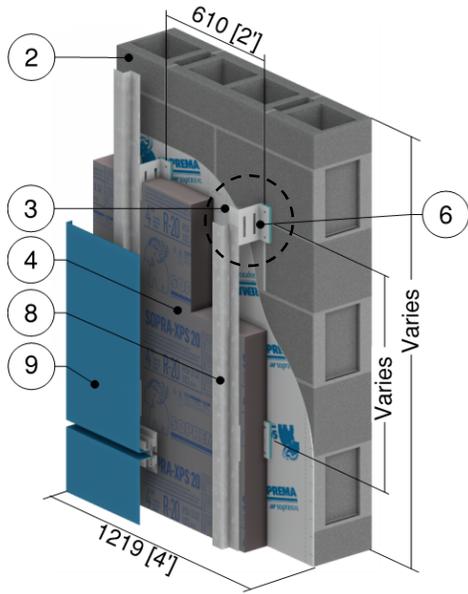
Horizontal Girt: ACS Clip Detail

ID	Component	Thickness Inches (mm)	Conductivity Btu-in / ft <sup>2</sup> -hr-°F (W/m K)	Nominal Resistance hr-ft <sup>2</sup> -°F/Btu (m <sup>2</sup> K/W)	Density lb/ft <sup>3</sup> (kg/m <sup>3</sup> )	Specific Heat Btu/lb-°F (J/kg K)
1	Interior Film <sup>1</sup>	-	-	R-0.7 (0.12 RSI)	-	-
2	Standard Concrete Blocks	8" (203)	10.4 (1.50)	-	119 (1900)	0.19 (800)
3	SOPREMA SOPRASEAL STICK 1100T membrane installed with SOPRASEAL STICK PRIMER	-	-	-	-	-
4	SOPRA-XPS 20 Exterior Insulation	Varies	0.20 (0.029)	R-15.0 to R-35.0 (2.64 RSI to 6.16 RSI)	2.5 (40)	0.29 (1220)
5	Thermal Break	1/2" (13)	0.13 (0.019)	-	2.1 (33)	0.50 (2100)
6	ACS-S Thermal Clip	16 Gauge	118 (17)	-	500 (8000)	0.13 (530)
7	Fastener	1/4" (6.4) Ø	347 (50)	-	489 (7830)	0.12 (500)
8	Girt	18 Gauge	430 (62)	-	489 (7830)	0.12 (500)
9	Cladding with 1/2" vented airspace incorporated into exterior heat transfer coefficient					
10	Exterior Film <sup>1</sup>	-	-	R-0.7 (0.12 RSI)	-	-

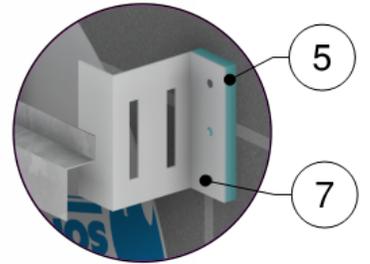
<sup>1</sup> Value selected from table 1, p. 26.1 of 2009 ASHRAE Handbook – Fundamentals depending on surface orientation

# Detail 4.2

## Exterior Insulated Concrete Block Wall Assembly with SOPREMA SOPRA-XPS 20 and ACS-S Thermal Clip (24" o.c. Horizontal) Supporting Metal Cladding - Clear Wall



Vertical Girt: ACS Clip Detail



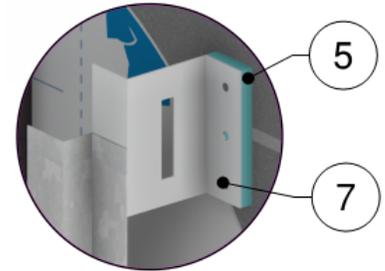
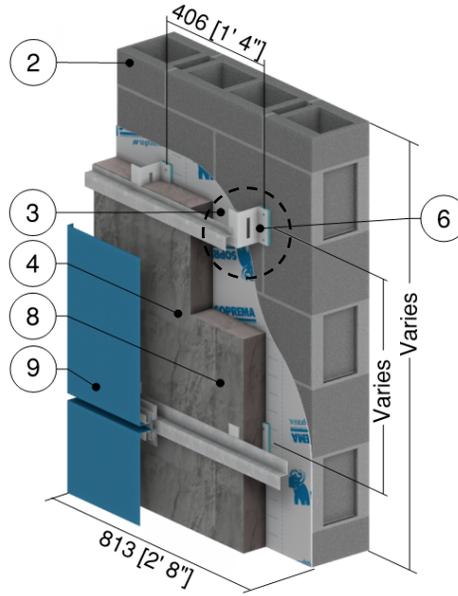
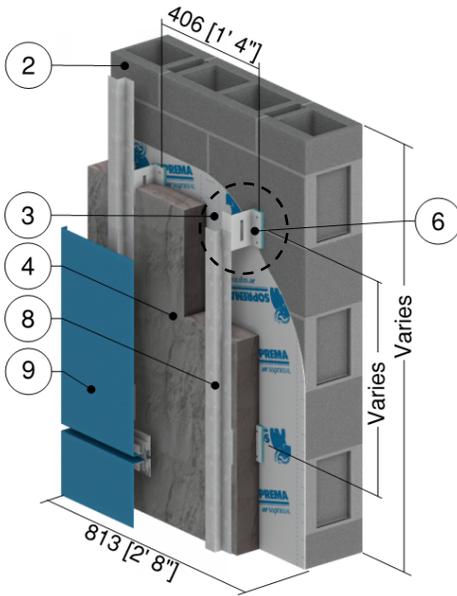
Horizontal Girt: ACS Clip Detail

ID	Component	Thickness Inches (mm)	Conductivity Btu·in / ft <sup>2</sup> ·hr·°F (W/m K)	Nominal Resistance hr·ft <sup>2</sup> ·°F/Btu (m <sup>2</sup> K/W)	Density lb/ft <sup>3</sup> (kg/m <sup>3</sup> )	Specific Heat Btu/lb·°F (J/kg K)
1	Interior Film <sup>1</sup>	-	-	R-0.7 (0.12 RSI)	-	-
2	Standard Concrete Blocks	8" (203)	10.4 (1.50)	-	119 (1900)	0.19 (800)
3	SOPREMA SOPRASEAL STICK 1100T membrane installed with SOPRASEAL STICK PRIMER	-	-	-	-	-
4	SOPRA-XPS 20 Exterior Insulation	Varies	0.20 (0.029)	R-15.0 to R-35.0 (2.64 RSI to 6.16 RSI)	2.5 (40)	0.29 (1220)
5	Thermal Break	1/2" (13)	0.13 (0.019)	-	2.1 (33)	0.50 (2100)
6	ACS-S Thermal Clip	16 Gauge	118 (17)	-	500 (8000)	0.13 (530)
7	Fastener	1/4" (6.4) Ø	347 (50)	-	489 (7830)	0.12 (500)
8	Girt	18 Gauge	430 (62)	-	489 (7830)	0.12 (500)
9	Cladding with 1/2" vented airspace incorporated into exterior heat transfer coefficient					
10	Exterior Film <sup>1</sup>	-	-	R-0.7 (0.12 RSI)	-	-

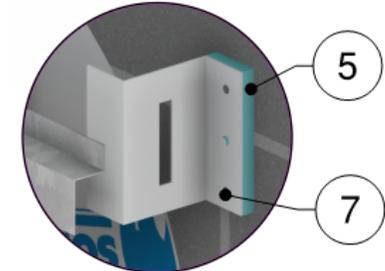
<sup>1</sup> Value selected from table 1, p. 26.1 of 2009 ASHRAE Handbook – Fundamentals depending on surface orientation

# Detail 4.3

## Exterior Insulated Concrete Block Wall Assembly with SOPREMA SOPRA-SPF 202 and ACS-S Thermal Clip (16" o.c. Horizontal) Supporting Metal Cladding - Clear Wall



