



Building America Case Study Technology Solutions for New and Existing Homes

Exterior Foundation Insulation Upgrade—Eagle Bluff

Lanesboro, MN

PROJECT INFORMATION

Deep Energy Reduction Retrofit, Eagle Bluff Environmental Learning Center
Lanesboro, MN

Partners: Minnesota Environment & Natural Resources Trust Fund

Builder: Jeff Vilen Construction

Designer: Kirk Project Management

Application: Single family deep energy retrofit

Year Tested: 2011

Climate Zone 6A

PERFORMANCE DATA

Cost of Energy-Efficiency Measure (including labor): \$20,300

Projected Energy Savings: 91% reduction in heat flow through basement walls based on PHPP modeling (59.5 MMBtu reduction per year)

A full project brief is available. Contact director@eagle-bluff.org



Eagle Bluff, a non-profit residential environmental learning center, has completed a deep energy reduction retrofit on the Eagle Bluff director's residence, its oldest, least energy-efficient building. The goal of the project was to reduce overall energy consumption of the residence by more than 70% and to offset all remaining energy use with renewables to achieve carbon neutrality. The residence is an early 1970s stick-framed 1½ story detached single-family home.

Prior to this project, the foundation was uninsulated cast-in-place concrete. Between one half and one third of the vertical dimension of the basement wall was exposed to the atmosphere, and there was a small walkout section, with full-height exposure. Six inches of extruded polystyrene (XPS) were added to the exterior of the foundation wall. This insulation lies in the same plane as the polyisocyanurate insulation added to the above-grade walls, maximizing thermal boundary continuity. The XPS was covered by fiber cement panels as a protective surface above grade.

This project used an exterior foundation insulation approach. While requiring excavation to expose the full height of the foundation wall, this option confers multiple benefits:

- Minimizes risk of moisture accumulation that can occur with interior retrofits, especially those that use batt insulation and / or vapor retarders
- Maximizes airtightness and thermal boundary continuity at the rim joist, compared to interior insulation approaches
- Minimizes disruption of interior finishes
- Allows in-plane alignment with foam insulation added outside the sheathing on above-grade walls.

“We made every effort to seal everything as tightly as possible...”

Jeff Vilen

Jeff Vilen Construction



In this image, the waterproofing membrane has been applied to the foundation walls. The trench is still open, and insulation installation will follow.



Here, the six inches of foundation insulation has been applied. Treated furring strips have been installed to allow fastening of protective cover materials. Note that the waterproof membrane extends beyond the height of the insulation. This will allow the membrane on the above-grade walls to lap correctly over the lower material.

Notice the post in the lower right corner of the image. It was put in place during backfill, and allows the installation of a deck without penetrating the water and thermal control layers.

Looking Ahead

Exterior foundation insulation confers many benefits in new construction and upgrade applications. One challenge in upgrades is with the monetary cost and landscape disruption. Another challenge is in assessing the ability of energy models to predict heat flow below grade. Both of these areas are under active study, and new information and methods are coming.



After installation of moisture control and thermal control layers, an auditor conducts a thermal imaging test to identify any air leaks or thermal bridges. It is critical to perform this testing before finish layers are added, in case remedial work is required.

Lessons Learned

- One significant challenge was the fact that the above-grade walls were out of alignment with the foundation walls by as much as nine inches. To bring the walls into alignment, pressure treated frame walls were added outside the foundation walls. These were in turn covered by a waterproofing membrane and insulation.
- Predicted savings are based on energy modeling done with the Passive House Planning Package (PHPP). The model determined that pre-upgrade foundation was responsible for 49% of the envelope heat loss, at 64 MMBtu per year. This upgrade cut that value by 91%, with a predicted post-upgrade heat loss of 4.6 MMBtu per year.
- The chief benefits of this approach are a reduction in building energy use, decrease in the potential for below-grade water intrusion, and an increase in comfort in below-grade spaces due to warmer, drier exterior walls.
- The other option for adding foundation insulation is to place the insulation on the inside of the foundation. This method is less costly, and less destructive to the landscape around the house. If insulated on the inside, basement walls can accumulate water. With no excavation, there is no opportunity to upgrade waterproofing on the correct (exterior) side. Any moisture is not allowed to dry to the interior due to the insulation and finish materials on that side of the wall. In addition, interior insulation does not allow in-plane alignment with moisture and thermal control layers above, potentially limiting their effectiveness.