How Canada's Building Codes & Energy Standards Affect Calculated Thermal Performance

An aerial view of construction of a new hospital with the building envelope designed to meet NECB 2017.

By Greer Stanier, M.ASc., Engineer-in-Training, Arthur Li, P.Eng., M.Eng., Project Engineer & Paul Pasqualini, P.Eng., M.ASc., Co-Founder, Engineering Link

The energy performance of a building is impacted by the building envelope's ability to resist energy transfer. Provincial codes and national energy standards state the minimum thermal resistance requirements for various assembly types. Compliance is generally demonstrated by either meeting these minimum prescriptive requirements, meeting a target overall building envelope thermal performance with allowable adjustments ("trade-offs"), or whole building energy modeling to demonstrate comparable or less energy consumption compared to an equivalent building designed to prescriptive requirements. In addition to outlining minimum thermal resistance requirements and compliance paths, the provincial codes and energy standards also indicate what components of building envelope assemblies are required to be considered when calculating the envelope thermal performance. Simply stated, the codes indicate what thermal bridging is to be considered when calculating effective thermal performance.

For designers and contractors, the implication from varying thermal bridging requirements across codes is that the same constructed envelope assembly can meet a target thermal performance in one jurisdiction but not another. This can have significant cost implications when trying to meet thermal resistance requirements, since the inclusion of previously omitted bridging elements may require different systems to be used to offset the reduction in R-value.

Taking this one step further, if a project requires a building's operating energy consumption to be accurately predicted (i.e., whole building energy modeling), it makes sense the effective thermal resistance provided should be as close to real-world performance as possible and include all thermal bridging elements. There are still thermal bridging components excluded in even the most stringent standards, like masonry ties and some major fasteners that can significantly reduce effective thermal performance of the envelope.

The effective thermal performance of typical rain screen brick veneer and metal cladding assemblies is significantly reduced under the guidelines of the *National Energy Code of Canada for Buildings (NECB 2017)* when compared to older energy standards such as *Ontario Supplementary Standard SB-10* and *NECB 2015*. Thermal performance of the typical assemblies is also considered for energy model input, revealing further reductions to the calculated thermal resistance when trying to achieve a specific target performance.

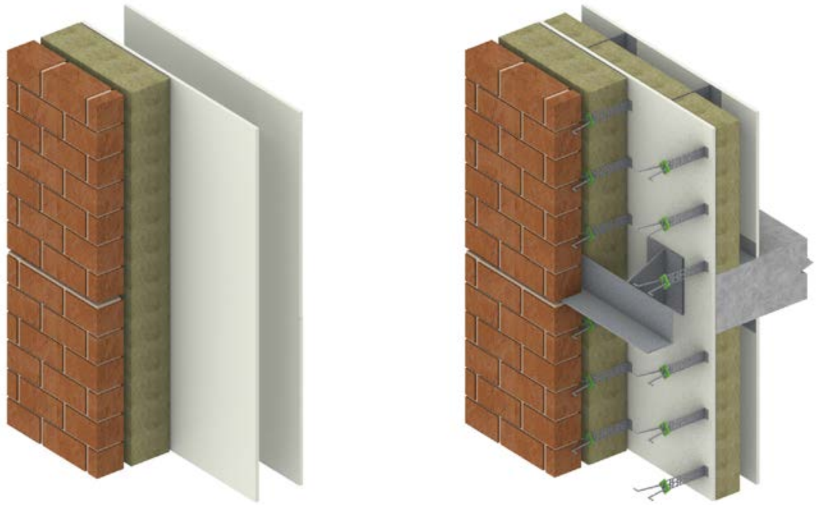

Figure 1. Representation of elements to be considered in Ontario Supplementary Standard SB-10 (left) vs. actual construction of the typical brick veneer assembly (right).

CURRENT ENERGY STANDARDS

In Ontario, *SB-10* remains the energy standard that has been enforced since January 1, 2017. Although the prescriptive thermal performance requirements in *SB-10* remain close to newer and current energy codes, many thermal bridging components aren't required to be considered for the thermal resistance calculation. Thermal bridging elements omitted include:

- Continuous steel shelf angle connections with a thermal break (thermal break type is ambiguous);
- Connections of structural load bearing elements where a thermal break can't be achieved;
- Structural projections that make up less than two per cent of the total envelope area;
- Masonry ties, and
- Flashings.