Vertical Girt: ACS Clip Detail



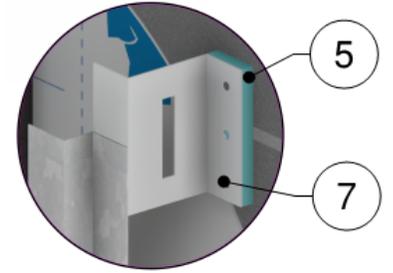
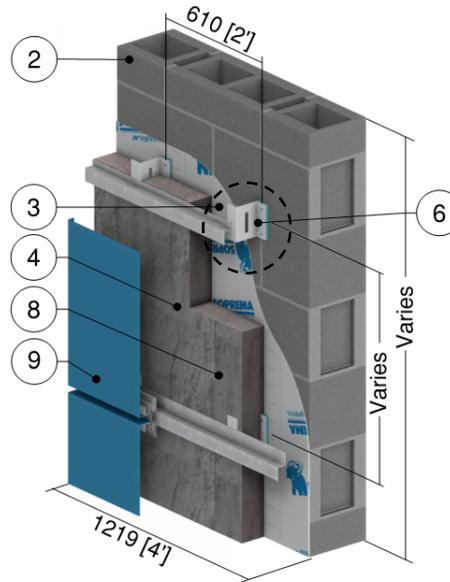
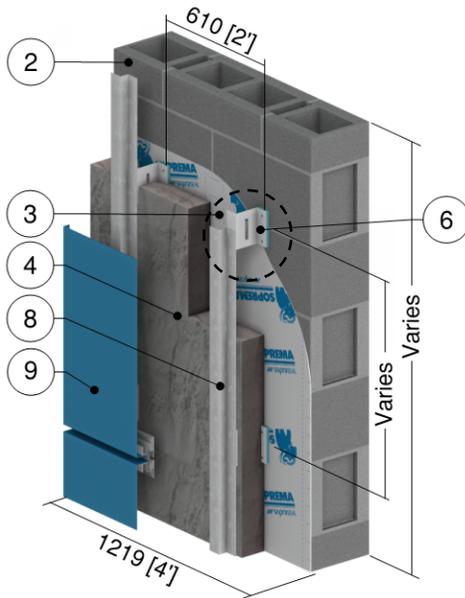
Horizontal Girt: ACS Clip Detail

ID	Component	Thickness Inches (mm)	Conductivity Btu·in / ft <sup>2</sup> ·hr·°F (W/m K)	Nominal Resistance hr·ft <sup>2</sup> ·°F/Btu (m <sup>2</sup> K/W)	Density lb/ft <sup>3</sup> (kg/m <sup>3</sup> )	Specific Heat Btu/lb·°F (J/kg K)
1	Interior Film <sup>1</sup>	-	-	R-0.7 (0.12 RSI)	-	-
2	Standard Concrete Blocks	8" (203)	10.4 (1.50)	-	119 (1900)	0.19 (800)
3	SOPREMA SOPRASEAL STICK 1100T membrane installed with SOPRASEAL STICK PRIMER	-	-	-	-	-
4	SOPRA-SPF 202 Exterior Insulation	Varies	0.16 (0.023)	R-6.2 to R-37.2 (1.09 RSI to 6.55 RSI)	1.8 (28)	0.29 (1220)
5	Thermal Break	1/2" (13)	0.13 (0.019)	-	2.1 (33)	0.50 (2100)
6	ACS-S Thermal Clip	16 Gauge	118 (17)	-	500 (8000)	0.13 (530)
7	Fastener	1/4" (6.4) Ø	347 (50)	-	489 (7830)	0.12 (500)
8	Girt	18 Gauge	430 (62)	-	489 (7830)	0.12 (500)
9	Cladding with 1/2" vented airspace incorporated into exterior heat transfer coefficient					
10	Exterior Film <sup>1</sup>	-	-	R-0.7 (0.12 RSI)	-	-

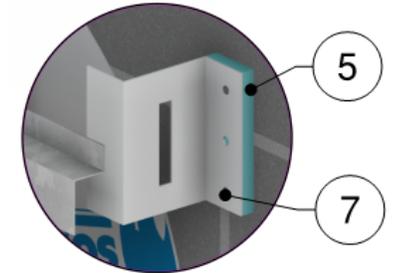
<sup>1</sup> Value selected from table 1, p. 26.1 of 2009 ASHRAE Handbook – Fundamentals depending on surface orientation

# Detail 4.4

## Exterior Insulated Concrete Block Wall Assembly with SOPREMA SOPRA-SPF 202 and ACS-S Thermal Clip (24" o.c. Horizontal) Supporting Metal Cladding - Clear Wall



Vertical Girt: ACS Clip Detail



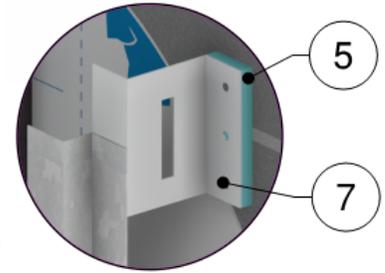
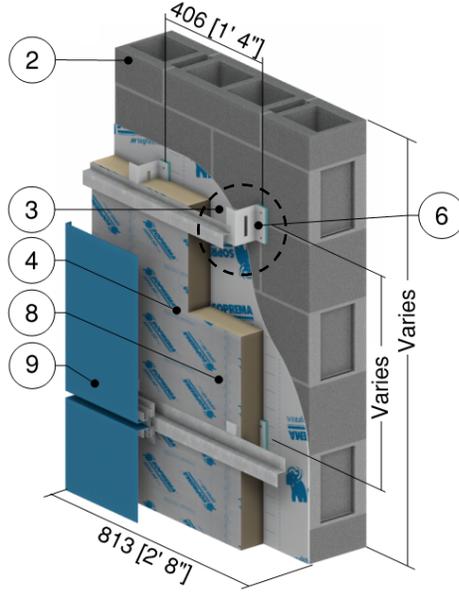
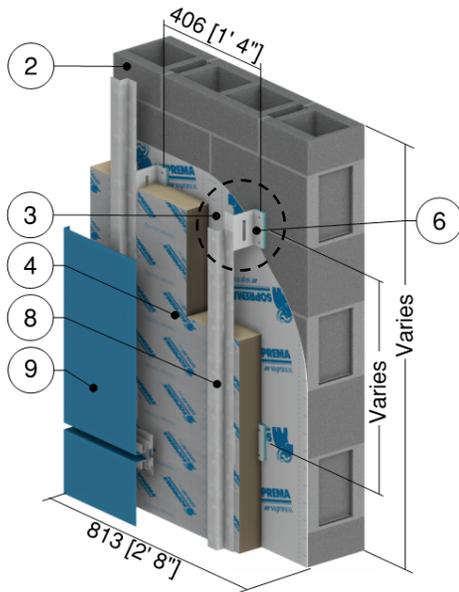
Horizontal Girt: ACS Clip Detail

ID	Component	Thickness Inches (mm)	Conductivity Btu·in / ft <sup>2</sup> ·hr·°F (W/m K)	Nominal Resistance hr·ft <sup>2</sup> ·°F/Btu (m <sup>2</sup> K/W)	Density lb/ft <sup>3</sup> (kg/m <sup>3</sup> )	Specific Heat Btu/lb·°F (J/kg K)
1	Interior Film <sup>1</sup>	-	-	R-0.7 (0.12 RSI)	-	-
2	Standard Concrete Blocks	8" (203)	10.4 (1.50)	-	119 (1900)	0.19 (800)
3	SOPREMA SOPRASEAL STICK 1100T membrane installed with SOPRASEAL STICK PRIMER	-	-	-	-	-
4	SOPRA-SPF 202 Exterior Insulation	Varies	0.16 (0.023)	R-6.2 to R-37.2 (1.09 RSI to 6.55 RSI)	1.8 (28)	0.29 (1220)
5	Thermal Break	1/2" (13)	0.13 (0.019)	-	2.1 (33)	0.50 (2100)
6	ACS-S Thermal Clip	16 Gauge	118 (17)	-	500 (8000)	0.13 (530)
7	Fastener	1/4" (6.4) Ø	347 (50)	-	489 (7830)	0.12 (500)
8	Girt	18 Gauge	430 (62)	-	489 (7830)	0.12 (500)
9	Cladding with 1/2" vented airspace incorporated into exterior heat transfer coefficient					
10	Exterior Film <sup>1</sup>	-	-	R-0.7 (0.12 RSI)	-	-

