MORRISON HERSHFIELD

October 23, 2018 Project Number: 190030900

Dave Sommer
Interra Architectural Products
16904 164th Way S.E.
Renton, WA 98058

Re: Thermal Analysis of R-Stud Wall Assembly with CERACLAD for Rohnert Station

Morrison Hershfield (MH) has been contracted by Interra Architectural Products (Interra) to evaluate the thermal performance of the wall assembly for the Rohnert Station in Rohnert Park, California. The primary objective is to evaluate overall U-value and effective R-value of an interior insulated steel frame wall assembly with slotted steel R-stud framing.

Background Information

The interior insulated steel frame wall assembly for the Rohnert Station includes the following:

- Cladding panel
- Ceraclad clip @ 16” o.c. horizontally and 18” o.c. vertically
- Ventilated rainscreen cavity
- Weather barrier membrane
- 1/2" exterior gypsum sheathing
- 6” x 1-5/8” Slotted Steel R-stud @ 16” o.c.
- R-21 batt insulation
- 1/2" gypsum drywall

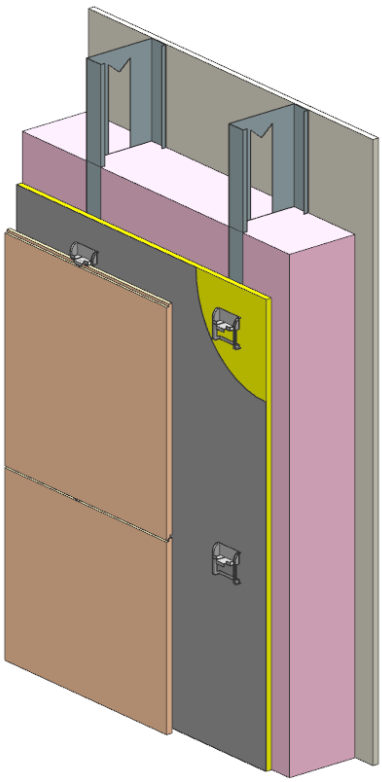

Figure 1: Modeled Wall Assembly

The modeled wall assembly is provided in Appendix A. The material properties of the details components are given in Appendix B.

Methodology

The thermal performance of the wall assembly 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 modeling 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*[1].

The thermal analysis utilized steady-state conditions and published thermal properties of materials from the ASHRAE Handbook of Fundamentals. Boundary conditions were modeled using heat transfer coefficients for convection (i.e. film coefficients) from the ASHRAE Handbook of Fundamentals. Additional assumptions for the thermal analysis are listed in Appendix B.

Assembly U- and R-Values Results

The assembly U-value and effective R-value for the interior insulated steel frame wall assembly is shown below in Table 1. Materials used in the analysis are given in Appendix B. Example temperature profiles for the wall assembly are provided in Appendix C.

Table 1: Thermal transmittance and Effective R-value of the Wall Assembly

Wall Assembly	**Overall U-value** Btu/hr ft^2 ^{o}F (W/m^{2}K)	**Effective R-value** hr ft^2 ^{o}F/Btu (m^{2}K/W)
6" x 1-5/8" Slotted Steel R-Stud @ 16" o.c. with R-21 Batt Insulation	0.064 (0.365)	**15.6** (2.74)

We believe that this report meets your objective for evaluating the thermal performance (U-values and effective R-values) of the interior insulated steel frame wall assembly for Rohnert Station. If you have any questions or comments related to the above, please do not hesitate to contact the undersigned.

