The Building Envelope Thermal Bridging Online Database

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THE BUILDING ENVELOPE THERMAL BRIDGING ONLINE DATABASE

Location:	Burnaby, British Columbia, Canada
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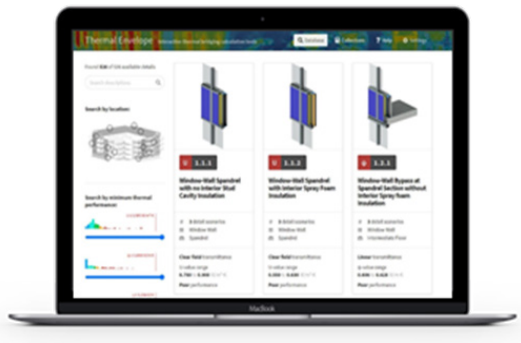
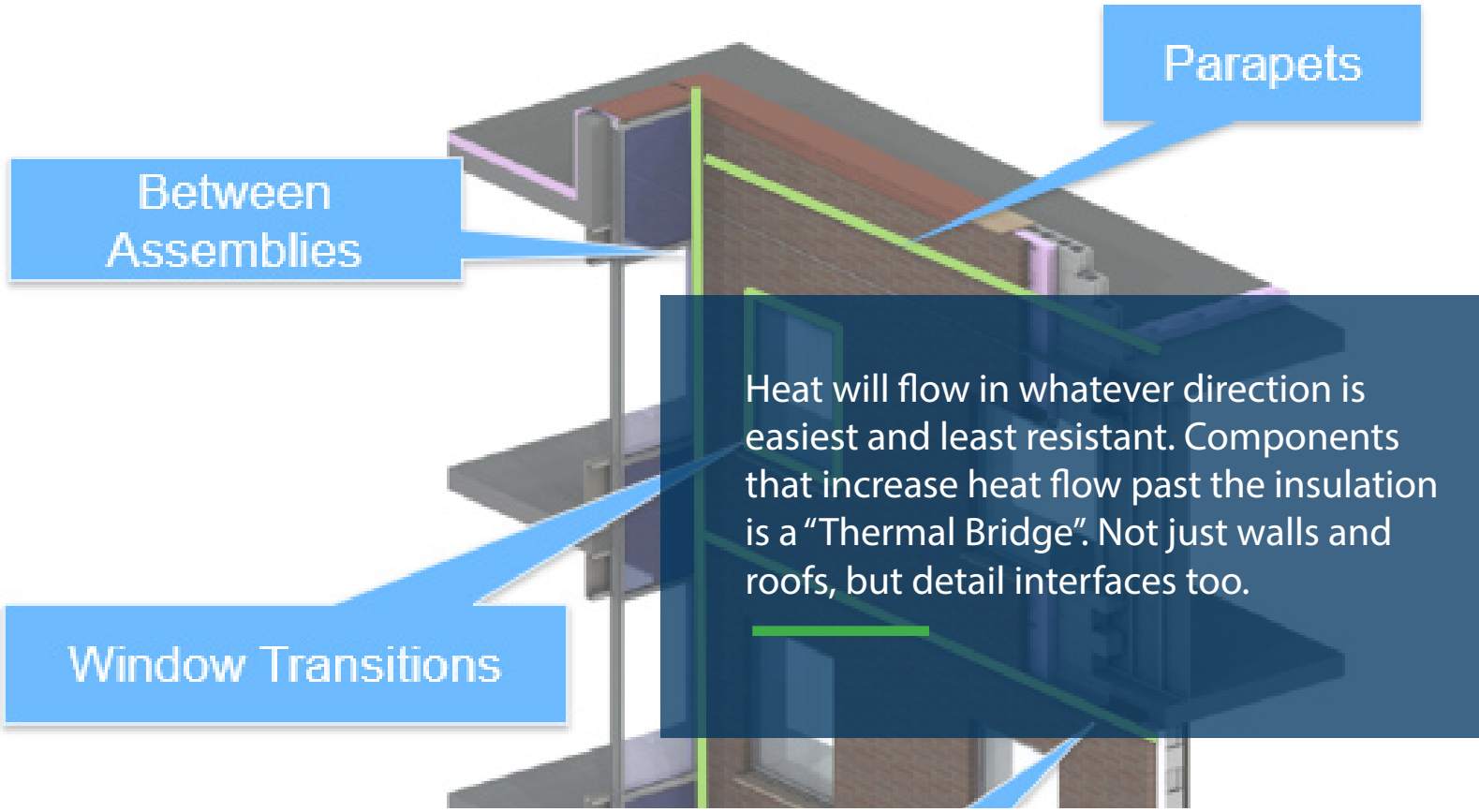
SUMMARY

