



August 30, 2019

MH Ref: 1904484.00

Mr. Patrick Lucas
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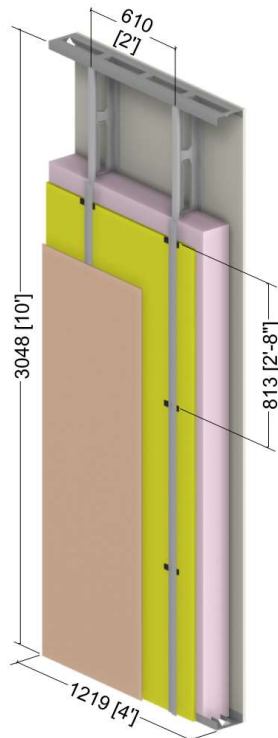
Dear Patrick:

Re: R-stud and R-track Thermal Analysis

Morrison Hershfield Limited (MH) was retained by R-stud LLC (R-stud) to analyze the thermal performance of the R-stud and R-track steel framing system and compare to standard steel framing. This report is a summary of the analysis.

BACKGROUND INFORMATION

The evaluated steel frame walls consists of steel studs at 24 inch spacing with top and bottom tracks with R-21 batt insulation in the stud cavity as shown in Figure 1.



Exterior

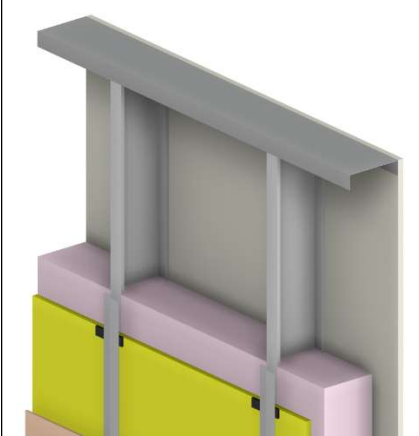
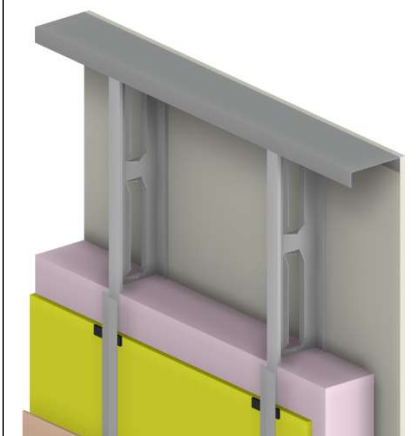
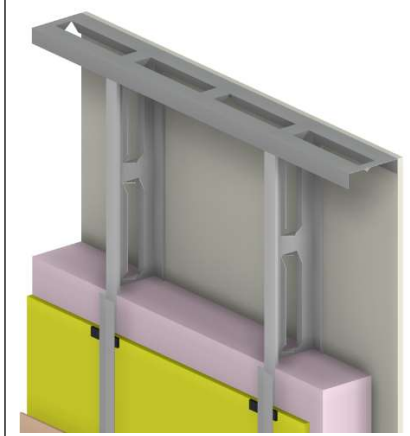
- 1/4 inch fibercement cladding
- Rainscreen cavity
- 18 ga. vertical z-bar
- 1 inch x 4 inch x 1/4 inch polypropylene shim
- 5/8 inch exterior gypsum sheathing
- 6 inch x 1 5/8 steel studs at 24 inch o.c. with top and bottom tracks
- R-21 batt insulation in stud cavity
- 5/8 inch interior gypsum

Interior

Figure 1: Evaluated Wall Assembly

Three scenarios were evaluated with standard studs and tracks, R-stud, and R-track framing as listed in Table 1. The material properties of the detail components are given in Appendix A.

Table 1: Evaluated Scenarios

		
Scenario 1	Scenario 2	Scenario 3
Standard Stud and Standard Top and Bottom Tracks	R-stud and Standard Top and Bottom Tracks	R-stud and Top and Bottom R-Tracks

THERMAL ANALYSIS

The thermal performance of the different assembly scenarios was evaluated by 3D thermal modeling 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 $\pm 5\%$ 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 Guide¹. The thermal analysis utilized steady-state conditions, published thermal properties of materials and information provided by R-stud. Additional assumptions for the thermal analysis are listed in Appendix A.

