October 24, 2025

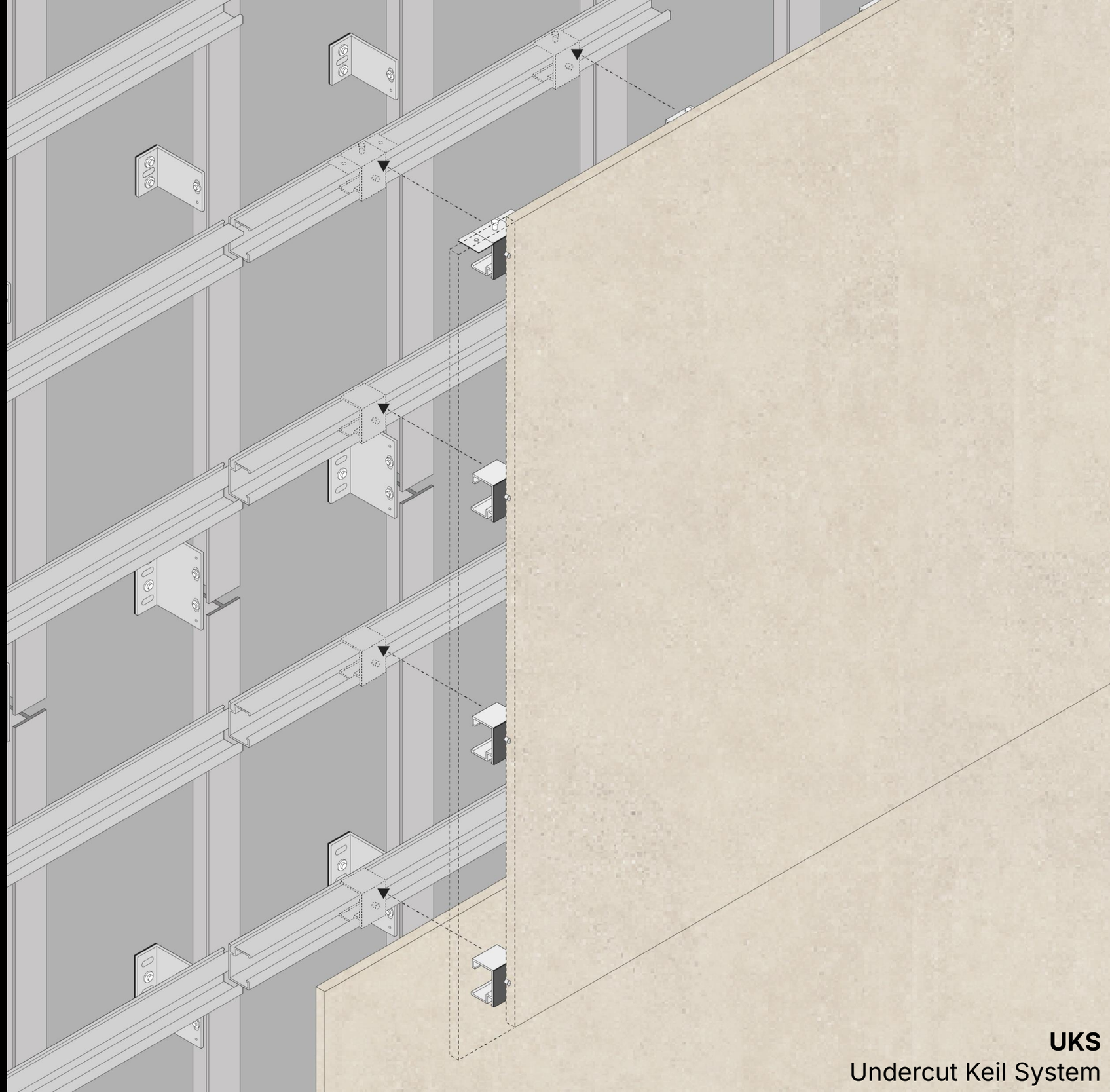
PORCELANOSA
FACADES

3D Thermal Simulation of UKS Cladding Attachment System

PREPARED FOR

PORCELANOSA FACADES

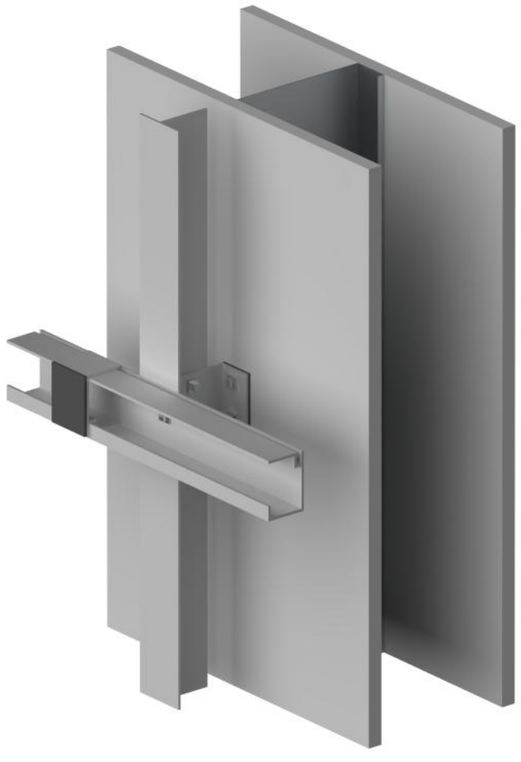
RDH BUILDING SCIENCE



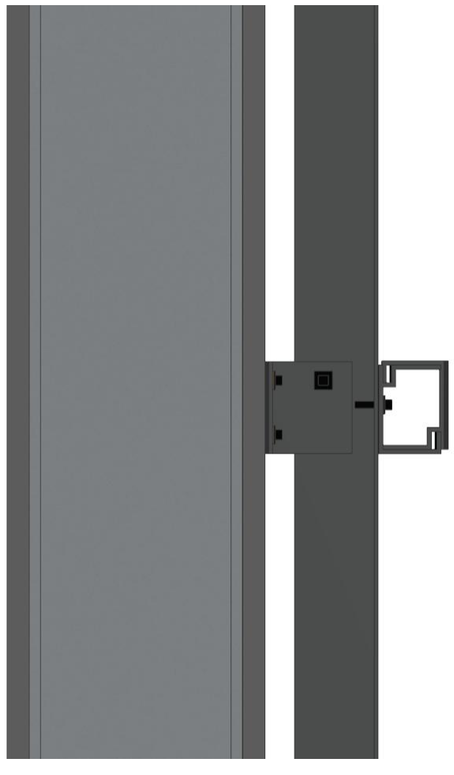
UKS
Undercut Keil System

SYSTEM DESCRIPTION | UKS Full Rainscreen

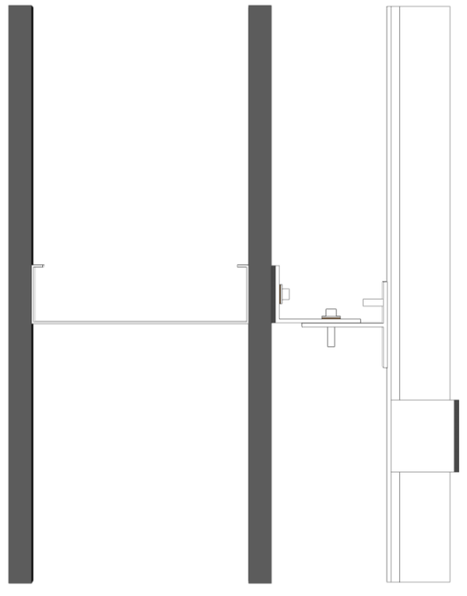
The Undercut Keil System is a ventilated façade solution developed by Porcelanosa. It's designed for pre-set sized and large-format porcelain cladding. UKS is a mechanical concealed fixing system with a substructure and hidden undercut keil anchors fastened to the back of porcelain panels. It includes a clip and rail cladding attachment system consisting of an intermittent aluminum bracket and a crossing aluminum rails as shown below in the case of a steel framed wall. The UKS profiles allow for cladding adjustability. Variations in insulation depth up to 5" are accommodated with varying lengths of brackets through the insulation. The brackets are fastened at the base through a non-conductive shim to the substrate.



UKS System
(Insulation Hidden)

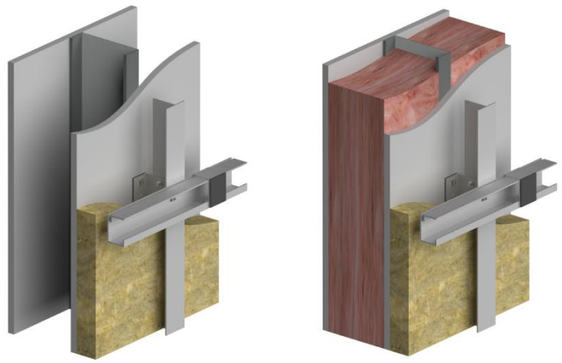


Section View



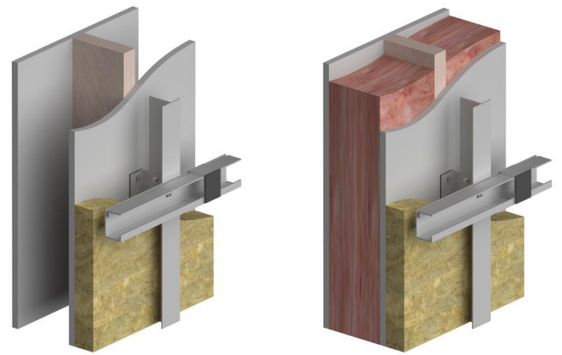
Plan View

SIMULATED CONFIGURATIONS | UKS Full Rainscreen



