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Making Buildings Better™

TO **Stefan Jansen van Vuuren**
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Longboard Architectural Products.
1777 Clearbrook Road, Unit 120
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R-25403.000
Longboard Hitch System Development | Thermal and Structural Review
DATE January 21, 2022

REGARDING **Longboard Hitch Cladding Attachment System Thermal Review**

Dear Mr. van Vuuren,

As requested by Longboard Architectural Products (LB), RDH Building Science Inc. (RDH) is pleased to provide you with this report for thermal assessment of the Hitch Cladding Attachment System. This report summarizes the U-value and effective R-value of the Hitch Clips for a variety of spacing arrangements and insulation thicknesses, as well as the Chi-value of the individual clips and wind load anchors for different scenarios.

1 System Description

The Hitch Clip system utilizes intermittent stainless-steel clips with thermal break shims to support exterior insulation and cladding. The system will be able to support up to 16" of exterior insulation and cladding outboard of the substrate.

The Hitch cladding attachment clip consists of three variations, Class 1, Class 2 and Class 3, as shown in Figure 1.1. Class 1 style is used for low levels of exterior insulation (1" to 2.5") and is made of a stainless-steel clip with polyamide thermal breaks. Class 2 and 3 styles are used for higher levels of exterior insulation (3"+) and are made of aluminum clip base, stainless steel square tube and polyamide thermal breaks.

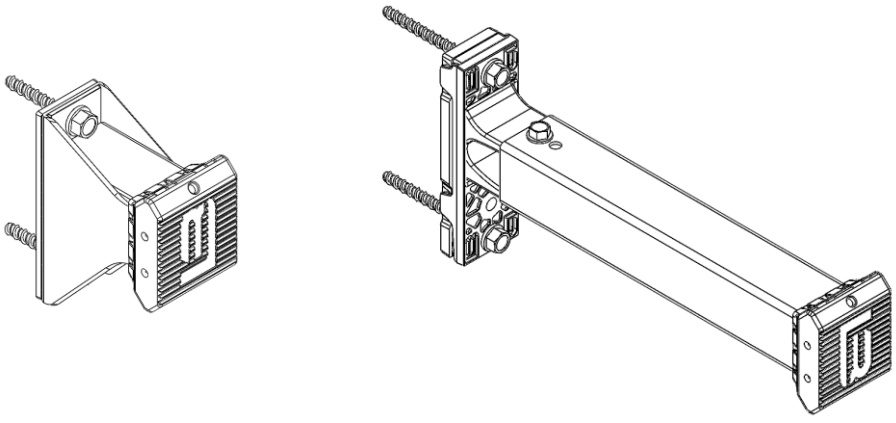

Figure 1.1: Isometric view of Hitch Class 1 Clip (left) and Hitch Class 2/3 Clip (right)

The Class 2 and 3 styles are differentiated by their aluminum clip base, as shown in Figure 1.2. The Class 3 style is intended to be used on walls with more than 6" of exterior insulation.

Figure 1.2: Side view of 2 aluminum clip base (left) and 3 aluminum clip base (right)

The installation tool for the 2 and 3 system, shown in Figure 1.3, punctures through the mineral wool insulation, and allows the excess insulation to be saved and inserted into the Hitch tube to help maintain insulation continuity.

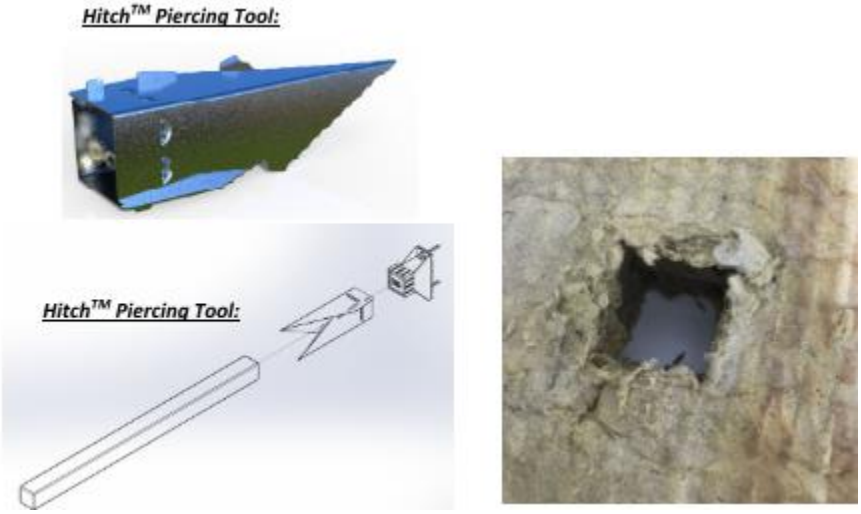

Figure 1.3: Hitch Piercing Tool

For this thermal analysis, a steel stud backup wall system was used with Class 1, 2 and 3. Hitch clips were evaluated for the typical clip arrangements shown in Figure 4. The system can also be installed with a staggered arrangement (see Appendix C attached).

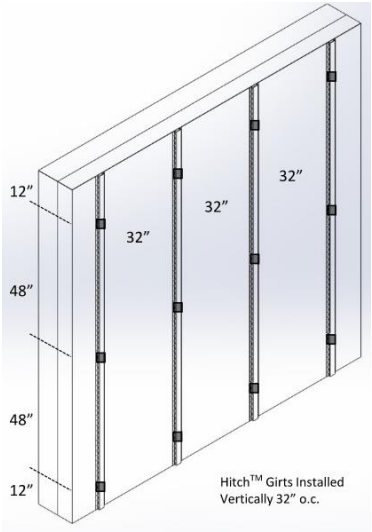

Figure 1.4: Typical clip arrangement configuration

While the typical arrangement would utilize a clip grid as per Figure 1.4, for additional thermal performance to meet very stringent performance requirements (such as for Passive House), a single point anchor is utilized to reduce thermal bridging while maintaining the structural performance of the system, as shown in Figure 1.5.

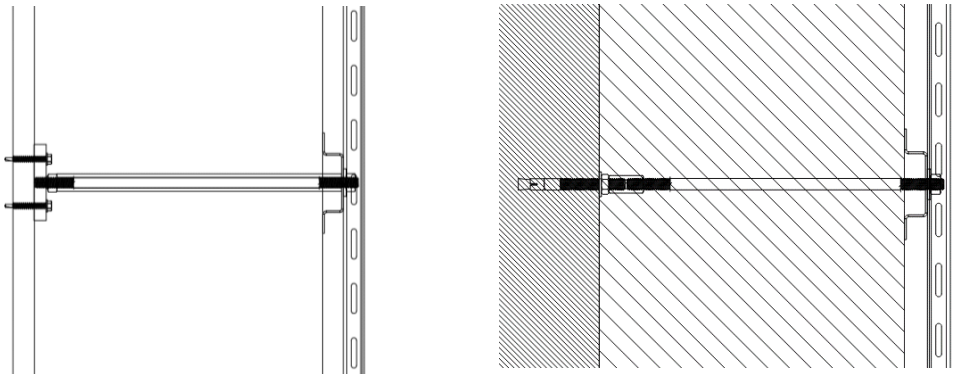

Figure 1.5: Wind load anchor for steel stud backup wall (left), and for concrete backup wall (right)

For highly insulated walls, the Class 3 clip system will carry the dead load, while the single fastener anchor would handle the wind load. For a steel stud wall, the wind load anchor consists of a 3/8" stainless-steel threaded rod, attached through the sheathing to the stud with a stainless-steel hanger flange. For a concrete wall, the anchor is also a stainless-steel rod that is coupled to a stainless-steel concrete expansion anchor that is embedded 1-7/8" into the concrete.