Morrison Hershfield, in partnership with BC Housing and project sponsors, expanded the Building Envelope Thermal Bridging Guide to include details applicable to all Canadian climates, energy codes and developed a web-based database (ThermalEnvelope.ca) that lets users easily search for building envelope details, compare approaches to mitigate thermal bridges and calculate the overall thermal transmittance of opaque wall assemblies. These tools play an important supporting role in achieving net zero design and implementation



>> ThermalEnvelope.ca database



Heat will flow in whatever direction is easiest and least resistant. Components that increase heat flow past the insulation is a "Thermal Bridge". Not just walls and roofs, but detail interfaces too.

Q.1 INNOVATION

Morrison Hershfield, in partnership with BC Housing and project sponsors, expanded the Building Envelope Thermal Bridging Guide to include details applicable to all Canadian climates, energy codes and developed a web-based database (ThermalEnvelope.ca) that lets users easily search for building envelope details, compare approaches to mitigate thermal bridges and calculate the overall thermal transmittance of opaque wall assemblies. These tools play an important supporting role in achieving net zero design and implementation within the industry.

The Canadian construction industry is undergoing significant changes to improve the overall energy performance of buildings. The National Energy Code for Buildings (NECB) aims to achieve net zero energy consumption for all new buildings in Canada by 2030. To support the achievement of this ambitious goal, the building industry requires tools to affordably design and build such high-performance buildings.

Prior to the launch of the Building Envelope Thermal Bridging (BETB) Guide in 2014, the impact of thermal bridges was largely overlooked in practice, energy standards and energy calculations. Their impact is now clearer, and comprehensive thermal bridging calculations are becoming a requirement in codes and standards across the country, such as the National Energy Code for Buildings 2017, B.C. Energy Step Code, Vancouver Building Bylaw, and the Toronto Green Standard V3, as well as internationally. The BETB Guide has become an essential resource for thermal bridging calculations, providing the necessary support to adopt these requirements for North American construction.

Facilitating the design and construction of more thermally efficient building envelopes and making tools accessible to practitioners will transform the building market.

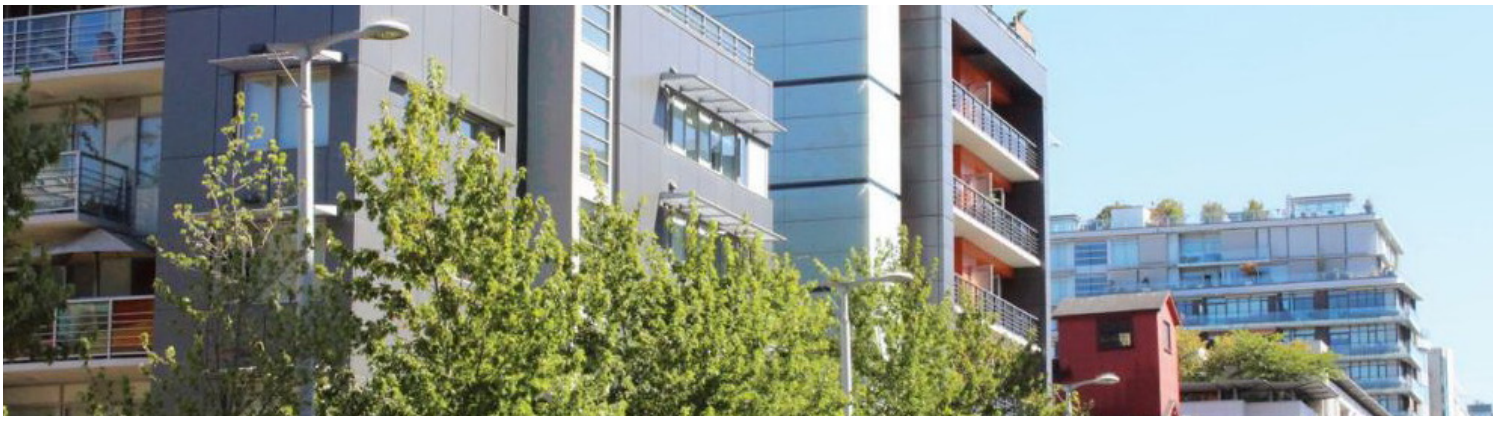
The expanded BETB Guide and first-of-its-kind online database (ThermalEnvelope.ca) developed by Morrison Hershfield, in collaboration with BC Housing and other industry supporters, seeks to transform the building market by facilitating the design and construction of more thermally efficient building envelopes and making the information and tools readily available to building industry stakeholders. Migrating the expanded BETB Guide to a web-based platform has minimized the need for project specific thermal simulations, making calculations less onerous in practice