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

- **Sheathing:** 5/8” Interior gypsum board; 5/8” 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
- **Thermal Pad:** 3mm HDPE thermal pad between L-angle and sheathing
- **Bracket:** Aluminum L-angle oriented vertically at 24” o.c. vertical spacing
- **T-Profile:** Continuous Aluminum T-shape oriented vertically at 16” or 32” o.c. horizontal spacing
- **Undercut Keil System** Horizontal C-Profile with C-Bolt Clips and Thermal Pad at 16” o.c. horizontal spacing
- **Exterior Insulation:** R-4.3/in mineral wool insulation at 3” or 5” thickness



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

- **Sheathing:** 5/8” Interior gypsum board; 5/8” Exterior sheathing board
- **Wood Stud:** 2×6 wood studs with air or R-19 Batt in stud cavity at 16” o.c. horizontal spacing
- **Thermal Pad:** 3mm HDPE thermal pad between L-angle and sheathing
- **Bracket:** Aluminum L-angle oriented vertically at 24” o.c. vertical spacing
- **T-Profile:** Continuous Aluminum T-shape oriented vertically at 16” or 32” o.c. horizontal spacing
- **Undercut Keil System** Horizontal C-Profile with C-Bolt Clips and Thermal Pad at 16” o.c. horizontal spacing
- **Exterior Insulation:** R-4.3/in mineral wool insulation at 3” or 5” thickness

