ThermaKlip 3D Thermal Simulation

March 12, 2025
Report No. 31001.000

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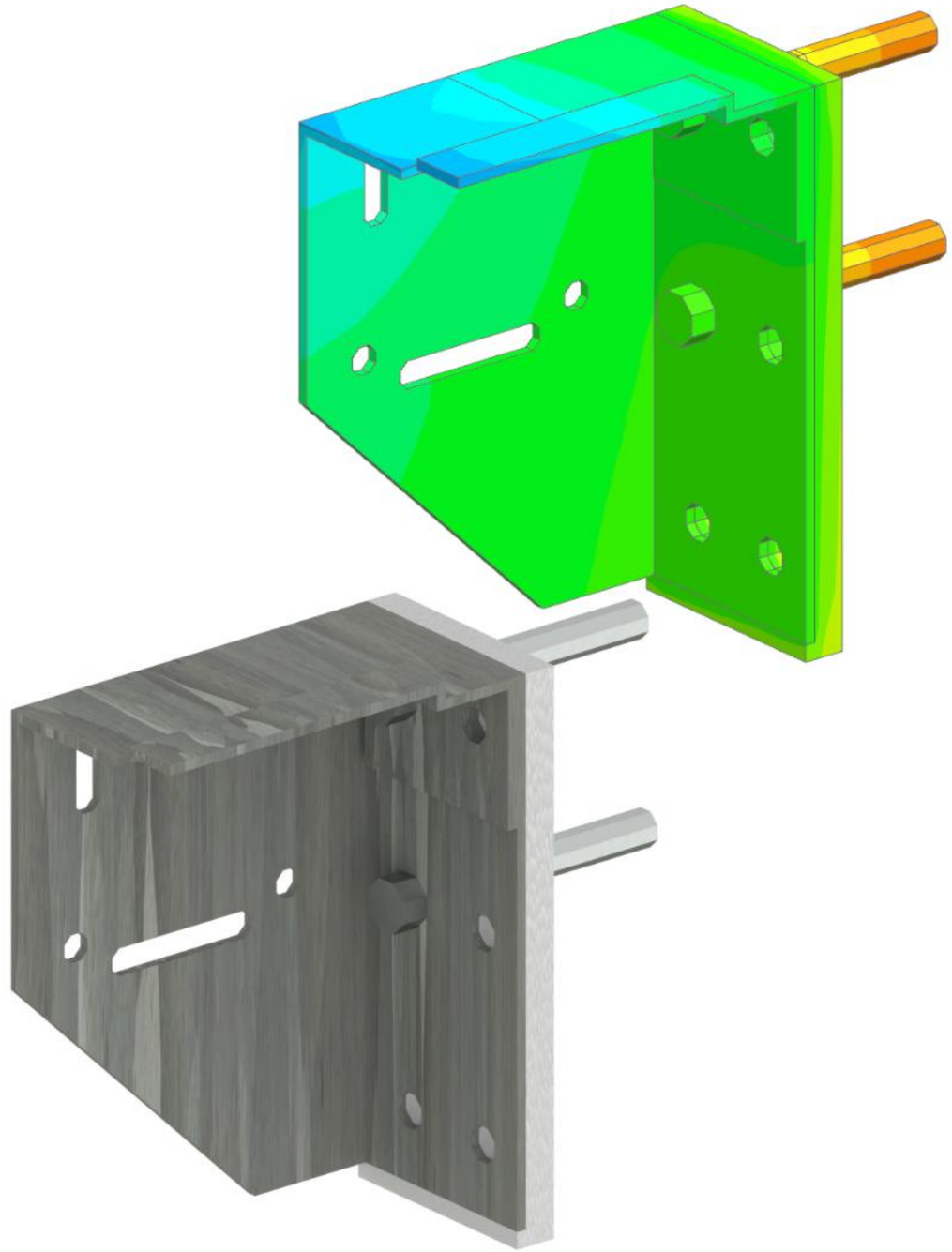
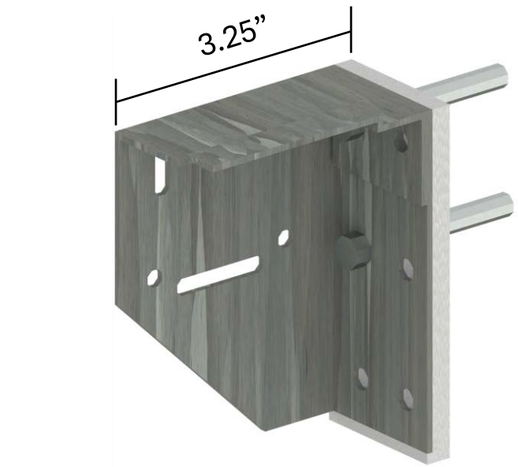


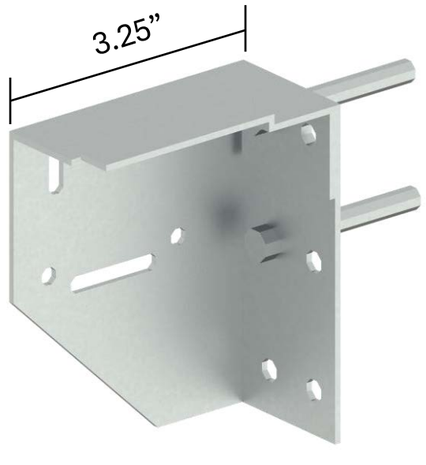
SYSTEM INFORMATION | System Description

The ThermaKlip consists of a 14-gauge stainless steel or galvanized steel bracket that receives and continuous rail. The stainless steel version of the bracket sits directly on the exterior sheathing and is fastened into the substrate. The galvanized steel version of the bracket includes a 6 mm polyamide thermal pad and a shortened bracket depth to maintain the same overall depth as the stainless-steel bracket. The ThermaKlip is 106 mm in height and 42 mm in width and is available in 3 sizes: 2”, 3.25”, and 4.75”. The 3.25” and 4.75” brackets are the focus of the current analysis and is designed to accommodate a nominal 4” and 6” of insulation, respectively. The continuous rail is an 18 gauge galvanized steel L-angle at 2” x 3” for the 3.25” clip and 2.5” x 3” for the 4.75” clip.

