TECHNICAL ARTICLE

Preventing heat loss through concrete parapets using structural thermal breaks.

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Trapped by effective rooftop insulation, rising heat finds another means of escape into cold exterior environments — through conductive concrete parapets. Supported by the warm interior building structure, conventional concrete parapets form a thermal bridge that dissipates heat energy into the atmosphere like large cooling fins, aided by cold winds whipping over the rooftop. One solution is to wrap the entire parapet in a layer of insulation. Another is to cast a structural thermal break between the parapet and the heated interior structure supporting it.

Thermal bridges at concrete parapets mitigated with structural thermal breaks

Parapets serve the vital function of protecting the edge of roof assemblies from uplift forces created by winds blowing against and over the building. However, solving one problem creates another: a thermal bridge the length of the building perimeter that penetrates the insulated building envelope, conducting heat energy from the building's interior and dissipating it into the environment. In addition to energy waste, uninsulated parapets chill the heated interior support structure adjacent to the building envelope, forming condensation that supports mold growth, an increased problem in today's airtight, high humidity buildings.

The traditional approach to mitigating thermal bridging at parapets is to wrap its exposed surfaces with insulation, making it a part of the heated building mass. A newer method attempts to accomplish the opposite: to thermally separate or "break" the parapet from the heated interior structure by casting structural thermal break modules between the two masses.

A closer look at parapets

In his paper "Parapets: Where Roofs Meet Walls," Joseph W. Lstiburek, Ph.D., mused, "Historically, so many problems have occurred with parapets that we have a name for it: parapetitus...thermal bridging everywhere."

Thermal bridging – a primer

"Thermal bridging in building construction occurs when thermally conductive materials penetrate through the insulation creating areas of reduced resistance to heat transfer," ("Thermal Bridging Research: Parapets," Payette, July 2015). "These thermal bridges are most often caused by structural elements that transfer loads from the building envelope back to the building superstructure." The results of thermal bridging can include higher heat transfer (Fig. 2 and 3), colder internal surface tem-

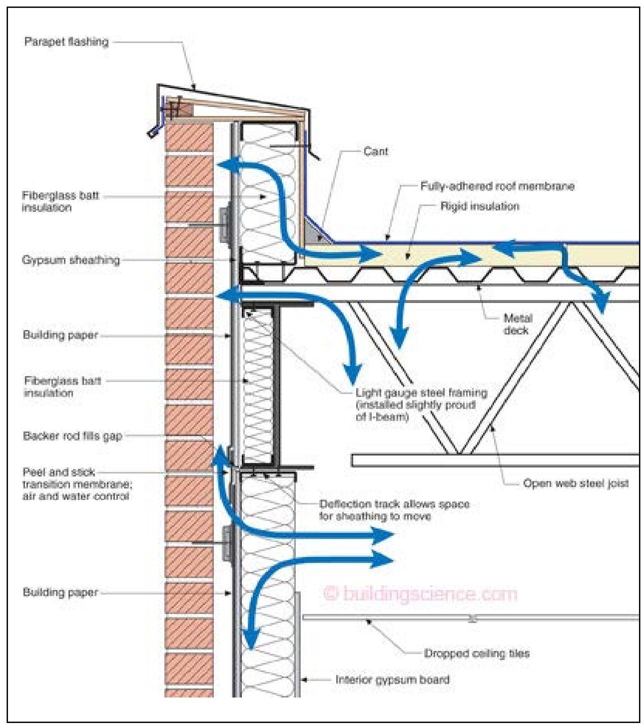

*Figure 1: Problem Parapet – Air leakage into and out of everything and everywhere. No membrane under the parapet flashing. No air control in either the roof assembly or the wall assembly. No vapor control layer and thermal bridging everywhere. (*Insight Parapets: Where Roofs Meet Walls*, June 2011)*

peratures, higher energy use for heating and cooling, noncompliance with building regulations, building occupant discomfort, condensation, and mold.
The two most common types of thermal bridging are material and geometric. Material thermal bridging occurs when a thermally conductive material or element penetrates an insulating layer and the protrusion conducts heat at a higher rate than does the insulation. Examples include balconies, parapets, steel anchor bolts, etc. Geometric thermal bridging occurs when a heat emitting surface is larger than the heat absorbing surface. Building corners are a typical example, but geometric thermal bridging can also affect wall/

