FACTS | Foam Plastic Applications for Better Building

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Building Thermal Envelope 101:
Identifying & Mitigating Thermal Bridges with FPIS ci

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INTRODUCTION

Modern energy codes, such as ASHRAE 90.1-2019 and the 2021 IECC, feature prescriptive requirements for continuous insulation (ci) in essentially all climate zones. Among other benefits, ci helps to prevent thermal bridging caused by framing as visualized in **Figure 1**. Without ci, the wall's cavity insulation is only 45% to 85% effective[1] for steel and wood framing, respectively. Ci also compliments the thermal mass of concrete and masonry walls, especially in cold climates where thermal mass effects are much diminished. It also plays a key role in other building applications such as roofs, foundations, and various retrofit or remodeling projects.

The conventional practice of addressing thermal bridges only within building assemblies is not the end of the story. Other major types of thermal bridges occur at building assembly and component intersections as shown in **Figure 2**. If not mitigated, a building thermal envelope's actual performance (effective R-value) can be decreased by typically 20-70%, or more, depending on the building materials, structural details, and insulation detailing (or lack thereof).

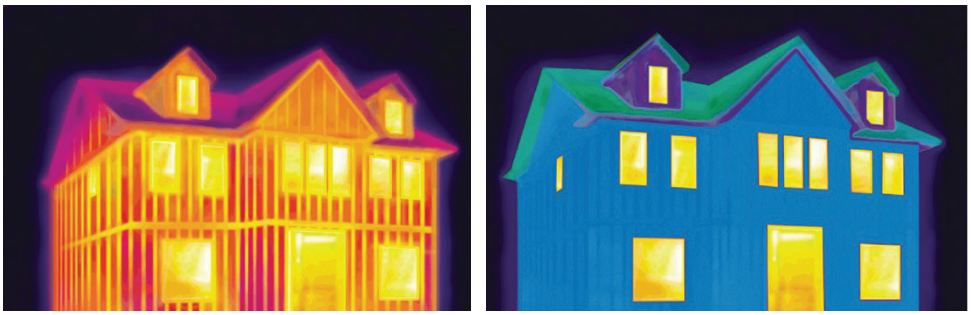
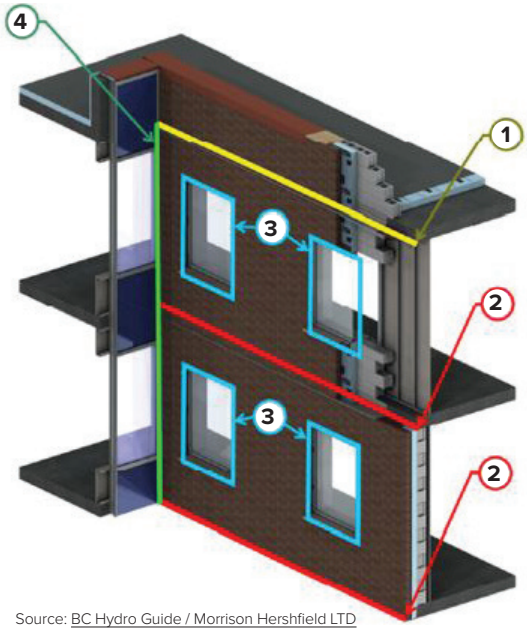


Figure 1. Thermal image illustration of (a) unmitigated thermal bridges with only cavity insulation between framing members and (b) use of ci to minimize thermal bridging. (Similar results can be expected in commercial buildings with and without ci.)



Source: BC Hydro Guide / Morrison Hershfield LTD

- **Clear field thermal bridges:** Repetitive framing members, cladding supports (e.g., Z-furring), and fasteners distributed relatively uniformly throughout a building assembly surface.[2]
- **Linear thermal bridges:** Roof-to-wall, floor-to-wall, window-to-wall, and wall-to-wall intersections that are linear in pattern of intensified heat flow (e.g., slab floor edges and projecting balconies, shelf-angles, parapets, etc.).

  See colored lines in figure:
  1 (yellow) = roof-to-wall linear thermal bridge
  2 (red) = floor-to-wall linear thermal bridge
  3 (blue) = window-to-wall linear thermal bridge
  4 (green) = wall-to-wall linear thermal bridge
- **Point thermal bridges:** Thermal bridges that occur at a discrete point on the surface area of the building thermal envelope assembly, such as a beam or column penetration.

Figure 2. Types of thermal bridges in building assemblies and assembly interfaces.

[1] Effective Insulation R-Values in Steel vs. Wood Framing, Building Enclosure Online, May 29, 2017.