The introduction of *NECB 2017* requires consideration for all of the above elements to be included in effective thermal resistance calculations, except for masonry ties. Although still a model code for provinces and territories to adopt, *NECB 2017* is an indication of the direction for future codes and the introduction of more stringent thermal resistance requirements in new construction. This trend is evident locally in Toronto, with the updated *Toronto Green Standard (TGS) Version 3* modeling guidelines (effective October 19, 2020) addressing the gaps in *SB-10* to include thermal bridging to match what is effectively required from *NECB 2017*.

Figures 1 and 2 (above and on the next page) illustrate the typical brick veneer and metal panel assemblies and contrast the thermal bridging elements required to be considered when meeting *SB-10* compared to the actual construction of the assembly and the components required to be considered for energy model input.

THE IMPACTS OF THE THERMAL BRIDGES

Going from *SB-10* to *NECB 2017* resulted in a significant reduction in the calculated effective R-value in both cases as a result of the inclusion of more thermal bridging elements. Further discussion regarding the specific iterations considered for the brick and metal panel assembly cases are included in the next paragraphs (assumptions for each of the models are included in the footnotes at the end of this article).

BRICK

When considering the base case against *SB-10*, the effects of the steel shelf angle can be ignored, and with six inches of mineral wool insulation, the thermal resistance greatly exceeds the target R-value of R-21.4. However, for the same assembly, the effective thermal resistance is reduced by more than 50 per cent when designing to *NECB 2017*. The thermal bridging impact of the shelf angle can be mitigated by considering supporting the shelf angle with discrete knife plates or through a proprietary thermally broken system, like a shelf angle bracket. The spacing of the knife plates can be increased to further reduce thermal bridging, however, there are structural limitations on the maximum spacing that can be achieved. Other iterations explored include adding cavity insulation to the stud back-up wall on the interior and using stainless steel brick masonry ties for both options to achieve the target R-value for energy model input. Table 1, below, summarizes the modeled iterations for the brick veneer assembly.

METAL PANEL

Similar to the brick veneer assembly, the inclusion of bridging elements as defined by *NECB 2017* reduces the effective R-value by over 50 per cent when compared to *SB-10*. Consideration of insulation pins further reduces the thermal resistance by another nine

ASSEMBLY DESCRIPTION	SB-10 / NECB 2015	NECB 2015	NECB 2017		ENERGY MODEL	
TARGET – R-21						
Base Case	26.4	26.4	12.7	-52%	12.4	-2%
1) Base Case, with Knife Plates 24" OC	n/a	n/a	17.8	-32%	16.7	-6%
1 a) Base Case, with Knife Plates 48" OC	n/a	n/a	19.7	-25%	18.3	-7%
1 b) Base Case, with Knife Plates 48" OC and 3.5" of Batt Insulation in Studs	40.6	40.6	26.6	-34%	24.1	-9%
2) Base Case, with Shelf Angle Bracket	26.4	26.4	21.7	-18%	20.0	-8%
2 a) Base Case, with Shelf Angle Bracket and SS Brick Ties	n/a	n/a	21.7	-18%	21.5	-1%

Table 1. Brick veneer assembly iterations.

ASSEMBLY DESCRIPTION B	SB-10	NECB 2015	NECB 2017		ENERGY MODEL	
TARGET – R 21						
Metal Stud Wall with 6" Ci (Base Case) and Z-Girt	26.4	26.4	12.5	-53%	11.5	-9%
1) Base Case, with Discrete Support	n/a	n/a	16.8	-36%	14.9	-11%
1 a) Base Case, with Discrete Support and SS Baffles	n/a	n/a	18.6	-30%	16.3	-12%
1 b) Base Case, with Discrete Support, SS Baffles, and 3.5" Batt Insulation in Studs	40.6	40.6	24.6	-39%	20.8	-15%
1 c) Base Case, with Discrete Support, SS Baffles, 3.5" Batt Insulation in Studs, and Tube Washers	40.6	40.6	24.6	-39%	24.4	-1%

Table 2. Metal panel assembly iterations.

per cent when considering energy model input. It's clear that continuous cladding support systems (i.e., continuous z-girts) are not a thermally feasible option for cladding attachment under *NECB 2017*. Discrete cladding supports are subsequently considered to further reduce thermal bridging.