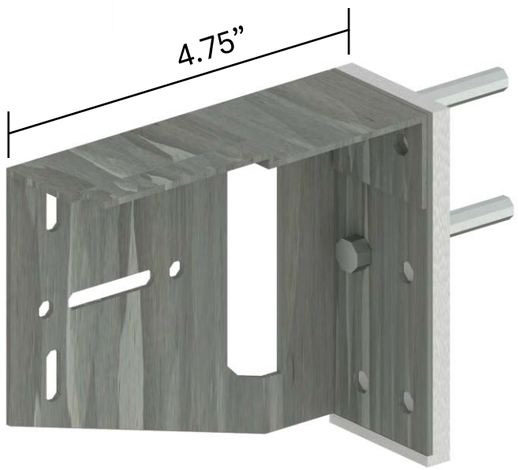
CLIP



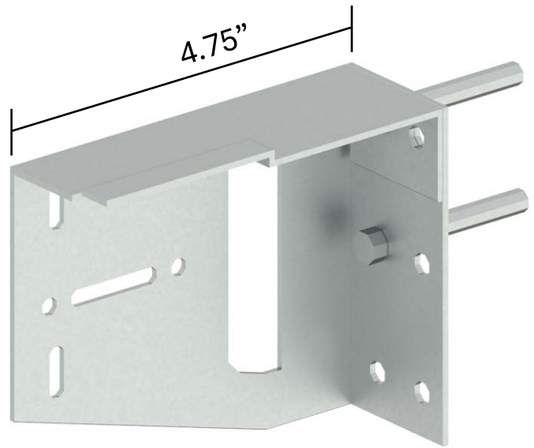
Galvanized Steel Clip with Thermal Pad



Stainless Steel Clip

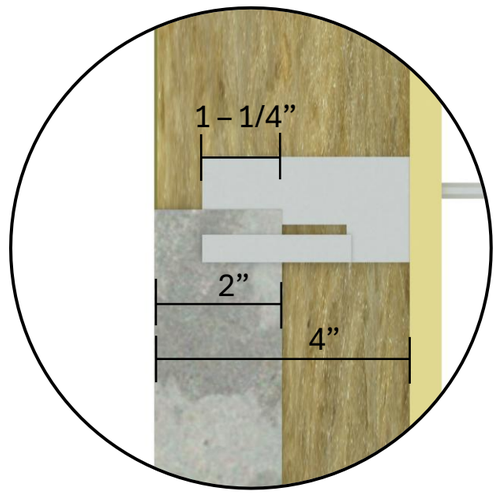


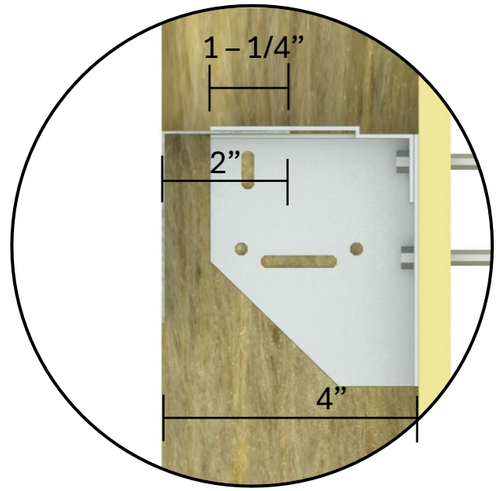
Galvanized Steel Clip with Thermal Pad



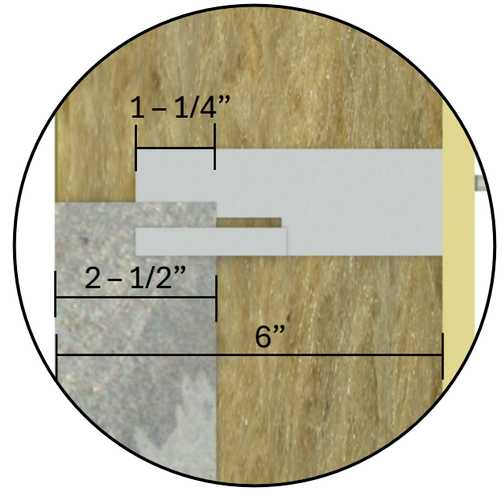
Stainless Steel Clip

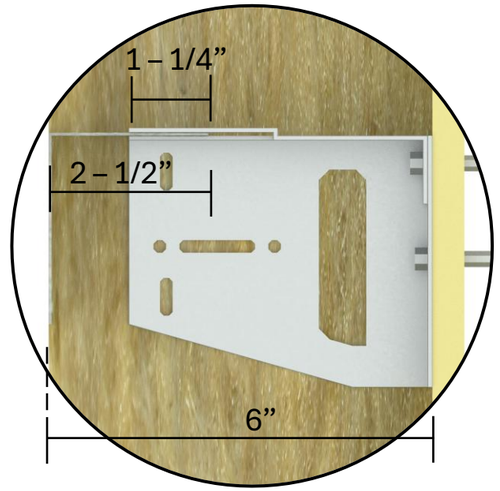
GIRT PENETRATION





3.25” Clip





4.75” Clip

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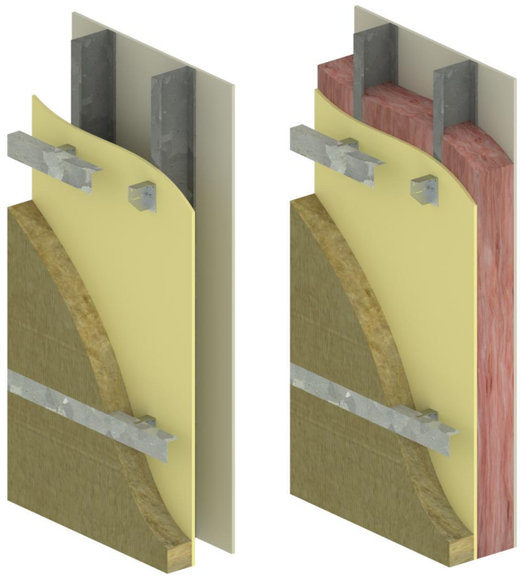
SYSTEM INFORMATION | Evaluated Scenarios

For this analysis, only the horizontal L-angle orientation were evaluated for the configurations shown below. The ThermaKlip system was evaluated for a range of backup walls, bracket sizes and bracket materials. The steel stud backup wall (with and without batt) was evaluated with a stainless steel bracket and a galvanized steel bracket with thermal pad at 3.25” depth. The wood stud wall with R-19 Batt was evaluated with a stainless steel bracket at 3.25” and 4.75” depths.



6” Steel Stud Wall With and Without R-19 Batt

- **Sheathing:** 1/2” Interior gypsum board; 1/2” Exterior sheathing board
- **Steel Stud:** 18 gauge, 6” x 1 5/8” steel studs with air or R-19 Batt in stud cavity at 16” o.c. horizontal spacing
- **Clip:** 14 gauge stainless steel clip or galvanized steel clip with thermal pad. Fastened with #14 stainless steel fasteners at 16” o.c. horizontal spacing and 32” o.c. vertical spacing. Overall clip depths of 3.25” or 4.75”
- **Thermal Pad:** 6mm polyamide thermal pad between galvanized steel clip and sheathing
- **L-angle:** 18 gauge steel L-angle oriented horizontally at 32” o.c. vertical spacing
- **Exterior Insulation:** R-4.3/in mineral wool insulation at 4” or 6” thickness

2x6 Wood Stud Wall With R-19 Batt

- **Sheathing:** 1/2” Interior gypsum board; 1/2” Exterior sheathing board
- **Wood Stud:** 2x6 wood studs with R-19 Batt in stud cavity at 16” o.c. horizontal spacing
- **Clip:** 14 gauge stainless steel clip or galvanized steel clip with thermal pad. Fastened with #14 stainless steel fasteners at 16” o.c. horizontal spacing and 32” o.c. vertical spacing. Overall clip depths of 3.25” or 4.75”
- **Thermal Pad:** 6mm polyamide thermal pad between galvanized steel clip and sheathing
- **L-angle:** 18 gauge steel L-angle oriented horizontally at 32” o.c. vertical spacing
- **Exterior Insulation:** R-4.3/in mineral wool insulation at 4” or 6” thickness

METHODOLOGY & ASSUMPTIONS

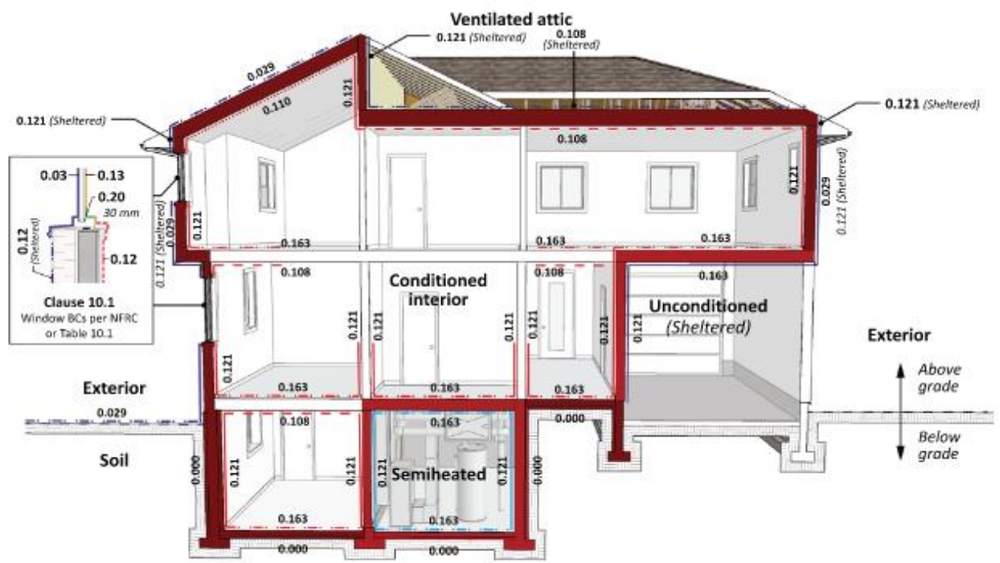
3D THERMAL SIMULATION

The assemblies and details were evaluated using three-dimensional thermal modelling. This method allows for the analysis of complex 3D geometries, such as point connections, pipes, and framing, which cannot be captured completely in a single plan or section detail.

Thermal modelling was performed in general conformance with ASHRAE 1365-RP, CSA Z5010: *Thermal Bridging Calculation Methodology* and the ASHRAE Handbook Fundamentals. Per industry standard modelling practices, the analysis was conducted under steady-state heat flow using published material properties assuming isotropic and temperature independent thermal conductivities.

BOUNDARY CONDITIONS

The thermal simulations assumed boundary condition surface film coefficients consistent with CSA Z5010.



Notes:

1) *Refer to Clause 8.2 and Table 8.*
2) *The default interior surface films resistance is 0.25 for Class B simulations.*

MATERIALS

The thermophysical properties of all materials included in the thermal simulation were based on data provided in ASHRAE HB Fundamentals, NFRC 101, or independent third-party tested values in accordance with ASTM C518.

Material	Thermal Conductivity BTU · in /ft² · hr · °F (W/m · K)
Drywall/Sheathing	1.1 (0.16)
Galvanized Steel	360.5 (52)
Mineral Wool Insulation (R4.3/in)	0.23 (0.034)
Polyamide Thermal Pad	1.7 (0.25)
Stainless Steel	117.9 (17)
Wood	0.8 (0.12)

TEMPERATURE INDEX

The thermal simulations were performed using a Temperature Index (I). The Temperature Index is a non-dimensional ratio of the surface temperature over the change in temperature across the assembly.

$$I = \frac{T_s - T_e}{T_i - T_e}$$

As the material properties are assumed independent of temperature, the temperature profile can be estimated for project specific temperature differences.

$$T_s = I \cdot (T_i - T_e) + T_e$$

SOFTWARE

The thermal modelling was performed using the NX software package from Siemens. NX is a three-dimensional multi-physics finite element analysis software tool. This software was validated as part of ASHRAE 1365-RP and the Building Envelope Thermal Bridging Guide.

