Building America Case Study
Technology Solutions for New and Existing Homes

Monitoring of Double Stud Wall Moisture Conditions in the Northeast

Devens, MA

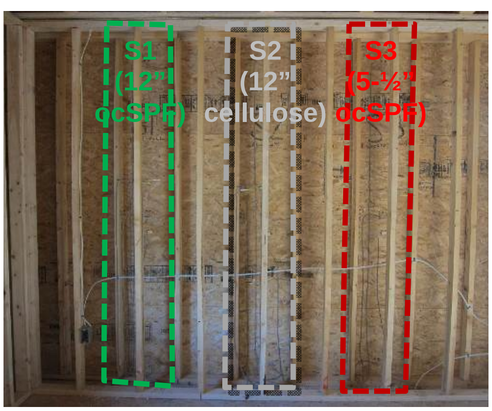
PROJECT INFORMATION

Construction: New construction

Builder: Transformations, Inc.

Size: 1100 to 2300 ft^2 houses

Climate Zone: Cold (5A)



Double-stud walls insulated with cellulose or low-density spray foam can have R-values of 40 or higher. They have been used in high performance housing since the 1970s: their advantages include trade familiarity with construction detailing (especially at the exterior), and the use of commonly available construction materials. However, double stud walls have a higher risk of interior-sourced condensation moisture damage, when compared with high-R approaches using exterior insulating sheathing.

Moisture conditions in double stud walls were monitored from 2011 through 2014 at a new production house located in Devens, MA (DOE Zone 5A). The builder has been using double-stud walls insulated with 12" of open cell polyurethane spray foam (ocSPF); however, the company has been considering a change to netted and blown cellulose insulation for cost reasons. Cellulose is a common choice for double-stud walls due to its lower cost (in most markets). However, cellulose is an air-permeable insulation, unlike spray foams, raising interior moisture risks.

Three double stud assemblies were compared: 12" of ocSPF, 12" of cellulose, and 5-½" of ocSPF at the exterior of a double-stud wall (to approximate conventional 2×6 wall construction and insulation levels, acting as a control wall). These assemblies were repeated on the north and south orientations, for a total of six assemblies.

Data were collected from December 2011 through July 2014, capturing three winters of operation in various states. Winter 2011-2012 was a very mild (warm) winter, and had very low interior RH due to a lack of occupancy. Winter 2012-2013 was a colder winter, and had very high (40-50%) interior RH until the ventilation system was put into operation (mid-February 2013). Winter 2013-2014 was a very cold winter, but the ventilation system was operated, resulting in moderate interior RHs.

CONSTRUCTION RECOMMENDATIONS

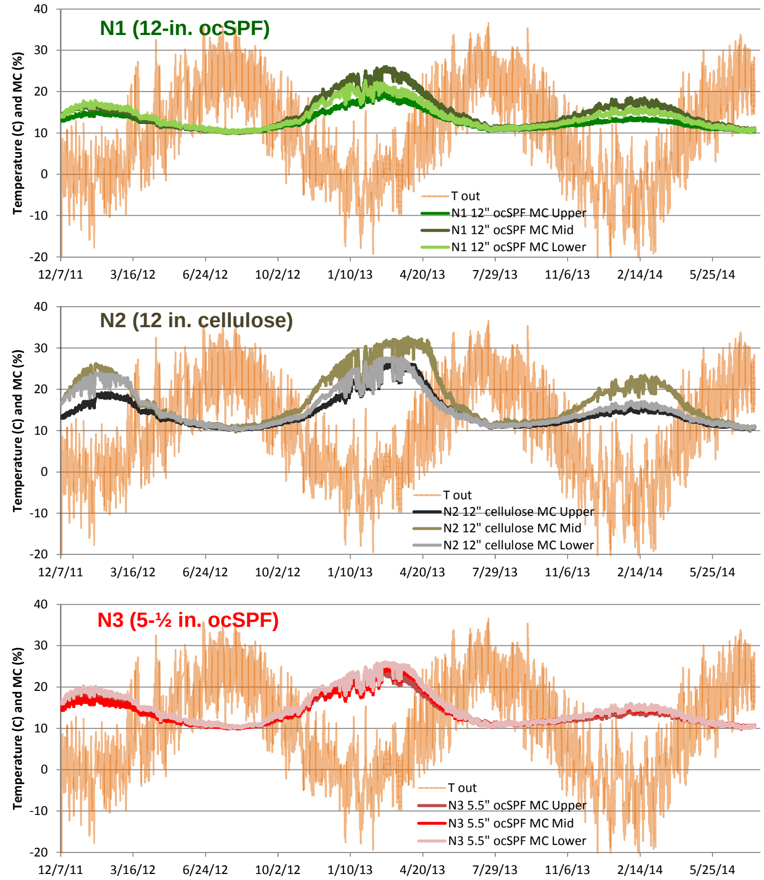
Based on the monitoring, it appears that both ocSPF and cellulose double stud walls will experience worryingly high moisture levels during high interior wintertime RH loadings (40-50% RH). However, disassembly demonstrated that the walls appear to be largely unaffected by this wetting. But for recommendation purposes, a more conservative approach is warranted. This is particularly true because it appears that these specific test walls were protected by some mechanisms of the cavity fill insulation (cellulose/ocSPF) or sheathing.

The cellulose walls clearly showed the highest moisture accumulation: the use of interior vapor control more restrictive than Class III (latex paint) is recommended. A Class II vapor retarder (e.g., variable permeability membrane or vapor retarder paint) will reduce moisture risks to more reasonable levels. However, it is entirely likely that there are many double stud walls insulated with cellulose with only Class III vapor control that are providing fine service. A Class I vapor retarder (polyethylene) is not recommended, due to the complete elimination of inward drying.

The ocSPF walls had less moisture accumulation than the cellulose walls; it is a marginal judgment call whether a Class II vapor retarder is needed or warranted. The ocSPF material used provides reasonable vapor control at the thicknesses applied (2.0 to 2.5 perms in 12”). The use of a Class II vapor retarder would definitely be conservative, but the double stud walls insulated with ocSPF have a history of providing excellent performance in this builder’s houses.

This project shows that a functional mechanical ventilation system is critical for enclosure durability in modern high performance construction in cold climates.

For more Information, see the Building America research report, at www.buildingscience.com



North side sheathing moisture contents w. exterior temperature

Under “normal” interior conditions (functioning ventilation system, wintertime RH 10-30%), ocSPF walls (both 12” and 5-½”) with latex paint as interior vapor control (Class III) showed low risk; all sheathing moisture contents remained below 20%. However, the 12” cellulose wall had moisture contents over 20% on the north side.

Under high interior humidity loading (non-functional ventilation system, 40-50% interior RH), all test walls showed moisture contents and sheathing-insulation interface RHs well into the high risk range. The cellulose walls showed particularly high moisture contents (sheathing over 30%), while the ocSPF walls showed MCs in the 18-25% range. In addition, the monitoring showed evidence of liquid water condensation (which can result in quick degradation) in all walls, the condensation was substantial in the cellulose walls.

But in all walls, during each summer after a winter of wetting, moisture levels fell well into the safe range. When the walls were disassembled at the conclusion of the experiment, the sheathing and framing showed remarkably little evidence of wetting damage or mold growth. No visible mold growth was found, nor evidence of staining or water rundown. The damage was limited to some limited grain raise of the interior surface of the OSB at the cellulose wall, and slight corrosion of fasteners and staples.