1.1 Evaluated Scenarios

The following scenarios, shown in Table 1.1, were evaluated for the various Hitch system components to determine the U-value, effective R-value and/or Chi-Value.

Table 1.1 Thermal Analysis Evaluated Scenarios

System Type	Backup Wall	Exterior Mineral Wool Insulation Thickness	Component Spacing
Class 1	• Steel Stud	• 1" • 2.5"	32" horizontally, 48" vertically
Class 2a	• Steel Stud	• 3" • 6" • 10" • 16"	
Class 2b	• Steel Stud	• 6" • 8" • 10" • 15" • 16"	
Wind Load Anchor	• Steel Stud • Concrete	• 10"	-

2 Methodology

2.1 Evaluation Assumptions

The Hitch System assemblies for this report were evaluated using three-dimensional thermal modelling. This method allows for the analysis of complex 3D geometries, such as point connections, complex clip shapes and exterior crossing substructure components, to provide a more comprehensive assessment of the impact of thermal bridging for the assembly that accounts for lateral heat flow.

Thermal modelling was performed in general conformance with CSA Z5010: *Calculation of Thermal Bridges in Building Enclosure Assemblies* 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, and assembly information provided by Longboard Architectural Products.

Further modelling assumptions and material properties are listed in Appendix A.

2.2 Software

Thermal modelling was performed using SOLIDWORKS Simulation Professional. SOLIDWORKS is a three-dimensional multi-physics finite element analysis software tool that can be used to analyze complex 3D geometries.

2.3 Thermal Performance Values

The model outputs provide the overall heat flow from the evaluated assemblies. Using these outputs, the following thermal values were calculated to characterize the Hitch System assemblies and components, as per CSA Z5010:

Clear Field U-Value (BTU/hrft^2°F, W/m^{2}K) – The thermal transmittance through a characteristic area of the assembly, per unit area, that includes uniformly repeating thermal bridges. For the Hitch system, this would be for the specific spacing of the clips and includes repeating elements such as the clips and studs.

Clear Field Effective R-Value (hrft^2°F/BTU, m^{2}K/W) – The thermal resistance through a characteristic area of the assembly, per unit area, which is the inverse of the U-value.

Component Chi-Value χ (BTU/hr°F, W/K) – Single points of additional heat flow through the assembly caused by the presence of point-oriented components. For the Hitch system, this value was calculated for the individual clips and for the wind load anchors.

The associated thermal performance values are provided with each assembly and component within their respective sections of this report.

3 Thermal Results

3.1 Hitch Clips

The effective R-values and chi-values for all Hatch cladding attachment clip configurations are shown in imperial units in Table 3.1IP, and SI units in Table 3.1SI below. Example model output including modeled 3D temperature profile are provided in Appendix B. This assumes the standard arrangement shown in Figure 1.4. For the performance of the staggered arrangement, see Appendix C.

TABLE 3.1-IP: RESULT FOR 32" HORIZONTAL AND 48" VERTICAL SPACING						
Clip Description	**Ex. Mineral Wool Insulation Thickness**	**Ex. Mineral Wool Insulation R-value**	**R1D**	**Effective R-value**	**Effective U-value**	**Chi-Value**
	in	**$ft^2 \cdot hr \cdot ^\circ F/$ Btu**			**$Btu/ft^2 \cdot hr \cdot ^\circ F$**	**$Btu/hr \cdot ^\circ F$**
C1 Clip	1.0	4.2	7.1	7.0	0.142	0.024
C1 Clip	2.5	10.5	13.4	12.8	0.078	0.036
C2 Clip	3.0	12.6	15.5	14.4	0.069	0.053
C2 Clip	6.0	25.2	28.1	25.6	0.039	0.038
C3 Clip	6.0	25.2	28.1	24.8	0.040	0.049
C3 Clip	8.0	33.6	36.5	32.2	0.031	0.038
C2 Clip	10.0	42.0	44.9	40.6	0.025	0.025
C3 Clip	10.0	42.0	44.9	39.7	0.025	0.031
C3 Clip	15.0	63.0	65.8	58.3	0.017	0.021
C2 Clip	16.0	67.2	70.0	63.0	0.016	0.017
C3 Clip	16.0	67.2	70.0	62.0	0.016	0.020

TABLE 3.1-SI: RESULT FOR 813 MM HORIZONTAL AND 1219 MM VERTIAL SPACING						
Clip Description	**Ex. Mineral Wool Insulation Thickness**	**Ex. Mineral Wool Insulation RSI-value**	**RSI-1D**	**Effective RSI-value**	**Effective USI-value**	**Chi-Value**
	mm	**$m^2 \cdot K/W$**			**$W/m^2 \cdot K$**	**W/K**
C1 Clip	25.4	0.74	1.26	1.24	0.81	0.012
C1 Clip	63.5	1.85	2.36	2.26	0.44	0.019
C2 Clip	76.2	2.22	2.73	2.54	0.39	0.028
C2 Clip	152.4	4.44	4.95	4.50	0.22	0.020
C3 Clip	152.4	4.44	4.95	4.37	0.23	0.026
C3 Clip	203.2	5.92	6.43	5.67	0.18	0.020
C2 Clip	254.0	7.40	7.90	7.15	0.14	0.013
C3 Clip	254.0	7.40	7.90	6.99	0.14	0.016
C3 Clip	381.0	11.10	11.59	10.26	0.10	0.011
C2 Clip	406.4	11.84	12.33	11.10	0.09	0.009
C3 Clip	406.4	11.84	12.33	10.92	0.09	0.010

The chi-values for Hitch wind load anchors are shown in imperial units in Table 3.2-IP and SI units in Table 3.2-SI below. Example model output including modeled 3D temperature profile for window load anchors are provided in Appendix A.

TABLE 3.2-IP: WIND LOAD ANCHOR CHI-VALUE RESULT SUMMARY			
Back Up Wall Description	**Ex. Insulation Thickness**	**Ex. Insulation R-value**	**Chi-Value**
	in	**ft² · hr · °F/ Btu**	**Btu/hr · °F**
Steel Framed	10.0	42.0	0.0072
Concrete	10.0	42.0	0.0078

TABLE 3.2-SI: WIND LOAD ANCHOR CHI-VALUE RESULT SUMMARY			
Back Up Wall Description	**Ex. Insulation Thickness**	**Ex. Insulation R-value**	**Chi-Value**
	mm	**m² · K/W**	**W/K**
Steel Framed	254.0	7.40	0.0038
Concrete	254.0	7.40	0.0041

4 Conclusion

RDH performed three-dimensional thermal simulations of the Hitch cladding attachment clip to determine the effective R-values and chi-values for 8 different exterior insulation depth ranging from 1" to 16". Based on the thermal simulation results, the Hitch cladding attachment clip have a thermal efficiency of 88%+ at simulated spacing with steel stud backup wall. Thermal analysis of two types of Hitch wind load anchors is also included as part of the report. The thermal simulation was carried out in general conformance with CSA Z5010 and ASHRAE Handbook Fundamentals.

We trust this report meets your needs at this time. Please do not hesitate to contact us with any questions you might have.

Yours truly,

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2022-01-25

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encl.

