ENCLOSURE SOLUTIONS THERMAL BRIDGING GUIDE

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DISCLAIMER

This publication provides thermal transmittance data for building enclosure assemblies using Owens Corning® insulation products and guidance for meeting building enclosure energy efficiency targets and standards. The greatest care has been taken to confirm the accuracy of the information contained herein and provide authoritative information. However, the authors assume no liability for any damage, injury, loss or expense that may be incurred or suffered as result of the use of this publication.

In addition to using this publication, readers are encouraged to consult applicable up-to-date technical publications on building enclosure science, practices and materials. Retain consultants with appropriate architectural and/or engineering qualifications and speak with appropriate municipal and other authorities with respect to issues of enclosure design, assembly fabrication and construction practices. Always review and comply with the specific requirements of the applicable building codes for any construction project.

GUIDE CONTENTS

OVERVIEW 4

INTRODUCTION 4

THERMAL BRIDGING IN CODES AND STANDARDS 6

CLEAR FIELD ASSEMBLY 6

INTERFACE DETAILS 6

CONTINUOUS INSULATION VS. INSULATION CONTINUITY 7

THERMAL TRANSMITTANCE CALCULATIONS 8

CLEAR FIELD ASSEMBLIES 8

TWO- VERSUS THREE-DIMENSIONAL SIMULATIONS 9

CONDENSATION RISK 9

INTERFACE DETAILS – LINEAR AND POINT TRANSMITTANCES 10

SUPERIMPOSING HEAT FLOWS 11

DETERMINING OVERALL THERMAL TRANSMITTANCE 11

THERMAL TRANSMITTANCE DATA FOR BUILDING ASSEMBLIES USING OWENS CORNING® INSULATION AND SYSTEMS 13

EXAMPLE U-VALUE CALCULATION FOR ENTIRE WALL FAÇADE 38

HIGH-RISE MULTI-UNIT RESIDENTIAL BUILDING EXAMPLE 38

LOW-RISE COMMERCIAL BUILDING EXAMPLE 45

ADDITIONAL RESOURCES 48

GLOSSARY 48

REFERENCES 51

APPENDIX A | MATERIAL DATA SHEETS 52-79

APPENDIX B | THERMAL DATA SHEETS 80-99

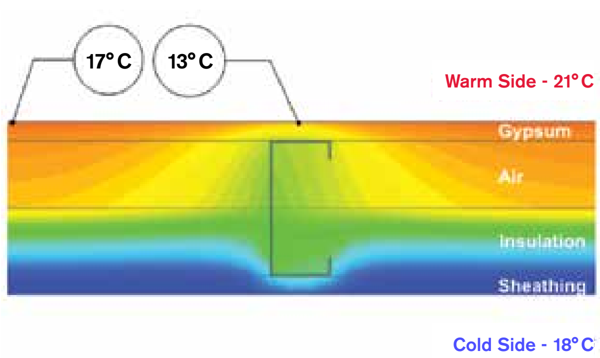
OVERVIEW

The focus of this document is to provide information and guidance for determining the thermal transmittance of commercial, institutional, and multi-unit residential construction using Owens Corning® products and systems. The thermal transmittance data outlined in this document was determined using the same methodology outlined by ASHRAE 1365-RP "Thermal Performance of Building Envelope Details for Mid- and High-Rise Buildings" and the Building Envelope Thermal Bridging (BETB) Guide. Accordingly, the data can be directly compared to the information contained in the BETB Guide and extrapolated to other systems and details.

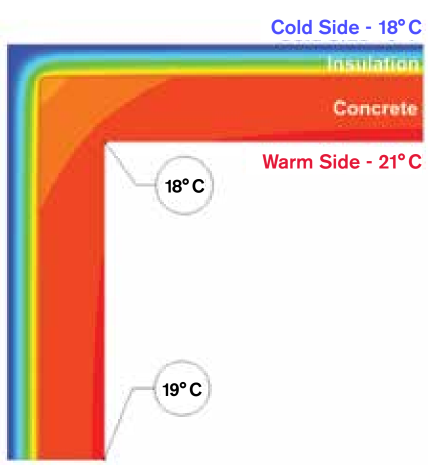
The initial sections of this Guide introduce the concept of thermal bridging, how thermal bridging is addressed in codes and standards, and how to perform thermal transmittance calculations. The later sections of this Guide provide thermal transmittance data for building enclosure assemblies using Owens Corning® insulation and systems, and provides example U-value calculations for the entire opaque building enclosure.

INTRODUCTION

Thermal bridges are localized areas of significantly higher heat flow through walls, roofs, and other insulated building enclosure components than the surrounding area. A consequence of thermal bridging is higher or lower surface temperatures compared to sections with uninterrupted insulation.



Thermal bridging occurs when a component with relatively higher thermal conductivity bypasses the thermal insulation, such as fiberglass batt insulation between wood and steel framing.



Changes in the uniformity of the building enclosure components, such as the thickness of insulation or structure, and/or the exterior and interior surface areas are dissimilar, such as the cold spot that occurs because the interior heat absorbing surface is smaller than the surface that is releasing heat to the exterior environment.

[1] Download the BETB Guide from BC Hydro's website at www.bchydro.com/thermalguide

In simple terms, heat flows through the path of least resistance. However, the impact of thermal bridging is not always obvious for multi-dimensional construction, especially when components do not fully penetrate the assembly and have intricate heat flow paths. The rate that heat flows through an assembly and surface temperatures are dependent on a number of factors, including:

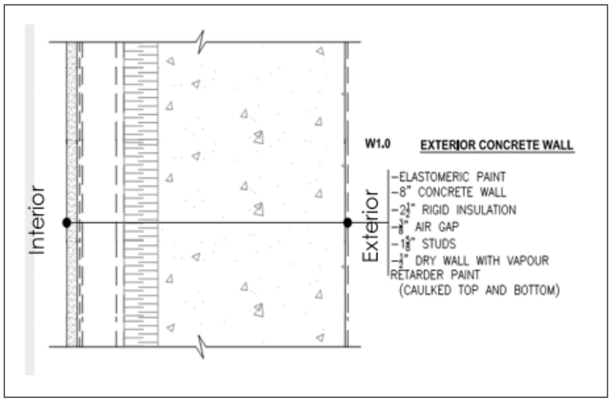
- The temperature difference across the assembly,
- The geometry and relative conductivity of the components that make up the assembly, and
- How components with higher conductivity are connected and located within the assembly.

Research and monitoring of buildings is increasingly showing the importance of mitigating the impact of thermal bridging, which can be significant to occupant comfort, risk of condensation on cold interior surfaces and building energy consumption. Mitigating thermal bridging will become an essential practice as industry shifts towards Net Zero Energy Ready or Net Zero Energy house levels of energy efficiency. However, significant thermal bridges at the junctions of building enclosure components, such as wall to roof, wall to window, or intermediate floors, are often overlooked by current codes, energy efficiency standards, and common practice. The reason that thermal bridging is often overlooked is due to the complexity and time required to fully assess thermal bridging using antiquated calculation methods.

Tools such as ASHRAE 1365-RP "Thermal Performance of Building Envelope Details for Mid- and High-Rise Buildings" and the Building Envelope Thermal Bridging (BETB) Guide simplify complex and time consuming calculations. These momentous energy efficiency initiatives put forward easy-to-use methods for understanding, accurately calculating and mitigating thermal bridging along with an extensive catalogue of thermal performance data. The Owens Corning® Thermal Bridging Guide follows the same methodology and provides examples of how to effectively mitigate thermal bridging, and make Owens Corning® insulation more effective.

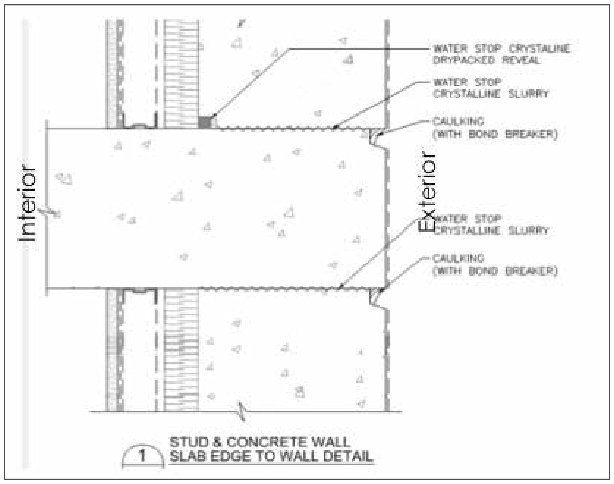
THERMAL BRIDGING IN CODES AND STANDARDS

Discussing the various ways that thermal bridging is addressed in codes and standards, now and in the future, requires a distinction be made between thermal bridging contained within an assembly and thermal bridging that occurs at junctions between components as shown below.



Clear Field Assembly

Wall, roof or floor assemblies that include all the components that make up an assembly, except windows and doors. Clear field assemblies are all the assemblies found in the wall/roof/floor schedules of an architectural drawing package. Clear field assemblies contain thermal bridges from uniformly distributed secondary structural components. Examples of thermal bridging included in clear field assemblies are brick ties, sub-girt framing and/or studs.



Interface Details

Occur at the junction between components or where the uniformity of the clear field assembly is interrupted. Thermal bridging at interface details are outlined in the detail section of an architectural drawing package. Examples of thermal bridging at interface details include intermediate floors, wall to glazing interfaces, wall to roof intersections, corners and beam penetrations.

Many energy standards currently only address thermal bridging contained within the clear field assembly, with the exception for wood-framed construction[2]. Compliance is met typically by meeting the minimum rated thermal resistance values of insulation in framing cavities and continuous insulation or by a maximum U-value for the clear field assembly. The problem is that the concept of continuous insulation and U-values for assemblies assumed to be parallel heat flow paths presents challenges to mitigating thermal bridging and enforcement of energy standards as outlined in the Image 1 below. There is a shift towards evaluating the thermal performance of the building enclosure as connected components, rather than looking at components in isolation or in parallel. NECB 2015, section 3.1.1.7. does provide some limited guidance towards the inclusion of repeating thermal bridges and major structural members in calculations for that standard. Energy standards such as Passive House already require a holistic approach and Canadian committees are currently looking to develop the next generation of codes and standards that effectively address thermal bridging. Changes are expected in the near future. The next section outlines the calculation methodologies for both current and future practice.

Continuous Insulation vs. Insulation Continuity

Despite the intent of the continuous insulation concept to make it simple and not require calculations, this approach does not effectively address thermal bridging.

Significant thermal bridging still occurs at interfaces, as shown to the left where a metal closure negates effectiveness of the exterior wall insulation. North American codes and standards are being developed to address thermal bridging at interfaces by shifting thinking towards insulation continuity and introducing thermal breaks when practical.

Image 1

[2] Thermal bridging related to wood headers, plates, and sills are factored into thermal transmittance values using framing factors.

THERMAL TRANSMITTANCE CALCULATIONS

Clear Field Assemblies

Thermal transmittances of clear field assemblies can be determined through calculations, two- or three-dimensional finite element analysis, and physical testing.

Codes and standards are currently largely based on two-dimensional heat transfer calculations. ASHRAE 90.1 Appendix A.9 (2013) and Chapter 27 of the ASHRAE Handbook of Fundamentals (2013) outlines the type of assemblies and conditions that calculations[3] are acceptable. The following table summarizes acceptable calculation procedures (shaded in gray) as outlined in ASHRAE 90.1. Finite element analysis and testing is seen as more accurate and are acceptable alternative to these calculations.

Opaque Element		Series	Parallel-Path	Isothermal-planes	Modified Zone Method	Other Assembly Specific Calculation Method	Testing or Finite Element Analysis
Roofs	Insulation entirely above Deck						
Roofs	Metal Building						
Roofs	Attic		Wood-frame, solid concrete, steel w/factors	Concrete if hollow sections	Steel-frame		
Roofs	All other						
Above Grade Walls	Mass						
Above Grade Walls	Metal Building						
Above Grade Walls	Steel Framed		With correction factors				
Above Grade Walls	Wood Framed or Other						

[3]NECB references ASHRAE Handbook, Standards and Guidelines for acceptable calculation procedures. Therefore the calculation methodology in the table above also applies to NECB.

Two-Versus Three-Dimensional Simulations

Two-dimensional software (such as **THERM**, (Mitchell, et al., Rev 2013)) is widely available and utilized in industry to calculate the thermal transmittance of building enclosure assemblies. Approximations for components that are not continuous in the modeled section are done using equivalent thermal conductivity. These approximations often are sufficient for approximating the thermal transmittance of an assembly but often is either more or less conservative than 3-D thermal simulations or physical testing. The difference depends on the geometry and relative conductivity of the components that make up the assembly, and how the components are connected and located within the assembly. Two-dimensional analysis has limitations for estimating the risk of condensation as outlined in Image 1 below.

For complex geometries and configurations, then 3D modeling or physical testing (such as ASTM C1363) is necessary if accurate approximations of thermal transmittance is required. The thermal data presented in this guide was determined using 3-D finite element analysis.

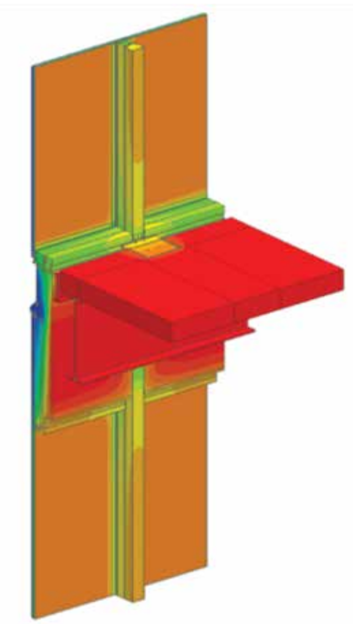


Image 1

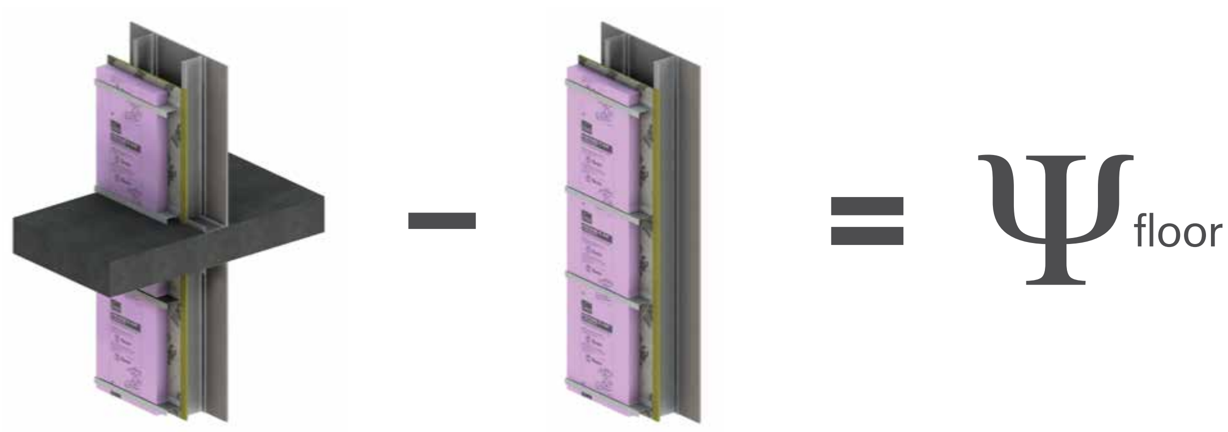
Condensation Risk

Two-dimensional analysis is often not up to the challenge of evaluating the risk of condensation. 2-D analysis calculates average temperature at best, but it's the coldest temperature that counts. All the necessary assumptions can overshadow the required resolution. Three-dimensional simulations capture lateral heat flow and will often show either warmer or colder temperatures compared to 2-D analysis. 3-D analysis will better reflect reality, which means that designers are better able to mitigate risk.

INTERFACE DETAILS – LINEAR AND POINT TRANSMITTANCES

Linear and point transmittances are the additional heat flow at interface details compared to the related undisturbed clear field transmittance. Linear and point transmittances are a means to simply calculating overall U-values and evaluating the thermal quality of details.

The following figure illustrates the concept of linear and point transmittance using an exterior insulated steel stud wall with a cantilevered balcony.



Heat flow with floor and balcony intersection

Clear Field heat flow

Additional heat flow due to thermal bridging at floor and balcony intersection

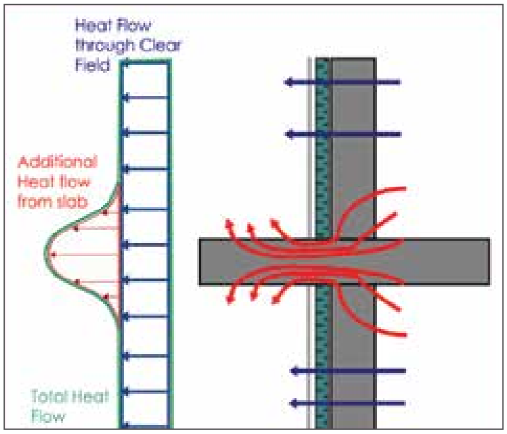
The clear field transmittance accounts for the heat flow of an assembly that includes uniformly distributed thermal bridges that modify the heat flow of the assembly (area based). The thermal bridges contained in the clear field transmittance are not practical to account for on an individual basis, such as steel studs and girts for attaching cladding. The linear transmittance is determined by subtracting the clear field transmittance from the transmittance that includes the additional thermal bridging at the balcony and divide by the perimeter length of the intermediate floor.

The extra heat flow prescribed to the floor slab using linear transmittances is not dependent on the area of the thermal bridge, but only by the linear length (width) of the intermediate floor. A point transmittance is similar in concept, but is a single point of additional heat flow, not dependent on area or length. Since the linear and point transmittances are separate from the clear field, they can be directly compared to assess approaches to mitigate the impact of thermal bridging. Adding the impact of linear, point, and clear field transmittances can be used for any enclosure area to determine the overall.

SUPERIMPOSING HEAT FLOWS

The figure below visualizes the direct and lateral heat flows around the insulation at the concrete floor compared to the clear field transmittance. The heat flow is uniform per the clear field transmittance away from the floor.

The total transmittance is determined by superimposing the additional heat flow at the interface detail, defined by linear transmittance, to the uniform clear field transmittance.

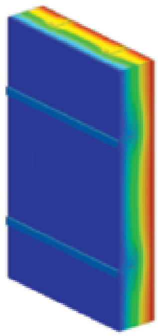


DETERMINING OVERALL THERMAL TRANSMITTANCE

The overall thermal transmittance is determined by superimposing all the clear field, linear, and point transmittances together. In straightforward terms this calculation is as follows:

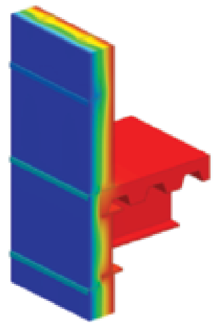
$$\text{Total Heat flow per area through the overall assembly} = \frac{\text{Heat flow through linear transmittances} + \text{Heat flow through point transmittances}}{\text{Total Area of assembly}} + \text{Heat flow per area through clear field assembly}$$

The overall thermal transmittance comprises of three types of transmittance details as defined as follows:



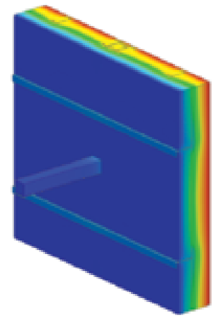
Clear field transmittance (U-value or U_o)

Heat flow per area of wall, floor and roof assemblies. Includes the effects of uniformly distributed thermal bridging, such as brick ties, structural framing, and cladding attachments.



Linear transmittance (psi or ψ)

Additional heat flow per length caused by linear thermal bridges. This includes intermediate floors, corners, parapets, and glazing interfaces.



Point transmittance (chi or χ)

Additional heat flow caused by point thermal bridges that occur infrequently. This includes structural beam penetrations and three-way corners.

In mathematical terms, the overall thermal transmittance is calculated as follows:

$$U_T = \frac{\Sigma(\Psi \cdot L) + \Sigma(\chi)}{A_{Total}} + U_o$$

Where:

U_T = total thermal transmittance (Btu/hr·ft^2·°F or W/m^{2}K)

U_o = clear field thermal transmittance (Btu/hr·ft^2·°F or W/m^{2}K)

A_{total} = the total opaque wall area (ft^2 or m^2)

ψ = linear transmittance (Btu/hr·ft °F or W/m K)

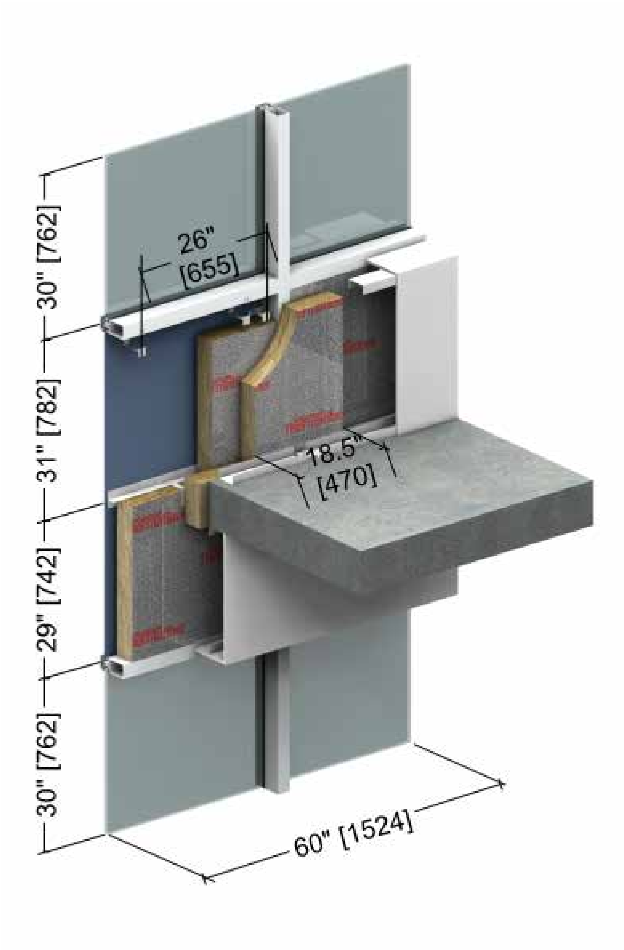
L = length of linear interface detail (ft or m)

χ = point thermal transmittance (Btu/hr· °F or W/K)

The length for the linear transmittance depends on the detail. For example, the length used in the calculation for an intermediate floor could be the width of the building perimeter. Similarly, a corner detail length could be the full-height of the building enclosure. Thermal transmittance data for walls and roofs using Owens Corning® Insulation and Systems and example U-value calculations follows in the next sections.

THERMAL TRANSMITTANCE DATA FOR BUILDING ASSEMBLIES USING OWENS CORNING® INSULATION AND SYSTEMS

DETAIL 1 - CURTAIN WALL SPANDREL WITH THERMAFIBER® IMPASSE SYSTEM



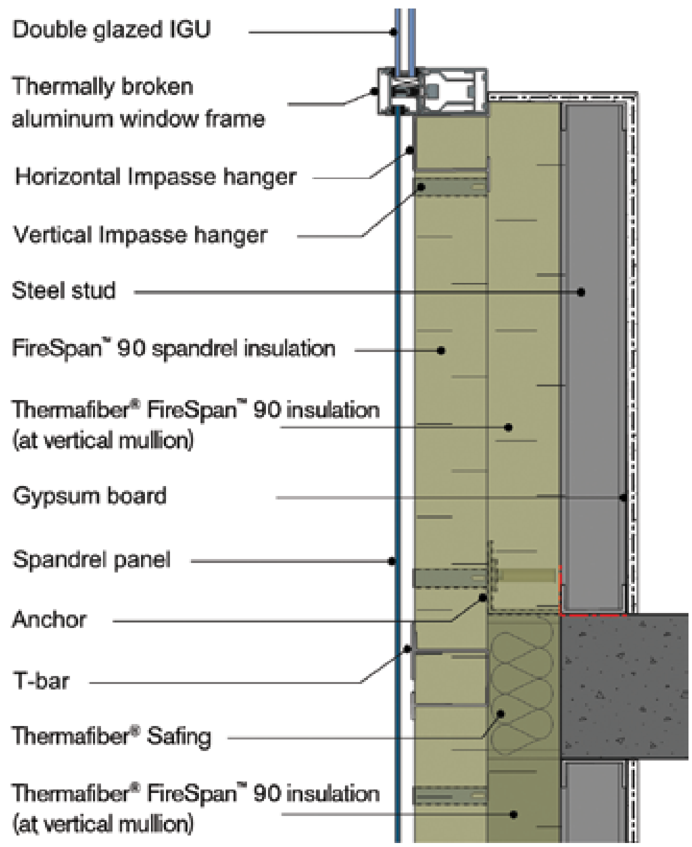
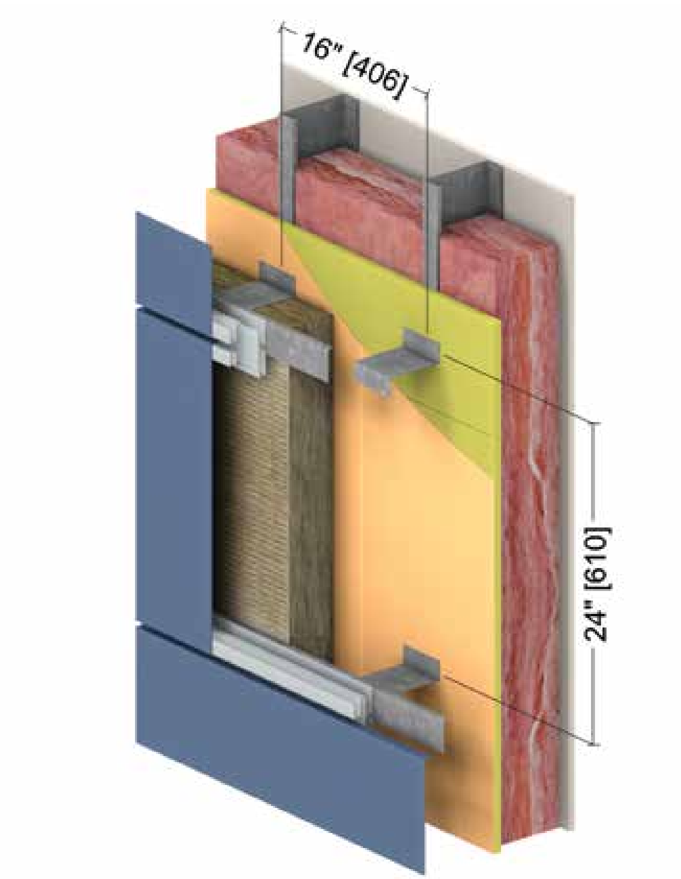


Table 5.1: Thermal Transmittance Data for Detail 1

Spandrel Insulation Thickness Inches (mm)	Spandrel Insulation Nominal R-value hr·ft²·°F/Btu (m²K/W)	Vision Assembly		Opaque Assembly		Highest Applicable Climate Zone per NECB 2015[1]
		Effective R-value hr·ft²·°F/Btu (m²K/W)	U-value Btu/hr·ft²·°F (W/m²K)	Effective R-value hr·ft²·°F/Btu (m²K/W)	U-value Btu/hr·ft²·°F (W/m²K)	
2" (50.8)	R-8.6 (1.51)	R-2.2 (0.39)	0.455 (2.582)	R-5.3 (0.94)	0.187 (1.062)	None
4" (101.6)	R-17.2 (3.03)			R-7.8 (1.38)	0.128 (0.725)	None

[1]Compared to above grade wall for maximum U-value in Table 3.2.2.2

DETAIL 2 - STEEL STUD WALL WITH THERMAFIBER® INSULATION AND METAL PANEL ATTACHED BY GALVANIZED INTERMITTENT HORIZONTAL Z-GIRTS



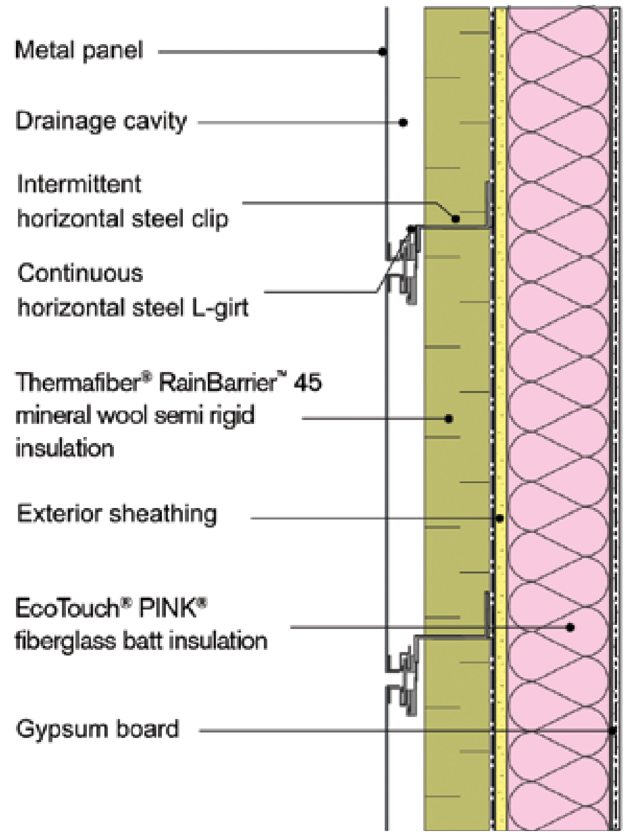
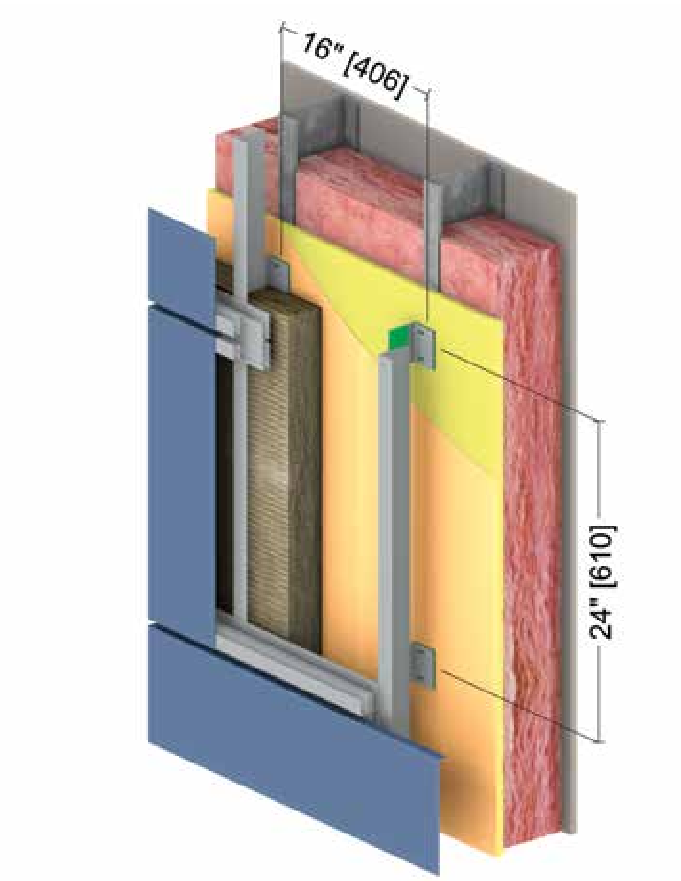


Table 5.2: Thermal Transmittance Data for Detail 2

Scenario	Exterior Insulation Thickness Inches (mm)	Exterior Insulation Nominal R-value hr·ft²·°F/Btu (m²K/W)	Assembly		Highest Applicable Climate Zone per NECB 2015[1]
			R-value hr·ft²·°F/Btu (m²K/W)	U-value Btu/hr·ft²·°F (W/m²K)	
R-20 (3.52 RSI) Batt Insulation in Stud Cavity	1.5" (38.1)	R-6.5 (1.14)	R-17.2 (3.03)	0.058 (0.330)	None
	2" (50.8)	R-8.6 (1.51)	R-18.8 (3.31)	0.053 (0.302)	4
	3" (76.2)	R-12.9 (2.27)	R-21.8 (3.83)	0.046 (0.261)	5
	4" (101.6)	R-17.2 (3.03)	R-24.5 (4.32)	0.041 (0.232)	6
	5" (127.0)	R-21.5 (3.79)	R-27.1 (4.78)	0.037 (0.209)	7
R-22.5 (3.96 RSI) Batt Insulation in Stud Cavity	1.5" (38.1)	R-6.5 (1.14)	R-17.9 (3.14)	0.056 (0.318)	None
	2" (50.8)	R-8.6 (1.51)	R-19.4 (3.42)	0.052 (0.293)	4
	3" (76.2)	R-12.9 (2.27)	R-22.4 (3.94)	0.045 (0.254)	5
	4" (101.6)	R-17.2 (3.03)	R-25.1 (4.43)	0.040 (0.226)	6
	5" (127.0)	R-21.5 (3.79)	R-27.7 (4.88)	0.036 (0.205)	7
R-24 (4.23 RSI) Batt Insulation in Stud Cavity	1.5" (38.1)	R-6.5 (1.14)	R-18.2 (3.21)	0.055 (0.312)	4
	2" (50.8)	R-8.6 (1.51)	R-19.7 (3.48)	0.051 (0.288)	4
	3" (76.2)	R-12.9 (2.27)	R-22.7 (4.00)	0.044 (0.250)	5
	4" (101.6)	R-17.2 (3.03)	R-25.5 (4.48)	0.039 (0.223)	6
	5" (127.0)	R-21.5 (3.79)	R-28.1 (4.94)	0.036 (0.202)	7

[1]Compared to above grade wall for maximum U-value in Table 3.2.2.2

DETAIL 3 - STEEL STUD WALL WITH THERMAFIBER® INSULATION AND METAL PANEL ATTACHED BY THERMALLY ISOLATED ALUMINUM BRACKETS AND VERTICAL RAIL



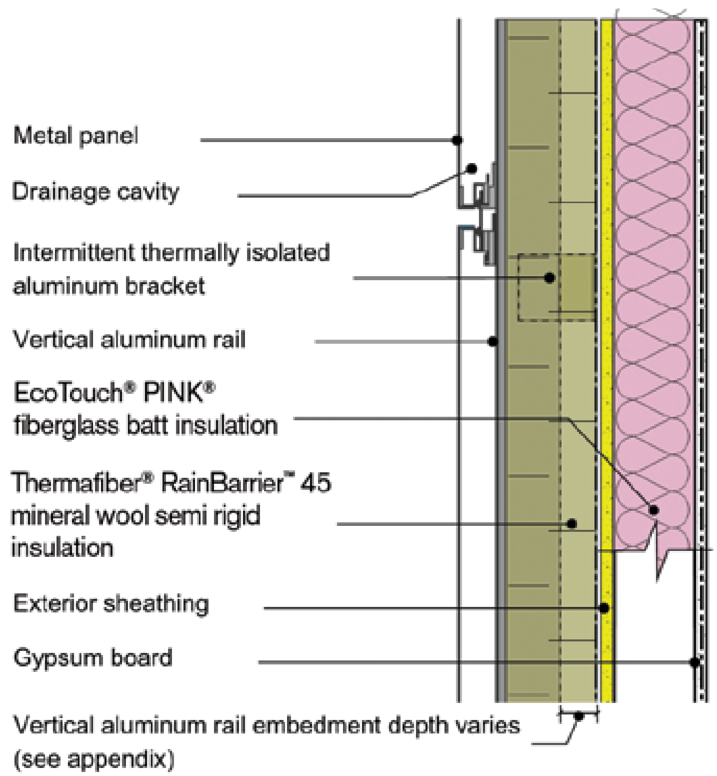
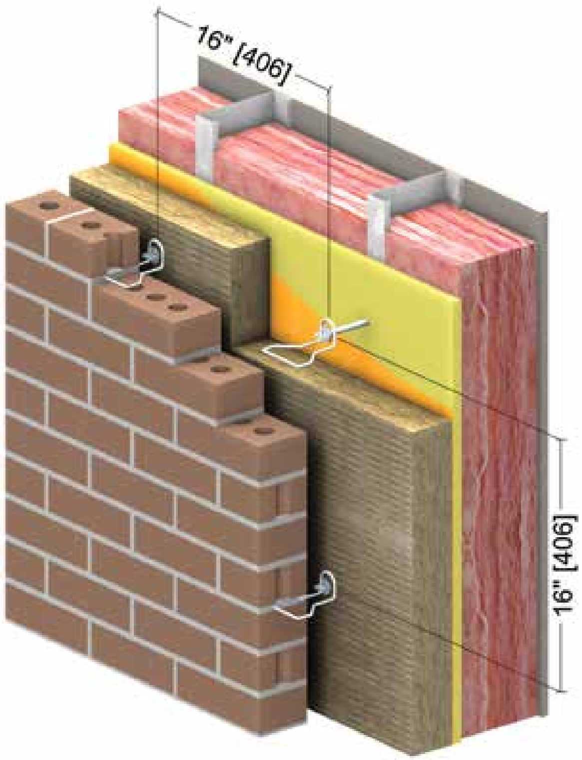


Table 5.3: Thermal Transmittance Data for Detail 3

Scenario	Exterior Insulation Thickness Inches (mm)	Exterior Insulation Nominal R-value hr·ft²·°F/Btu (m²K/W)	Assembly		Highest Applicable Climate Zone per NECB 2015[1]
			R-value hr·ft²·°F/Btu (m²K/W)	U-value Btu/hr·ft²·°F (W/m²K)	
Air in Stud Cavity	2" (50.8) 5" (127)	R-8.6 (1.51) R-21.5 (3.79)	R-10.2 (1.80) R-18.0 (3.16)	0.098 (0.557) 0.056 (0.316)	None None
R-20 (3.52 RSI) Batt Insulation in Stud Cavity	1.5" (38.1) 2" (50.8) 3" (76.2) 4" (101.6) 5" (127.0)	R-6.5 (1.14) R-8.6 (1.51) R-12.9 (2.27) R-17.2 (3.03) R-21.5 (3.79)	R-17.3 (3.05) R-18.4 (3.25) R-20.7 (3.65) R-23.5 (4.13) R-26.0 (4.59)	0.058 (0.327) 0.054 (0.308) 0.048 (0.274) 0.043 (0.242) 0.038 (0.218)	None 4 5 6 6
R-22.5 (3.96 RSI) Batt Insulation in Stud Cavity	1.5" (38.1) 2" (50.8) 3" (76.2) 4" (101.6) 5" (127.0)	R-6.5 (1.14) R-8.6 (1.51) R-12.9 (2.27) R-17.2 (3.03) R-21.5 (3.79)	R-18.0 (3.17) R-19.1 (3.36) R-21.3 (3.75) R-24.1 (4.24) R-26.6 (4.69)	0.056 (0.316) 0.052 (0.298) 0.047 (0.266) 0.042 (0.236) 0.038 (0.213)	None 4 5 6 6
R-24 (4.23 RSI) Batt Insulation in Stud Cavity	1.5" (38.1) 2" (50.8) 3" (76.2) 4" (101.6) 5" (127)	R-6.5 (1.14) R-8.6 (1.51) R-12.9 (2.27) R-17.2 (3.03) R-21.5 (3.79)	R-18.4 (3.23) R-19.4 (3.42) R-21.7 (3.81) R-24.4 (4.30) R-27.0 (4.76)	0.054 (0.309) 0.051 (0.292) 0.046 (0.262) 0.041 (0.233) 0.037 (0.210)	4 4 5 6 7

[1]Compared to above grade wall for maximum U-value in Table 3.2.2.2

DETAIL 4 - STEEL STUD WALL WITH THERMAFIBER® INSULATION AND BRICK VENEER



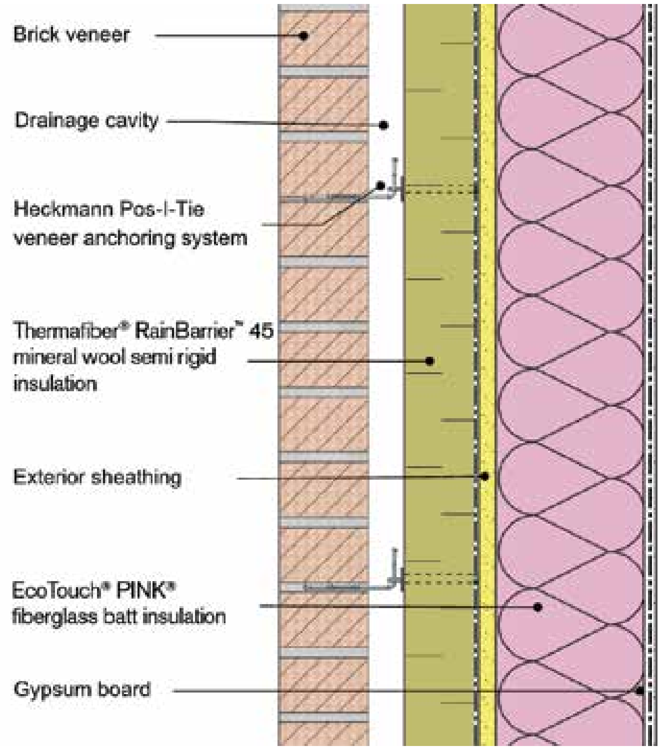
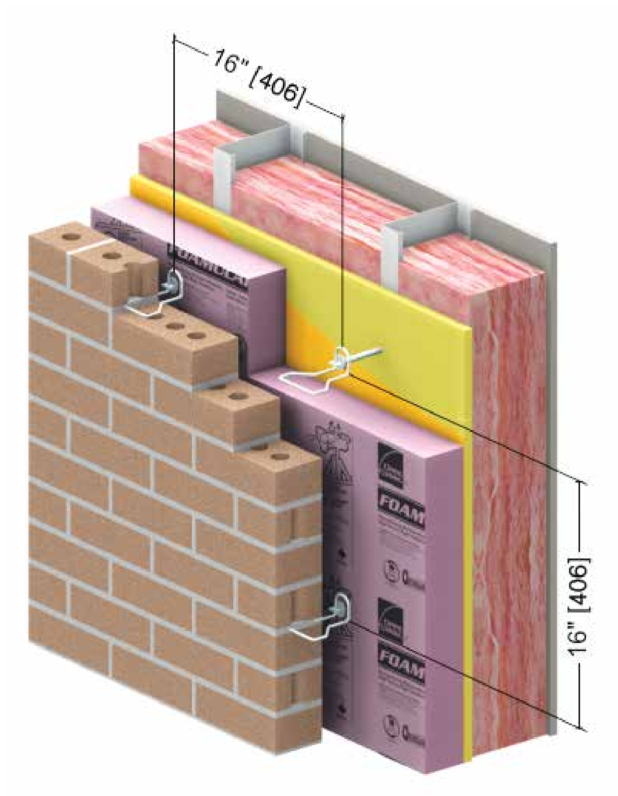