Assembly U- and R-Values

The U-values and effective R-values are shown in Table 1. Example temperature profiles for each configuration are provided in Appendix B.

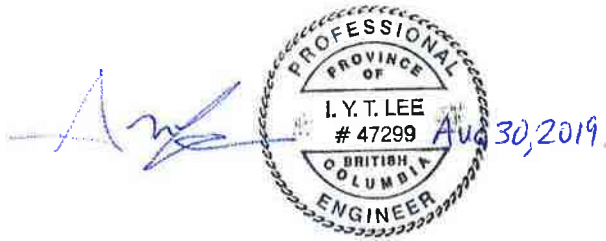
Table 1: Thermal Transmittance of the Evaluated Steel Frame Assemblies

Scenario		U-Value Btu/h · ft ² · °F (W/m ² · °K)	Effective R-Value ft ² · hr · °F/Btu (m ² · °K/W)
1	Standard Stud and Standard Top and Bottom Tracks	0.077 (0.439)	R-12.9 (2.28 RSI)
2	R-stud and Standard Top and Bottom Tracks	0.066 (0.373)	R-15.2 (2.68 RSI)
3	R-stud and R-Track Top and Bottom Tracks	0.062 (0.354)	R-16.0 (2.82 RSI)

¹ <https://www.bchydro.com/thermalguide>.

We believe that this report meets your objectives for evaluating the thermal performance of the proposed assemblies. If you have any questions or comments related to the above, please do not hesitate to contact the undersigned.

Yours truly,
MORRISON HERSHFIELD LIMITED



Ivan Lee, P.Eng.
Building Science Consultant



Patrick Roppel, P.Eng.
Principal, Building Science Specialist

APPENDIX A: MODELING PARAMETERS AND ASSUMPTIONS

A.1 THERMAL MODELING ASSUMPTIONS

For this report, a steady-state conduction model was used. The following parameters were also assumed:

- Material properties were taken from information provided by R-stud LLC and ASHRAE Handbook – Fundamentals for common materials.
- Interior/exterior air films were taken from Table 1, p. 26.1 of 2009 ASHRAE Handbook – Fundamentals depending on surface orientation.
- From the calibration in 1365-RP, contact resistances between materials were modeled 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.
- No solar heating impacts were included.
- Impacts of air leakage through the system was not modeled.

A.2 BOUNDARY CONDITIONS

Table A2.1: Boundary Conditions

Boundary Location	Combined Convective and Radiation Heat Transfer Coefficient BTU/hft ² °F (W/m ² K)
Exterior Wall Surfaces	6.0 (34)
Interior Walls	1.5 (8.3)

A.3 MATERIAL PROPERTIES

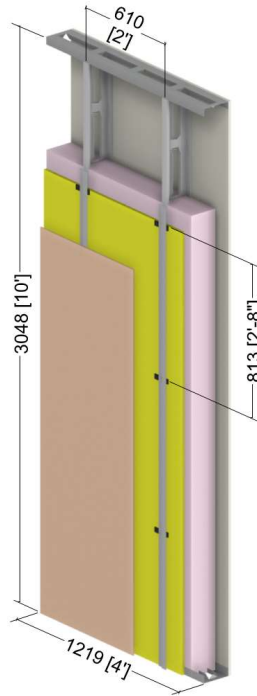


Figure A3.1: Modeled Geometry

Table A3.1: Material Properties

Component	Material	Thickness Inches (mm)	Thermal Conductivity Btu in / ft ² hr °F (W/m K)	Nominal Resistance ft ² hr °F / Btu (m ² K/W)
Interior Film	-	-	-	R-0.7 (0.12 RSI)
Drywall	Gypsum	5/8 (13)	1.1 (0.16)	R-0.6 (0.10 RSI)
Steel Studs	Galvanized Steel	18 Gauge	430 (62)	-
Steel Tracks	Galvanized Steel	18 Gauge	430 (62)	-
Cavity	Batt Insulation	6 (152)	0.28 (0.04)	R-21 (3.70 RSI)
Sheathing	Gypsum	5/8 (16)	1.1 (0.16)	R-0.6 (0.10 RSI)
Rainscreen Cavity	Vented Air Gap	5/8 (16)	-	R-0.4 (0.07 RSI)
Z-Girt	Galvanized Steel	18 Gauge	430 (62)	-
Shim	Polypropylene	1/4 (6)	1.5 (0.22)	-
Fasteners	Steel	3/16 (5) Ø	347 (50)	-
Cladding	Fibercement	1/4 (6)	1.7 (0.25)	R-0.1 (0.03 RSI)
Exterior Film	-	-	-	R-0.2 (0.03 RSI)
Overall Assembly 1D	-	-	-	R-23.5 (4.04 RSI)

