



Building America Case Study

Durable Interior Foundation Insulation Retrofits for Cold Climates

Cloquet, Minnesota

PROJECT INFORMATION

Project Name: Cold Climate Foundation Research Facility

Location: Cloquet Residential Research Facility, Cloquet, MN

Partners: NorthernSTAR Building America Partnership

Building Component: Foundation wall system

Application: Retrofit and new; single-family and multifamily

Year Tested: 2012-2014

Applicable Climate Zone(s): Cold, very cold

The U.S. Department of Energy Building America team, NorthernSTAR, conducted experiments at the Cloquet Residential Research Facility in Cloquet, Minnesota, to test the heat and moisture performance of four full-scale hollow masonry block wall systems and two rim-joist systems. These systems were retrofitted with interior insulation in compliance with the 2012 International Energy Conservation Code (IECC).

The primary objectives of this research were to:

- Develop credible long-term hygrothermal performance data for retrofitted foundation wall insulation systems.
- Generate public experimental data sets to validate and calibrate building foundation hygrothermal simulation codes that can be used to quantitatively assess compliance with the performance criteria.
- Test retrofitted foundation wall systems with interior and exterior insulation placements.

A conductance-based method for measuring masonry moisture contents with high precision should be used to test the moisture content of the wall interior face. This should be done during a wet time of year such as spring for at least 1 month (this method is described in detail in the accompanying technical report). The moisture content data should be reduced to the average moisture saturation ratio of the interior wall face.

The research showed for the first time that, for masonry block walls in a cold climate, a solid bond beam or equivalent provides adequate resistance to moisture transport from a hollow core to the rim-joist cavity. Thus, a solid top course is a minimum requirement for an interior retrofit insulation system.

If the saturation ratio is $\leq 25\%$, a self-adhered water separation plane (WSP) (usually a “peel-and-stick” membrane adhered directly to the wall) may be used if the surface of the wall is bare, clean (or can be rendered clean) and reasonably smooth. Before the WSP is installed, a compatible primer should be used to prime the wall per manufacturer’s instructions. The WSP is then installed from

Interior Basement Retrofit Wall System Configurations



Self-adhered WSP



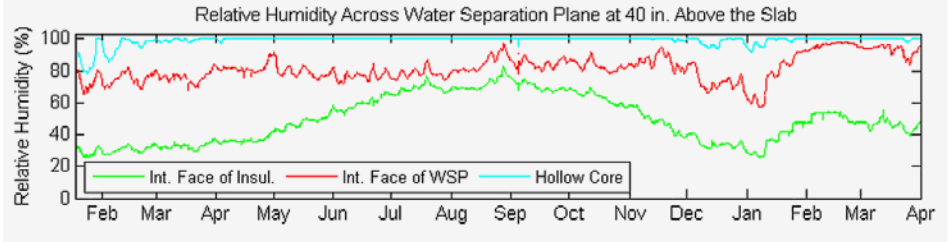
Nonadhered WSP with sealed perimeter



Rigid insulation with caulked joints

For more information, see the Building America technical report, *Cold-Climate Foundation Retrofit Experimental Hygrothermal Performance: Cloquet Residential Research Facility Laboratory Results*, at buildingamerica.gov.

Image credit: All images were created by the NorthernSTAR team.



Relative Humidity Across Self-Adhered WSP on a North Masonry Block Wall

the top of the slab to the top of the wall with all vertical joints overlapped at least 6 in. Horizontal seams are not recommended but, if necessary, should be ship-lapped with a 6-in. overlap.

If the saturation ratio > 25%, there is visible evidence of current or past bulk water leakage, or the wall surface is unfit for an adhered WSP, a nonadhered WSP must be used. These products provide a small gap between the sheet and wall (e.g., dimpled sheet with dimples facing the wall). The drainage plane between the membrane and the wall must be directed to a drainage system at the base of the WSP. In the experiment, this was a channel at the base of the wall above the slab. Instead, a perimeter drain tile beneath the slab edge (which must be removed) is possible with the WSP extended to the top of the footing. WSP horizontal joints should be avoided and all vertical joints should be overlapped at least 6 in. and sealed with a compatible, durable, vapor-resistant adhesive (not caulk). The WSP is adhered to the wall with mechanical fasteners and all fastener penetrations should be sealed. The exposed perimeter of the WSP and the drainage system should be vapor sealed from the basement interior.

Per the 2012 IECC, insulation should be installed against the face of the WSP so it does not damage the WSP. Vapor-retarding insulation, such as extruded polystyrene board, is preferred. Whichever insulation system is used should prevent condensate rundown on the WSP interior face at 50% indoor relative humidity and allow the insulation system to dry to the interior. All insulation joints and vapor bypasses must be air sealed.

Lessons Learned

- There is no particular advantage for the partial wall exterior insulation system unless the insulation extends at least to the top of the rim joist, in which case the interior rim board surface relative humidity was lowered substantially over the uninsulated case.
- Neither adhered nor nonadhered interior WSPs produced perpetually wet walls during the experiment, but the relative humidity/temperature/time profile in the drainage cavity between the nonadhered WSP and the wall during the experiment is sufficient to grow mold if enough nutrients are available.
- There was no coupling between moisture-saturated (100% relative humidity) cores and the moisture content of any rim-joist cavity wooden boundary components with and without exterior insulation.