Q What is the best way to reduce thermal bridging from a cantilevered steel beam protruding from a building for a balcony or canopy? We aim for high-performance enclosures and have been applying closed-cell spray foam along the length of the beam inside the structure, but we are not sure this completely mitigates the energy loss from this massive member conducting heat through the enclosure.

A *Marc Forget, associate editor of* JLC *responds:* While working with Kohta Ueno of Building Science Corporation on another question (see page 14), I ran this one by him as well. He agreed that any piece of steel that's projecting through a building's shell is a thermal bridge that degrades the overall value of the enclosure's insulation. "It becomes even worse," he explained, "as you add thicker and thicker insulation levels. You have a tighter bucket, but you have slit the same big hole in it."

According to Ueno, the ideal way to address the thermal bridge is with off-the-shelf structural thermal break products made by Schöck, Armatherm, and others. For a steel-to-steel connection, these are typically made with a high-density plastic pad that interrupts the steel beam at a bolt-through connection. This requires you to create your cantilever with two segments of steel—an interior section and an exterior section. Is this weaker than the typical unbroken, through-steel cantilever? "Absolutely," Ueno responded. "The beam must be designed by your structural engineer to account for that."

If the structure is already built, and a steel cantilever protrudes from the building, a 2-inch-thick coating of closed-cell spray will reduce the transfer, Ueno said. He compared it to wearing a mitten in winter; it's not ideal, but your hand will be warmer for wearing the mitten. "However, this solution, or coating the steel with an aerogel-incorporated paint, is only going to be as good as it is maintained or protected," Ueno cautions. "If decking is applied without care, or if [the insulation is] left to the elements, its performance will degrade over time."

I also consulted engineer Peter Baker, president of Building Science Corporation, to explore how different structural materials might perform. "Different materials are worse at [energy] transfer than others," he said. "Concrete is worse, steel next, and wood being the least." A concrete beam or concrete slab projecting from the building typically conducts more energy, he explained, because it needs to be bigger. "The bigger the protrusion, the more energy transferred through the building enclosure. A concrete slab coming out for a balcony or canopy generally has the most mass."

To minimize the energy transfer, Baker urged that we need to first think of minimizing the cross section of material that is being used. "Simply make the protrusion material as small as possible to reduce the potential transfer," he said.

Once the materials have been defined, we can add thermal breaks. Thermal break products for steel-to-steel, concrete-to-steel, and concrete-to-concrete connections are available from several sources, as noted above.

"Insulating the material both inside *and* outside of the penetration is a good strategy, too," Baker continued. "But this can be a challenge depending on both the material used and what will be applied to the beam outside of the building." For example, steel beams supporting a cantilevered deck can be insulated, but the connection between the deck and the cantilevered beams will create its own thermal bridge into the beam and through the enclosure. In this case, the steel beam can be fully coated before the deck is attached, and standoffs incorporated into the structure to allow for attaching the deck, minimizing the thermal bridging.

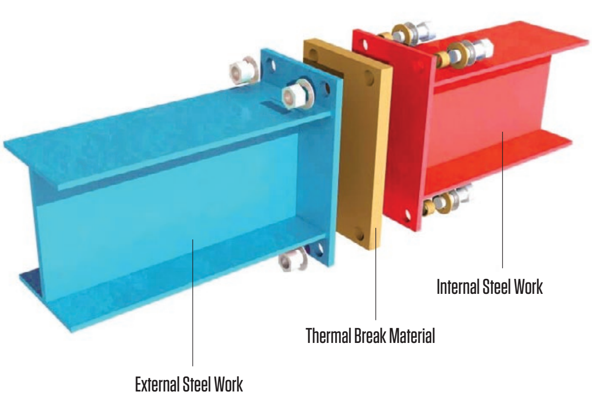

Illustration courtesy Armatherm

A thermal break material can reduce energy transfer through a steel balcony support.

Q As construction techniques and materials have advanced, we have gone from simple moisture-resistant drywall or cement board to plastic (polymer-based) bath and shower enclosure systems by Schluter, Mapei, Wedi, and the like. With these systems, do we need to start thinking of the vapor barrier and insulation behind these areas differently?

