Building America Case Study

# Hygrothermal Performance of a Double-Stud Cellulose Wall

Devens, Massachusetts

## PROJECT INFORMATION

**Project Name:** Monitored Performance of a High-R Wall

**Location:** Devens, MA

**Partners:**

Consortium for Advanced Residential Buildings, *carb-swa.com*

Metric Development Corporation

**Building Component:** Double-stud cellulose walls

**Application:** New; single- and multifamily

**Year Tested:** 2012

**Climate Zone:** Cold (5A)

## ASSEMBLY CONSTRUCTION

Interior Vapor Retarder: Vapor retarder paint, 0.5 perm per manufacturer

Framing: Double-stud 2×4 walls, 16 in. on center

Insulation: Dense-pack cellulose, R3.6/in.

Sheathing: Oriented strand board with integrated water-resistant barrier (0.3 perm at 0% relative humidity/13 perm at 100% relative humidity)

Siding: Vinyl, assumed 10 air changes per hour ventilation behind siding

Building AMERICA SM U.S. Department of Energy

Numerous factors can cause moisture problems in a building shell. These include excess interior moisture that is transported into the wall through air leakage and vapor drive, bulk water intrusion from leaks and wind-driven rain, capillary action from concrete to wood connections, and rain splash-back that wets building materials such as siding. As walls become increasingly thick, moisture issues could increase.

High-R wall assemblies are gaining popularity in the market because of programs such as Passive House, Zero Energy Ready Home challenges in several states, and highly incentivized retrofit programs. Several builders have successfully used "double-wall" systems to more practically achieve higher R-values in thicker framed walls. A double wall typically consists of a load-bearing external frame wall constructed with 2×4 framing at 16 in. on center using conventional methods. After the building is enclosed, an additional frame wall is constructed several inches inside the load-bearing wall.

Several researchers have used moisture modeling software to conduct extensive analysis of these assemblies; however, little field research has been conducted to validate the results. In response, the U.S. Department of Energy's Building America research team Consortium for Advanced Residential Buildings (CARB) monitored a double-stud assembly in climate zone 5A to determine the accuracy of moisture modeling and make recommendations to ensure durable and efficient assemblies.

CARB performed tests to capture the performance through the full depth of these double-stud walls. Temperature, relative humidity, and moisture content sensors were clustered in several locations throughout two stud bays—one on the north side and one on the south side. Results from 1 year of data collection are shown in the figure on page 2.

## DESCRIPTION

The following images show critical details that must be considered when constructing double-stud walls.

These double-stud walls are framed out and waiting for insulation. Corners must be framed so insulation can be installed in all gaps to eliminate thermal bypasses and cold spots.

Window openings in double-stud walls can be framed square as shown here or with a slanted reveal on the sides to allow for more daylight.

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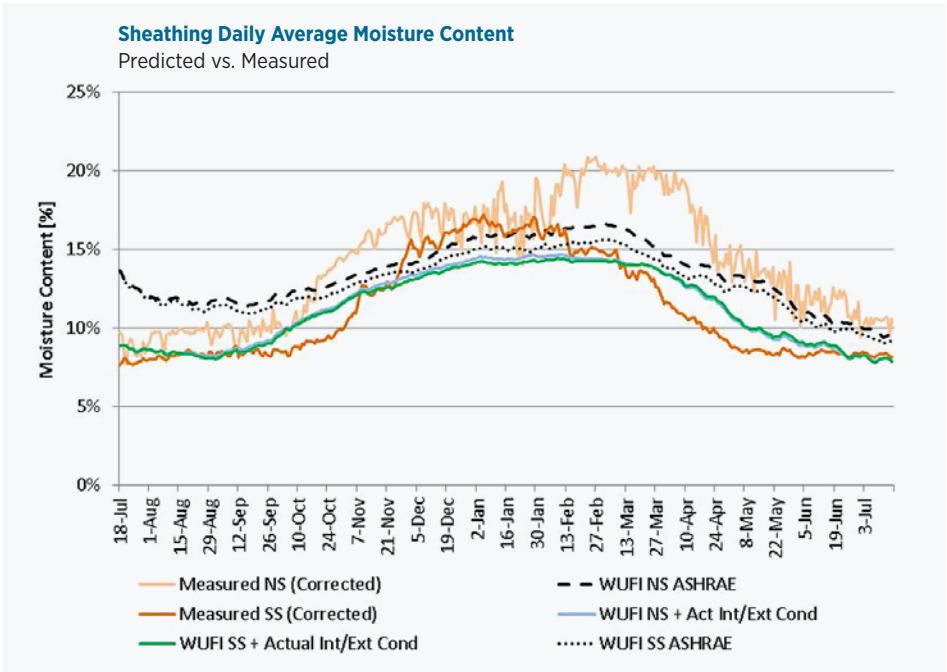
Image credit: All images were created by the CARB team.




Measured and predicted moisture content for the north and south sheathing

## Lessons Learned

- High R-value wall assemblies such as double-stud walls constructed with exterior structural sheathing on the exterior of the insulation should employ a vented cladding to help dry that layer.
- Moisture must be prevented from getting into the walls through proper air sealing, installation of the water-resistant barrier on the exterior, and control of interior moisture levels to ensure a durable assembly.
- Properly ventilating and dehumidifying the space immediately after construction is complete will help to prevent moisture buildup in the building assembly components.

## Looking Ahead

Data collected from July 2012 to July 2013 indicate good agreement with predictions from the modeling software. Modeling was quite accurate for this wall construction. Designers and practitioners who analyze hygrothermal performance can assume it is reliable.

Data also show that this assembly dries over the course of the year. Modeling further predicts that this assembly should experience decreasing peak moisture content levels for at least 2 years following the first year of construction. Both results are indications of good hygrothermal performance.

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