Table 5.4: Thermal Transmittance Data for Detail 4

Scenario	Exterior Insulation Thickness Inches (mm)	Exterior Insulation Nominal R-value hr·ft²·°F/Btu (m²K/W)	Assembly R-value hr·ft²·°F/Btu (m²K/W)	Assembly U-value Btu/hr·ft²·°F (W/m²K)	Highest Applicable Climate Zone per NECB 2015[1]
R-20 (3.52 RSI) Batt Insulation in Stud Cavity	1.5" (38.1)	R-6.5 (1.14)	R-17.2 (3.03)	0.058 (0.330)	None
	2" (50.8)	R-8.6 (1.51)	R-18.7 (3.30)	0.053 (0.303)	4
	3" (76.2)	R-12.9 (2.27)	R-21.5 (3.78)	0.047 (0.265)	5
	4" (101.6)	R-17.2 (3.03)	R-23.9 (4.21)	0.042 (0.238)	6
	5" (127.0)	R-21.5 (3.79)	R-26.5 (4.68)	0.038 (0.214)	6
R-22.5 (3.96 RSI) Batt Insulation in Stud Cavity	1.5" (38.1)	R-6.5 (1.14)	R-17.7 (3.12)	0.056 (0.320)	None
	2" (50.8)	R-8.6 (1.51)	R-19.2 (3.38)	0.052 (0.296)	4
	3" (76.2)	R-12.9 (2.27)	R-21.9 (3.85)	0.046 (0.260)	5
	4" (101.6)	R-17.2 (3.03)	R-24.2 (4.26)	0.041 (0.235)	6
	5" (127.0)	R-21.5 (3.79)	R-26.8 (4.71)	0.037 (0.212)	6
R-24 (4.23 RSI) Batt Insulation in Stud Cavity	1.5" (38.1)	R-6.5 (1.14)	R-18.1 (3.19)	0.055 (0.314)	4
	2" (50.8)	R-8.6 (1.51)	R-19.6 (3.45)	0.051 (0.290)	4
	3" (76.2)	R-12.9 (2.27)	R-22.5 (3.96)	0.044 (0.252)	5
	4" (101.6)	R-17.2 (3.03)	R-24.9 (4.39)	0.040 (0.228)	6
	5" (127.0)	R-21.5 (3.79)	R-27.3 (4.81)	0.037 (0.208)	7

[1]Compared to above grade wall for maximum U-value in Table 3.2.2.2

DETAIL 5 - STEEL STUD WALL WITH FOAMULAR® INSULATION AND BRICK VENEER



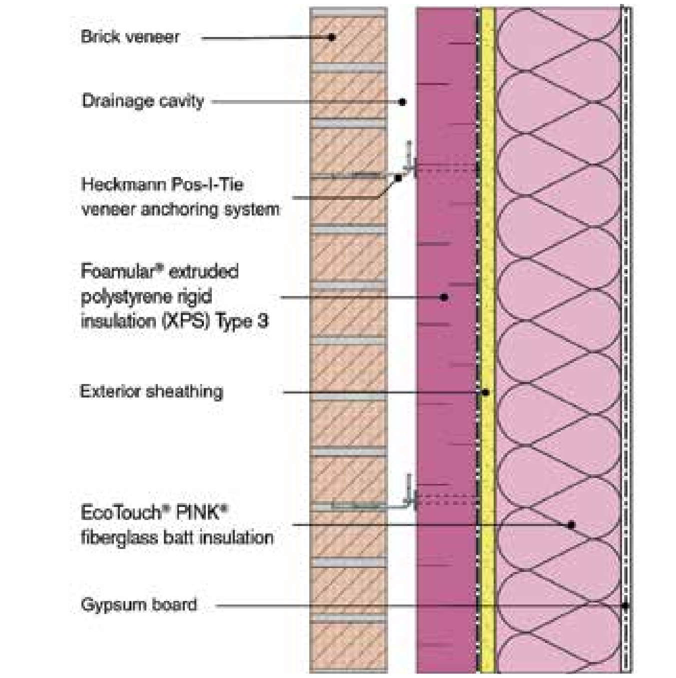
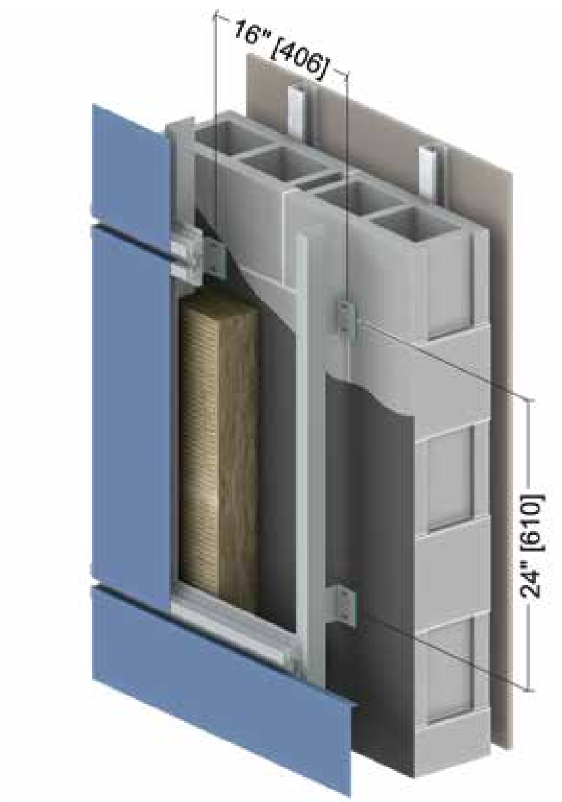


Table 5.5: Thermal Transmittance Data for Detail 5

Scenario	Exterior Insulation Thickness Inches (mm)	Exterior Insulation Nominal R-value hr·ft²·°F/Btu (m²K/W)	Assembly		Highest Applicable Climate Zone per NECB 2015[1]
			R-value hr·ft²·°F/Btu (m²K/W)	U-value Btu/hr·ft²·°F (W/m²K)	
R-20 (3.52 RSI) Batt Insulation in Stud Cavity	1.5" (38.1)	R-7.5 (1.32)	R-17.9 (3.16)	0.056 (0.316)	None
	2" (50.8)	R-10 (1.76)	R-19.6 (3.46)	0.051 (0.289)	4
	3" (76.2)	R-15 (2.64)	R-22.7 (3.99)	0.044 (0.251)	5
	4" (101.6)	R-20 (3.52)	R-25.2 (4.45)	0.040 (0.225)	6
R-22.5 (3.96 RSI) Batt Insulation in Stud Cavity	1.5" (38.1)	R-7.5 (1.32)	R-18.5 (3.26)	0.054 (0.307)	4
	2" (50.8)	R-10 (1.76)	R-20.2 (3.56)	0.050 (0.281)	4
	3" (76.2)	R-15 (2.64)	R-23.2 (4.09)	0.043 (0.245)	6
	4" (101.6)	R-20 (3.52)	R-25.8 (4.55)	0.039 (0.220)	6
R-24 (4.23 RSI) Batt Insulation in Stud Cavity	1.5" (38.1)	R-7.5 (1.32)	R-18.8 (3.32)	0.053 (0.301)	4
	2" (50.8)	R-10 (1.76)	R-20.5 (3.61)	0.049 (0.277)	5
	3" (76.2)	R-15 (2.64)	R-23.5 (4.14)	0.043 (0.242)	6
	4" (101.6)	R-20 (3.52)	R-26.2 (4.61)	0.038 (0.217)	6

[1]Compared to above grade wall for maximum U-value in Table 3.2.2.2

DETAIL 6 - CONCRETE BLOCK WALL WITH THERMAFIBER® INSULATION AND METAL PANEL ATTACHED BY ALUMINUM BRACKETS AND VERTICAL RAIL



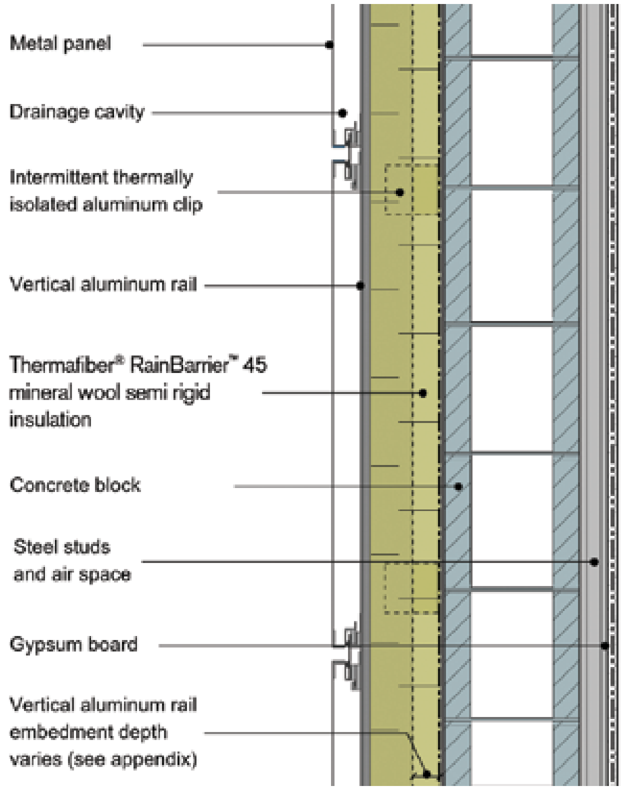
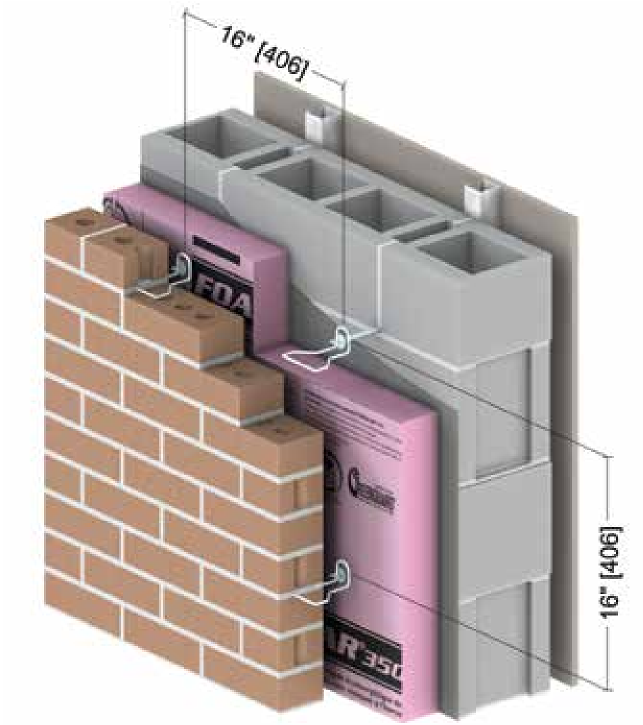


Table 5.6: Thermal Transmittance Data for Detail 6

Exterior Insulation Thickness Inches (mm)	Exterior Insulation Nominal R-value hr·ft²·°F/Btu (m²K/W)	Assembly		Highest Applicable Climate Zone per NECB 2015[1]
		R-value hr·ft²·°F/Btu (m²K/W)	U-value Btu/hr·ft²·°F (W/m²K)	
1.5" (38.1)	R-6.5 (1.14)	R-9.3 (1.65)	0.107 (0.607)	None
2" (50.8)	R-8.6 (1.51)	R-10.4 (1.84)	0.096 (0.545)	None
2.5" (63.5)	R-10.8 (1.89)	R-11.6 (2.04)	0.086 (0.491)	None
3" (76.2)	R-12.9 (2.27)	R-12.6 (2.22)	0.079 (0.451)	None
3.5" (88.9)	R-15.1 (2.65)	R-13.9 (2.45)	0.072 (0.409)	None
4" (101.6)	R-17.2 (3.03)	R-14.8 (2.61)	0.067 (0.383)	None
4.5" (114.3)	R-19.4 (3.41)	R-16.0 (2.81)	0.063 (0.356)	None
5" (127.0)	R-21.5 (3.79)	R-16.9 (2.97)	0.059 (0.337)	None

[1]Compared to above grade wall for maximum U-value in Table 3.2.2.2

DETAIL 7 - CONCRETE BLOCK WALL WITH FOAMULAR® INSULATION AND BRICK VENEER



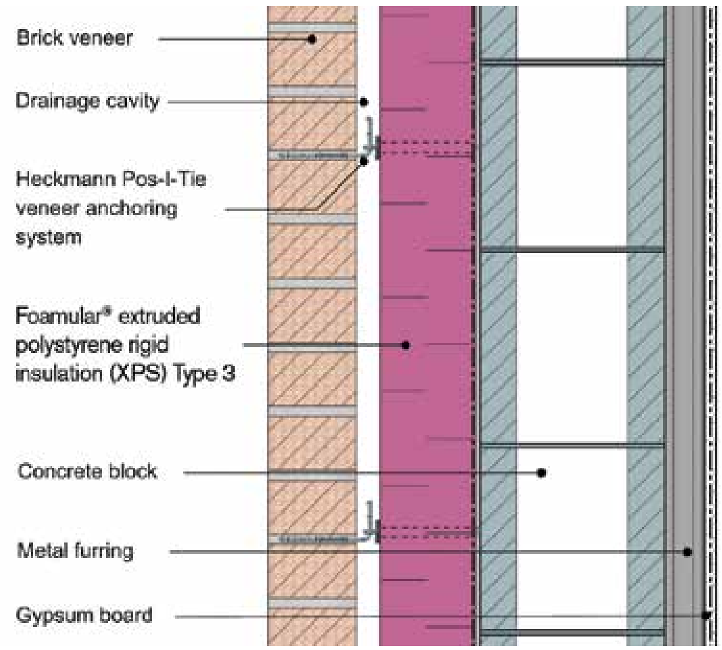
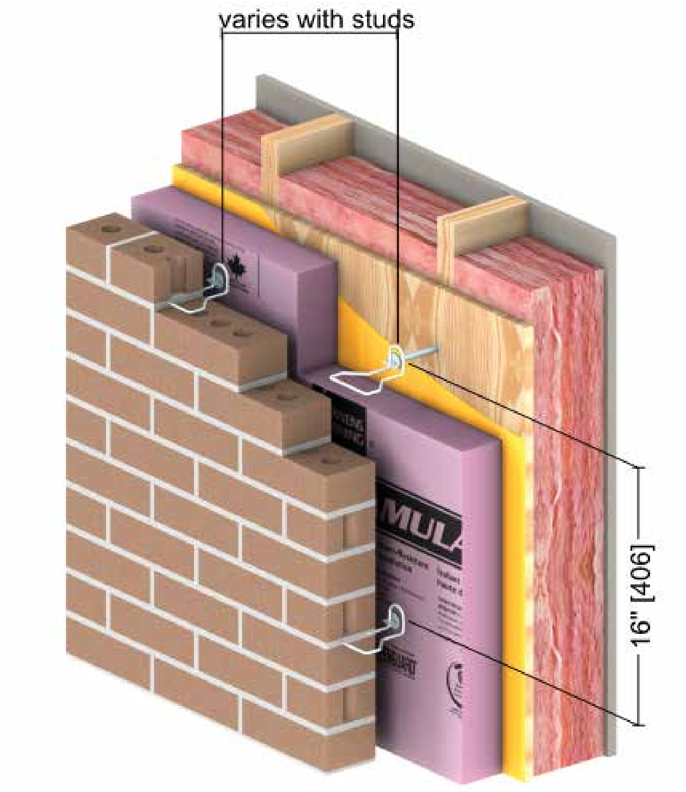


Table 5.7: Thermal Transmittance Data for Detail 7

Exterior Insulation Thickness Inches (mm)	Exterior Insulation Nominal R-value hr·ft²·°F/Btu (m²K/W)	Assembly R-value hr·ft²·°F/Btu (m²K/W)	Assembly U-value Btu/hr·ft²·°F (W/m²K)	Highest Applicable Climate Zone per NECB 2015[1]
1.5" (38.1)	R-7.5 (1.32)	R-11.5 (2.03)	0.087 (0.492)	None
2" (50.8)	R-10 (1.76)	R-13.4 (2.36)	0.075 (0.424)	None
2.5" (63.5)	R-12.5 (2.20)	R-15.2 (2.68)	0.066 (0.374)	None
3" (76.2)	R-15 (2.64)	R-16.9 (2.97)	0.059 (0.336)	None
3.5" (88.9)	R-17.5 (3.08)	R-18.5 (3.27)	0.054 (0.306)	4
4" (101.6)	R-20 (3.52)	R-20.0 (3.52)	0.050 (0.284)	4
4.5" (114.3)	R-22.5 (3.96)	R-21.7 (3.83)	0.046 (0.261)	5
5" (127.0)	R-25 (4.40)	R-23.1 (4.06)	0.043 (0.246)	6

[1]Compared to above grade wall for maximum U-value in Table 3.2.2.2

DETAIL 8 - WOOD FRAME WALL WITH FOAMULAR® INSULATION AND BRICK VENEER



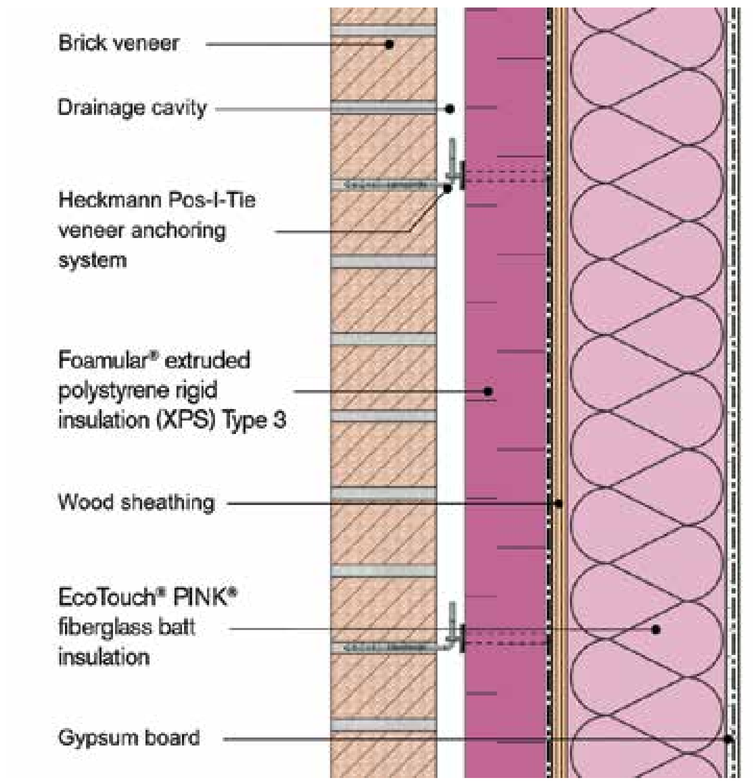
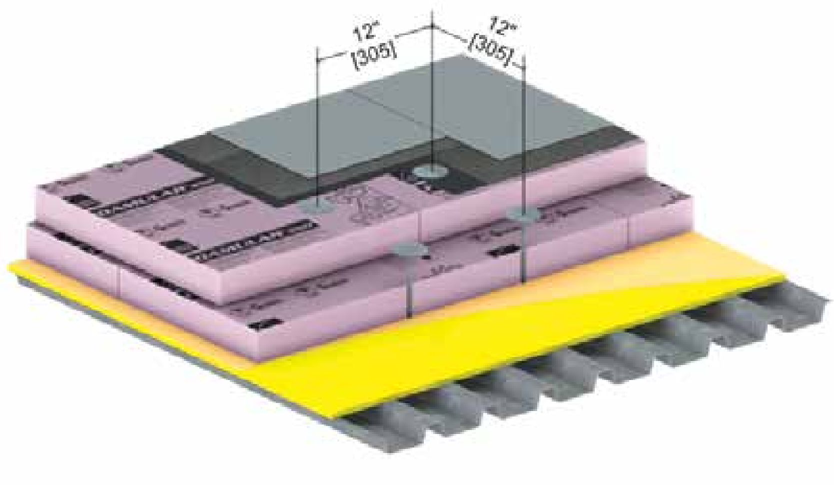


Table 5.8: Thermal Transmittance Data for Detail 8

Scenario	Exterior Insulation Thickness Inches (mm)	Exterior Insulation Nominal R-value hr·ft²·°F/Btu (m²K/W)	Assembly		Highest Applicable Climate Zone per NECB 2015[1]
			R-value hr·ft²·°F/Btu (m²K/W)	U-value Btu/hr·ft²·°F (W/m²K)	
R-19 (3.35 RSI) Batt[2] Insulation in Stud Cavity Studs @ 16" o.c.	2" (50.8) 3" (76.2) 4" (101.6)	R-10 (1.76) R-15 (2.64) R-20 (3.52)	R-29.6 (5.21) R-33.6 (5.92) R-37.4 (6.59)	0.034 (0.192) 0.030 (0.169) 0.027 (0.152)	7 8 8
R-19 (3.35 RSI) Batt[2] Insulation in Stud Cavity Studs @ 24" o.c.	2" (50.8) 3" (76.2) 4" (101.6)	R-10 (1.76) R-15 (2.64) R-20 (3.52)	R-30.6 (5.39) R-35.0 (6.16) R-39.1 (6.89)	0.033 (0.185) 0.029 (0.162) 0.026 (0.145)	7 8 8
R-22 (3.87 RSI) Batt[2] Insulation in Stud Cavity Studs @ 16" o.c.	2" (50.8) 3" (76.2) 4" (101.6)	R-10 (1.76) R-15 (2.64) R-20 (3.52)	R-31.7 (5.58) R-35.8 (6.30) R-39.6 (6.97)	0.032 (0.179) 0.028 (0.159) 0.025 (0.144)	8 8 8
R-22 (3.87 RSI) Batt[2] Insulation in Stud Cavity Studs @ 24" o.c.	2" (50.8) 3" (76.2) 4" (101.6)	R-10 (1.76) R-15 (2.64) R-20 (3.52)	R-33.0 (5.82) R-37.3 (6.58) R-41.3 (7.28)	0.030 (0.172) 0.027 (0.152) 0.024 (0.137)	8 8 8
R-24 (4.23 RSI) Batt[2] Insulation in Stud Cavity Studs @ 16" o.c.	2" (50.8) 3" (76.2) 4" (101.6)	R-10 (1.76) R-15 (2.64) R-20 (3.52)	R-33.2 (5.84) R-37.1 (6.53) R-41.0 (7.21)	0.030 (0.171) 0.027 (0.153) 0.024 (0.139)	8 8 8
R-24 (4.23 RSI) Batt[2] Insulation in Stud Cavity Studs @ 24" o.c.	2" (50.8) 3" (76.2) 4" (101.6)	R-10 (1.76) R-15 (2.64) R-20 (3.52)	R-34.7 (6.11) R-39.0 (6.86) R-42.9 (7.56)	0.029 (0.164) 0.026 (0.146) 0.023 (0.132)	8 8 8

[1]Compared to above grade wall for maximum U-value in Table 3.2.2.2
[2]Installed R-value. Rated R-20 Fiberglass Batt is compressed to R-19 when installed in a 5.5-inches wood studs cavity

DETAIL 9 - MECHANICALLY FASTENED ROOF ON STEEL DECK



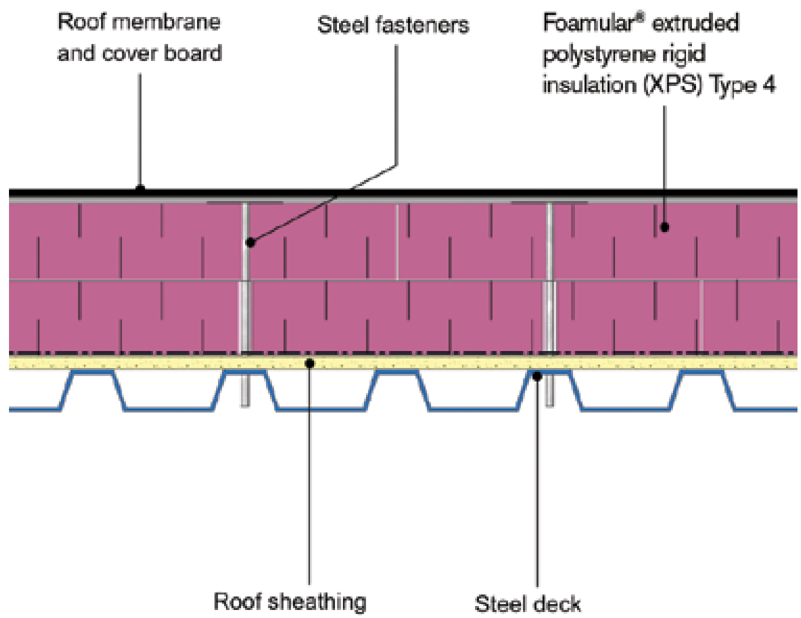
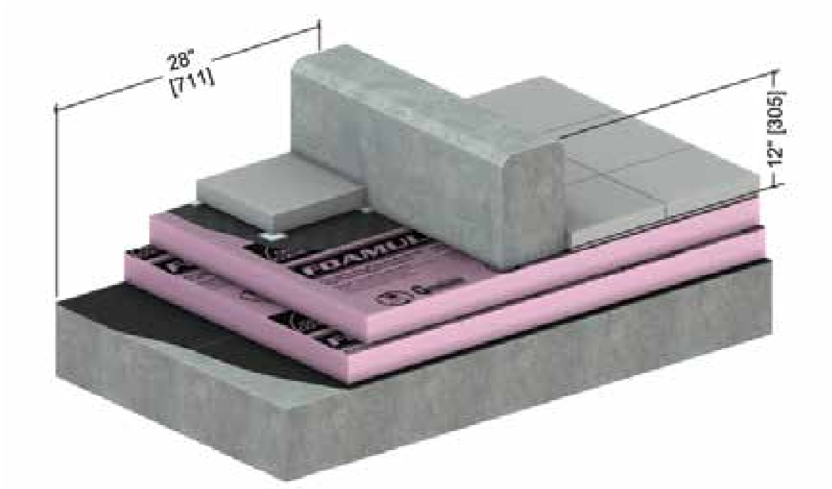


Table 5.9: Thermal Transmittance Data for Detail 9

Exterior Insulation Thickness Inches (mm)	Exterior Insulation Nominal R-value hr·ft²·°F/Btu (m²K/W)	Assembly		Highest Applicable Climate Zone per NECB 2015[1]
1x4" (1x101.6mm)	R-20 (3.52)	R-20.8 (3.67)	0.048 (0.272)	None
2x3" (2x76.2mm)	R-30 (5.28)	R-30.5 (5.36)	0.033 (0.186)	4
2x4" (2x101.6mm)	R-40 (7.04)	R-39.8 (7.02)	0.025 (0.142)	8

[1]Compared to roof for maximum U-value in Table 3.2.2.2

DETAIL 10 - INVERTED ROOF ON CONCRETE DECK



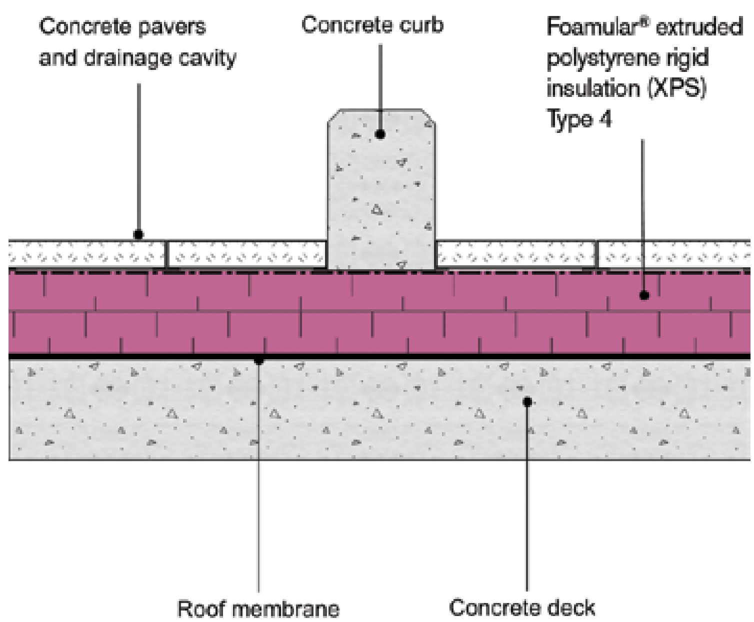
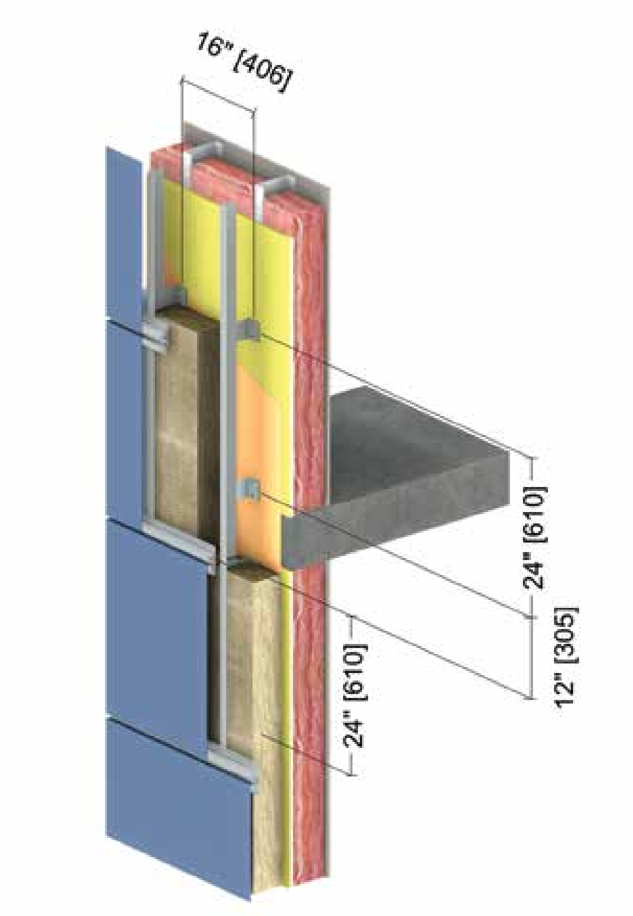


Table 5.10: Thermal Transmittance Data for Detail 10

Exterior Insulation Thickness Inches (mm)	Exterior Insulation Nominal R-value hr·ft²·°F/Btu (m²K/W)	Assembly		Highest Applicable Climate Zone per NECB 2015[1]
1x4" (1x101.6mm)	R-20 (3.52)	R-21.9 (3.86)	0.046 (0.259)	None
2x3" (2x76.2mm)	R-30 (5.28)	R-31.9 (5.62)	0.031 (0.178)	6
2x4" (2x101.6mm)	R-40 (7.04)	R-41.9 (7.38)	0.024 (0.135)	8

[1]Compared to roof for maximum U-value in Table 3.2.2.2

DETAIL 11 - INTERMEDIATE FLOOR INTERFACE WITH THERMAFIBER® INSULATION AND LIGHTWEIGHT CLADDING ATTACHED BY THERMALLY ISOLATED ALUMINUM BRACKETS AND VERTICAL RAIL



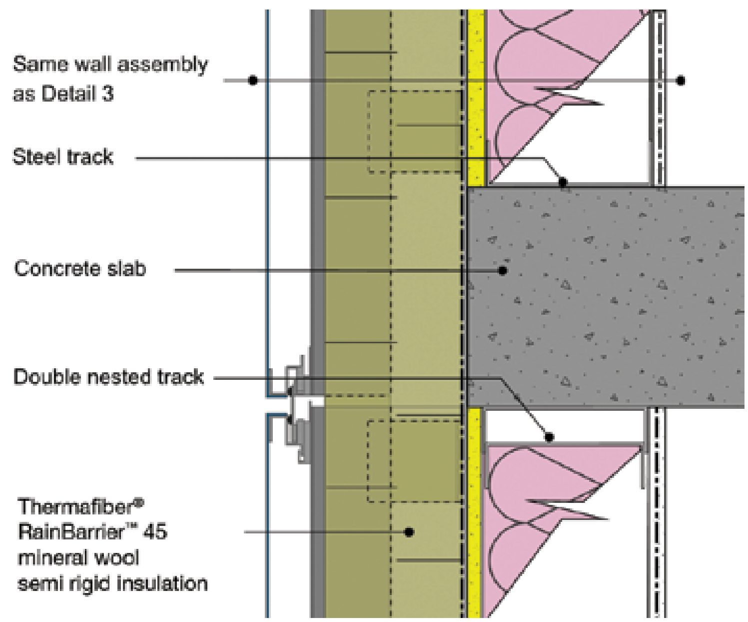
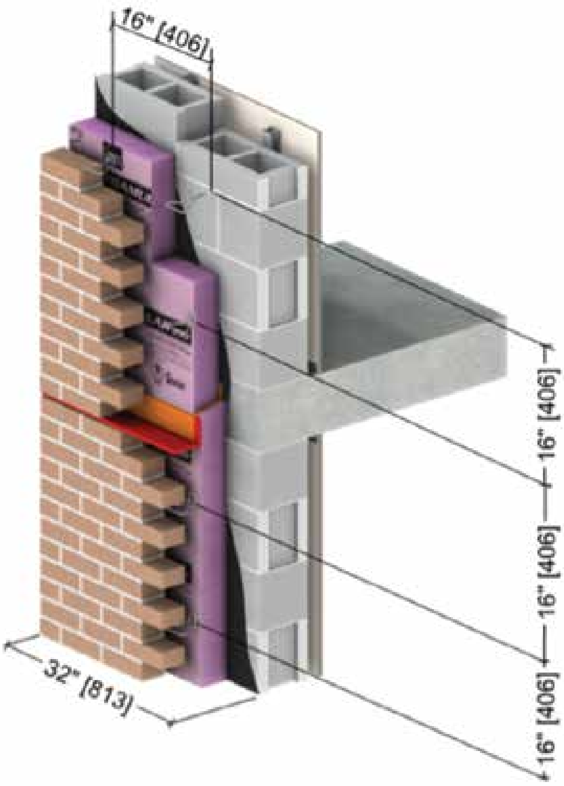


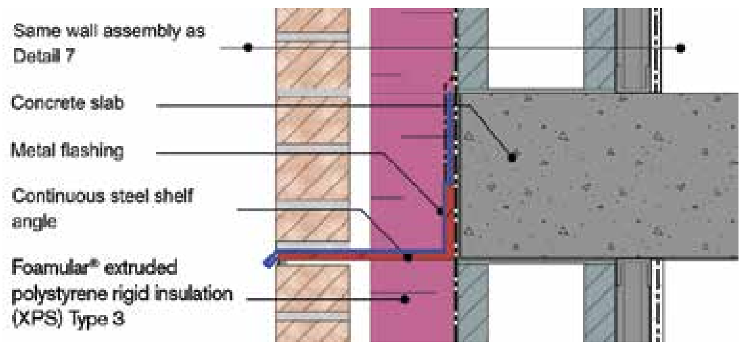
Table 5.11: Thermal Transmittance Data for Detail 11

Scenario	Exterior Insulation Thickness Inches (mm)	Exterior Insulation Nominal R-value hr·ft²·°F/Btu (m²K/W)	ψ Btu/hr·ft·°F (W/m K)
Air in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)	0.019 (0.034) 0.013 (0.023)
R-20 (3.52 RSI) Batt in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)	0.076 (0.132) 0.040 (0.069)
R-22.5 (3.96 RSI) Batt in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)	0.079 (0.136) 0.041 (0.071)
R-24 (4.23 RSI) Batt in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)	0.080 (0.138) 0.042 (0.072)

DETAIL 12 - INTERMEDIATE FLOOR INTERFACE WITH FOAMULAR® INSULATION AND BRICK VENEER



Scenario A



Scenario B

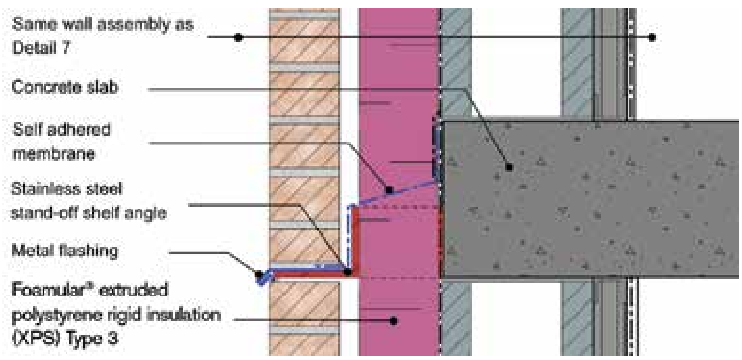
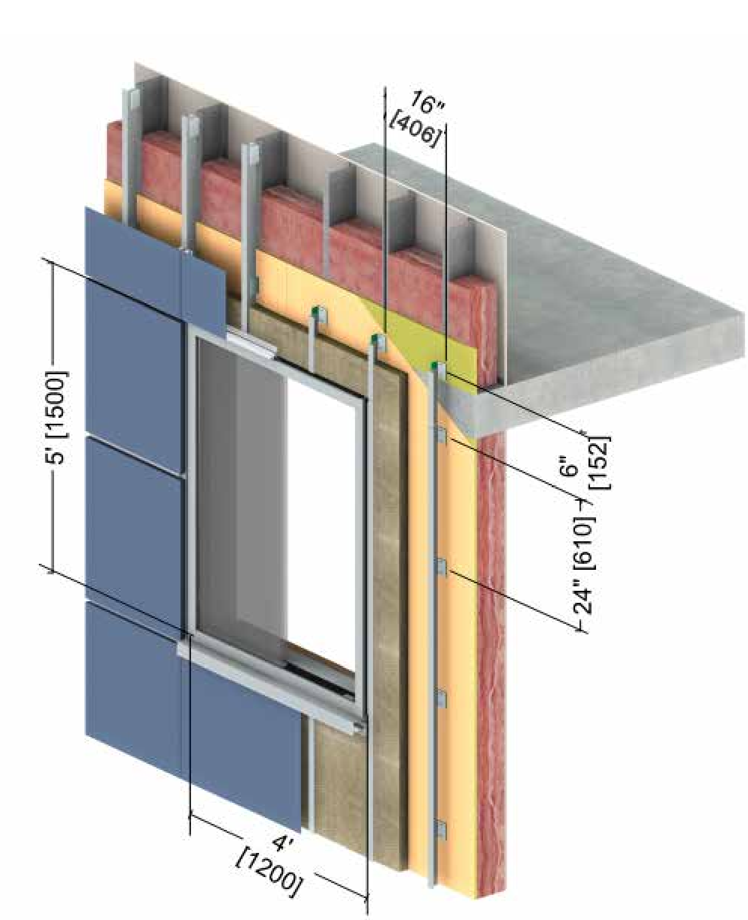


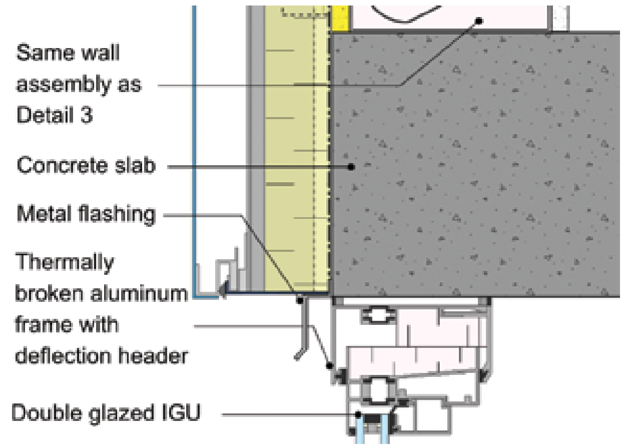
Table 5.12: Thermal Transmittance Data for Detail 12

Scenario		Exterior Insulation Thickness Inches (mm)	Exterior Insulation Nominal R-value hr·ft²·°F/Btu (m²K/W)	ψ Btu/hr·ft·°F (W/m K)
A	Direct Attached Steel Angle	2" (50.8) 4" (101.6)	R-10 (1.76) R-20 (3.52)	0.277 (0.480) 0.292 (0.506)
B	Stand-off Stainless Steel Angle	2" (50.8) 4" (101.6)	R-10 (1.76) R-20 (3.52)	0.064 (0.112) 0.054 (0.093)

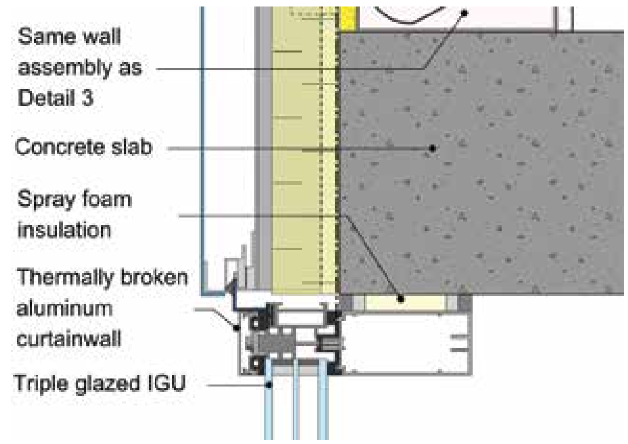
DETAIL 13 - GLAZING INTERFACE WITH THERMAFIBER® INSULATION AND EXTERIOR INSULATED STEEL FRAME WALL



