

The Ontario Wall Drying Project—Phase 2

INTRODUCTION

From 1989 to 1991, Canada Mortgage and Housing Corporation (CMHC) and six partners conducted a study at the University of Waterloo on the consequences of using wet or green lumber in wall systems in southwestern Ontario. The primary objective was to obtain a better understanding of the moisture-related performance of various house wall assemblies constructed using framing lumber with a moisture content in excess of 19 per cent.

This research highlight focuses on the second phase of the project, which assessed the impact of longer term, seasonal weather variations. The first phase is the subject of a separate report, *The Ontario Wall Drying Project* and Research Highlight 01-129.

The primary objective of the second phase was to monitor and assess wall system performance over at least one winter, one swing period (spring or fall) and one summer. As in the first phase, variations in the moisture content of the framing lumber was of primary concern.

Table 1—Details of wall assemblies

Panels	Framing	Sheathing	Exterior
N1-S1 N2-S2 N3-S3	2X6	#1: 1 1/2" gypsum board #2: 7/16" fibreboard #3: 7/16" waferboard	• building paper • vinyl siding
N4-S4	2X4	1 1/2" semi-rigid glass fibre insulation board with spun-bonded polyolefin	• taped joints • vinyl siding
N5-S5 N6-S6	2X4	#5: 1 1/2" type 4 extruded polystyrene (EXPS), shiplapped and butted #6: 1" trilaminate polyisocyanurate, butted	• building paper • vinyl siding
E1-W1	2X4	1 1/2" semi-rigid glass fibre insulation board with spun-bonded polyolefin	• taped joints • clay brick
E2-W2 E3-W3	2X4	#2: 7/16" fibreboard #3: 7/16" waferboard	• building paper • clay brick
E4-W4	2X4	1 1/2" semi-rigid glass fibre insulation board with spun-bonded polyolefin	• taped joints • vinyl siding
E5-W5 E6-W6	2X4	1 1/2" type 4 EXPS, shiplapped and butted (#6: delayed closing)	• building paper • clay brick

METHODOLOGY

In essence, this research involved further monitoring of the test panels previously constructed and installed in the testing facility built at the University of Waterloo for the first phase. A total of 10 different wall systems were built, with the principal differences being 2x4 or 2x6 framing, insulating or non-insulating sheathing, vinyl or masonry cladding and north-south or east-west orientation. Details of the 12 pairs of wall assemblies are presented in Table 1.

Monitoring for Phase 2 began in mid-November 1990, immediately following the completion of monitoring for the first phase. The 12 pairs of panels were monitored over the next six months, with some interruption from February to April 1991 because of hardware and software problems. In the fall, 1991, six pairs of panels were replaced with panels for three new unrelated projects. To compensate for these interruptions, it was decided to continue Phase 2 monitoring on the six remaining pairs for a second period, from the beginning of November 1991 to mid-August 1992.

As in the first phase, both interior and exterior weather conditions, particularly temperature and relative humidity, were continuously monitored. Wind speed and direction were also measured.

Before the official start of Phase 2 in November 1990, excess built-in moisture in the framing lumber in all panels had been released and an equilibrium moisture content reached. Although the wood had dried, moisture content could still be retained within the wall system or infiltrate from the exterior or the interior.

Test results confirmed that the vapour retarder and air barrier were so effective that researchers deemed the moisture penetration from the interior negligible. This meant that changes in wood moisture content would be the result of exterior changes or changes within the wall system itself.