REFERENCE DOCUMENTS

RDH relied on the ThermaKlip CAD drawings received September 27, 2024.

RESULTS | Stainless Steel Clip - Uninsulated Steel Stud

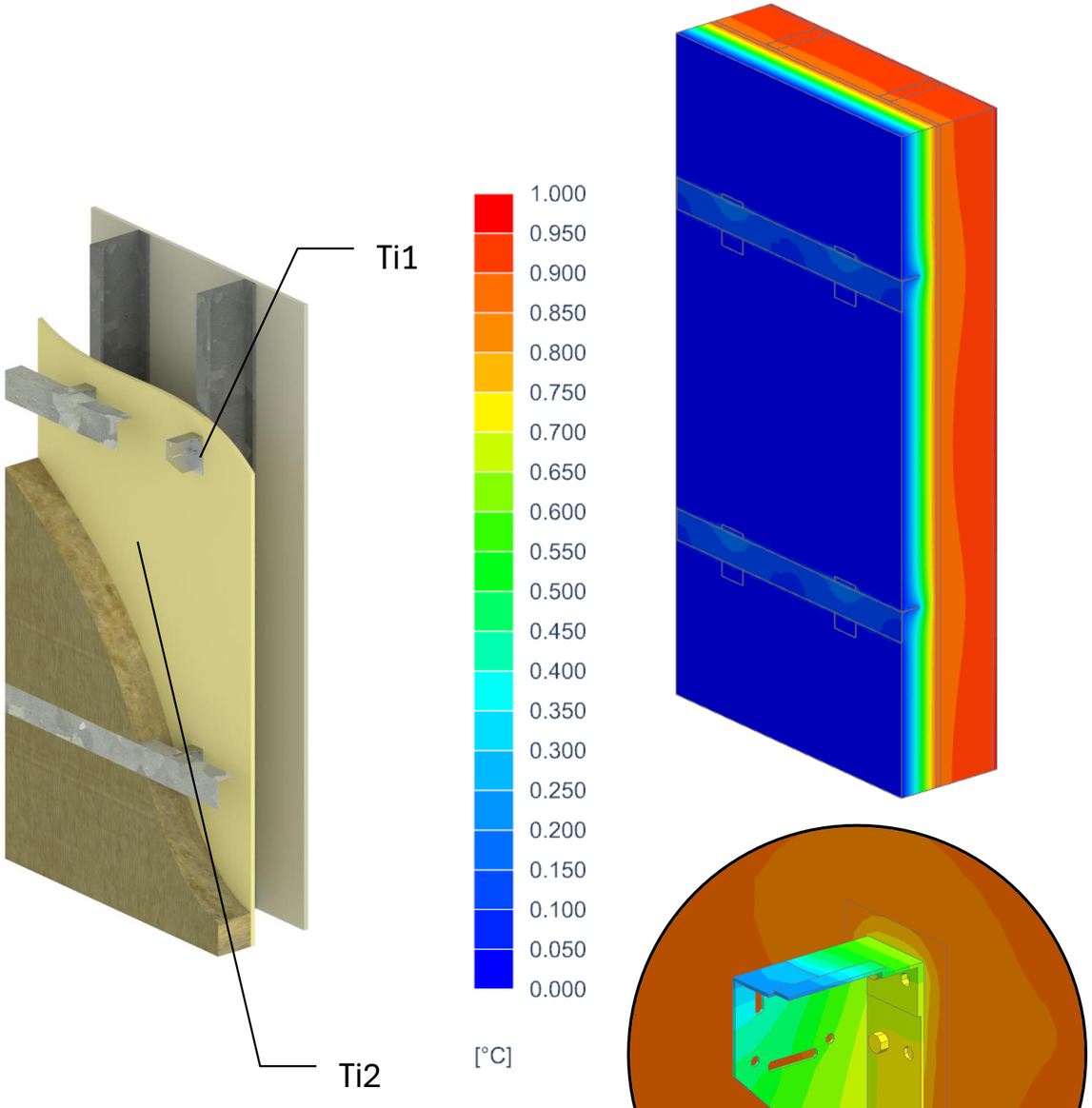


TABLE 1	THERMAL RESULTS FOR UNINSULATED STEEL STUD BACKUP WALL			
Clip	**Exterior Insulation Thickness**	**Exterior Insulation 1D R-value** ft²·hr·°F/Btu (m²·K/W)	**16” x 32” Spacing**	
			U_o Btu/ft²·hr·°F (W/m²·K)	**R_o** ft²·hr·°F/Btu (m²·K/W)
Stainless Steel	4”	R-17.2 (3.03 RSI)	0.058 (0.328)	**R-17.3** (3.04 RSI)
	6”	R-25.8 (4.54 RSI)	0.042 (0.236)	**R-24.0** (4.23 RSI)

TABLE 2	TEMPERATURE INDICES FOR UNINSULATED STEEL STUD BACKUP WALL	
Temperature Indices	**16” x 32” Spacing** R17.2	Location
Ti1	0.814	Min T on interior sheathing face at fastener
Ti2	0.901	Max T on interior sheathing face between studs away from fastener

*temperature indices are from 4” scenario

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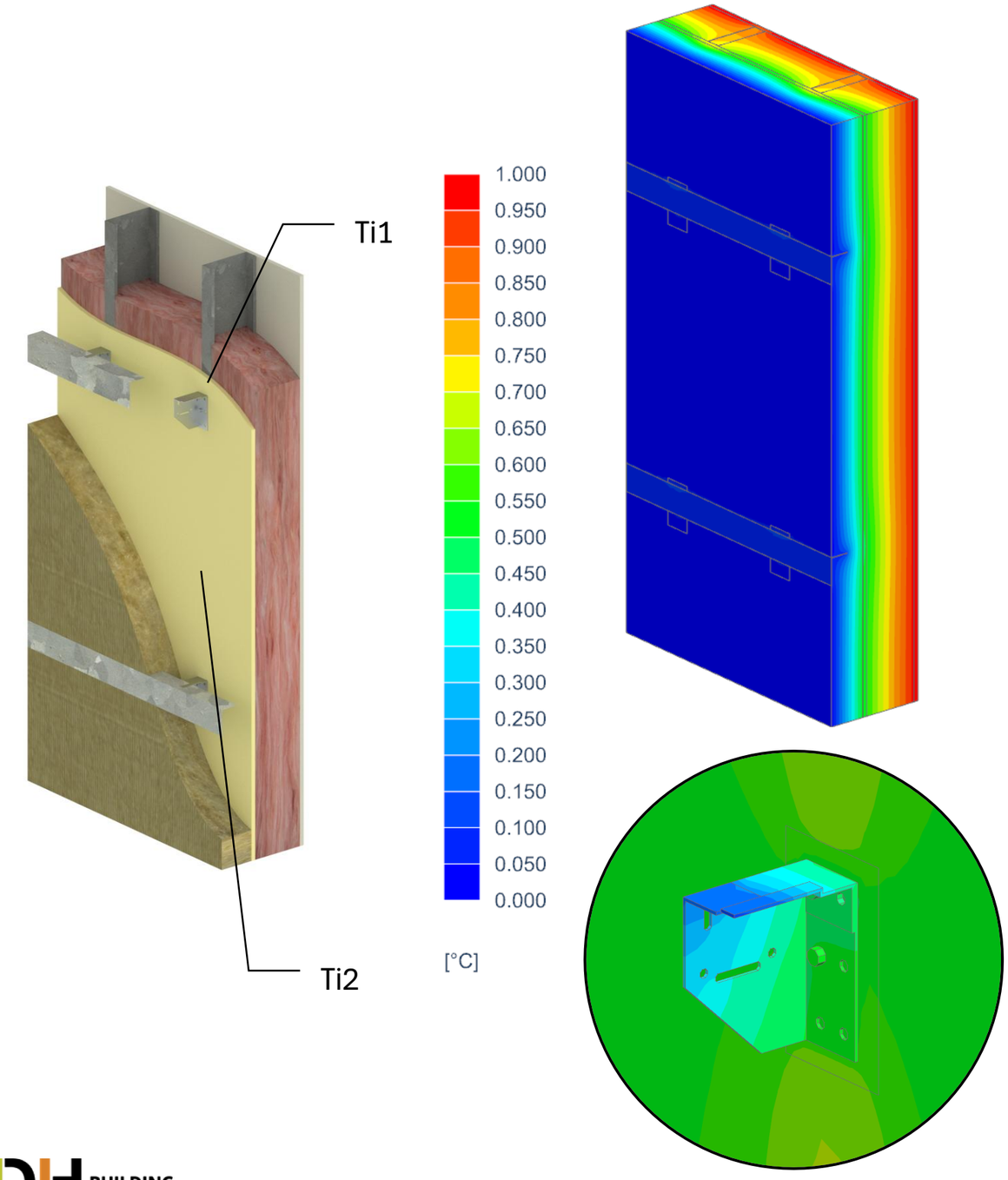
RESULTS | Stainless Steel Clip - Insulated Steel Stud