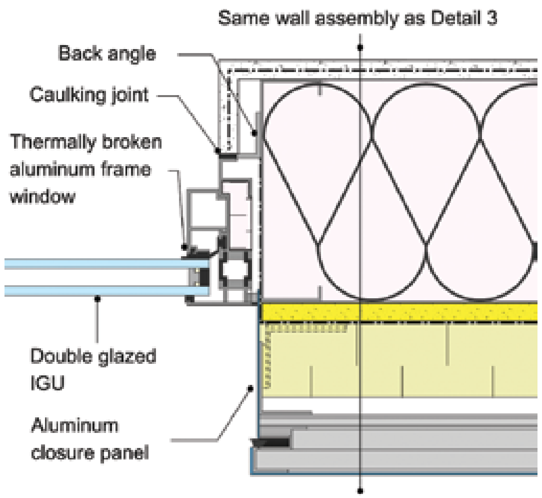
Head – Scenario A



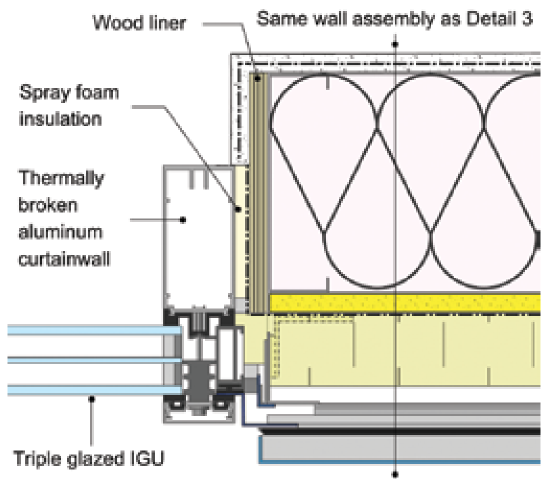
Head – Scenario B



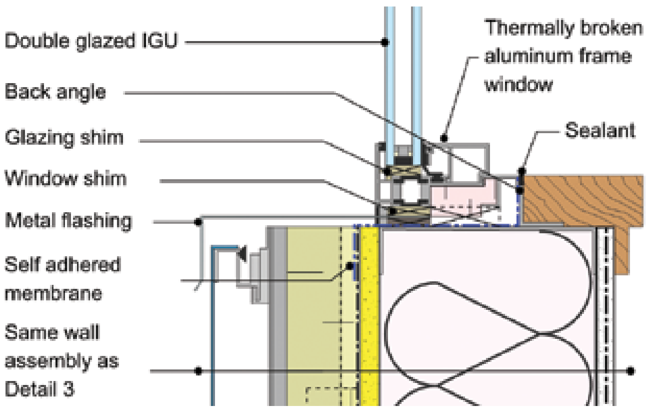
Jamb – Scenario A



Jamb – Scenario B



Sill – Scenario A



Sill – Scenario B

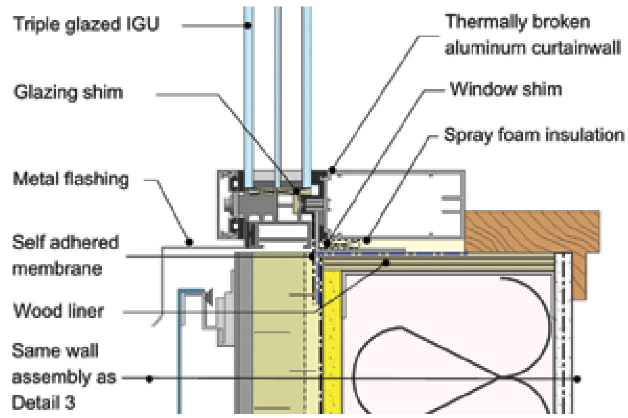
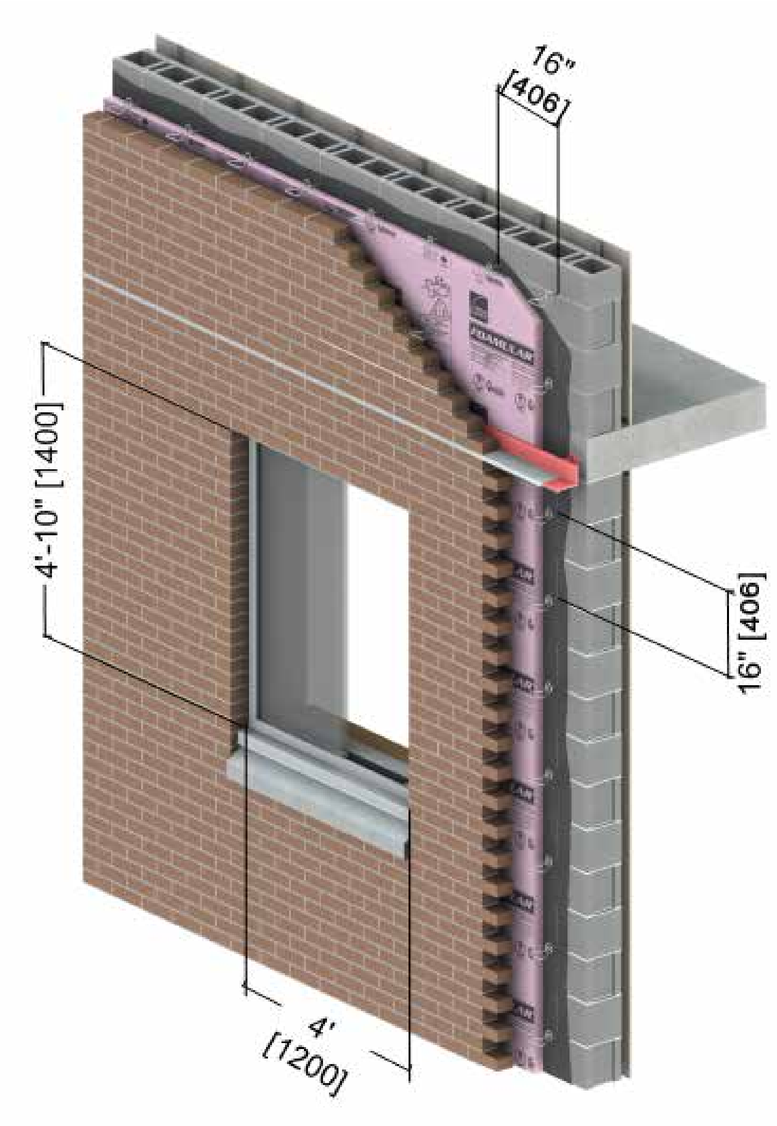


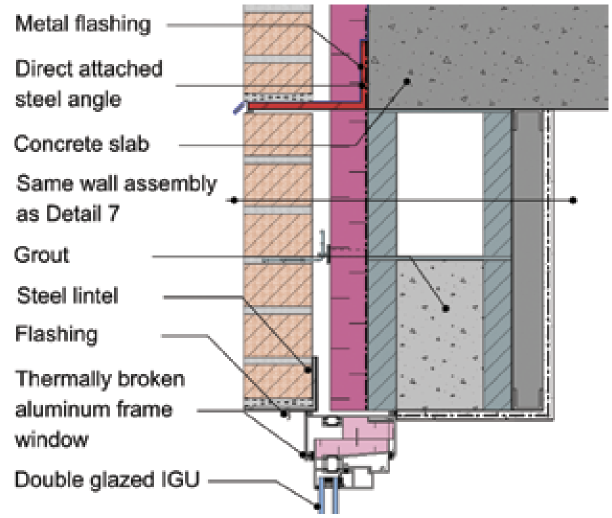
Table 5.13: Thermal Transmittance Data for Detail 13

Scenario		Exterior Insulation Thickness Inches (mm)	Exterior Insulation Nominal R-value hr·ft²·°F/Btu (m²K/W)	Ψ Sill Btu/hr·ft·°F (W/m K)	Ψ Jamb Btu/hr·ft·°F (W/m K)	Ψ Head Btu/hr·ft·°F (W/m K)	Ψ Total Btu/hr·ft·°F (W/m K)
A – Glazing Thermal Break Aligned with Back-up Wall and Double Glazed IGU	Air in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)	0.219 (0.379) 0.250 (0.433)	0.127 (0.220) 0.146 (0.252)	0.279 (0.483) 0.301 (0.520)	0.189 (0.326) 0.220 (0.381)
	R-20 (3.52 RSI) Batt in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)	0.147 (0.255) 0.160 (0.276)	0.095 (0.165) 0.103 (0.178)	0.309 (0.535) 0.304 (0.526)	0.160 (0.277) 0.165 (0.286)
	R-22.5 (3.96 RSI) Batt in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)	0.146 (0.253) 0.157 (0.273)	0.095 (0.164) 0.102 (0.177)	0.313 (0.542) 0.305 (0.527)	0.160 (0.277) 0.165 (0.285)
B – Glazing Thermal Break Aligned with Exterior Insulation and Triple Glazed IGU	Air in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)	0.036 (0.063) 0.055 (0.095)	0.047 (0.081) 0.050 (0.086)	0.053 (0.092) 0.047 (0.081)	0.039 (0.067) 0.066 (0.114)
	R-20 (3.52 RSI) Batt in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)	0.034 (0.058) 0.044 (0.077)	0.046 (0.080) 0.044 (0.077)	0.094 (0.163) 0.064 (0.110)	0.046 (0.080) 0.054 (0.094)
	R-22.5 (3.96 RSI) Batt in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)	0.034 (0.059) 0.046 (0.080)	0.046 (0.080) 0.044 (0.077)	0.096 (0.166) 0.065 (0.112)	0.046 (0.080) 0.054 (0.094)

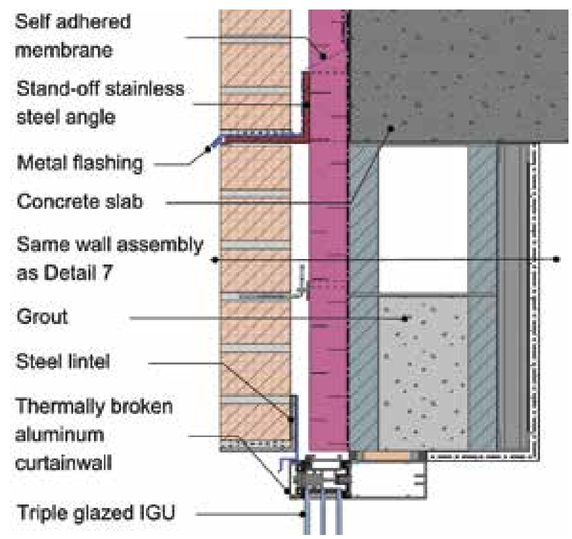
DETAIL 14 - GLAZING INTERFACE WITH FOAMULAR® INSULATION AND BRICK VENEER



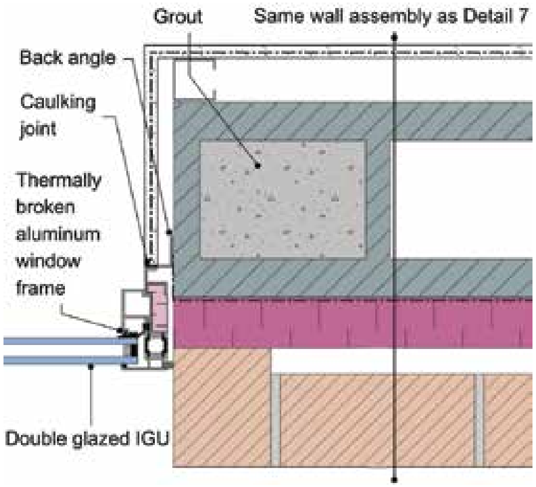
Head – Scenario A



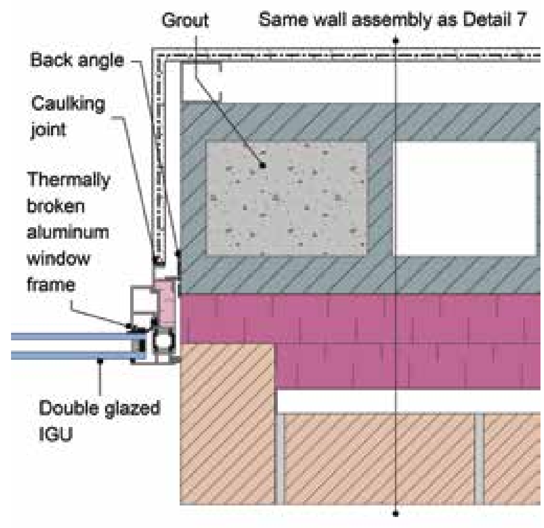
Head – Scenario B



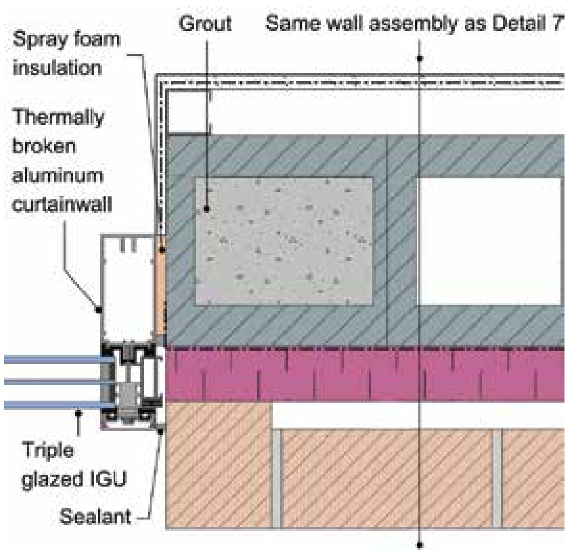
Jamb – Scenario A (2" Insulation)



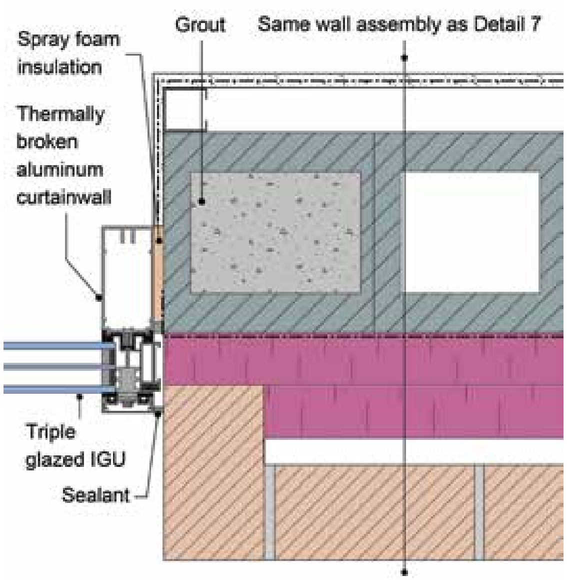
Jamb – Scenario A (4" Insulation)



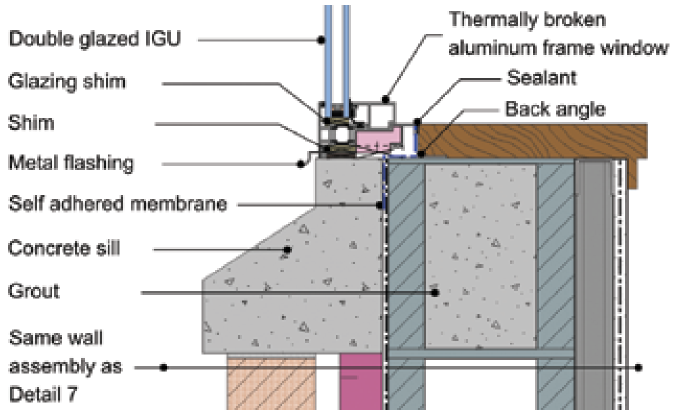
Jamb – Scenario B (2" Insulation)



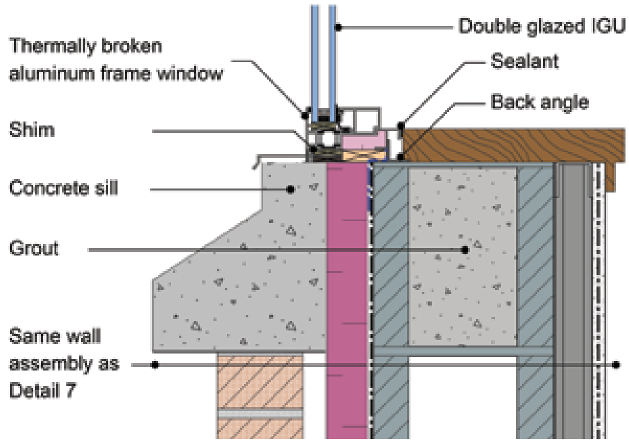
Jamb – Scenario B (4" Insulation)



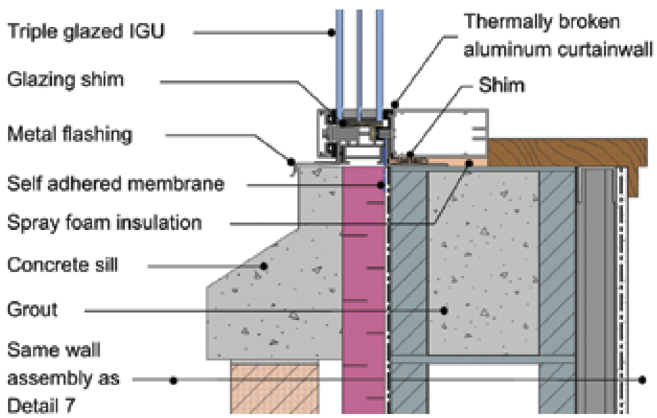
Sill – Scenario A (2" Insulation)



Sill – Scenario A (4" Insulation)



Sill – Scenario B (2" Insulation)



Sill – Scenario B (4" Insulation)

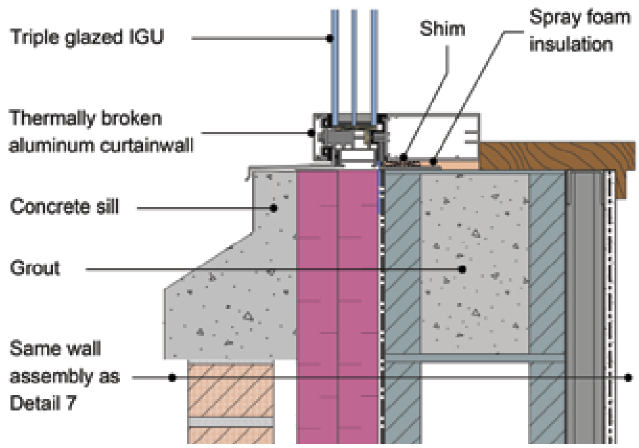
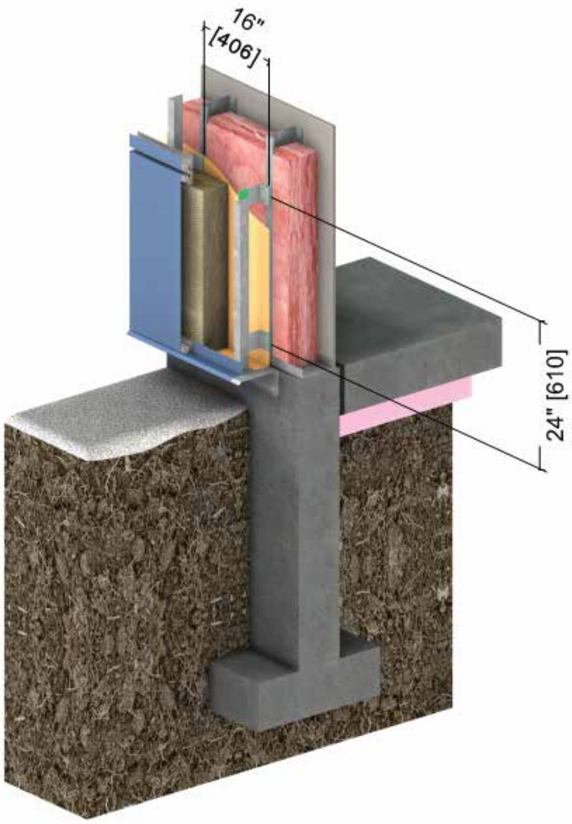


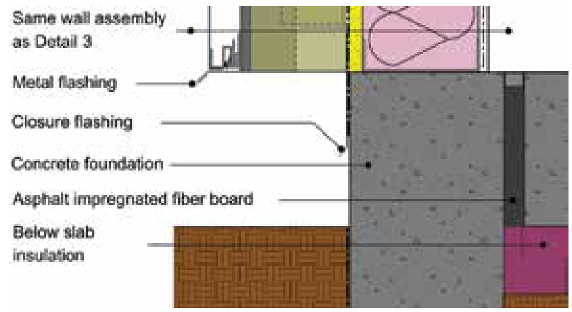
Table 5.14: Thermal Transmittance Data for Detail 14

Scenario		Exterior Insulation Thickness Inches (mm)	Exterior Insulation Nominal R-value hr·ft²·°F/Btu (m²K/W)	Ψ Sill Btu/hr·ft·°F (W/m K)	Ψ Jamb Btu/hr·ft·°F (W/m K)	Ψ Head Btu/hr·ft·°F (W/m K)	Ψ Total Btu/hr·ft·°F (W/m K)
A	Insulation Interrupted at Perimeter of Double IGU Glazing	2" (50.8) 4" (101.6)	R-10 (1.76) R-20 (3.52)	0.395 (0.684) 0.131 (0.227)	0.244 (0.422) 0.076 (0.132)	0.141 (0.244) 0.362 (0.626)	0.431 (0.746) 0.148 (0.257)
B	Insulation Uninterrupted at Perimeter of Triple IGU Glazing	2" (50.8) 4" (101.6)	R-10 (1.76) R-20 (3.52)	0.020 (0.035) 0.015 (0.026)	0.082 (0.141) 0.058 (0.100)	0.053 (0.091) 0.142 (0.246)	0.051 (0.088) 0.058 (0.101)

DETAIL 15 - BASE OF WALL INTERSECTION TO SLAB-ON-GRADE WITH THERMAFIBER® INSULATION AND STEEL FRAME WALL



Scenario A



Scenario B

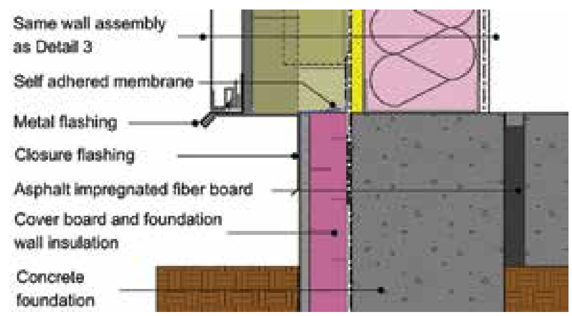
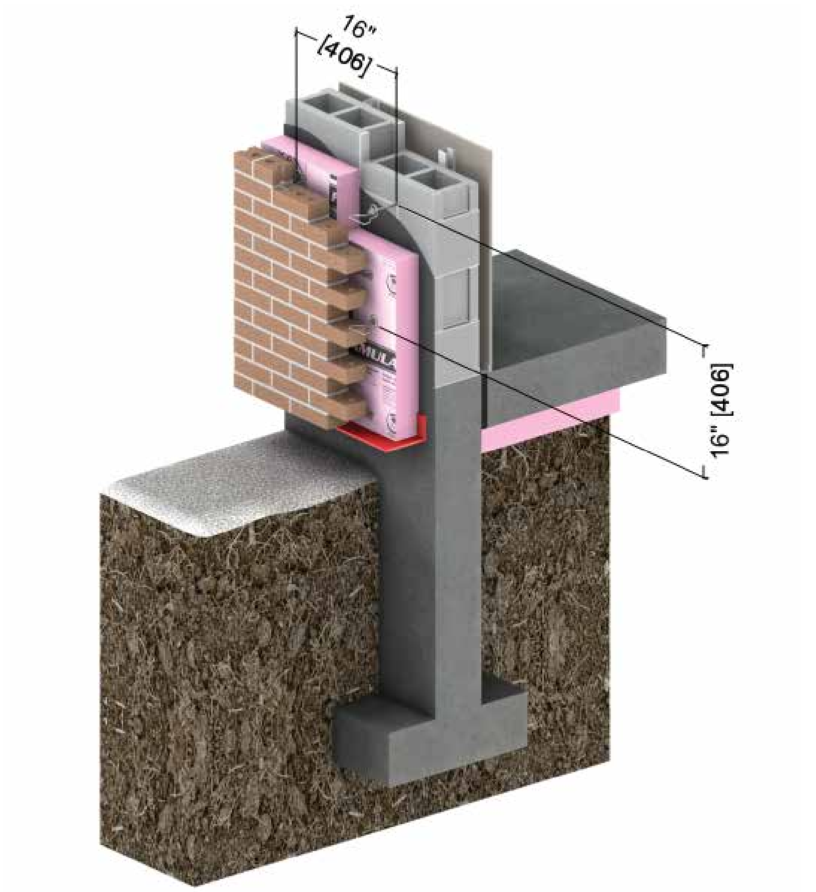
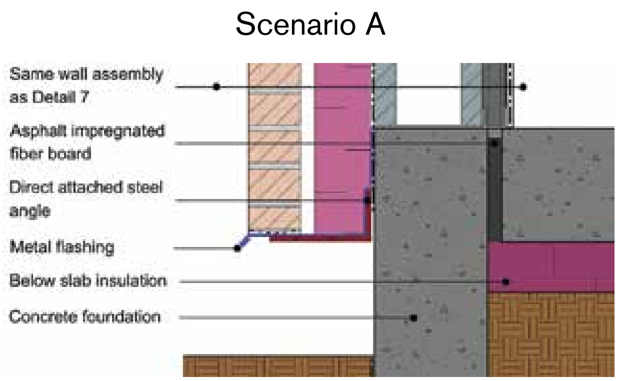


Table 5.15: Thermal Transmittance Data for Detail 15

Scenario		Exterior Insulation Thickness Inches (mm)	Exterior Insulation Nominal R-value hr·ft²·°F/Btu (m²K/W)	Floor Perimeter Heat Loss Btu/hr·ft·°F (W/m K)	Ψ Btu/hr·ft·°F (W/m K)
A – With Insulation Below Slab and Exposed Floor Edge	Air in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)	1.312 (2.271)	0.319 (0.551) 0.351 (0.607)
	R-20 (3.52 RSI) Batt in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)		0.206 (0.357) 0.219 (0.379)
	R-22.5 (3.96 RSI) Batt in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)		0.206 (0.357) 0.218 (0.377)
	R-24 (4.23 RSI) Batt in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)		0.207 (0.357) 0.216 (0.374)
B – With Insulation Outboard of Foundation Wall and Insulated Floor Edge	Air in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)	1.061 (1.836)	0.031 (0.053) 0.034 (0.059)
	R-20 (3.52 RSI) Batt in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)		0.028 (0.049) 0.028 (0.048)
	R-22.5 (3.96 RSI) Batt in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)		0.029 (0.049) 0.028 (0.048)
	R-24 (4.23 RSI) Batt in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)		0.031 (0.054) 0.028 (0.048)

DETAIL 16 - BASE OF WALL INTERSECTION TO SLAB-ON-GRADE WITH FOAMULAR® INSULATION AND BRICK VENEER





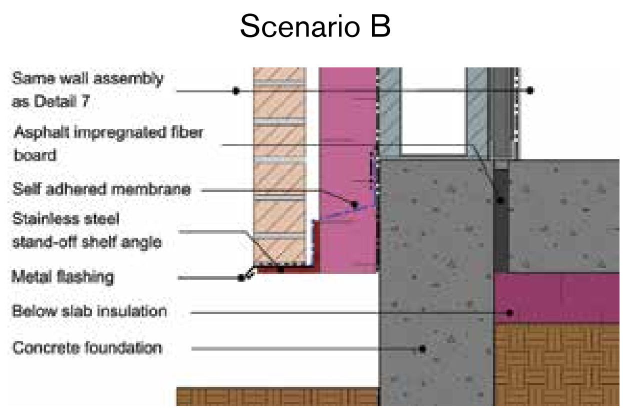
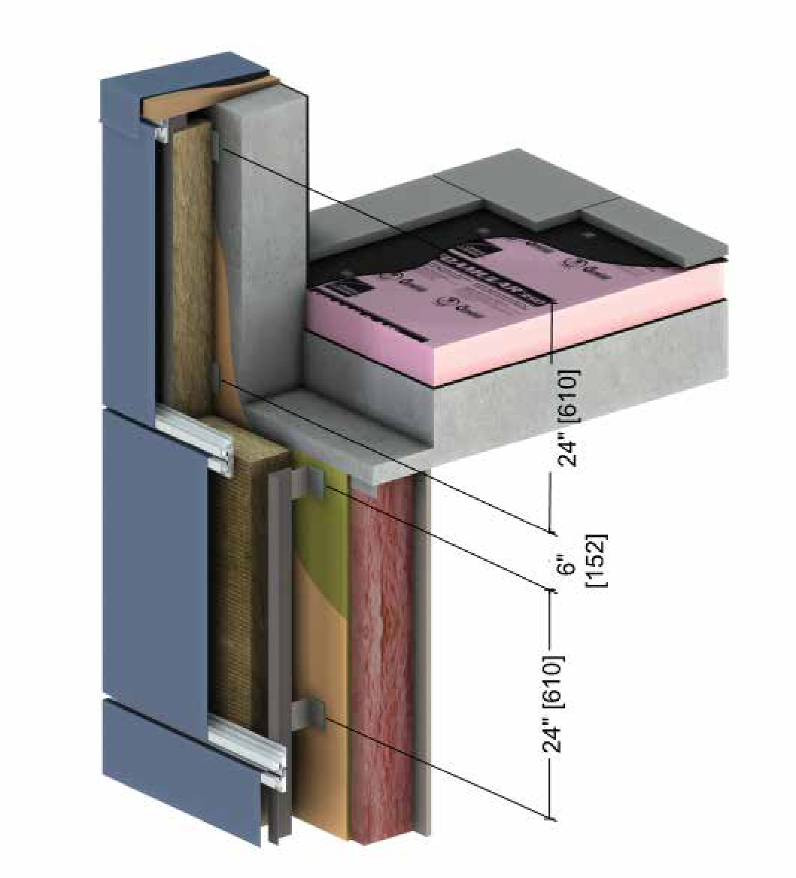


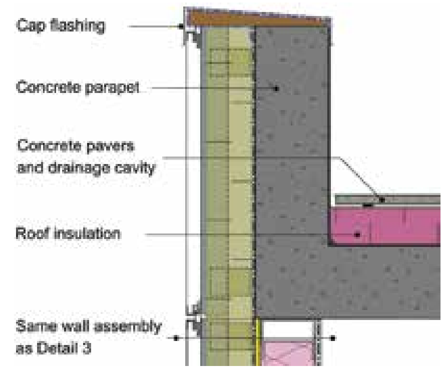
Table 5.16: Thermal Transmittance Data for Detail 16

Scenario		Exterior Insulation Thickness Inches (mm)	Exterior Insulation Nominal R-value hr·ft²·°F/Btu (m²K/W)	Floor Perimeter Heat Loss Btu/hr·ft·°F (W/m K)	ψ Btu/hr·ft·°F (W/m K)
A	Direct Attached Steel Angle, Insulation below the Slab	2" (50.8) 4" (101.6)	R-10 (1.76) R-20 (3.52)	1.247 (2.158)	0.301 (0.521) 0.322 (0.557)
B	Stand-off Stainless Steel Angle, Insulation below the Slab	2" (50.8) 4" (101.6)	R-10 (1.76) R-20 (3.52)	1.247 (2.158)	0.230 (0.399) 0.241 (0.418)

DETAIL 17 - ROOF TO WALL INTERSECTION WITH THERMAFIBER® INSULATION AND STEEL FRAME WALL



Scenario A



Scenario B

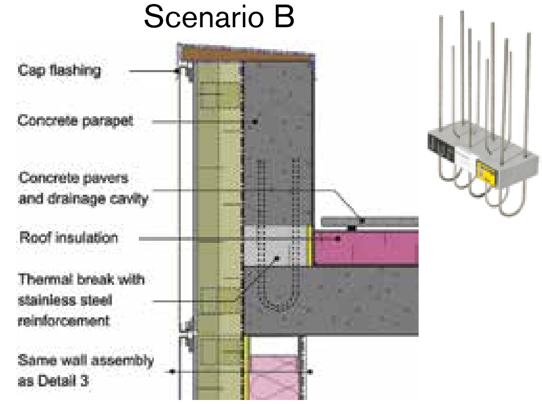
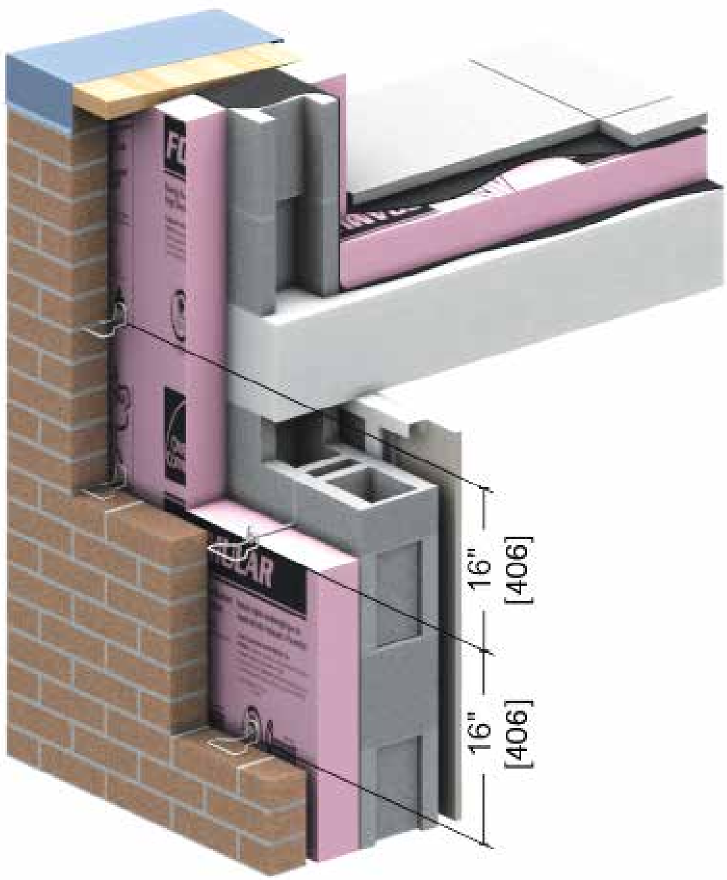
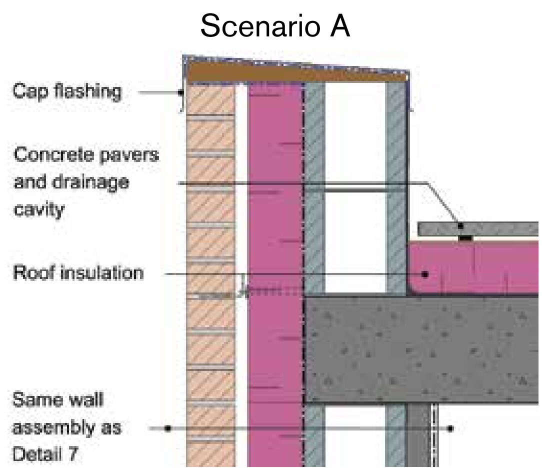


Table 5.17: Thermal Transmittance Data for Detail 17

Scenario		Exterior Insulation Thickness Inches (mm)	Exterior Insulation Nominal R-value hr·ft²·°F/Btu (m²K/W)	Ψ Btu/hr·ft·°F (W/m K)
A – Uninsulated Concrete Parapet	Air in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)	0.409 (0.708) 0.402 (0.696)
	R-20 (3.52 RSI) Batt in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)	0.407 (0.704) 0.384 (0.665)
	R-22.5 (3.96 RSI) Batt in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)	0.407 (0.705) 0.381 (0.660)
	R-24 (4.23 RSI) Batt in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)	0.410 (0.709) 0.394 (0.681)
B – With Thermally Broken Parapet	Air in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)	0.126 (0.218) 0.110 (0.190)
	R-20 (3.52 RSI) Batt in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)	0.140 (0.243) 0.122 (0.212)
	R-22.5 (3.96 RSI) Batt in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)	0.141 (0.245) 0.120 (0.207)
	R-24 (4.23 RSI) Batt in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)	0.142 (0.246) 0.115 (0.198)

DETAIL 18 - ROOF TO WALL INTERSECTION WITH FOAMULAR® INSULATION AND BRICK VENEER





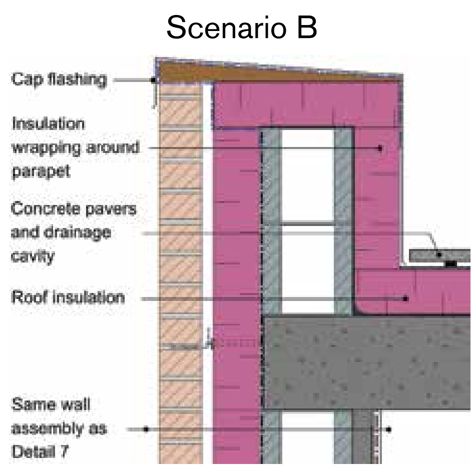


Table 5.18: Thermal Transmittance Data for Detail 18

Scenario		Exterior Insulation Thickness Inches (mm)	Exterior Insulation Nominal R-value hr·ft²·°F/Btu (m²K/W)	ψ Btu/hr·ft·°F (W/m K)
A	Uninsulated CMU Parapet	2" (50.8) 4" (101.6)	R-10 (1.76) R-20 (3.52)	0.292 (0.505) 0.290 (0.502)
B	With Insulation Wrapped Around Parapet	2" (50.8) 4" (101.6)	R-10 (1.76) R-20 (3.52)	0.150 (0.260) 0.121 (0.209)

EXAMPLE U-VALUE CALCULATION FOR ENTIRE WALL FAÇADE

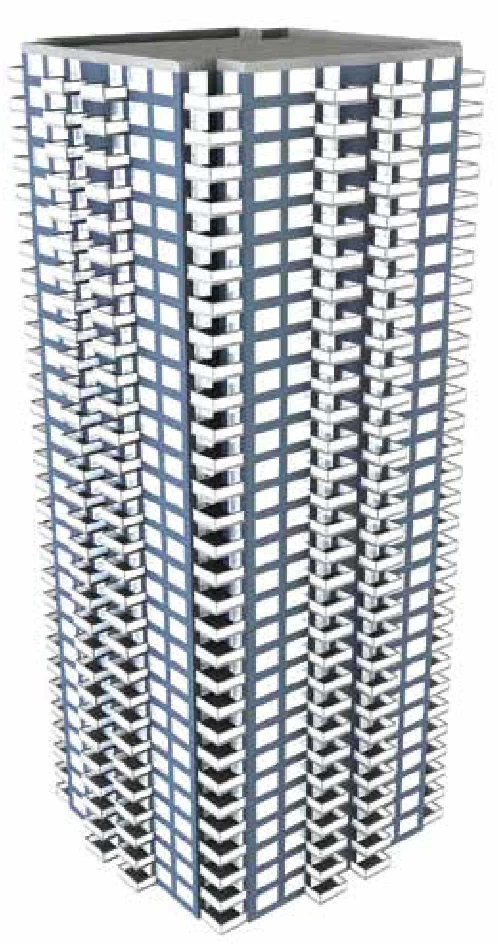
The following step-by step calculation example shows how the thermal performance information, presented in the previous sections, can be used in practice to calculate a whole wall façade U-value that fully takes into account thermal bridging.

High-Rise Multi-Unit Residential Building Example

This example shows how to find the overall U-value for the opaque sections of the West Façade of a High-Rise Multi-unit Residential Building (MURB).

The 40-Storey MURB has the following characteristics:

- 40% glazing, mix of 1524 mm x 914 mm (5'x3') punched windows and sliding doors at balconies
- Concrete structure with steel-framed infill walls
- The exterior walls are clad with metal panel that is attached to the wall with a thermally broken clip system through the exterior insulation
- The roof is an inverted or protected roof membrane assembly
- Balconies are 20% of the intermediate floor perimeter
- Each floor has an identical layout and footprint



Example High-Rise Multi-Unit Residential Building

Step 1: What U-Value is Needed?

Before calculating any U-values, you should always be clear of how the thermal transmittance will be applied. For example, will the thermal transmittances be used in whole building energy model, be compared to maximum U-values in a prescriptive energy standard, and/or needed for a heating load calculation? Energy standards may require different construction types to have separate thermal transmittances.

Knowing how the U-value will be used will help determine how much of the enclosure should be included in each U-value calculation. Regardless of the area of the enclosure being examined, the methodology to determine the U-value is still the same.

In this example we are looking at the opaque wall on the west façade.

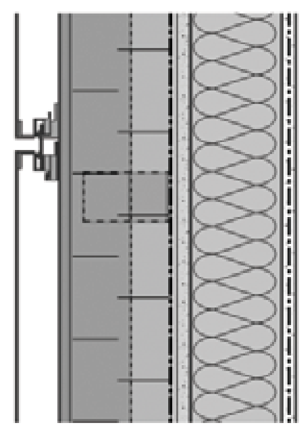
Step 2: Determine the Clear Field Assemblies

The next step is to determine the clear field assemblies for the area of the building enclosure being examined. Typically in architectural drawings, the assemblies are listed with their components in the wall/floor/roof schedules. For a given area of the building enclosure, there may be multiple clear field assemblies. Depending on the objective of the analysis, as determined in Step 1, the clear field assemblies may need to be separate or averaged together in the calculation for one overall U-value.

For this example, we have only one wall assembly for the steel stud wall, as shown below

W1 Exterior Steel Stud Wall

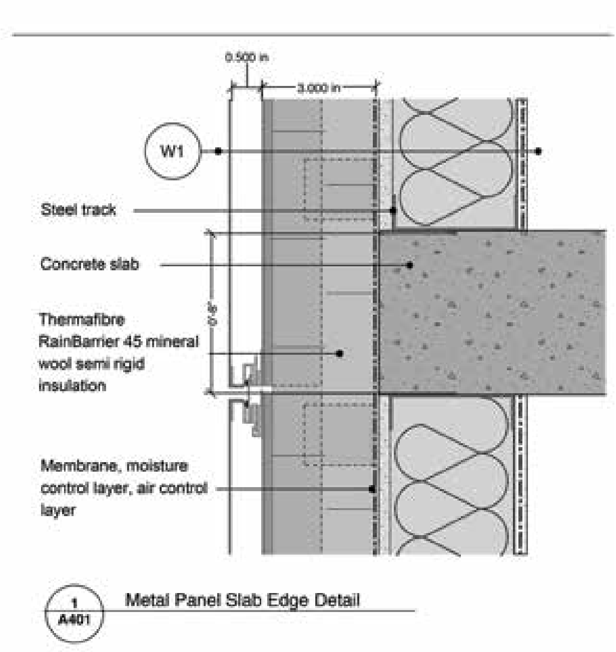
- Metal Panel Cladding
-1/2" Drained Cavity
- 3" Mineral Fibre Insulation supported by Thermally Broken Clip System
- Vapor Permeable Membrane
- 1/2" Sheathing Board
- R-20 Batt Insulation
- Vapor Control Layer
- 1/2" Gypsum Board



Example Steel Stud Wall Assembly Drawing

Step 3: Determine Linear and Point Transition Details

In architectural drawings, linear and point transition details can be found on the elevations, plans and detail drawings. If the design is still in early development, generic values can be included based on what can be expected from typical detailing, such as intermediate floors, parapets and window transitions. Conservative estimations for the transition details can be applied in early design and refined as the design develops.



Example Floor Slab Detail Drawing

When dividing the enclosure into multiple clear field assemblies, the interface details should be divided in the same manner and be assigned to a specific assembly. For details between two clear field assemblies, such as a parapet transition between a wall and roof, it is up to the analyst to choose which assembly to assign the transition detail. This could be split evenly between the two assemblies, or assigned fully to one or the other. Regardless of which assembly the transition detail is assigned to, the overall heat loss through the enclosure is still accounted for in one assembly or the other.

For this example there is the one clear field assembly from Step 2 and all transition details are assigned to the wall. From review of the architectural drawings, it is determined there are the following transition details (for simplicity, corners and at-grade details were omitted):

Transmittance Type	Description
Clear Field	Metal Panel Steel Stud Wall
Linear Transition	Balcony
	Intermediate Floor
	Window Transition (Head, Sill, Jamb)
	Parapet

Step 4: Determine Area and Length Takeoffs

With all the transmittances identified (clear field, linear and point), the areas, lengths and quantities are determined.

The takeoffs for the clear field is the total opaque wall area for the façade. If there are more than one clear field assembly, then the area is the respective areas.

Lengths for linear details, like intermediate floors and parapets can be found through the plans and elevations. This can be done by tracing a line from where a detail begins and ends. These linear takeoffs are for the projected length of a detail on the plane of the enclosure. This means for a balcony the length is where the balcony slab penetrates through the enclosure and **not** the outside face around the balcony. For window transitions, the length is the perimeter around the window.

For point details, like beam penetrations, the takeoff is counting the number of times these details occur.

Using floor plans and elevations, the takeoffs yield the following quantities.

Transmittance Type	Description	Quantity
Clear Field	Metal Panel Steel Stud Wall	17820 ft^2
Linear Transition	Balcony Slab	624 ft
	Slab Edge	2496 ft
	Window Head	2280 ft
	Window Sill	2280 ft
	Window Jamb	7600 ft
	Parapet	80 ft

Since each floor is the same, take offs for a single floor can be multiplied by the amount of similar floors, with the parapet being added for the top floor. In this example we have no point transmittances.

Step 5: Determine Clear Field, Linear and Point Transmittances

Thermal transmittances for the clear field assembly and linear details can be determined by calculation, modelling or from catalogues such as this Guide. See the Additional Resources section for additional sources.

When using catalogues, each of the assemblies/details need to be reviewed for their specific configuration, such as insulation thickness, spacing and arrangement of components, and matched to similar details and assemblies.

If a good match cannot be found for a certain assembly/detail, judgment will be required to reasonably estimate the thermal performance values. If a higher degree of certainty is needed, then estimates from a catalogue may not be sufficient and modeling or testing may be necessary.

For this example, the clear field assemblies and most of the interface details are available in this Guide (See Thermal Transmittance Data in this Guide).