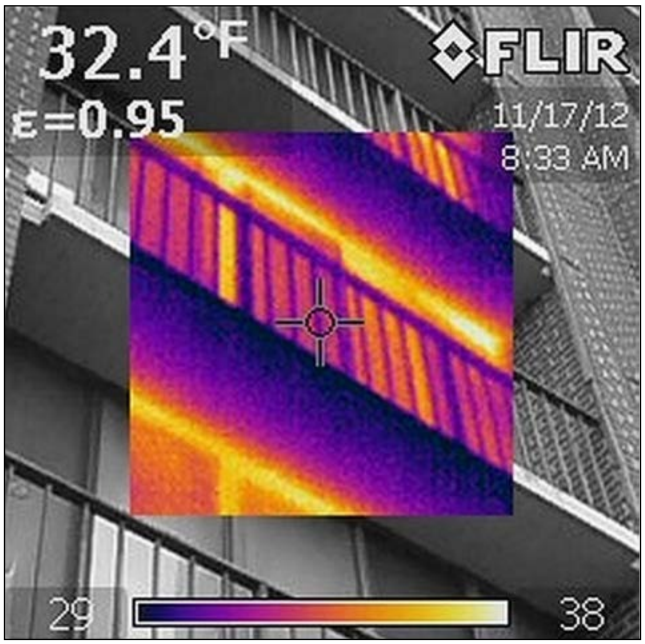

Figure 2: The thermographic inset shows the severity of heat loss without thermal breaking. (January 2013, “Schöck Blog: Bridging at NESEA BuildingEnergy”)

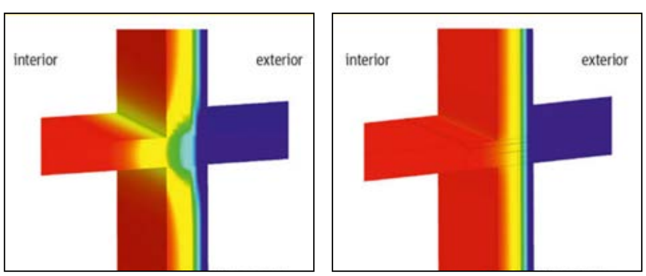

Figure 3: The thermographic image illustrates the difference in heat transference/temperature between an uninsulated balcony slab (left), and a balcony slab with a thermal break (right). (May 2018, Schöck Thermal Bridging Guide*)*

roof junctions, wall/floor junctions, junctions between windows, walls, and doors, and of course parapets. Often, material and geometric thermal bridging occur in concert.

Thermal bridges can also be described as having linear or point transmittance. Thermal bridges with linear transmittance are disturbances in the continuity of the thermal envelope that can occur along a certain length of the envelope. Typical examples include concrete balcony connections with the floor slab penetrating the wall, outer wall edges, floor supports and window-to-wall junctions.

Thermal bridges with point transmittance occur in one spot, when a fastening element (dowel, curtain wall support, anchor bolt) penetrates an insulating layer. Examples also include steel balconies, canopies and roof extensions.

While heat energy loss and carbon emissions are obvious consequences of thermal bridging, developers are faced with a newer and potentially more significant outcome: condensation and mold growth.

New efficiencies worsen a costly problem
Since older buildings leaked air profusely, interior humidity levels equalized with low exterior humidity levels, typically between 18% to 25% during winter months. Forced hot air blowing at or near cold penetrations such as balconies and parapets further ensured that the local interior humidity never rose to the dew point, thus preventing condensation and mold growth.

Because modern buildings are airtight, humidity levels can reach 30% to 40% during winter months. While comfortable for occupants, high interior humidity levels near chilled building penetrations can reach dew point, forming condensation that supports mold growth on adjacent surfaces such as sheetrock, insulation and any cellulose-based material, particularly in stagnant air cavities. Mold can become airborne years before it migrates to visible surfaces, exposing the developer to liability and remediation costs.

As a high-mass structural element that penetrates the building at its windiest point, parapets are especially susceptible to thermal bridging and its consequences, including mold.