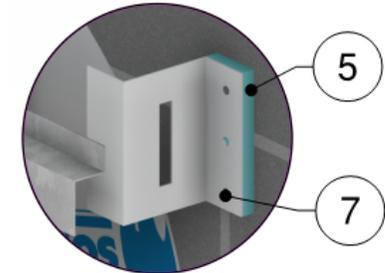
<sup>1</sup> Value selected from table 1, p. 26.1 of 2009 ASHRAE Handbook – Fundamentals depending on surface orientation

# Detail 4.5

## Exterior Insulated Concrete Block Wall Assembly with SOPREMA SOPRA-ISO V ALU and ACS-S Thermal Clip (16" o.c. Horizontal) Supporting Metal Cladding - Clear Wall



Vertical Girt: ACS Clip Detail



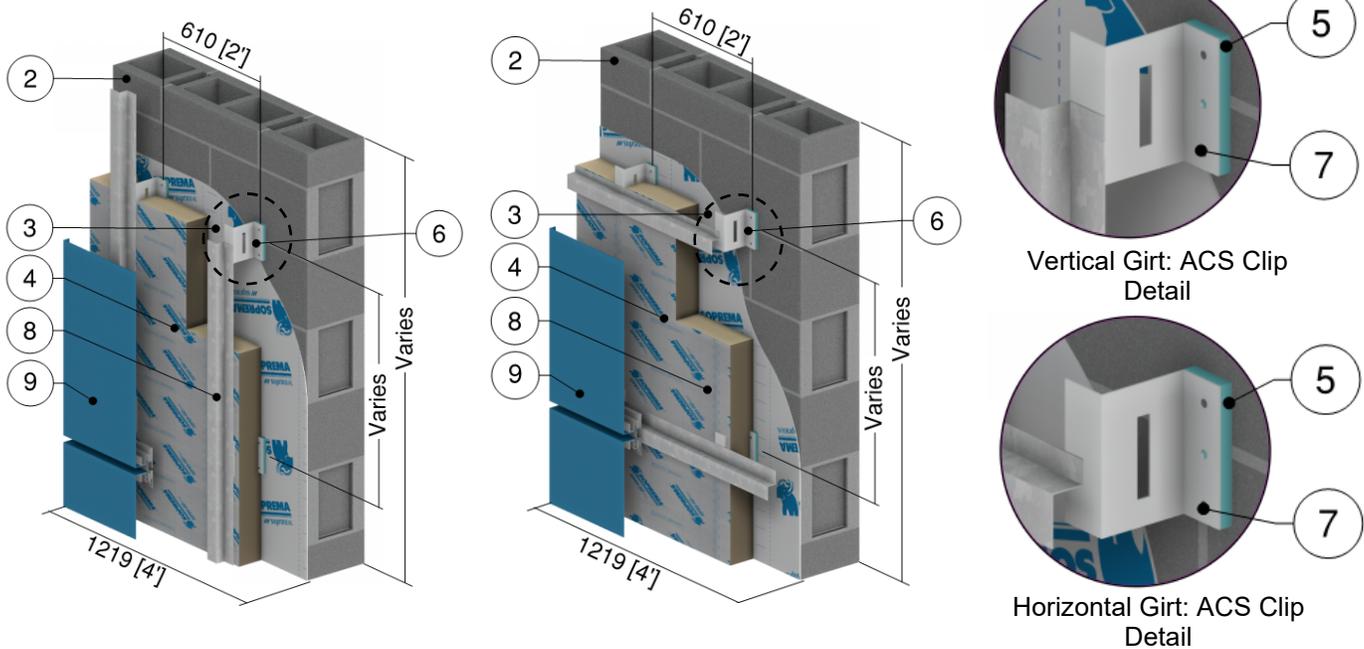
Horizontal Girt: ACS Clip Detail

ID	Component	Thickness Inches (mm)	Conductivity Btu·in / ft <sup>2</sup> ·hr·°F (W/m K)	Nominal Resistance hr·ft <sup>2</sup> ·°F/Btu (m <sup>2</sup> K/W)	Density lb/ft <sup>3</sup> (kg/m <sup>3</sup> )	Specific Heat Btu/lb·°F (J/kg K)
1	Interior Film <sup>1</sup>	-	-	R-0.7 (0.12 RSI)	-	-
2	Standard Concrete Blocks	8" (203)	10.4 (1.50)	-	119 (1900)	0.19 (800)
3	SOPREMA SOPRASEAL STICK 1100T membrane installed with SOPRASEAL STICK PRIMER	-	-	-	-	-
4	SOPRA-ISO V ALU Exterior Insulation	Varies	0.15 (0.022)	R-6.5 to R-39.0 (1.14 RSI to 6.87 RSI)	1.9 (30)	0.36 (1500)
5	Thermal Break	1/2" (13)	0.13 (0.019)	-	2.1 (33)	0.50 (2100)
6	ACS-S Thermal Clip	16 Gauge	118 (17)	-	500 (8000)	0.13 (530)
7	Fastener	1/4" (6.4) Ø	347 (50)	-	489 (7830)	0.12 (500)
8	Girt	18 Gauge	430 (62)	-	489 (7830)	0.12 (500)
9	Cladding with 1/2" vented airspace incorporated into exterior heat transfer coefficient					
10	Exterior Film <sup>1</sup>	-	-	R-0.7 (0.12 RSI)	-	-

<sup>1</sup> Value selected from table 1, p. 26.1 of 2009 ASHRAE Handbook – Fundamentals depending on surface orientation

# Detail 4.6

## Exterior Insulated Concrete Block Wall Assembly with SOPREMA SOPRA-ISO V ALU and ACS-S Thermal Clip (24" o.c. Horizontal) Supporting Metal Cladding - Clear Wall

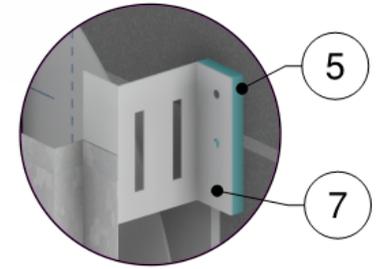
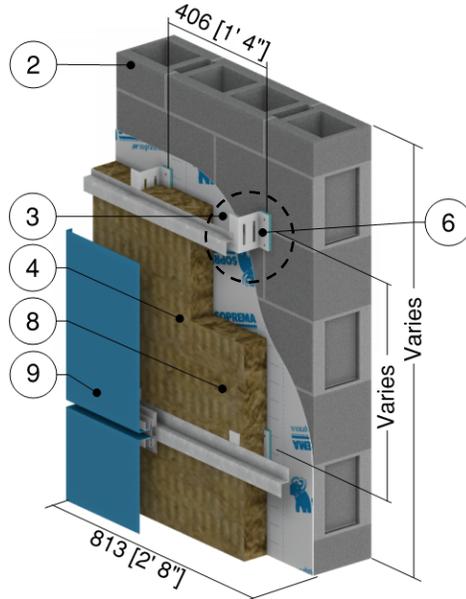
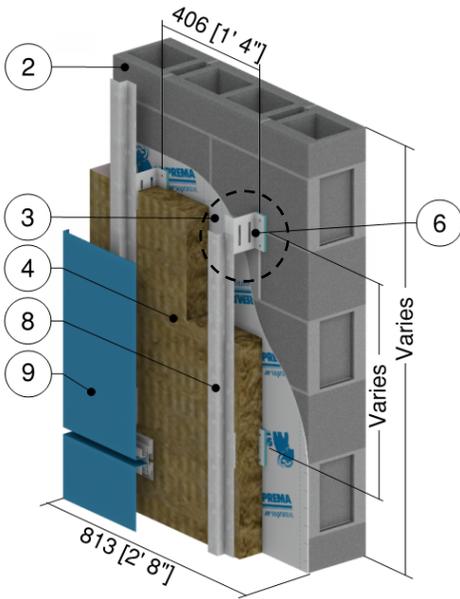