Appendix A: Simulation Methodology
Appendix B: Model Outputs
Appendix C: Staggered Arrangement Analysis

Appendix A

Simulation Methodology

A.1 Additional Assumptions

Thermal modelling was performed in general conformance with CSA Z5010: *Calculation of Thermal Bridges in Building Enclosure Assemblies* and the ASHRAE Handbook Fundamentals. Per industry standard modelling practices, the following assumptions have been made:

- → Steady-state heat flow
- → Isotropic material properties (constant in all direction of the material)
- → Material conductivities utilized in this study were from published sources and are typically provided at 24°C, but assumed to be constant under typical operating conditions.

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

- → The insulation was assumed to be installed tight to the clips with no gaps.
- → Air spaces are included as unventilated frame cavities using the equivalent thermal conductivity method presented in ISO 10077.
- → Exterior cladding system was indirectly simulated using a protected air film. This approach is considered conservative and permits the results to be used more broadly for a range of similar cladding options.

A.2 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 (Equation 1).

$$I = \frac{T_s - T_e}{T_i - T_e} \tag{1}$$

Where,

T_s, is the surface thermal temperature of interest in ˚C

T_i, is the interior air temperature in ˚C

T_e, is the exterior air temperature in ˚C

I, is the Temperature Index

The simulations were run with an exterior temperature index of 0 and an interior index of 1. As the material properties were assumed independent of temperature, this allows the temperature profile to be reasonably applicable for any temperature difference. Equation 1 can be rearranged to solve for a specific surface temperature at different interior and exterior design temperatures.

$$T_s = I \cdot (T_i - T_e) + T_e \tag{2}$$

Temperature profiles shown in Appendix B provide surface temperatures and scale as per this index.

A.3 Air Films

Table A1 below presents the Air Film properties used for Hitch Clip thermal simulation.

TABLE A1 – AIR FILMS	
Location	**Thermal Resistance ($m^2 \cdot K/W$)**
Exterior Protected	0.12
Interior	0.12

A.3 Contact Resistances

Table A2 below presents the contact resistances used for Hitch Clip thermal simulation.

TABLE A2 – Contact Resistances	
Description	**Contact Resistance ($m^2 \cdot K/W$)**
Sheathing to Exterior Insulation	0.01
Sheathing to Cladding Clips	0.01

A.4 Material Properties

Table A4 lists all materials included in the thermal simulation and their associated thermal properties. Materials were assigned to the models based on the documents provided by LB or taken from published sources, including from Lawrence Berkley National Laboratories and the ASHRAE Handbook of Fundamentals.

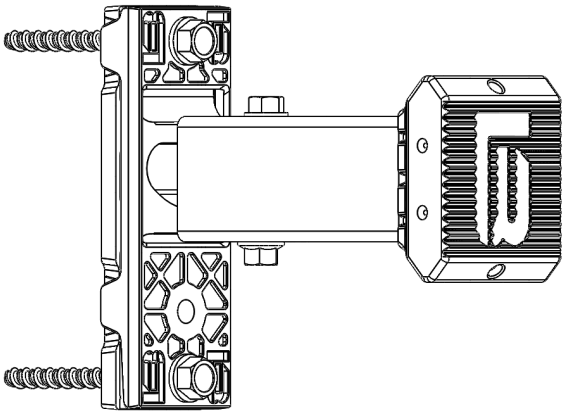
TABLE A4 – LIST OF MATERIAL PROPERTIES USED IN THE THERMAL MODELING		
Component	**Material**	**Conductivity (W/m·K)**
Gypsum	Gypsum	0.160
Stud Cavity	Air[1]	-
Steel Stud	Galv. Steel	52.00
Sheathing	Gypsum	0.160
Exterior Insulation	Mineral Wool	0.034
Concrete Backup Wall	Reinforced Concrete	2.5
Hitch Clip - Class 1		
Base Thermal Break & Shim Plate	Polyamide	0.251
Class 1 Clip	Stainless Steel	17.00
Fastener #14	Stainless Steel	17.00
Head Thermal Break Cap	Polyamide	0.251
Hitch Clip Class 2 & 3		
Two-piece Thermal Break	Polyamide	0.251
Class 2 Clip Base	Aluminum Alloy	160.0
Fasteners #14	Stainless Steel	17.00
1 ½" Square Slotted Tube	Stainless Steel	17.00
Mineral Wool Infill	Mineral Wool	0.034
Head Thermal Break Cap	Polyamide	0.251
Wind Load Anchor		
Fastener #12	Stainless Steel	17.00
Hanger Flange	Stainless Steel	17.00
3/8" threaded rod	Stainless Steel	17.00
Coupler	Stainless Steel	17.00
Hat Track	Galv. Steel	52.00
Air Spaces	Air[1]	-

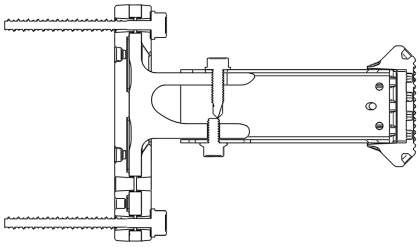
Notes to Table A4:
[1] The thermal conductivities of the air spaces were determined according to ISO 10077.

Appendix B

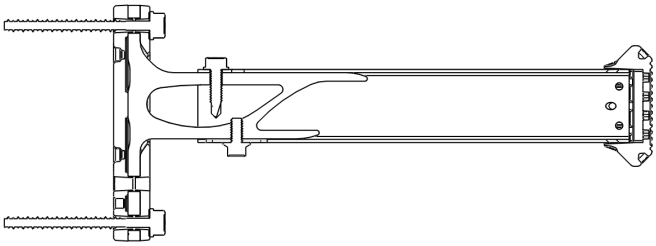
Model Outputs

MANUFACTURER'S DETAIL:





C2 Clip



C3 Clip

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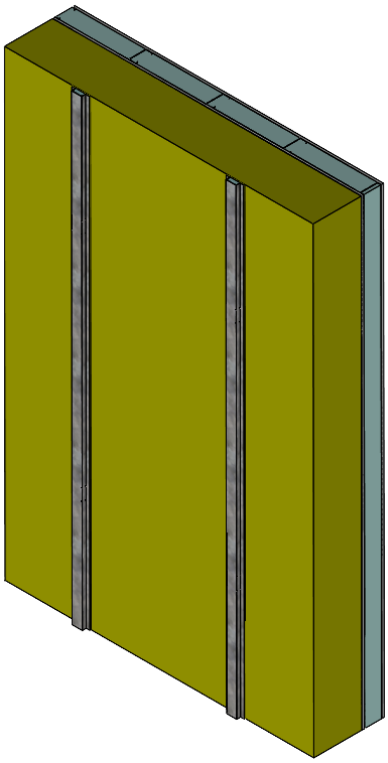