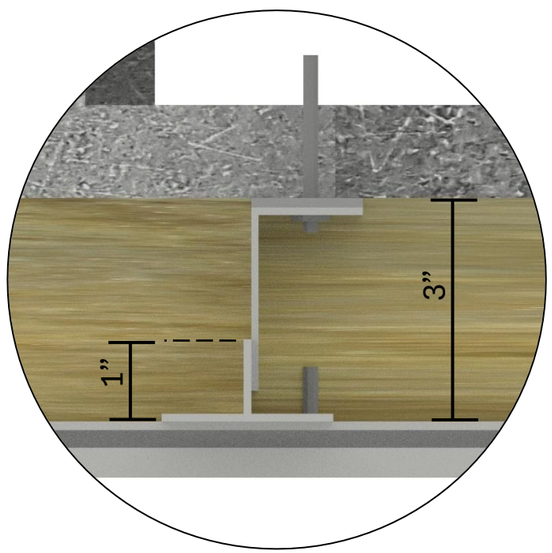
8” CMU Block Wall

- **CMU Wall:** 8”x16” CMU blocks with air in cavity
- **Thermal Pad:** 3mm HDPE thermal pad between L-angle and sheathing
- **Bracket:** Aluminum L-angle oriented vertically at 24” o.c. vertical spacing
- **T-Profile:** Continuous Aluminum T-shape oriented vertically at 16” or 32” o.c. horizontal spacing
- **Undercut Keil System** Horizontal C-Profile with C-Bolt Clips and Thermal Pad at 16” o.c. horizontal spacing
- **Exterior Insulation:** R-4.3/in mineral wool insulation at 3” or 5” thickness

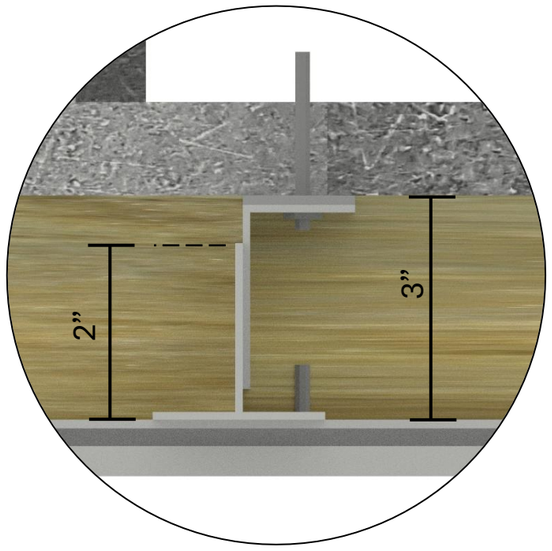
FACTORS AFFECTING THERMAL PERFORMANCE

A sensitivity analysis was conducted to assess the impact of possible system variations:
— T-profile penetration depth
— Number of fasteners
This sensitivity analysis was investigated for the scenario with 3″ of exterior insulation, 24″ vertical by 16″ horizontal bracket spacing on a CMU backup.

T-Profile Penetration

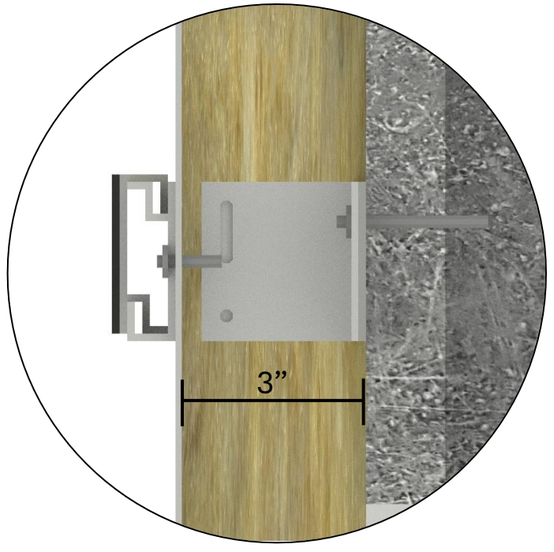


R-9.7 (1.71 RSI)

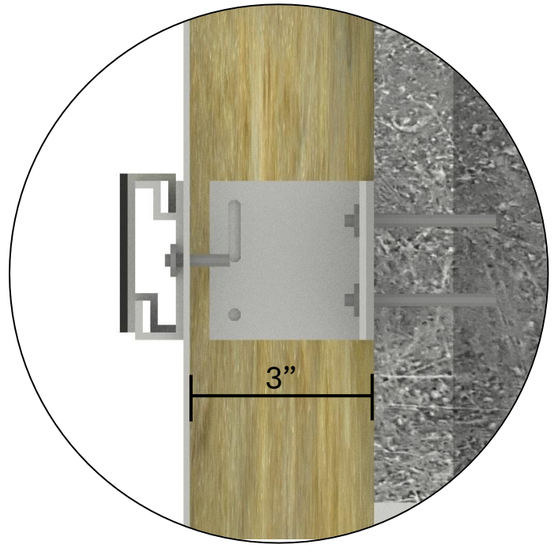


R-9.0 (1.59 RSI)

Number of Fasteners



R-9.2 (1.62 RSI)



R-9.0 (1.59 RSI)

METHODOLOGY & ASSUMPTIONS

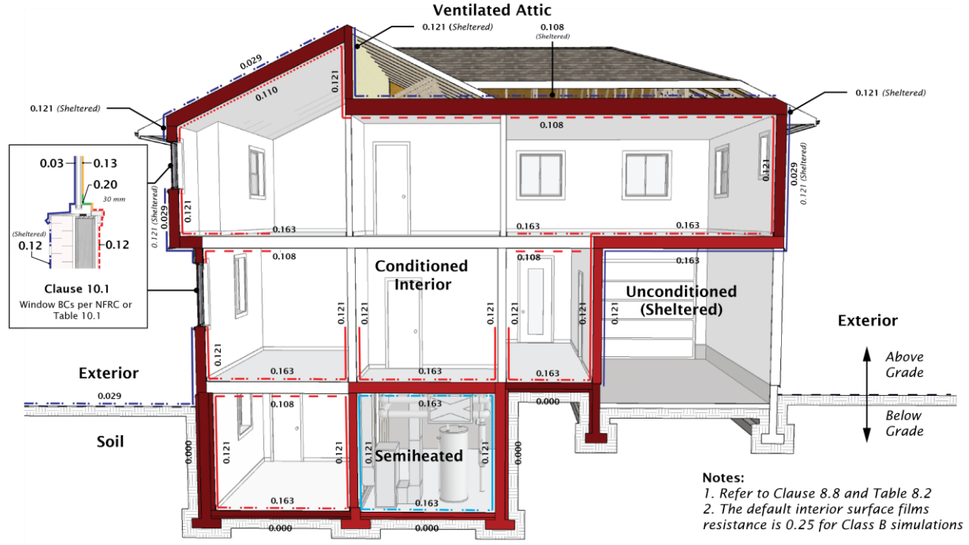
3D THERMAL SIMULATION

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.



