U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

BUILDING TECHNOLOGIES PROGRAM

Building America Case Study
Technology Solutions for New and Existing Homes

Exterior Foundation Insulation Upgrade—Duluth Residence

Duluth, MN

PROJECT INFORMATION

Private residence, phased deep energy retrofit

Duluth, MN

Builder: Steve Johnson Building and Remodeling, Duluth MN

Designer: Wagner Zaun Architecture, Duluth, MN

Building Component: Envelope: Foundation Wall

Application: Single family home, retrofit (also suitable for multi-family)

Project year: 2009

Climate Zone 7A (applicable to most climate zones. Termite risk must be assessed)

PERFORMANCE DATA

Cost of Energy-Efficiency Measure (including labor): $7,142

No testing or modeling done on project. Homeowners report increase in winter basement temps of 5-10°F. The dehumidifier sees about half the summer runtime compared to pre-project operation.

The owners of this home in Duluth, MN conducted a phased deep energy retrofit in 2009. The residence is a one and three-quarter story, stick-framed house built in 1902. The home is located on Park Point, an area with very sandy soils. Its concrete block foundation had no evidence of groundwater intrusion. Approximately one fourth of the foundation wall was exposed to the atmosphere. The interior was unfinished, but contained all the home's mechanical systems as well as a lot of storage. The main intent was threefold: create a warmer basement in winter, reduce the need for summer dehumidification in the basement, and reduce energy usage for winter heating and summer dehumidification.

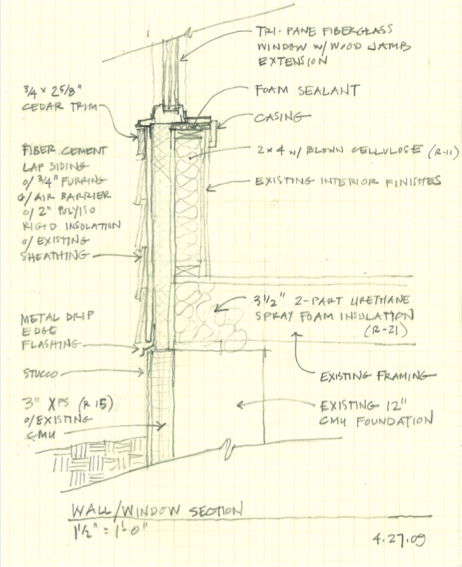
Three inches of extruded polystyrene (XPS) was used for below-grade insulation. The rim joist was addressed by adding three inches of spray polyurethane on the inside, and two inches of polyisocyanurate on the outside. Waterproofing was applied to the soil side of the XPS, due to the irregularity of the foundation surface and concerns about water freezing in the joints between XPS sheets. This approach also minimizes risk of moisture accumulation in the insulation. Existing clay drain tile were left in place; no additional drainage was installed due to the free-draining soils on site.

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 in concrete block foundations
- Maximizes airtightness and thermal boundary continuity at the rim joist, compared to interior-only insulation approaches
- Minimizes disruption of interior spaces

"Taking care of the foundation from the exterior literally laid the groundwork for the work we plan to do to upgrade the above grade walls."
Rachel Wagner, Wagner Zaun Architecture

Building America U.S. Department of Energy



Wall section showing the final assembly, after above-grade walls are insulated.

Full-height foundation wall insulation prior to backfill. Note waterproofing membrane applied to insulation.

Same section of wall after backfill. Metal lath has been applied to receive a protective coat of stucco.

All images courtesy of Rachel Wagner

Corner condition at the rim joist as it progresses throughout the project. The first image shows the condition after installation of insulation and protective stucco covering. The second shows the addition of flashing and waterproofing materials, and partial application of exterior rim joist insulation. The third shows the completed detail.

Lessons Learned

- Site conditions and cost constraints must be weiged against upgrade benefits. In this case, 42 linear feet of sidewalk had to be removed to provide access on the south wall. Meanwhile, the west wall was left uninsulated due to mature plantings, a bay window, and a concrete stoop. In total, about 85% of the foundation wall was addressed.
- The chief benefits of this approach are a reduction in building energy use, decrease in the potential for below-grade water intrusion and other moisture issues, and an increase in comfort in below-grade spaces due to warmer, drier exterior walls and lower humidity in the basement.
- The other option for adding foundation insulation is to place the insulation on the inside of the foundation. This method is usually less costly, and less destructive to the landscape around the house. If insulated on the inside, moisture management is critical. Concrete block foundations are at enhanced risk of moisture issues when insulated from the interior due to the hollow block cores, which led the project team to use an exterior approach.

Looking Ahead

Exterior foundation insulation confers many benefits in new construction and upgrade applications, but there are many challenges. 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, to justify the costs. Both of these areas are under active study, and new information and methods are coming.