WALL INSULATION

Measured R-values in arctic conditions

Heat loss from houses in the Canadian Arctic is a major concern. Fuel oil, which is used to heat most houses in the remote northern communities, is costly thus the need for houses that are energy efficient and able to stand up to the harsh climatic conditions of long winters and cold temperatures.

It has been suggested that the harsh climate creates a unique environment that over time may reduce the insulating value of wall sections. Factors such as shrinkage of wood shifting of structures and degradation of individual components within wall sections may create air spaces between the insulation and the studs, allowing for convective loops to form. Degradation of individual building components may be caused by moisture migration into the structure.

Building officials in the Northwest Territories Housing Corporation and Yukon Housing Corporation are concerned about the long term performance of building components exposed to the Arctic environment.

To see if there is any cause for concern, a field study was done by G. K. Yuill and Associates for CMHC. It looked at the wall sections in several Arctic houses to see if there is accelerated deterioration causing reduction of insulating value, and what the reasons might be for the deterioration.

Four houses were selected for detailed testing. Each was to have been a different type and constructed in different years to see if wall sections in older houses show signs of increased deterioration. Because many older houses (built before 1980) have deteriorated wall sections, the houses selected were either constructed or retrofitted within the last five years.

Testing was done in two steps. The first was to take infrared thermography scans on the wall sections chosen. The second was to measure the heat loss through the wall sections using guarded hot box calorimeters.

Temperature measurements made included indoor temperature, outdoor temperature, air film temperatures on the outside of the exterior wall section (over-stud and non-stud). In the analysis to determine thermal resistance values (R-values) two temperatures were used: the average indoor air film temperature and the average outdoor air film temperature.

The effective R values measured in the four housing units are more meaningful when they are compared to their theoretical values (listed in Table 1). Theoretical values were calculated using the cross-sections as shown in Figures 1, 2, 3, and 4 and the individual component R-values obtained from the ASHRAE Handbook of Fundamentals. Thermal bridges (including wood framing and strapping) were accounted for in the calculations.

As indicated in Table 1, the measured R-values of the wall sections tested are, in general, reasonably close to their theoretical values (within 15% of their theoretical values). In three cases, the measured values were actually higher than the theoretical values. There are three major reasons for this. First, the baseboard heaters, located immediately below the test equipment may have decreased the load on the heating elements within the test equipment. Secondly, there was likely a certain amount of experimental error. Finally, the insulating materials in the wall sections may have performed better than expected, as the component R values used in the calculations were based on laboratory measurements which are made at about 24°C. As temperatures decrease, the insulating value of materials generally increases.

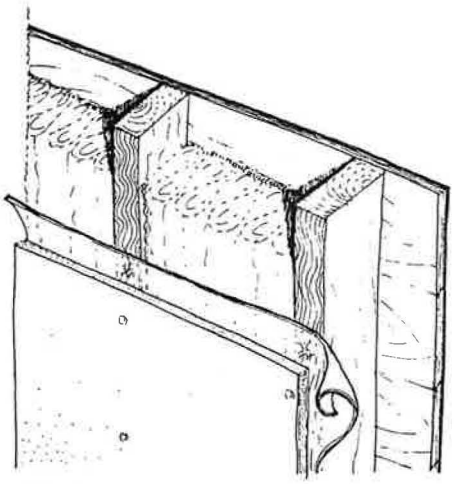

Fig. 1
½" gypsum board; poly v.b.; R20 batt insulation; 2x6 studs @24"; cedar siding

TABLE 1

House No.	House Type	Construction Year	Measured R-Value *(RSI)*	Calculated Difference *(RSI)*	Percentage Difference*
1	Nineplex	1984	20.78 *(3.66)*	18.34 *(3.23)*	-13.3%
2	Duplex	1985	28.90 *(5.09)*	25.55 *(4.50)*	-13.1%
3	Retrofit (1976 Single Detached)	1986	11.98 *(2.11)*	20.61 *(3.63)*	41.9%
4	Duplex	1986	30.43 *(5.36)*	27.08 *(4.77)*	-12.4%

** Calculated R value relative to actual measured numbers*

The measured effective R-value of the wall section in House No. 3 was found to be 42% lower than the calculated theoretical value. The infrared thermography scan did not indicate signs of moisture damage. However, there was an air space behind the gypsum board wall to which the test equipment was attached. Cold spots that were close but not immediately behind the metered area may have provided a route for heat to escape from the adjoining air space by convection currents in the void.