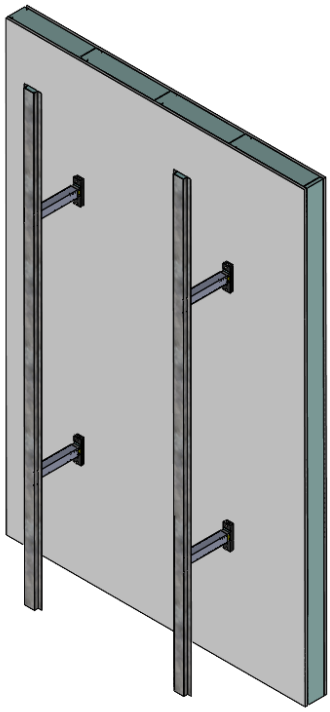

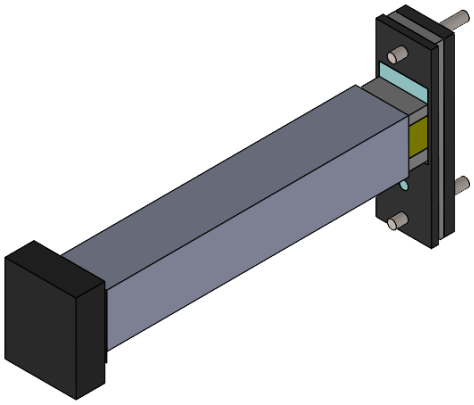

10" Exterior Insulation C2 Clip Sill

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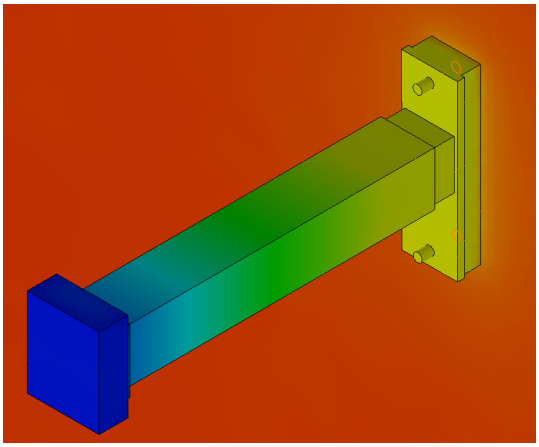
PROJECT NAME: Hatch Cladding Attachment System Thermal Review	CLIENT NAME: LB
PRODUCT NAME: Hitch Cladding Attachment Clip	PROJECT NO.: 25403.000
DRAWING REFERENCE: Hitch Cladding Attachment System	DATE: Jan 21, 2021
	DRAWN BY: BG
	CHECKED BY: NN

Vancouver



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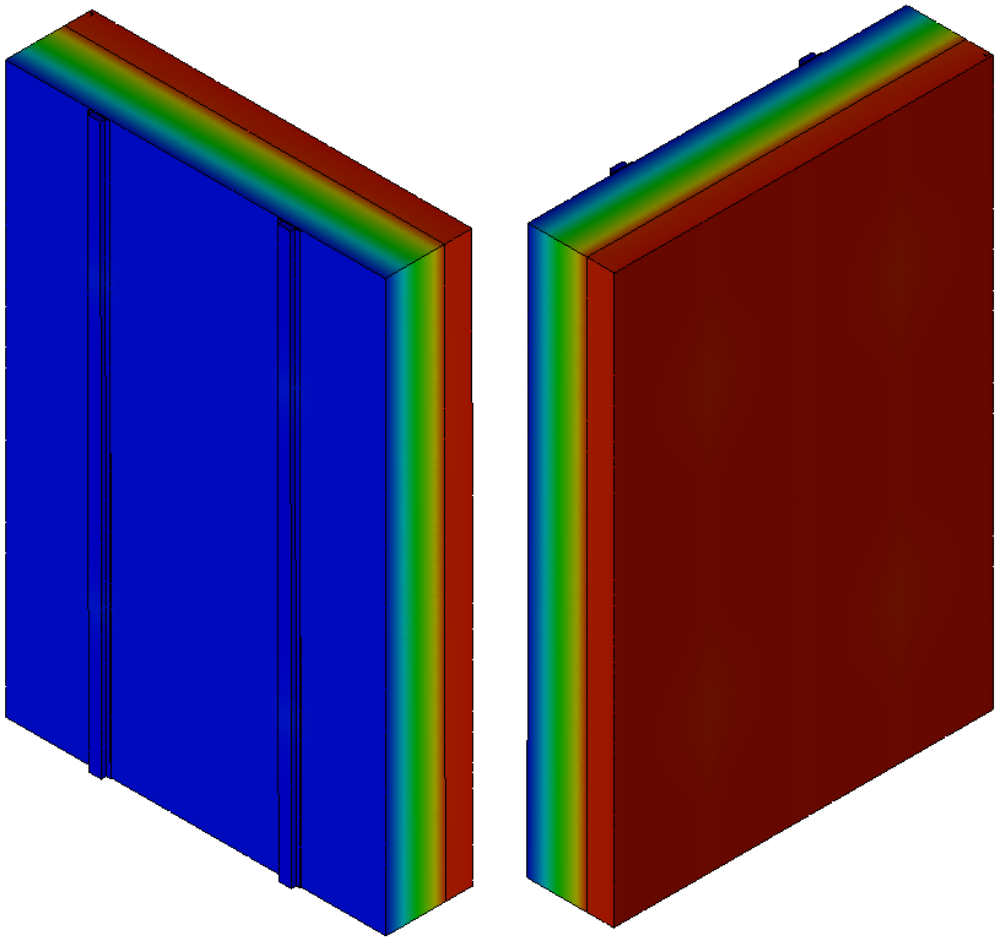

MODEL:

Sill

10" Exterior Insulation C2 Clip

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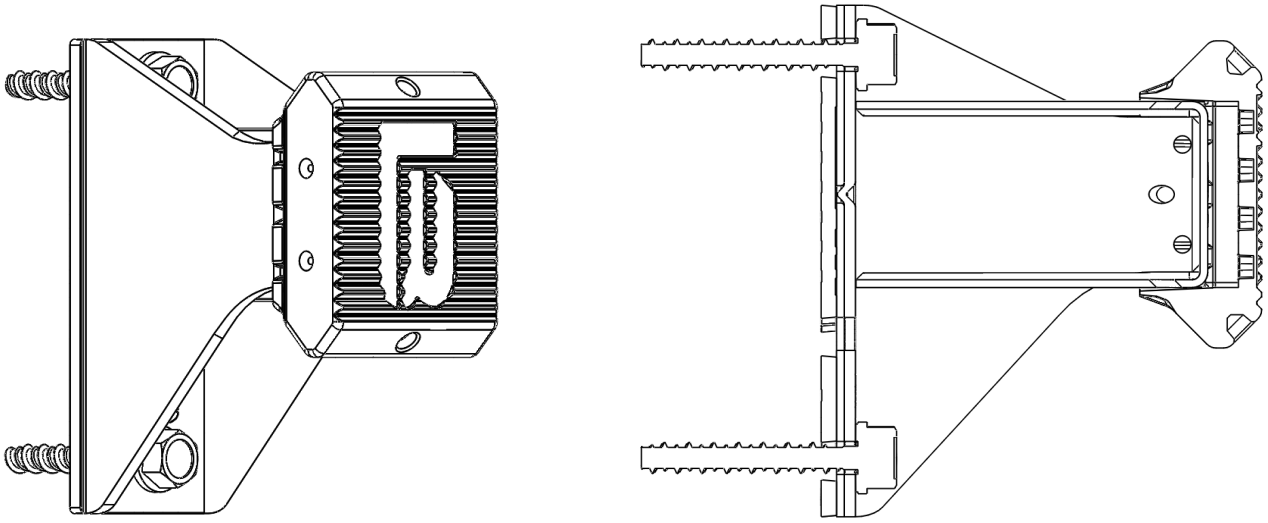