ID	Component	Thickness Inches (mm)	Conductivity Btu·in / ft <sup>2</sup> ·hr·°F (W/m K)	Nominal Resistance hr·ft <sup>2</sup> ·°F/Btu (m <sup>2</sup> K/W)	Density lb/ft <sup>3</sup> (kg/m <sup>3</sup> )	Specific Heat Btu/lb·°F (J/kg K)
1	Interior Film <sup>1</sup>	-	-	R-0.7 (0.12 RSI)	-	-
2	Standard Concrete Blocks	8" (203)	10.4 (1.50)	-	119 (1900)	0.19 (800)
3	SOPREMA SOPRASEAL STICK 1100T membrane installed with SOPRASEAL STICK PRIMER	-	-	-	-	-
4	SOPRA-ISO V ALU Exterior Insulation	Varies	0.15 (0.022)	R-6.5 to R-39.0 (1.14 RSI to 6.87 RSI)	1.9 (30)	0.36 (1500)
5	Thermal Break	1/2" (13)	0.13 (0.019)	-	2.1 (33)	0.50 (2100)
6	ACS-S Thermal Clip	16 Gauge	118 (17)	-	500 (8000)	0.13 (530)
7	Fastener	1/4" (6.4) Ø	347 (50)	-	489 (7830)	0.12 (500)
8	Girt	18 Gauge	430 (62)	-	489 (7830)	0.12 (500)
9	Cladding with 1/2" vented airspace incorporated into exterior heat transfer coefficient					
10	Exterior Film <sup>1</sup>	-	-	R-0.7 (0.12 RSI)	-	-

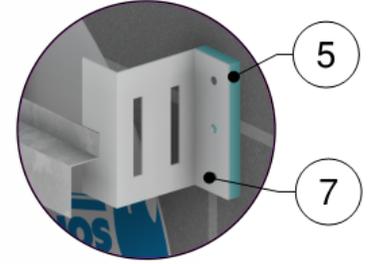
<sup>1</sup> Value selected from table 1, p. 26.1 of 2009 ASHRAE Handbook – Fundamentals depending on surface orientation

# Detail 4.7

## Exterior Insulated Concrete Block Wall Assembly with Mineral Wool and ACS-S Thermal Clip (16" o.c. Horizontal) Supporting Metal Cladding - Clear Wall



Vertical Girt: ACS Clip Detail



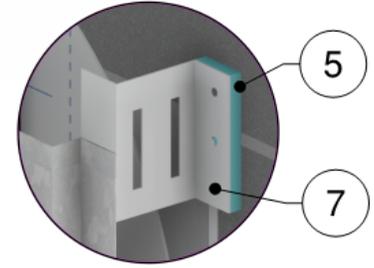
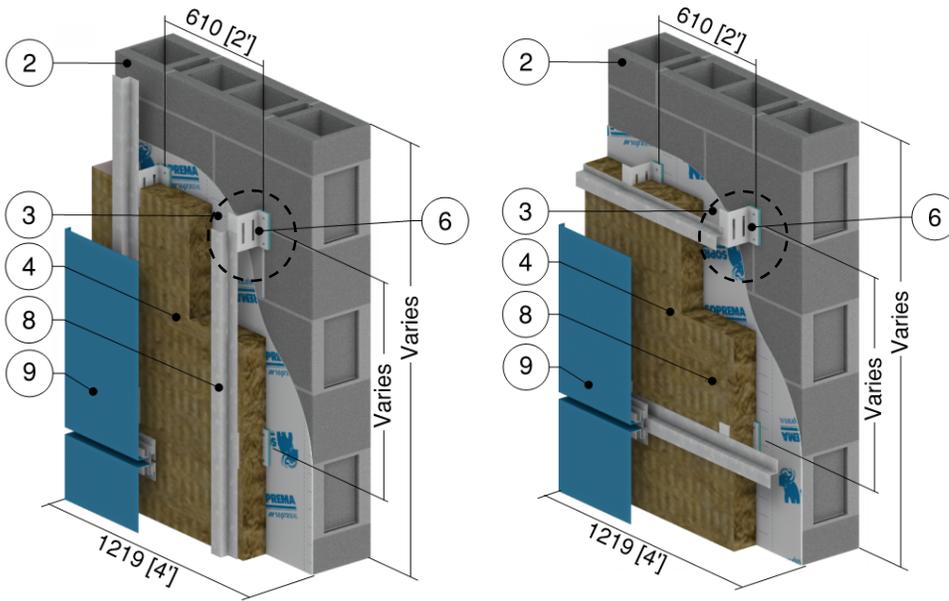
Horizontal Girt: ACS Clip Detail

ID	Component	Thickness Inches (mm)	Conductivity Btu·in / ft <sup>2</sup> ·hr·°F (W/m K)	Nominal Resistance hr·ft <sup>2</sup> ·°F/Btu (m <sup>2</sup> K/W)	Density lb/ft <sup>3</sup> (kg/m <sup>3</sup> )	Specific Heat Btu/lb·°F (J/kg K)
1	Interior Film <sup>1</sup>	-	-	R-0.7 (0.12 RSI)	-	-
2	Standard Concrete Blocks	8" (203)	10.4 (1.50)	-	119 (1900)	0.19 (800)
3	SOPREMA SOPRASEAL STICK 1100T membrane installed with SOPRASEAL STICK PRIMER	-	-	-	-	-
4	Exterior Mineral Wool Insulation	Varies	0.23 (0.034)	R-12.9 to R-34.4 (2.27 RSI to 6.06 RSI)	1.8 (28)	0.29 (1220)
5	Thermal Break	1/2" (13)	0.13 (0.019)	-	2.1 (33)	0.50 (2100)
6	ACS-S Thermal Clip	16 Gauge	118 (17)	-	500 (8000)	0.13 (530)
7	Fastener	1/4" (6.4) Ø	347 (50)	-	489 (7830)	0.12 (500)
8	Girt	18 Gauge	430 (62)	-	489 (7830)	0.12 (500)
9	Cladding with 1/2" vented airspace incorporated into exterior heat transfer coefficient					
10	Exterior Film <sup>1</sup>	-	-	R-0.7 (0.12 RSI)	-	-

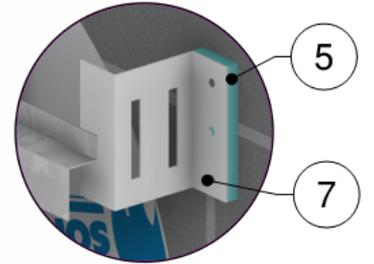
<sup>1</sup> Value selected from table 1, p. 26.1 of 2009 ASHRAE Handbook – Fundamentals depending on surface orientation

# Detail 4.8

## Exterior Insulated Concrete Block Wall Assembly with Mineral Wool and ACS-S Thermal Clip (24" o.c. Horizontal) Supporting Metal Cladding - Clear Wall



Vertical Girt: ACS Clip Detail



Horizontal Girt: ACS Clip Detail

ID	Component	Thickness Inches (mm)	Conductivity Btu-in / ft <sup>2</sup> ·hr·°F (W/m K)	Nominal Resistance hr·ft <sup>2</sup> ·°F/Btu (m <sup>2</sup> K/W)	Density lb/ft <sup>3</sup> (kg/m <sup>3</sup> )	Specific Heat Btu/lb·°F (J/kg K)
1	Interior Film <sup>1</sup>	-	-	R-0.7 (0.12 RSI)	-	-
2	Standard Concrete Blocks	8" (203)	10.4 (1.50)	-	119 (1900)	0.19 (800)
3	SOPREMA SOPRASEAL STICK 1100T membrane installed with SOPRASEAL STICK PRIMER	-	-	-	-	-
4	Exterior Mineral Wool Insulation	Varies	0.23 (0.034)	R-12.9 to R-34.4 (2.27 RSI to 6.06 RSI)	1.8 (28)	0.29 (1220)
5	Thermal Break	1/2" (13)	0.13 (0.019)	-	2.1 (33)	0.50 (2100)
6	ACS-S Thermal Clip	16 Gauge	118 (17)	-	500 (8000)	0.13 (530)
7	Fastener	1/4" (6.4) Ø	347 (50)	-	489 (7830)	0.12 (500)
8	Girt	18 Gauge	430 (62)	-	489 (7830)	0.12 (500)
9	Cladding with 1/2" vented airspace incorporated into exterior heat transfer coefficient					
10	Exterior Film <sup>1</sup>	-	-	R-0.7 (0.12 RSI)	-	-