Transmittance Type	Description	Quantity	Ref	Transmittance
Clear Field	Metal Panel Wall	17820 ft^2	OC Detail 3	0.038 BTU/hr·ft^2·°F
Linear Transition	Balcony Slab	624 ft	BETB Detail	0.612 BTU/hr·ft·°F
	Slab Edge	2496 ft	OC Detail 11	0.040 BTU/hr·ft·°F
	Window Head	2280 ft	OC Detail 13A	0.304 BTU/hr·ft·°F
	Window Sill	2280 ft	OC Detail 13A	0.159 BTU/hr·ft·°F
	Window Jamb	7600 ft	OC Detail 13A	0.103 BTU/hr·ft·°F
	Parapet	80 ft	OC Detail 17	0.384 BTU/hr·ft·°F

As a first step, we can choose the unmitigated details. This will provide a conservative estimate and help highlight opportunities to mitigate the impact of thermal bridging.

Step 6: Calculate Individual Transmittances

While not necessary to calculate the overall U-value, it is advantageous to calculate the individual impact of each detail to help make informed design decisions and identify targeted details for improvement. The individual impact can be calculated by separating the equation for U_T provided earlier:

- Clear Field Assembly = $U_o \cdot A$
- Linear details = $\psi \cdot L$
- Point details = $\chi \cdot$ number of occurrences

For this example, the largest amount of heat flow through the enclosure is through the window transitions (more than 60%). That is more than twice the conductive heat flow through the entire clear field assembly! If there are improvements to be made, it will likely be the most effective to focus on the glazing interfaces.

Step 7: Calculate the Overall U-Value

The overall assembly U-value is calculated using the U_T equation:

$$U_T = \frac{\Sigma(\Psi \cdot L) + \Sigma(\chi)}{A_{Total}} + U_o$$

For this example, each step is summarized below:

Step 1-2	Step 3	Step 4	Step 5		Step 6	
Transmittance Type	**Description**	**Quantity**	**Ref**	**Transmittance**	**Heat Flow BTU/hr·°F**	**% of Total Heat Flow**
Clear Field	Metal Panel Wall	17820 ft²	OC Detail 3	0.038 BTU/hr·ft²·°F	657	22%
Linear Transition	Balcony	624 ft	BETB Detail 5.2.5	0.612 BTU/hr·ft·°F	382	13%
	Intermediate floor	2496 ft	OC Detail 11	0.040 BTU/hr·ft·°F	100	3%
	Window Head	2280 ft	OC Detail 13A	0.304 BTU/hr·ft·°F	693	23%
	Window Sill	2280 ft	OC Detail 13A	0.159 BTU/hr·ft·°F	363	12%
	Window Jamb	7600 ft	OC Detail 13A	0.103 BTU/hr·ft·°F	783	26%
	Parapet	80 ft	OC Detail 17	0.384 BTU/hr·ft·°F	31	1%

Step 7	**Overall West Façade Wall U-value, BTU/hr·ft²·°F**	U-0.174
	Overall West Façade Wall R-value, hr·ft²·°F/BTU (m²K/W)	R-5.7 (1.0)

One thing to note, in this example the clear wall assembly is equivalent to R-25.6 (4.51). However when all the details were included in the calculation, the actual performance of the enclosure was closer to R-6 (1.06). This stresses the importance of accounting for the details in to provide more realistic performance of the building enclosure.

Step 8: Improving Performance

Ways to improve the overall thermal transmittance can be evaluated at this stage. By studying the individual conductive heat flows in Step 6, the biggest opportunities for improvement are identified. If there is a particular overall thermal transmittance goal, you can determine what improvements maybe required to meet these goals by increasing the insulation and/or mitigating thermal bridging at the interface details.

For this example, improving the window interface as shown in Detail 13 Scenario B, greatly improves the overall enclosure U-value, decreasing it by more than half. The next opportunity for improvement is the balconies.

Step 1-2	Step 3	Step 4	Step 5		Step 6	
Transmittance Type	**Description**	**Quantity**	**Ref**	**Transmittance**	**Heat Flow BTU/hr·°F**	**% of Total Heat Flow**
Clear Field	Metal Panel Wall	17820 ft^2	OC Detail 3	0.038 BTU/hr·ft^2·°F	657	38%
Linear Transition	Balcony	624 ft	BETB Detail	0.612 BTU/hr·ft·°F	382	22%
	Intermediate floor	2496 ft	OC Detail 11	0.[illegible] BTU/hr·ft·°F	97	6%
	Window Head	2280 ft	OC Detail 13B	**Step 8** 0.064 BTU/hr·ft·°F	146	8%
	Window Sill	2280 ft	OC Detail 13B	0.044 BTU/hr·ft·°F	100	6%
	Window Jamb	7600 ft	OC Detail 13B	0.044 BTU/hr·ft·°F	334	19%
	Parapet	80 ft	OC Detail 17	0.384 BTU/hr·ft·°F	31	2%

Step 7	**Overall West Façade Wall U-value, BTU/hr·ft^2·°F**	U-0.101
	Overall West Façade Wall R-value, hr·ft^2·°F/BTU (m^{2}K/W)	R-9.9 (1.74)

LOW-RISE COMMERCIAL BUILDING EXAMPLE

Following the same steps as the previous example, this example is for a medium-rise office building with the following characteristics:

- 40% glazing, mix of 1524 mm x 914 mm (5'x3') windows in punched openings
- Concrete structure with CMU block infill walls and brick veneer
- The west façade is identical on each floor

Example Medium-Rise Office Building

The overall thermal performance of the building enclosure with standard details are listed below:

Step 1-2	Step 3	Step 4	Step 5		Step 6	
Transmittance Type	**Description**	**Quantity**	**Ref**	**Transmittance**	**Heat Flow BTU/hr·°F**	**% of Total Heat Flow**
Clear Field	Brick Wall	40828 ft²	OC Detail 7	0.050 BTU/hr·ft²·°F	2042	26%
Linear Transition	Intermediate floor	4813 ft	OC Detail 12A	0.292 BTU/hr·ft·°F	1407	18%
	Window Head	5400 ft	OC Detail 14A	0.362 BTU/hr·ft·°F	1955	25%
	Window Sill	5400 ft	OC Detail 14A	0.131 BTU/hr·ft·°F	708	9%
	Window Jamb	18000 ft	OC Detail 14A	0.076 BTU/hr·ft·°F	1373	18%
	Parapet	561 ft	OC Detail 18A	0.290 BTU/hr·ft·°F	163	2%
	Base of Wall	561 ft	OC Detail 16A	0.322 BTU/hr·ft·°F	181	2%

Step 7		
	Overall Façade Wall U-value, BTU/hr·ft²·°F	U-0.192
	Overall Façade Wall R-value, hr·ft²·°F/BTU (m²K/W)	R-5.2 (0.92)

Minimizing thermal bridging can improve the overall thermal transmittance as shown below:

Step 1-2	Step 3	Step 4	Step 5		Step 6	
Transmittance Type	**Description**	**Quantity**	**Ref**	**Transmittance**	**Heat Flow BTU/hr·°F**	**% of Total Heat Flow**
Clear Field	Brick Wall	40828 ft²	OC Detail 7	0.050 BTU/hr·ft²·°F	2042	46%
Linear Transition	Intermediate floor	4813 ft	OC Detail 12B	0.054 BTU/hr·ft·°F	259	6%
	Window Head	5400 ft	OC Detail 14B	0.142 BTU/hr·ft·°F	767	17%
	Window Sill	5400 ft	OC Detail 14B	0.015 BTU/hr·ft·°F	81	2%
	Window Jamb	18000 ft	OC Detail 14B	0.058 BTU/hr·ft·°F	1044	24%
	Parapet	561 ft	OC Detail 18B	0.121 BTU/hr·ft·°F	68	2%
	Base of Wall	561 ft	OC Detail 16B	0.242 BTU/hr·ft·°F	136	3%

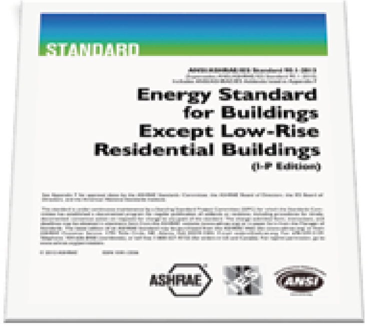
Step 7	**Overall Façade Wall U-value, BTU/hr·ft²·°F**	U-0.108
	Overall Façade Wall R-value, hr·ft²·°F/BTU (m²K/W)	R-9.3 (1.64)

In both examples, the glazing to wall transitions (head, sill, and jamb) had a significant impact even with thermally efficient clear field assembly. This is due to the quantity of lineal feet of glazed transitions due to the punched window openings. Even buildings with 40% window-to-wall ratio can have a lot of glazing to wall interfaces. The length varies with window size and quantity of windows. A building with many small windows will have more lineal feet of window transitions than a building with the same glazing ratio, but made up of fewer larger windows. Larger window at the same glazing ratio will reduce the impact of thermal bridging at the glazing interface.

ADDITIONAL RESOURCES

This document provides data and an overview on determining the overall thermal transmittance, but is not an extensive catalog. Additional sources of information to supplement this guide for other details and assemblies. Here are a few examples:

Building Envelope Thermal Bridging (BETB) Guide has additional guidance on calculating overall thermal transmittance and an extensive catalogue of details and assemblies. The data contained in this document follows the same methodology and can be directly compared to the information contained in the BETB Guide and extrapolated to other systems and details.



Appendix A of **ASHRAE 90.1 "Energy Standard for Buildings Except Low-Rise Residential"** (ASHRAE, 2013) contains several tables of thermal performance values for a variety of clear field assemblies, including walls, roofs and floors for concrete, steel-frame and wood-frame constructions. The values for many of the exterior insulated structures assume continuous insulation and do not account for cladding attachments which penetrate the exterior insulation.

In the absence of linear transmittance values for construction details, **ISO 14683:2007 "Thermal Bridges in Building Construction – Linear thermal transmittance – Simplified methods and default values"** (CEN, 2007) provides default linear transmittances with simplified geometry. ISO 14683 default values were determined using two-dimensional numerical modelling in accordance with ISO 10211 with parameters that are intended to cautiously overestimate the impact of thermal bridging effects. The default values are intended to be the worst-case scenarios and to be used when more precise values are not available. However, complex heat flow paths created by misaligned glazing thermal breaks or flashing are not captured by these values. Comparisons to generic linear transmittance for construction details that includes all components is recommended.

GLOSSARY

Term	Symbol	Units Imperial	Units SI	Description
Conductivity	K	$\frac{(BTU\ in)}{(hr\ ft^2\ {}^oF)}$	$\frac{W}{(m\ K)}$	The ability of a material to transmit heat in terms of energy per unit area per unit thickness and degree of temperature difference.
Equivalent Conductivity	K_{eq}	$\frac{(BTU\ in)}{(hr\ ft^2\ {}^oF)}$	$\frac{W}{(m\ K)}$	The average or equivalent thermal conductivity of a component consisting of several building materials, effectively treating the component as a homogeneous material that provides the same thermal characteristics.
Heat Flow	Q	BTU/hr	W	The amount of energy per unit time that passes through an assembly under a specific temperature difference of ΔT.
Thermal Transmission Coefficient	U	$\frac{(BTU)}{(hr\ ft^2\ {}^oF)}$	$\frac{W}{(m^2\ K)}$	Heat flow per unit time through a unit area of an assembly per degree of temperature difference. The convention is to include the impact of air films.
Thermal Resistance of a Material	R	$\frac{(hr\ ft^2\ {}^oF)}{(BTU)}$	$\frac{(m^2\ K)}{W}$	A measure of a material's resistance to heat flow.
Effective Thermal Resistance	R_{eff}	$\frac{(hr\ ft^2\ {}^oF)}{(BTU)}$	$\frac{(m^2\ K)}{W}$	A measure of an assembly's resistance to heat flow, including the effects of thermal bridging. The inverse of the assembly U-value.
Clear Field Assembly Thermal Transmittance	U_o	$\frac{(BTU)}{(hr\ ft^2\ {}^oF)}$	$\frac{W}{(m^2\ K)}$	Heat flow coefficient for an assembly with uniformly distributed thermal bridges, which are not practical to account for on an individual basis for U-value calculations. Examples of thermal bridging included in U_o are brick ties, girts supporting cladding, and structural studs.
Linear Heat Transmittance Coefficient	ψ	$\frac{(BTU)}{(hr\ ft\ {}^oF)}$	$\frac{W}{(m\ K)}$	Heat flow coefficient representing the added heat flow associated with linear thermal bridges that are not included in the clear field U_o. Linear thermal bridges typically occur at interface details. Examples are shelf angles, slab edges, balconies, corner framing, parapets, and window interfaces.
Point Heat Transmittance Coefficient	χ	$\frac{(BTU)}{(hr\ {}^oF)}$	$\frac{W}{(K)}$	Heat flow coefficient representing the added heat flow associated with a point thermal bridge that is not included in the clear field U_o. Point thermal bridges are countable points and are considered feasible to account for on an individual basis for U-value calculations. An example is a structural beam penetration through insulation.
Length of a Linear Transmittance	L	ft	m	The length of a linear thermal bridge, i.e. height of a corner or width of a slab.

Term	Description
Air Films	An approximation of the combined radiative and/or conductive-convective heat exchange at air boundary surfaces.
Area of Influence	The area that heat flow through an assembly is affected by a thermal bridge by lateral heat flows.
Area Weighted Method	The method by which an average U-value is determined by summing the Area multiplied by U-Value of each component and then dividing by total Area. This method assumes parallel heat flow paths.
At-Grade Interface Detail	An interface detail at the transition between the above-grade wall assembly intersections with either an at-grade floor slab or below grade assemblies.
Building Elevation	A view of a building seen from one side, a flat representation of one façade. Elevations drawings typically show views of the exterior of a building by orientation (North, East, South or West).
Building Enclosure	The elements of a building that separate the conditioned space from unconditioned space of a building. This includes walls, roofs, windows and doors.
Clear Field Assembly	Wall, floor and roof assemblies of a building. (see definition of U_o above)
Corner Interface Detail	Where walls meet at a corner of the building. Interface details can have additional heat flow than compared to the clear field assembly because of additional framing and related to the geometry (increased exterior surface area).
Curtain Wall	A non-load bearing building façade that sits outboard of the main building structure made up of metal framing, vision glass and spandrel sections. The curtain wall only carries its own dead-load and lateral loads (wind).
Dynamic Thermal Response	The time variant heat flows through the building enclosure that result in delayed heat gain or loss depending on the amount of energy that is stored within the building enclosure. The amount of energy that is stored within the building enclosure at any given time is related to the mass of all the combined components of the building enclosure (thermal mass).
Fenestration	All areas (including the frames) in the building enclosure that let in light, including windows, plastic panels, clerestories, skylights, doors that are more than one-half glass, and glass block walls.
Firestop	A fire protection system made of various components used to seal openings and joints in fire-resistance rated wall and floor assemblies.
Glazing	See definition of fenestration. Examples of glazing are windows, window-wall, and curtain-wall.
Glazing Interface Detail	Linear thermal bridges that occur at the intersection of glazing and opaque assemblies.
Insulating Glass Unit (IGU)	Double or triple glass planes separated by air or other gas filled space. The space between the panes is glass is created by a physical spacer that is also adhered to the glass. Sealant is provided at the perimeter of the unit as a gas and moisture barrier.
Interface Details	Thermal bridging related to the details at the intersection of building enclosure assemblies and/or structural components. Interface details interrupt the uniformity of a clear field assembly and the additional heat loss associated with interface details is accounted for by linear and point thermal transmittances.
Lateral Heat Flow	Heat flow in multiple directions through an assembly as a result of conductive components bypassing the thermal insulation in multiple dimensions.
Linear Thermal Bridge	An interface detail that can be defined by a linear length along a plane of the building enclosure.
MURB	Multi-unit residential building.
NECB 2015	National Energy Code of Canada for Buildings 2015.
Opaque Assembly	All areas in the building enclosure, except fenestration and building services openings such as vents and grilles.
Parallel Path	The assumption that the heat flow paths through an assembly are perpendicular to the plane of the assembly and there is no lateral heat flow.
Parapet	An interface detail at the wall to roof intersection.

Term	Description
Point Thermal Bridge	Points of heat loss that are considered feasible to account for on an individual basis for U-value calculations. An example is a structural beam penetrations through insulation.
Poured-in-Place Concrete Wall	Commonly exposed concrete wall that is cast on site and is part of the building structural support.
Precast Concrete Wall	An architectural concrete cladding that is cast off site and shipped to the location of installation.
Plane of Heat Transfer	The theoretical projected area between the interior and exterior environment where the net heat flow through the building enclosure is calculated.
Shelf Angle	A structural support that transfers the dead load of brick veneer to the building structure.
Floor Slab	An intermediate concrete floor that partially or fully penetrates the building enclosure at the exterior.
Spandrel Section	An opaque section of curtain wall or window wall with insulation between the system framing.
Stick Built Curtain Wall	A site installed and glazed curtain-wall system that is assembled by running long pieces of framing between floors vertically and between vertical members horizontally.
Structural Beam	A steel beam that penetrates through the building enclosure to support an exterior element, such as a canopy.
Quantity Takeoff	A quantity measurement that determines the areas and lengths needed for U-value calculations. The quantities are determined using architectural drawings.
Thermal Break	A non-conductive material that interrupts a conductive heat flow path. For example, aluminum framing for glazing in cold climates typically utilizes a low conductivity material to join an exterior and interior portion of the metal framing.
Thermal Bridge	Part of the building enclosure where otherwise uniform thermal resistance is changed by full or partial penetration of the thermal insulation by materials with lower thermal conductivities and/or when the interior and exterior areas of the enclosure are different, such as what occurs at parapets and corners.
Thermal Modeling	The process by which the thermal performance of assemblies is determined through computer simulations utilizing heat transfer models. Assemblies can be modeled two- or three- dimensions (2D and 3D).
Thermal Performance	A broad term to describe performance indicators related to the heat transfer through an assembly. The performance indicators include thermal transmittances, effective R-values, and metrics to evaluate condensation resistance related to surface temperatures.
Thermal Zone	A grouping of the interior building spaces that experience similar heating and cooling requirements.
Total Energy Use	The amount of annual energy use of a building, including space heating/cooling, ventilation, lighting, plug loads, domestic hot water, pumps, fans etc.
Unitized Curtain Wall	A curtain-wall system that is assembled in modules that is glazed before arriving at site.
Vision Section	The section of glazing that contains transparent or translucent elements.
Window to Wall Ratio/ Glazing Ratio	The percentage of glazing to the wall area of a building.
Whole Building Energy Use	The amount of energy a building uses, typically on a yearly basis. This includes, but is not limited to energy for space and ventilation heating and cooling, domestic hot water heating, lighting, miscellaneous electrical loads and auxiliary HVAC equipment such as pumps and fans.

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APPENDIX A – CATALOGUE MATERIAL DATA SHEETS

Detail 1 55

Conventional Curtain Wall System with Vertical and Horizontal Pressure Plates and 5' x 5' Spandrel Section – Thermafiber® Impasse System and Intermediate Floor Intersection

Detail 2 56

Exterior and Interior Insulated 2" x 6" Steel Stud (16" o.c.) Wall Assembly with Galvanized Horizontal Intermittent Clips (24" o.c.) Supporting Metal Cladding – Clear Wall

Detail 3 57

Exterior and Interior Insulated 2" x 6" Steel Stud (16" o.c.) Wall Assembly with Thermally Isolated Vertical Brackets and Rail System (24" o.c.) Supporting Metal Cladding – Clear Wall

Detail 4 58

Exterior Insulated 2" x 6" Steel Stud (16" o.c.) Wall Assembly with Heckmann Pos-I-Tie Veneer Anchoring System Supporting Brick Veneer – Clear Wall

Detail 5 59

Exterior Insulated 2" x 6" Steel Stud (16" o.c.) Wall Assembly with Heckmann Pos-I-Tie Veneer Anchoring System Supporting Brick Veneer – Clear Wall

Detail 6 60

Exterior Insulated Concrete Block Wall with Thermally Isolated Vertical Brackets and Rail System Supporting Metal Cladding – Clear Wall

Detail 7 61

Exterior Insulated Concrete Block Wall Assembly with Heckmann Pos-I-Tie Veneer Anchoring System Supporting Brick Veneer – Clear Wall

Detail 8 62

Exterior and Interior Insulated 2" x 6" Wood Stud (16" o.c. and 24" o.c.) Wall Assembly with Heckmann Pos-I-Tie Veneer Anchoring System Supporting Brick Veneer – Clear Wall

Detail 9 63

Exterior Insulated Low Sloped Roof – Clear Roof Assembly

Detail 10 64

Insulated Protected Membrane Roof – Floating Concrete Wall Intersection

Detail 11 65

Exterior Insulated 2" x 6" Steel Stud (16" o.c.) Wall Assembly with Thermally Isolated Vertical Brackets and Rail System (24" o.c.) Supporting Metal Cladding – Intermediate Floor Intersection

Detail 12-A 66

Exterior Insulated Concrete Block Wall Assembly with Shelf Angle and Heckmann Pos-I-Tie Veneer Anchoring System Supporting Brick Veneer – Intermediate Floor Intersection

Detail 12-B 67

Exterior Insulated Concrete Block Wall Assembly with Stainless Steel Stand-off Shelf Angle and Heckmann Pos-I-Tie Veneer Anchoring System Supporting Brick Veneer – Intermediate Floor Intersection

Detail 13-A 68

Exterior and Interior Insulated 2" x 6" Steel Stud (16" o.c.) Wall Assembly with Thermally Isolated Vertical Brackets and Rail System (24" o.c.) Supporting Metal Cladding – Window and Intermediate Floor Intersection

Detail 13-B 69

Exterior and Interior Insulated 2" x 6" Steel Stud (16" o.c.) Wall Assembly with Thermally Isolated Vertical Brackets and Rail System (24" o.c.) Supporting Metal Cladding – Window and Intermediate Floor Intersection

Detail 14-A 70

Exterior Insulated Concrete Block Wall Assembly with Heckmann Pos-I-Tie Veneer Anchoring System Supporting Brick Veneer – Window and Intermediate Floor Intersection

Detail 14-B 71

Exterior Insulated Concrete Block Wall Assembly with Heckmann Pos-I-Tie Veneer Anchoring System Supporting Brick Veneer – Window and Intermediate Floor Intersection

Detail 15-A 72

Exterior and Interior Insulated 2" x 6" Steel Stud (16" o.c.) Wall Assembly with Thermally Isolated Vertical Brackets and Rail System (24" o.c.) Supporting Metal Cladding – Slab and Foundation Intersection

Detail 15-B 73

Exterior and Interior Insulated 2" x 6" Steel Stud (16" o.c.) Wall Assembly with Thermally Isolated Vertical Brackets and Rail System (24" o.c.) Supporting Metal Cladding – Slab and Foundation Intersection

Detail 16-A 74

Exterior Insulated Concrete Block Wall Assembly with Steel Shelf Angle and Heckmann Pos-I-Tie Veneer Anchoring System Supporting Brick Veneer – Slab and Foundation Intersection

Detail 16-B 75

Exterior Insulated Concrete Block Wall Assembly with Stainless Steel Stand-off Shelf Angle and Heckmann Pos-I-Tie Veneer Anchoring System Supporting Brick Veneer – Slab and Foundation Intersection

Detail 17-A **76**

Exterior and Interior Insulated 2" x 6" Steel Stud (16" o.c.) Wall Assembly with Thermally Isolated Vertical Brackets and Rail System (24" o.c.) Supporting Metal Cladding – Parapet and Roof Intersection

Detail 17-B **77**

Exterior and Interior Insulated 2" x 6" Steel Stud (16" o.c.) Wall Assembly with Thermally Isolated Vertical Brackets and Rail System (24" o.c.) Supporting Metal Cladding – Parapet and Roof Intersection

Detail 18-A **78**

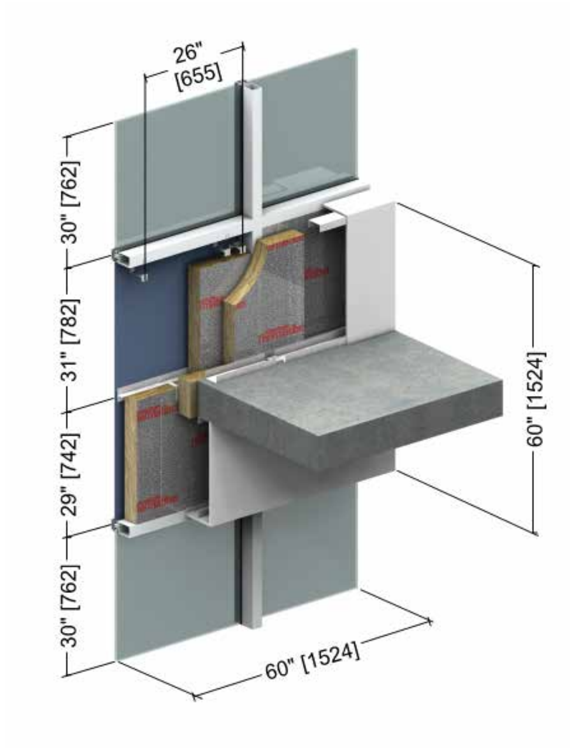
Exterior Insulated Concrete Block Wall Assembly with Heckmann Pos-I-Tie Veneer Anchoring System Supporting Brick Veneer – Parapet & Roof Intersection, Scenario A with Uninsulated Parapet

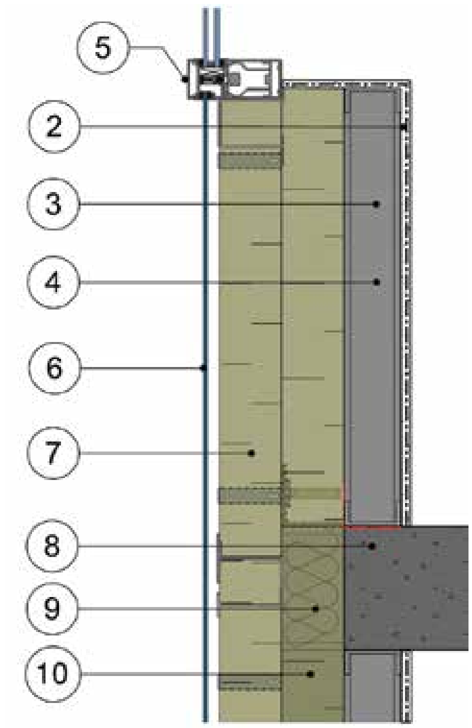
Detail 18-B **79**

Exterior Insulated Concrete Block Wall Assembly with Heckmann Pos-I-Tie Veneer Anchoring System Supporting Brick Veneer – Parapet & Roof Intersection, Scenario B with Insulation Wrapped Around Parapet

Detail 1

Conventional Curtain Wall System with Vertical and Horizontal Pressure Plates and 5' x 5' Spandrel Section – Thermafiber® Impasse System and Intermediate Floor Intersection



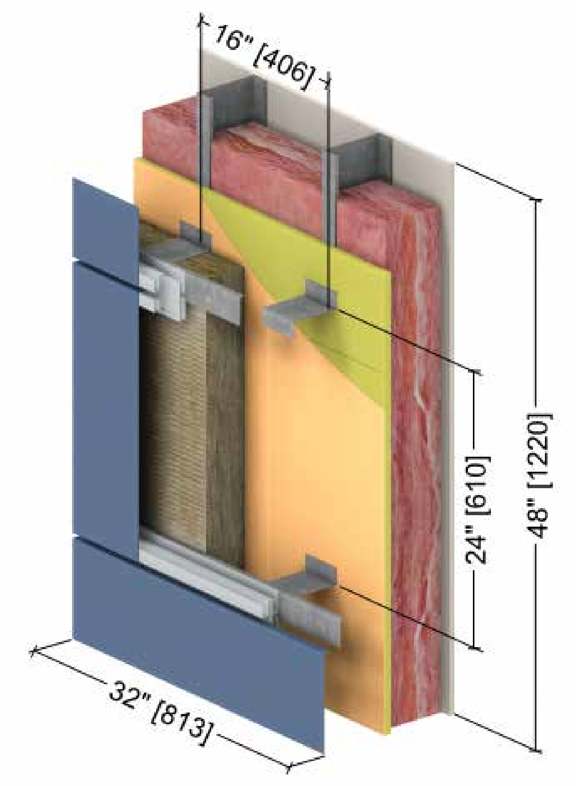


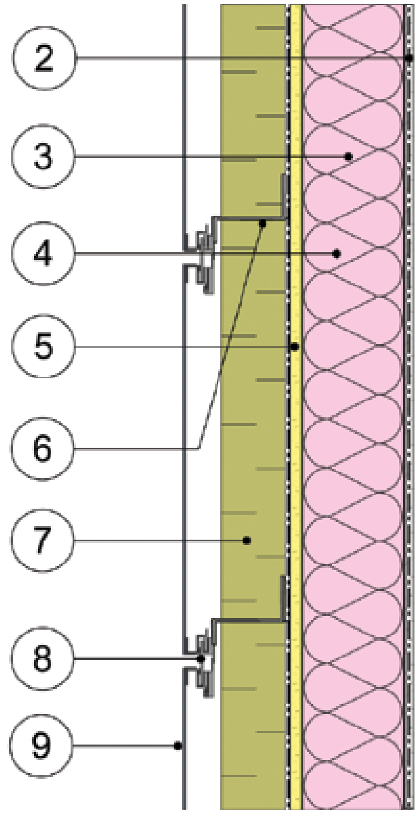
ID	Component	Thickness Inches (mm)	Conductivity Btu·in/ft²·hr·°F (W/m K)	Nominal Resistance hr·ft²·°F/Btu (m²K/W)	Density lb/ft³ (kg/m³)
1	Interior Films[1]	-	-	R-0.6 (0.12 RSI) to R-1.1 (0.20 RSI)	-
2	Gypsum Board	1/2" (13)	1.1 (0.16)	R-0.5 (0.08 RSI)	50 (800)
3	Air in Stud Cavity	1 5/8" (41)	-	R-0.9 (0.16 RSI)	0.075 (1.2)
4	1 5/8" x 1 5/8" Steel Studs (16"o.c.) with Top and Bottom Tracks	18 Gauge	430 (62)	-	489 (7830)
5	5' (1.5m) x 5' (1.5m) Aluminum window: thermally broken, double glazed IGU[2] U_{IGU} = 0.32 BTU/hr·ft²·°F (1.82 W/m²K)				
6	5' (1.5m) x 5' (1.5m) Conventional Curtain Wall Spandrel Section with Thermafiber Impasse System[2]				
7	Thermafiber® RainBarrier™ 45 Mineral Wool Semi Rigid Spandrel Insulation	4" (102)	0.23 (0.033)	R-17.2 (3.03 RSI)	4.5 (72)
8	Concrete Slab	8" (203)	12.5 (1.8)	-	140 (2250)
9	Safing Mineral Wool Insulation	3" (76)	0.23 (0.033)	-	4.5 (72)
10	Thermafiber® RainBarrier™ 45 Mineral Wool Semi Rigid Mullion Cover Insulation	2" (51)	0.23 (0.033)	R-8.6 (1.51 RSI)	4.5 (72)
11	Exterior Film[1]	-	-	R-0.2 (0.03 RSI)	-

[1]Value selected from table 1, p. 26.1 of 2009 ASHRAE Handbook – Fundamentals depending on surface orientation
[2]The thermal conductivity of air spaces within framing was found using ISO 100077-2

Detail 2

Exterior and Interior Insulated 2" x 6" Steel Stud (16" o.c.) Wall Assembly with Galvanized Horizontal Intermittent Clips (24" o.c.) Supporting Metal Cladding – Clear Wall



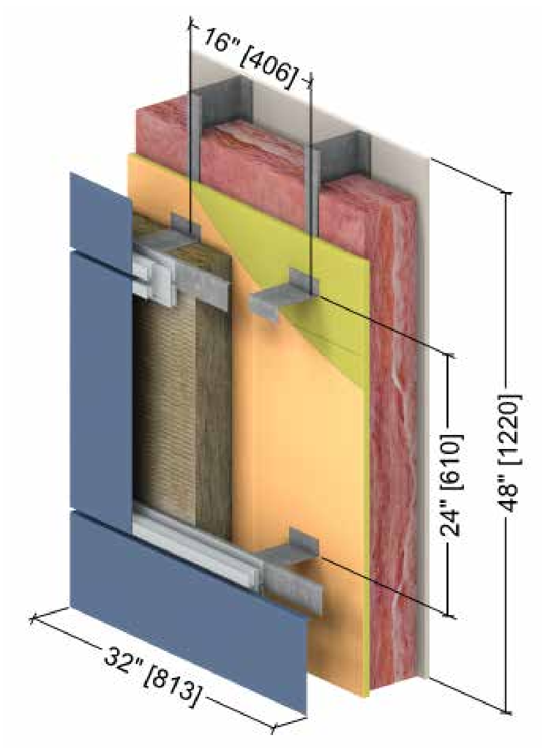


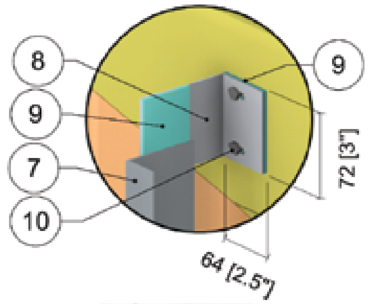
ID	Component	Thickness Inches (mm)	Conductivity Btu·in/ft²·hr·°F (W/m K)	Nominal Resistance hr·ft²·°F/Btu (m²K/W)	Density lb/ft³ (kg/m³)
1	Interior Film[1]	-	-	R-0.7 (0.12 RSI)	-
2	Gypsum Board	1/2" (13)	1.1 (0.16)	R-0.5 (0.08 RSI)	50 (800)
3	2" x 6" Steel Studs	18 Gauge	430 (62)	-	489 (7830)
4	EcoTouch® PINK® Fiberglass Batt	6" (152)	-	R-20, 22.5, 24 (3.52, 3.96, 4.23 RSI)	varies
5	Exterior Sheathing	5/8" (16)	1.1 (0.16)	R-0.6 (0.10 RSI)	50 (800)
6	Horizontal Clips w/ 1 1/2" horizontal rail	18 Gauge	430 (62)	-	489 (7830)
7	Thermafiber® RainBarrier™ 45 Mineral Wool Semi Rigid Insulation	1.5, 2, 3, 4, 5" (38, 51, 76, 102, 127)	0.23 (0.033)	R-6.5, 8.6, 12.9, 17.2, 21.5 (1.14, 1.51, 2.27, 3.03, 3.79 RSI)	4.5 (72)
8	Panel Clip	14 Gauge	430 (62)	-	489 (7830)
9	Metal Cladding with 1/2" vented airspace incorporated into exterior heat transfer coefficient				
10	Exterior Film[1]	-	-	R-0.7 (0.12 RSI)	-

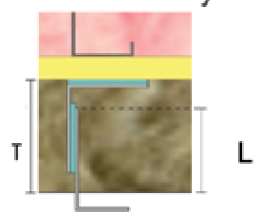
[1]Value selected from table 1, p. 26.1 of 2009 ASHRAE Handbook – Fundamentals depending on surface orientation

Detail 3

Exterior and Interior Insulated 2" x 6" Steel Stud (16"o.c.) Wall Assembly with Thermally Isolated Vertical Brackets and Rail System (24" o.c.) Supporting Metal Cladding – Clear Wall

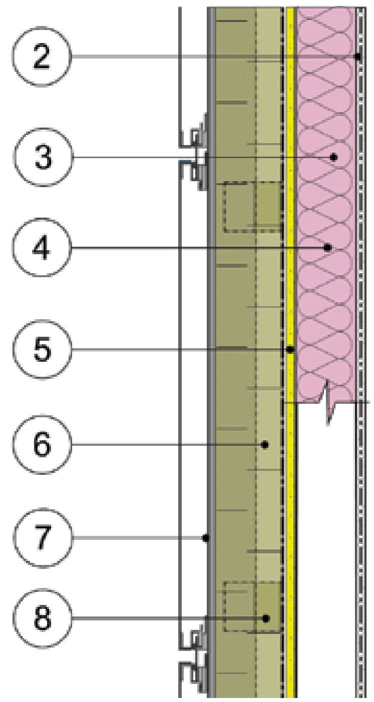






Girt Penetration Detail

T	L
1.5"	1"
2"	1.5"
3"	2-1/4"
4"	2-3/8"
5"	2-3/8"

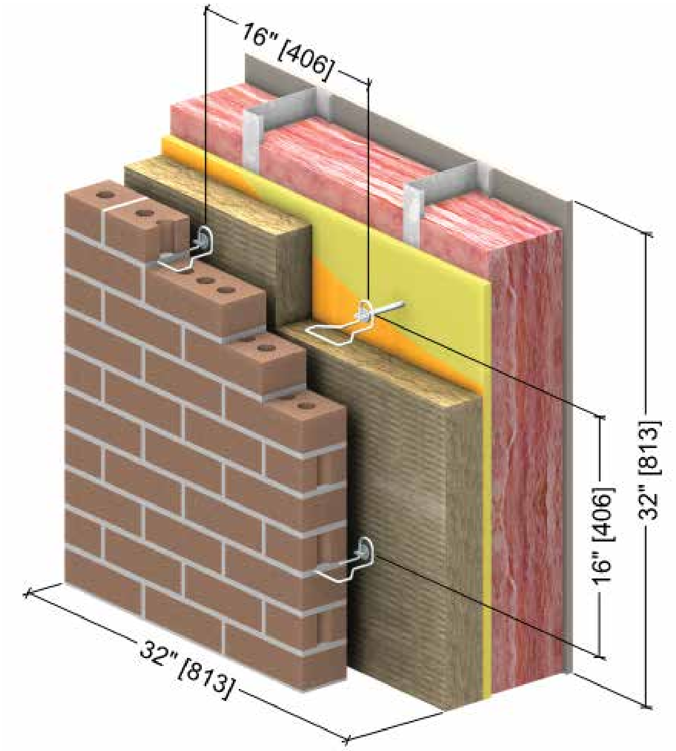


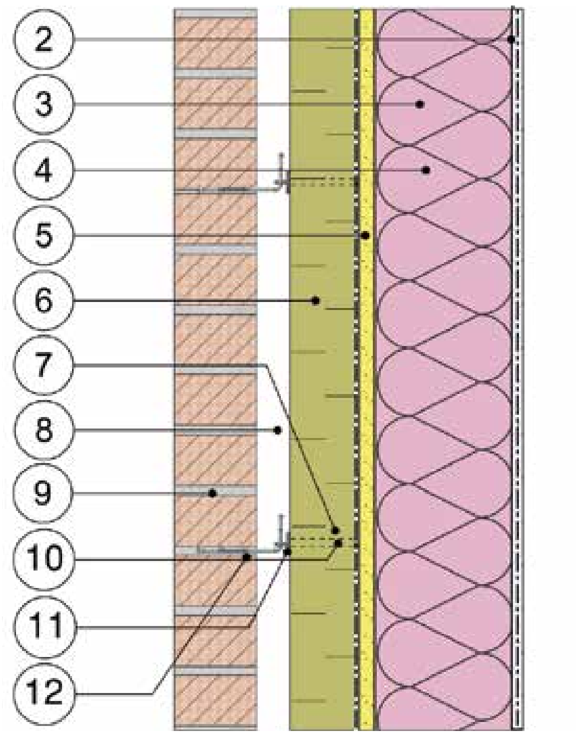
ID	Component	Thickness Inches (mm)	Conductivity Btu·in/ft^2·hr·°F (W/m K)	Nominal Resistance hr·ft^2·°F/Btu (m^{2}K/W)	Density lb/ft^3 (kg/m^3)
1	Interior Films[1]	-	-	R-0.7 (0.12 RSI)	-
2	Gypsum Board	1/2" (13)	1.1 (0.16)	R-0.5 (0.09 RSI)	50 (800)
3	EcoTouch® PINK® Fiberglass Batt	6" (152)	-	R-20, 22.5, 24 (3.52, 3.96, 4.23 RSI)	varies
4	2" x 6" Steel Studs	18 Gauge	430 (62)	-	489 (7830)
5	Exterior Sheathing	5/8" (16)	1.1 (0.16)	R-0.6 (0.10 RSI)	50 (800)
6	Thermafiber® RainBarrier™ 45 Mineral Wool Semi Rigid Insulation	1.5, 2, 3, 4, 5" (38, 51, 76, 102, 127)	0.23 (0.033)	R-6.5, 8.6, 12.9, 17.2, 21.5 (1.14, 1.51, 2.27, 3.03, 3.79 RSI)	4.5 (72)
7	Vertical Aluminum L-girt	0.09" (2.2)	1109 (160)	-	171 (2739)
8	Aluminum Bracket	0.09" (2.2)	1109 (160)	-	171 (2739)
9	HDPE Isolator	1/8" (3)	3.5 (0.5)	-	59 (950)
10	Stainless Steel Fastener	1/4" D (6D)	118 (17)	-	500 (8000)
11	Cladding with 1/2" vented airspace incorporated into exterior heat transfer coefficient				
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 4

Exterior Insulated 2" x 6" Steel Stud (16" o.c.) Wall Assembly with Heckmann Pos-I-Tie Veneer Anchoring System Supporting Brick Veneer – Clear Wall



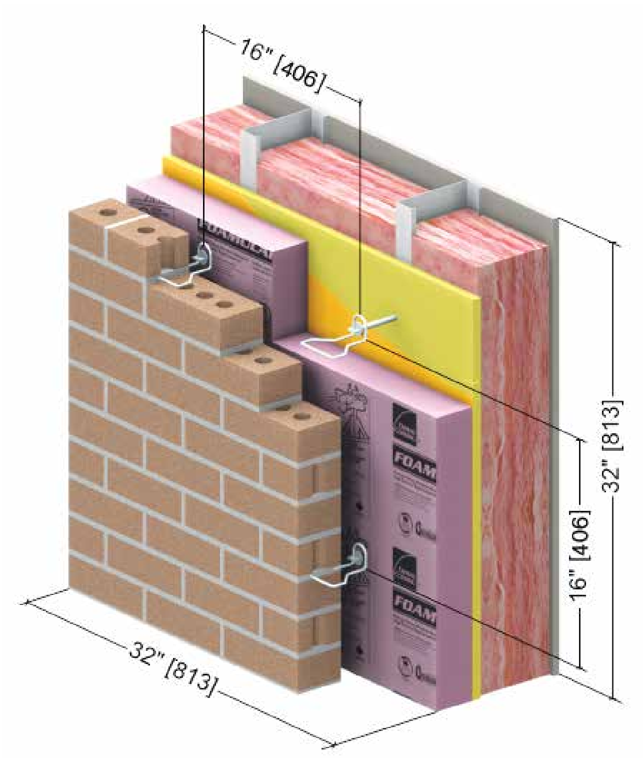


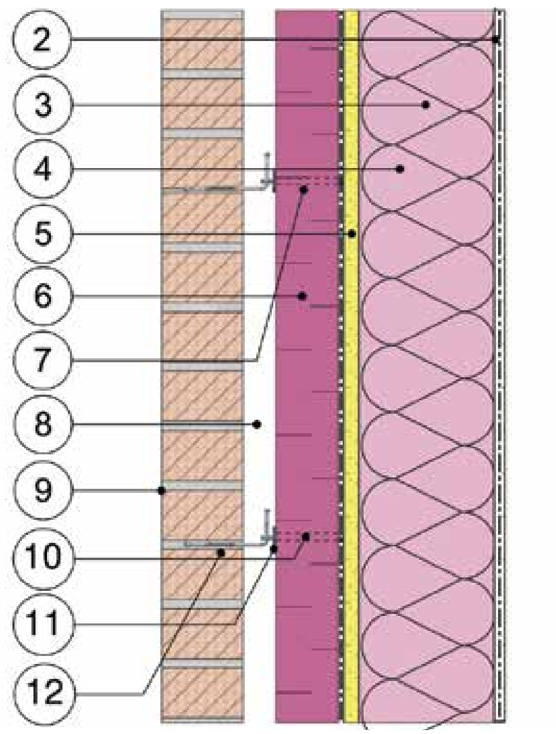
ID	Component	Thickness Inches (mm)	Conductivity Btu·in/ft²·hr·°F (W/m K)	Nominal Resistance hr·ft²·°F/Btu (m²K/W)	Density lb/ft³ (kg/m³)
1	Interior Films[1]	-	-	R-0.7 (0.12 RSI)	-
2	Gypsum Board	1/2" (13)	1.1 (0.16)	R-0.5 (0.08 RSI)	50 (800)
3	EcoTouch® PINK® Fiberglass Batt	6" (152)	-	R-20, 22.5, 24 (3.52, 3.96, 4.23 RSI)	varies
4	2" x 6" Steel Studs	18 Gauge	430 (62)	-	489 (7830)
5	Exterior Sheathing	5/8" (16)	1.1 (0.16)	R-0.6 (0.10 RSI)	50 (800)
6	Thermafiber® RainBarrier™ 45 Mineral Wool Semi Rigid Insulation	1.5, 2, 3, 4, 5" (38, 51, 76, 102, 127)	0.23 (0.033)	R-6.5, 8.6, 12.9, 17.2, 21.5 (1.14, 1.51, 2.27, 3.03, 3.79 RSI)	4.5 (72)
7	Heckmann Pos-I-Tie Masonry Tie 16" (406) o.c.	1.5, 2, 3, 4, 5" (38, 51, 76, 102, 127)	-	-	-
8	Vented Air Cavity[2]	1.5" (38)	-	R-0.4 (0.70 RSI)	0.075 (1.2)
9	Brick Veneer	3 5/8" (92)	5.4 (0.78)	-	120 (1920)
10	Zinc Barrel	-	726 (105)	-	412 (6600)
11	Rubber Washer (EPDM)	1/16" (1.59)	1.7 (0.25)	-	62 (997)
12	Galvanized Steel Wire Pintle	3/16" D (5 D)	645 (93)	-	489 (7830)
13	Exterior Film[1]	-	-	R-0.2 (0.03 RSI)	-

