Building America Case Study

Innovative Retrofit Foundation Insulation Strategies

Minneapolis, Minnesota

PROJECT INFORMATION

Project Name: Innovative Retrofit Foundation Insulation Strategies for Concrete Masonry Foundations

Location: Minneapolis, MN

Northern*STAR* Building America Partnership

Building Component: Concrete block masonry foundation

Application: Retrofit

Year Tested: 2013

Climate Zones: Cold (6 and 7)

PERFORMANCE DATA

Cost of energy-efficiency measure (including labor): $4,600

Projected energy savings: 8.8% site energy savings compared to uninsulated concrete block

Projected energy cost savings: $125/year

Historically, most foundations in International Energy Conservation Code climate zones 6 and 7 have been basements with uninsulated concrete block walls. These types of basements account for a meaningful fraction of a home's total heat loss and frequently experience moisture damage. Buoyant cavity flow loops in a basement's open block cavities can transport water vapor upward to the rim joist. Even when block cavities are capped, wet foundation masonry can act as a moisture source for wood rim joist components in contact with the wall. As below-grade basements are increasingly retrofitted for habitable space, cold foundation walls pose increased challenges for moisture durability, energy use, and occupant comfort.

The Northern*STAR* Building America Partnership, which is a U.S. Department of Energy research team, is addressing the problem. The team evaluated a retrofit insulation strategy that is designed for use with open-core concrete block foundation walls. The three main goals were to improve moisture control, improve occupant comfort, and reduce heat loss. The strategy relies on a three-step process:

1. Fill open concrete block cores entirely with a Class II vapor-retarding solid insulating fill such as closed-cell spray polyurethane foam (ccSPF).
2. Install a water-control layer on the outside of the rim joist.
3. Add R-10 exterior insulation.

The water-control layer and the insulation extend 1 ft below grade. The core fill is designed to improve the R-value of the foundation wall but more importantly to block potential advective core cavity thermal and moisture flows. The water-control layer sheds bulk exterior water and keeps the rim joist and foundation wall relatively dry. The exterior insulation increases interior enclosure surface temperatures, improves occupant comfort, and reduces heat loss through the foundation. Such an insulation package achieves many of the benefits of full-wall exterior insulation, including comparable performance, at a lower cost and minimizes the moisture and indoor air quality issues associated with interior insulation retrofits.

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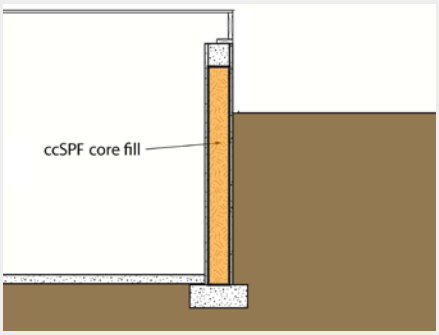
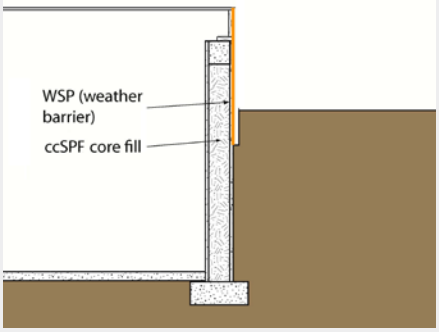
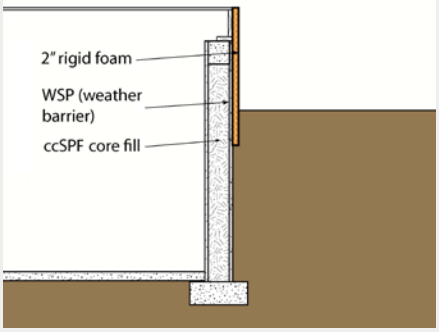
INSULATION RETROFIT



Step 1. Hollow masonry block cores are filled with ccSPF to block convection currents and associated moisture transfer.



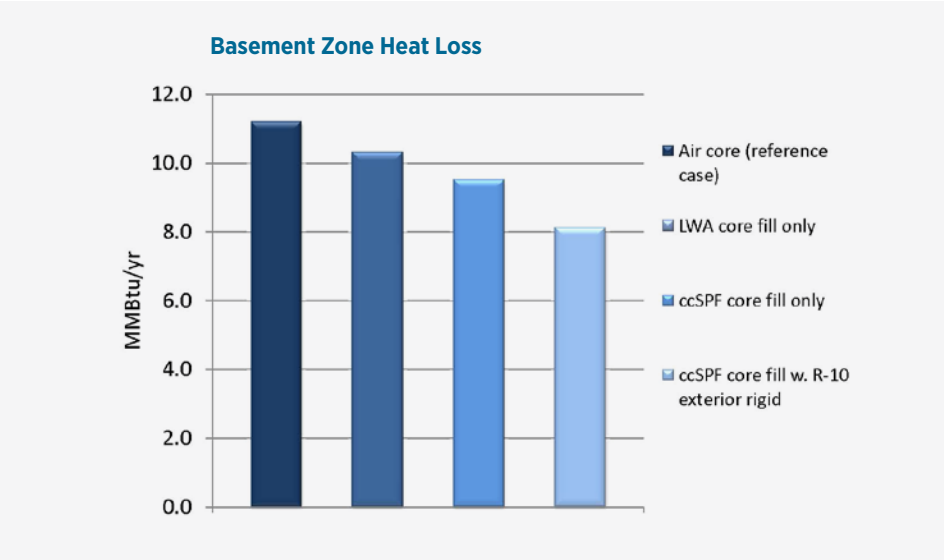
Step 2. A water-control layer is added to the exterior rim joist down to 1 ft below grade to shed bulk water.



Step 3. 2 in. of exterior rigid foam is added down to 1 ft below grade to control heat loss and warm interior surface temperatures.

For more information, see the Building America report *Innovative Retrofit Foundation Insulation Strategies for Concrete Masonry Foundations* at *buildingamerica.gov*

Image credit: All images were created by Northern*STAR*.



A simple ccSPF core fill reduced basement zone heat loss by 15%. Combining a ccSPF core fill with R-10 exterior rigid insulation installed to 1 ft below grade reduced heat loss by 27%.

The research team studied the benefits of this retrofit insulation approach by using several simulation tools, which included Building Energy Optimization (BEopt™), EnergyPlus energy, space, and surface temperature modeling, and WUFI 2D hygrothermal analysis.

Lessons Learned

- The ccSPF core fill combined with R-10 exterior rigid foam installed to 1 ft below grade reduced basement heat loss by 27% and saved 8.8% in site energy use.
- Above- and below-grade interior wall surface temperatures increased from approximately 50°F in the winter (on average) to 66°F. This resulted in warmer interior temperatures and improved occupant comfort.
- Installation costs are low because minimal excavation and interior work are needed. Estimated costs were $36/linear foot of foundation compared to $71/linear foot for full-depth extruded polystyrene exterior insulation.

Looking Ahead

More work is needed to understand—both theoretically and experimentally—moisture transport in hollow-core masonry block walls. This phenomenon was measured during an experiment at the Cloquet Residential Research Facility in Cloquet, Minnesota.

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