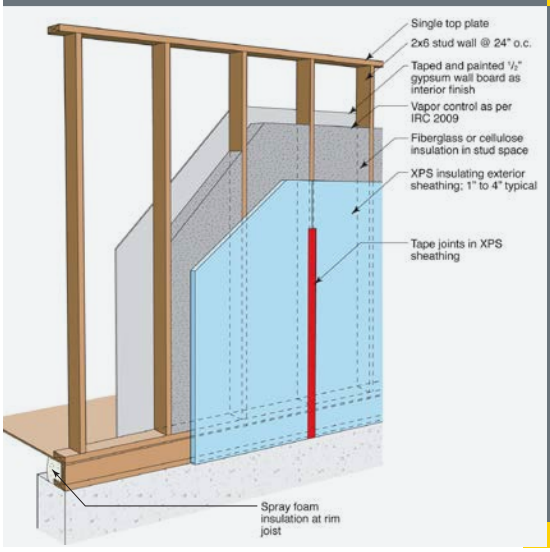


Building America Case Study

Technology Solutions for New and Existing Homes

Moisture Management of High-R Walls

PROJECT APPLICATION

Construction: Existing homes with vapor open wall assemblies

Type: Residential

Climate Zones: All

TECHNICAL PARAMETERS

Moisture Sources:

Water vapor is moisture that flows from areas of high vapor pressure to low vapor pressure. It can accumulate behind vapor impermeable materials.

Construction moisture is moisture that is stored in materials when exposed to the environment during construction. Rain is the primary source. This was simulated with a starting condition of 28% moisture content.

Air leakage condensation is moisture that condenses on cold interstitial surfaces when air flows through a wall. This was simulated by allowing indoor air to leak at 0.04 cfm4/ft^2.

Bulk Water represents precipitation that leaks into a wall cavity. It is the most serious of all the leaks. This was simulated by allowing 5% of wind-driven rain to deposit on the sheathing.

Moisture management of high-R walls is important to ensure optimal performance. This case study focuses on how eight high-R walls handle the three main sources of moisture—construction moisture, air leakage condensation, and bulk water leaks.

A high-R wall is defined as a wall with an effective R-value that at least doubles the code-required R-value. This includes framing members and any other thermal bridges. Eight wall types were considered in this analysis, divided into four categories: advanced framed walls with exterior insulation, double stud walls with vapor permeable cavity insulation, hybrid wall assemblies using closed cell spray foam cavity insulation, and a structural insulated panel system (SIPS).

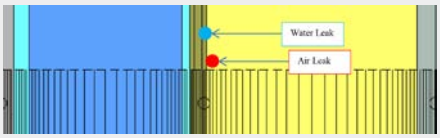
Researchers from Building Science Corporation, a U.S. Department of Energy Building America team, used a series of hygrothermal simulations to assess the moisture durability of these eight walls, as identified by the peak daily annual moisture contents, when exposed to three main moisture sources. The walls were simulated in several cities that present a range of climate zones—International Falls, Minnesota; Chicago, Illinois; St. Louis, Missouri; Seattle, Washington; Atlanta, Georgia; and Houston, Texas.

Under idealized circumstances, all of the walls perform well. However, as soon as adverse conditions occur, some of the walls did not adequately manage the moisture problems. The hygrothermal simulations are intended to provide a good, preliminary estimate of wall performance, but additional analysis may be required on a project-by-project basis.

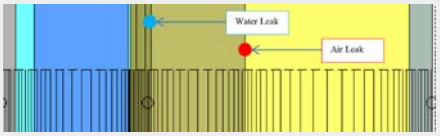
Materials used in the walls should not be installed if they are saturated with water. Proper air barriers should be installed and detailed accordingly. All wall penetrations should be detailed with proper water shedding materials and details.

