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Cellulose Insulation (3)

Blown-in batt approach (2)

Blown insulation in the walls of new construction is not allowed under some Canadian building codes, mainly due to concerns about the ability to inspect the installed insulation to ensure complete coverage and uniform density in all locations.

To demonstrate the feasibility of these construction techniques, the Cellulose Insulation Manufacturers' Association of Canada (CIMAC) sponsored the construction of an R2000 developmental home. The object was to demonstrate one approach to using blown cellulose insulation. The entire house (except for the floor) was insulated with blown dry insulation. The house was monitored from November 1986 to November 1987.

The main goal was to determine whether the cellulose insulated house would perform as required for R-2000 approval. Another concern was whether the insulation would interfere with the normal drying process of the newly-constructed walls.

Monitored items included:

** wall blowing procedures to determine how easy it would be to inspect for completeness of coverage and uniformity of insulation density;*
** moisture content of the framing material and insulation;*
** air flows of the heat recovery ventilator;*
** energy consumption for the heating, domestic hot water and other systems;*
** thermal integrity of the building envelope using an infra-red thermographic camera (twice, at one year intervals);*
** radon, formaldehyde and carbon dioxide levels over a one week period;*
** fan depressurization tests (performed twice).*

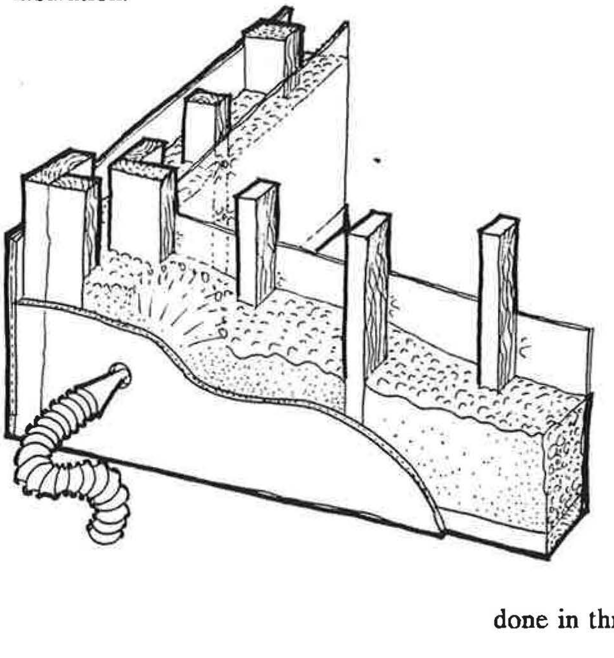
The cellulose house met all of the program requirements for certification as an R-2000 home. It was found to be adequately ventilated, very tight (approximately 0.4 ach @ 50 Pa) and within the energy budget.

The actual energy consumption was found to be 20% higher than predicted by HOT-2000 but most of the discrepancy was due to differences between standard R-2000 Program assumptions about how a home is occupied and run and actual operating conditions. The main differences were actual temperatures, ventilation rates and solar gains, all of which increased the energy consumption significantly.

The thermal integrity and airtightness did not change significantly over the one-year period.

The house

The demonstration house was built by Enersol Ltd. of Smith Falls, Ont. It is a 1,200 ft^2 bungalow over an insulated, preserved wood, crawlspace foundation. The above grade walls, ceiling and crawlspace walls are all insulated with blown cellulose insulation.



The construction

Perhaps the most original feature of the house are the walls. The construction was intended to provide a method of filling the walls with loose fill insulation in a uniform way.

The walls are a staggered stud arrangement. The 2"x4" outer studs and 2"x3" inner studs, each on 2 foot centres are attached to common top and bottom 2"x6". This staggered stud arrangement reduces thermal bridging through the wall and allows the insulation to flow around the studs during the filling operation. The corner detail also provides a free path for insulation flow and limits thermal bridges.

The outer surface of the wall is sheathed primarily with fibreboard. The inner surface of the cavity is a 6 mil polyethylene air vapour barrier attached to the studs by 2"x2" horizontal strapping on 16" centres. The joints in the polyethylene are overlapped, sealed with acoustical caulking and clamped with blocking. The inner surface is unsheathed for the insulating operation to allow the inspection of the insulation through the transparent vapour barrier.

