

The Ontario Wall Drying Project (1991)

INTRODUCTION

The National Building Code of Canada requires moisture content of lumber to be 19 per cent or less when it is installed. This is to prevent water from being built into an enclosure and the potential for moisture-related problems. These problems include warping and twisting of framing members, resulting in a loss of airtightness; mold, mildew and deterioration of the wood, leading to structural damage and reduced air quality; reduction in the effectiveness of thermal insulation; paint peeling; and nail popping. However, a survey of construction practices shows that wood with a moisture content higher than 19 per cent is regularly used. In 1989, Canada Mortgage and Housing Corporation (CMHC) and six partners initiated a study on the consequences of using wet lumber in south-western Ontario.

The project, formally designated the Ontario Wall Drying Project, was conducted at the University of Waterloo. An Advisory Committee directed the project. The committee members were CMHC, the Ontario Home Builders' Association, Ontario New Home Warranty Program, the Society of the Plastics Industry of Canada, the Structural Board Association, Canadian Fibreboard Manufacturers Association, Canadian Association of Man Made Mineral Fibre Manufacturers, Forintek Canada Corp. and the Building Engineering Group, University of Waterloo.

The primary objective was to obtain a better understanding of the performance of various house wall assemblies built using wet or green framing lumber (more than 19 per cent moisture content). One goal was to determine whether moisture levels increase, decrease or cycle over time in different wall assemblies and whether these changes result in moisture-related problems. The project was also designed to determine whether exterior cladding, wall orientation and the time taken to close wall assemblies had an impact on subsequent changes in moisture levels and the occurrence of moisture-related problems.

For the purposes of this project, the Advisory Committee defined moisture-related degradation as including one or more of the following conditions:

- A reduction in the wall's ability to perform its basic functions, such as a loss of structural soundness or thermal efficiency.
- A deleterious impact on the appearance or function of either the interior or exterior surfaces of the wall cavity, for example siding deformation or condensation.
- The creation and growth of molds or fungi that harm human health.

A second phase of the project subsequently assessed the impact of longer term, seasonal weather variations. This is the subject of *Research Highlight 01-130: The Ontario Wall Drying Project – Phase 2*.

METHODOLOGY

A full-scale test facility for the project was built at the University of Waterloo. The square building was oriented with one side facing due North (9 degrees east of magnetic North). Twelve pairs of 1,200 x 1,400 mm (4 x 8 ft.) test panels were constructed using framing lumber with moisture content well in excess of 19 per cent. In all, 10 different wall systems were constructed, as detailed in Figure 1. The principal differences were 2x4 or 2x6 framing, insulating or non-insulating sheathing, vinyl or masonry cladding and north-south or east-west orientation (see Table 1).

Six panels were installed on each side of the building in December 1989. They were continuously monitored for 11 months. The interior environment was maintained at about 20°C, with 50 per cent relative humidity. Instruments measured wood moisture content, temperature and relative humidity on each panel. A weather station was mounted above the peak of the roof. Supplementary tests for air leakage and microbiological activity were conducted.

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" trillaminate 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