[1]Value selected from table 1, p. 26.1 of 2009 ASHRAE Handbook – Fundamentals depending on surface orientation
[2]The thermal conductivity of air spaces was found using ISO 100077-2

Detail 5

Exterior Insulated 2" x 6" Steel Stud (16" o.c.) Wall Assembly with Heckmann Pos-I-Tie Veneer Anchoring System Supporting Brick Veneer – Clear Wall



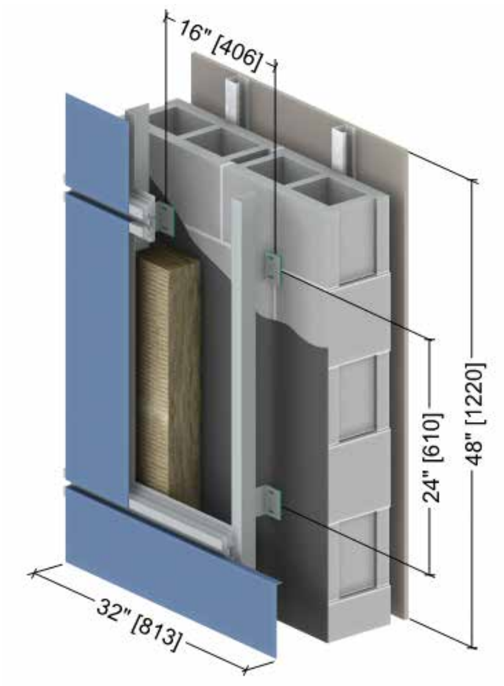


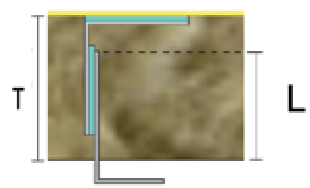
ID	Component	Thickness Inches (mm)	Conductivity Btu·in/ft²·hr·°F (W/m K)	Nominal Resistance hr·ft²·°F/Btu (m²K/W)	Density lb/ft³ (kg/m³)
1	Interior Film[1]	-	-	R-0.7 (0.12 RSI)	-
2	Gypsum Board	1/2" (13)	1.1 (0.16)	R-0.5 (0.08 RSI)	50 (800)
3	EcoTouch® PINK® Fiberglass Batt	6" (152)	-	R-20, 22.5, 24 (3.52, 3.96, 4.23 RSI)	varies
4	2" x 6" Steel Studs	18 Gauge	430 (62)	-	489 (7830)
5	Exterior Sheathing	5/8" (16)	1.1 (0.16)	R-0.6 (0.10 RSI)	50 (800)
6	Foamular® CodeBord®/C-200 Extruded Polystyrene (XPS) Rigid Insulation Type 3	1.5, 2, 3, 4" (38, 51, 76, 102)	0.20 (0.029)	R-7.5, 10, 15, 20 (1.32, 1.76, 2.64, 3.52 RSI)	1.3 (20.8)
7	Heckmann Pos-I-Tie Masonry Tie @ 16" (406) o.c.	1.5, 2, 3, 4" (38, 51, 76, 102)	-	-	-
8	Vented Air Cavity[2]	1.5" (38)	-	R-0.4 (0.70 RSI)	0.075 (1.2)
9	Brick Veneer	3 5/8" (92)	5.4 (0.78)	-	120 (1920)
10	Zinc Barrel	-	726 (105)	-	412 (6600)
11	Rubber Washer (EPDM)	1/16" (1.59)	1.7 (0.25)	-	62 (997)
12	Galvanized Steel Wire Pintle	3/16" D (5 D)	645 (93)	-	489 (7830)
13	Exterior Film[1]	-	-	R-0.2 (0.03 RSI)	-

[1]Value selected from table 1, p. 26.1 of 2009 ASHRAE Handbook – Fundamentals depending on surface orientation
[2]The thermal conductivity of air spaces was found using ISO 100077-2

Detail 6

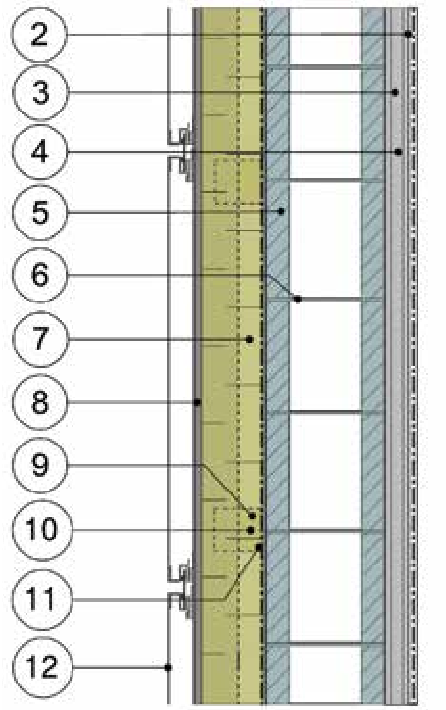
Exterior Insulated Concrete Block Wall with Thermally Isolated Vertical Brackets and Rail System Supporting Metal Cladding – Clear Wall





Girt Penetration Detail

T	L
1.5"	1"
2"	1.5"
3"	2-1/4"
4"	2-3/8"
5"	2-3/8"

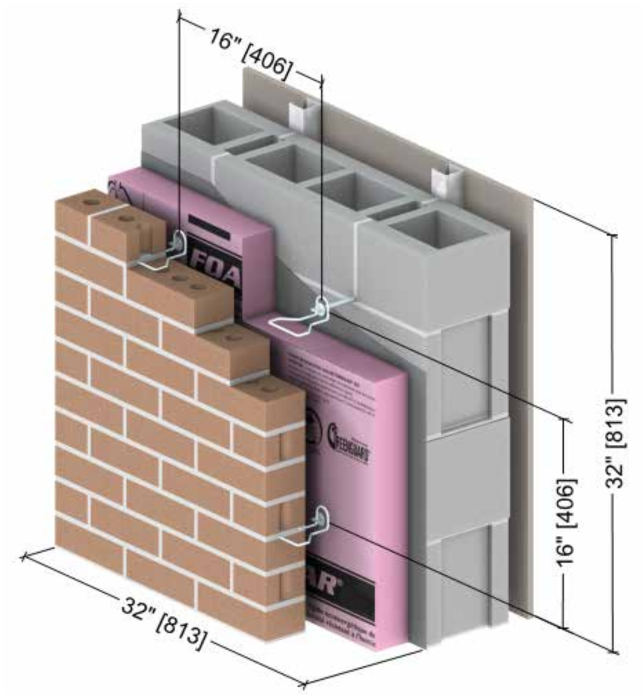


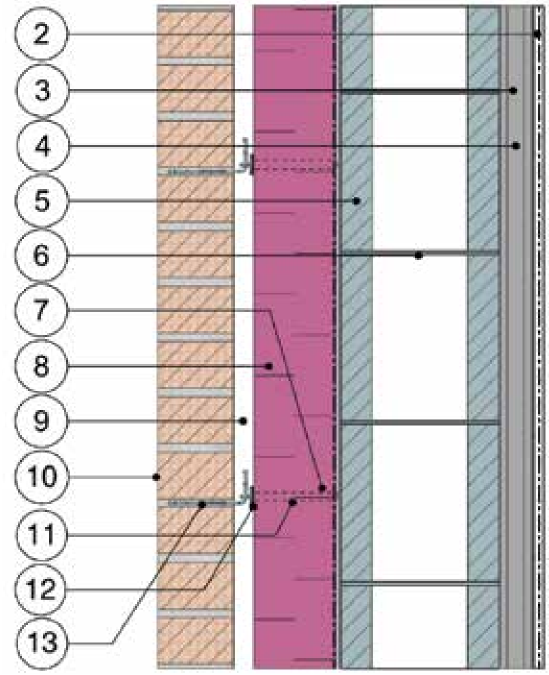
ID	Component	Thickness Inches (mm)	Conductivity Btu·in/ft²·hr·°F (W/m K)	Nominal Resistance hr·ft²·°F/Btu (m²K/W)	Density lb/ft³ (kg/m³)
1	Interior Film[1]	-	-	R-0.7 (0.12 RSI)	-
2	Gypsum Board	1/2" (13)	1.1 (0.16)	R-0.5 (0.08 RSI)	50 (800)
3	Air in Stud Cavity	1 5/8" (92)	-	R-0.9 (0.16 RSI)	0.075 (1.2)
4	1 5/8" x 1 5/8" Steel Studs	18 Gauge	430 (62)	-	489 (7830)
5	Standard Concrete Blocks	8" (203)	3.5 (0.5)	-	119 (1900)
6	Cement Mortar	-	3.5 (0.5)	-	113 (1800)
7	Thermafiber® RainBarrier™ 45 Mineral Wool Semi Rigid Insulation	1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5" (38, 51, 64, 76, 90, 105, 114, 127)	0.23 (0.033)	R-6.5, 8.6, 10.8, 12.9, 15.1, 17.2, 19.4, 21.5 (1.14, 1.51, 1.89, 2.27, 2.65, 3.03, 3.41, 3.79 RSI)	4.5 (72)
8	Vertical Aluminum L-girt	0.09" (2.2)	1109 (160)	-	171 (2739)
9	Aluminum Bracket	0.09" (2.2)	1109 (160)	-	171 (2739)
10	HDPE Isolator	1/8" (3)	3.5 (0.5)	-	59 (950)
11	Stainless Steel Fastener	1/4" D (6D)	118 (17)	-	500 (8000)
12	Generic Cladding with 1/2" (13mm) vented air space is incorporated into exterior heat transfer coefficient				
13	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 7

Exterior Insulated Concrete Block Wall Assembly with Heckmann Pos-I-Tie Veneer Anchoring System Supporting Brick Veneer – Clear Wall



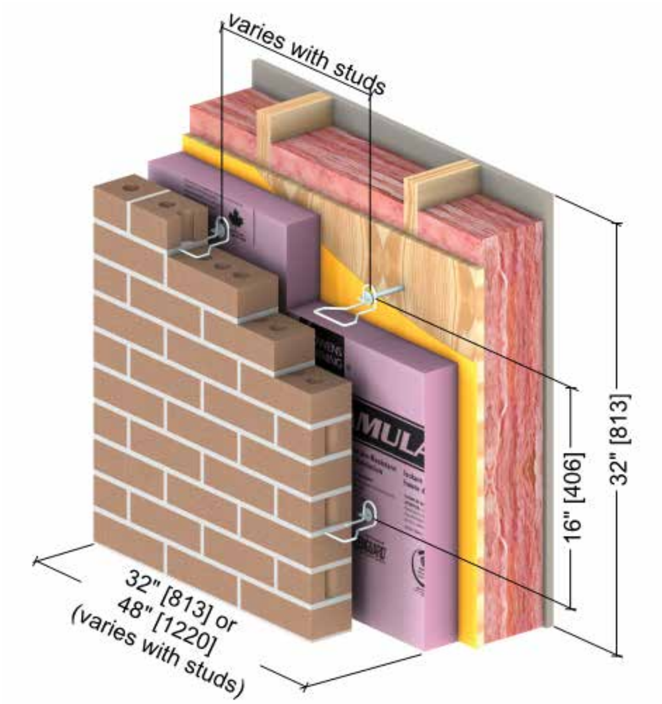


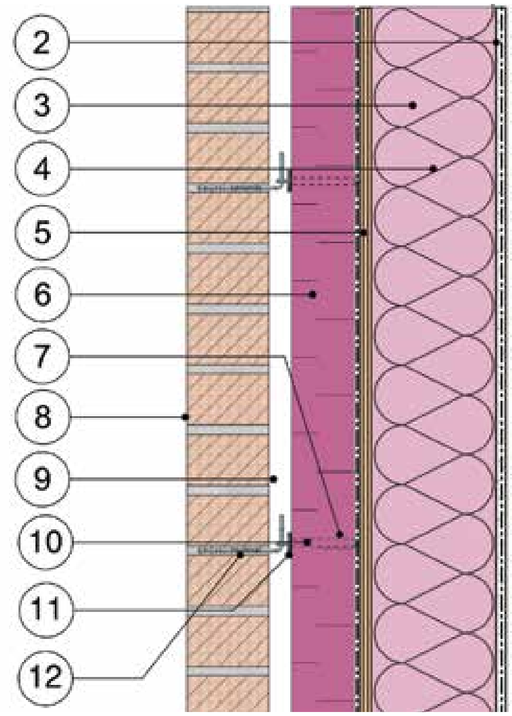
ID	Component	Thickness Inches (mm)	Conductivity Btu·in/ft²·hr·°F (W/m K)	Nominal Resistance hr·ft²·°F/Btu (m²K/W)	Density lb/ft³ (kg/m³)
1	Interior Film[1]	-	-	R-0.7 (0.12 RSI)	-
2	Gypsum Board	1/2" (13)	1.1 (0.16)	R-0.5 (0.08 RSI)	50 (800)
3	1 5/8" x 1 5/8" Steel Studs	20 gauge	430 (62)	-	489 (7830)
4	Air in Stud Cavity	1 5/8" (41)	-	R-0.9 (0.16 RSI)	0.075 (1.2)
5	Standard Concrete Block	8" (203)	3.5 (0.5)	-	119 (1900)
6	Cement Mortar	-	3.5 (0.5)	-	113 (1800)
7	Heckmann Pos-I-Tie Masonry Tie @ 16" (406) o.c.	1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5" (38, 51, 64, 76, 90, 105, 114, 127)	-	-	-
8	Foamular® CodeBord®/C-200 Extruded Polystyrene (XPS) Rigid Insulation Type 3	1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5" (38, 51, 64, 76, 90, 105, 114, 127)	0.20 (0.029)	R-7.5, 10, 12.5, 15, 17.5, 20, 22.5, 25 (1.32, 1.76, 2.20, 2.64, 3.08, 3.52, 3.96, 4.4 RSI)	1.8 (28)
9	Vented Air Cavity[2]	1" (25)	-	R-0.9 (0.16 RSI)	0.075 (1.2)
10	Brick Veneer	3 5/8" (92)	5.4 (0.78)	-	120 (1920)
11	Zinc Barrel	-	726 (105)	-	412 (6600)
12	Rubber Washer (EPDM)	1/16" (1.59)	1.7 (0.25)	-	62 (997)
13	Galvanized Steel Wire Pintle	3/16" D (5 D)	645 (93)	-	489 (7830)
14	Exterior Film[1]	-	-	R-0.2 (0.03 RSI)	-

[1]Value selected from table 1, p. 26.1 of 2009 ASHRAE Handbook – Fundamentals depending on surface orientation
[2]The thermal conductivity of air spaces was found using ISO 100077-2

Detail 8

Exterior and Interior Insulated 2" x 6" Wood Stud (16" o.c. and 24" o.c.) Wall Assembly with Heckmann Pos-I-Tie Veneer Anchoring System Supporting Brick Veneer – Clear Wall



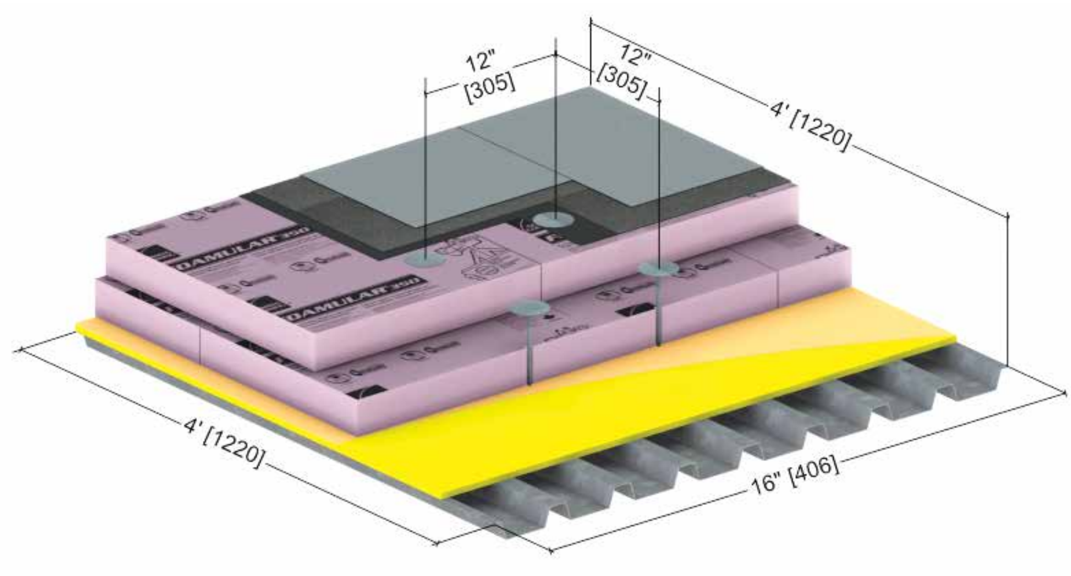


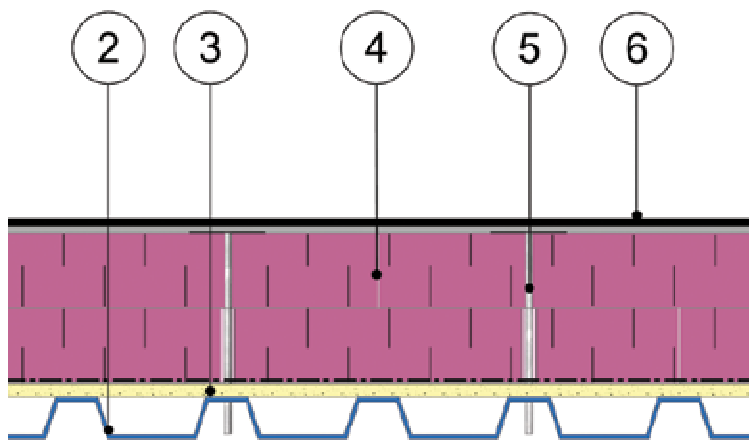
ID	Component	Thickness Inches (mm)	Conductivity Btu·in/ft²·hr·°F (W/m K)	Nominal Resistance hr·ft²·°F/Btu (m²K/W)	Density lb/ft³ (kg/m³)
1	Interior Film[1]	-	-	R-0.7 (0.12 RSI)	-
2	Gypsum Board	1/2" (13)	1.1 (0.16)	R-0.5 (0.08 RSI)	50 (800)
3	EcoTouch® PINK® Fiberglass Batt	5 1/2" (140)	-	R-19, 22, 24 (3.35, 3.87, 4.23 RSI)	0.9 (14)
4	2x6 Wood Stud (16" o.c. and 24" o.c.)	5 1/2" (140)	0.69 (0.10)	-	31 (500)
5	Exterior Wood Sheathing	1/2" (16)	0.69 (0.10)	R-0.7 (0.12 RSI)	31 (500)
6	Foamular® CodeBord®/C-200 Extruded Polystyrene (XPS) Rigid Insulation Type 3	2, 3, 4" (51, 76, 102)	0.20 (0.029)	R-10, 15, 20 (1.76, 2.64, 3.52 RSI)	1.8 (28)
7	Heckmann Pos-I-Tie Masonry Tie @ 16" (406) o.c.	2, 3, 4" (51, 76, 102)	-	-	-
8	Brick Veneer	3 5/8" (92)	5.4 (0.78)	-	120 (1920)
9	Vented Air Cavity[2]	1" (25)	-	R-0.9 (0.16 RSI)	0.075 (1.2)
10	Zinc Barrel	-	726 (105)	-	412 (6600)
11	Rubber Washer (EPDM)	1/16" (1.59)	1.7 (0.25)	-	62 (997)
12	Galvanized Steel Wire Pintle	3/16" D (5 D)	645 (93)	-	489 (7830)
13	Exterior Film[1]	-	-	R-0.2 (0.03 RSI)	-

[1]Value selected from table 1, p. 26.1 of 2009 ASHRAE Handbook – Fundamentals depending on surface orientation
[2]The thermal conductivity of air spaces was found using ISO 100077-2

Detail 9

Exterior Insulated Low Sloped Roof – Clear Roof Assembly



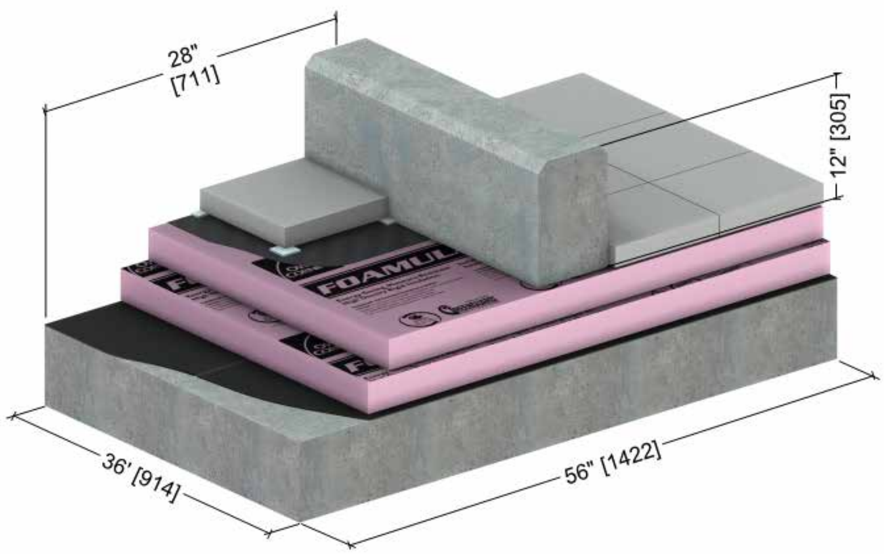


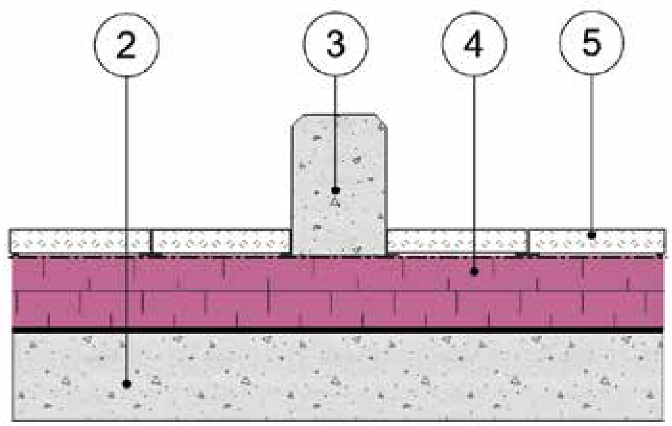
ID	Component	Thickness Inches (mm)	Conductivity Btu·in/ft²·hr·°F (W/m K)	Nominal Resistance hr·ft²·°F/Btu (m^2K/W)	Density lb/ft^3 (kg/m^3)
1	Interior Films[1]	-	-	R-0.6 (0.11 RSI)	-
2	Steel Deck	1/16" (1.6)	347 (50)	-	489 (7830)
3	Gypsum Board	1/2" (13)	1.1 (0.16)	R-0.5 (0.08 RSI)	50 (800)
4	Foamular® 350 Extruded Polystyrene (XPS) Rigid Insulation Type 4	1x4", 2x3", 2x4" (1x102mm, 2x76mm, 2x102mm)	0.20 (0.029)	R-20, 30, 40 (3.52, 5.28, 7.04 RSI)	1.8 (28)
5	Steel Fasteners	3/16" D (4.8 D)	347 (50)	-	489 (7830)
6	Asphalt Cover Board and Roof Membrane	1/2" (12)	3 (0.43)	R-0.2 (0.03 RSI)	100 (1600)
7	Exterior Film[1]	-	-	R-0.2 (0.03 RSI)	-

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

Detail 10

Insulated Protected Membrane Roof – Floating Concrete Wall Intersection



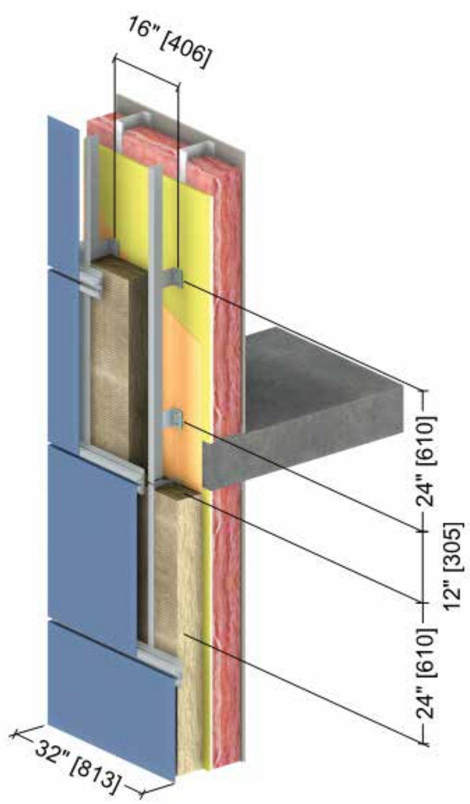


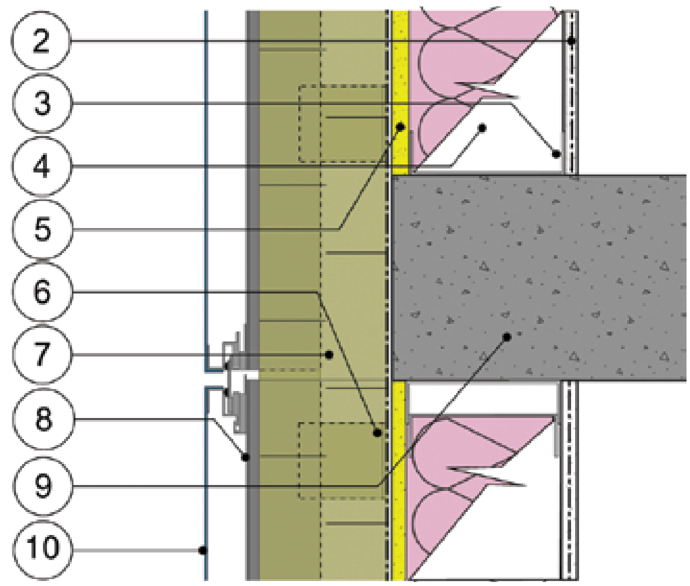
ID	Component	Thickness Inches (mm)	Conductivity Btu·in/ft²·hr·°F (W/m K)	Nominal Resistance hr·ft²·°F/Btu (m²K/W)	Density lb/ft³ (kg/m³)
1	Interior Films[1]	-	-	R-0.6 (0.11 RSI)	-
2	Concrete Deck	8" (203)	12.5 (1.8)	-	140 (2250)
3	Concrete Curb	8" (203)	12.5 (1.8)	-	140 (2250)
4	Foamular® 350 Extruded Polystyrene (XPS) Rigid Insulation Type 4	1x4", 2x3", 2x4" (1x102mm, 2x76mm, 2x102mm)	0.20 (0.029)	R-20, 30, 40 (3.52, 5.28, 7.04 RSI)	1.8 (28)
5	Finish roof material is incorporated into exterior heat transfer coefficient				
6	Exterior Film[1]	-	-	R-0.2 (0.03 RSI)	-

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

Detail 11

Exterior Insulated 2" x 6" Steel Stud (16" o.c.) Wall Assembly with Thermally Isolated Vertical Brackets and Rail System (24" o.c.) Supporting Metal Cladding – Intermediate Floor Intersection



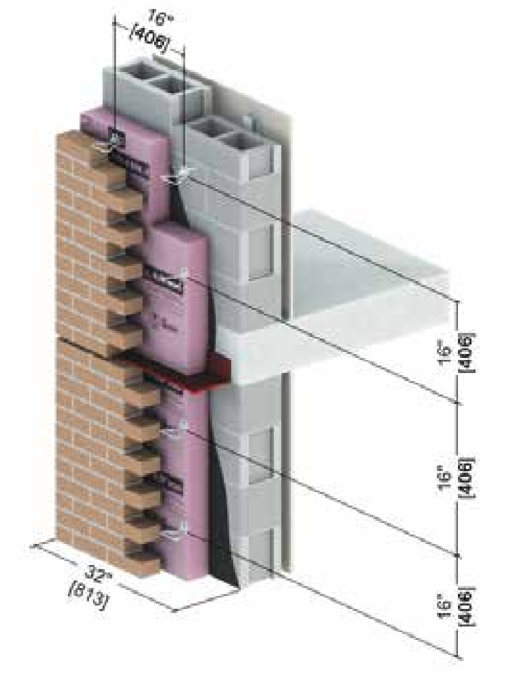


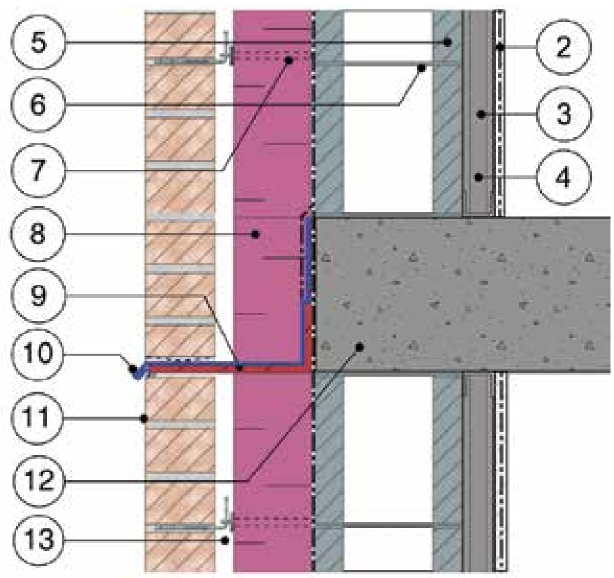
ID	Component	Thickness Inches (mm)	Conductivity Btu·in/ft²·hr·°F (W/m K)	Nominal Resistance hr·ft²·°F/Btu (m²K/W)	Density lb/ft³ (kg/m³)
1	Interior Film[1]	-	-	R-0.6 (0.11 RSI) to R-0.9 (0.16 RSI)	-
2	Gypsum Board	1/2" (13)	1.1 (0.16)	R-0.5 (0.08 RSI)	50 (800)
3	2" x 6" Steel Studs with Tracks	18 Gauge	430 (62)	-	489 (7830)
4	Air or EcoTouch® PINK® Fiberglass Batt in Stud Cavity	6" (152)	-	R-0.9, 20, 22.5, 24 (0.16, 3.52, 3.96, 4.23 RSI)	-
5	Exterior Sheathing	5/8" (16)	1.1 (0.16)	R-0.6 (0.10 RSI)	50 (800)
6	Thermally Isolated Aluminum Bracket as per Detail 3	2, 5" (51, 127)	-	-	-
7	Thermafiber® RainBarrier™ 45 Mineral Wool Semi Rigid Insulation	2, 5" (51, 127)	0.23 (0.033)	R-8.6, 21.5 (1.51, 3.79 RSI)	4.5 (72)
8	Vertical Aluminum L-girt	0.09" (2.2)	1109 (160)	-	171 (2739)
9	Concrete Slab	8" (203)	12.5 (1.8)	-	140 (2250)
10	Cladding with 1/2" (13mm) vented airspace incorporated into exterior heat transfer coefficient				
11	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 12-A

Exterior Insulated Concrete Block Wall Assembly with Shelf Angle and Heckmann Pos-I-Tie Veneer Anchoring System Supporting Brick Veneer – Intermediate Floor Intersection



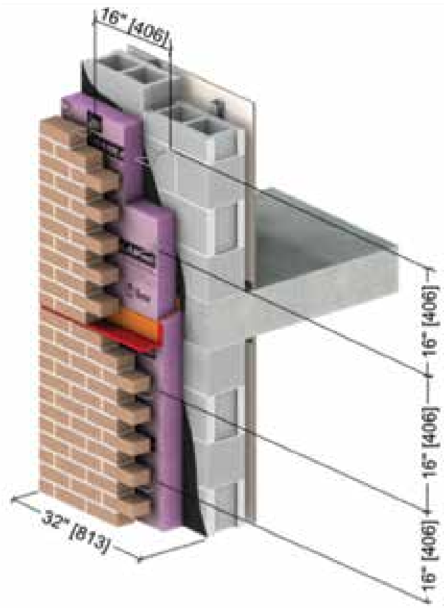


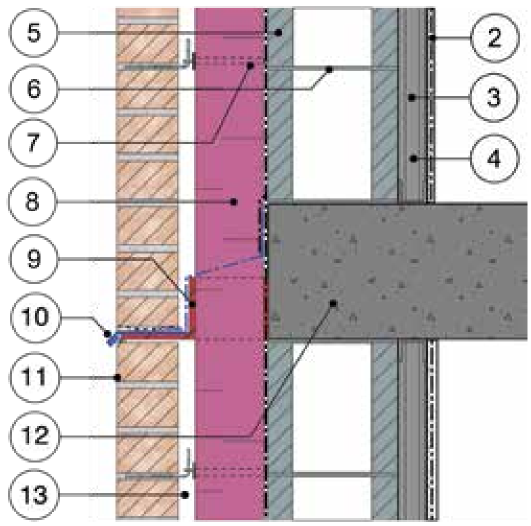
ID	Component	Thickness Inches (mm)	Conductivity Btu·in/ft²·hr·°F (W/m K)	Nominal Resistance hr·ft²·°F/Btu (m²K/W)	Density lb/ft³ (kg/m³)
1	Interior Film[1]	-	-	R-0.6 (0.11 RSI) to R-0.9 (0.16 RSI)	-
2	Gypsum Board	1/2" (13)	1.1 (0.16)	R-0.5 (0.08 RSI)	50 (800)
3	1 5/8" Steel Studs with Metal Tracks	20 gauge	430 (62)	-	489 (7830)
4	Air in Stud Cavity	1 5/8" (41)	-	R-0.9 (0.16 RSI)	0.075 (1.2)
5	Standard Concrete Block	7 5/8" (190)	3.5 (0.5)	-	119 (1900)
6	Cement Mortar	-	3.5 (0.5)	-	113 (1800)
7	Heckmann Pos-I-Tie Masonry Tie @ 16" (406) o.c. as per Detail 7	2, 4" (51, 102)	-	-	-
8	Foamular® CodeBord®/C-200 Extruded Polystyrene (XPS) Rigid Insulation Type 3	2, 4" (51, 102)	0.20 (0.029)	R-10, 20 (1.76, 3.52 RSI)	1.8 (28)
9	Steel Shelf Angle	3/8" (10)	347 (50)	-	489 (7830)
10	Metal Flashing	20 gauge	430 (62)	-	489 (7830)
11	Brick Veneer	3 5/8" (92)	5.4 (0.78)	-	120 (1920)
12	Concrete Slab	8" (203)	12.5 (1.8)	-	140 (2250)
13	Vented Air Gap[2]	1" (25)	-	R-0.9 (0.16 RSI)	0.075 (1.2)
14	Exterior Film[1]	-	-	R-0.2 (0.03 RSI)	-

[1]Value selected from table 1, p. 26.1 of 2009 ASHRAE Handbook – Fundamentals depending on surface orientation
[2]The thermal conductivity of air spaces was found using ISO 100077-2

Detail 12-B

Exterior Insulated Concrete Block Wall Assembly with Stainless Steel Stand-off Shelf Angle and Heckmann Pos-I-Tie Veneer Anchoring System Supporting Brick Veneer – Intermediate Floor Intersection



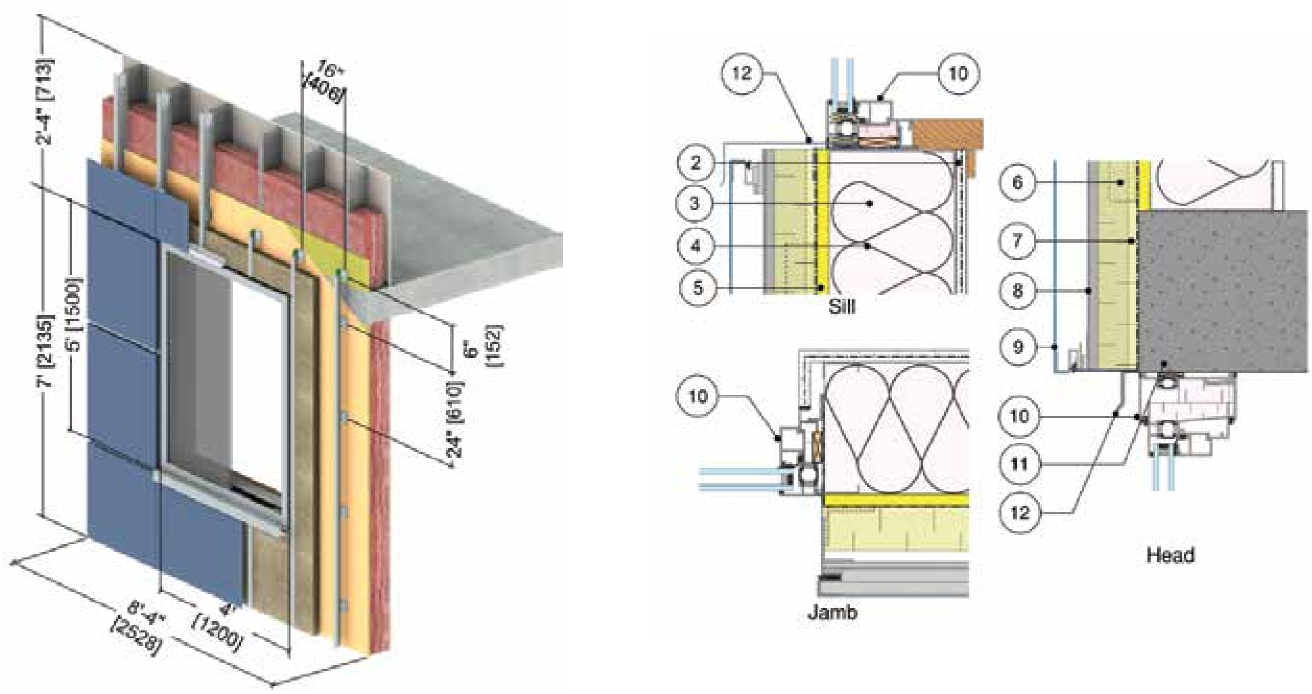


ID	Component	Thickness Inches (mm)	Conductivity Btu·in/ft²·hr·°F (W/m K)	Nominal Resistance hr·ft²·°F/Btu (m²K/W)	Density lb/ft³ (kg/m³)
1	Interior Film[1]	-	-	R-0.6 (0.11 RSI) to R-0.9 (0.16 RSI)	-
2	Gypsum Board	1/2" (13)	1.1 (0.16)	R-0.5 (0.08 RSI)	50 (800)
3	1 5/8" Steel Studs with Metal Tracks	20 gauge	430 (62)	-	489 (7830)
4	Air in Stud Cavity	1 5/8" (41)	-	R-0.9 (0.16 RSI)	0.075 (1.2)
5	Standard Concrete Block	7 5/8" (190)	3.5 (0.5)	-	119 (1900)
6	Cement Mortar	-	3.5 (0.5)	-	113 (1800)
7	Heckmann Pos-I-Tie Masonry Tie @ 16" (406) o.c. as per Detail 7	2, 4" (51, 102)	-	-	-
8	Foamular® CodeBord®/C-200 Extruded Polystyrene (XPS) Rigid Insulation Type 3	2, 4" (51, 102)	0.20 (0.029)	R-10, 20 (1.76, 3.52 RSI)	1.8 (28)
9	Stainless Steel Stand-off Shelf Angle	3/8" (10)	118 (17)	-	503 (8060)
10	Flashing	20 gauge	430 (62)	-	489 (7830)
11	Brick Veneer	3 5/8" (92)	5.4 (0.78)	-	120 (1920)
12	Concrete Slab	8" (203)	12.5 (1.8)	-	140 (2250)
13	Air Gap[2]	1" (25)	-	R-0.9 (0.16 RSI)	0.075 (1.2)
14	Exterior Film[1]	-	-	R-0.2 (0.03 RSI)	-

[1]Value selected from table 1, p. 26.1 of 2009 ASHRAE Handbook – Fundamentals depending on surface orientation
[2]The thermal conductivity of air spaces was found using ISO 100077-2

Detail 13-A

Exterior and Interior Insulated 2" x 6" Steel Stud (16" o.c.) Wall Assembly with Thermally Isolated Vertical Brackets and Rail System (24" o.c.) Supporting Metal Cladding – Window and Intermediate Floor Intersection

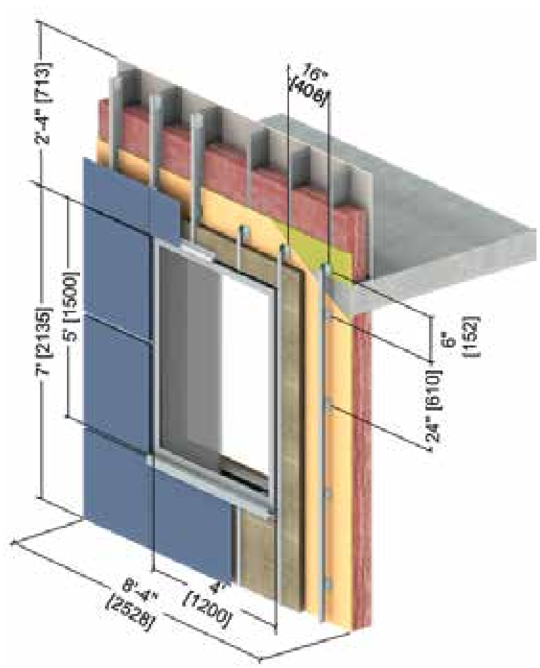


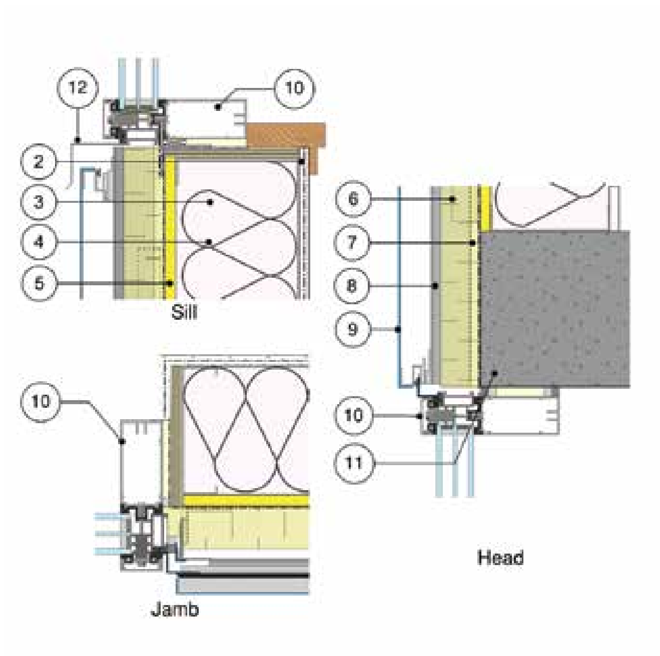
ID	Component	Thickness Inches (mm)	Conductivity Btu·in/ft^2·hr·°F (W/m K)	Nominal Resistance hr·ft^2·°F/Btu (m^2K/W)	Density lb/ft^3 (kg/m^3)
1	Interior Film[1]	-	-	R-0.6 (0.11 RSI) to R-1.1 (0.20 RSI)	-
2	Gypsum Board	1/2" (13)	1.1 (0.16)	R-0.5 (0.08 RSI)	50 (800)
3	2" x 6" Steel Studs with Top and Bottom Tracks	18 Gauge	430 (62)	-	489 (7830)
4	Air or EcoTouch® PINK® Fiberglass Batt in Stud Cavity	6" (152)	-	R-0.9, 20, 22.5 (0.16, 3.52, 3.96 RSI)	-
5	Exterior Sheathing	5/8" (16)	1.1 (0.16)	R-0.6 (0.10 RSI)	50 (800)
6	Thermally Isolated Aluminum Bracket as per Detail 3	2, 5" (51, 127)	-	-	-
7	Thermafiber® RainBarrier™ 45 Mineral Wool Semi Rigid Insulation	2, 5" (51, 127)	0.23 (0.033)	R-8.6, 21.5 (1.51, 3.79 RSI)	4.5 (72)
8	Vertical Aluminum L-girt	0.09" (2.2)	1109 (160)	-	171 (2739)
9	Metal Cladding with 1/2" vented airspace incorporated into exterior heat transfer coefficient				
10	5' (1.5m) x 4' (1.2m) Aluminum window: thermally broken, double glazed IGU[2] U_{IGU} = 0.32 BTU/hr·ft^2·°F (1.82 W/m^2K)				
11	Concrete Slab	8" (203)	12.5 (1.8)	-	140 (2250)
12	Aluminum Flashing	18 gauge	1109 (160)	-	171(2739)
13	Exterior Film[1]	-	-	R-0.2 (0.03 RSI) to R-0.7 (0.12 RSI)	-

[1]Value selected from table 1, p. 26.1 of 2009 ASHRAE Handbook – Fundamentals depending on surface orientation
[2]The thermal conductivity for air spaces within window framing was found using ISO 10077-2.