A *Kohta Ueno, a principal of the Building Science Corporation, responds*: For the most part, having an impermeable material on the inside is typically not a fundamental problem. In standard construction in a cooler climate, you typically put your less vapor-permeable material on the inside, whether it's polyethylene sheeting or a variable-perm retarder, such as Membrane or Intello. The downside of adding an impermeable layer on the inside is that you've reduced the amount of drying inward through the wall. So, if, for instance, you have a catastrophic water leak like a constantly leaking window in your shower stall, your wall has less of a chance to dry out.

In a shower, you have a lot of warm, moist air building up on the shower side and, in a cold climate, you have a strong vapor drive that wants to draw moisture toward the exterior. If warm, moist air leaks or diffuses into the framing cavity, it would likely condense on the inside face of the exterior wall sheathing. Fortunately, all the care and attention needed to install a shower system to be watertight also helps shuts down air leaks. Plus, the mechanical ventilation added to most shower areas helps exhaust the moisture and lightens the interior moisture load. For these reasons, failure (mold growth or rot) tends to be uncommon.

Shower enclosure membranes like Schluter's Kerdi, or Wedi's Subliner and the like, are not as vapor tight as, say, a sheet of plastic. I could see trouble in a hot, humid climate if you had a catastrophic air leak though the exterior into a shower-area stud bay. Inward airflow and condensation on the back surface of that enclosure membrane could become a problem. That's why putting polyethylene vapor barriers or vinyl wallpaper in a wall in Georgia or Alabama is a terrible idea, given all the air conditioning needed in those climates.

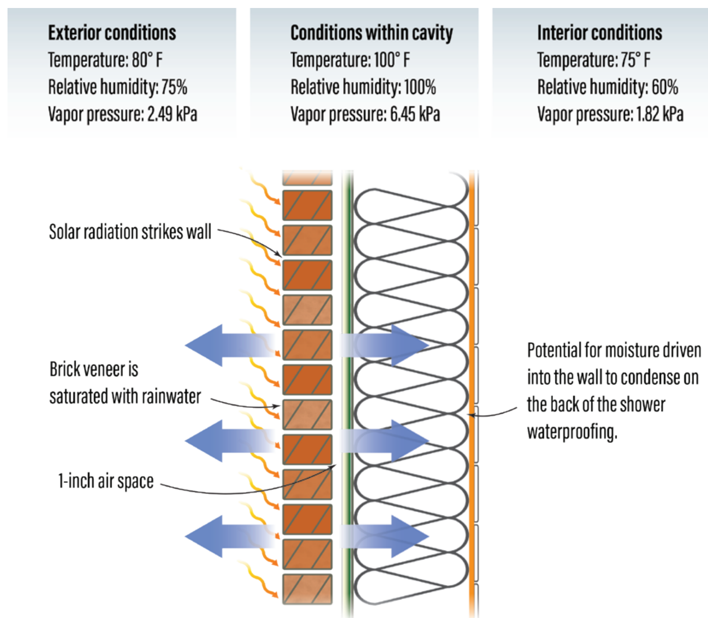

Illustration: Ola Kwiatkowska; adapted from Building Science Corp.

The other possible failure in any climate zone is when you have a brick veneer wall with inward vapor drive. Brick soaks up water like a sponge. When the sun hits the brick, vapor moves both inward and outward (see illustration above), but the vapor drive is blocked by the waterproofing system used on the shower walls. Theoretically, this could be a problem if the vapor condenses on the back of the shower enclosure. But in practice, it is extremely rare that problems develop—perhaps if the shower wall was completely impermeable, as you might have for a steam shower enclosure. But again, reported failures are rare.

CORRECTION In the May/June *Q&A* column, we reported on the volume requirements for a utility closet housing a heat pump water heater (HPWH). Requirements vary by manufacturer and model from 450 cubic feet to 700 cubic feet or more. While we got the volume right, we missed on the dimensions of a 450-cubic-foot space. An example of correct dimensions for a closet of this volume would be 10 feet by 6 feet by 7 feet 6 inches. Reader Wayne Bunker, P.E., also pointed out that the louver door on a utility closet will do nothing to isolate the HPWH from the rest of the basement. He rightly sums up: "These conventional heat pump water heaters work best in moderate climates where the cooling effect is beneficial."