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 / ft^2·hr·^{o}F (W/m K)
Drywall / Sheathing	1.1 (0.16)
Galvanized Steel	360.6 (52)
Aluminum	1109.4 (160)
Mineral Wool (R4.3/in.)	0.24 (0.034)
Fiber Batt (R-19)	0.32 (0.045)
HDPE Thermal Pad	3.5 (0.5)
Stainless Steel	117.9 (17)
Wood	0.97 (0.14)
CMU Block	10.4 (1.5)

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 Porcelanosa CAD drawings and brochures received June 11, 2025

RESULTS | UKS – Uninsulated Steel Stud

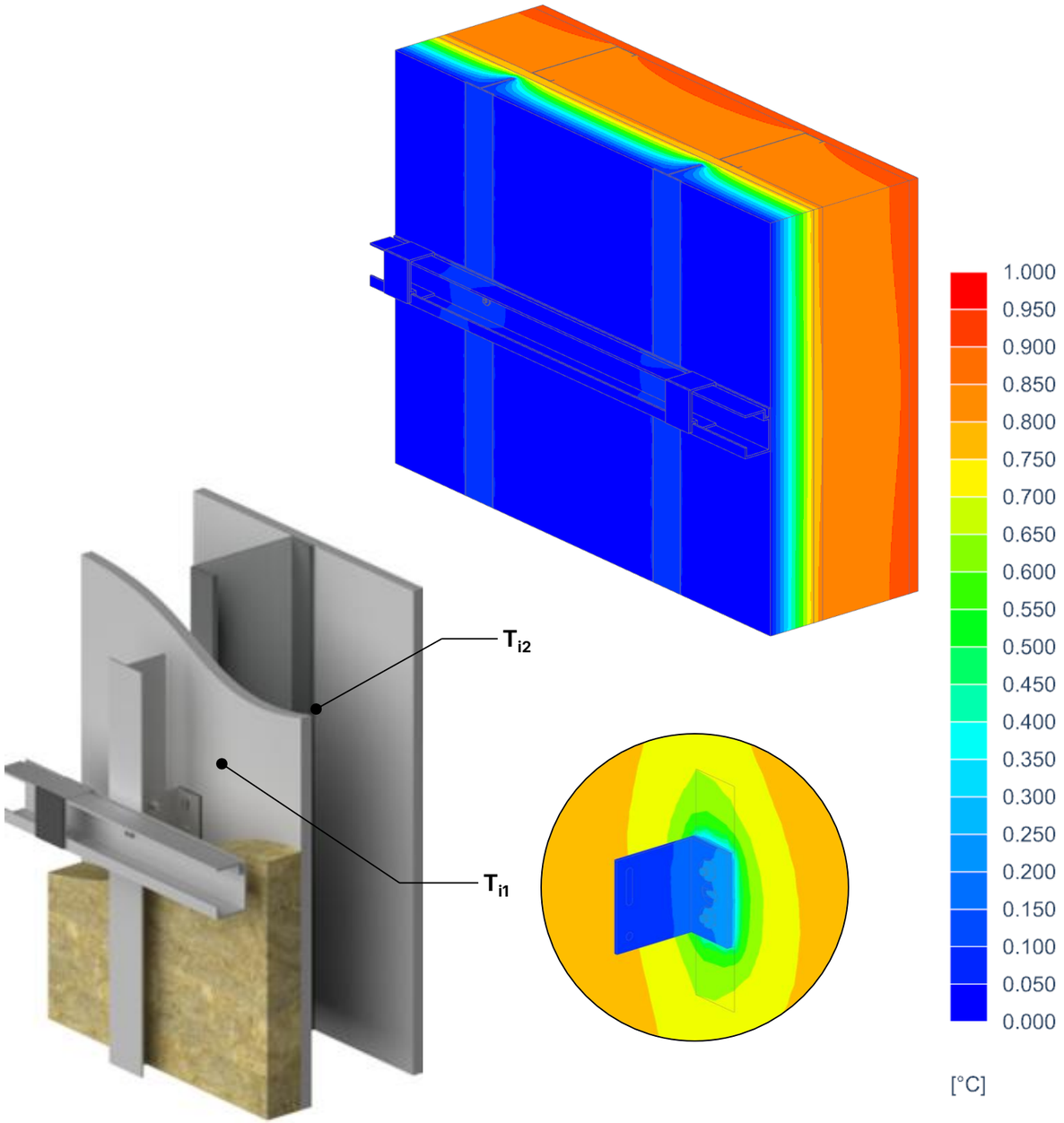


TABLE 1	THERMAL RESULTS FOR UNINSULATED STEEL STUD BACKUP WALL					
Exterior Insulation 1D R-Value (RSI)	R_{1D} $ft^2 \cdot hr \cdot °F$ / Btu (m^2 K / W)	16" x 24" Spacing		32" x 24" Spacing		
		R_o $ft^2 \cdot hr \cdot °F$ / Btu (m^2 K / W)	U_o Btu / ft^2 ·hr ·°F (W/m^2 K)	R_o $ft^2 \cdot hr \cdot °F$ / Btu (m^2 K / W)	U_o Btu / ft^2 ·hr ·°F (W/m^2 K)
R-12.6 (2.2)	R-16.2 (2.8)	R-9.7 (1.7)	U-0.10 (0.58)	R-12.1 (2.1)	U-0.08 (0.47)
R-16.8 (3.0)	*R-20.4 (3.6)*	*R-28.9 (5.1)*	*U-0.03 (0.20)*	*R-61.4 (10.8)*	*U-0.02 (0.09)*
R-21.0 (3.7)	R-24.7 (4.3)	R-13.1 (2.3)	U-0.08 (0.43)	R-17.0 (3.0)	U-0.06 (0.33)

TABLE 2	TEMPERATURE INDICES FOR UNINSULATED STEEL STUD BACKUP WALL				
Temperature Indices	R-12.6		R-21.0		Location
	16" x 24"	32" x 24"	16" x 24"	32" x 24"	
T_{i1}	0.62	0.61	0.66	0.69	Min T on exterior side in air cavity.
T_{i2}	0.92	0.92	0.94	0.94	Min T on interior face of sheathing.