Detail 13-B

Exterior and Interior Insulated 2" x 6" Steel Stud (16" o.c.) Wall Assembly with Thermally Isolated Vertical Brackets and Rail System (24" o.c.) Supporting Metal Cladding – Window and Intermediate Floor Intersection



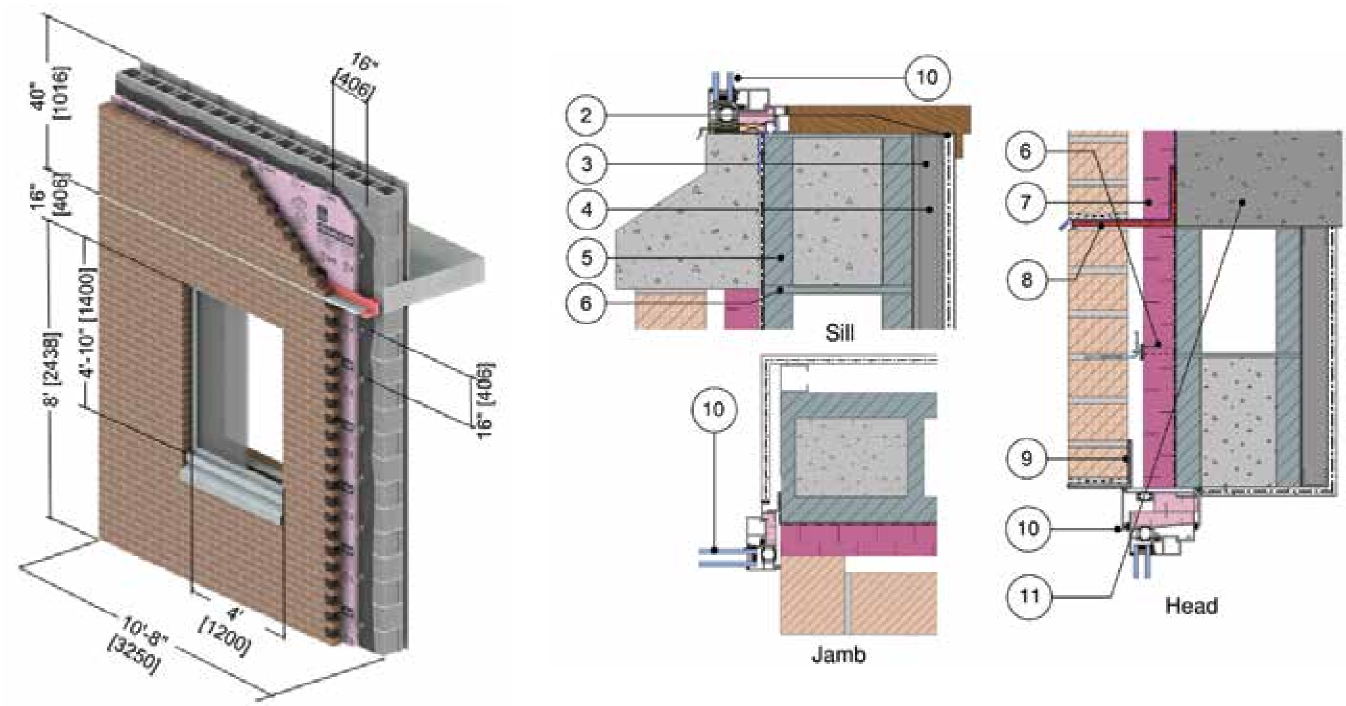


ID	Component	Thickness Inches (mm)	Conductivity Btu·in/ft^2·hr·°F (W/m K)	Nominal Resistance hr·ft^2·°F/Btu (m^{2}K/W)	Density lb/ft^3 (kg/m^3)
1	Interior Film[1]	-	-	R-0.6 (0.11 RSI) to R-1.1 (0.20 RSI)	-
2	Gypsum Board	1/2" (13)	1.1 (0.16)	R-0.5 (0.08 RSI)	50 (800)
3	2" x 6" Steel Studs with Top and Bottom Tracks	18 Gauge	430 (62)	-	489 (7830)
4	Air or EcoTouch® PINK® Fiberglass Batt in Stud Cavity	6" (152)	-	R-0.9, 20, 22.5 (0.16, 3.52, 3.96 RSI)	-
5	Exterior Sheathing	5/8" (16)	1.1 (0.16)	R-0.6 (0.10 RSI)	50 (800)
6	Thermally Isolated Aluminum Bracket as per Detail 3	2, 5" (51, 127)	-	-	-
7	Thermafiber® RainBarrier™ 45 Mineral Wool Semi Rigid Insulation	2, 5" (51, 127)	0.23 (0.033)	R-8.6, 21.5 (1.51, 3.79 RSI)	4.5 (72)
8	Vertical Aluminum L-girt	0.09" (2.2)	1109 (160)	-	171 (2739)
9	Metal Cladding with 1/2" vented airspace incorporated into exterior heat transfer coefficient				
10	5' (1.5m) x 4' (1.2m) Aluminum window: thermally broken, triple glazed IGU[2] U_{IGU} = 0.22 BTU/hr·ft^2·°F (1.25 W/m^{2}K)				
11	Concrete Slab	8" (203)	12.5 (1.8)	-	140 (2250)
12	Aluminum Flashing	18 gauge	1109 (160)	-	171(2739)
13	Exterior Film[1]	-	-	R-0.2 (0.03 RSI) to R-0.7 (0.12 RSI)	-

[1]Value selected from table 1, p. 26.1 of 2009 ASHRAE Handbook – Fundamentals depending on surface orientation
[2]The thermal conductivity for air spaces within window framing was found using ISO 10077-2.

Detail 14-A

Exterior Insulated Concrete Block Wall Assembly with Heckmann Pos-I-Tie Veneer Anchoring System Supporting Brick Veneer – Window and Intermediate Floor Intersection

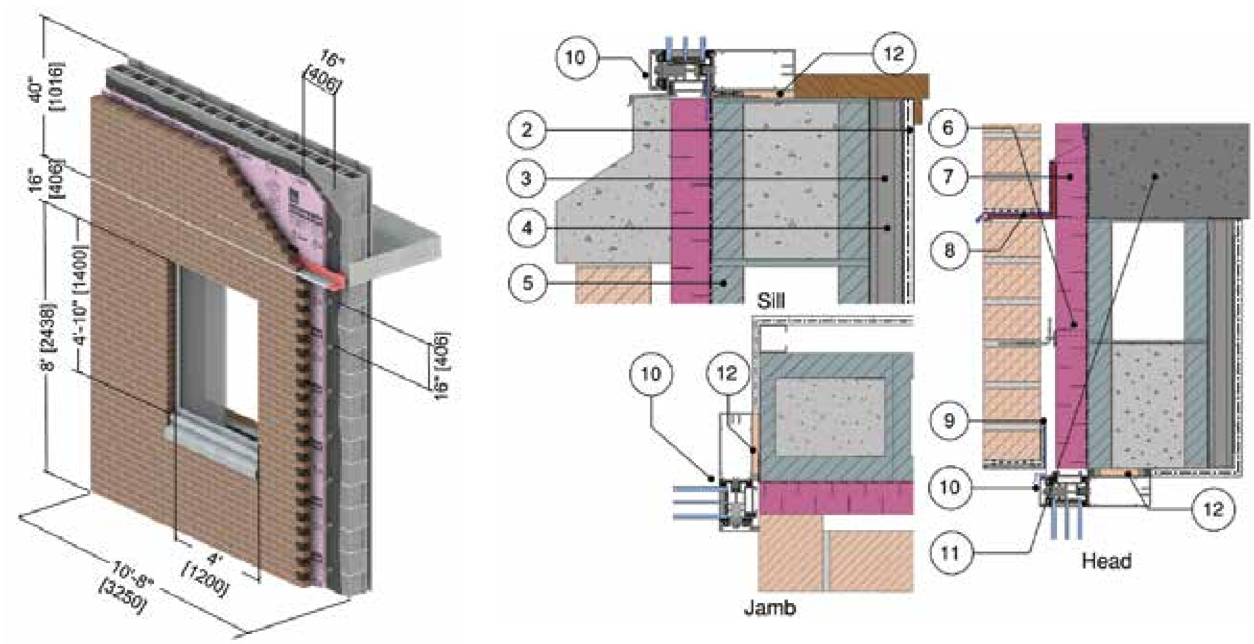


ID	Component	Thickness Inches (mm)	Conductivity Btu·in/ft²·hr·°F (W/m K)	Nominal Resistance hr·ft²·°F/Btu (m²K/W)	Density lb/ft³ (kg/m³)
1	Interior Films[1]	-	-	R-0.6 (0.11 RSI) to R-1.1 (0.20 RSI)	-
2	Gypsum Board	1/2" (13)	1.1 (0.16)	R-0.5 (0.08 RSI)	50 (800)
3	1 5/8" x 1 5/8" Steel Studs (16"o.c.) with Top and Bottom Tracks	18 Gauge	430 (62)	-	489 (7830)
4	Air in Stud Cavity	1 5/8" (41)	-	R-0.9 (0.16 RSI)	0.075 (1.2)
5	Standard Concrete Block	7 5/8" (190)	3.5 (0.5)	-	119 (1900)
6	Cement Mortar	-	3.5 (0.5)	-	119 (1900)
6	Heckmann Pos-I-Tie Masonry Tie @ 16" (406) o.c. as per Detail 7	2, 4" (51, 102)	-	-	-
7	Foamular® CodeBord®/C-200 Extruded Polystyrene (XPS) Rigid Insulation Type 3	2, 4" (51, 102)	0.20 (0.029)	R-10, 20 (1.76, 3.52 RSI)	1.8 (28)
8	Steel Shelf Angle	3/8" (10)	347 (50)	-	489 (7830)
9	Steel Lintel	1/4" (6)	347 (50)	-	489 (7830)
10	4'8 (1.4m) x 4' (1.2m) Aluminum window: thermally broken, double glazed IGU[2] U_{IGU} = 0.32 BTU/hr·ft²·°F (1.82 W/m²K)				
11	Concrete Slab	8" (203)	12 (1.8)	-	140 (2250)
12	Exterior Film[1]	-	-	R-0.2 (0.03 RSI)	-

[1]Value selected from table 1, p. 26.1 of 2009 ASHRAE Handbook – Fundamentals depending on surface orientation
[2]The thermal conductivity of air spaces within framing was found using ISO 100077-2

Detail 14-B

Exterior Insulated Concrete Block Wall Assembly with Heckmann Pos-I-Tie Veneer Anchoring System Supporting Brick Veneer – Window and Intermediate Floor Intersection

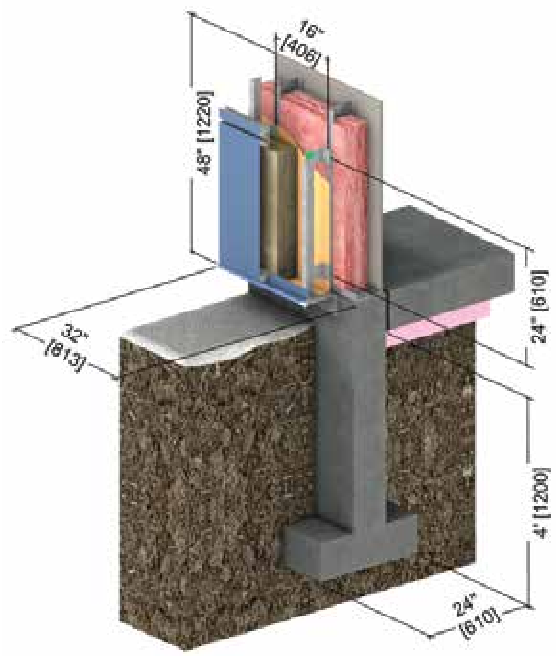


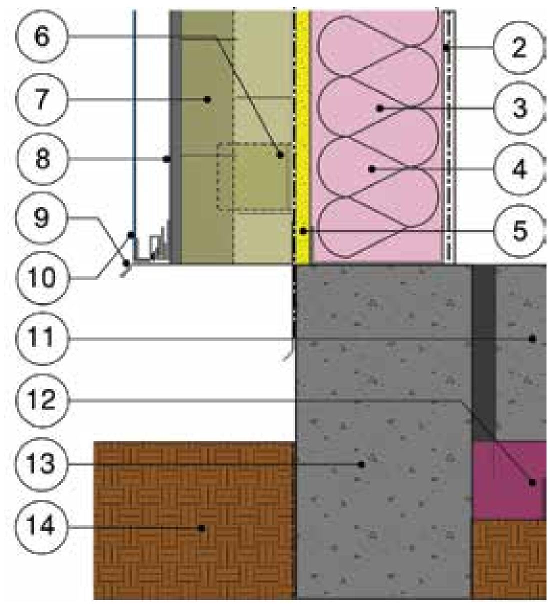
ID	Component	Thickness Inches (mm)	Conductivity $Btu{\cdot}in/ft^2{\cdot}hr{\cdot}{}^{\circ}F$ (W/m K)	Nominal Resistance $hr{\cdot}ft^2{\cdot}{}^{\circ}F/Btu$ (m^2K/W)	Density lb/ft^3 (kg/m^3)
1	Interior Films[1]	-	-	R-0.6 (0.11 RSI) to R-0.9 (0.16 RSI)	-
2	Gypsum Board	1/2" (13)	1.1 (0.16)	R-0.5 (0.08 RSI)	50 (800)
3	1 5/8" x 1 5/8" Steel Studs (16"o.c.) with Top and Bottom Tracks	18 Gauge	430 (62)	-	489 (7830)
4	Air in Stud Cavity	1 5/8" (41)	-	R-0.9 (0.16 RSI)	0.075 (1.2)
5	Standard Concrete Block	7 5/8" (190)	3.5 (0.5)	-	119 (1900)
6	Heckmann Pos-I-Tie Masonry Tie @ 16" (406) o.c. as per Detail 7	2, 4" (51, 102)	-	-	-
7	Foamular® CodeBord®/C-200 Extruded Polystyrene (XPS) Rigid Insulation Type 3	2, 4" (51, 102)	0.20 (0.029)	R-10, 20 (1.76, 3.52 RSI)	1.8 (28)
8	Stainless Steel Stand-off Shelf Angle	3/8" (10)	118 (17)	-	503 (8060)
9	Steel Lintel	1/4" (6)	347 (50)	-	489 (7830)
10	4'8 (1.5m) x 4' (1.2m) Aluminum window: thermally broken, triple glazed IGU[2] U_{IGU} = 0.22 $BTU/hr{\cdot}ft^2{\cdot}{}^{\circ}F$ (1.25 W/m^2K)				
11	Concrete Slab	8" (203)	12 (1.8)	-	140 (2250)
12	Spray Foam Insulation	3/8" (10)	0.17 (0.024)	-	2.8 (39)
13	Exterior Film[1]	-	-	R-0.2 (0.03 RSI)	-

[1]Value selected from table 1, p. 26.1 of 2009 ASHRAE Handbook – Fundamentals depending on surface orientation
[2]The thermal conductivity of air spaces within framing was found using ISO 100077-2

Detail 15-A

Exterior and Interior Insulated 2" x 6" Steel Stud (16" o.c.) Wall Assembly with Thermally Isolated Vertical Brackets and Rail System (24" o.c.) Supporting Metal Cladding – Slab and Foundation Intersection



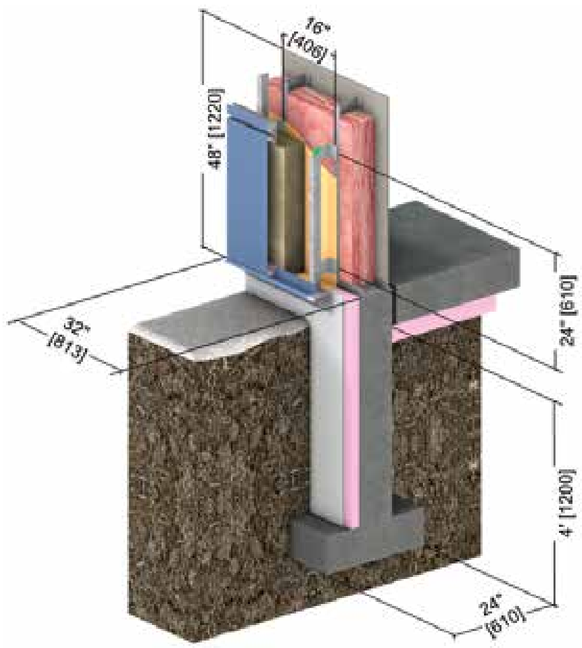


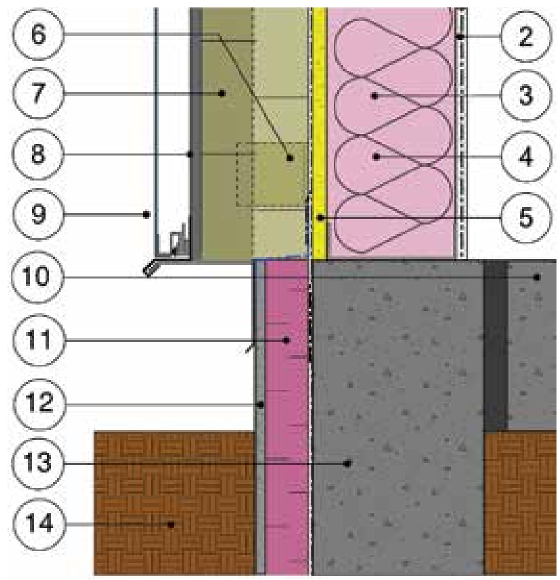
ID	Component	Thickness Inches (mm)	Conductivity Btu·in/ft²·hr·°F (W/m K)	Nominal Resistance hr·ft²·°F/Btu (m²K/W)	Density lb/ft³ (kg/m³)
1	Interior Film[1]	-	-	R-0.7 (0.12 RSI) to R-0.9 (0.16 RSI)	-
2	Gypsum Board	1/2" (13)	1.1 (0.16)	R-0.5 (0.08 RSI)	50 (800)
3	2" x 6" Steel Studs with Bottom Track	18 Gauge	430 (62)	-	489 (7830)
4	Air or EcoTouch® PINK® Fiberglass Batt in Stud Cavity	6" (152)	-	R-0.9, 20, 22.5, 24 (0.16, 3.52, 3.96, 4.23 RSI)	-
5	Exterior Sheathing	5/8" (16)	1.1 (0.16)	R-0.6 (0.10 RSI)	50 (800)
6	Thermally Isolated Aluminum Bracket as per Detail 3	2, 5" (51, 127)	-	-	-
7	Thermafiber® RainBarrier™ 45 Mineral Wool Semi Rigid Insulation	2, 5" (51, 127)	0.23 (0.033)	R-8.6, 21.5 (1.51, 3.79 RSI)	4.5 (72)
8	Vertical Aluminum L-girt	0.09" (2.2)	1109 (160)	-	171 (2739)
9	Flashing	20 gauge	430 (62)	-	489 (7830)
10	Cladding with 1/2" (13mm) vented airspace incorporated into exterior heat transfer coefficient				
11	Concrete Slab on Grade	8" (203)	12.5 (1.8)	-	140 (2250)
12	Foamular® XPS Insulation	3 1/2" (89)	0.20 (0.029)	R-17.5 (3.08 RSI)	1.8 (28)
13	Concrete Footing	24" (610)	12.5 (1.8)	-	140 (2250)
14	Soil	-	15.6 (2.25)	-	-
15	Exterior Film[1]	-	-	R-0.2 (0.03 RSI)	-

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

Detail 15-B

Exterior and Interior Insulated 2" x 6" Steel Stud (16" o.c.) Wall Assembly with Thermally Isolated Vertical Brackets and Rail System (24" o.c.) Supporting Metal Cladding – Slab and Foundation Intersection



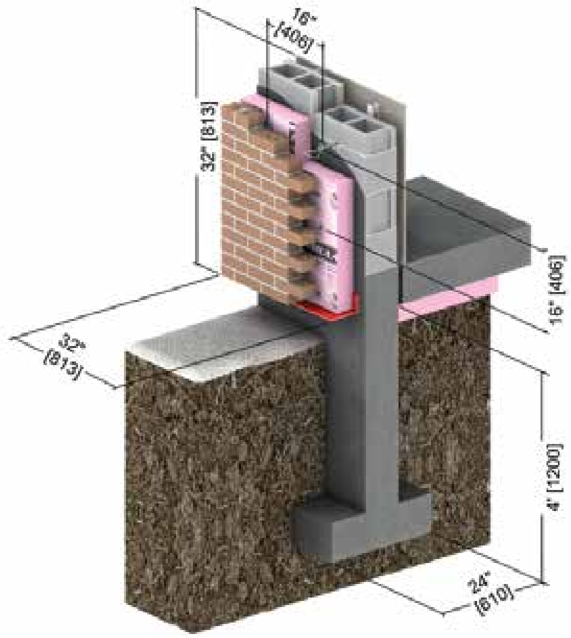


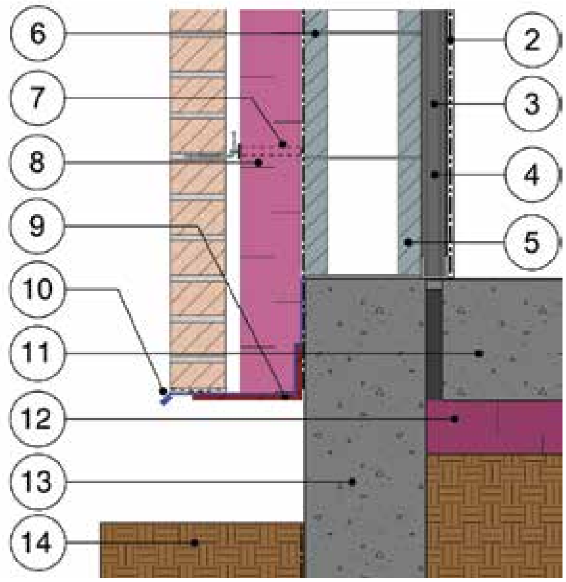
ID	Component	Thickness Inches (mm)	Conductivity Btu·in/ft²·hr·°F (W/m K)	Nominal Resistance hr·ft²·°F/Btu (m²K/W)	Density lb/ft³ (kg/m³)
1	Interior Film[1]	-	-	R-0.7 (0.12 RSI) to R-0.9 (0.16 RSI)	-
2	Gypsum Board	1/2" (13)	1.1 (0.16)	R-0.5 (0.08 RSI)	50 (800)
3	2" x 6" Steel Studs with Bottom Track	18 Gauge	430 (62)	-	489 (7830)
4	Air or EcoTouch® PINK® Fiberglass Batt in Stud Cavity	6" (152)	-	R-0.9, 20, 22.5, 24 (0.16, 3.52, 3.96, 4.23 RSI)	-
5	Exterior Sheathing	5/8" (16)	1.1 (0.16)	R-0.6 (0.10 RSI)	50 (800)
6	Thermally Isolated Aluminum Bracket as per Detail 3	2, 5" (51, 127)	-	-	-
7	Thermafiber® RainBarrier™ 45 Mineral Wool Semi Rigid Insulation	2, 5" (51, 127)	0.23 (0.033)	R-8.6, 21.5 (1.51, 3.79 RSI)	4.5 (72)
8	Vertical Aluminum L-girt	0.09" (2.2)	1109 (160)	-	171 (2739)
9	Cladding with 1/2" (13mm) vented airspace incorporated into exterior heat transfer coefficient				
10	Concrete Slab on Grade	8" (203)	12.5 (1.8)	-	140 (2250)
11	Foamular® XPS Insulation	2" (51)	0.20 (0.029)	R-10 (1.76 RSI)	1.8 (28)
12	Protection Board	1/2" (13)	12.5 (1.8)	-	140 (2250)
13	Concrete Footing	24" (610)	12.5 (1.8)	-	140 (2250)
14	Soil	-	15.6 (2.25)	-	-
15	Exterior Film[1]	-	-	R-0.2 (0.03 RSI)	-

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

Detail 16-A

Exterior Insulated Concrete Block Wall Assembly with Steel Shelf Angle and Heckmann Pos-I-Tie Veneer Anchoring System Supporting Brick Veneer – Slab and Foundation Intersection



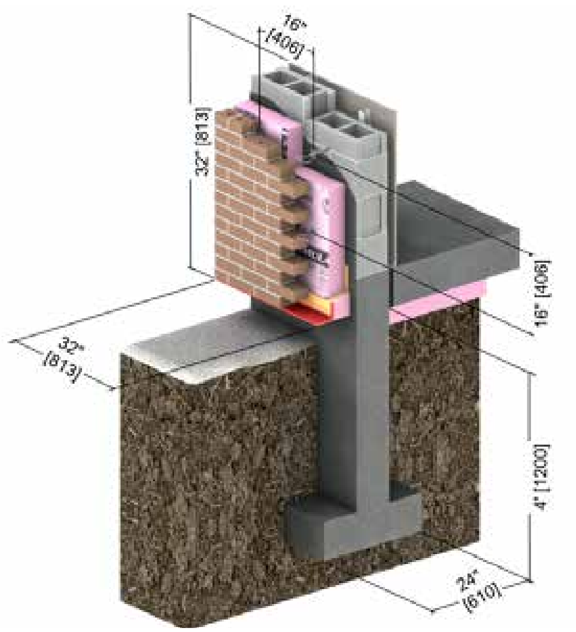


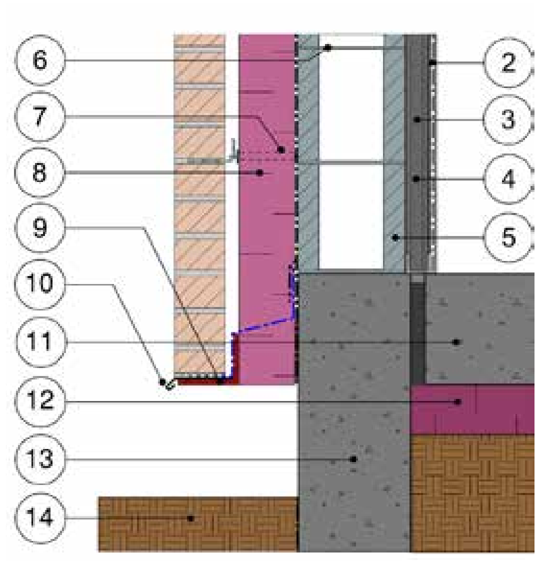
ID	Component	Thickness Inches (mm)	Conductivity Btu·in/ft²·hr·°F (W/m K)	Nominal Resistance hr·ft²·°F/Btu (m²K/W)	Density lb/ft³ (kg/m³)
1	Interior Film[1]	-	-	R-0.7 (0.12 RSI) to R-0.9 (0.16 RSI)	-
2	Gypsum Board	1/2" (13)	1.1 (0.16)	R-0.5 (0.08 RSI)	50 (800)
3	1 5/8" Steel Studs with Bottom Track	20 gauge	430 (62)	-	489 (7830)
4	Air in Stud Cavity	1 5/8" (41)	-	R-0.9 (0.16 RSI)	0.075 (1.2)
5	Standard Concrete Block	7 5/8" (190)	3.5 (0.5)	-	119 (1900)
6	Cement Mortar	-	3.5 (0.5)	-	113 (1800)
7	Heckmann Pos-I-Tie Masonry Tie @ 16" (406) o.c. as per Detail 7	2, 4" (51, 102)	-	-	-
8	Foamular® CodeBord®/C-200 Extruded Polystyrene (XPS) Rigid Insulation Type 3	2, 4" (51, 102)	0.20 (0.029)	R-10, 20 (1.76, 3.52 RSI)	1.8 (28)
9	Steel Shelf Angle	3/8" (10)	347 (50)	-	489 (7830)
10	Metal Flashing	20 gauge	430 (62)	-	489 (7830)
11	Concrete Slab on Grade	8" (203)	12.5 (1.8)	-	140 (2250)
12	Foamular® XPS Insulation	3 1/2" (89)	0.20 (0.029)	R-17.5 (3.08 RSI)	1.8 (28)
13	Concrete Footing	24" (610)	12.5 (1.8)	-	140 (2250)
14	Soil	-	15.6 (2.25)	-	-
15	Exterior Film[1]	-	-	R-0.2 (0.03 RSI)	-

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

Detail 16-B

Exterior Insulated Concrete Block Wall Assembly with Stainless Steel Stand-off Shelf Angle and Heckmann Pos-I-Tie Veneer Anchoring System Supporting Brick Veneer – Slab and Foundation Intersection



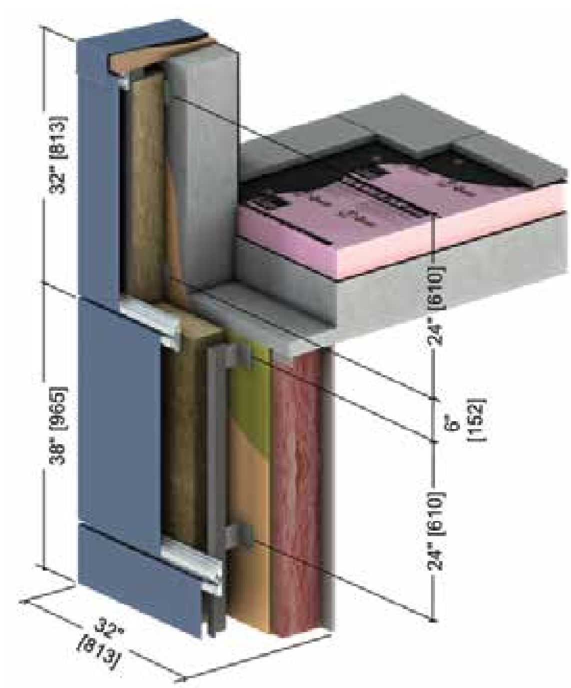


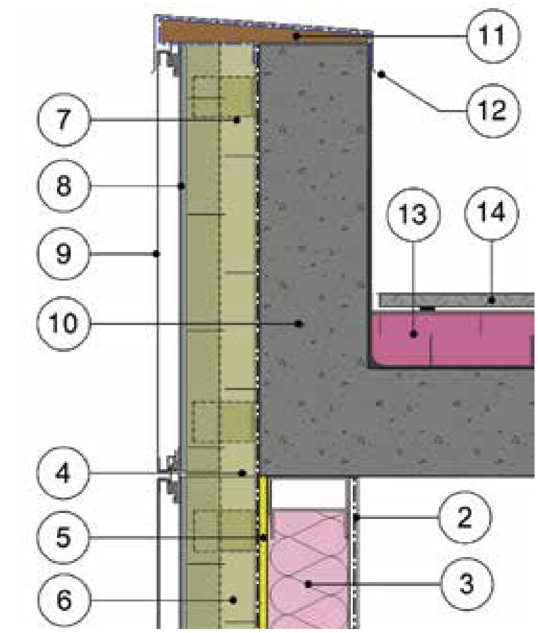
ID	Component	Thickness Inches (mm)	Conductivity Btu·in/ft^2·hr·°F (W/m K)	Nominal Resistance hr·ft^2·°F/Btu (m^{2}K/W)	Density lb/ft^3 (kg/m^3)
1	Interior Film[1]	-	-	R-0.7 (0.12 RSI) to R-0.9 (0.16 RSI)	-
2	Gypsum Board	1/2" (13)	1.1 (0.16)	R-0.5 (0.08 RSI)	50 (800)
3	1 5/8" Steel Studs with Bottom Track	20 gauge	430 (62)	-	489 (7830)
4	Air in Stud Cavity	1 5/8" (41)	-	R-0.9 (0.16 RSI)	0.075 (1.2)
5	Standard Concrete Block	7 5/8" (190)	3.5 (0.5)	-	119 (1900)
6	Cement Mortar	-	3.5 (0.5)	-	113 (1800)
7	Heckmann Pos-I-Tie Masonry Tie @ 16" (406) o.c. as per Detail 7	2, 4" (51, 102)	-	-	-
8	Foamular® CodeBord®/C-200 Extruded Polystyrene (XPS) Rigid Insulation Type 3	2, 4" (51, 102)	0.20 (0.029)	R-10, 20 (1.76, 3.52 RSI)	1.8 (28)
9	Stainless Steel Stand-off Shelf Angle	3/8" (10)	118 (17)	-	503 (8060)
10	Metal Flashing	20 gauge	430 (62)	-	489 (7830)
11	Concrete Slab on Grade	8" (203)	12.5 (1.8)	-	140 (2250)
12	Foamular® XPS Insulation	3 1/2" (89)	0.20 (0.029)	R-17.5 (3.08 RSI)	1.8 (28)
13	Concrete Footing	24" (610)	12.5 (1.8)	-	140 (2250)
14	Soil	-	15.6 (2.25)	-	-
15	Exterior Film[1]	-	-	R-0.2 (0.03 RSI)	-

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

Detail 17-A

Exterior and Interior Insulated 2" x 6" Steel Stud (16" o.c.) Wall Assembly with Thermally Isolated Vertical Brackets and Rail System (24" o.c.) Supporting Metal Cladding – Parapet and Roof Intersection



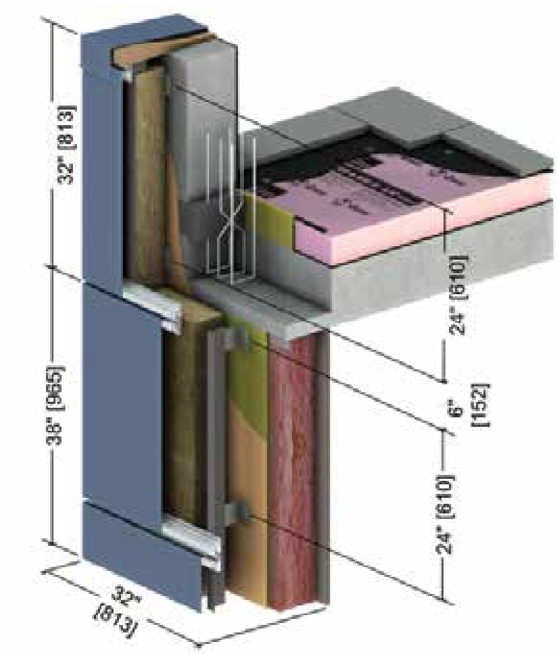


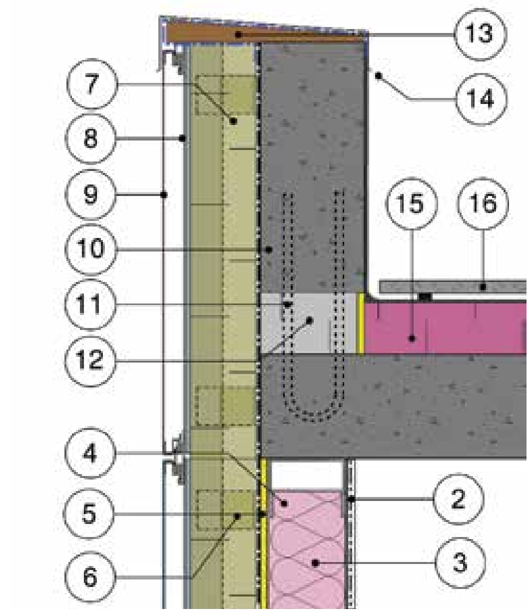
ID	Component	Thickness Inches (mm)	Conductivity Btu·in/ft^2·hr·°F (W/m K)	Nominal Resistance hr·ft^2·°F/Btu (m^2K/W)	Density lb/ft^3 (kg/m^3)
1	Interior Film[1]	-	-	R-0.6 (0.11 RSI) to R-0.7 (0.12 RSI)	-
2	Gypsum Board	1/2" (13)	1.1 (0.16)	R-0.5 (0.08 RSI)	50 (800)
3	2" x 6" Steel Studs with Top Track	18 Gauge	430 (62)	-	489 (7830)
4	Air or EcoTouch® PINK® Fiberglass Batt in Stud Cavity	6" (152)	-	R-0.9, 20, 22.5, 24 (0.16, 3.52, 3.96, 4.23 RSI)	-
5	Exterior Sheathing	5/8" (16)	1.1 (0.16)	R-0.6 (0.10 RSI)	50 (800)
6	Thermally Isolated Aluminum Bracket as per Detail 3	2, 5" (51, 127)	-	-	-
7	Thermafiber® RainBarrier™ 45 Mineral Wool Semi Rigid Insulation	2, 5" (51, 127)	0.23 (0.033)	R-8.6, 21.5 (1.51, 3.79 RSI)	4.5 (72)
8	Vertical Aluminum L-girt	0.09" (2.2)	1109 (160)	-	171 (2739)
9	Metal Cladding with 1/2" vented airspace incorporated into exterior heat transfer coefficient				
10	Concrete Slab and Parapet	8" (203)	12.5 (1.8)	-	140 (2250)
11	Wood Blocking	5/8" (16)	0.69 (0.10)	R-1.0 (0.18 RSI)	31 (500)
12	Cap Flashing	18 Gauge	430 (62)	-	489 (7830)
13	Foamular® XPS Rigid Insulation	4" (102)	0.20 (0.029)	R-20 (3.52 RSI)	1.8 (28)
14	Flashing & roof finish material are incorporated into exterior heat transfer coefficient				
15	Exterior Film[1]	-	-	R-0.2 (0.03 RSI) to 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 17-B

Exterior and Interior Insulated 2" x 6" Steel Stud (16" o.c.) Wall Assembly with Thermally Isolated Vertical Brackets and Rail System (24" o.c.) Supporting Metal Cladding – Parapet and Roof Intersection



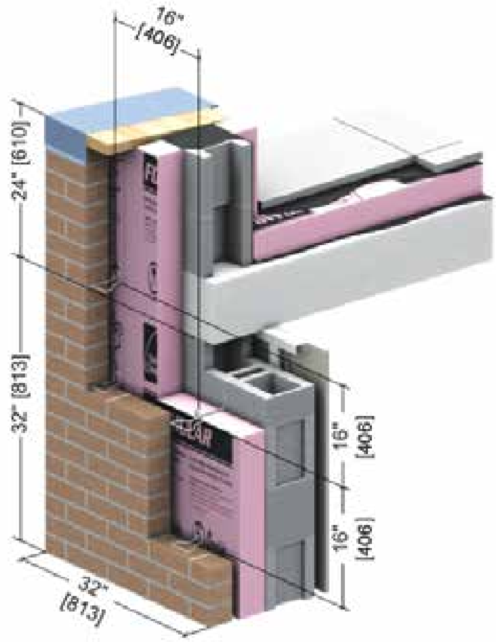


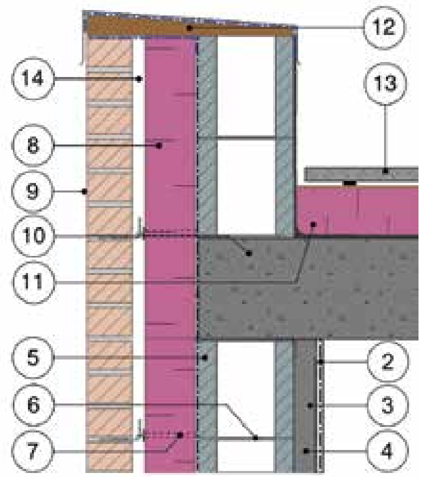
ID	Component	Thickness Inches (mm)	Conductivity Btu·in/ft^2·hr·°F (W/m K)	Nominal Resistance hr·ft^2·°F/Btu (m^2K/W)	Density lb/ft^3 (kg/m^3)
1	Interior Film[1]	-	-	R-0.6 (0.11 RSI) to R-0.7 (0.12 RSI)	-
2	Gypsum Board	1/2" (13)	1.1 (0.16)	R-0.5 (0.08 RSI)	50 (800)
3	2" x 6" Steel Studs with Top Track	18 Gauge	430 (62)	-	489 (7830)
4	Air or EcoTouch® PINK® Fiberglass Batt in Stud Cavity	6" (152)	-	R-0.9, 20, 22.5, 24 (0.16, 3.52, 3.96, 4.23 RSI)	-
5	Exterior Sheathing	5/8" (16)	1.1 (0.16)	R-0.6 (0.10 RSI)	50 (800)
6	Thermally Isolated Aluminum Bracket as per Detail 3	2, 5" (51, 127)	-	-	-
7	Thermafiber® RainBarrier™ 45 Mineral Wool Semi Rigid Insulation	2, 5" (51, 127)	0.23 (0.033)	R-8.6, 21.5 (1.51, 3.79 RSI)	4.5 (72)
8	Vertical Aluminum L-girt	0.09" (2.2)	1109 (160)	-	171 (2739)
9	Metal Cladding with 1/2" vented airspace incorporated into exterior heat transfer coefficient				
10	Concrete Slab and Parapet	8" (203)	12.5 (1.8)	-	140 (2250)
11	Stainless Steel Rebar	-	118 (17)	-	500 (8000)
12	Polystyrene Rigid Foam Insulation	4 3/4" (120)	0.217 (0.031)	R-22.0 (3.87 RSI)	66 (1060)
13	Wood Blocking	5/8" (16)	0.69 (0.10)	R-1.0 (0.18 RSI)	31 (500)
14	Steel Cap Flashing	18 Gauge	430 (62)	-	489 (7830)
15	Foamular® XPS Rigid Roof Insulation	4" (102)	0.20 (0.029)	R-20 (3.52 RSI)	1.8 (28)
16	Flashing & roof finish material are incorporated into exterior heat transfer coefficient				
17	Exterior Film[1]	-	-	R-0.2 (0.03 RSI) to 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 18-A