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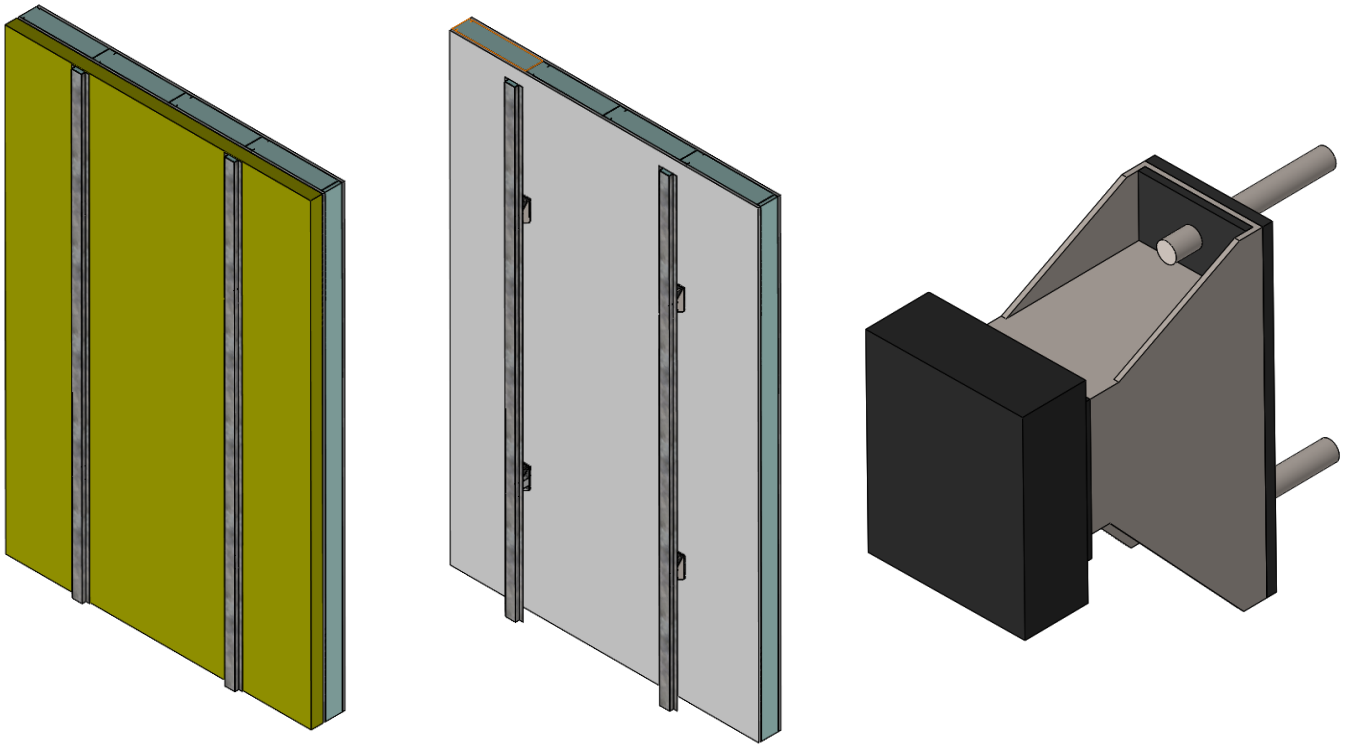

2.5" Exterior Insulation Clip

Sill

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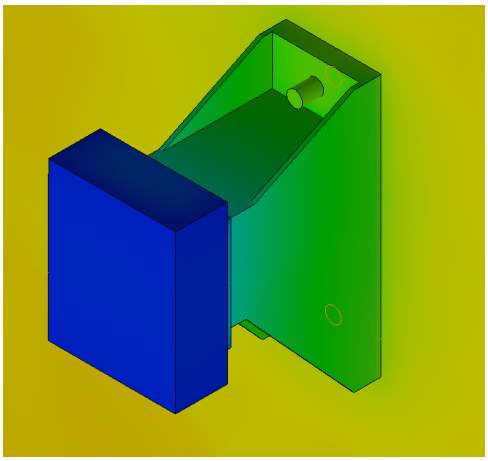

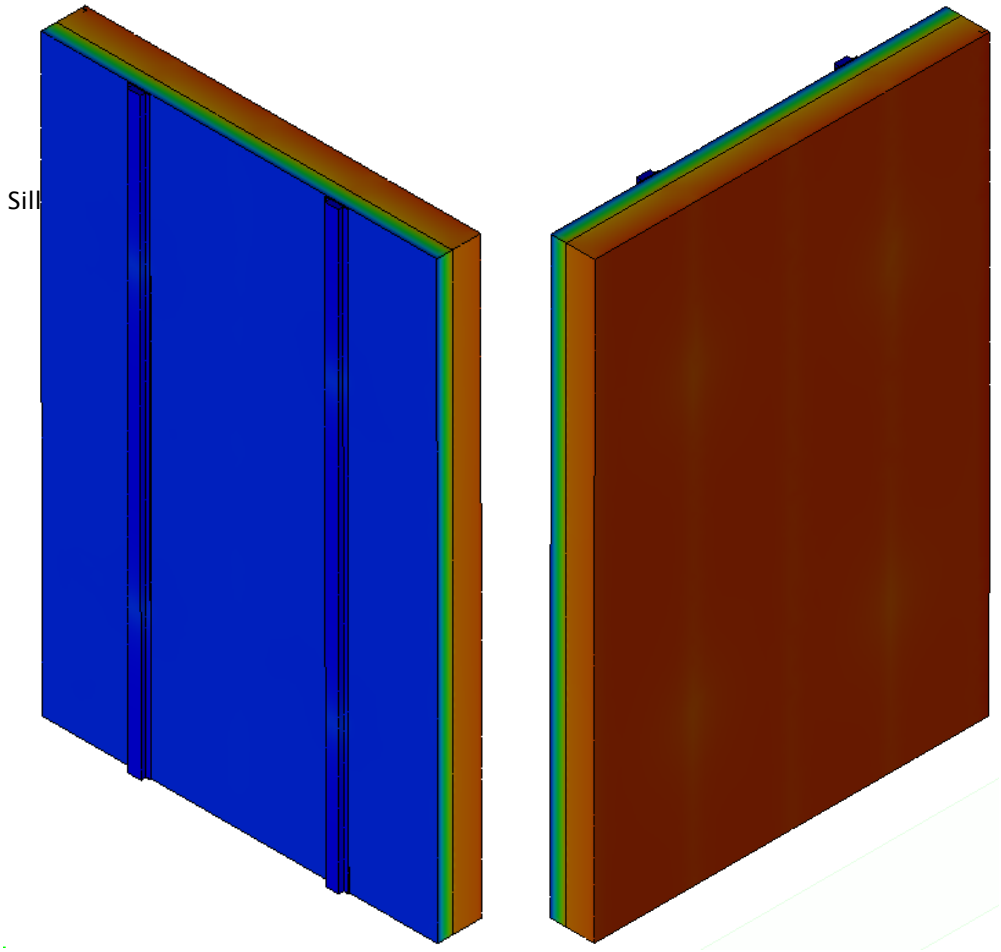

MODEL:

Sill

2.5" Exterior Insulation C1 Clip

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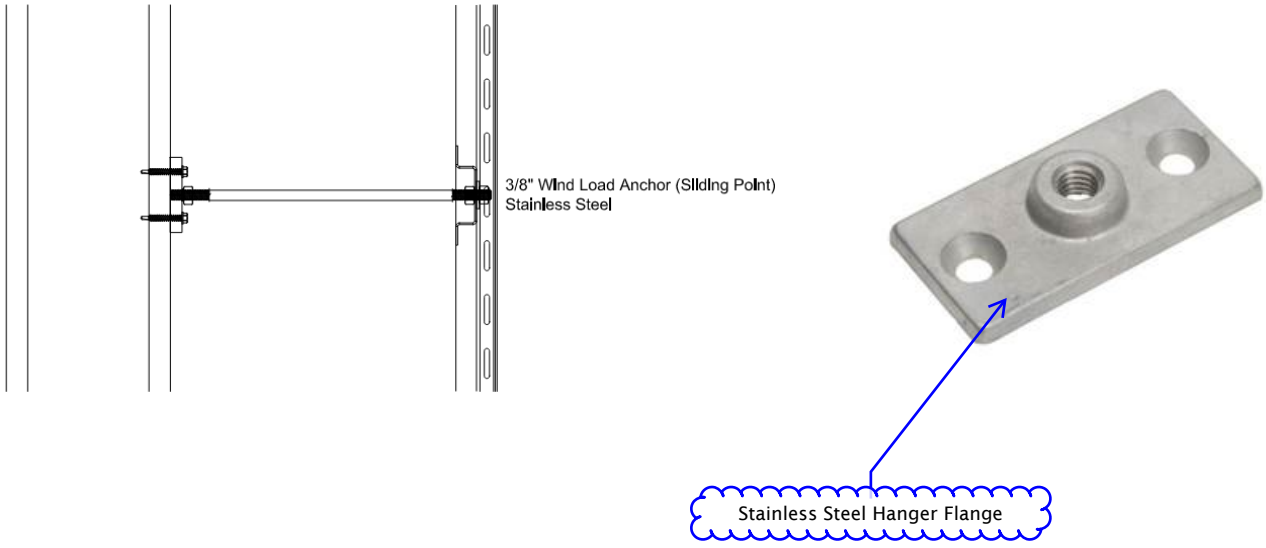

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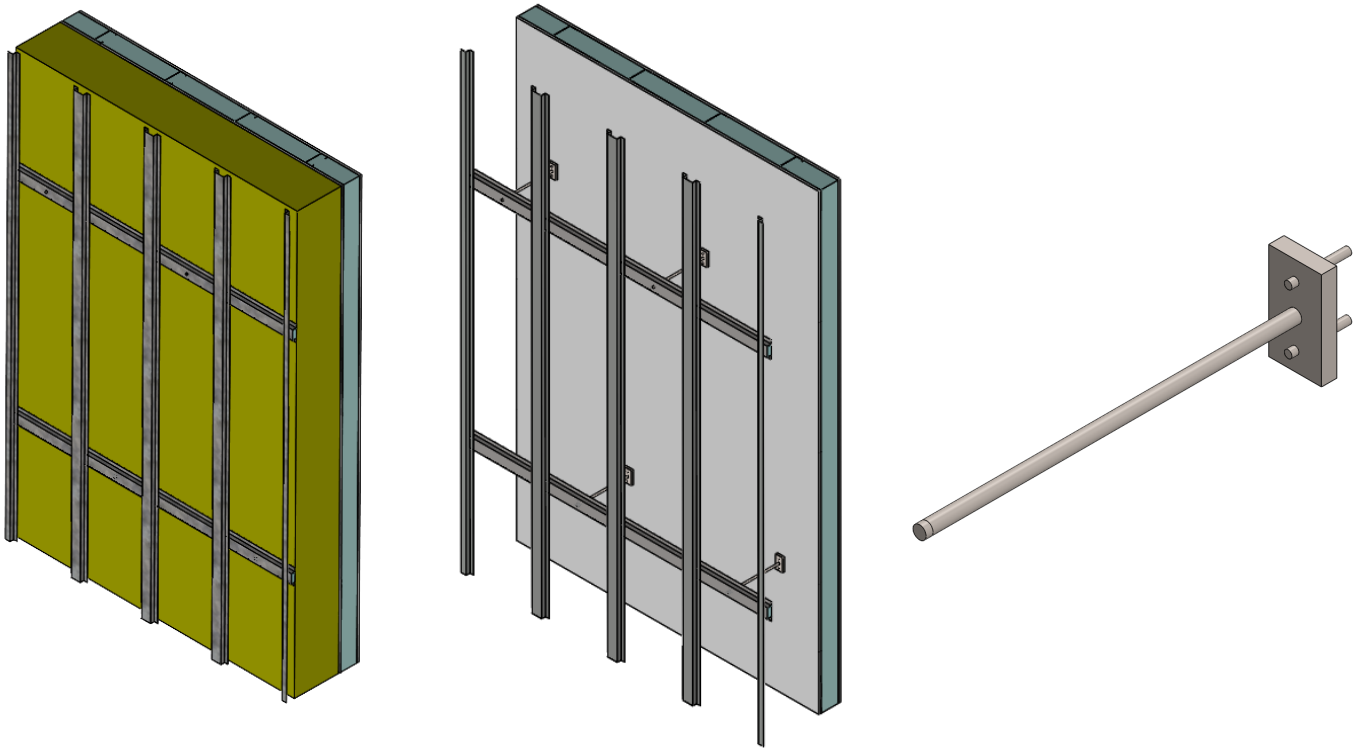

10" Exterior Insulation Steel Stud Backup Wall Wind Load Anchor

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PRODUCT NAME: Hitch Wind Load Anchor	PROJECT NO.: 25403.000
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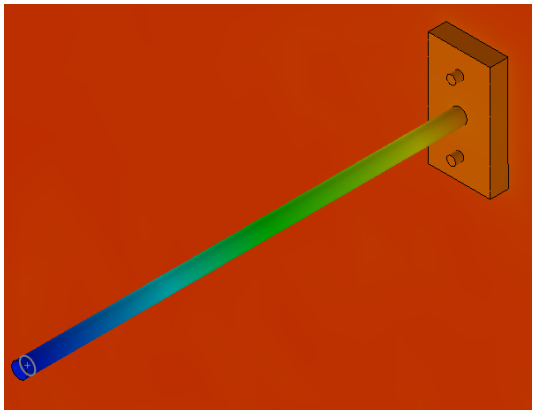
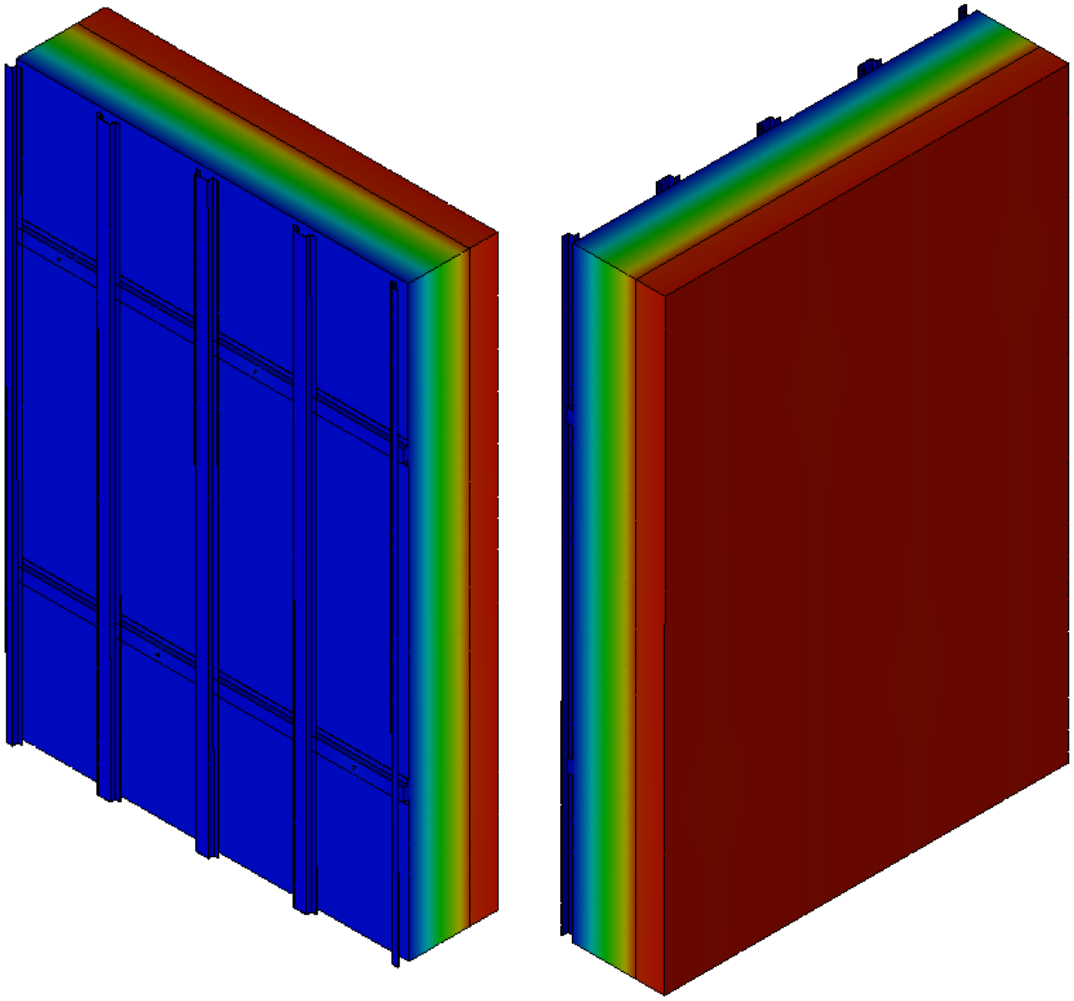
Vancouver