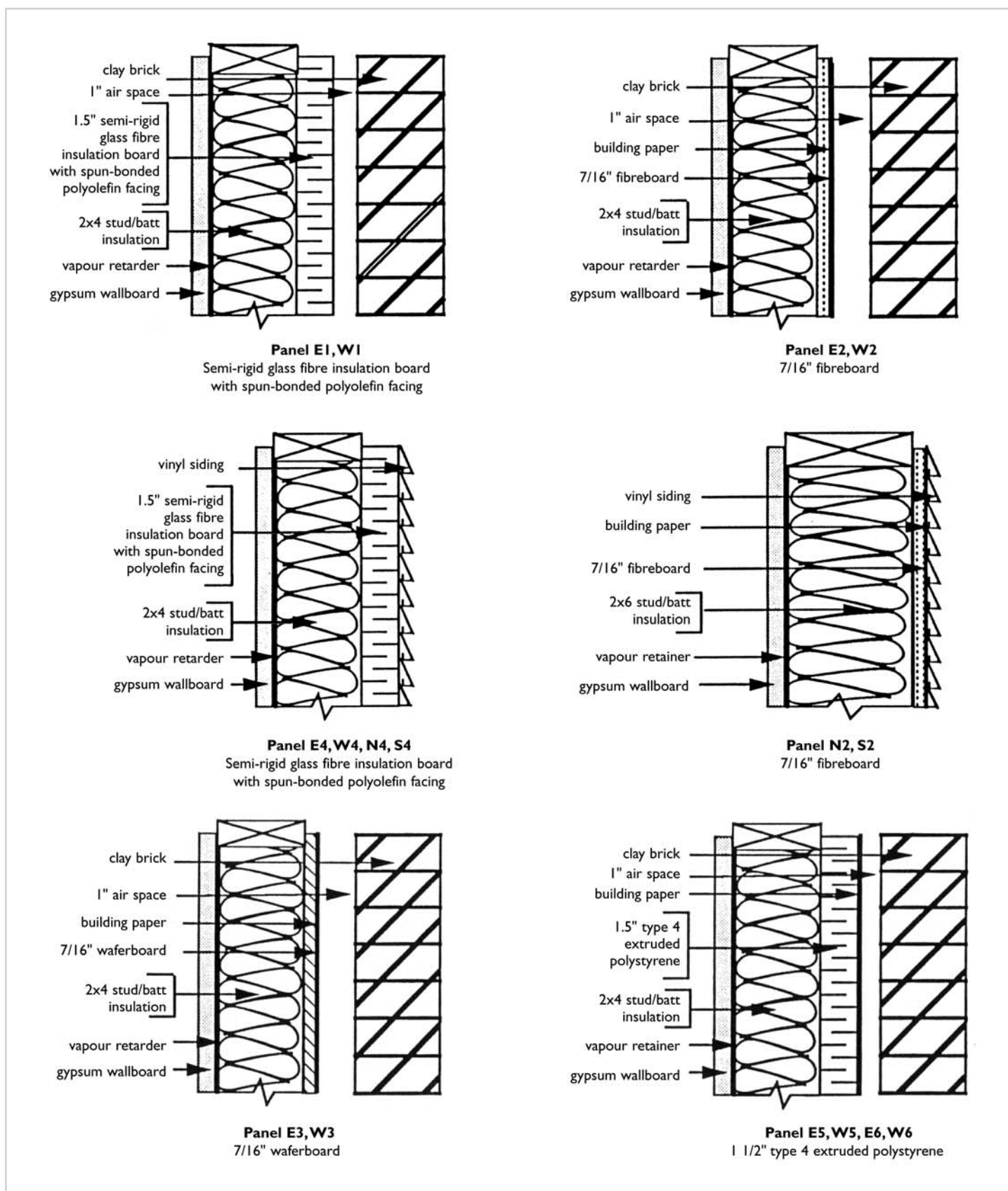
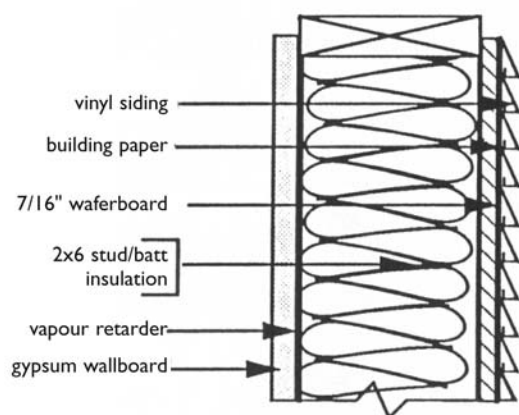
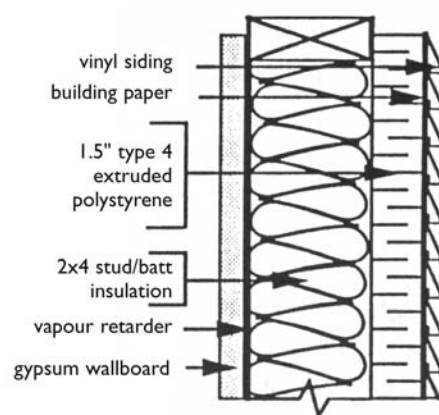