Exterior Insulated Concrete Block Wall Assembly with Heckmann Pos-I-Tie Veneer Anchoring System Supporting Brick Veneer – Parapet & Roof Intersection, Scenario A with Uninsulated Parapet



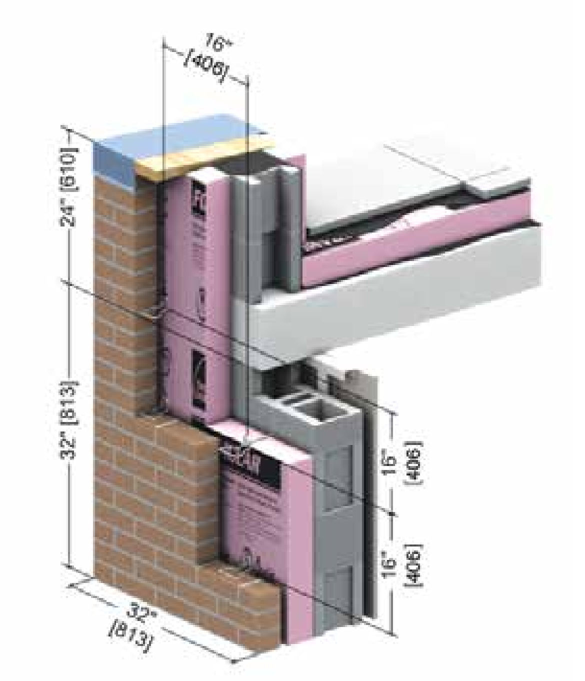


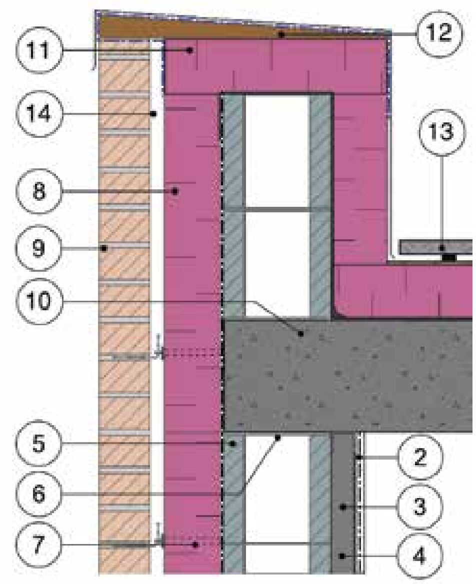
ID	Component	Thickness Inches (mm)	Conductivity Btu·in/ft²·hr·°F (W/m K)	Nominal Resistance hr·ft²·°F/Btu (m²K/W)	Density lb/ft³ (kg/m³)
1	Interior Film[1]	-	-	R-0.6 (0.11 RSI) to R-0.7 (0.12 RSI)	-
2	Gypsum Board	1/2" (13)	1.1 (0.16)	R-0.5 (0.08 RSI)	50 (800)
3	1 5/8" Steel Studs with Top Track	20 gauge	430 (62)	-	489 (7830)
4	Air in Stud Cavity	1 5/8" (41)	-	R-0.9 (0.16 RSI)	0.075 (1.2)
5	Standard Concrete Block	7 5/8" (190)	3.5 (0.5)	-	119 (1900)
6	Cement Mortar	-	3.5 (0.5)	-	113 (1800)
7	Heckmann Pos-I-Tie Masonry Tie @ 16" (406) o.c. as per Detail 7	2, 4" (51, 102)	-	-	-
8	Foamular® CodeBord®/C-200 Extruded Polystyrene (XPS) Rigid Insulation Type 3	2, 4" (51, 102)	0.20 (0.029)	R-10, 20 (1.76, 3.52 RSI)	1.8 (28)
9	Brick Veneer	3 5/8" (92)	5.4 (0.78)	-	120 (1920)
10	Concrete Slab	8" (203)	12.5 (1.8)	-	140 (2250)
11	Foamular® XPS Continuous Rigid Insulation	4" (102)	0.20 (0.029)	R-20 (3.52 RSI)	1.8 (28)
12	Wood Blocking	5/8" (16)	0.63 (0.09)	-	27.8 (445)
13	Flashing & roof finish materials are incorporated into exterior heat transfer coefficient				
14	Air Gap	1" (25)	-	R-0.9 (0.16 RSI)	0.075 (1.2)
15	Exterior Film[1]	-	-	R-0.2 (0.03 RSI)	-

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

Detail 18-B

Exterior Insulated Concrete Block Wall Assembly with Heckmann Pos-I-Tie Veneer Anchoring System Supporting Brick Veneer – Parapet & Roof Intersection, Scenario B with Insulation Wrapped Around Parapet





ID	Component	Thickness Inches (mm)	Conductivity Btu·in/ft^2·hr·°F (W/m K)	Nominal Resistance hr·ft^2·°F/Btu (m^2K/W)	Density lb/ft^3 (kg/m^3)
1	Interior Film[1]	-	-	R-0.6 (0.11 RSI) to R-0.7 (0.12 RSI)	-
2	Gypsum Board	1/2" (13)	1.1 (0.16)	R-0.5 (0.08 RSI)	50 (800)
3	1 5/8" Steel Studs with Top Track	20 gauge	430 (62)	-	489 (7830)
4	Air in Stud Cavity	1 5/8" (41)	-	R-0.9 (0.16 RSI)	0.075 (1.2)
5	Standard Concrete Block	7 5/8" (190)	3.5 (0.5)	-	119 (1900)
6	Cement Mortar	-	3.5 (0.5)	-	113 (1800)
7	Heckmann Pos-I-Tie Masonry Tie @ 16" (406) o.c. as per Detail 7	2, 4" (51, 102)	-	-	-
8	Foamular® CodeBord®/C-200 Extruded Polystyrene (XPS) Rigid Insulation Type 3	2, 4" (51, 102)	0.20 (0.029)	R-10, 20 (1.76, 3.52 RSI)	1.8 (28)
9	Brick Veneer	3 5/8" (92)	5.4 (0.78)	-	120 (1920)
10	Concrete Slab	8" (203)	12.5 (1.8)	-	140 (2250)
11	Foamular® XPS Continuous Rigid Insulation	4" (102)	0.20 (0.029)	R-20 (3.52 RSI)	1.8 (28)
12	Wood Blocking	5/8" (16)	0.63 (0.09)	-	27.8 (445)
13	Flashing & roof finish materials are incorporated into exterior heat transfer coefficient				
14	Air Gap	1" (25)	-	R-0.9 (0.16 RSI)	0.075 (1.2)
15	Exterior Film[1]	-	-	R-0.2 (0.03 RSI)	-

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

APPENDIX B – CATALOGUE THERMAL DATA SHEETS

Detail 1 82

Conventional Curtain Wall System with Vertical and Horizontal Pressure Plates and 5' x 5' Spandrel Section – Thermafiber® Impasse System and Intermediate Floor Intersection

Detail 2 83

Exterior and Interior Insulated 2" x 6" Steel Stud (16" o.c.) Wall Assembly with Galvanized Horizontal Intermittent Clips (24" o.c.) Supporting Metal Cladding – Clear Wall

Detail 3 84

Exterior and Interior Insulated 2" x 6" Steel Stud (16" o.c.) Wall Assembly with Thermally Isolated Vertical Brackets and Rail System (24" o.c.) Supporting Metal Cladding – Clear Wall

Detail 4 85

Exterior Insulated 2" x 6" Steel Stud (16" o.c.) Wall Assembly with Heckmann Pos-I-Tie Veneer Anchoring System Supporting Brick Veneer – Clear Wall

Detail 5 86

Exterior Insulated 2" x 6" Steel Stud (16" o.c.) Wall Assembly with Heckmann Pos-I-Tie Veneer Anchoring System Supporting Brick Veneer – Clear Wall

Detail 6 87

Exterior Insulated Concrete Block Wall Assembly with Thermally Isolated Vertical Brackets and Rail System Supporting Metal Cladding – Clear Wall

Detail 7 88

Exterior Insulated Concrete Block Wall Assembly with Heckmann Pos-I-Tie Veneer Anchoring System Supporting Brick Veneer – Clear Wall

Detail 8 89

Exterior and Interior Insulated 2" x 6" Wood Stud (16" o.c. and 24" o.c.) Wall Assembly with Heckmann Pos-I-Tie Veneer Anchoring System Supporting Brick Veneer – Clear Wall

Detail 9 90

Exterior Insulated Low Sloped Roof – Clear Roof Assembly

Detail 10 91

Inverted Roof on Concrete Deck – Floating Concrete Wall Intersection

Detail 11 92

Exterior Insulated 2" x 6" Steel Stud (16" o.c.) Wall Assembly with Thermally Isolated Vertical Brackets and Rail System (24" o.c.) Supporting Metal Cladding – Intermediate Floor Intersection

Detail 12 .... **93**

Exterior Insulated Concrete Block Wall Assembly with Shelf Angle and Heckmann Pos-I-Tie Veneer Anchoring System Supporting Brick Veneer – Intermediate Floor Intersection

Detail 13 .... **94**

Exterior and Interior Insulated 2" x 6" Steel Stud (16" o.c.) Wall Assembly with Thermally Isolated Vertical Brackets and Rail System (24" o.c.) Supporting Metal Cladding – Window and Intermediate Floor Intersection

Detail 14 .... **95**

Exterior Insulated Concrete Block Wall Assembly with Heckmann Pos-I-Tie Veneer Anchoring System Supporting Brick Veneer – Window and Intermediate Floor Intersection

Detail 15 .... **96**

Exterior and Interior Insulated 2" x 6" Steel Stud (16" o.c.) Wall Assembly with Thermally Isolated Vertical Brackets and Rail System (24" o.c.) Supporting Metal Cladding – Slab and Foundation Intersection

Detail 16 .... **97**

Exterior Insulated Concrete Block Wall Assembly with Stainless Steel Stand-off Shelf Angle and Heckmann Pos-I-Tie Veneer Anchoring System Supporting Brick Veneer – Slab and Foundation Intersection

Detail 17 .... **98**

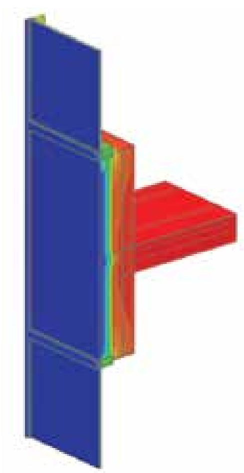
Exterior and Interior Insulated 2" x 6" Steel Stud (16" o.c.) Wall Assembly with Thermally Isolated Vertical Brackets and Rail System (24" o.c.) Supporting Metal Cladding – Parapet and Roof Intersection

Detail 18 .... **99**

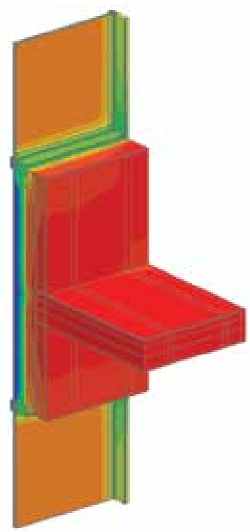
Exterior Insulated Concrete Block Wall Assembly with Stainless Steel Stand-off Shelf Angle and Heckmann Pos-I-Tie Veneer Anchoring System Supporting Brick Veneer – Parapet & Roof Intersection

Detail 1

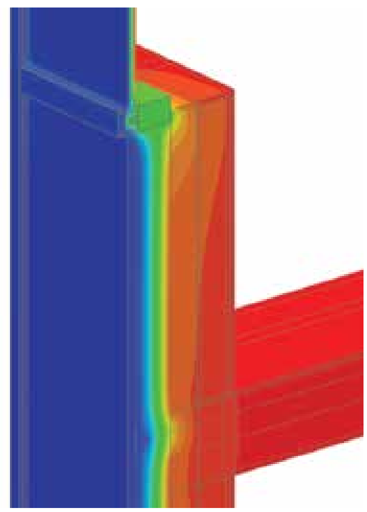
Conventional Curtain Wall System with Vertical and Horizontal Pressure Plates and 5' x 5' Spandrel Section – Thermafiber® Impasse System and Intermediate Floor Intersection



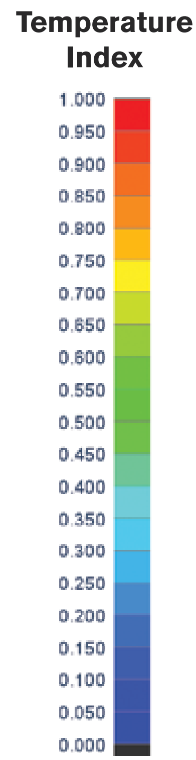
Thermal Profile from Exterior



Thermal Profile from Interior



Thermal Profile Closeup at Mullion



(4" spandrel insulation shown)

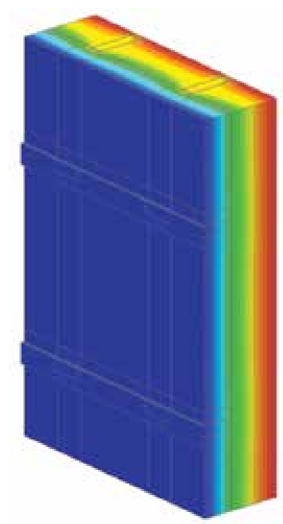
Performance Indicators

Spandrel Insulation Thickness Inches (mm)	Spandrel Insulation Nominal R-value hr·ft²·°F/Btu (m²K/W)	Vision Assembly		Opaque Assembly		Total Assembly[1]	
		R-value hr·ft²·°F/Btu (m²K/W)	U-value Btu/hr·ft²·°F (W/m²K)	R-value hr·ft²·°F/Btu (m²K/W)	U-value Btu/hr·ft²·°F (W/m²K)	R-value hr·ft²·°F/Btu (m²K/W)	U-value Btu/hr·ft²·°F (W/m²K)
2" (50.8)	R-8.6 (1.51)	R-2.2 (0.39)	0.455 (2.582)	R-5.3 (0.94)	0.187 (1.062)	R-3.1 (0.55)	0.321 (1.822)
4" (101.6)	R-17.2 (3.03)			R-7.8 (1.38)	0.128 (0.725)	R-3.4 (0.60)	0.291 (1.656)

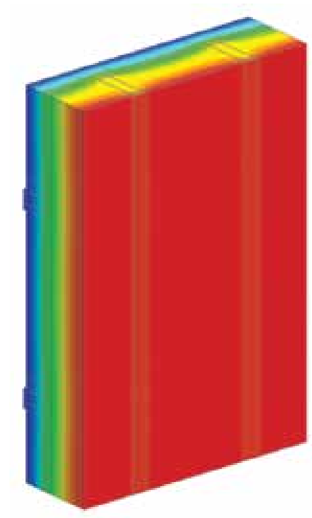
[1]Based on a window to wall ratio of 50%

Detail 2

Exterior and Interior Insulated 2" x 6" Steel Stud (16" o.c.) Wall Assembly with Galvanized Horizontal Intermittent Clips (24" o.c.) Supporting Metal Cladding – Clear Wall

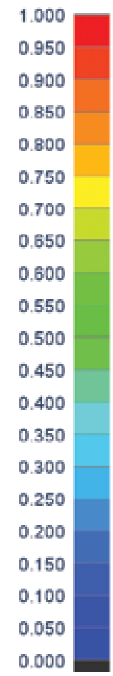


Thermal Profile from Exterior



Thermal Profile from Interior

Temperature Index



(3" Exterior Insulation and R-20 Batt Insulation scenario shown)

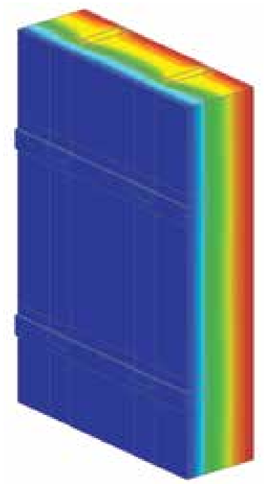
Performance Indicators

Scenario	Exterior Insulation Thickness Inches (mm)	Exterior Insulation Nominal R-value hr·ft²·°F/Btu (m²K/W)	Assembly		Highest Applicable Climate Zone per NECB 2015[1]
			R-value hr·ft²·°F/Btu (m²K/W)	U-value Btu/hr·ft²·°F (W/m²K)	
R-20 (3.52 RSI) Batt Insulation in Stud Cavity	1.5" (38.1) 2" (50.8) 3" (76.2) 4" (101.6) 5" (127.0)	R-6.5 (1.14) R-8.6 (1.51) R-12.9 (2.27) R-17.2 (3.03) R-21.5 (3.79)	R-17.2 (3.03) R-18.8 (3.31) R-21.8 (3.83) R-24.5 (4.32) R-27.1 (4.78)	0.058 (0.330) 0.053 (0.302) 0.046 (0.261) 0.041 (0.232) 0.037 (0.209)	None 4 5 6 7
R-22.5 (3.96 RSI) Batt Insulation in Stud Cavity	1.5" (38.1) 2" (50.8) 3" (76.2) 4" (101.6) 5" (127.0)	R-6.5 (1.14) R-8.6 (1.51) R-12.9 (2.27) R-17.2 (3.03) R-21.5 (3.79)	R-17.9 (3.14) R-19.4 (3.42) R-22.4 (3.94) R-25.1 (4.43) R-27.7 (4.88)	0.056 (0.318) 0.052 (0.293) 0.045 (0.254) 0.040 (0.226) 0.036 (0.205)	None 4 5 6 7
R-24 (4.23 RSI) Batt Insulation in Stud Cavity	1.5" (38.1) 2" (50.8) 3" (76.2) 4" (101.6) 5" (127.0)	R-6.5 (1.14) R-8.6 (1.51) R-12.9 (2.27) R-17.2 (3.03) R-21.5 (3.79)	R-18.2 (3.21) R-19.7 (3.48) R-22.7 (4.00) R-25.5 (4.48) R-28.1 (4.94)	0.055 (0.312) 0.051 (0.288) 0.044 (0.250) 0.039 (0.223) 0.036 (0.202)	4 4 5 6 7

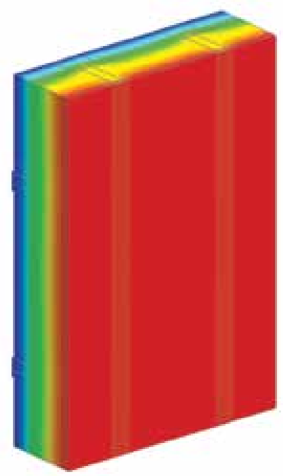
[1]Compared to above grade wall for maximum U-value in Table 3.2.2.2

Detail 3

Exterior and Interior Insulated 2" x 6" Steel Stud (16" o.c.) Wall Assembly with Thermally Isolated Vertical Brackets and Rail System (24" o.c.) Supporting Metal Cladding – Clear Wall

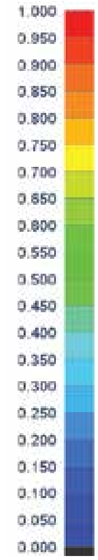


Thermal Profile from Exterior



Thermal Profile from Interior

Temperature Index



(3" Exterior Insulation and R-20 Batt Insulation scenario shown)

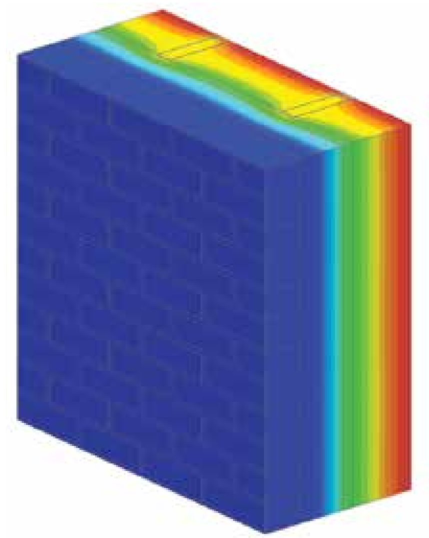
Performance Indicators

Scenario	Exterior Insulation Thickness Inches (mm)	Exterior Insulation Nominal R-value hr·ft²·°F/Btu (m²K/W)	Assembly		Highest Applicable Climate Zone per NECB 2015[1]
			R-value hr·ft²·°F/Btu (m²K/W)	U-value Btu/hr·ft²·°F (W/m²K)	
Air in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)	R-10.2 (1.80) R-18.0 (3.16)	0.098 (0.557) 0.056 (0.316)	None None
R-20 (3.52 RSI) Batt Insulation in Stud Cavity	1.5" (38.1) 2" (50.8) 3" (76.2) 4" (101.6) 5" (127.0)	R-6.5 (1.14) R-8.6 (1.51) R-12.9 (2.27) R-17.2 (3.03) R-21.5 (3.79)	R-17.3 (3.05) R-18.4 (3.25) R-20.7 (3.65) R-23.5 (4.13) R-26.0 (4.59)	0.058 (0.327) 0.054 (0.308) 0.048 (0.274) 0.043 (0.242) 0.038 (0.218)	None 4 5 6 6
R-22.5 (3.96 RSI) Batt Insulation in Stud Cavity	1.5" (38.1) 2" (50.8) 3" (76.2) 4" (101.6) 5" (127.0)	R-6.5 (1.14) R-8.6 (1.51) R-12.9 (2.27) R-17.2 (3.03) R-21.5 (3.79)	R-18.0 (3.17) R-19.1 (3.36) R-21.3 (3.75) R-24.1 (4.24) R-26.6 (4.69)	0.056 (0.316) 0.052 (0.298) 0.047 (0.266) 0.042 (0.236) 0.038 (0.213)	None 4 5 6 6
R-24 (4.23 RSI) Batt Insulation in Stud Cavity	1.5" (38.1) 2" (50.8) 3" (76.2) 4" (101.6) 5" (127.0)	R-6.5 (1.14) R-8.6 (1.51) R-12.9 (2.27) R-17.2 (3.03) R-21.5 (3.79)	R-18.4 (3.23) R-19.4 (3.42) R-21.7 (3.81) R-24.4 (4.30) R-27.0 (4.76)	0.054 (0.309) 0.051 (0.292) 0.046 (0.262) 0.041 (0.233) 0.037 (0.210)	4 4 5 6 7

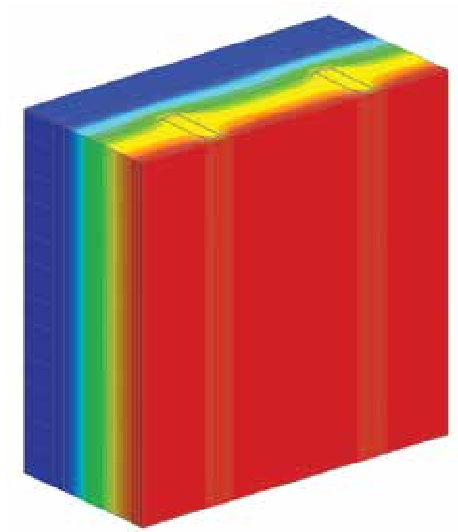
[1]Compared to above grade wall for maximum U-value in Table 3.2.2.2

Detail 4

Exterior Insulated 2" x 6" Steel Stud (16" o.c.) Wall Assembly with Heckmann Pos-I-Tie Veneer Anchoring System Supporting Brick Veneer – Clear Wall

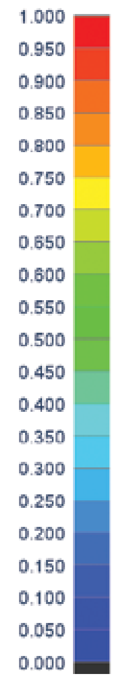


Thermal Profile from Exterior



Thermal Profile from Interior

Temperature Index



(3" Exterior Insulation and R-20 Batt Insulation scenario shown)

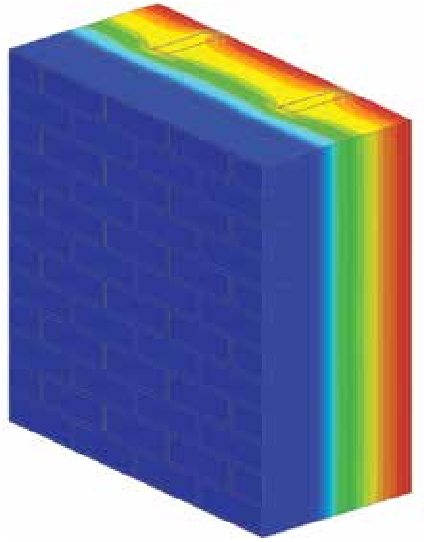
Performance Indicators

Scenario	Exterior Insulation Thickness Inches (mm)	Exterior Insulation Nominal R-value hr·ft²·°F/Btu (m²K/W)	Assembly		Highest Applicable Climate Zone per NECB 2015[1]
			R-value hr·ft²·°F/Btu (m²K/W)	U-value Btu/hr·ft²·°F (W/m²K)	
R-20 (3.52 RSI) Batt Insulation in Stud Cavity	1.5" (38.1) 2" (50.8) 3" (76.2) 4" (101.6) 5" (127.0)	R-6.5 (1.14) R-8.6 (1.51) R-12.9 (2.27) R-17.2 (3.03) R-21.5 (3.79)	R-17.2 (3.03) R-18.7 (3.30) R-21.5 (3.78) R-23.9 (4.21) R-26.5 (4.68)	0.058 (0.330) 0.053 (0.303) 0.047 (0.265) 0.042 (0.238) 0.038 (0.214)	None 4 5 6 6
R-22.5 (3.96 RSI) Batt Insulation in Stud Cavity	1.5" (38.1) 2" (50.8) 3" (76.2) 4" (101.6) 5" (127.0)	R-6.5 (1.14) R-8.6 (1.51) R-12.9 (2.27) R-17.2 (3.03) R-21.5 (3.79)	R-17.7 (3.12) R-19.2 (3.38) R-21.9 (3.85) R-24.2 (4.26) R-26.8 (4.71)	0.056 (0.320) 0.052 (0.296) 0.046 (0.260) 0.041 (0.235) 0.037 (0.212)	None 4 5 6 6
R-24 (4.23 RSI) Batt Insulation in Stud Cavity	1.5" (38.1) 2" (50.8) 3" (76.2) 4" (101.6) 5" (127.0)	R-6.5 (1.14) R-8.6 (1.51) R-12.9 (2.27) R-17.2 (3.03) R-21.5 (3.79)	R-18.1 (3.19) R-19.6 (3.45) R-22.5 (3.96) R-24.9 (4.39) R-27.3 (4.81)	0.055 (0.314) 0.051 (0.290) 0.044 (0.252) 0.040 (0.228) 0.037 (0.208)	4 4 5 6 7

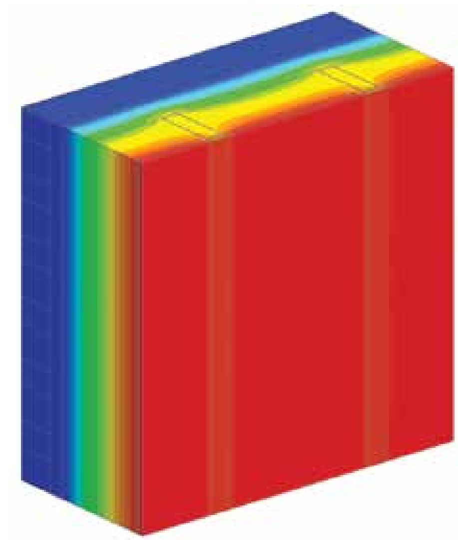
[1]Compared to above grade wall for maximum U-value in Table 3.2.2.2

Detail 5

Exterior Insulated 2" x 6" Steel Stud (16" o.c.) Wall Assembly with Heckmann Pos-I-Tie Veneer Anchoring System Supporting Brick Veneer – Clear Wall

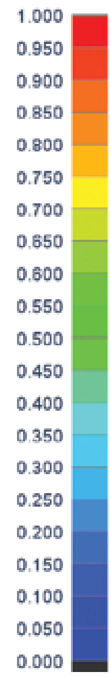


Thermal Profile from Exterior



Thermal Profile from Interior

Temperature Index



(3" Exterior Insulation and R-20 Batt Insulation scenario shown)

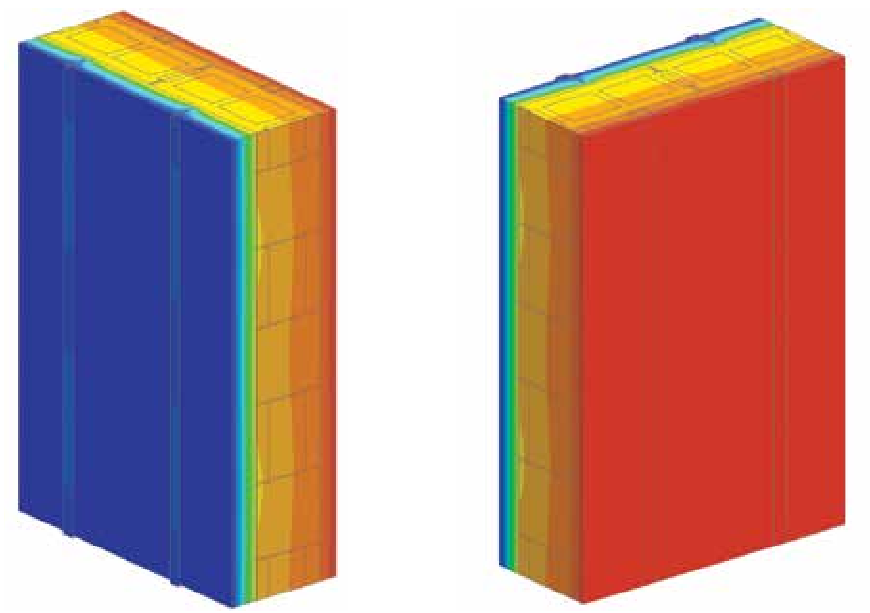
Performance Indicators

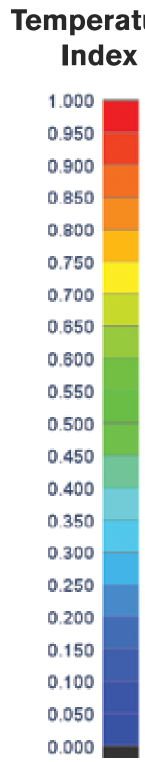
Scenario	Exterior Insulation Thickness Inches (mm)	Exterior Insulation Nominal R-value hr·ft²·°F/Btu (m²K/W)	Assembly		Highest Applicable Climate Zone per NECB 2015[1]
			R-value hr·ft²·°F/Btu (m²K/W)	U-value Btu/hr·ft²·°F (W/m²K)	
R-20 (3.52 RSI) Batt Insulation in Stud Cavity	1.5" (38.1) 2" (50.8) 3" (76.2) 4" (101.6)	R-7.5 (1.32) R-10 (1.76) R-15 (2.64) R-20 (3.52)	R-17.9 (3.16) R-19.6 (3.46) R-22.7 (3.99) R-25.2 (4.45)	0.056 (0.316) 0.051 (0.289) 0.044 (0.251) 0.040 (0.225)	None 4 5 6
R-22.5 (3.96 RSI) Batt Insulation in Stud Cavity	1.5" (38.1) 2" (50.8) 3" (76.2) 4" (101.6)	R-7.5 (1.32) R-10 (1.76) R-15 (2.64) R-20 (3.52)	R-18.5 (3.26) R-20.2 (3.56) R-23.2 (4.09) R-25.8 (4.55)	0.054 (0.307) 0.050 (0.281) 0.043 (0.245) 0.039 (0.220)	4 4 6 6
R-24 (4.23 RSI) Batt Insulation in Stud Cavity	1.5" (38.1) 2" (50.8) 3" (76.2) 4" (101.6)	R-7.5 (1.32) R-10 (1.76) R-15 (2.64) R-20 (3.52)	R-18.8 (3.32) R-20.5 (3.61) R-23.5 (4.14) R-26.2 (4.61)	0.053 (0.301) 0.049 (0.277) 0.043 (0.242) 0.038 (0.217)	4 5 6 6

[1]Compared to above grade wall for maximum U-value in Table 3.2.2.2

Detail 6

Exterior Insulated Concrete Block Wall Assembly with Thermally Isolated Vertical Brackets and Rail System Supporting Metal Cladding – Clear Wall





Thermal Profile from Exterior

Thermal Profile from Interior

(3" Exterior Insulation scenario shown)

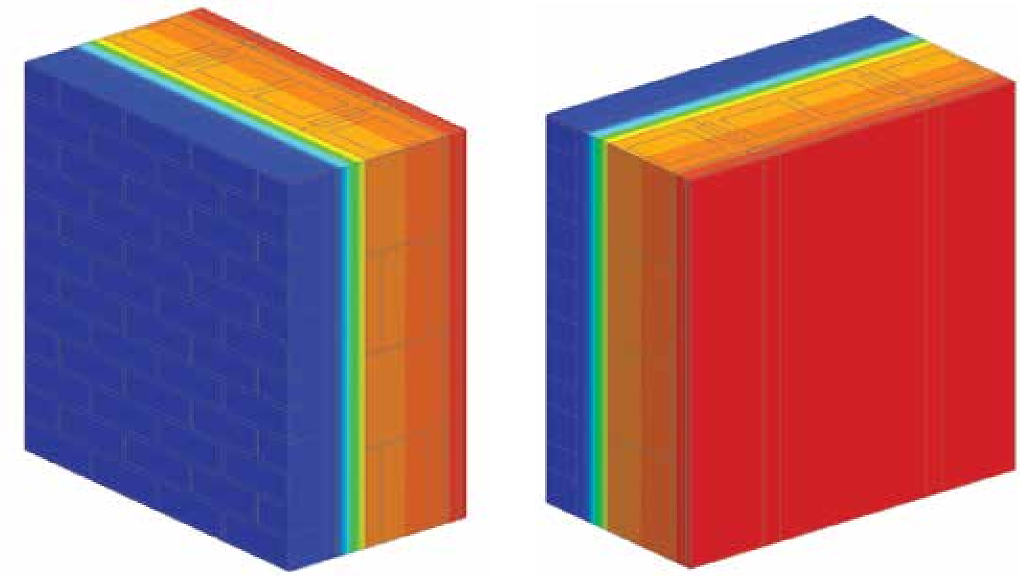
Performance Indicators

Exterior Insulation Thickness Inches (mm)	Exterior Insulation Nominal R-value hr·ft^2·°F/Btu (m^{2}K/W)	Assembly		Highest Applicable Climate Zone per NECB 2015[1]
1.5" (38.1)	R-6.5 (1.14)	R-9.3 (1.65)	0.107 (0.607)	None
2" (50.8)	R-8.6 (1.51)	R-10.4 (1.84)	0.096 (0.545)	None
2.5" (63.5)	R-10.8 (1.89)	R-11.6 (2.04)	0.086 (0.491)	None
3" (76.2)	R-12.9 (2.27)	R-12.6 (2.22)	0.079 (0.451)	None
3.5" (88.9)	R-15.1 (2.65)	R-13.9 (2.45)	0.072 (0.409)	None
4" (101.6)	R-17.2 (3.03)	R-14.8 (2.61)	0.067 (0.383)	None
4.5" (114.3)	R-19.4 (3.41)	R-16.0 (2.81)	0.063 (0.356)	None
5" (127.0)	R-21.5 (3.79)	R-16.9 (2.97)	0.059 (0.337)	None

[1]Compared to above grade wall for maximum U-value in Table 3.2.2.2

Detail 7

Exterior Insulated Concrete Block Wall Assembly with Heckmann Pos-I-Tie Veneer Anchoring System Supporting Brick Veneer – Clear Wall

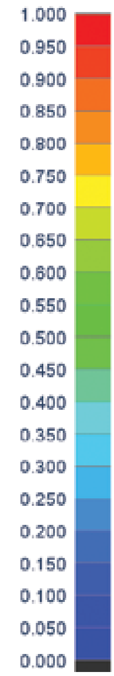


Thermal Profile from Exterior

Thermal Profile from Interior

(3" Exterior Insulation scenario shown)

Temperature Index



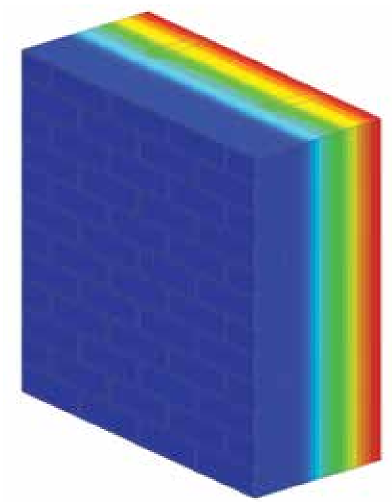
Performance Indicators

Exterior Insulation Thickness Inches (mm)	Exterior Insulation Nominal R-value hr·ft²·°F/Btu (m²K/W)	Assembly		Highest Applicable Climate Zone per NECB 2015[1]
1.5" (38.1)	R-7.5 (1.32)	R-11.5 (2.03)	0.087 (0.492)	None
2" (50.8)	R-10 (1.76)	R-13.4 (2.36)	0.075 (0.424)	None
2.5" (63.5)	R-12.5 (2.20)	R-15.2 (2.68)	0.066 (0.374)	None
3" (76.2)	R-15 (2.64)	R-16.9 (2.97)	0.059 (0.336)	None
3.5" (88.9)	R-17.5 (3.08)	R-18.5 (3.27)	0.054 (0.306)	4
4" (101.6)	R-20 (3.52)	R-20.0 (3.52)	0.050 (0.284)	4
4.5" (114.3)	R-22.5 (3.96)	R-21.7 (3.83)	0.046 (0.261)	5
5" (127.0)	R-25 (4.40)	R-23.1 (4.06)	0.043 (0.246)	6

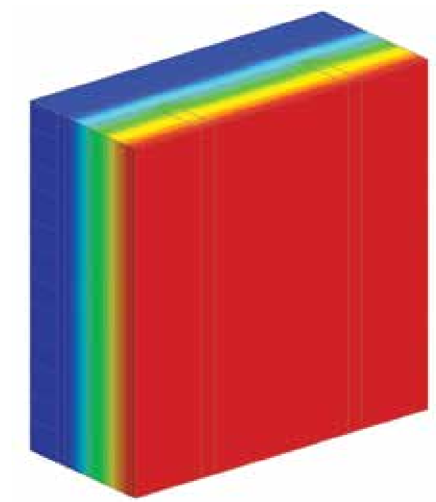
[1]Compared to above grade wall for maximum U-value in Table 3.2.2.2

Detail 8

Exterior and Interior Insulated 2" x 6" Wood Stud (16" o.c. and 24" o.c.) Wall Assembly with Heckmann Pos-I-Tie Veneer Anchoring System Supporting Brick Veneer – Clear Wall



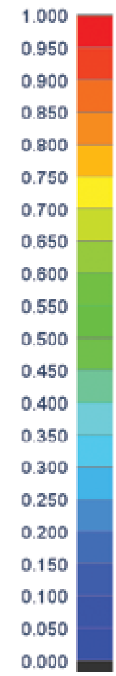
Thermal Profile from Exterior



Thermal Profile from Interior

(3" Exterior Insulation with Studs at 16" o.c. scenario shown)

Temperature Index



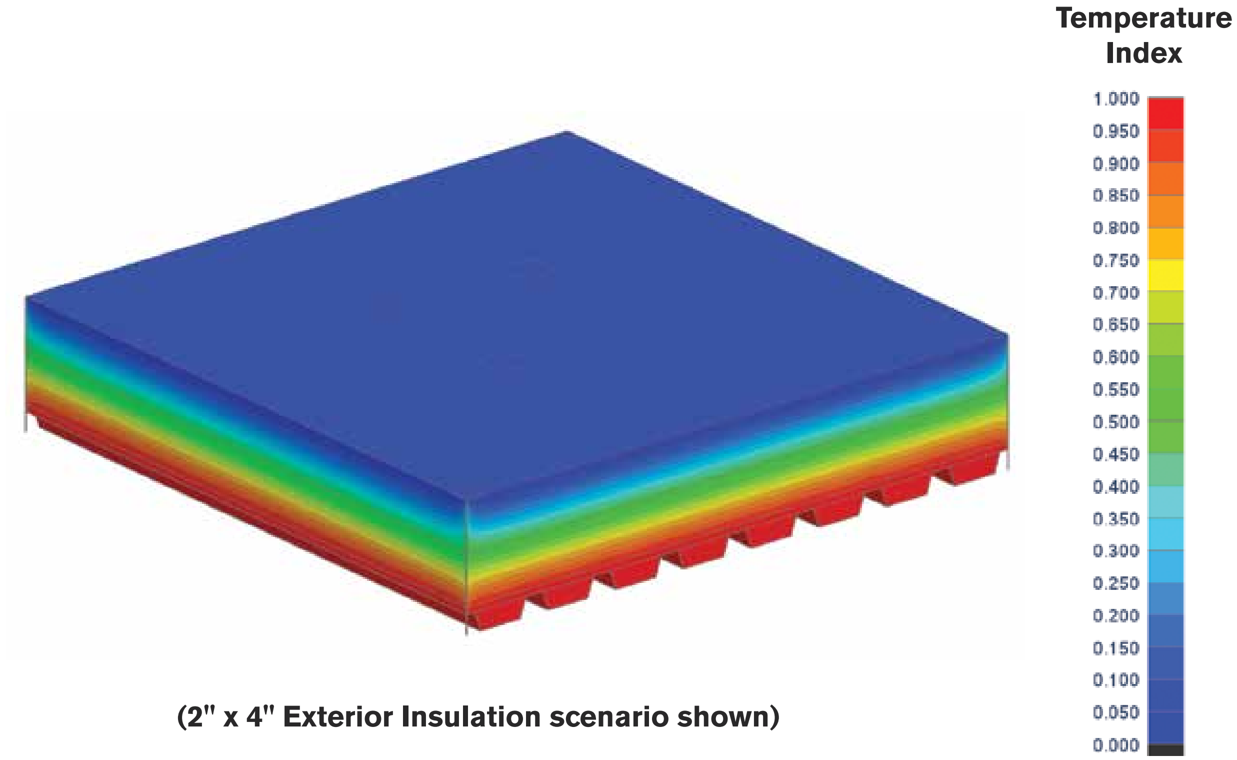
Performance Indicators

Scenario	Exterior Insulation Thickness Inches (mm)	Exterior Insulation Nominal R-value hr·ft²·°F/Btu (m²K/W)	Assembly		Highest Applicable Climate Zone per NECB 2015[1]
			R-value hr·ft²·°F/Btu (m²K/W)	U-value Btu/hr·ft²·°F (W/m²K)	
R-19 (3.35 RSI) Batt Insulation in Stud Cavity Studs @ 16" o.c.	2" (50.8) 3" (76.2) 4" (101.6)	R-10 (1.76) R-15 (2.64) R-20 (3.52)	R-29.6 (5.21) R-33.6 (5.92) R-37.4 (6.59)	0.034 (0.192) 0.030 (0.169) 0.027 (0.152)	7 8 8
R-19 (3.35 RSI) Batt Insulation in Stud Cavity Studs @ 24" o.c.	2" (50.8) 3" (76.2) 4" (101.6)	R-10 (1.76) R-15 (2.64) R-20 (3.52)	R-30.6 (5.39) R-35.0 (6.16) R-39.1 (6.89)	0.033 (0.185) 0.029 (0.162) 0.026 (0.145)	7 8 8
R-22 (3.87 RSI) Batt Insulation in Stud Cavity Studs @ 16" o.c.	2" (50.8) 3" (76.2) 4" (101.6)	R-10 (1.76) R-15 (2.64) R-20 (3.52)	R-31.7 (5.58) R-35.8 (6.30) R-39.6 (6.97)	0.032 (0.179) 0.028 (0.159) 0.025 (0.144)	8 8 8
R-22 (3.87 RSI) Batt Insulation in Stud Cavity Studs @ 24" o.c.	2" (50.8) 3" (76.2) 4" (101.6)	R-10 (1.76) R-15 (2.64) R-20 (3.52)	R-33.0 (5.82) R-37.3 (6.58) R-41.3 (7.28)	0.030 (0.172) 0.027 (0.152) 0.024 (0.137)	8 8 8
R-24 (4.23 RSI) Batt Insulation in Stud Cavity Studs @ 16" o.c.	2" (50.8) 3" (76.2) 4" (101.6)	R-10 (1.76) R-15 (2.64) R-20 (3.52)	R-33.2 (5.84) R-37.1 (6.53) R-41.0 (7.21)	0.030 (0.171) 0.027 (0.153) 0.024 (0.139)	8 8 8
R-24 (4.23 RSI) Batt Insulation in Stud Cavity Studs @ 24" o.c.	2" (50.8) 3" (76.2) 4" (101.6)	R-10 (1.76) R-15 (2.64) R-20 (3.52)	R-34.7 (6.11) R-39.0 (6.86) R-42.9 (7.56)	0.029 (0.164) 0.026 (0.146) 0.023 (0.132)	8 8 8