About half of the ceiling area is covered with a conventional truss roof system with a horizontal bottom chord. The other half has a scissor truss arrangement to provide a cathedral ceiling effect. Over that portion of the ceiling, the loose insulation is actually resting on a slope.

Blowing Procedures

The vapour barrier of the walls and ceiling was in place and strapped. The blowing process was done in three stages:

1. Holes were drilled through the exterior sheathing at two-foot centres near the bottom of the wall. Insulation was blown in through these holes. Although this procedure filled most of the volume in the walls, high density was only achieved in the lower portion.

2. Another series of holes were drilled at two-foot centres near the top of the cavity. The space was filled until the overall density was judged to be adequate.

3. In areas of questionable density or coverage, additional holes were drilled and those specific areas were brought up to the desired level of density and coverage.

A total of 84 bags of insulation (30 pounds each) were used in the walls. By judging the amount of bulging of the polyethylene vapour barrier it was determined that the average depth of insulation was close to 6½ inches.

A visual inspection determined that the coverage looked to be consistent. Although there were some small variations in density and depth of insulation, no significant voids were observed.

The only areas where any leakage developed in the polyethylene vapour barrier during the blowing process were at the seams in the vapour barrier. These had not been properly strapped prior to the blowing process. The technique provided a very good way of judging the integrity of the vapour barrier since any leaks were visible.

Problems were encountered in the confined areas around windows, doors and especially the corners. These areas required the drilling of extra access holes.

Insulation Inspection

Access panels were placed in two closets of the house. These were removed to visually inspect the wall insulation at the beginning and end of the monitoring period. No indication of settling or moisture collection was noted.

The insulation was also visible through the polyethylene on the interior of the crawl space walls. No signs of moisture accumulation or insulation settling were noted in these areas.

What was found?

Thermographic scans were done at the beginning and end of the monitoring period. The thermal integrity of the building proved to be very good. The surface temperatures of the exterior walls were consistent.

The ceiling in the east side of the building was a "mock" cathedral ceiling with a roof structure made of scissor trusses. The insulation itself showed no deviation under thermographic scanning. However, there were problems with the two gable end walls in the area above the wall plate and below the ceiling. This area was insulated from the attic space by blowing insulation down into a framed out area. The area had not been inspected in the same way as the main walls, but surface area temperatures of the interior wall at these locations only had a maximum variation of 3°C from other interior surfaces.

Only the gable ends showed an insulation deficiency. These areas where insulated using the more conventional building practice of blowing insulation down from the top. The insulation in these areas did not meet the same uniformity of insulation density and completeness of coverage as did the wall sections.

One location where surface temperature variation was noted during the second survey was in some areas at the top of the kitchen/laundry room wall. This was an interior wall and the cold spots were attributed to air leakage. It was thought that there was some shrinkage of the caulking where wiring passed through the vapour barrier

The construction technique of the walls provided good insulation inspection capabilities and, in fact, provided a very good way of judging the integrity of the vapour barrier since any leaks were quite visible.

Moisture monitoring indicated that the moisture content of the studs and insulation dropped from construction conditions and remained well below rot conditions. The studs went from 13-17% to less than 9%; the insulation went from 16-24% to less than 12% (depending on location).

A lot of data on the performance of the house was collected. Some was typical monitoring data gathered for low energy home performance studies. But what was notable about the cellulose insulation as used in this project?

The main object was to address the ability to inspect the thermal and mechanical performance of the blown-wall insulating system. The system performed well over the year-long monitoring program. However, one year is a limited part of the life of a building; there could be other issues related to the use of such a system, and cellulose insulation in particular, which were not addressed by this project.

The construction type is not standard, so it would require special consideration. We are not certain how practical this type of construction may be. It seems like a lot of fussing, especially if the house had a shape more complex than a single rectangular box.

Alternate approaches to blown-in insulation may be easier to tie to conventional building practices.

This summarizes a the report "Cellulose Insulation Manufacturers' Association of Canada Development House Monitoring" prepared by Buchan Lawton Parent Ltd. For copies of the report contact: R-2000 Program, Energy Mines & Resources Canada, 580 Booth St., Ottawa, Ont. K1A 0E4