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Clip	**Exterior Insulation Thickness**	**Exterior Insulation 1D R-value** ft²·hr·°F/Btu (m²·K/W)	**16” x 32” Spacing**	
			U_o Btu/ft²·hr·°F (W/m²·K)	**R_o** ft²·hr·°F/Btu (m²·K/W)
Stainless Steel	4”	R-17.2 (3.03 RSI)	0.039 (0.220)	**R-25.8** (4.55 RSI)
	6”	R-25.8 (4.54 RSI)	0.031 (0.177)	**R-32.0** (5.64 RSI)

TABLE 2	TEMPERATURE INDICES FOR UNINSULATED STEEL STUD BACKUP WALL	
Temperature Indices	**16” x 32” Spacing** R17.2	Location
Ti1	0.505	Min T on interior sheathing between studs aligned with fastener
Ti2	0.755	Max T on interior sheathing at stud away from fastener

*temperature indices are from 4” scenario

RESULTS | Galvanized Steel Clip - Uninsulated Steel Stud

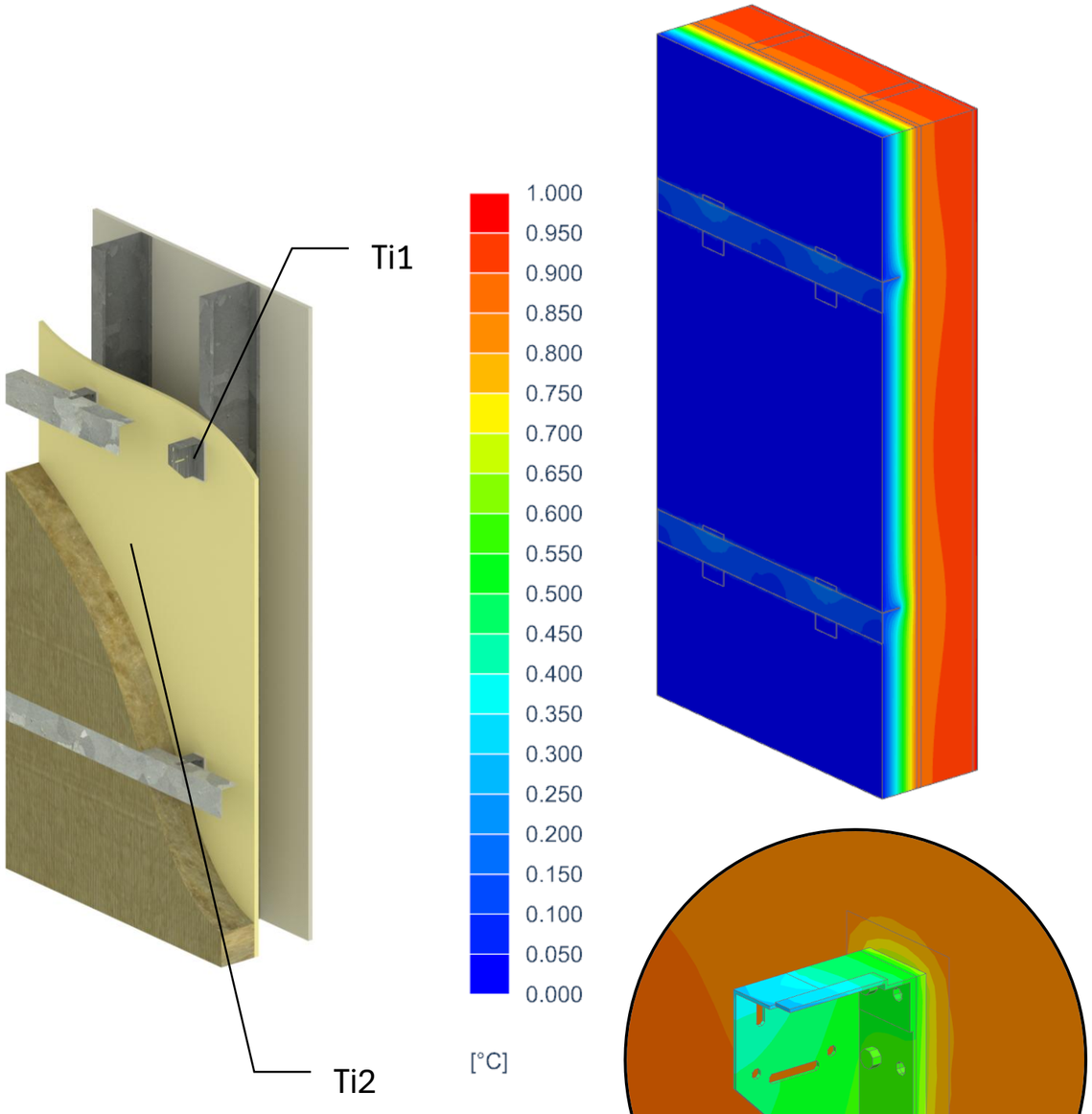

TABLE 1	THERMAL RESULTS FOR UNINSULATED STEEL STUD BACKUP WALL			
Clip	**Exterior Insulation Thickness**	**Exterior Insulation 1D R-value** ft²·hr·°F/Btu (m²·K/W)	**16” x 32” Spacing**	
			U_o Btu/ft²·hr·°F (W/m²·K)	**R_o** ft²·hr·°F/Btu (m²·K/W)
Galvanized Steel + Thermal Pad	4”	R-17.2 (3.03 RSI)	0.061 (0.345)	**R-16.5** (2.90 RSI)
	6”	R-25.8 (4.54 RSI)	0.042 (0.236)	**R-24.1** (4.24 RSI)

TABLE 2	TEMPERATURE INDICES FOR UNINSULATED STEEL STUD BACKUP WALL	
Temperature Indices	**16” x 32” Spacing** R17.2	Location
Ti1	0.784	Min T on interior sheathing face at fastener
Ti2	0.898	Max T on interior sheathing face between studs away from fastener

*temperature indices are from 4” scenario

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RESULTS | Galvanized Steel Clip - Insulated Steel Stud

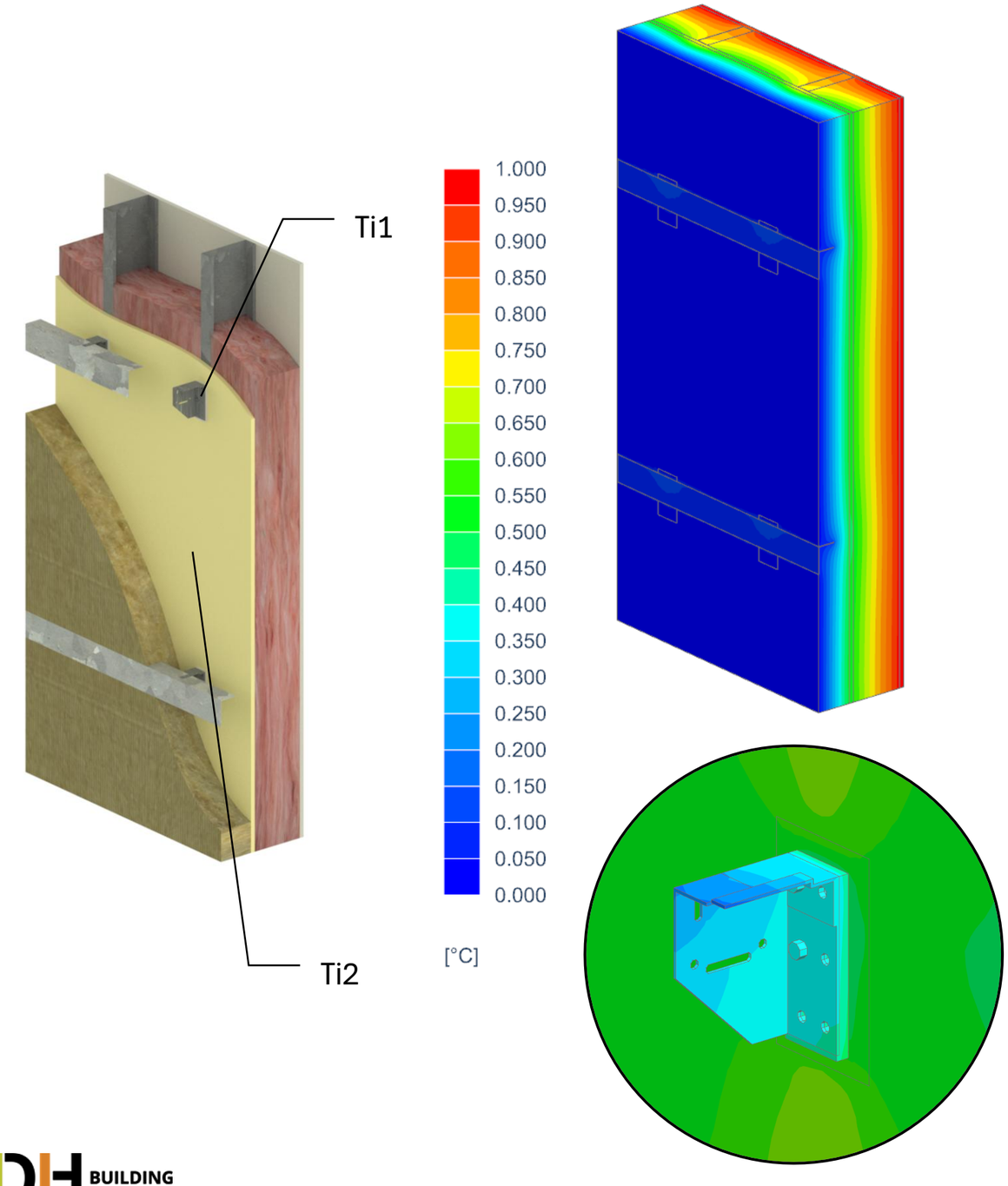

TABLE 1	THERMAL RESULTS FOR UNINSULATED STEEL STUD BACKUP WALL			
Clip	**Exterior Insulation Thickness**	**Exterior Insulation 1D R-value** ft²·hr·°F/Btu (m²·K/W)	**16” x 32” Spacing**	
			U_o Btu/ft²·hr·°F (W/m²·K)	**R_o** ft²·hr·°F/Btu (m²·K/W)
Galvanized Steel + Thermal Pad	4”	R-17.2 (3.03 RSI)	0.040 (0.228)	**R-24.9** (4.39 RSI)
	6”	R-25.8 (4.54 RSI)	0.031 (0.177)	**R-32.1** (5.66 RSI)