With over 500 building details, ThermalEnvelope.ca provides a streamlined, automated process to find details, do calculations, provide compliance documentation, review calculations and collaborate with the design team.

Users search for and easily compare details using criteria like construction type, insulation characteristics, proprietary systems, and/or desired performance level. Access to these easy-to-use methods to mitigate thermal bridging will result in increasingly more energy efficient buildings.

This new and expanded resource goes beyond BC climate and construction practice and is now applicable to all energy standards and climates in Canada. It also provides details that would be applicable for net-zero or Passive House design. It is timely and necessary given the new and contemplated changes to energy efficiency requirements in jurisdictions across the country and the commitments that the federal, provincial and territorial governments have made to reducing greenhouse gases under the Pan Canadian Framework on Clean Growth and Climate Change.

>> The BETB Online Database is applicable to all energy standards and climates in Canada



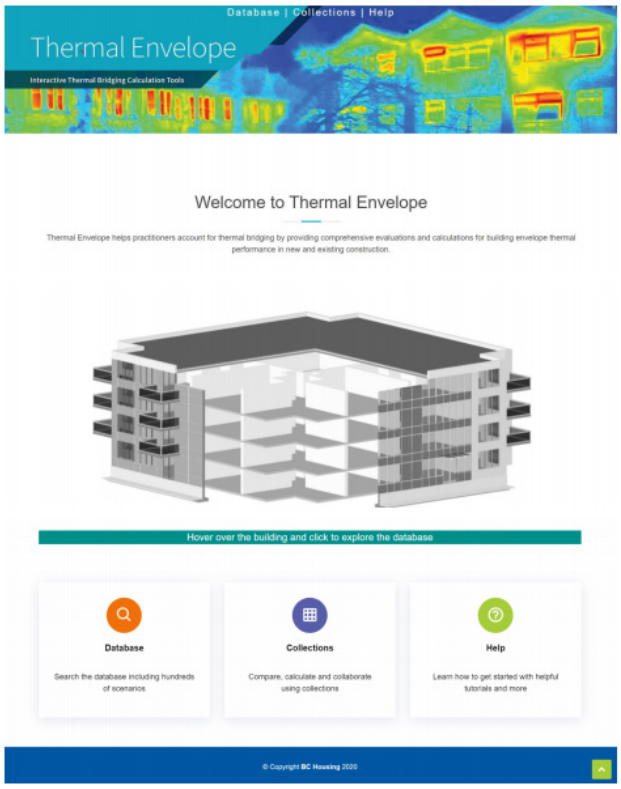
Q.2
COMPLEXITY

ThermalEnvelope.ca is a highly intuitive online database that consolidates vast amounts of technically sophisticated and complex information, a catalogue of over 500 common building envelope assemblies and interface details along with their associated thermal performance data into an accessible, practical and easily understood tool that allows practitioners to make informed design decisions.