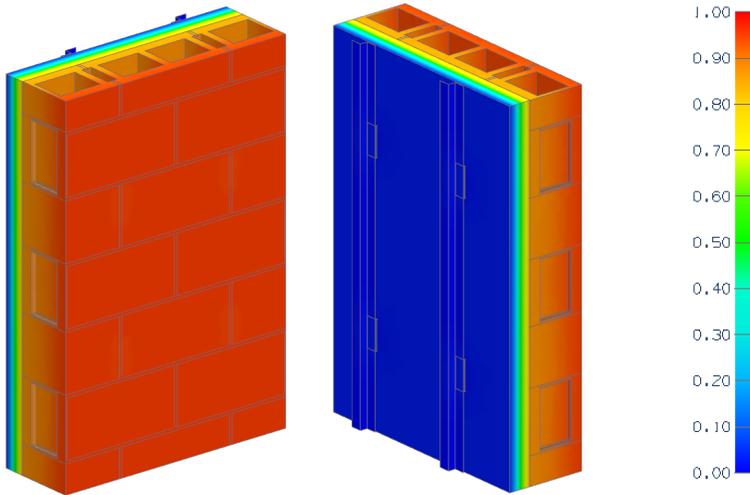
<sup>1</sup> Value selected from table 1, p. 26.1 of 2009 ASHRAE Handbook – Fundamentals depending on surface orientation

**APPENDIX D:  
BUILDING ENVELOPE THERMAL  
BRIDGING GUIDE RESULT SHEETS**



# Detail 4.1

## Exterior Insulated Concrete Block Wall Assembly with SOPREMA SOPRA-XPS 20 and ACS-S Thermal Clip (16" o.c. Horizontal) Supporting Metal Cladding - Clear Wall



### Thermal Performance Indicators

Assembly 1D (Nominal) R-Value	R <sub>1D</sub>	R-2.87 (0.51 RSI) + exterior insulation
Transmittance / Resistance	U <sub>o</sub> , R <sub>o</sub>	"Clear wall" U- and R-value

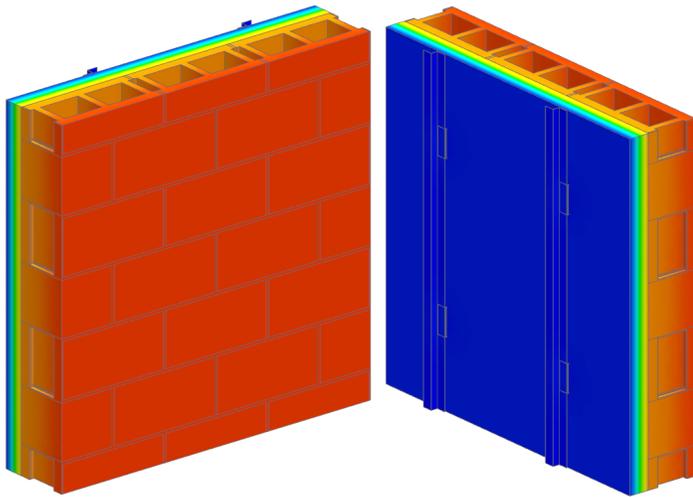
View from Interior      View from Exterior

### Nominal (1D) vs. Assembly Performance Indicators

Exterior Insulation 1D R-value (RSI)	R <sub>1D</sub> ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	24" Vertical Spacing		36" Vertical Spacing		48" Vertical Spacing	
		R <sub>o</sub> ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	U <sub>o</sub> Btu/ft <sup>2</sup> ·hr ·°F (W/m <sup>2</sup> K)	R <sub>o</sub> ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	U <sub>o</sub> Btu/ft <sup>2</sup> ·hr ·°F (W/m <sup>2</sup> K)	R <sub>o</sub> ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	U <sub>o</sub> Btu/ft <sup>2</sup> ·hr ·°F (W/m <sup>2</sup> K)
R-15.0 (2.64)	R-17.9 (3.15)	R-16.7 (2.94)	0.060 (0.34)	R-17.0 (2.99)	0.059 (0.33)	R-17.1 (3.02)	0.058 (0.33)
R-20.0 (3.52)	R-22.9 (4.03)	R-21.1 (3.71)	0.047 (0.27)	R-21.6 (3.80)	0.046 (0.26)	R-21.8 (3.85)	0.046 (0.26)
R-25.0 (4.40)	R-27.9 (4.91)	R-25.3 (4.46)	0.039 (0.22)	R-26.0 (4.59)	0.038 (0.22)	R-26.5 (4.66)	0.038 (0.21)
R-30.0 (5.28)	R-32.9 (5.79)	R-29.6 (5.22)	0.034 (0.19)	R-30.6 (5.39)	0.033 (0.19)	R-31.1 (5.48)	0.032 (0.18)
R-35.0 (6.16)	R-37.9 (6.67)	R-33.8 (5.94)	0.030 (0.17)	R-34.9 (6.16)	0.029 (0.16)	R-35.6 (6.27)	0.028 (0.16)

# Detail 4.2

## Exterior Insulated Concrete Block Wall Assembly with SOPREMA SOPRA-XPS 20 and ACS-S Thermal Clip (24" o.c. Horizontal) Supporting Metal Cladding - Clear Wall



View from Interior

View from Exterior

### Thermal Performance Indicators



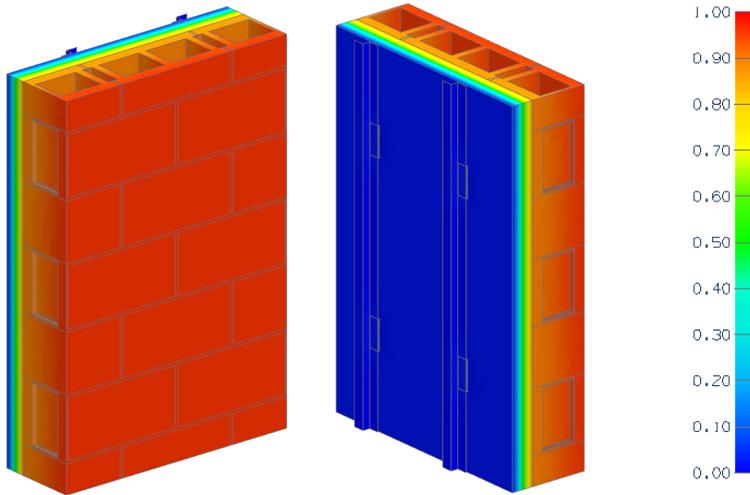
Assembly 1D (Nominal) R-Value	$R_{1D}$	R-2.87 (0.51 RSI) + exterior insulation
Transmittance / Resistance	$U_o$ , $R_o$	"Clear wall" U- and R-value

### Nominal (1D) vs. Assembly Performance Indicators

Exterior Insulation 1D R-value (RSI)	$R_{1D}$ ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	24" Vertical Spacing		36" Vertical Spacing		48" Vertical Spacing	
		$R_o$ ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	$U_o$ Btu/ft <sup>2</sup> ·hr·°F (W/m <sup>2</sup> K)	$R_o$ ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	$U_o$ Btu/ft <sup>2</sup> ·hr·°F (W/m <sup>2</sup> K)	$R_o$ ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	$U_o$ Btu/ft <sup>2</sup> ·hr·°F (W/m <sup>2</sup> K)
R-15.0 (2.64)	R-17.9 (3.15)	R-17.0 (2.99)	0.059 (0.33)	R-17.2 (3.03)	0.058 (0.33)	R-17.3 (3.05)	0.058 (0.33)
R-20.0 (3.52)	R-22.9 (4.03)	R-21.6 (3.80)	0.046 (0.26)	R-21.9 (3.86)	0.046 (0.26)	R-22.1 (3.89)	0.045 (0.26)
R-25.0 (4.40)	R-27.9 (4.91)	R-26.0 (4.59)	0.038 (0.22)	R-26.6 (4.68)	0.038 (0.21)	R-26.8 (4.72)	0.037 (0.21)
R-30.0 (5.28)	R-32.9 (5.79)	R-30.6 (5.39)	0.033 (0.19)	R-31.2 (5.50)	0.032 (0.18)	R-31.6 (5.57)	0.032 (0.18)
R-35.0 (6.16)	R-37.9 (6.67)	R-35.0 (6.16)	0.029 (0.16)	R-35.8 (6.30)	0.028 (0.16)	R-36.2 (6.38)	0.028 (0.16)