[1] https://www.bchydro.com/thermalguide

Sincerely,

Morrison Hershfield Limited

Ivan Lee, P.Eng., M.A.Sc.
Building Science Consultant

Patrick Roppel, P.Eng., M.A.Sc.
Building Science Specialist

APPENDIX A: MODELED ASSEMBLY

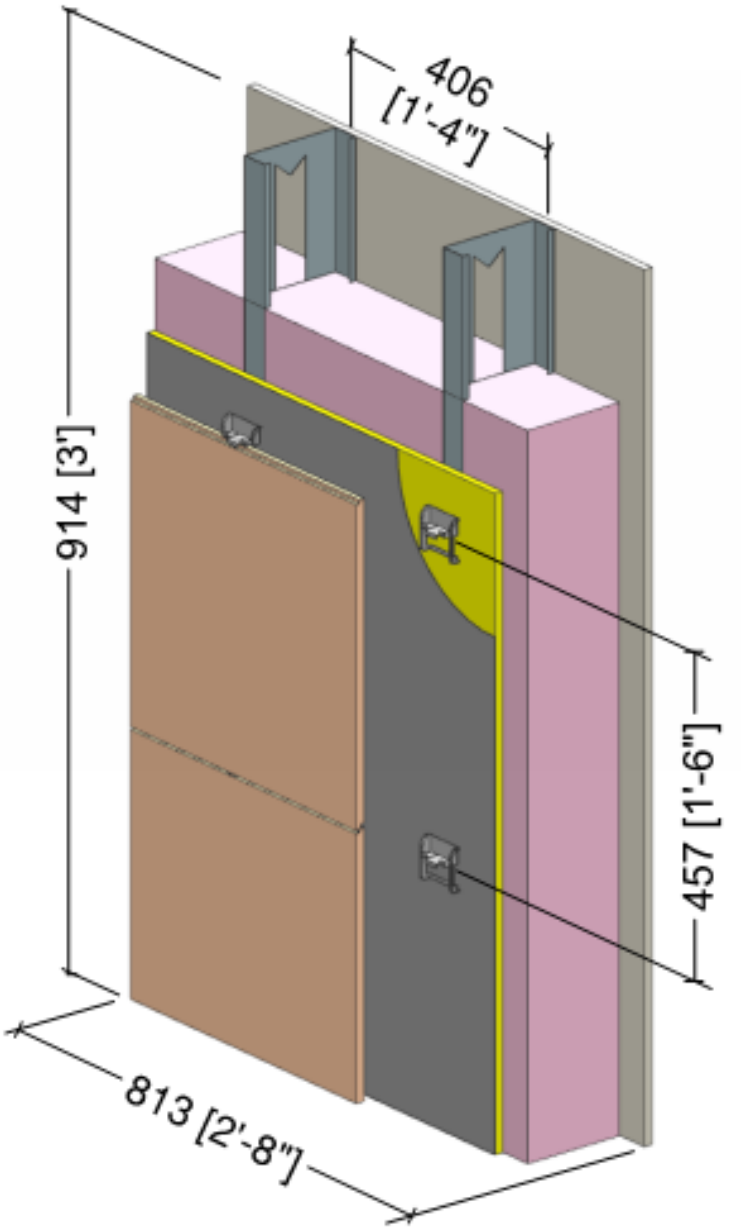

Figure A-1: Exterior View of Modeled Interior Insulated 6" x 1-5/8" Slotted Steel R-Stud Wall Assembly

APPENDIX B: MODELING PARAMETERS AND ASSUMPTIONS

B.1 Thermal Modeling Assumptions

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

- Air cavity conductivities were taken from ISO 10077 and Table 3, p. 26.13 of 2013 ASHRAE Handbook – Fundamentals
- Interior/exterior air films were taken from Table 1, p. 26.1 of 2009 ASHRAE Handbook – Fundamentals depending on surface orientation. The exterior air films were based on an exterior windspeed of 15mph.
- Material properties were taken from information provided by published material information from ASHRAE Handbook – Fundamentals for common materials (such sheathings, steel components etc).
- Materials used in this analysis were assumed to have a constant thermal conductivity.
- 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. Air gaps smaller than 2 mm were assumed incorporated with the contact resistances.
- Impacts of air leakage within the assembly were not included.
- The temperature difference between interior and exterior was modelled as a dimensionless temperature index between 0 and 1 (see Appendix C).
- As per standard U-value evaluation, no solar heating impacts were included.