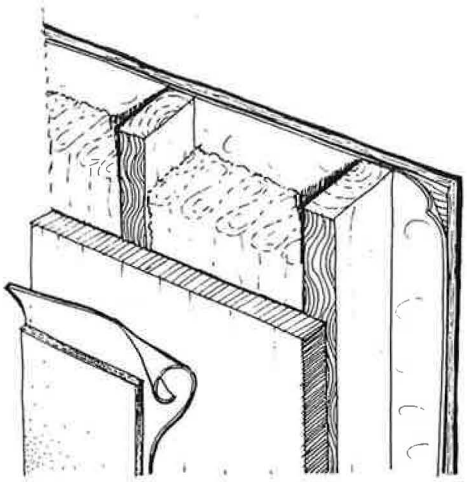

Fig. 2
½" gypsum board; poly v.b.; 1" rigid insulation; R20 batt insulation; 2x6@24"; air barreir; 5/8" plywood siding

So what did the exercise prove?

The results show that major reductions of insulating value of wall sections in houses constructed in the last five years have not happened as the measured R-values appear to be in line with theoretical calculations.

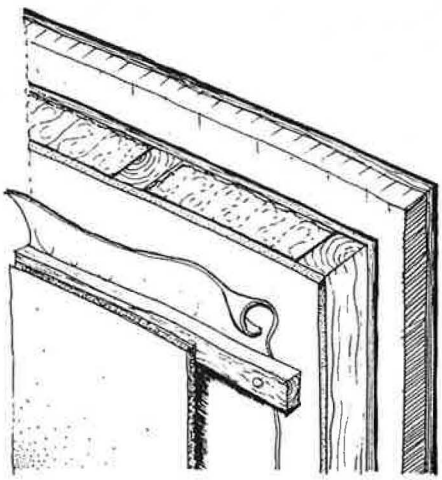

Fig. 3
gypsum board on 1x3@ 16"; 6 mil poly v.b. on existing wall plus 2x2 vertical @4'0" with 1½" glasclad and plywood siding

The oldest house tested was built in 1976 and retrofitted in 1986. It was the only house where the insulating value tested was lower than the theoretical value. What the cause for this reduction of R-value were not identified in this project. However, as there was an air space in the well, it may be the convection currents were established in the cavity and worked to speed heat transmission through the wall.

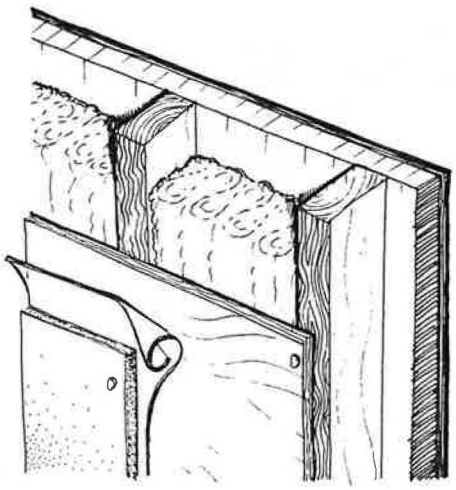

Fig 4
½" gypsum board; 6 mil poly v.b.; 3/8" plywood; R20 batt insulation; 2x6@24"; 1½" glasclad; plywood siding

Summary of: "In situ testing of the thermal performance of wall sections in NWT" by G.K. Yuill & Assoc. for CMHC.

Preserved Wood Foundations: an evaluation

Preserved wood foundations (PWF's) have been built in Canada for almost 30 years but in Alberta only since the mid-1970's when they were approved by code authorities.

While PWF use is widespread, there has been little monitoring done to evaluate their performance. Recently, the Alberta Ministry of Municipal Affairs sponsored a project to evaluate the performance of preserved wood foundations in Alberta and to recommend any changes to current standards if appropriate.

The project involved:
- a computer search of 7 construction and forestry databases,
- a literature review,
- a survey involving 14 industry representatives,
- site inspection and material sampling at 32 test homes,
- a questionnaire sent to 225 owners

Site Inspections

32 site inspections involved a detailed review of the residences, discussions with the owners, plus the collection of soil and 25 wood samples from each PWF.

The soil and wood samples were collected and analyzed for moisture content. The key issues raised in the study concerned the wood and soil moisture content as they were affected by construction practices; these in turn affected the PWF basement. It was noted that in general the construction quality was acceptable but there were major deficiencies in selection and placement of backfill materials and in surface water management.