TABLE 2	TEMPERATURE INDICES FOR UNINSULATED STEEL STUD BACKUP WALL	
Temperature Indices	**16” x 32” Spacing** R17.2	Location
Ti1	0.500	Min T on interior sheathing between studs aligned with fastener
Ti2	0.748	Max T on interior sheathing at stud away from fastener

*temperature indices are from 4” scenario

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RESULTS | Stainless Steel Clip – Wood Stud R-19 Batt

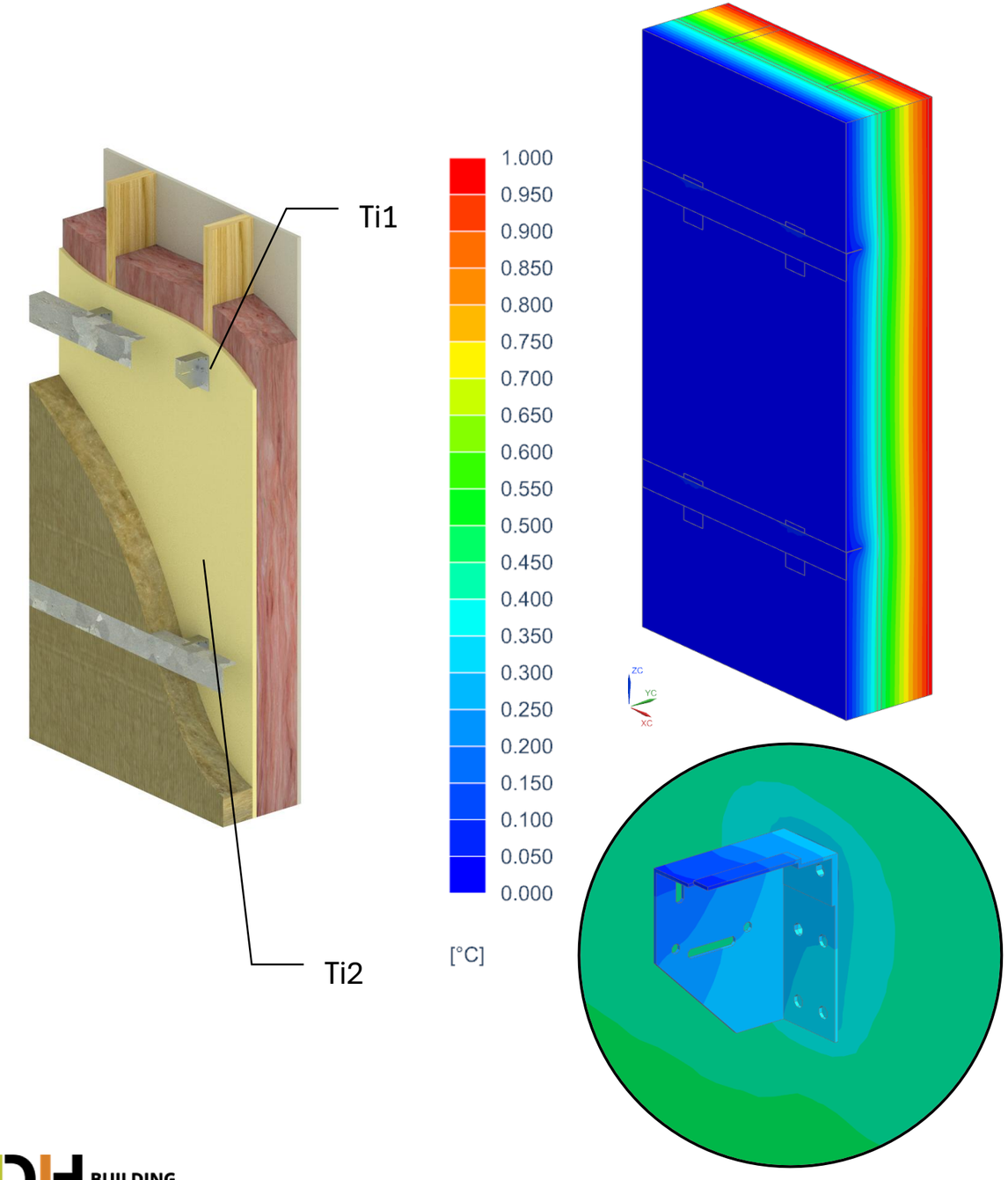


TABLE 1	THERMAL RESULTS FOR UNINSULATED STEEL STUD BACKUP WALL			
Clip	**Exterior Insulation Thickness**	**Exterior Insulation 1D R-value** ft²·hr·°F/Btu (m²·K/W)	**16” x 32” Spacing**	
			U_o Btu/ft²·hr·°F (W/m²·K)	**R_o** ft²·hr·°F/Btu (m²·K/W)
Stainless Steel	4”	R-17.2 (3.03 RSI)	0.030 (0.170)	**R-33.4** (5.88 RSI)
	6”	R-25.8 (4.54 RSI)	0.025 (0.141)	**R-40.3** (7.09 RSI)

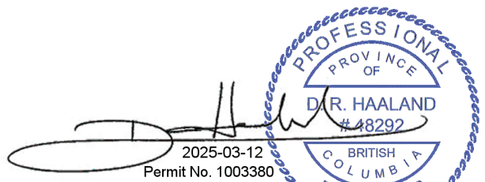
TABLE 2	TEMPERATURE INDICES FOR UNINSULATED STEEL STUD BACKUP WALL	
Temperature Indices	**16” x 32” Spacing** R17.2	Location
Ti1	0.305	Min T on interior sheathing at fastener
Ti2	0.547	Max T on interior sheathing at stud away from fastener

*temperature indices are from 4” scenario

CLOSING

We trust this reports meets your requirements for the thermal analysis of the ThermaKlip system. Please do not hesitate to contact us with any questions you might have.

AUTHORS



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Fabio Almeida | Ph.D.
Building Science Engineer

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APPENDIX A | Simulation Notes

A.1 Additional Assumptions

In addition to the standard modelling assumptions, the following assumptions were made for the assembly:

- Steady state conditions with no solar heating
- The clear field modelling does not include the impacts of the thermal bridging from interface details, such as balcony slabs, parapets or window transitions. It only includes repeated thermal bridges such as studs and clips.
- Constant isotropic material properties from the ASHRAE Handbook of Fundamentals, and NFRC 101
- Equivalent conductivities for glazing and air cavities were determined using ISO 10077-2.
- The insulation was assumed to be installed tight to the clips and substrate with no gaps.
- Based on ASHRAE- 1365-RP and CSA Z5010, contact resistances between materials were used, and are shown in A.2.
- Placement and thicknesses of weather barriers and membranes were assumed to have no impact.
- Any air leakage through the assembly is not included.
- Air spaces are included as unventilated frame cavities using the equivalent thermal conductivity method presented in ISO 10077.
- Exterior cladding systems was indirectly simulated using a protected air film. This approach is considered conservative and permits results to be used more broadly for a range of similar cladding options.

A.2 Contact Resistances

Table A1 below presents the contact resistances assumed in the analysis, as per ASHRAE 1365-RP and CSA Z5010.

TABLE A1 CONTACT RESISTANCES

Boundary Conditions	Contact Resistances $ft^2 \cdot °F\ hr / BTU$ ($m2 \cdot K / W$)
Steel Flanges at Sheathing Interfaces	0.170 (0.030)
Steel to Steel Interfaces	0.051 (0.002)
Insulation Interfaces	0.254 (0.010)

A.3 Boundary Conditions

Values for the boundary conditions used in the analysis are shown below in Table A2. These values were derived from the ASHRAE Handbook of Fundamentals and CSA Z5010.