Sill



MODEL:

Sill

10" Exterior Insulation Steel Stud Backup Wall Wind Load Anchor

RDH

4333 STILL CREEK DRIVE #400 WWW.RDH.COM

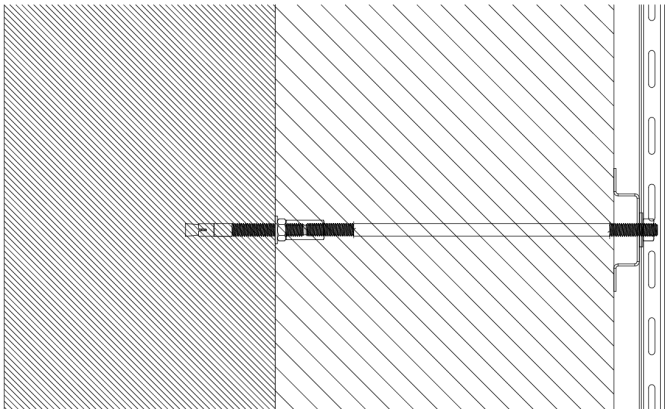
BURNABY BC V5C 6S6 TEL 604 873 1181

THE DETAILS WERE MODELED AND ASSESSED FOR THERMAL HEAT TRANSMITTANCE ONLY. THE DETAILS WERE NOT EVALUATED WITH RESPECT TO OTHER BUILDING ENCLOSURE FUNCTIONS SUCH AS MOISTURE CONTROL, AIR LEAKAGE, STRUCTURAL, OR DURABILITY. RDH AND ITS EMPLOYEES NEITHER ENDORSE NOR WARRANT THE SUITABILITY OF THE SIMULATED PRODUCTS.

PROJECT NAME: Hatch Cladding Attachment System Thermal Review	CLIENT NAME: LB
PRODUCT NAME: Hitch Wind Load Anchor	PROJECT NO.: 25403.000
DRAWING REFERENCE: CAD drawing provided by LB	DATE: Jan 21, 2021
	DRAWN BY: BG
	CHECKED BY: NN

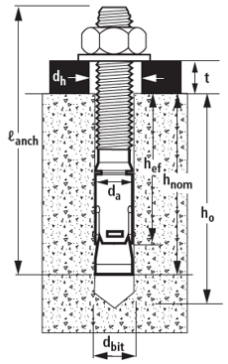
Vancouver

MANUFACTURER'S DETAIL:



3/8" Wind Load Anchor (Sliding Point)
Stainless Steel

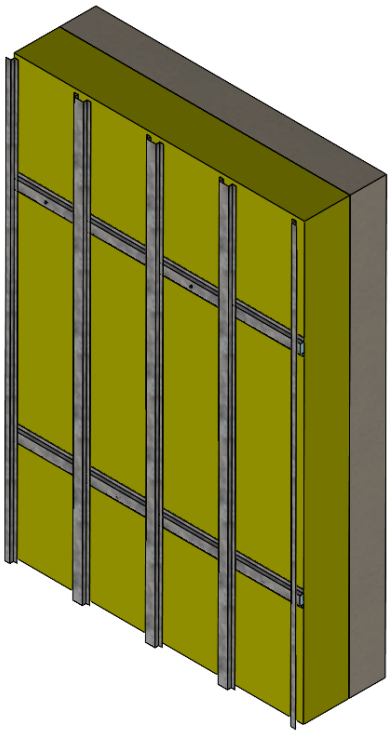
316 Stainless DeWalt Power-Stud + SD-6

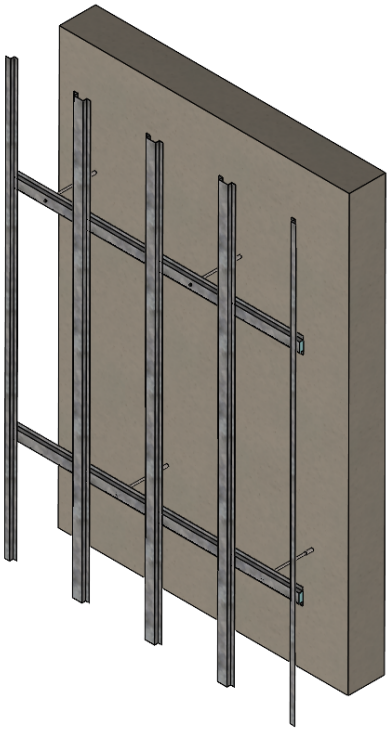


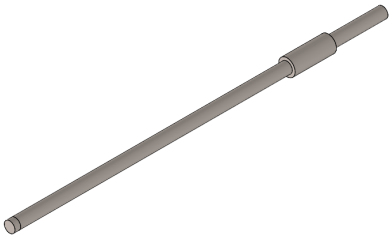
316 Stainless Coupling Nut

316 Stainless Threaded Rod

3D MODEL:







10" Exterior Insulation Concrete Backup Wall Wind Load Anchor Sill

RDH

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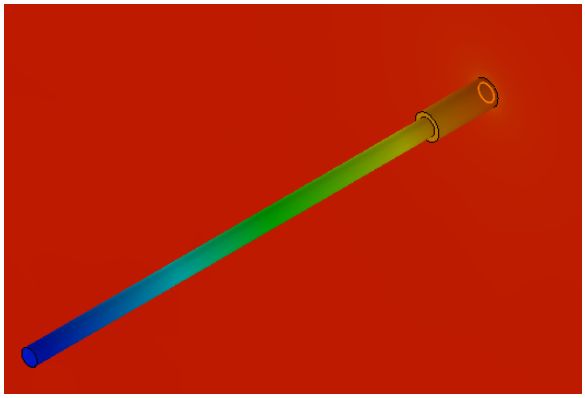
BURNABY BC V5C 6S6 TEL 604 873 1181