The BETB catalogue was expanded to include over 500 details. After each release of the updated BETB Guide (four updates), details were re-assessed, recirculated and ranked in order of priority based on feedback from industry stakeholders. New details were constantly added to the queue and ranked based on impact, usefulness and client input.

When designing the online database, the challenge was to not simply replicate the PDF version of the Guide on a website, but to create an enhanced and intuitive user experience that includes all the features a user would expect when calculating the thermal performance of a building envelope. The user interface, functionality and features of the online database were defined from scratch based on the team's technical expertise and feedback received throughout the multi-year process with many presentations and workshops with industry stakeholders.

The expansion of the BETB Guide, identification of details and the development of the web application was highly collaborative, aiming to meet the needs of multiple stakeholders across the industry and the country to ensure the most inclusive and effective tool possible. The result is a first-of-its-kind website applicable to all energy standards and climates in Canada, with the potential for future expansion.



ThermalEnvelope.ca – BETB Web Application

ThermalEnvelope.ca enhances the BETB Guide user experience by reducing the effort required to perform holistic thermal transmittance calculations and empower designers to consider alternatives. The web application has the following features:

- Search and compare details and assemblies.
- An integrated Thermal Calculator.
- Collaboration tools.
- Help features and resources.

It is important that we begin to minimize thermal inefficiencies in the building envelope in order to meet energy reduction goals.

Q.3

SOCIAL AND/OR ECONOMIC BENEFITS

Expanding the BETB Guide into a national resource, supported by a fully developed web-application has significant technological, regulatory, economic and ultimately societal benefits. The easy-to-use, web-based database supports the building industry in fully recognizing the impact of thermal bridging in energy codes and in practice. Understanding the impact of thermal bridging and the benefits of innovative technologies to mitigate thermal bridging will ultimately contribute to reduced greenhouse gas emissions in the design and implementation of new and retrofit construction.

The database provides easy access to objective, consistent and essential information for all types of construction, buildings, energy standards, and climates in Canada and tools to evaluate cost-effective and innovative technologies and practices. In the past, the cost of conducting thermal transmittance calculations were a significant burden for designers. The online tool reduces the effort necessary for practitioners to do the detailed calculations essential to adopt net-zero energy codes and contribute to market transformation.

Manufacturers are also innovating and further developing energy efficient building systems that address costs, constructability and other constraints, in an effort to efficiently and effectively meet new regulations.

Awareness of thermal bridging's impact on energy performance and the ability to more quickly, accurately and easily account for it using the online database has far reaching implications to the design and construction of more thermally efficient building envelopes. New buildings designed and built to higher standards of energy efficiency benefit the industry, building owners and occupants, and society in general.

>>Thermal imaging of window assembly illustrates potential sources of thermal bridging

Q.4

ENVIRONMENTAL BENEFITS

Buildings consume a large percentage of electricity and natural gas. Designing and constructing energy efficient buildings and improving energy conservation in existing buildings can lead to large and vital reductions in energy consumption and is an important approach to reduce greenhouse gas emissions.

The adoption of the BETB methodology into standard practice will help inform building design and reduce the energy use impact of buildings. In Canada, space heating is a significant source of energy consumption (and GHG emissions) in commercial, institutional and residential buildings. Building envelope thermal performance is a critical consideration for reducing space heating loads and is an increasingly important factor as authorities strive for lower energy consumption in buildings and reduced reliance on high emission energy production.

According to the World Green Building Council, the building sector has the largest potential to significantly reduce GHG emissions compared to other major emitting sectors. The emissions savings potential could be as much as 84 gigatonnes of CO_2 by 2050, through direct measures in buildings such as energy efficiency, fuel switching and the use of renewable energy (UNEP, 2016). The building sector has the potential to achieve energy savings of 50% or more in 2050, in support of limiting global temperature rises to 2°C (UNEP, 2016)

The tool is key to meeting the challenges of net zero construction, which is a cornerstone of policy for Canada meeting greenhouse gas emission targets. This is essential to the long-term health and resilience of communities.