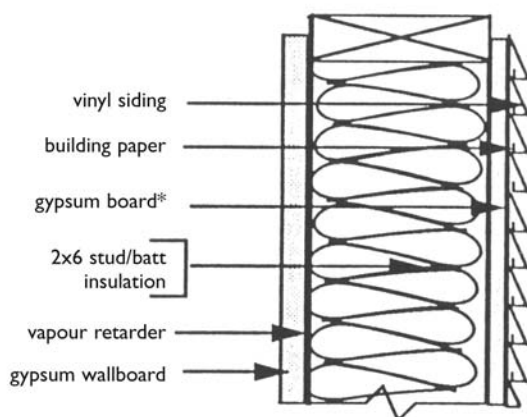
Figure 1 Test panel configurations



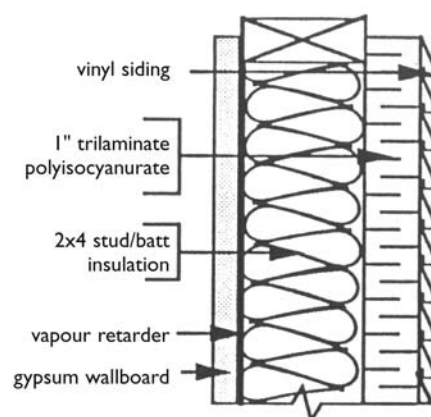
Panel N3, S3
7/16" waferboard



Panel N5, S5, N6, S6
1 1/2" type 4 extruded polystyrene



Panel N1, S1
Gypsum board



Panel N6, S6
Trilaminate polyisocyanurate

*The initial intention was to install exterior grade gypsum board. In fact gypsum "lath" was supplied and installed. This is not a recommended use for this particular gypsum product and the associated test result should not be used out of context.

Figure 1 Test panel configurations (continued)

RESULTS AND RECOMMENDATIONS

All systems dried to an equilibrium level within a reasonable period of time, without giving rise to visible moisture-related damage or impairment. No significant mold or fungal growth was detected.

More specifically, the test results indicated that framing in most wall systems constructed during winter in south-western Ontario—but specifically in the 10 systems tested—can be expected to dry to a maximum of 19 per cent moisture content in three months or less, and down to an equilibrium of 9 to 12 per cent in five months or less. The bottom plate can be expected to take the longest time to dry.

Gypsum lath board was inadvertently used as exterior sheathing for one pair of panels. The results confirmed that this material should not be used for this purpose, as it has an absorbent paper coating. The gypsum industry recommends using only exterior grade gypsum board manufactured specifically for exterior use.

Since all systems dried satisfactorily, the effect of different sheathings on drying is somewhat less significant. However, sheathing was the main component variable in the wall systems tested, with the results for the different types of sheathing as follows:

- Glass fibre sheathing dried the fastest.
- Fibreboard and waferboard sheathings were relatively fast.
- Extruded polystyrene sheathing was slow.
- Polyisocyanurate sheathing was the slowest.

It is recommended that sheathing with thermal insulating properties be used in winter construction in south-western Ontario to avoid frost and condensation problems. The results also indicated that, for winter construction, a wall system incorporating both an insulating sheathing and a masonry veneer cladding has some advantages over a non-insulating sheathing and a lightweight, contact-installed cladding such as vinyl, aluminium or even a wood-based siding.