Building America SM
U.S. Department of Energy

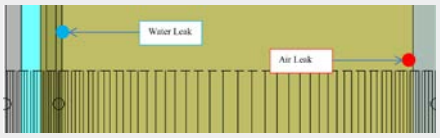
RESEARCH DETAILS



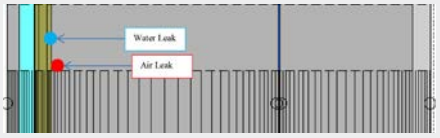
Advanced frame wall with exterior insulation



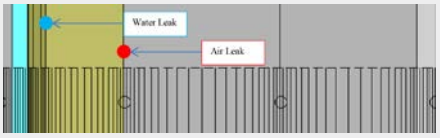
Hybrid advanced frame wall with exterior insulation



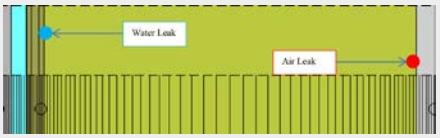
Advanced frame wall with ccSPF cavity insulation



Double stud wall with cellulose insulation and polyethylene vapor retarder



Double stud wall with cellulose and 2 in. of ccSPF



Double stud wall with ocSPF insulation

Structural insulated panel wall

For more information, see the Building America report, *Moisture Management for High-R Walls,* at *www.buildingamerica.gov*

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

Modeled Climate Zone	Modeled City	Wall 1: A.F. w/4-in IS, 5.5-in Batt	Wall 2: A.F. w/2-in IS, 2-in ccSPF, 3.5-in Batt	Wall 3: A.F. 2×8 w/7.25-in ccSPF	Wall 4: Dbl. Std. w/9.5-in CFI	Wall 5: Dbl. Std. w/2-in ccSPF, 7.5-in CFI	Wall 6: Dbl. Std. w/9.5-in ocSPF	Wall 7: SIP w/11.25-in EPS	Wall 8: Truss Wall with 9.5-in CFI
CZ2C	Houston	Low	Moderate	Low	Moderate	Low	High	Low	Moderate
CZ3	Atlanta	Low	Low	Low	High	Low	High	Low	High
CZ4C	Seattle	Low	Low	Low	High	Low	High	Moderate	High
CZ4	St. Louis	Moderate	Low	Low	High	Low	High	High	High
CZ5	Chicago	Low	Low	Low	High	Low	High	High	High
CZ7	Intl. Falls	Low	Low	Low	High	Low	Moderate	High	High

The above table demonstrates the moisture durability risk for each wall assembly in a range of climates. These risk levels assume air leakage effects for a 2.5 ACH50 home. A "high risk level" indicates that mold growth is likely and that this design is not recommended. A "moderate risk" level suggests a potential for mold growth eventually, depending on frequency and length of wetting, and temperature during wetting. This design can be successful but conservative durability assessments usually require corrective action. A "low risk level" suggests no mold growth or biodeterioration problems.

Conclusions

The conclusions from this research include:

Advanced frame wall with exterior insulation:

- Maintains elevated sheathing temperatures and minimizes air leakage condensation.
- Vapor permeable cavity insulation allows for inward drying.

Hybrid advanced framed wall with exterior insulation:

- Closed cell spray foam (ccSPF) helps isolate the sheathing from interior moisture and air leakage.

Double stud wall/truss wall with cellulose insulation:

- Sheathing susceptible to air leakage condensation.

Double stud wall with ccSPF or open cell spray foam (ocSPF):

- The ccSPF protects the sheathing from air leakage condensation.
- The ocSPF is susceptible to moisture diffusion and requires smart vapor control.

Structural insulated panel:

- Susceptible to significant damage from air leakage at joints. Center of panel poses no significant moisture susceptibility.

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

For more information, visit:
www.buildingamerica.gov

Printed with a renewable-source ink on paper containing at least 50% wastepaper, including 10% post consumer waste.

The U.S. Department of Energy's Building America program is engineering the American home for energy performance, durability, quality, affordability, and comfort.

DOE/GO-102013-4267 • December 2013