[1] *Data is interpolated based on simulated analysis of R-12.6 and R-21.0 exterior insulation models.*

RESULTS | UKS – Insulated Steel Stud

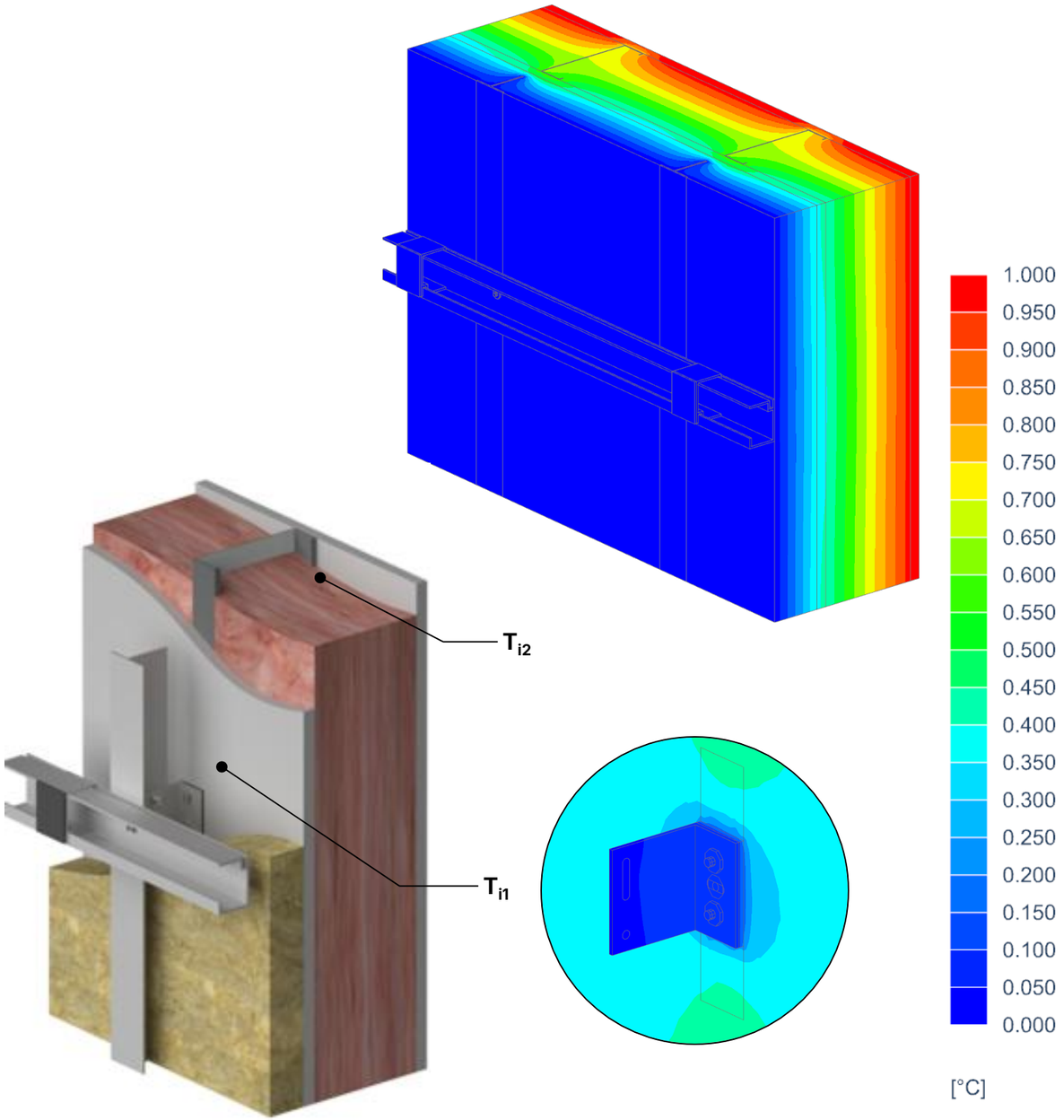


TABLE 1	THERMAL RESULTS FOR INSULATED STEEL STUD BACKUP WALL					
Exterior Insulation 1D R-Value (RSI)	R_{1D} $ft^2 \cdot hr \cdot °F$ / Btu (m^2 K / W)	16" x 24" Spacing		32" x 24" Spacing		
		R_o $ft^2 \cdot hr \cdot °F$ / Btu (m^2 K / W)	U_o Btu / ft^2 ·hr ·°F (W/m^2 K)	R_o $ft^2 \cdot hr \cdot °F$ / Btu (m^2 K / W)	U_o Btu / ft^2 ·hr ·°F (W/m^2 K)
R-12.6 (2.2)	R-34.3 (6.0)	R-17.3 (3.0)	U-0.06 (0.33)	R-20.9 (3.7)	U-0.05 (0.27)
R-16.8 (3.0)	*R-38.5 (6.8)*	*R-32.7 (5.8)*	*U-0.03 (0.17)*	*R-63.3 (11.1)*	*U-0.02 (0.09)*
R-21.0 (3.7)	R-42.8 (7.5)	R-20.7 (3.6)	U-0.05 (0.27)	R-26.0 (4.6)	U-0.04 (0.22)

TABLE 2	TEMPERATURE INDICES FOR INSULATED STEEL STUD BACKUP WALL				
Temperature Indices	R-12.6		R-21.0		Location
	16" x 24"	32" x 24"	16" x 24"	32" x 24"	
T_{i1}	0.34	0.34	0.41	0.42	Min T on exterior side in air cavity.
T_{i2}	0.87	0.87	0.89	0.89	Min T on interior face of sheathing.