APPENDIX B: SIMULATED TEMPERATURE PROFILES

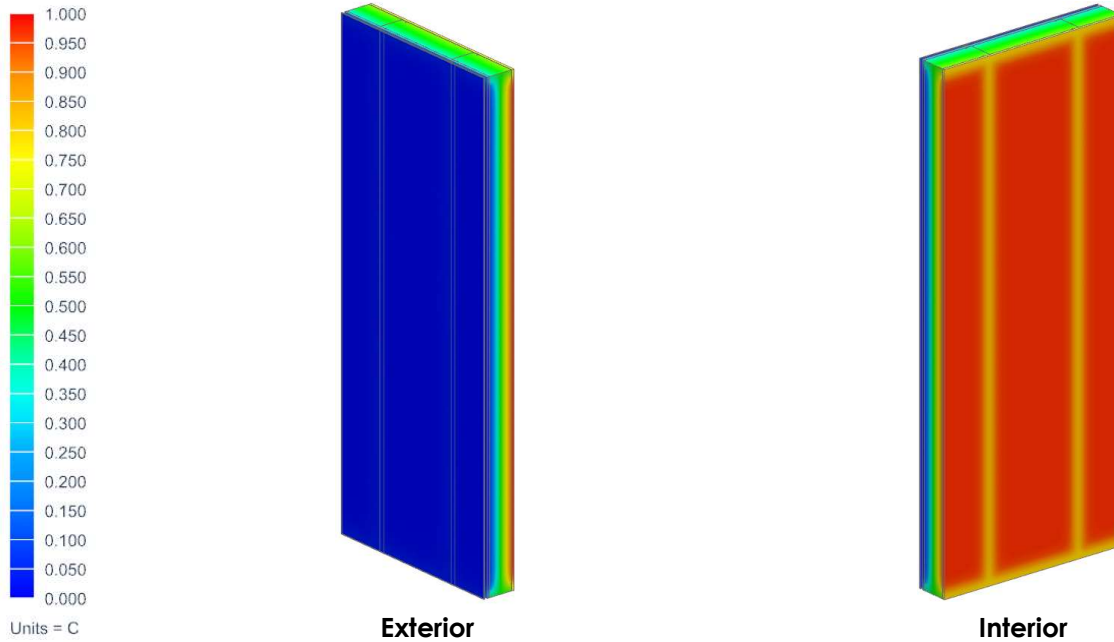


Figure B1.1: Steel Frame Wall Assembly with Standard Studs at 24 inch o.c. and Standard Top and Bottom Tracks with Vertical Z-Girts: Isometric view from exterior and interior