[1]Compared to above grade wall for maximum U-value in Table 3.2.2.2

Detail 9

Exterior Insulated Low Sloped Roof – Clear Roof Assembly



(2" x 4" Exterior Insulation scenario shown)

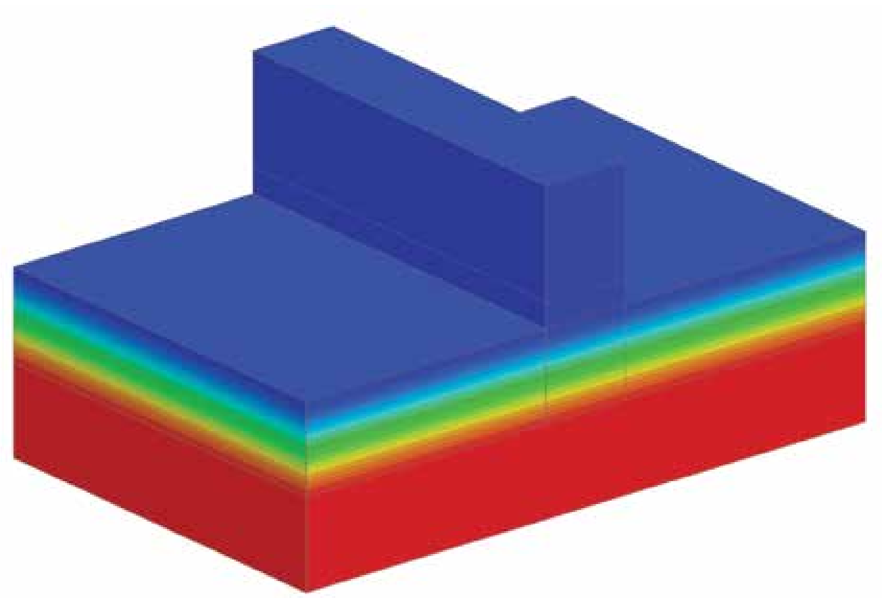
Performance Indicators

Exterior Insulation Thickness Inches (mm)	Exterior Insulation Nominal R-value hr·ft²·°F/Btu (m²K/W)	Assembly		Highest Applicable Climate Zone per NECB 2015[1]
1x4" (1x101.6mm)	R-20 (3.52)	R-20.8 (3.67)	0.048 (0.272)	None
2x3" (2x76.2mm)	R-30 (5.28)	R-30.5 (5.36)	0.033 (0.186)	4
2x4" (2x101.6mm)	R-40 (7.04)	R-39.8 (7.02)	0.025 (0.142)	8

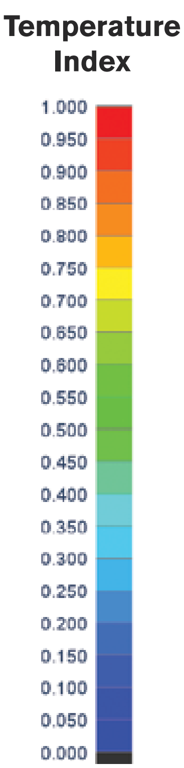
[1]Compared to roof for maximum U-value in Table 3.2.2.2

Detail 10

Inverted Roof on Concrete Deck – Floating Concrete Wall Intersection



(2" x 4" Exterior Insulation scenario shown)



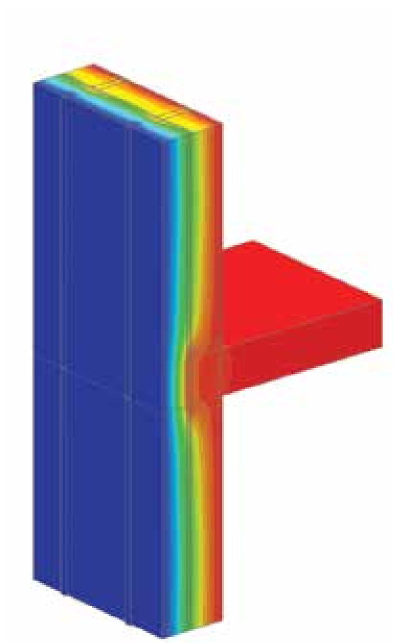
Performance Indicators

Exterior Insulation Thickness Inches (mm)	Exterior Insulation Nominal R-value hr·ft²·°F/Btu (m²K/W)	Assembly		Highest Applicable Climate Zone per NECB 2015[1]
1x4" (1x101.6mm)	R-20 (3.52)	R-21.9 (3.86)	0.046 (0.259)	None
2x3" (2x76.2mm)	R-30 (5.28)	R-31.9 (5.62)	0.031 (0.178)	6
2x4" (2x101.6mm)	R-40 (7.04)	R-41.9 (7.38)	0.024 (0.135)	8

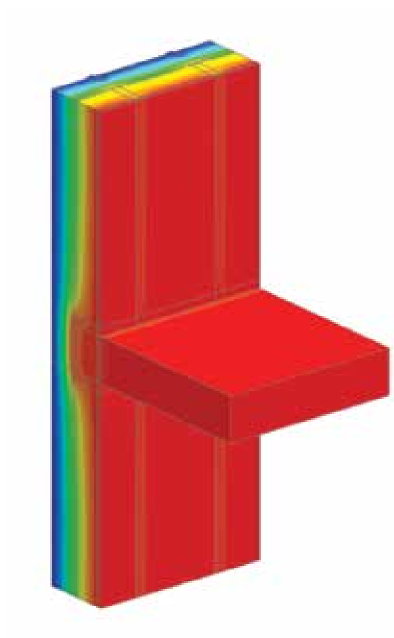
[1]Compared to roof for maximum U-value in Table 3.2.2.2

Detail 11

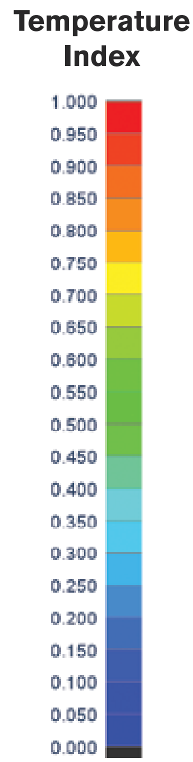
Exterior Insulated 2" x 6" Steel Stud (16" o.c.) Wall Assembly with Thermally Isolated Vertical Brackets and Rail System (24" o.c.) Supporting Metal Cladding – Intermediate Floor Intersection



Thermal Profile from Exterior



Thermal Profile from Interior



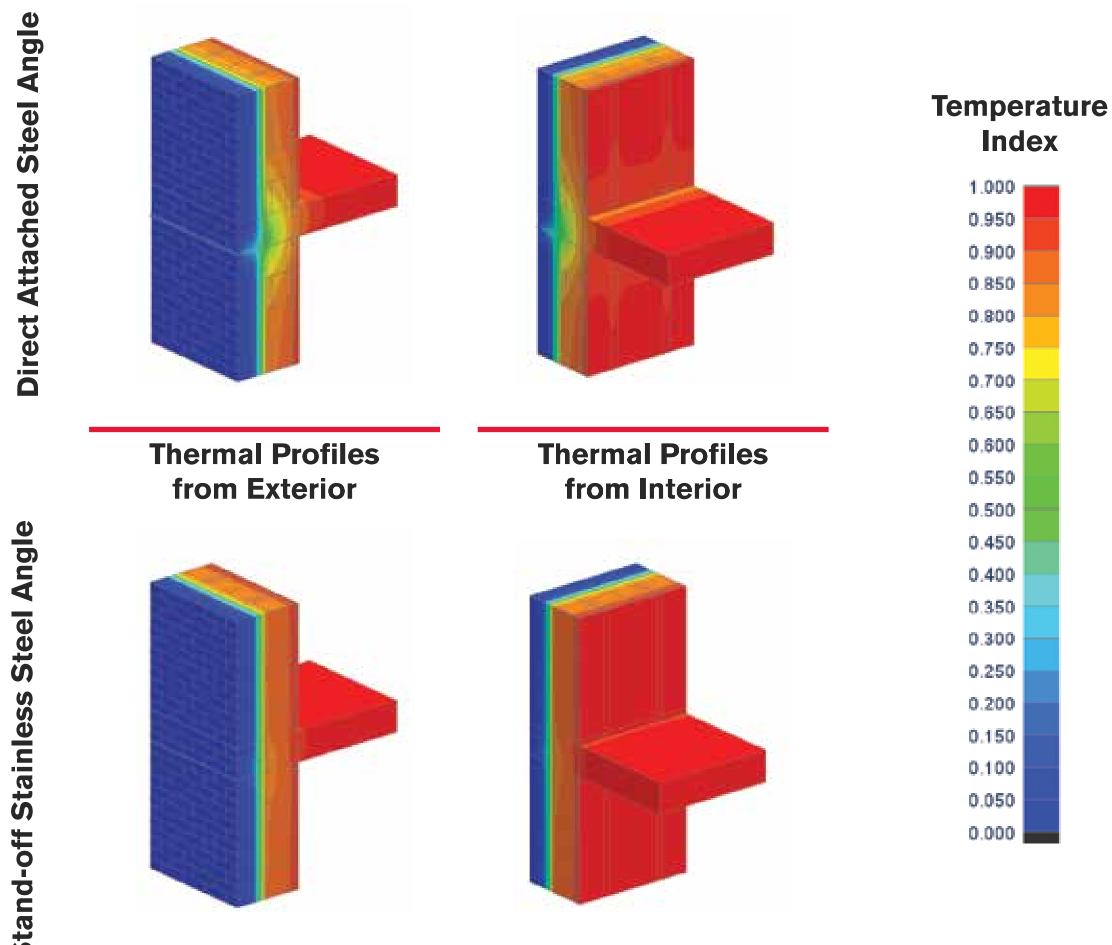
(5" Exterior Insulation and R-20 Batt Insulation scenario shown)

Performance Indicators

Scenario	Exterior Insulation Thickness Inches (mm)	Exterior Insulation Nominal R-value hr·ft²·°F/Btu (m²K/W)	Clear Wall – Detail 3		Assembly		Ψ Btu/hr·ft·°F (W/m K)
			R-value hr·ft²·°F/Btu (m²K/W)	U-value Btu/hr·ft²·°F (W/m²K)	R-value hr·ft²·°F/Btu (m²K/W)	U-value Btu/hr·ft²·°F (W/m²K)	
Air in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)	R-10.2 (1.80) R-18.0 (3.16)	0.098 (0.557) 0.056 (0.316)	R-9.9 (1.75) R-17.4 (3.06)	0.101 (0.573) 0.058 (0.327)	0.019 (0.034) 0.013 (0.023)
R-20 (3.52 RSI) Batt in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)	R-18.4 (3.25) R-26.0 (4.59)	0.054 (0.308) 0.038 (0.218)	R-15.3 (2.69) R-22.7 (4.00)	0.066 (0.372) 0.044 (0.251)	0.076 (0.132) 0.040 (0.069)
R-22.5 (3.96 RSI) Batt in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)	R-19.1 (3.36) R-26.6 (4.69)	0.052 (0.298) 0.038 (0.213)	R-15.6 (2.75) R-22.8 (4.02)	0.064 (0.363) 0.044 (0.249)	0.079 (0.136) 0.041 (0.071)
R-24 (4.23 RSI) Batt in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)	R-19.4 (3.42) R-27.0 (4.76)	0.051 (0.292) 0.037 (0.210)	R-15.9 (2.80) R-23.2 (4.09)	0.063 (0.357) 0.043 (0.244)	0.080 (0.138) 0.042 (0.072)

Detail 12

Exterior Insulated Concrete Block Wall Assembly with Shelf Angle and Heckmann Pos-I-Tie Veneer Anchoring System Supporting Brick Veneer – Intermediate Floor Intersection



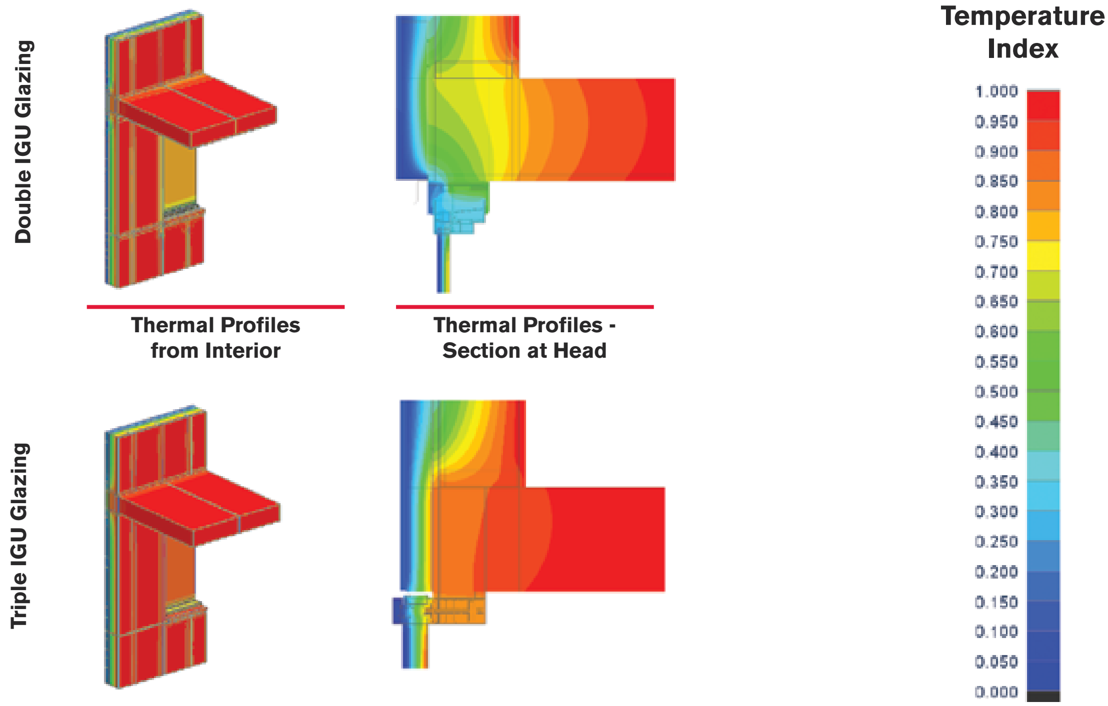
(4" Exterior Insulation scenario shown)

Performance Indicators

Scenario		Exterior Insulation Thickness Inches (mm)	Exterior Insulation Nominal R-value hr·ft²·°F/Btu (m²K/W)	Clear Wall – Detail 7		Assembly		Ψ Btu/hr·ft·°F (W/m K)
				R-value hr·ft²·°F/Btu (m²K/W)	U-value Btu/hr·ft²·°F (W/m²K)	R-value hr·ft²·°F/Btu (m²K/W)	U-value Btu/hr·ft²·°F (W/m²K)	
A	Direct Attached Steel Angle	2" (50.8) 4" (101.6)	R-10 (1.76) R-20 (3.52)	R-13.4 (2.36) R-20.0 (3.52)	0.075 (0.424) 0.050 (0.284)	R-8.3 (1.46) R-10.1 (1.78)	0.121 (0.686) 0.099 (0.561)	0.277 (0.480) 0.292 (0.506)
B	Stand-off Stainless Steel Angle	2" (50.8) 4" (101.6)	R-10 (1.76) R-20 (3.52)	R-13.4 (2.36) R-20.0 (3.52)	0.075 (0.424) 0.050 (0.284)	R-11.7 (2.06) R-16.9 (2.98)	0.085 (0.485) 0.059 (0.335)	0.064 (0.112) 0.054 (0.093)

Detail 13

Exterior and Interior Insulated 2" x 6" Steel Stud (16" o.c.) Wall Assembly with Thermally Isolated Vertical Brackets and Rail System (24" o.c.) Supporting Metal Cladding – Window and Intermediate Floor Intersection



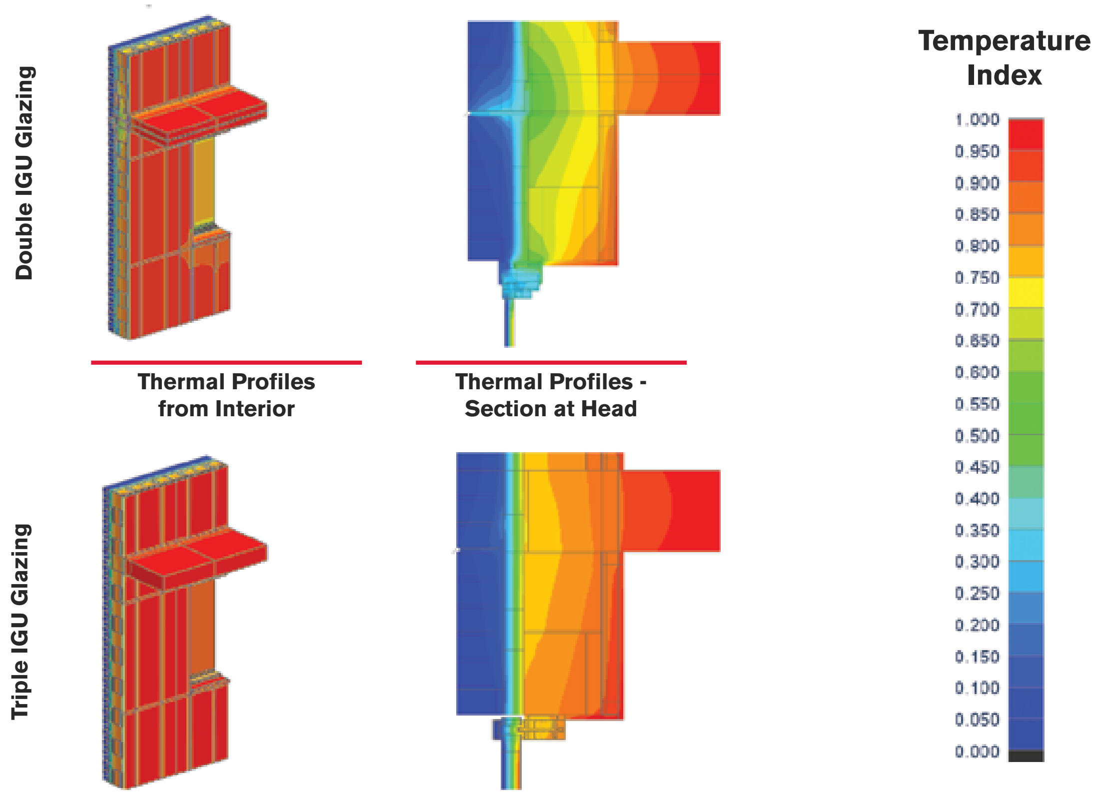
(2" Exterior Insulation and R-20 Batt Insulation scenario shown)

Performance Indicators

Scenario		Exterior Insulation Thickness Inches (mm)	Exterior Insulation Nominal R-value hr·ft²·°F/Btu m²K/W)	Clear Wall – Detail 3		Ψ Sill Btu/hr·ft·°F (W/m K)	Ψ Jamb Btu/hr·ft·°F (W/m K)	Ψ Head Btu/hr·ft·°F (W/m K)	Ψ Total Btu/hr·ft·°F (W/m K)
				R-value hr·ft²·°F/Btu (m²K/W)	U-value Btu/hr·ft²·°F (W/m²K)				
A - Double IGU	Air in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)	R-10.2 (1.80) R-18.0 (3.16)	0.098 (0.557) 0.056 (0.316)	0.219 (0.379) 0.250 (0.433)	0.127 (0.220) 0.146 (0.252)	0.279 (0.483) 0.301 (0.520)	0.189 (0.326) 0.220 (0.381)
	R-20 (3.52 RSI) Batt in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)	R-18.4 (3.25) R-26.0 (4.59)	0.054 (0.308) 0.038 (0.218)	0.147 (0.254) 0.159 (0.275)	0.095 (0.165) 0.103 (0.178)	0.309 (0.535) 0.304 (0.526)	0.160 (0.277) 0.165 (0.286)
	R-22.5 (3.96 RSI) Batt in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)	R-19.1 (3.36) R-26.6 (4.69)	0.052 (0.298) 0.038 (0.213)	0.146 (0.253) 0.157 (0.273)	0.095 (0.164) 0.102 (0.177)	0.313 (0.542) 0.305 (0.527)	0.160 (0.277) 0.165 (0.285)
B - Triple IGU	Air in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)	R-10.2 (1.80) R-18.0 (3.16)	0.098 (0.557) 0.056 (0.316)	0.036 (0.063) 0.055 (0.095)	0.047 (0.081) 0.050 (0.086)	0.053 (0.092) 0.047 (0.081)	0.039 (0.067) 0.066 (0.114)
	R-20 (3.52 RSI) Batt in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)	R-18.4 (3.25) R-26.0 (4.59)	0.054 (0.308) 0.038 (0.218)	0.034 (0.058) 0.044 (0.077)	0.046 (0.080) 0.044 (0.077)	0.094 (0.163) 0.064 (0.110)	0.046 (0.079) 0.054 (0.093)
	R-22.5 (3.96 RSI) Batt in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)	R-19.1 (3.36) R-26.6 (4.69)	0.052 (0.298) 0.038 (0.213)	0.034 (0.059) 0.046 (0.080)	0.046 (0.080) 0.044 (0.077)	0.096 (0.166) 0.065 (0.112)	0.046 (0.080) 0.054 (0.094)

Detail 14

Exterior Insulated Concrete Block Wall Assembly with Heckmann Pos-I-Tie Veneer Anchoring System Supporting Brick Veneer – Window and Intermediate Floor Intersection



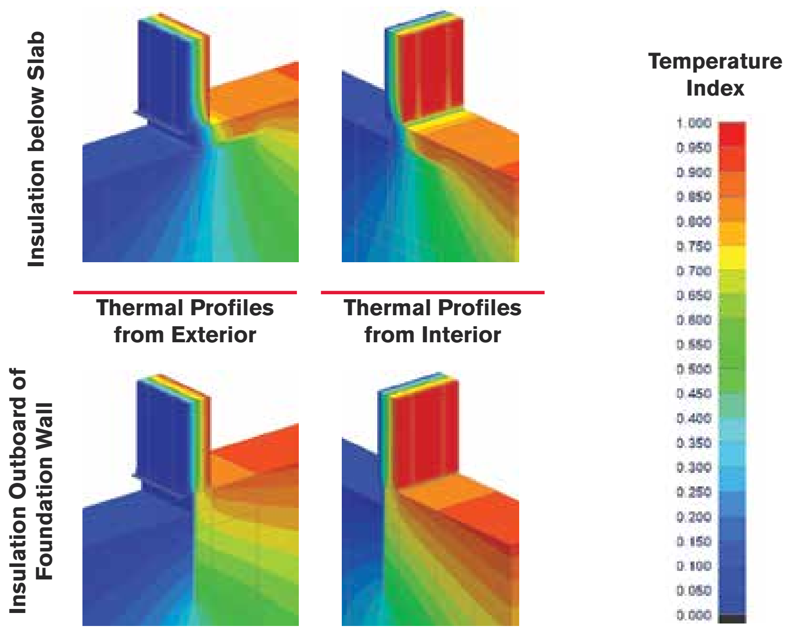
(2" Exterior Insulation scenario shown)

Performance Indicators

Scenario		Exterior Insulation Thickness Inches (mm)	Exterior Insulation Nominal R-value hr·ft²·°F/Btu (m²K/W)	Clear Wall – Detail 7		Ψ Sill Btu/hr·ft·°F (W/m K)	Ψ Jamb Btu/hr·ft·°F (W/m K)	Ψ Head Btu/hr·ft·°F (W/m K)	Ψ Total Btu/hr·ft·°F (W/m K)
				R-value hr·ft²·°F/Btu (m²K/W)	U-value Btu/hr·ft²·°F (W/m²K)				
A	Insulation Interrupted at Perimeter of Double IGU Glazing	2" (50.8) 4" (101.6)	R-10 (1.76) R-20 (3.52)	R-13.4 (2.36) R-20.0 (3.52)	0.075 (0.424) 0.050 (0.284)	0.395 (0.684) 0.131 (0.227)	0.244 (0.422) 0.076 (0.132)	0.141 (0.244) 0.362 (0.626)	0.431 (0.746) 0.148 (0.257)
B	Insulation Un-Interrupted at Perimeter of Triple IGU Glazing	2" (50.8) 4" (101.6)	R-10 (1.76) R-20 (3.52)	R-13.4 (2.36) R-20.0 (3.52)	0.075 (0.424) 0.050 (0.284)	0.020 (0.035) 0.026 (0.045)	0.082 (0.141) 0.058 (0.100)	0.053 (0.091) 0.142 (0.246)	0.051 (0.088) 0.058 (0.101)

Detail 15

Exterior and Interior Insulated 2" x 6" Steel Stud (16" o.c.) Wall Assembly with Thermally Isolated Vertical Brackets and Rail System (24" o.c.) Supporting Metal Cladding – Slab and Foundation Intersection



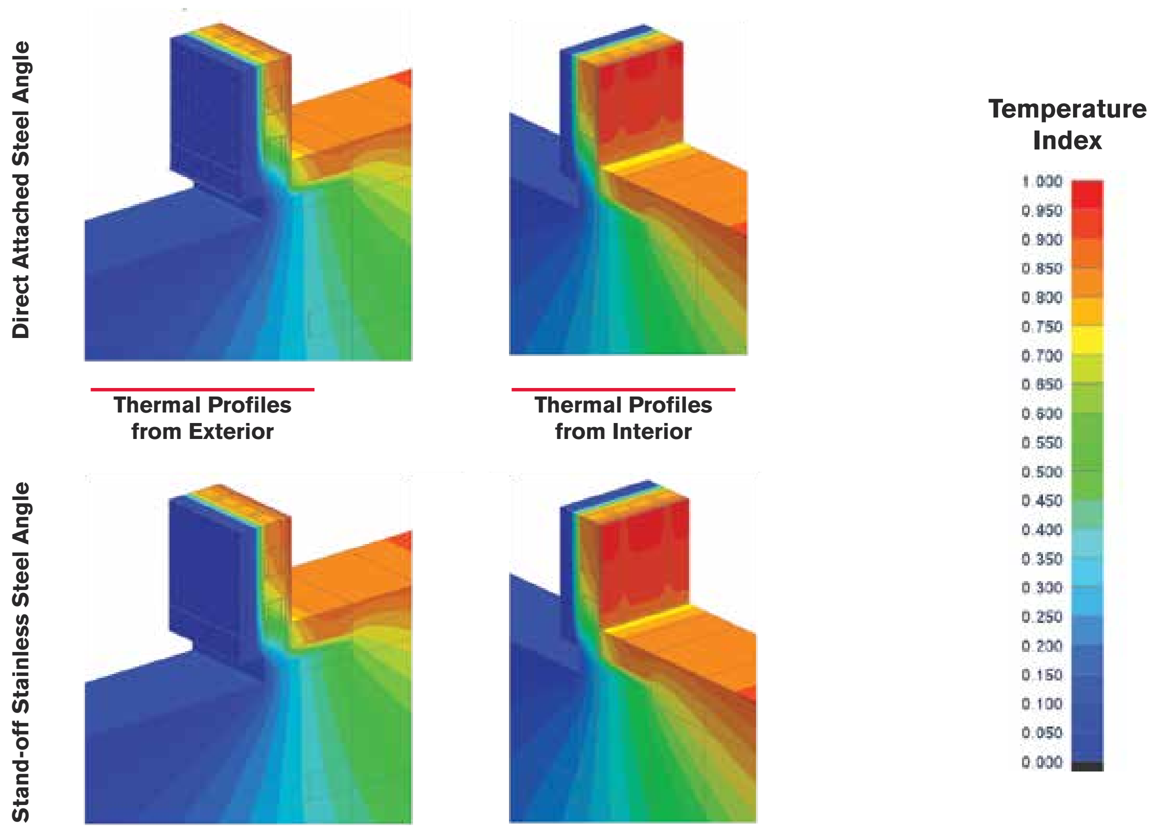
(5" Exterior Insulation and R-20 Batt Insulation scenario shown)

Performance Indicators

Scenario		Exterior Insulation Thickness Inches (mm)	Exterior Insulation Nominal R-value hr·ft²·°F/Btu (m²K/W)	Clear Wall – Detail 3		Floor Perimeter Heat Loss Btu/hr·ft·°F (W/m K)	Ψ Btu/hr·ft·°F (W/m K)
				R-value hr·ft²·°F/Btu (m²K/W)	U-value Btu/hr·ft²·°F (W/m²K)		
A – With Insulation Below Slab and Exposed Floor Edge	Air in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)	R-10.2 (1.80) R-18.0 (3.16)	0.098 (0.557) 0.056 (0.316)	1.312 (2.271)	0.319 (0.551) 0.351 (0.607)
	R-20 (3.52 RSI) Batt in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)	R-18.4 (3.25) R-26.0 (4.59)	0.054 (0.308) 0.038 (0.218)		0.207 (0.359) 0.220 (0.380)
	R-22.5 (3.96 RSI) Batt in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)	R-19.1 (3.36) R-26.6 (4.69)	0.052 (0.298) 0.038 (0.213)		0.205 (0.355) 0.217 (0.375)
	R-24 (4.23 RSI) Batt in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)	R-19.4 (3.42) R-27.0 (4.76)	0.051 (0.292) 0.037 (0.210)		0.207 (0.357) 0.216 (0.374)
B – With Insulation Outboard of Foundation Wall and Insulated Floor Edge	Air in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)	R-10.2 (1.80) R-18.0 (3.16)	0.098 (0.557) 0.056 (0.316)	1.061 (1.836)	0.031 (0.053) 0.034 (0.059)
	R-20 (3.52 RSI) Batt in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)	R-18.4 (3.25) R-26.0 (4.59)	0.054 (0.308) 0.038 (0.218)		0.028 (0.049) 0.028 (0.048)
	R-22.5 (3.96 RSI) Batt in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)	R-19.1 (3.36) R-26.6 (4.69)	0.052 (0.298) 0.038 (0.213)		0.029 (0.049) 0.028 (0.048)
	R-24 (4.23 RSI) Batt in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)	R-19.4 (3.42) R-27.0 (4.76)	0.051 (0.292) 0.037 (0.210)		0.031 (0.054) 0.028 (0.048)

Detail 16

Exterior Insulated Concrete Block Wall Assembly with Stainless Steel Stand-off Shelf Angle and Heckmann Pos-I-Tie Veneer Anchoring System Supporting Brick Veneer – Slab and Foundation Intersection



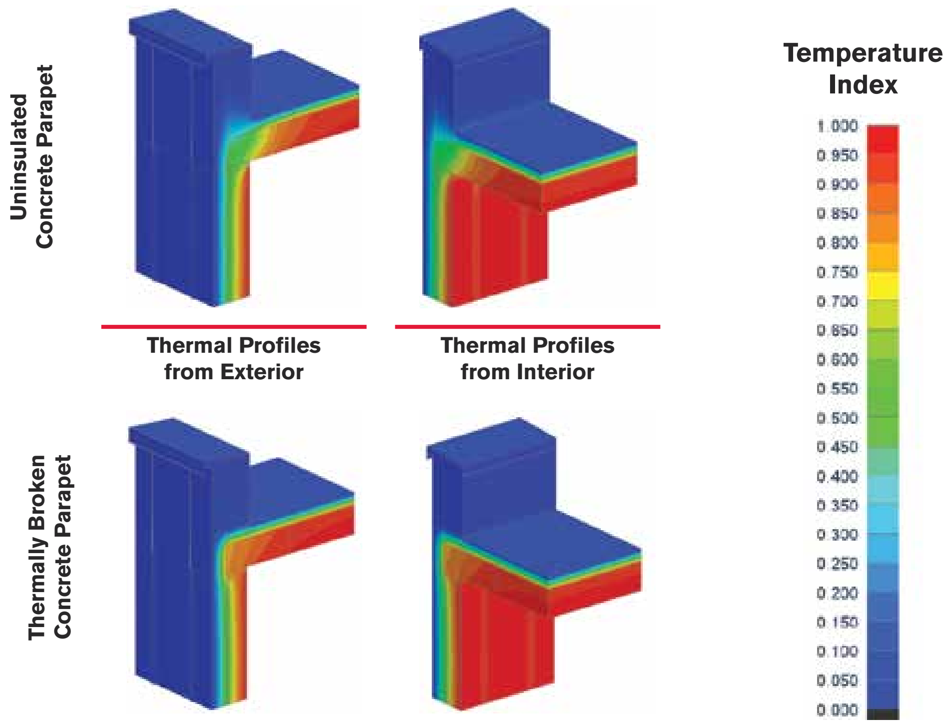
(4" Exterior Insulation scenario shown)

Performance Indicators

Scenario		Exterior Insulation Thickness Inches (mm)	Exterior Insulation Nominal R-value hr·ft²·°F/Btu (m²K/W)	Clear Wall – Detail 7		Floor Perimeter Heat Loss Btu/hr·ft·°F (W/m K)	Ψ Total Btu/hr·ft·°F (W/m K)
				R-value hr·ft²·°F/Btu (m²K/W)	U-value Btu/hr·ft²·°F (W/m²K)		
A	Direct Attached Steel Angle, Insulation below the Slab	2" (50.8) 4" (101.6)	R-10 (1.76) R-20 (3.52)	R-13.4 (2.36) R-20.0 (3.52)	0.075 (0.424) 0.050 (0.284)	1.247 (2.158)	0.301 (0.521) 0.322 (0.557)
B	Stand-off Stainless Steel Angle, Insulation below the Slab	2" (50.8) 4" (101.6)	R-10 (1.76) R-20 (3.52)	R-13.4 (2.36) R-20.0 (3.52)	0.075 (0.424) 0.050 (0.284)	1.247 (2.158)	0.230 (0.399) 0.241 (0.418)

Detail 17

Exterior and Interior Insulated 2" x 6" Steel Stud (16" o.c.) Wall Assembly with Thermally Isolated Vertical Brackets and Rail System (24" o.c.) Supporting Metal Cladding – Parapet and Roof Intersection



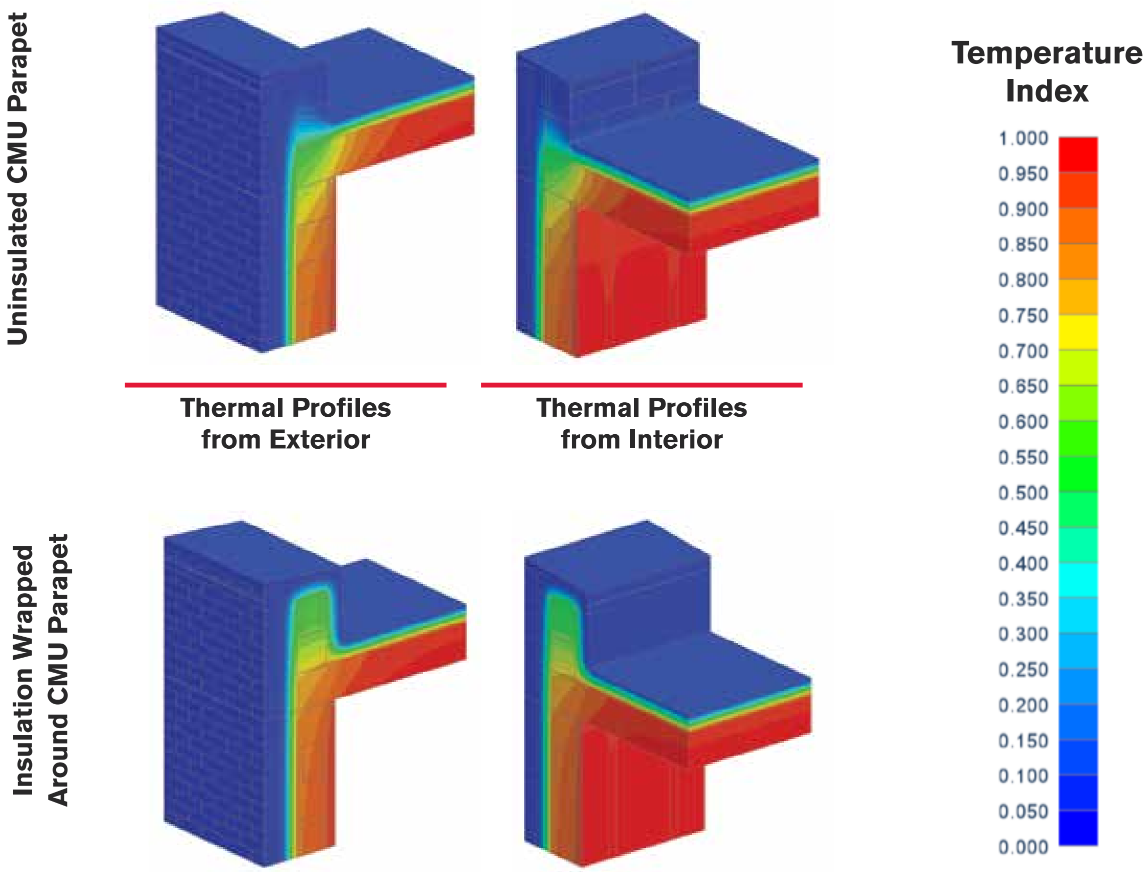
(5" Exterior Insulation and R-20 Batt Insulation scenario shown)

Performance Indicators

Scenario		Exterior Insulation Thickness Inches (mm)	Exterior Insulation Nominal R-value hr·ft²·°F/Btu (m²K/W)	Base Wall – Detail 3		Base Assembly – Roof		Ψ Btu/hr·ft·°F (W/m K)
				R-value hr·ft²·°F/Btu (m²K/W)	U-value Btu/hr·ft²·°F (W/m²K)	R-value hr·ft²·°F/Btu (m²K/W)	U-value Btu/hr·ft²·°F (W/m²K)	
A – Uninsulated Concrete Parapet	Air in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)	R-10.2 (1.80) R-18.0 (3.16)	0.098 (0.557) 0.056 (0.316)	R-21.9 (3.86)	0.046 (0.259)	0.409 (0.708) 0.402 (0.696)
	R-20 (3.52 RSI) Batt in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)	R-18.2 (3.20) R-26.0 (4.59)	0.054 (0.308) 0.039 (0.218)			0.407 (0.704) 0.384 (0.665)
	R-22.5 (3.96 RSI) Batt in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)	R-19.1 (3.36) R-26.6 (4.69)	0.052 (0.298) 0.038 (0.213)			0.407 (0.705) 0.381 (0.660)
	R-24 (4.23 RSI) Batt in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)	R-19.4 (3.42) R-27.0 (4.76)	0.051 (0.292) 0.037 (0.210)			0.410 (0.709) 0.394 (0.681)
B – With Thermally Broken Parapet	Air in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)	R-10.2 (1.80) R-18.0 (3.16)	0.098 (0.557) 0.056 (0.316)	R-21.9 (3.86)	0.046 (0.259)	0.126 (0.218) 0.110 (0.190)
	R-20 (3.52 RSI) Batt in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)	R-18.2 (3.20) R-25.8 (4.54)	0.054 (0.308) 0.039 (0.218)			0.140 (0.243) 0.122 (0.212)
	R-22.5 (3.96 RSI) Batt in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)	R-19.1 (3.36) R-26.6 (4.69)	0.052 (0.298) 0.038 (0.213)			0.141 (0.245) 0.120 (0.207)
	R-24 (4.23 RSI) Batt in Stud Cavity	2" (50.8) 5" (127.0)	R-8.6 (1.51) R-21.5 (3.79)	R-19.4 (3.42) R-27.0 (4.76)	0.051 (0.292) 0.037 (0.210)			0.142 (0.246) 0.115 (0.198)

Detail 18

Exterior Insulated Concrete Block Wall Assembly with Stainless Steel Stand-off Shelf Angle and Heckmann Pos-I-Tie Veneer Anchoring System Supporting Brick Veneer – Parapet and Roof Intersection



(4" Exterior Insulation scenario shown)

Performance Indicators

Scenario		Exterior Insulation Thickness Inches (mm)	Exterior Insulation Nominal R-value hr·ft²·°F/Btu (m²K/W)	Clear Wall – Detail 7		Base Assembly – Roof		Ψ Btu/hr·ft·°F (W/m K)
				R-value hr·ft²·°F/Btu (m²K/W)	U-value Btu/hr·ft²·°F (W/m²K)	R-value hr·ft²·°F/Btu (m²K/W)	U-value Btu/hr·ft²·°F (W/m²K)	
A	Uninsulated CMU Parapet	2" (50.8) 4" (101.6)	R-10 (1.76) R-20 (3.52)	R-13.4 (2.36) R-20.0 (3.52)	0.075 (0.424) 0.050 (0.284)	R-21.9 (3.86)	0.046 (0.259)	0.292 (0.505) 0.290 (0.502)
B	With Insulation Wrapped Around Parapet	2" (50.8) 4" (101.6)	R-10 (1.76) R-20 (3.52)	R-13.4 (2.36) R-20.0 (3.52)	0.075 (0.424) 0.050 (0.284)	R-21.9 (3.86)	0.046 (0.259)	0.150 (0.260) 0.121 (0.209)

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