[1] Data is interpolated based on simulated analysis of R-12.6 and R-21.0 exterior insulation models.

RESULTS | UKS – Uninsulated Wood Stud

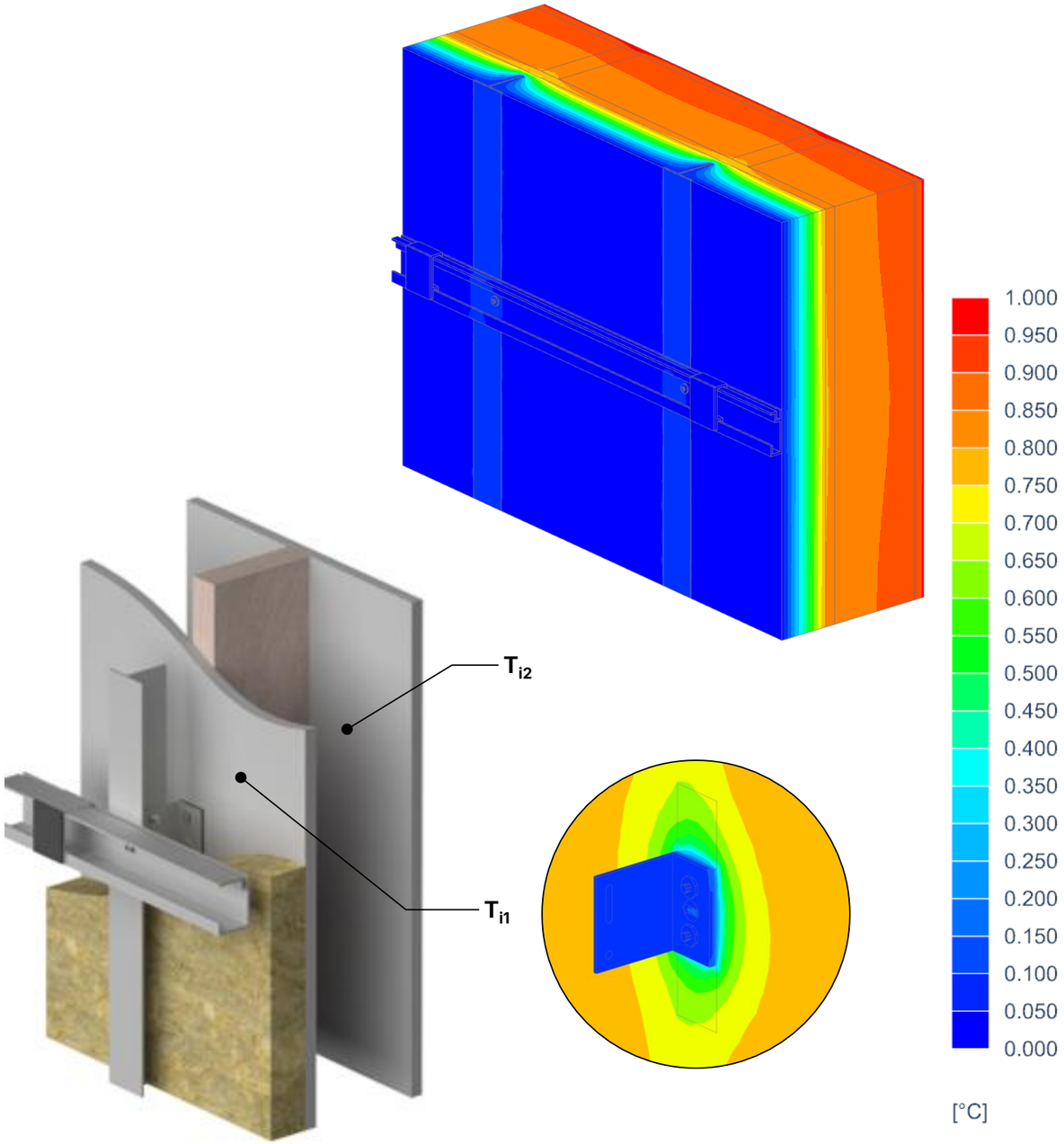


TABLE 1	THERMAL RESULTS FOR UNINSULATED WOOD STUD BACKUP WALL					
Exterior Insulation 1D R-Value (RSI)	R_{1D} $ft^2 \cdot hr \cdot °F$ / Btu (m^2 K / W)	16" x 24" Spacing		32" x 24" Spacing		
		R_o $ft^2 \cdot hr \cdot °F$ / Btu (m^2 K / W)	U_o Btu / ft^2 ·hr ·°F (W/m^2 K)	R_o $ft^2 \cdot hr \cdot °F$ / Btu (m^2 K / W)	U_o Btu / ft^2 ·hr ·°F (W/m^2 K)
R-12.6 (2.2)	R-16.2 (2.8)	R-11.8 (2.1)	U-0.09 (0.48)	R-13.6 (2.4)	U-0.07 (0.42)
R-16.8 (3.0)	*R-20.4 (3.6)*	*R-31.5 (5.5)*	*U-0.03 (0.18)*	*R-67.7 (11.9)*	*U-0.01 (0.08)*
R-21.0 (3.7)	R-24.7 (4.3)	R-16.5 (2.9)	U-0.06 (0.35)	R-19.7 (3.5)	U-0.05 (0.29)

TABLE 2	TEMPERATURE INDICES FOR UNINSULATED WOOD STUD BACKUP WALL				
Temperature Indices	R-12.6		R-21.0		Location
	16" x 24"	32" x 24"	16" x 24"	32" x 24"	
T_{i1}	0.61	0.62	0.64	0.67	Min T on exterior side in air cavity.
T_{i2}	0.94	0.94	0.95	0.96	Min T on interior face of sheathing.