Wrapping exterior parapet surfaces with insulation
To prevent thermal bridging, architects historically wrapped the perimeter of the wall with an insulation barrier and then wrapped the parapet as well, making it part of the heated building mass (Fig. 4). In addition to being costly and minimally effective, this method presented long-term risks.

When a parapet is wrapped, it functions similarly to an insulated flat roof, and has many of the same problems. Both roofs and parapets are prone to damage and need repair and maintenance, particularly if railings or other elements breach the insulating layer. Waterproofing of wrapped parapets rarely provides effective, long-term moisture protection, and leakage can incur significant recurring maintenance costs.

Designers at Payette researched this subject in their article, "Thermal Bridging Research: Parapets" (Payette, July 2015). "One question we found intriguing was whether it was better to insulate around the parapet — covering all structural interfaces — or underneath it by finding a way to design a structural connection that effectively attaches the parapet after installation of the insulation. Since there are many variables in the detailing of a parapet, we started with a sensitivity analysis of parapet height normalized to one construction type. Because the degree of impact of the assembly depends on how much of the building we are looking at in conjunction with the parapet, we also normalized on an extracted detail that includes 24 in. (61 cm) in height of inside wall surface and 48 in. (122 cm) in length of inside roof surface."

The Payette findings were compelling but not surprising. Naturally, the higher the parapet, the greater the potential for energy loss. Payette also discovered that insulating beneath the parapet – thermally breaking it from the roof – negated the height factor and provided the greatest possible insulation. "We tested a commercially available structural thermal break designed for concrete slabs (balconies) and installed this in a vertical orientation. The improvement decreased the heat flow through the assembly by 27%." (Fig. 5)

New parapet paradigm
A newer method of preventing thermal bridging at parapets calls for a thermal break designed specifically for the application. One example from Schöck North America, is an Isokorb® structural thermal break for parapets (Fig. 6 and 7), a load-bearing thermal insulation element that supports the parapet while thermally isolating it from the heated interior support structure.

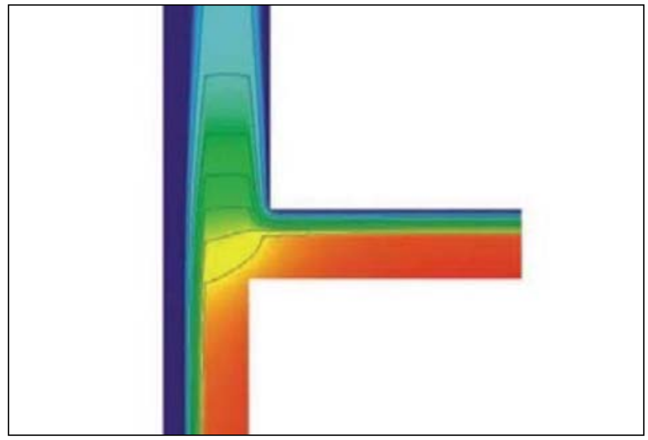
Figure 4: A parapet connection wrapped along its entire length, shown in this thermograph, demonstrates the significant heat loss that still takes place. (Schöck Technical Release, 2017)

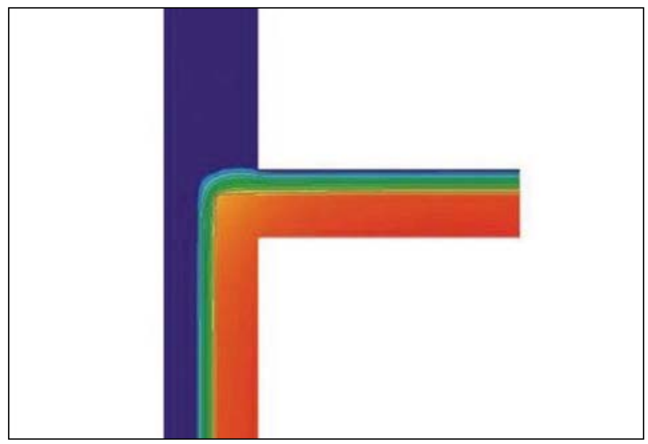
Figure 5: Thermographic image of the parapet connection in Figure 4, except thermally broken using the Isokorb® concrete-to-concrete parapet module, significantly reducing heat loss. (Schöck Technical Release, 2017)

Schöck describes the module as "a longitudinal assembly fabricated to the same width as the parapet. Graphite-enhanced expanded polystyrene insulation surrounds the stainless steel reinforcing bars, creating a structurally insulated module capable of transferring the loads from the parapet to the concrete roof slab that supports it, while minimizing thermal conductivity between the two concrete masses. U-shaped stainless steel rebar projecting from the underside of the module is cast into the rooftop slab, while vertically oriented stainless rebar projecting from the topside of the module is cast into the parapet, transferring moment and shear forces from the parapet to the concrete roof structure."