According to the WGBC, the building sector has the largest potential to significantly reduce GHG emissions compared to other major emitting sectors.

The multi-year process was highly collaborative, involving a variety of engagement events and tools to increase awareness and solicit feedback.

Q.5

MEETING CLIENT'S NEEDS

Expanding the BETB Guide and developing an easy-to-use web application supports the broad spectrum of building industry stakeholders in fully recognizing and accounting for the impact of thermal bridging.

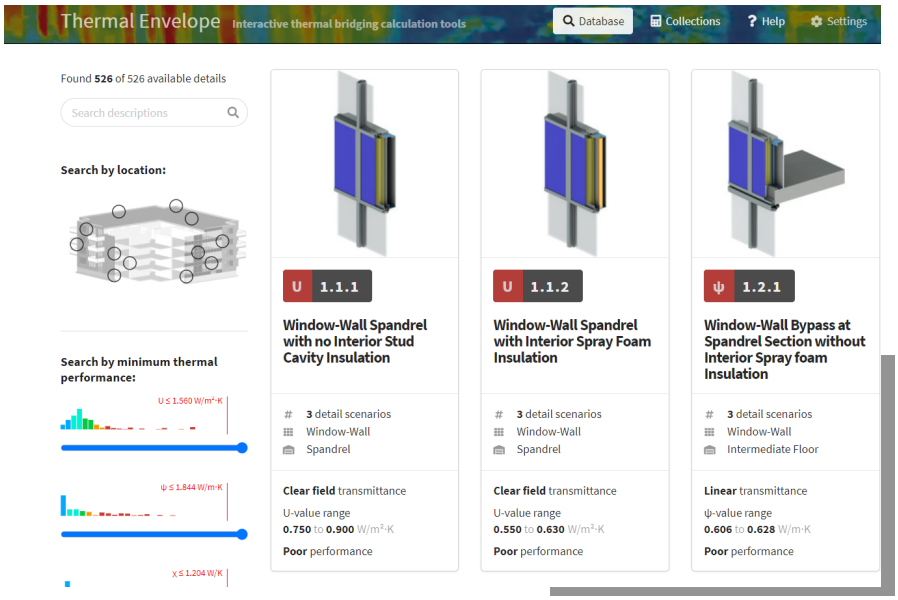
"This innovative project transforms the popular BETB Guide into a platform that enables industry-wide collaboration and sharing of information across disciplines. It accelerates the development and adoption of Net-Zero Ready standards and enhances building design and construction. By providing essential resources for practitioners to better assess the thermal performance of the building envelope, this project supports the industry in selecting options that reduce greenhouse gas emissions in buildings." - Denisa Ionescu, Senior Manager, Research & Education, BC Housing

The expanded BETB catalogue and online database support the development of building energy-efficiency policy in Canada. ThermalEnvelope.ca allows users to search for and compare over 500 building envelope details and assemblies and calculate the overall thermal transmittance of walls, roofs and floors. Results of the thermal calculations can be used for code compliance documentation, HVAC load calculations and input into whole building energy models.

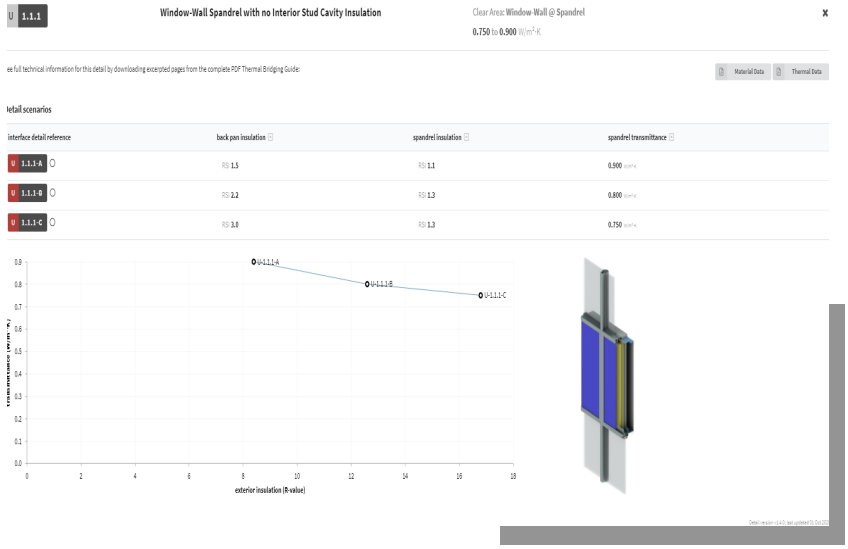
The timing of the groundbreaking and internationally significant online database is ideal in the context of new regulations that require detailed thermal transmittance calculations to minimize thermal bridging and the demand from industry for objective and consistent information regarding building envelope thermal performance.