# Detail 4.3

## Exterior Insulated Concrete Block Wall Assembly with SOPREMA SOPRA-SPF 202 and ACS-S Thermal Clip (16" o.c. Horizontal) Supporting Metal Cladding - Clear Wall



### Thermal Performance Indicators

Assembly 1D (Nominal) R-Value	$R_{1D}$	R-2.87 (0.51 RSI) + exterior insulation
Transmittance / Resistance	$U_o$ , $R_o$	"Clear wall" U- and R-value

View from Interior      View from Exterior

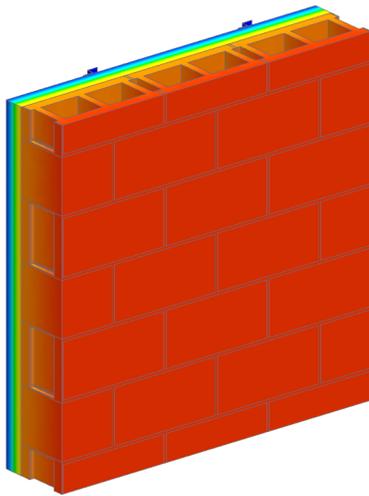
### Nominal (1D) vs. Assembly Performance Indicators

Exterior Insulation 1D R-value (RSI)	$R_{1D}$ ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	24" Vertical Spacing		36" Vertical Spacing		48" Vertical Spacing	
		$R_o$ ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	$U_o$ Btu/ft <sup>2</sup> ·hr·°F (W/m <sup>2</sup> K)	$R_o$ ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	$U_o$ Btu/ft <sup>2</sup> ·hr·°F (W/m <sup>2</sup> K)	$R_o$ ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	$U_o$ Btu/ft <sup>2</sup> ·hr·°F (W/m <sup>2</sup> K)
R-6.2 (1.09)	R-9.1 (1.60)	R-8.7 (1.53)	0.115 (0.65)	R-8.7 (1.54)	0.115 (0.65)	R-8.7 (1.54)	0.115 (0.65)
R-12.4 (2.18)	R-15.3 (2.69)	R-14.3 (2.52)*	0.070 (0.40)*	R-14.5 (2.56)*	0.069 (0.39)*	R-14.6 (2.57)*	0.068 (0.39)*
R-18.6 (3.28)	R-21.5 (3.78)	R-19.8 (3.49)	0.051 (0.29)	R-20.2 (3.56)	0.049 (0.28)	R-20.5 (3.60)	0.049 (0.28)
R-24.8 (4.37)	R-27.7 (4.87)	R-25.1 (4.42)	0.040 (0.23)	R-25.8 (4.55)	0.039 (0.22)	R-26.2 (4.61)	0.038 (0.22)
R-31.0 (5.46)	R-33.9 (5.97)	R-30.2 (5.32)	0.033 (0.19)	R-31.2 (5.50)	0.032 (0.18)	R-31.8 (5.61)	0.031 (0.18)
R-37.2 (6.55)	R-40.1 (7.06)	R-35.4 (6.23)	0.028 (0.16)	R-36.7 (6.47)	0.027 (0.15)	R-37.5 (6.60)	0.027 (0.15)

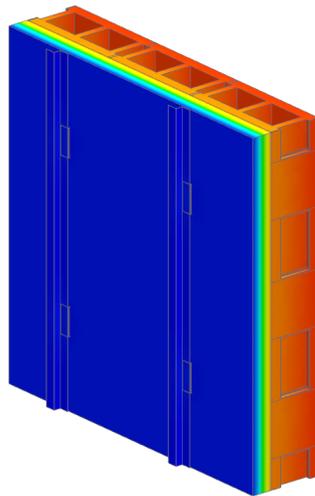
\*Indicates interpolated value

# Detail 4.4

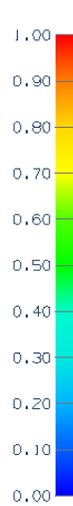
## Exterior Insulated Concrete Block Wall Assembly with SOPREMA SOPRA-SPF 202 and ACS-S Thermal Clip (24" o.c. Horizontal) Supporting Metal Cladding - Clear Wall



View from Interior



View from Exterior



### Thermal Performance Indicators

Assembly 1D (Nominal) R-Value	$R_{1D}$	R-2.87 (0.51 RSI) + exterior insulation
Transmittance / Resistance	$U_o$ , $R_o$	"Clear wall" U- and R-value

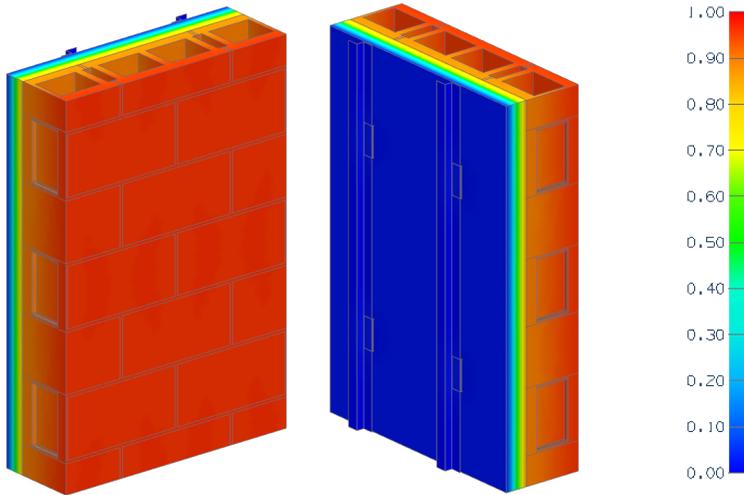
### Nominal (1D) vs. Assembly Performance Indicators

Exterior Insulation 1D R-value (RSI)	$R_{1D}$ ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	24" Vertical Spacing		36" Vertical Spacing		48" Vertical Spacing	
		$R_o$ ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	$U_o$ Btu/ft <sup>2</sup> ·hr·°F (W/m <sup>2</sup> K)	$R_o$ ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	$U_o$ Btu/ft <sup>2</sup> ·hr·°F (W/m <sup>2</sup> K)	$R_o$ ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	$U_o$ Btu/ft <sup>2</sup> ·hr·°F (W/m <sup>2</sup> K)
R-6.2 (1.09)	R-9.1 (1.60)	R-8.7 (1.53)	0.115 (0.65)	R-8.7 (1.54)	0.114 (0.65)	R-8.7 (1.54)	0.114 (0.65)
R-12.4 (2.18)	R-15.3 (2.69)	R-14.5 (2.56)*	0.069 (0.39)*	R-14.7 (2.58)*	0.068 (0.39)*	R-14.7 (2.59)*	0.068 (0.39)*
R-18.6 (3.28)	R-21.5 (3.78)	R-20.2 (3.56)	0.049 (0.28)	R-20.5 (3.62)	0.049 (0.28)	R-20.7 (3.64)	0.048 (0.27)
R-24.8 (4.37)	R-27.7 (4.87)	R-25.8 (4.55)	0.039 (0.22)	R-26.3 (4.63)	0.038 (0.22)	R-26.6 (4.68)	0.038 (0.21)
R-31.0 (5.46)	R-33.9 (5.97)	R-31.2 (5.50)	0.032 (0.18)	R-32.0 (5.63)	0.031 (0.18)	R-32.4 (5.70)	0.031 (0.18)
R-37.2 (6.55)	R-40.1 (7.06)	R-36.7 (6.47)	0.027 (0.15)	R-37.7 (6.64)	0.027 (0.15)	R-38.2 (6.73)	0.026 (0.15)