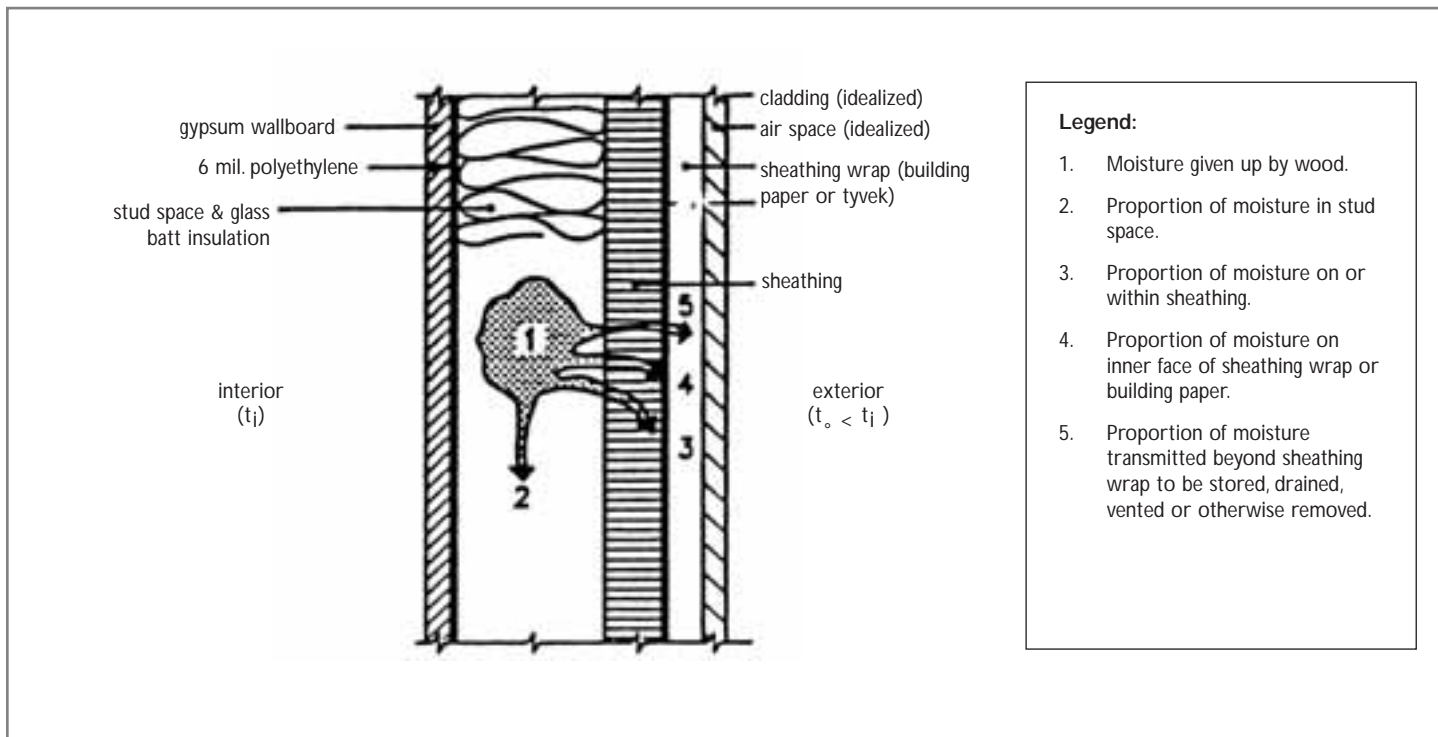


Figure 1—Construction moisture considerations

RESULTS

By the third year of monitoring (over both phases), all wood had dried to a base equilibrium of 13 per cent or less. Equilibrium wood moisture content values of between 10 and 13 per cent seem to be consistent with the nature of southwestern Ontario's climate. At these levels, the wood is not susceptible to microbiological growth.

There is clear evidence that the timing of wall closure and the amount of drying that takes place before warm weather arrives are important factors affecting moisture content levels. Test results show that the onset of warm weather can increase wood moisture content by two to three per cent or more. Drying process can not only slow down, it can reverse. Sheathings with low water-vapour permeability need to take advantage of a winter drying period to help offset the impact of warm weather.