This project supports policy already in place in several provinces and will be a cornerstone to developing model energy codes and adopting "net-zero energy ready" codes by NECB by 2030.

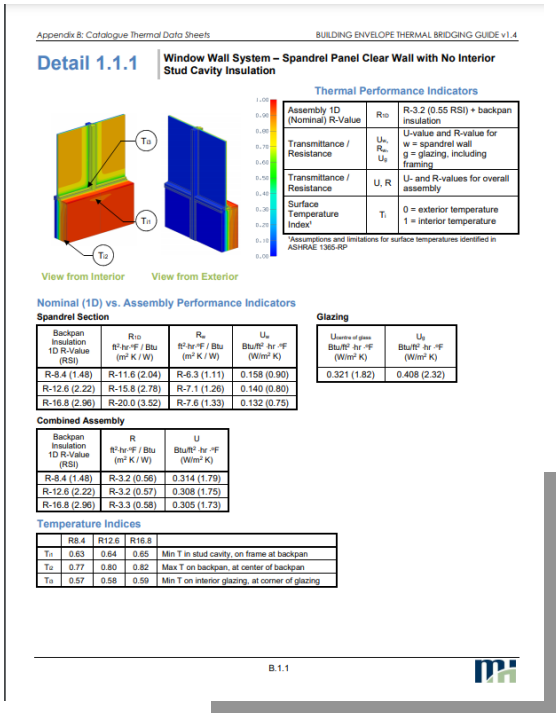
>> Searching a Window Wall Spandrel Detail on ThermalEnvelope.ca



>> Window Wall Spandrel Detail



>>Window Wall Spandrel Thermal Data



Appendix B: Catalogue Thermal Data Sheets — BUILDING ENVELOPE THERMAL BRIDGING GUIDE v1.4

Detail 1.1.1 — **Window Wall System – Spandrel Panel Clear Wall with No Interior Stud Cavity Insulation**

View from Interior — View from Exterior

Thermal Performance Indicators

Assembly 1D (Nominal) R-Value	R_{1D}	R-3.2 (0.55 RSI) + backpan insulation
Transmittance / Resistance	U_w, R_w, U_g	U-value and R-value for w = spandrel wall g = glazing, including framing
Transmittance / Resistance	U, R	U- and R-values for overall assembly
Surface Temperature Index*	T_i	0 = exterior temperature 1 = interior temperature

*Assumptions and limitations for surface temperatures identified in ASHRAE 1365-RP

Nominal (1D) vs. Assembly Performance Indicators

Spandrel Section

Backpan Insulation 1D R-Value (RSI)	R_{1D} ft²·hr·°F / Btu (m² K / W)	R_w ft²·hr·°F / Btu (m² K / W)	U_w Btu/ft² ·hr ·°F (W/m² K)
R-8.4 (1.48)	R-11.6 (2.04)	R-6.3 (1.11)	0.158 (0.90)
R-12.6 (2.22)	R-15.8 (2.78)	R-7.1 (1.26)	0.140 (0.80)
R-16.8 (2.96)	R-20.0 (3.52)	R-7.6 (1.33)	0.132 (0.75)

Glazing

$U_{centre\ of\ glass}$ Btu/ft² ·hr ·°F (W/m² K)	U_g Btu/ft² ·hr ·°F (W/m² K)
0.321 (1.82)	0.408 (2.32)

