BY CLAYTON DEKORNE

Retrofit Exterior Foundation Insulation

Researchers on the NorthernSTAR team of the U.S. Department of Energy's Building America program have been working on a problem that will intrigue anyone finishing out a basement or wanting to make a real dent in the energy performance of an existing home in a cold climate: Is there a minimally invasive, cost-competitive, easily deployable method of upgrading soil-side foundation insulation in existing buildings? There's a lot packed into that question.

Minimally invasive. Adding insulation to the outside of a building foundation is usually difficult to impossible to do on an existing home. In cold climates, we are typically dealing with frost walls or a full basement, so the job will require a wide trench around the building perimeter to allow workers to damp-proof and secure rigid foam insulation or drainable fiberglass boards. Concrete steps, sidewalks, and driveways next to the house, as well as decks, porches, landscaping, attached garages, and utility connections are some of the common obstructions that make it difficult to excavate the perimeter. This is to say nothing of tree roots and unstable soils that can further complicate the excavation.

A "water knife" (a power washer) is used to slice a narrow slot around the perimeter of a house in Minneapolis. The Building America project successfully demonstrated that exterior foundation insulation can be cost-effectively retrofitted on existing homes to boost energy savings and help control moisture migration through the foundation.

Photo: NorthernSTAR Building America Partnership

Cost-competitive. With all of these complications, the cost to excavate will almost always seem more expensive than insulating the interior walls. But there are some hidden costs to interior foundation insulation, lurking in the form of moisture problems.

Soil-side foundation insulation. In new construction, best practice favors exterior foundation insulation for the simple reason that insulating the interior of a basement in most climates, and especially cold ones, is fraught with problems. The soil will always be wetter than the conditioned interior, and the air in all of the tiny spaces between soil particles will be saturated (100% relative humidity). This creates high vapor pressure relative to the interior space that will result in a continuous flow of moisture through the below-grade portion of the foundation wall from outside to inside. Plus, water will wick up from the ground under the footing, which is below the perimeter drain and is consistently wet. To prevent condensation on interior surfaces within the insulated assembly, you will need perfect vapor barriers on both sides of the interior assembly. And perfect just doesn't happen in basements.

Exterior insulation solves most moisture problems by allowing the foundation to dry to the inside. Exterior insulation will also help to reduce the amount of water the foundation sees and will keep the foundation wall warm, which also promotes drying. Interior moisture may still need to be exhausted with mechanical ventilation, but you won't have wet walls or mold. (For a detailed discussion of interior versus exterior foundation insulation, search YouTube for "foundation insulation effectiveness.") The potential for mold and moisture may be worse if the existing foundation walls are not damp-proofed and perimeter drainage does not exist.

"Excavationless" retrofit strategy. In an exploratory study, published early in 2013, the NorthernSTAR team examined all of the variables involved with retrofitting exterior foundation insulation and considered all the options available as retrofit strategies. The strategy that rose to the top, at least on paper, was an "excavationless" approach that involved cutting a narrow slot near the

At wide spots in the trench, the foam is poured to a consistent thickness against a sheet of OSB.

Rigid foam covers the rim joist. The top edge will be capped and flashed, and the face covered with an elastomeric parge coat.

foundation and filling it with a "pourable" polyurethane foam—a low-expansion, closed-cell formulation that cures more slowly than the usual spray-applied variety. The pourable foam can be applied in a much thicker layer to fill the slot without risk of spontaneous combustion caused by an exothermic curing reaction.

To cut the slot, the technique that seemed to hold the most promise uses pressurized water to loosen soil and a truck-mounted vacuum to remove the loosened slurry through a hose. This technique, which sometimes uses compressed air rather than water, derives from an operation called "potholing" that utility companies commonly employ to sink small, deep holes when locating utility lines.

Retrofit in action. Last summer, the NorthernSTAR team got its first chance to put these ideas into practice, retrofitting exterior insulation on a turn-of-the-last-century, two-story home in Minneapolis. Using a "water knife" and a truck-mounted vacuum, the crew was able to cut a fairly consistent slot around almost half the house **(1)**. In some places, sandy backfill could be removed using just the vacuum, but this resulted in a fairly wide hole. In other places, rubble from an earlier addition caused trouble, and the sides of the trench opened up. When it came time to pour the foam in these wide spots, a piece of OSB was needed to contain the pour and maintain uniform thickness **(2)**. The slotting technique avoided most of the common obstructions near the foundations. At concrete steps and other unavoidable obstacles, the water knife was used to tunnel underneath, so the foundation could still be insulated. Penetrations from water, electrical, and gas lines were identified from inside, and the crew moved cautiously around these. But these delicate obstacles are what the "excavationless" technology was designed for, and the crew was able to clear these without damage to the lines.

Pat Huelman, coordinator of the Cold Climate Housing program at the University of Minnesota and a member of the NorthernSTAR team, admits that whatever could go wrong on this first project did. But in the end, the team proved that the techniques were feasible. Compared with any other technology—a backhoe, chain trencher, pick and shovel—the water knife was incredibly efficient. The downside was that no perimeter drainage could be installed in such a narrow slot. But it's a calculated trade-off. The home didn't have drainage to begin with, and the water-resistive nature of the foam would reduce moisture flow.

To complete the retrofit, the team extended the pourable foam with rigid foam insulation above grade to cover the rim joist **(3)**. Insulating the rim joist brings it inside the thermal envelope, which helps keep it dry. This is better than insulating the rim on the interior within the joist bay. Even when air-sealed, this isolates the rim joist to the cold exterior. If the rim sees moisture, which will inevitably wick up from the sill, it tends to rot. Huelman says that there are many ways to make the transition from the poured foam to the above-grade portion, and the method tried this first time can be improved on future projects. But overall, the project was successful in demonstrating what used to be just a pipe dream: a cost-effective retrofit strategy for insulating the exterior of basement walls.

Clayton DeKorne is the executive editor of JLC. *For more information, search for "Excavationless Exterior Foundation Insulation Exploratory Study" at the EERE Library (http://www1.eere.energy.gov/library).*

Photos: NorthernSTAR Building America Partnership