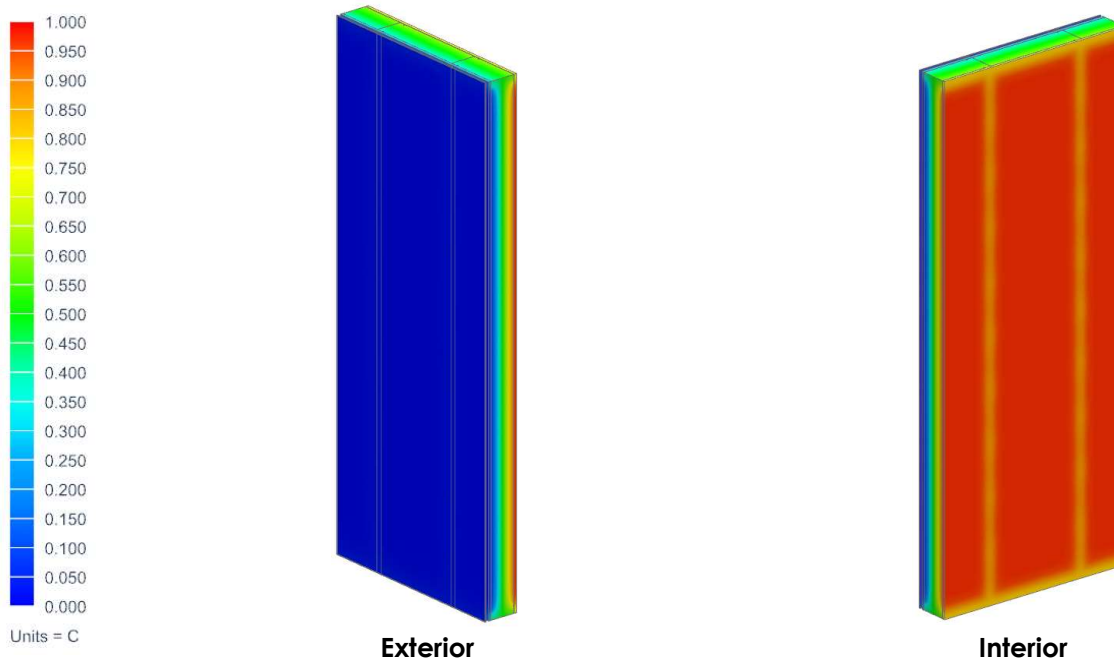


Figure B1.2: Steel Frame Wall Assembly with R-Stud at 24 inch o.c. and Standard Top and Bottom Tracks with Vertical Z-Girts: Isometric view from exterior and interior

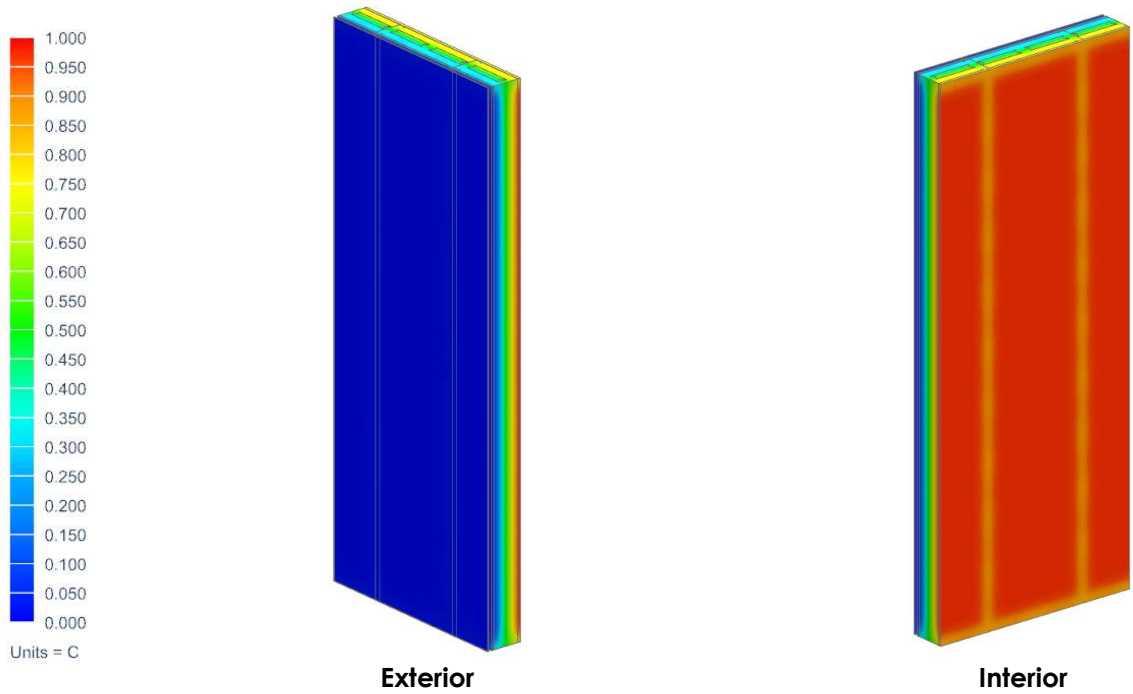


Figure B1.3: Steel Frame Wall Assembly with R-Stud at 24 inch o.c. and R-Tracks Top and Bottom Tracks with Vertical Z-Girts: Isometric view from exterior and interior