\*Indicates interpolated value

# Detail 4.5

## Exterior Insulated Concrete Block Wall Assembly with SOPREMA SOPRA-ISO V ALU and ACS-S Thermal Clip (16" o.c. Horizontal) Supporting Metal Cladding - Clear Wall



### Thermal Performance Indicators

Assembly 1D (Nominal) R-Value	R <sub>1D</sub>	R-2.87 (0.51 RSI) + exterior insulation
Transmittance / Resistance	U <sub>o</sub> , R <sub>o</sub>	"Clear wall" U- and R-value

View from Interior      View from Exterior

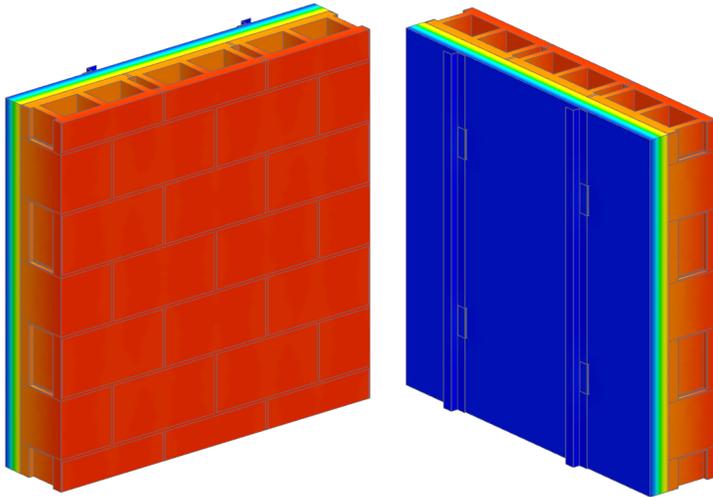
### Nominal (1D) vs. Assembly Performance Indicators

Exterior Insulation 1D R-value (RSI)	R <sub>1D</sub> ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	24" Vertical Spacing		36" Vertical Spacing		48" Vertical Spacing	
		R <sub>o</sub> ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	U <sub>o</sub> Btu/ft <sup>2</sup> ·hr ·°F (W/m <sup>2</sup> K)	R <sub>o</sub> ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	U <sub>o</sub> Btu/ft <sup>2</sup> ·hr ·°F (W/m <sup>2</sup> K)	R <sub>o</sub> ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	U <sub>o</sub> Btu/ft <sup>2</sup> ·hr ·°F (W/m <sup>2</sup> K)
R-6.5 (1.14)	R-9.4 (1.65)	R-9.0 (1.59)	0.111 (0.63)	R-9.1 (1.60)	0.110 (0.63)	R-9.1 (1.60)	0.110 (0.63)
R-13.0 (2.29)	R-15.9 (2.79)	R-14.9 (2.62)*	0.067 (0.38)*	R-15.1 (2.66)*	0.066 (0.38)*	R-15.2 (2.68)*	0.066 (0.37)*
R-16.3 (2.86)	R-19.1 (3.37)	R-17.8 (3.13)*	0.056 (0.32)*	R-18.1 (3.19)*	0.055 (0.31)*	R-18.3 (3.22)*	0.055 (0.31)*
R-19.5 (3.43)	R-22.4 (3.94)	R-20.6 (3.63)	0.048 (0.28)	R-21.1 (3.72)	0.047 (0.27)	R-21.3 (3.76)	0.047 (0.27)
R-22.8 (4.01)	R-25.6 (4.51)	R-23.4 (4.12)*	0.043 (0.24)*	R-24.0 (4.23)*	0.042 (0.24)*	R-24.3 (4.29)*	0.041 (0.23)*
R-26.0 (4.58)	R-28.9 (5.08)	R-26.2 (4.61)	0.038 (0.22)	R-26.9 (4.75)	0.037 (0.21)	R-27.4 (4.82)	0.037 (0.21)
R-29.3 (5.15)	R-32.1 (5.66)	R-28.9 (5.09)*	0.035 (0.20)*	R-29.8 (5.25)*	0.034 (0.19)*	R-30.3 (5.34)*	0.033 (0.19)*
R-32.5 (5.72)	R-35.4 (6.23)	R-31.5 (5.55)	0.032 (0.18)	R-32.6 (5.75)	0.031 (0.17)	R-33.3 (5.86)	0.030 (0.17)
R-35.8 (6.30)	R-38.6 (6.80)	R-34.3 (6.03)*	0.029 (0.17)*	R-35.5 (6.26)*	0.028 (0.16)*	R-36.2 (6.38)*	0.028 (0.16)*
R-39.0 (6.87)	R-41.9 (7.37)	R-36.9 (6.50)	0.027 (0.15)	R-38.4 (6.76)	0.026 (0.15)	R-39.2 (6.90)	0.026 (0.14)

\*Indicates interpolated value

# Detail 4.6

## Exterior Insulated Concrete Block Wall Assembly with SOPREMA SOPRA-ISO V ALU and ACS-S Thermal Clip (24" o.c. Horizontal) Supporting Metal Cladding - Clear Wall



View from Interior

View from Exterior

### Thermal Performance Indicators



Assembly 1D (Nominal) R-Value	R <sub>1D</sub>	R-2.87 (0.51 RSI) + exterior insulation
Transmittance / Resistance	U <sub>o</sub> , R <sub>o</sub>	"Clear wall" U- and R-value

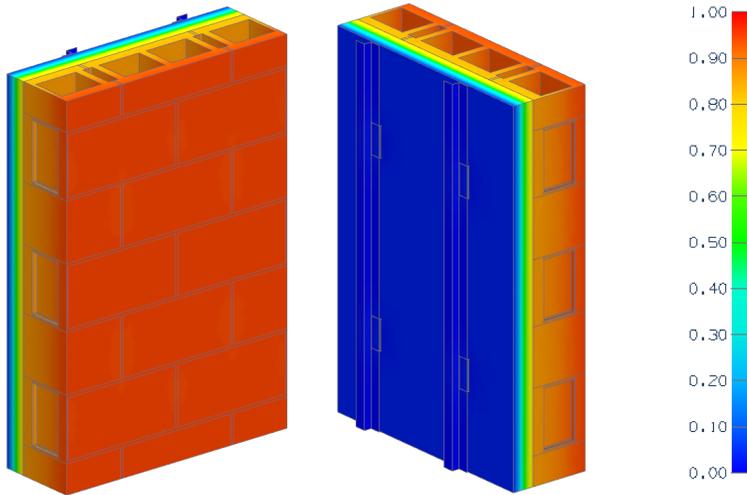
### Nominal (1D) vs. Assembly Performance Indicators