B.2 Boundary Conditions

Table B-1: Boundary Conditions

Boundary Location	**Combined Convective and Radiation Heat Transfer Coefficient** Btu/hr ft^2 °F (W/m^2K)
Exterior (15 mph wind)	6.0 (34)
Interior	1.5 (8.3)

B.3 Material Properties

Table B-2: Material Properties

Component	**Conductivity** Btu in / ft² hr °F (W/m K)	**Nominal Resistance** hr ft² °F/Btu (m²K/W)
Gypsum Board Drywall	1.1 (0.16)	R-0.5 (0.08 RSI)
6" x 1-5/8" Slotted Steel R-stud	430 (62)	-
Batt Insulation	0.28 (0.04)	R-21 (3.70 RSI)
Exterior Gypsum Sheathing	1.1 (0.16)	R-0.5 (0.08 RSI)
Vented Rainscreen Cavity	1.0 (0.15)	R-0.5 (0.08 RSI)
Fiber Cement Cladding	1.7 (0.25)	R-0.3 (0.05 RSI)

APPENDIX C: SIMULATED TEMPERATURE PROFILES

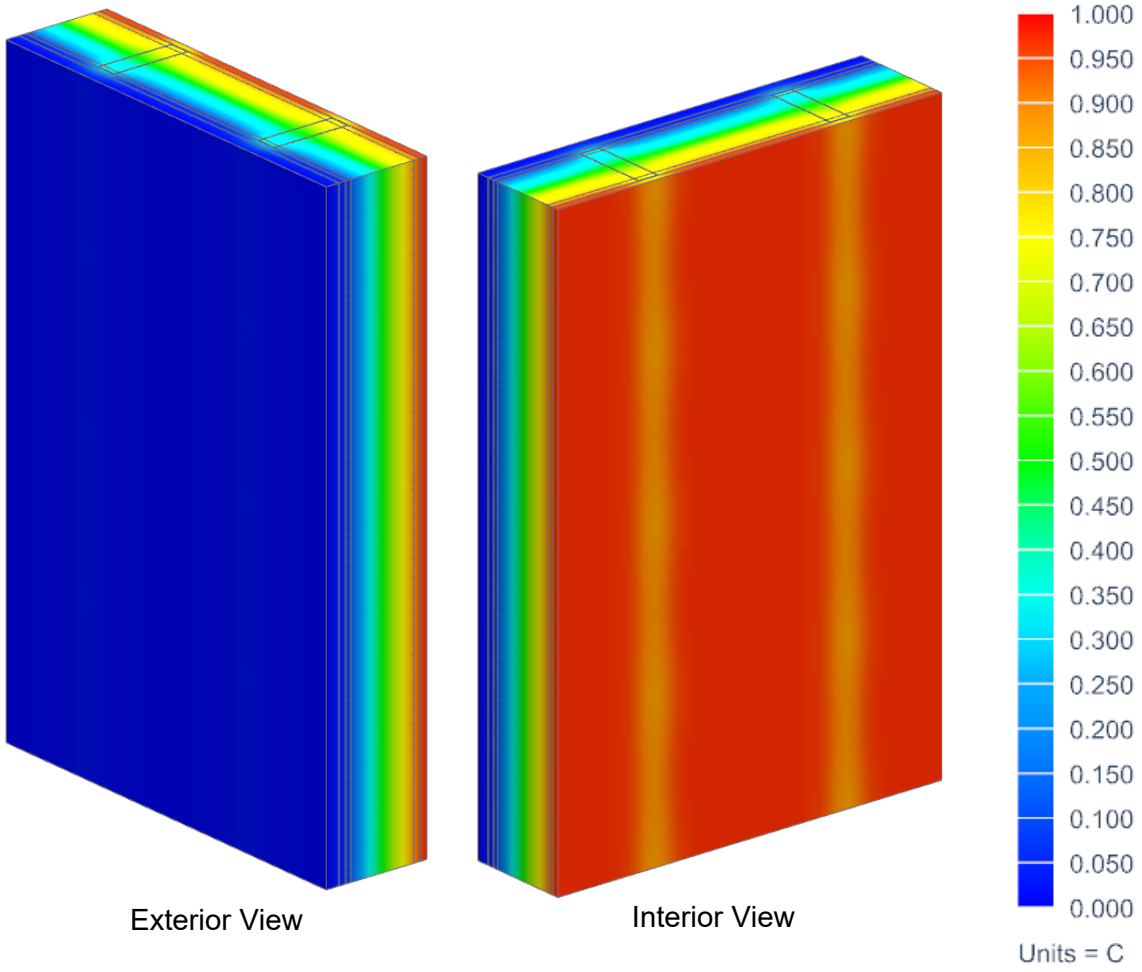

Figure C-1: Exterior and Interior Temperature Profiles of the Interior Insulated R-stud Wall Assembly