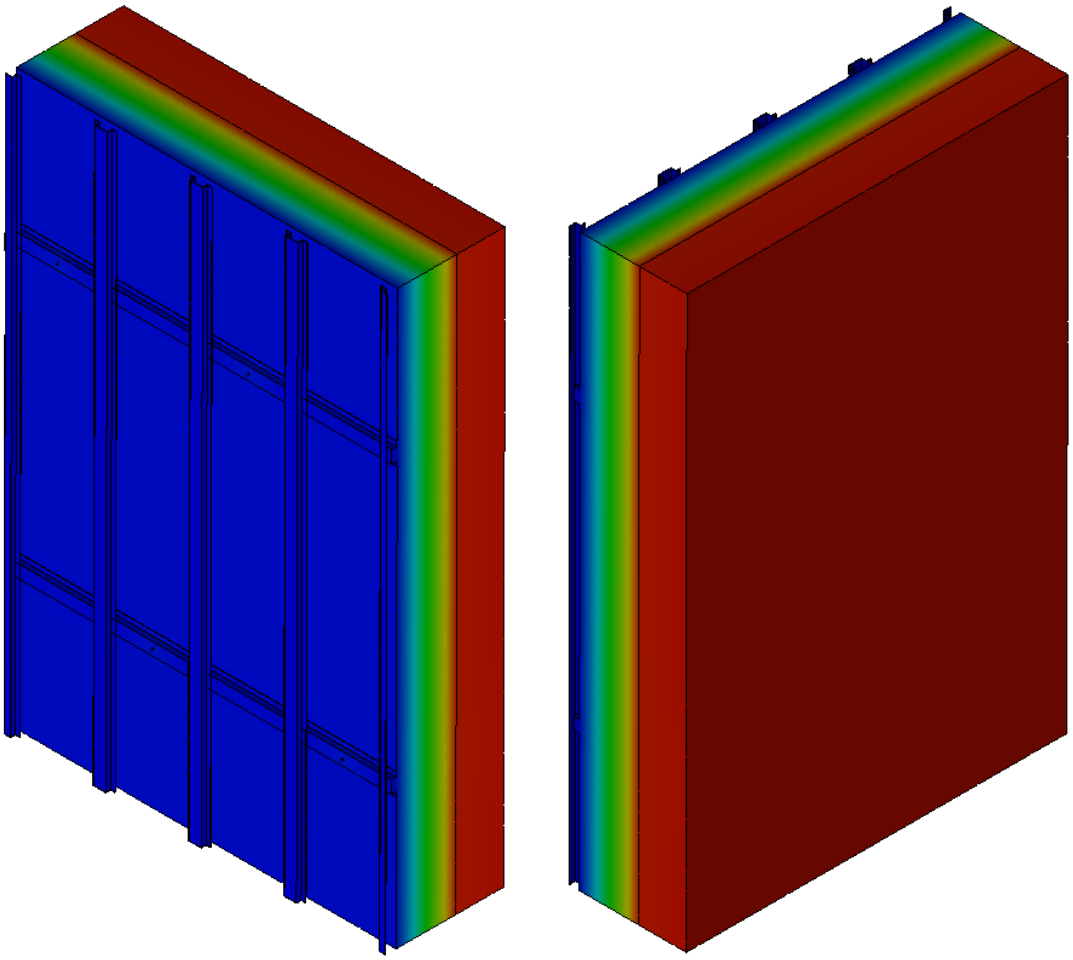
THE DETAILS WERE MODELED AND ASSESSED FOR THERMAL HEAT TRANSMITTANCE ONLY. THE DETAILS WERE NOT EVALUATED WITH RESPECT TO OTHER BUILDING ENCLOSURE FUNCTIONS SUCH AS MOISTURE CONTROL, AIR LEAKAGE, STRUCTURAL, OR DURABILITY. RDH AND ITS EMPLOYEES NEITHER ENDORSE NOR WARRANT THE SUITABILITY OF THE SIMULATED PRODUCTS.

PROJECT NAME: Hitch Cladding Attachment System Thermal Review	CLIENT NAME: LB
PRODUCT NAME: Hitch Wind Load Anchor	PROJECT NO.: 25403.000
DRAWING REFERENCE: CAD drawing provided by LB	DATE: Jan 21, 2021
	DRAWN BY: BG
	CHECKED BY: NN

Vancouver



Sill



MODEL:

Sill

10" Exterior Insulation Concrete Backup Wall Wind Load Anchor

RDH

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BURNABY BC V5C 6S6 TEL 604 873 1181

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PROJECT NAME: Hitch Cladding Attachment System Thermal Review	CLIENT NAME: LB
PRODUCT NAME: Hitch Wind Load Anchor	PROJECT NO.: 25403.000
DRAWING REFERENCE: CAD drawing provided by LB	DATE: Jan 21, 2021
	DRAWN BY: BG
	CHECKED BY: NN

Vancouver

Appendix C

Staggered Arrangement Analysis

C.1 Staggered Arrangement Analysis

The staggered clip arrangement is shown in Figure C1 below.

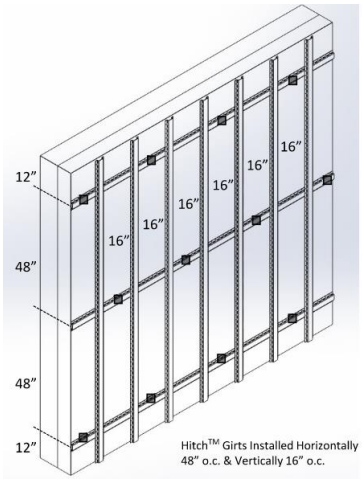

Figure C1: Staggered clip arrangements

The effective R-values and chi-values for staggered Hitch cladding attachment clip configurations are shown in imperial units in Table C1-IP, and SI units in Table C1-SI below.

TABLE C1-IP: RESULT FOR 32" HORIZONTAL AND 48" VERTICAL SPACING						
Clip Description	**Ex. Mineral Wool Insulation Thickness**	**Ex. Mineral Wool Insulation R-value**	**R1D**	**Effective R-value**	**Effective U-value**	**Chi-Value**
	in	**ft² · hr · ˚F/ Btu**			**Btu/ft² · hr · ˚F**	**Btu/hr · ˚F**
C1 Clip	1.0	4.2	7.1	7.0	0.143	0.028
C1 Clip	2.5	10.5	13.4	12.8	0.078	0.037
C2 Clip	3.0	12.6	15.5	14.4	0.070	0.054
C2 Clip	6.0	25.2	28.1	25.5	0.039	0.038
C3 Clip	8.0	33.6	36.5	32.1	0.031	0.038
C2 Clip	10.0	42.0	44.9	40.5	0.025	0.025
C3 Clip	10.0	42.0	44.9	39.6	0.025	0.031
C3 Clip	15.0	63.0	65.8	58.2	0.017	0.021

TABLE C1-SI: RESULT FOR 813 MM HORIZONTAL AND 1219 MM VERTIAL SPACING						
Clip Description	**Ex. Mineral Wool Insulation Thickness**	**Ex. Mineral Wool Insulation RSI-value**	**RSI-1D**	**Effective RSI-value**	**Effective USI-value**	**Chi-Value**
	mm	**m² · K/W**			**W/m² · K**	**W/K**
C1 Clip	25.4	0.74	1.25	1.23	0.81	0.015
C1 Clip	63.5	1.85	2.36	2.25	0.44	0.020
C2 Clip	76.2	2.22	2.73	2.53	0.40	0.029
C2 Clip	152.4	4.44	4.95	4.50	0.22	0.020
C3 Clip	203.2	5.92	6.42	5.66	0.18	0.020
C2 Clip	254.0	7.40	7.90	7.14	0.14	0.013
C3 Clip	254.0	7.40	7.90	6.98	0.14	0.016
C3 Clip	381.0	11.10	11.59	10.25	0.10	0.011