Exterior Insulation 1D R-value (RSI)	R <sub>1D</sub> ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	24" Vertical Spacing		36" Vertical Spacing		48" Vertical Spacing	
		R <sub>o</sub> ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	U <sub>o</sub> Btu/ft <sup>2</sup> ·hr ·°F (W/m <sup>2</sup> K)	R <sub>o</sub> ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	U <sub>o</sub> Btu/ft <sup>2</sup> ·hr ·°F (W/m <sup>2</sup> K)	R <sub>o</sub> ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	U <sub>o</sub> Btu/ft <sup>2</sup> ·hr ·°F (W/m <sup>2</sup> K)
R-6.5 (1.14)	R-9.4 (1.65)	R-9.1 (1.59)	0.110 (0.63)	R-9.1 (1.60)	0.110 (0.63)	R-9.1 (1.60)	0.110 (0.63)
R-13.0 (2.29)	R-15.9 (2.79)	R-15.1 (2.66)*	0.066 (0.38)*	R-15.3 (2.69)*	0.065 (0.37)*	R-15.4 (2.70)*	0.065 (0.37)*
R-16.3 (2.86)	R-19.1 (3.37)	R-18.1 (3.19)*	0.055 (0.31)*	R-18.4 (3.23)*	0.054 (0.31)*	R-18.5 (3.25)*	0.054 (0.31)*
R-19.5 (3.43)	R-22.4 (3.94)	R-21.1 (3.72)	0.047 (0.27)	R-21.4 (3.77)	0.047 (0.26)	R-21.6 (3.80)	0.046 (0.26)
R-22.8 (4.01)	R-25.6 (4.51)	R-24.0 (4.23)*	0.042 (0.24)*	R-24.5 (4.31)*	0.041 (0.23)*	R-24.7 (4.34)*	0.041 (0.23)*
R-26.0 (4.58)	R-28.9 (5.08)	R-27.0 (4.75)	0.037 (0.21)	R-27.5 (4.84)	0.036 (0.21)	R-27.8 (4.89)	0.036 (0.20)
R-29.3 (5.15)	R-32.1 (5.66)	R-29.8 (5.25)*	0.034 (0.19)*	R-30.5 (5.37)*	0.033 (0.19)*	R-30.8 (5.43)*	0.032 (0.18)*
R-32.5 (5.72)	R-35.4 (6.23)	R-32.6 (5.75)	0.031 (0.17)	R-33.4 (5.88)	0.030 (0.17)	R-33.8 (5.96)	0.030 (0.17)
R-35.8 (6.30)	R-38.6 (6.80)	R-35.5 (6.26)*	0.028 (0.16)*	R-36.4 (6.41)*	0.027 (0.16)*	R-36.9 (6.50)*	0.027 (0.15)*
R-39.0 (6.87)	R-41.9 (7.37)	R-38.4 (6.76)	0.026 (0.15)	R-39.4 (6.93)	0.025 (0.14)	R-40.0 (7.04)	0.025 (0.14)

\*Indicates interpolated value

# Detail 4.7

## Exterior Insulated Concrete Block Wall Assembly with Mineral Wool and ACS-S Thermal Clip (16" o.c. Horizontal) Supporting Metal Cladding - Clear Wall



View from Interior

View from Exterior

### Thermal Performance Indicators

Assembly 1D (Nominal) R-Value	$R_{1D}$	R-2.87 (0.51 RSI) + exterior insulation
Transmittance / Resistance	$U_o$ , $R_o$	"Clear wall" U- and R-value

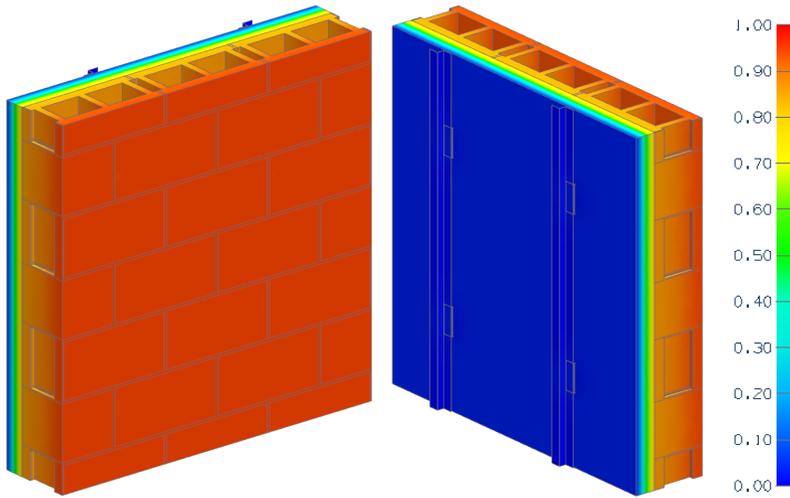
### Nominal (1D) vs. Assembly Performance Indicators

Exterior Insulation 1D R-value (RSI)	$R_{1D}$ ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	24" Vertical Spacing		36" Vertical Spacing		48" Vertical Spacing	
		$R_o$ ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	$U_o$ Btu/ft <sup>2</sup> ·hr ·°F (W/m <sup>2</sup> K)	$R_o$ ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	$U_o$ Btu/ft <sup>2</sup> ·hr ·°F (W/m <sup>2</sup> K)	$R_o$ ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	$U_o$ Btu/ft <sup>2</sup> ·hr ·°F (W/m <sup>2</sup> K)
R-12.9 (2.27)	R-15.8 (2.78)	R-14.8 (2.61)	0.068 (0.38)	R-15.0 (2.65)	0.067 (0.38)	R-15.2 (2.67)	0.066 (0.37)
R-17.2 (3.03)	R-20.1 (3.53)	R-18.6 (3.28)*	0.054 (0.31)*	R-19.0 (3.34)*	0.053 (0.30)*	R-19.2 (3.38)*	0.052 (0.30)*
R-21.5 (3.79)	R-24.4 (4.29)	R-22.4 (3.94)	0.045 (0.25)	R-22.9 (4.04)	0.044 (0.25)	R-23.2 (4.09)	0.043 (0.24)
R-25.8 (4.54)	R-28.7 (5.05)	R-26.1 (4.60)	0.038 (0.22)	R-26.9 (4.73)	0.037 (0.21)	R-27.3 (4.80)	0.037 (0.21)
R-30.1 (5.30)	R-33.0 (5.81)	R-29.8 (5.24)	0.034 (0.19)	R-30.7 (5.40)	0.033 (0.19)	R-31.2 (5.49)	0.032 (0.18)
R-34.4 (6.06)	R-37.3 (6.56)	R-33.5 (5.90)	0.030 (0.17)	R-34.6 (6.09)	0.029 (0.16)	R-35.2 (6.20)	0.028 (0.16)

\*Indicates interpolated value

# Detail 4.8

## Exterior Insulated Concrete Block Wall Assembly with Mineral Wool and ACS-S Thermal Clip (24" o.c. Horizontal) Supporting Metal Cladding - Clear Wall



View from Interior

View from Exterior

### Thermal Performance Indicators

Assembly 1D (Nominal) R-Value	R <sub>1D</sub>	R-2.87 (0.51 RSI) + exterior insulation
Transmittance / Resistance	U <sub>o</sub> , R <sub>o</sub>	"Clear wall" U- and R-value

### Nominal (1D) vs. Assembly Performance Indicators

Exterior Insulation 1D R-value (RSI)	R <sub>1D</sub> ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	24" Vertical Spacing		36" Vertical Spacing		48" Vertical Spacing	
		R <sub>o</sub> ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	U <sub>o</sub> Btu/ft <sup>2</sup> ·hr·°F (W/m <sup>2</sup> K)	R <sub>o</sub> ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	U <sub>o</sub> Btu/ft <sup>2</sup> ·hr·°F (W/m <sup>2</sup> K)	R <sub>o</sub> ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	U <sub>o</sub> Btu/ft <sup>2</sup> ·hr·°F (W/m <sup>2</sup> K)
R-12.9 (2.27)	R-15.8 (2.78)	R-15.0 (2.65)	0.066 (0.38)	R-15.2 (2.68)	0.066 (0.37)	R-15.3 (2.69)	0.065 (0.37)
R-17.2 (3.03)	R-20.1 (3.53)	R-19.0 (3.35)*	0.053 (0.30)*	R-19.3 (3.39)*	0.052 (0.29)*	R-19.4 (3.42)*	0.052 (0.29)*
R-21.5 (3.79)	R-24.4 (4.29)	R-22.9 (4.04)	0.044 (0.25)	R-23.3 (4.11)	0.043 (0.24)	R-23.5 (4.14)	0.043 (0.24)
R-25.8 (4.54)	R-28.7 (5.05)	R-26.9 (4.73)	0.037 (0.21)	R-27.3 (4.82)	0.037 (0.21)	R-27.6 (4.87)	0.036 (0.21)
R-30.1 (5.30)	R-33.0 (5.81)	R-30.7 (5.41)	0.033 (0.19)	R-31.3 (5.52)	0.032 (0.18)	R-31.7 (5.58)	0.032 (0.18)
R-34.4 (6.06)	R-37.3 (6.56)	R-34.6 (6.09)	0.029 (0.16)	R-35.4 (6.23)	0.028 (0.16)	R-35.8 (6.30)	0.028 (0.16)

\*Indicates interpolated value