Combined Assembly

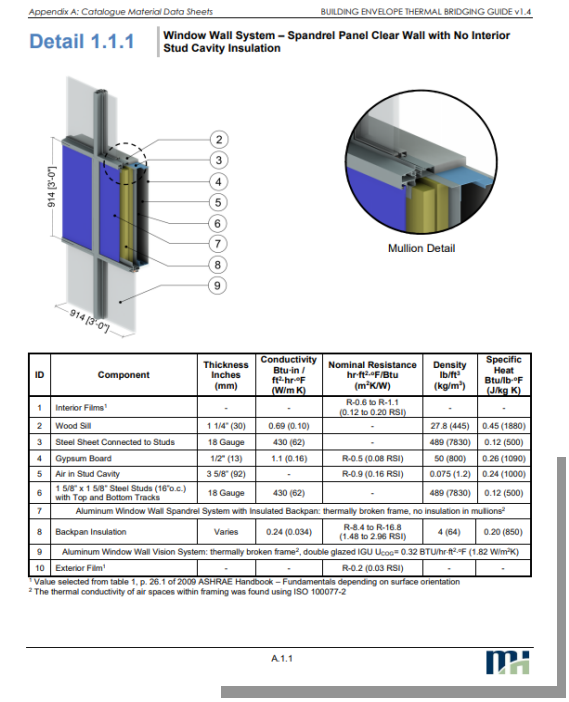
Backpan Insulation 1D R-Value (RSI)	R ft²·hr·°F / Btu (m² K / W)	U Btu/ft² ·hr ·°F (W/m² K)
R-8.4 (1.48)	R-3.2 (0.56)	0.314 (1.79)
R-12.6 (2.22)	R-3.2 (0.57)	0.308 (1.75)
R-16.8 (2.96)	R-3.3 (0.58)	0.305 (1.73)

Temperature Indices

	R8.4	R12.6	R16.8	
T_{i1}	0.63	0.64	0.65	Min T in stud cavity, on frame at backpan
T_{i2}	0.77	0.80	0.82	Max T on backpan, at center of backpan
T_{i3}	0.57	0.58	0.59	Min T on interior glazing, at corner of glazing

B.1.1

>>Window Wall Spandrel Material Data



Appendix A: Catalogue Material Data Sheets — BUILDING ENVELOPE THERMAL BRIDGING GUIDE v1.4

Detail 1.1.1 — **Window Wall System – Spandrel Panel Clear Wall with No Interior Stud Cavity Insulation**

Mullion Detail

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)	Specific Heat Btu/lb·°F (J/kg K)
1	Interior Films[1]	-	-	R-0.6 to R-1.1 (0.12 to 0.20 RSI)	-	-
2	Wood Sill	1 1/4" (30)	0.69 (0.10)	-	27.8 (445)	0.45 (1880)
3	Steel Sheet Connected to Studs	18 Gauge	430 (62)	-	489 (7830)	0.12 (500)
4	Gypsum Board	1/2" (13)	1.1 (0.16)	R-0.5 (0.08 RSI)	50 (800)	0.26 (1090)
5	Air in Stud Cavity	3 5/8" (92)	-	R-0.9 (0.16 RSI)	0.075 (1.2)	0.24 (1000)
6	1 5/8" x 1 5/8" Steel Studs (16"o.c.) with Top and Bottom Tracks	18 Gauge	430 (62)	-	489 (7830)	0.12 (500)
7	Aluminum Window Wall Spandrel System with Insulated Backpan: thermally broken frame, no insulation in mullions[2]					
8	Backpan Insulation	Varies	0.24 (0.034)	R-8.4 to R-16.8 (1.48 to 2.96 RSI)	4 (64)	0.20 (850)
9	Aluminum Window Wall Vision System: thermally broken frame[2], double glazed IGU U_{DOG}= 0.32 BTU/hr·ft²·°F (1.82 W/m²K)					
10	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

A.1.1

Morrison Hershfield

75 Years