Additional iterations considered to achieve the target R-value for energy model input include using less thermally conductive materials for baffles / compartmentalization flashings (i.e., stainless steel), adding cavity insulation to the stud back-up wall on the interior, and using less thermally conductive insulation attachment systems, like plastic "tube washers." Table 2, above, summarizes the modeled iterations for the metal panel assembly.

WHAT THIS MEANS

Although a very simple comparison, the purpose of this analysis was to demonstrate the impact of the incoming newer energy standards on thermal performance of a typical brick veneer and metal panel assembly. Newer energy standards such as *NECB 2017*, *TGS Version 3*, and subsequent versions of each of these standards will continue to progressively introduce more stringent energy efficiency standards for new buildings in Ontario (and in Canada).

Inputs for energy modeling should be indicative of real-world performance and should be inclusive of all thermal bridging, beyond what current energy standards require. This analysis ultimately shows there are multiple wall design options that can be considered to achieve the required thermal performance of the envelope, and the costing implications of each option should be considered by the project team (designers, owners, and contractors) during design. ■

Greer Stanier is an engineer-in-training at Engineering Link. She has a master's degree in building science from Ryerson University.

Arthur Li, M.Eng., P.Eng. is a project engineer at Engineering Link. He has five years of building science experience in thermal modeling, building envelope restoration, and building envelope design for new construction.

Paul Pasqualini, M.ASc., P.Eng. is a co-founder of Engineering Link, focused on leading the firm's building envelope services and the parking structures practice area. Paul's expertise has led him to design envelope systems around the world, addressing various complex environmental and maintenance issues, including condensation and mould sensitivity, thermal and moisture management, deterioration, and preventative maintenance systems design.

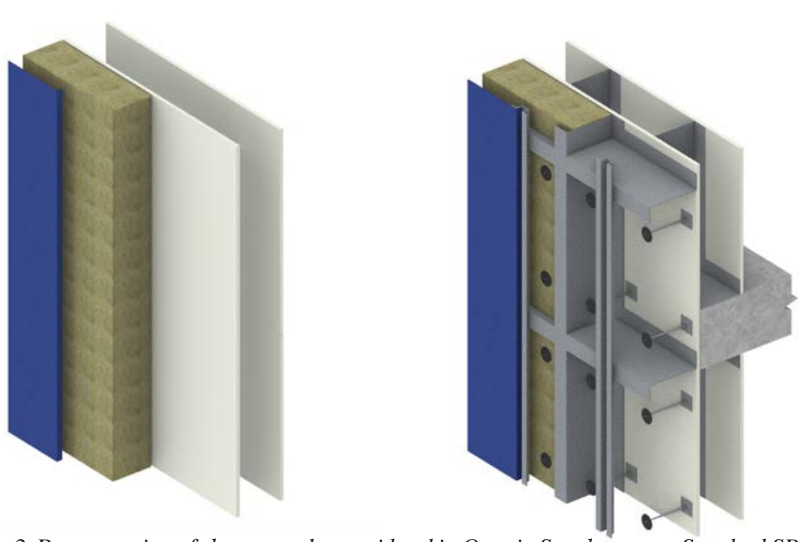

Figure 2. Representation of elements to be considered in Ontario Supplementary Standard SB-10 (left) vs. actual construction of the typical metal panel assembly (right).

FOOTNOTES

1. Both assemblies generally consist of exterior cladding, well-ventilated air space, six inches of semi-rigid insulation (mineral wool), half-inch sheathing on six-inch steel stud back-up wall, and half-inch drywall on a sample three-storey building with a 30 per cent window-to-wall ratio. Base case brick veneer assembly assumes a shelf angle anchored back to floor slab and galvanized steel masonry ties. Base case metal panel assembly assumes continuous z-girts with galvanized steel stick pins for insulation attachment.
2. For all iterations, effective thermal performance values are calculated based on *ASHRAE 1365-RP*, accounting for thermal bridges using linear and point thermal transmittances. The model considers typical linear thermal transmittance values for common attributes, like the slab edge, window transitions, corners, and parapet.