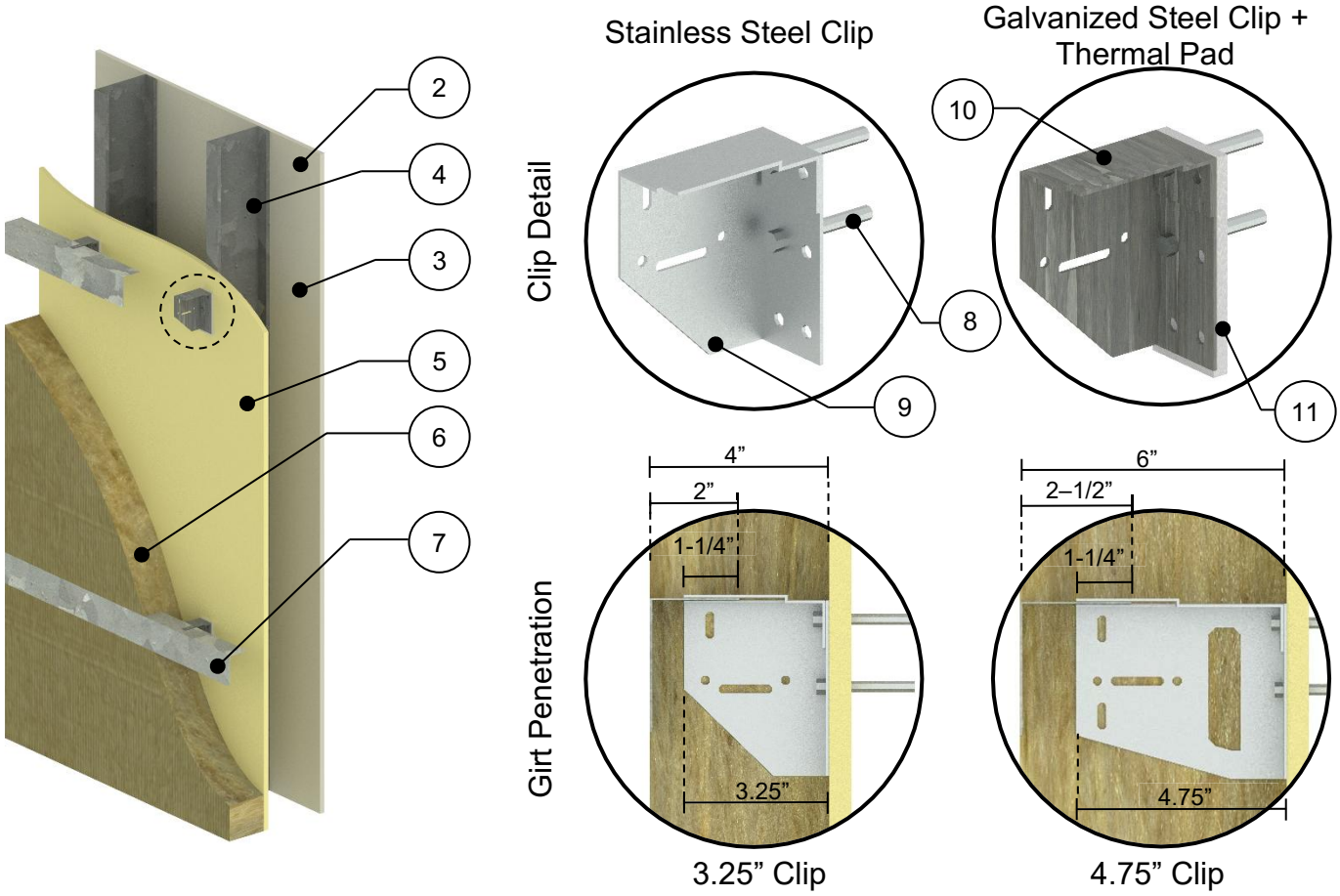
TABLE A2 BOUNDARY CONDITIONS

Location	Thermal Resistances $ft^2 \cdot °F\ hr / BTU$ ($m2 \cdot K / W$)
Exterior (15 mph wind)	0.170 (0.03)
Exterior (protected)	0.681 (0.12)
Interior (opaque wall)	0.681 (0.12)

APPENDIX B | System Data Sheets

Detail 1.1.1

Exterior Insulated 6” x 1 5/8” Steel Stud Wall Assembly with ThermaKlip supporting Horizontal Sub-girts – Clear Wall

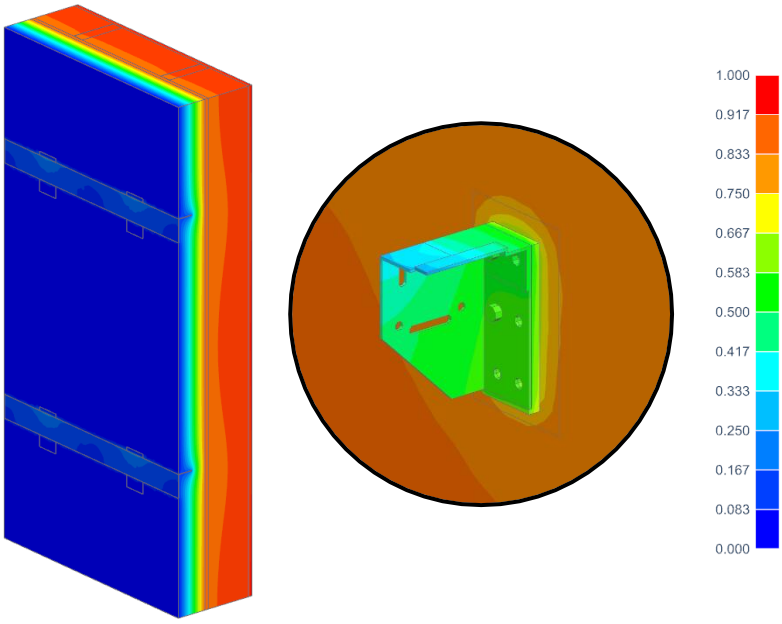


ID	Component	Thickness Inches (mm)	Conductivity Btu·in / ft²·hr·°F (W/m K)	Nominal Resistance hr·ft²·°F/Btu (m²K/W)	Density lb/ft³ (kg/m³)	Specific Heat Btu/lb·°F (J/kg K)
1	Interior Film[1]	-	-	R-0.7 (0.12 RSI)	-	-
2	Gypsum Board	1/2” (12.7)	1.1 (0.16)	R-0.5 (0.08 RSI)	50 (800)	0.26 (1090)
3	Air in Stud Cavity	6” (152)	-	R-0.91 (0.16 RSI)	0.075 (1.2)	0.24 (1000)
4	6” x 1 5/8” Steel Studs	18 Gauge	360 (52)	-	489 (7830)	0.12 (500)
5	Exterior Sheathing	1/2” (12.7)	1.1 (0.16)	R-0.5 (0.08 RSI)	50 (800)	0.26 (1090)
6	Exterior Mineral Wool Insulation	4”, 6” (102, 152)	0.23 (0.034)	R-17.2 (3.03 RSI), R-25.8 (4.54 RSI)	4 (64)	0.20 (850)
7	Steel L-Shaped Girt	18 Gauge	360 (52)	-	489 (7830)	0.12 (500)
8	#14 Stainless-Steel Fasteners	1/4” (6.5) Ø	118 (17)	-	500 (8000)	0.12 (500)
9	ThermaKlip – Stainless Steel	14 Gauge	118 (17)	-	500 (8000)	0.12 (500)
10	ThermaKlip – Galvanized Steel	14 Gauge	360 (52)	-	489 (7830)	0.12 (500)
11	Polyamide Thermal Pad	1/4" (6)	1.7 (0.25)	-	-	-
12	Exterior Film[1]	-	-	R-0.7 (0.12 RSI)	-	-

[1] Value selected from table 1, p. 26.1 of 2009 ASHRAE Handbook – Fundamentals depending on surface orientation.

Detail 1.1.1

Exterior Insulated 6” x 1 5/8” Steel Stud Wall Assembly with ThermaKlip supporting Horizontal Sub-girts – Clear Wall



View from Exterior View of Clip

*3.25” galvanized steel clip and thermal pad scenario is shown

Thermal Performance Indicators

Assembly 1D R-Value	R_{1D}	R-3.2 (0.56 RSI) + exterior insulation
Transmittance / Resistance	U_o, R_o	“Clear Wall” U- and R-value