[1] *Data is interpolated based on simulated analysis of R-12.6 and R-21.0 exterior insulation models.*

RESULTS | UKS – Insulated Wood Stud

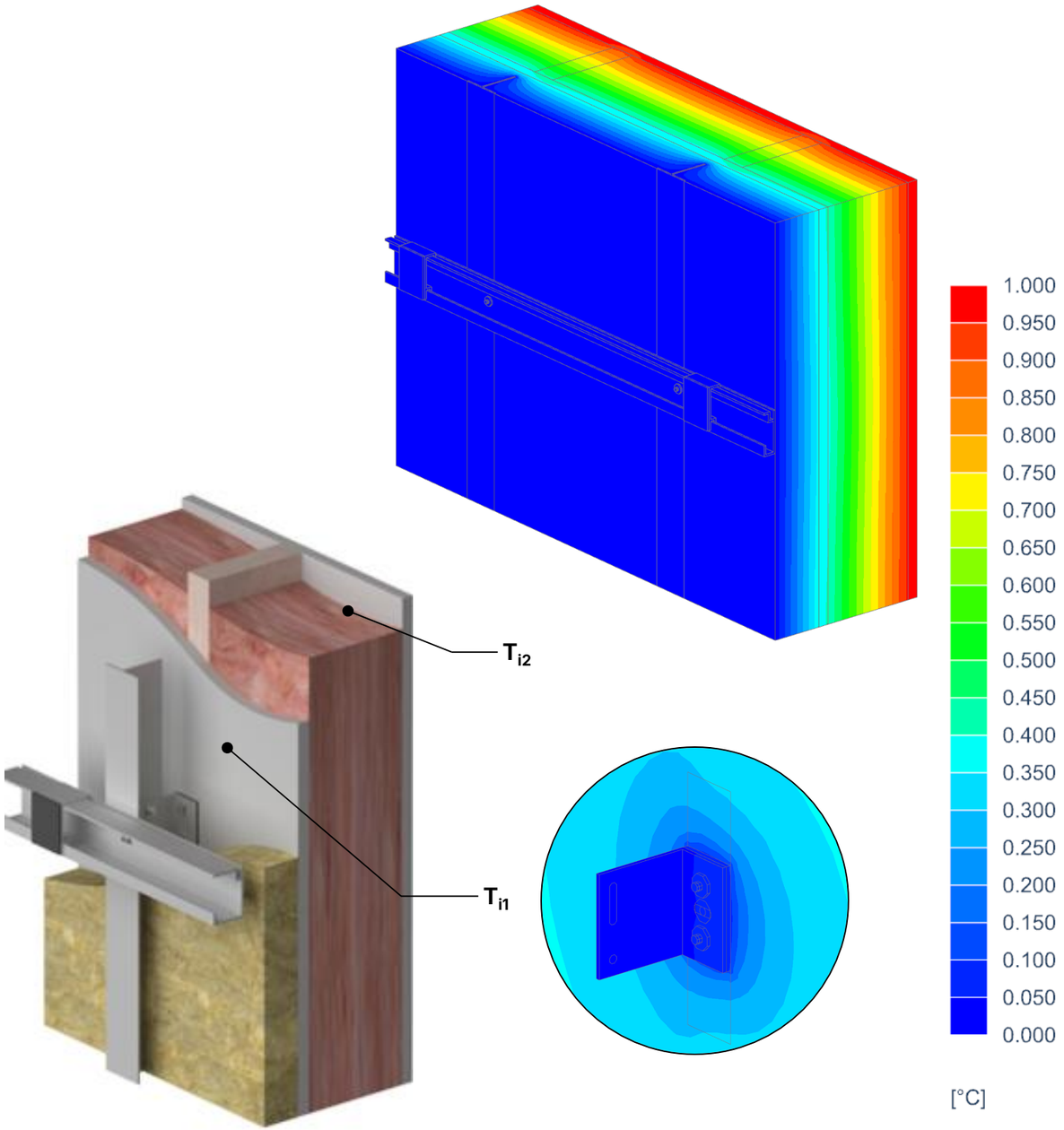


TABLE 1	THERMAL RESULTS FOR INSULATED WOOD STUD BACKUP WALL					
Exterior Insulation 1D R-Value (RSI)	R_{1D} $ft^2 \cdot hr \cdot °F$ / Btu (m^2 K / W)	16" x 24" Spacing		32" x 24" Spacing		
		R_o $ft^2 \cdot hr \cdot °F$ / Btu (m^2 K / W)	U_o Btu / ft^2 ·hr ·°F (W/m^2 K)	R_o $ft^2 \cdot hr \cdot °F$ / Btu (m^2 K / W)	U_o Btu / ft^2 ·hr ·°F (W/m^2 K)	
R-12.6 (2.2)	R-34.3 (6.0)	R-26.3 (4.6)	U-0.04 (0.22)	R-28.5 (5.0)	U-0.04 (0.20)	
R-16.8 (3.0)	*R-20.5 (3.6)*	*R-36.6 (6.4)*	*U-0.03 (0.16)*	*R-70.3 (12.4)*	*U-0.01 (0.08)*	
R-21.0 (3.7)	R-42.8 (7.5)	R-31.7 (5.6)	U-0.03 (0.18)	R-35.2 (6.2)	U-0.03 (0.16)	

TABLE 2	TEMPERATURE INDICES FOR INSULATED WOOD STUD BACKUP WALL				
Temperature Indices	R-12.6		R-21.0		Location
	16" x 24"	32" x 24"	16" x 24"	32" x 24"	
T_{i1}	0.16	0.17	0.21	0.22	Min T on exterior side in air cavity.
T_{i2}	0.95	0.95	0.96	0.96	Min T on interior face of sheathing.