When a non-insulating sheathing and a lightweight, contact-installed cladding are used, relatively more attention needs to be given to the moisture content of the framing lumber. For example, if 2x6 framing is used at 400 mm (16 in.) centres, then it is relatively more important to have a moisture content less than 19 per cent.

While the research also sought to determine the effect of wall orientation and cladding on the drying, the project showed that more than two identical panels for each of these aspects are required to produce statistically significant results. The report recommends further research in this area.

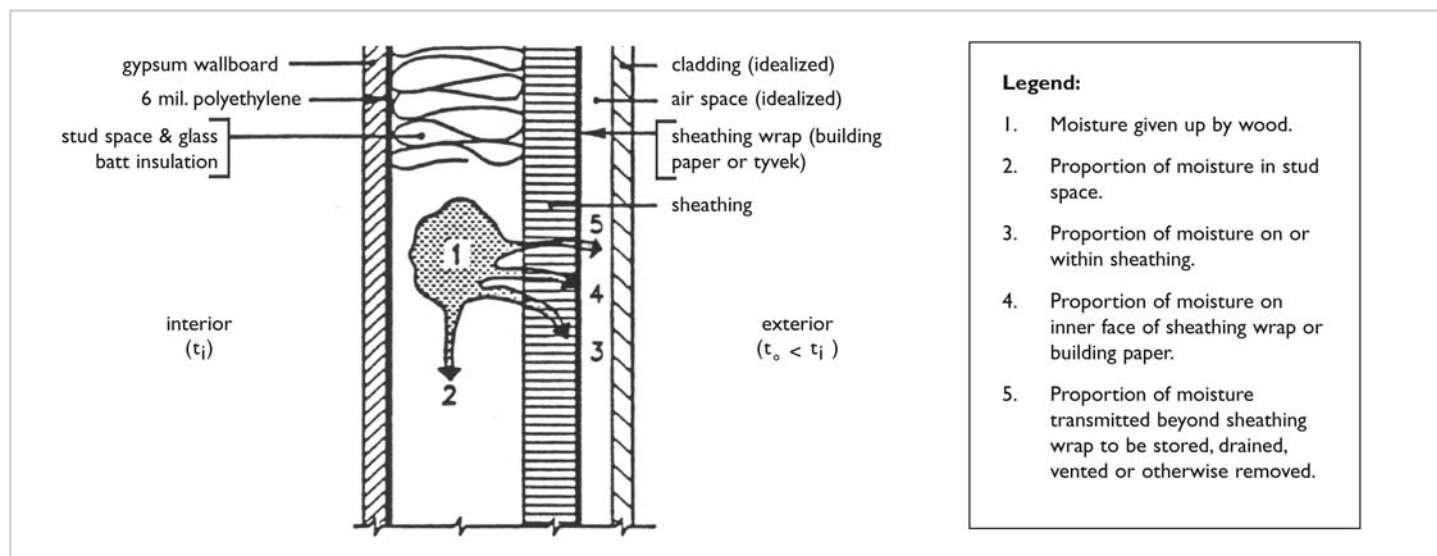


Figure 2 Construction moisture considerations

CONCLUSIONS

Designers and builders can help minimize the probability of moisture-related problems arising in housing by using wall systems that dissipate moisture. The project demonstrated that moisture content of framing lumber is only one aspect of a wall system's ability to adequately handle built-in moisture load. In addition to drying rate, how and where moisture is moved and stored are also important considerations.

Controlling built-in moisture load depends on several wall features and their characteristics:

- Wood moisture load—installed moisture content and volume of wood per stud space.
- Stud space—storage and vapour transfer capabilities.
- Sheathing-stud space interface—potential for condensation and accumulation of water, frost or ice.
- Sheathing—storage, water vapour diffusion and air movement characteristics.
- Wrap layer (if any)—its properties with regard to air movement, water vapour diffusion and water movement (permeability and surface drainage).
- Vent-screen system—its properties with regard to pressure equalization, venting, drying and gravity drainage.

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Housing Research at CMHC

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