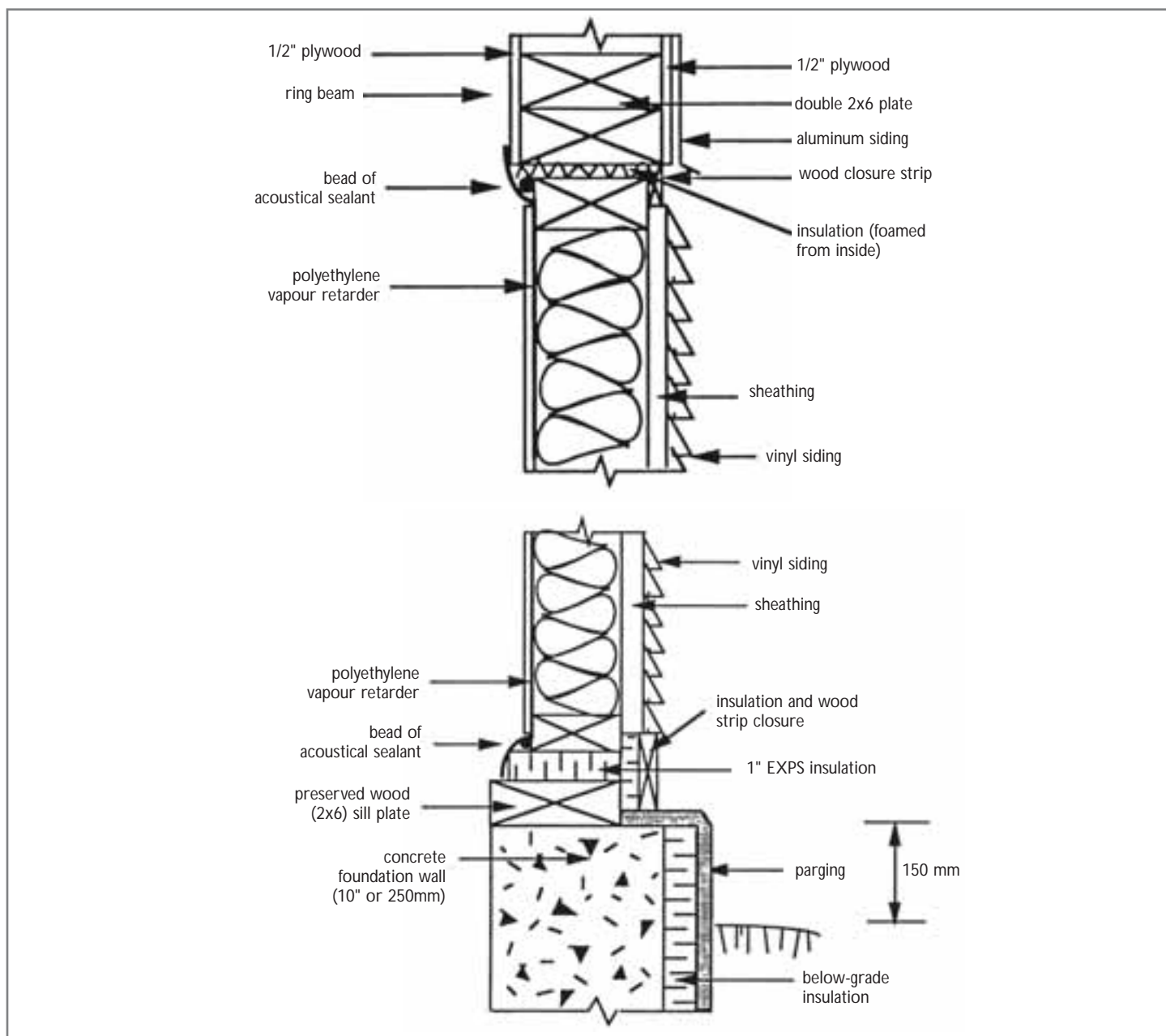


Figure 2—Construction details: top and bottom plates

However, changes in the drying process did not appear to have any significant impact on the overall performance of the wall systems tested.

As in the first phase, the lower plate always seemed to be wetter and colder, and more susceptible to weather variations, than the vertical studs or top plate. This may have been partly due to the lower plate being exposed in a non-representative manner. Still, it is significant that by the third year the bottom plate had generally dried to nearly the same levels as the other framing elements.

The following sections briefly discuss the equilibrium moisture levels achieved in each of the wall systems tested.

Panels with semi-rigid insulation board sheathing

The wood moisture content in panels N4-S4 and E4-W4, all with vinyl siding, remained relatively constant through Phase 2, ranging from 9 to 12 per cent during the first period and 11 to 13 per cent during the second period. There was no evidence to suggest seasonal variations had any influence on moisture content, although weather can have some impact. The slightly higher moisture content in the second period may have been due to a generally cooler summer in 1992.

After two years, the wood moisture content in panels E1-W1 (brick veneer) stabilized at between 10 and 15 per cent. While moisture content varied slightly with time, only W1 gave any evidence to suggest that equilibrium values were affected by weather. During the first monitoring period, moisture content values in W1 appeared to be one to two per cent higher during colder months, but this was less evident during the second period of monitoring.

Panels with type 4 extruded polystyrene sheathing

The insulating material in the N5-S5 panels (vinyl siding) has a relatively high resistance to vapour flow and, if properly assembled, is relatively airtight. Variations over time in moisture content in these panels showed that the insulating material influenced the rate of drying.

For both panels, wood drying not only slowed down, it reversed. This phenomenon, also evident in panel S6, is a function of wood moisture content and the weather. For example, in panels where moisture content was still relatively high when warm weather arrived in 1990, the vapour pressure difference across the wall decreased and then reversed. N5-S5 finally reached equilibrium moisture content levels of less than 14 per cent with the onset of colder weather in December 1991.

Panels E6-W6 and W5 (all with brick veneer) were only monitored during the first period of Phase 2. Still, the results from two years of monitoring over both phases support the conclusions drawn from N5-S5. In particular, if the framing lumber has not dried to base levels of about 13 per cent, then there will be a slowing down, and possibly even a reversal, of the drying process during warm weather.

Panels with trilaminate polyisocyanurate sheathing

The trilaminate facing on both sides of the insulation renders this sheathing virtually impermeable to air, moisture and vapour flow. Wall system drying with this type of insulation must necessarily be from air leakage at the joints. Timing of installation and the wood moisture content at that time are critical factors in drying. After panels N6-S6 (vinyl siding) were assembled in December 1989, they underwent fairly rapid drying, but the process arrested and reversed with the onset of warm weather. Both panels eventually reached a base equilibrium level of 10 to 11 per cent over 14 months.

Panels with non-insulating sheathing (fibreboard and waferboard)

These panels exhibited somewhat different drying tendencies than the panels with insulated sheathings. This is probably because fibreboard and waferboard sheathings have large surface areas and nearly as much volume as the framing lumber.

Panels N2-S2 (fibreboard, vinyl siding) dried to equilibrium levels of less than 13 per cent fairly rapidly, but subsequent changes in weather induced changes in water vapour and air pressure differentials. Panels E2-W2 (fibreboard, brick veneer) and E3-W3 (waferboard, brick veneer) performed in a similar manner. Both systems showed only a small variation in moisture content with the onset of warm weather, which was not considered significant.

CONCLUSIONS

Seasonal variations in equilibrium levels of wood moisture content are relatively small, and in most instances there is little evidence to suggest these changes are of any significance. These conclusions, though, are subject to two conditions:

- Drying of built-in moisture must have occurred and the wood moisture content should be well below 19 per cent.
- A good vapour retarder and air barrier on the warm side of the stud space must have been used.

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