[1] Data is interpolated based on simulated analysis of R-12.6 and R-21.0 exterior insulation models.

RESULTS | UKS – Uninsulated CMU Wall

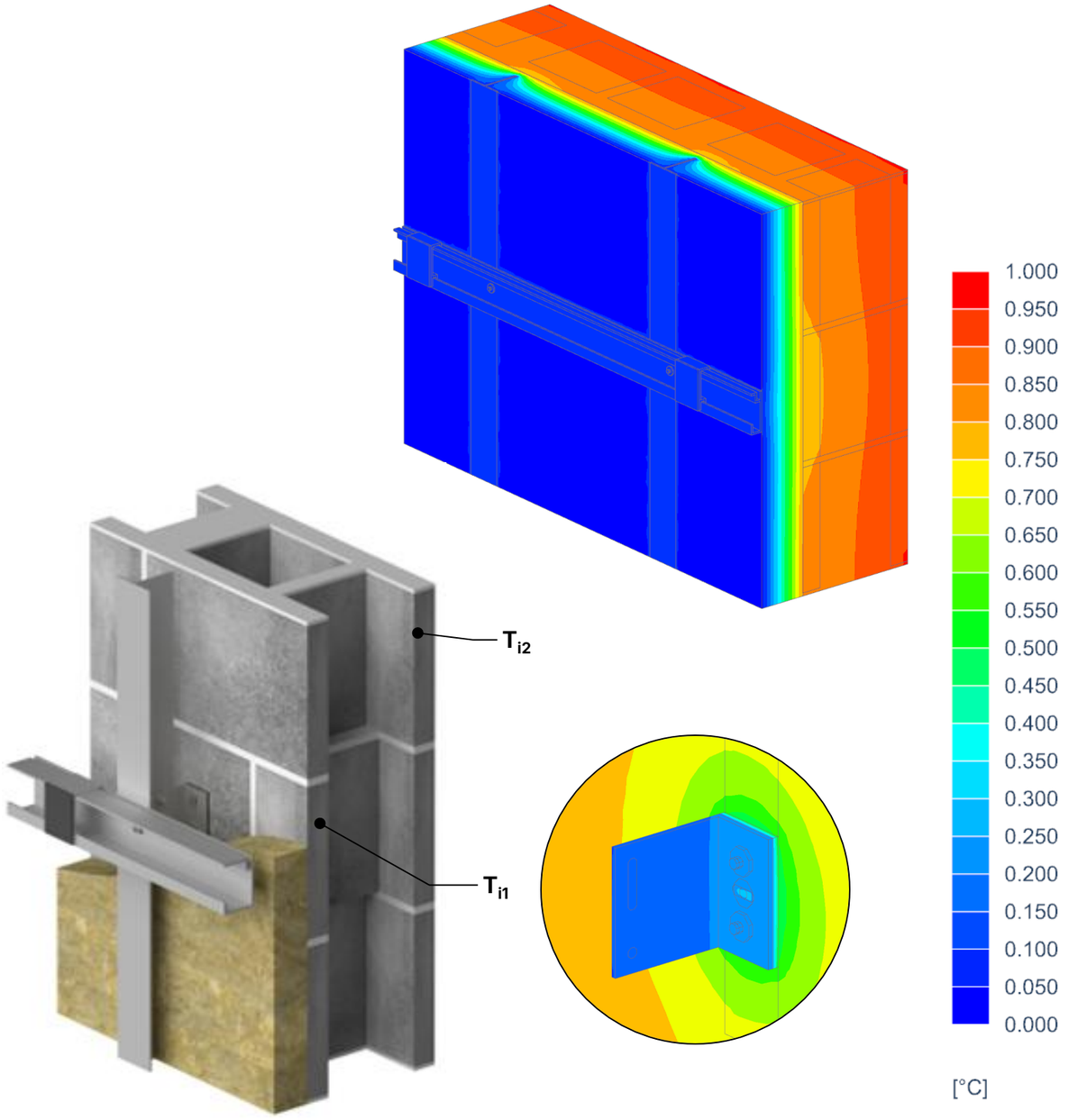


TABLE 1	THERMAL RESULTS FOR CMU BACKUP WALL				
Exterior Insulation 1D R-Value (RSI)	R_{1D} ft²·hr·°F / Btu (m² K / W)	16" x 24" Spacing		32" x 24" Spacing	
		R_o ft²·hr·°F / Btu (m² K / W)	U_o Btu / ft² ·hr ·°F (W/m² K)	R_o ft²·hr·°F / Btu (m² K / W)	U_o Btu / ft² ·hr ·°F (W/m² K)
R-12.6 (2.2)	R-15.9 (2.8)	R-9.0 (1.6)	U-0.11 (0.63)	R-11.2 (2.0)	U-0.09 (0.51)
R-16.8 (3.0)	*R-20.1 (3.5)*	*R-26.8 (4.7)*	*U-0.04 (0.21)*	*R-49.3 (8.7)*	*U-0.02 (0.12)*
R-21.0 (3.7)	R-24.4 (4.3)	R-12.0 (2.1)	U-0.08 (0.47)	R-15.8 (2.8)	U-0.06 (0.36)

TABLE 2	TEMPERATURE INDICES FOR CMU BACKUP WALL				
Temperature Indices	R-12.6		R-21.0		Location
	16" x 24"	32" x 24"	16" x 24"	32" x 24"	
T_{i1}	0.57	0.53	0.59	0.6	Min T on exterior side in air cavity.
T_{i2}	0.91	0.92	0.93	0.94	Min T on interior face of sheathing.

[1] Data is interpolated based on simulated analysis of R-12.6 and R-21.0 exterior insulation models.

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DISCLAIMER

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