The module conserves heat energy, prevents condensation and mold, and lowers the parapet assembly U-value (the material insulation value) by up to 44%. Maintenance free once installed, it simplifies the formwork process, reducing construction costs by up to 10 percent versus the conventional parapet insulation wrapping method.

Parapet thermal breaks help attain LEED Gold
Developer Pacific Arbour Retirement Communities (PARC) pioneered the use of thermal breaks for balconies and shading eyebrows in their senior residences in Vancouver, BC. They subsequently welcomed a similar solution for their project in White Rock (part of the Vancouver metro area), as it not only had balconies and shading eyebrows, but also parapets.

Comprised of a 23-story tower main building and a two-story auxiliary building — White Rock's 199 residential units and tower building incorporate

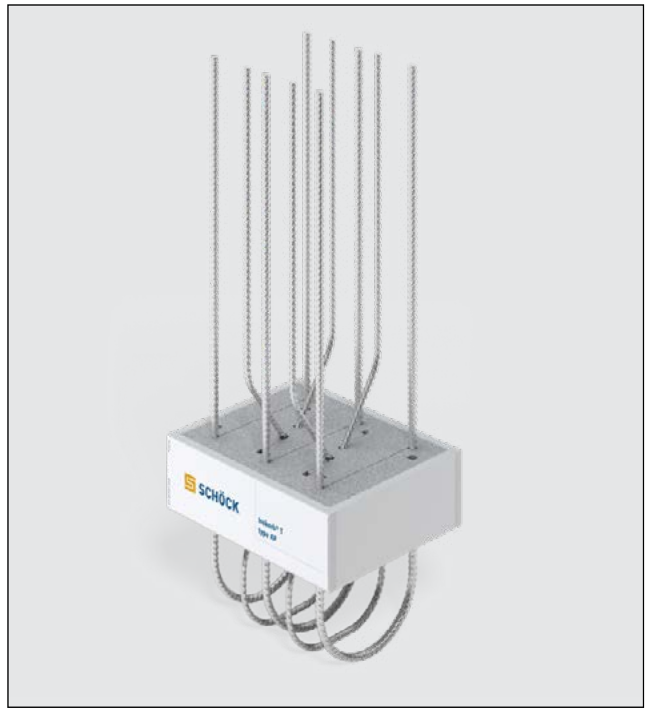

Figure 6: Isokorb® parapet structural thermal breaks can be oriented vertically (shown) or horizontally.

Figure 7: Rendering of an Isokorb® concrete parapet thermal break cast between a concrete roof slab and concrete parapet.

Figure 8: Isokorb® structural thermal breaks for parapets positioned against wooden parapet forms are tied into rooftop reinforcement before being cast in concrete.

1,820 concrete-to-concrete thermal breaks that insulate 5,970 linear feet (1,820 m) of balconies from exterior temperatures.

Parapets form the perimeter of levels two and three in both the main tower and the auxiliary building, for a total 1,100 ft (335.3 m).

“This was a new product for us and for Ventana Construction, which installed them,” explains White Rock Construction Manager Bob Fritz. “We’re always looking to improve on the comfort, efficiency, and sustainability of our facilities. So, White Rock was the perfect setting for us to work on incorporating the thermal breaks for parapets. If you’re going to be an owner/developer and your facility has parapets, this thermal break concept has significant benefit.”

References:

1. “Parapets: Where Roofs Meet Walls,” (June 2011) Building Science Corporation
2. Thermal Bridging Research: Parapets (Payette, July 2015)
3. *Schöck Thermal Bridging Guide*, (May 2018), Schöck Ltd. (UK)
4. “Facts about Mold and Dampness,” US Centers for Disease Control and Prevention
5. “Room Climatic Conditions in Residential Areas,” Heilman, K et al (1999)

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