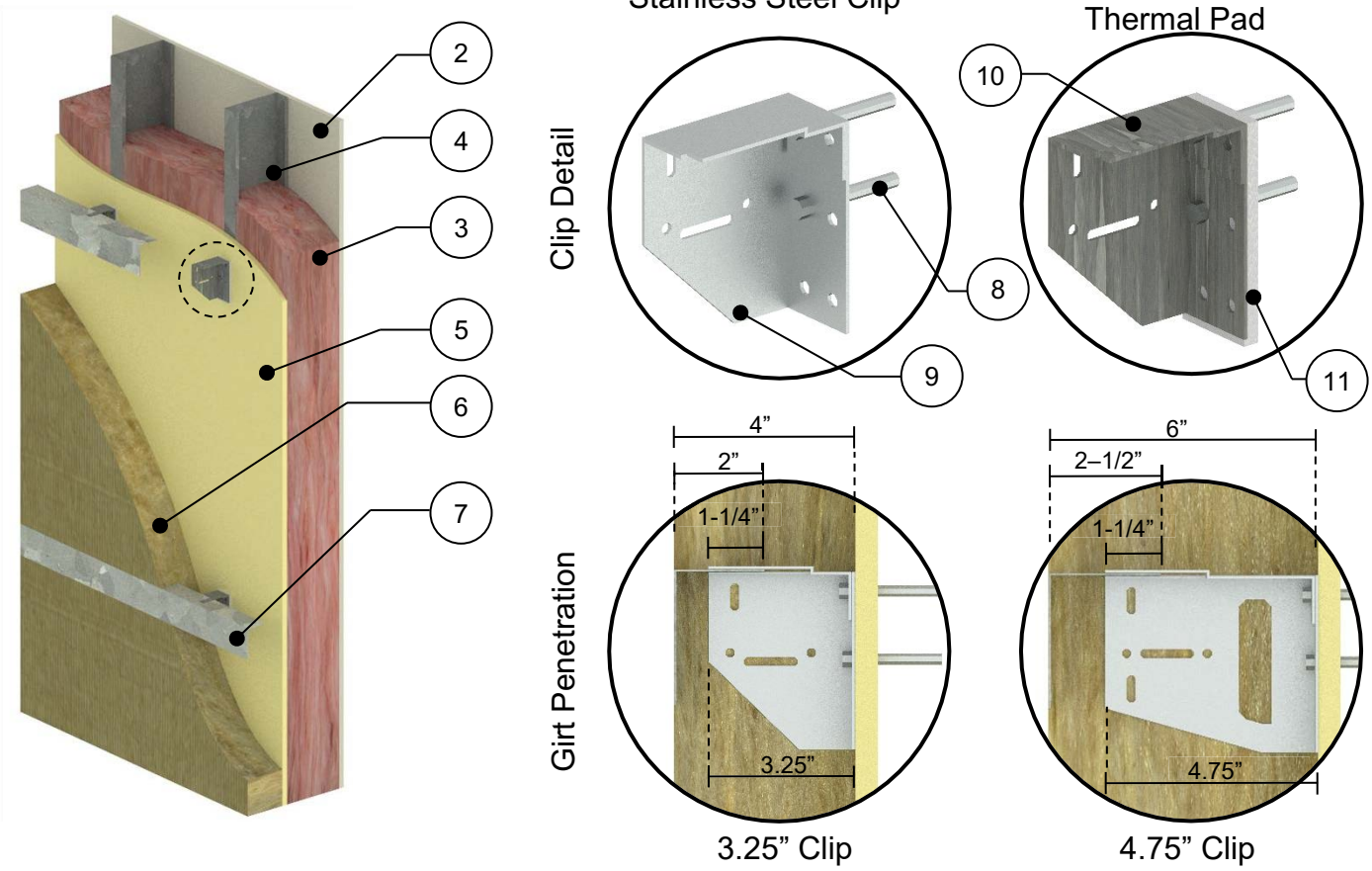
[1] Assumptions and limitations for surface temperatures identified in ASHRAE 1365-RP.

Nominal (1D) vs. Assembly Performance Indicators

Exterior Insulation 1D R-Value (RSI)	R_{1D} $ft^2 \cdot hr \cdot {}^oF$ / Btu (m^2 K / W)	Stainless Steel Clip		Galvanized Steel Clip	
		R_o $ft^2 \cdot hr \cdot {}^oF$ / Btu (m^2 K / W)	U_o Btu/ft^2 $\cdot hr \cdot {}^oF$ (W/m^2 K)	R_o $ft^2 \cdot hr \cdot {}^oF$ / Btu (m^2 K / W)	U_o Btu/ft^2 $\cdot hr \cdot {}^oF$ (W/m^2 K)
R-17.2 (3.03)	R-20.4 (3.59)	R-17.3 (3.04)	0.058 (0.328)	R-16.5 (2.90)	0.061 (0.345)
R-25.8 (4.54)	R-29.0 (5.10)	R-24.0 (4.23)	0.042 (0.236)	R-24.1 (4.24)	0.042 (0.236)

Detail 1.1.2

Exterior Insulated 6” x 1 5/8” Steel Stud Wall Assembly with ThermaKlip supporting Horizontal Sub-girts and R-19 Batt Insulation in Stud Cavity – Clear Wall

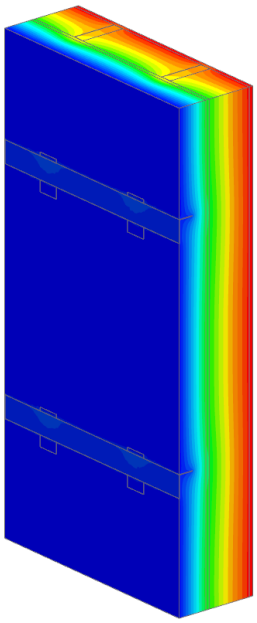


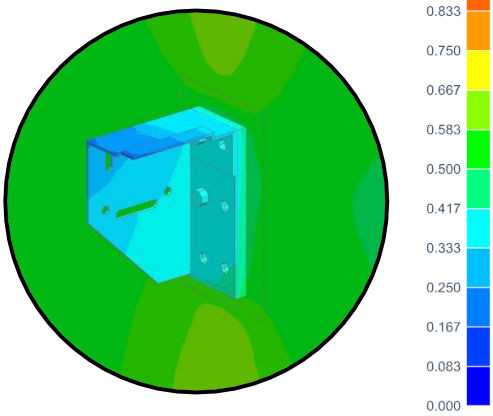
ID	Component	Thickness Inches (mm)	Conductivity Btu·in / ft²·hr·°F (W/m K)	Nominal Resistance hr·ft²·°F/Btu (m²K/W)	Density lb/ft³ (kg/m³)	Specific Heat Btu/lb·°F (J/kg K)
1	Interior Film[1]	-	-	R-0.7 (0.12 RSI)	-	-
2	Gypsum Board	1/2” (12.7)	1.1 (0.16)	R-0.5 (0.08 RSI)	50 (800)	0.26 (1090)
3	Fiberglass Batt Insulation	6” (152)	-	R-19 (3.35 RSI)	0.9 (14)	0.17 (710)
4	6” x 1 5/8” Steel Studs	18 Gauge	360 (52)	-	489 (7830)	0.12 (500)
5	Exterior Sheathing	1/2” (12.7)	1.1 (0.16)	R-0.5 (0.08 RSI)	50 (800)	0.26 (1090)
6	Exterior Mineral Wool Insulation	4”, 6” (102, 152)	0.23 (0.034)	R-17.2 (3.03 RSI), R-25.8 (4.54 RSI)	4 (64)	0.20 (850)
7	Steel L-Shaped Girt	18 Gauge	360 (52)	-	489 (7830)	0.12 (500)
8	#14 Stainless-Steel Fasteners	1/4” (6.5) Ø	118 (17)	-	500 (8000)	0.12 (500)
9	ThermaKlip – Stainless Steel	14 Gauge	118 (17)	-	500 (8000)	0.12 (500)
10	ThermaKlip – Galvanized Steel	14 Gauge	360 (52)	-	489 (7830)	0.12 (500)
11	Polyamide Thermal Pad	1/4" (6)	1.7 (0.25)	-	-	-
12	Exterior Film[1]	-	-	R-0.7 (0.12 RSI)	-	-

[1] Value selected from table 1, p. 26.1 of 2009 ASHRAE Handbook – Fundamentals depending on surface orientation.

Detail 1.1.2

Exterior Insulated 6” x 1 5/8” Steel Stud Wall Assembly with ThermaKlip supporting Horizontal Sub-girts and R-19 Batt Insulation in Stud Cavity – Clear Wall





View from Exterior View of Clip

*3.25” galvanized steel clip and thermal pad scenario is shown

Thermal Performance Indicators

Assembly 1D R-Value	R_{1D}	R-21.3 (3.75 RSI) + exterior insulation
Transmittance / Resistance	U_o, R_o	“Clear Wall” U- and R-value