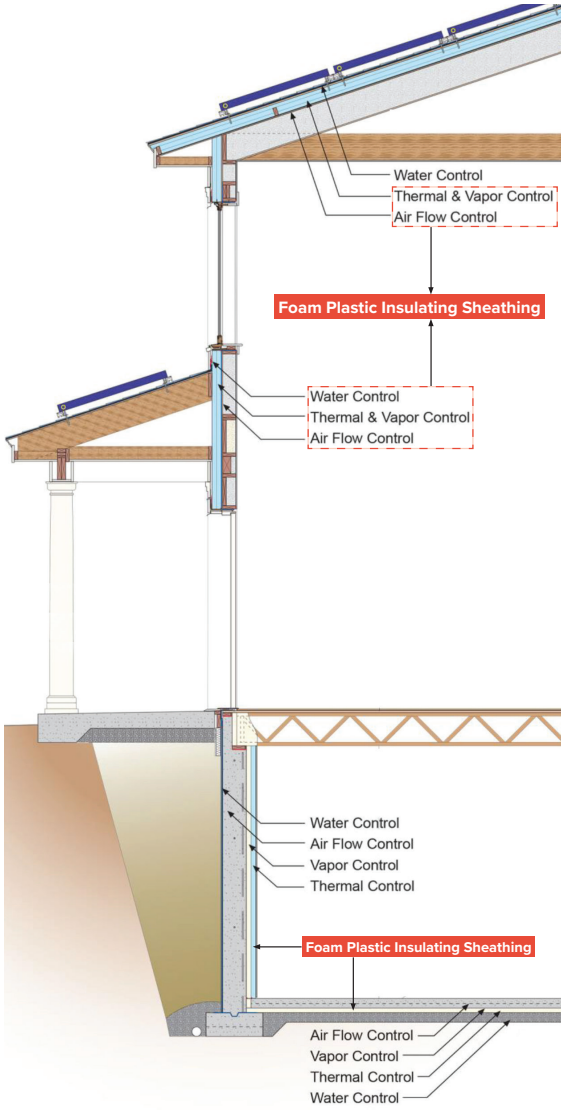
[2] According to the IECC and ASHRAE 90.1 definition of continuous insulation, the only permitted penetrations through continuous insulation are fasteners and service openings. Other penetrations, such as metal Z-furring (when not placed over the ci and fastened through it) are not permitted unless the impact on the assembly U-factor is accounted for.

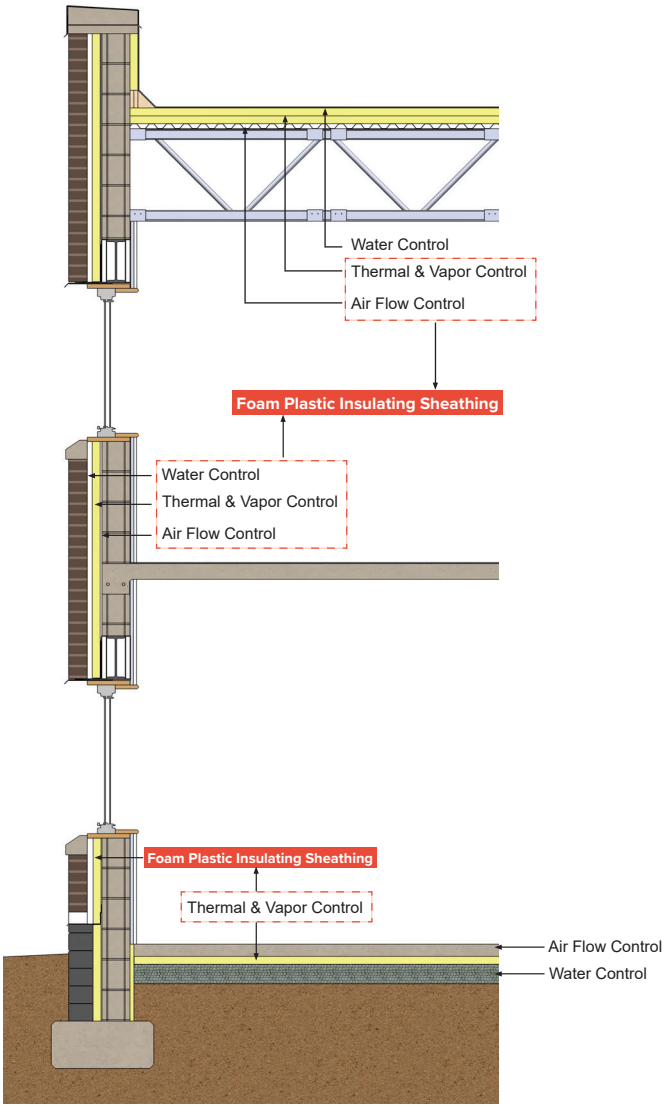
RESOURCES to Mitigate Thermal Bridges

Major thermal bridges at assembly interfaces have gone overlooked in past U.S. energy codes and practice. This is no longer the case in the pending 2024 IECC and the recently completed ASHRAE 90.1-2022 standard for commercial buildings. The following resources provide guidance for code compliance and best practices to mitigate thermal bridges:

- Thermal Bridging Prevention (web page with multiple resources listed).
- Thermal Bridging: Small Details with a Large Impact (educational presentation)
- Building Envelope Thermal Bridging (BETB) Guide (detailed design guide and data)
- Development of Thermal Bridging Factors for Use in Energy Models (design details and data)
- Thermal Performance of Façades (design details and data)
- BSI-081 Zeroing In and Construction Plans (details for high performance zero energy building continuous insulation)
- BSI-132 More on Continuous Exterior Insulation… (detailing cladding support fastening through ci)
- Cladding Connections through FPIS ci (solutions for cladding and furring attachments to minimize thermal bridging)

The following are example details used to mitigate thermal bridges at roof-to-wall, floor-to-wall, window-to-wall, and foundation conditions in both residential and commercial applications.





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