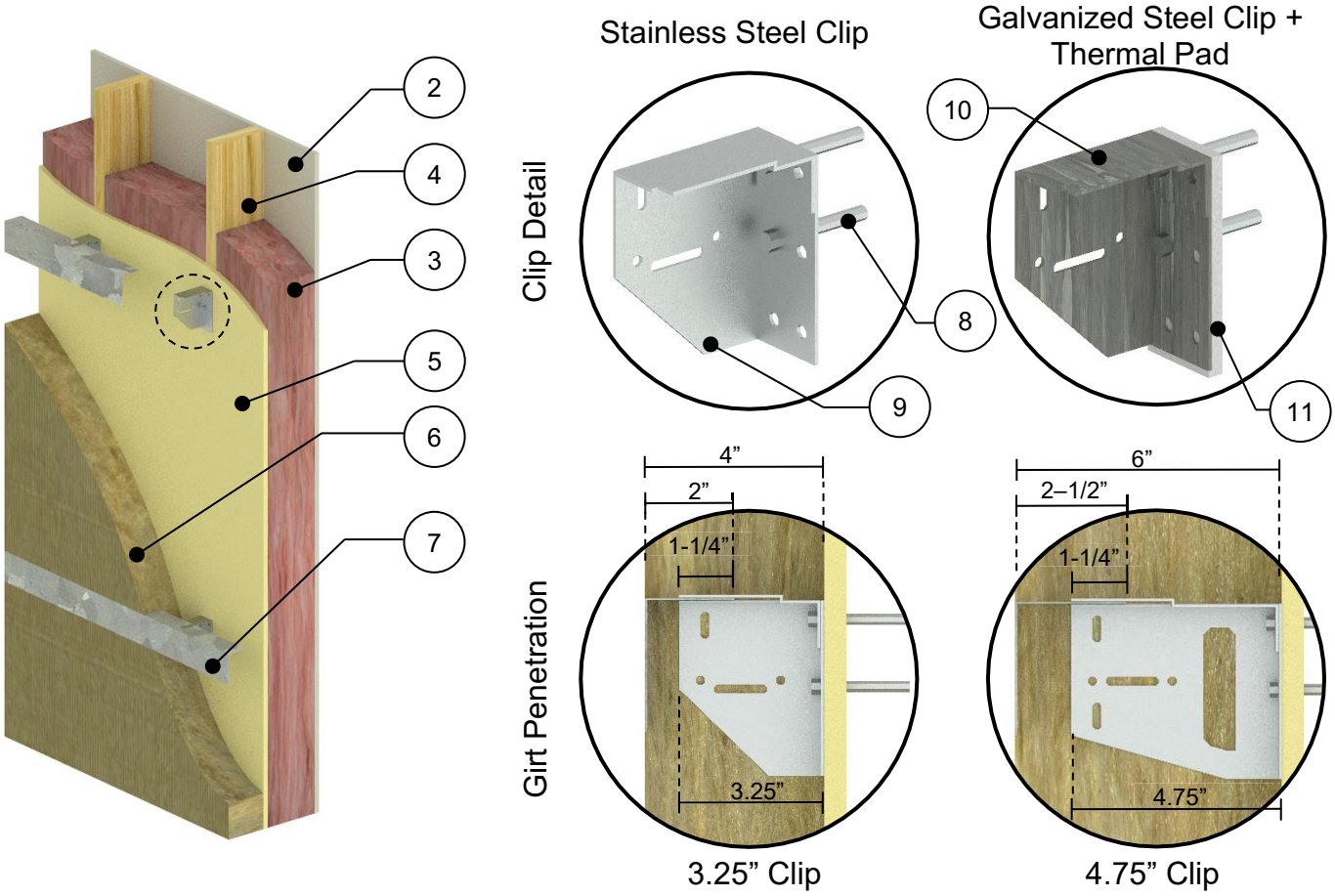
[1] Assumptions and limitations for surface temperatures identified in ASHRAE 1365-RP.

Nominal (1D) vs. Assembly Performance Indicators

Exterior Insulation 1D R-Value (RSI)	R_{1D} $ft^2 \cdot hr \cdot {}^oF$ / Btu (m^2 K / W)	Stainless Steel Clip		Galvanized Steel Clip	
		R_o $ft^2 \cdot hr \cdot {}^oF$ / Btu (m^2 K / W)	U_o Btu/ft^2 $\cdot hr \cdot {}^oF$ (W/m^2 K)	R_o $ft^2 \cdot hr \cdot {}^oF$ / Btu (m^2 K / W)	U_o Btu/ft^2 $\cdot hr \cdot {}^oF$ (W/m^2 K)
R-17.2 (3.03)	R-38.5 (6.78)	R-25.8 (4.55)	0.039 (0.220)	R-24.9 (4.39)	0.040 (0.228)
R-25.8 (4.54)	R-47.1 (8.29)	R-32.0 (5.64)	0.031 (0.177)	R-32.1 (5.66)	0.031 (0.177)

Detail 1.1.3

Split Insulated 2x6 Wood Stud Wall Assembly with ThermaKlip supporting Horizontal Sub-girts and R-19 Batt Insulation in Stud Cavity – Clear Wall

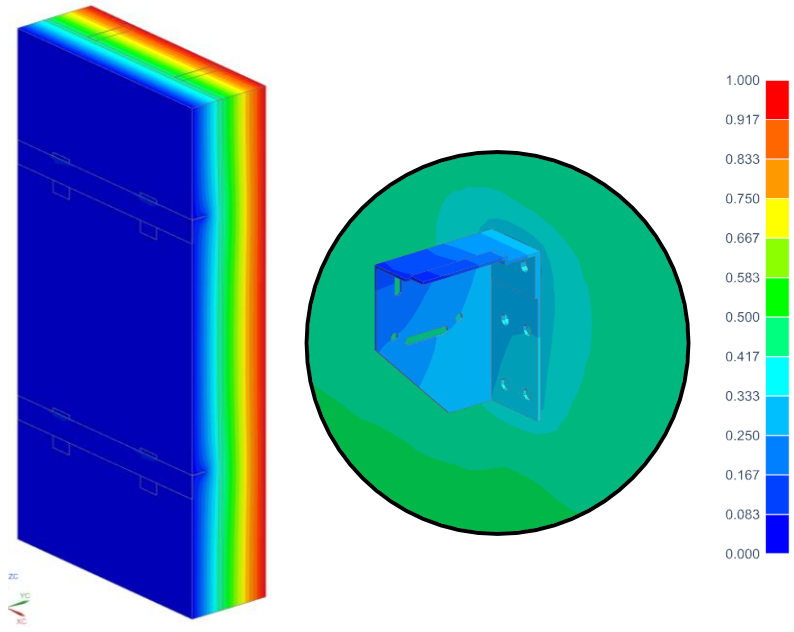


ID	Component	Thickness Inches (mm)	Conductivity Btu·in / ft²·hr·°F (W/m K)	Nominal Resistance hr·ft²·°F/Btu (m²K/W)	Density lb/ft³ (kg/m³)	Specific Heat Btu/lb·°F (J/kg K)
1	Interior Film[1]	-	-	R-0.7 (0.12 RSI)	-	-
2	Gypsum Board	1/2” (12.7)	1.1 (0.16)	R-0.5 (0.08 RSI)	50 (800)	0.26 (1090)
3	Fiberglass Batt Insulation	5-1/2” (140)	-	R-19 (3.35 RSI)	0.9 (14)	0.17 (710)
4	2x6 Wood Studs	5-1/2” (140)	0.8 (0.12)	-	31 (500)	0.45 (1880)
5	Exterior Sheathing	1/2” (12.7)	1.1 (0.16)	R-0.5 (0.08 RSI)	50 (800)	0.26 (1090)
6	Exterior Mineral Wool Insulation	4”, 6” (102, 152)	0.23 (0.034)	R-17.2 (3.03 RSI), R-25.8 (4.54 RSI)	4 (64)	0.20 (850)
7	Steel L-Shaped Girt	18 Gauge	360 (52)	-	489 (7830)	0.12 (500)
8	#14 Stainless-Steel Fasteners	1/4” (6.5) Ø	118 (17)	-	500 (8000)	0.12 (500)
9	ThermaKlip – Stainless Steel	14 Gauge	118 (17)	-	500 (8000)	0.12 (500)
10	ThermaKlip – Galvanized Steel	14 Gauge	360 (52)	-	489 (7830)	0.12 (500)
11	Polyamide Thermal Pad	1/4" (6)	1.7 (0.25)	-	-	-
10	Exterior Film[1]	-	-	R-0.7 (0.12 RSI)	-	-

[1] Value selected from table 1, p. 26.1 of 2009 ASHRAE Handbook – Fundamentals depending on surface orientation.

Detail 1.1.3

Split Insulated 2x6 Wood Stud Wall Assembly with ThermaKlip supporting Horizontal Sub-girts and R-19 Batt Insulation in Stud Cavity – Clear Wall



View from Exterior View of Clip

*3.25" stainless steel clip scenario is shown

Thermal Performance Indicators

Assembly 1D R-Value	R_{1D}	R-21.3 (3.75 RSI) + exterior insulation
Transmittance / Resistance	U_o, R_o	"Clear Wall" U- and R-value

[1] Assumptions and limitations for surface temperatures identified in ASHRAE 1365-RP.

Nominal (1D) vs. Assembly Performance Indicators

Exterior Insulation 1D R-Value (RSI)	R_{1D} $ft^2 \cdot hr \cdot {}^oF$ / Btu (m^2 K / W)	Stainless Steel Clip		Galvanized Steel Clip	
		R_o $ft^2 \cdot hr \cdot {}^oF$ / Btu (m^2 K / W)	U_o Btu/ft^2 $\cdot hr \cdot {}^oF$ (W/m^2 K)	R_o $ft^2 \cdot hr \cdot {}^oF$ / Btu (m^2 K / W)	U_o Btu/ft^2 $\cdot hr \cdot {}^oF$ (W/m^2 K)
R-17.2 (3.03)	R-38.5 (6.78)	R-33.4 (5.88)	0.030 (0.170)	R-31.9 (5.62)	0.031 (0.178)
R-25.8 (4.54)	R-47.1 (8.29)	R-40.3 (7.09)	0.025 (0.141)	R-39.0 (6.88)	0.026 (0.145)