#3679

Cellulose Insulation (2)

Loose-fill Attic Insulation in Manitoba Housing

R.E. Chant

The cold climate in Manitoba, and recent emphasis on energy conservation, means that higher levels of insulation are now used. The practice that has developed is to blow loose-fill insulation into the attic to a depth of about 15 inches. This settles to a depth of 11 to 12 in. The total thermal resistance for this depth varies between R30 and 35 depending on the density (which is influenced by the moisture content).

A study to evaluate the performance of blown loose-fill cellulose fibre as an attic insulating material for wood-frame dwellings was undertaken for Manitoba Housing Corporation as they have frequently encountered wet insulation in attics. More maintenance problems concerning wet cellulose fibre have been brought to their attention than with glass fibre insulation. In some casaes it has been necessary to replace the cellulose insulation.

To evaluate the performance of cellulose fibre insulation under adverse conditions a method was developed to compare the performance of this loose-fill material to a competing product (loose-fill glass fibre) under identical conditions. What was considered was how the thermal and physical properties deteriorated and then recovered under conditions that may be encountered in the application for which they were intended.

A literature review revealed that only normal migrating moisture had been investigated. That is, the movement of moisture when the insulating materials are exposed to moisture levels which occur due to poor vapour barriers and/or to high relative humidities. The maximum moisture content reported was 20% by weight.

Sources of moisture also include drifting snow and other moisure movement driven by nasty weather conditions. As it may not be possible to guarantee that the insulation will always remain dry, the recovery rate of the thermal resistance when it dries is significant. Thus this study tried to determine what a realistic moisture content is, the time required for recovery, and the degree of thermal resistance recovery.

Full-scale prototype samples simulated 2x8 ceiling joists on 24 in. centres. The researchers then:

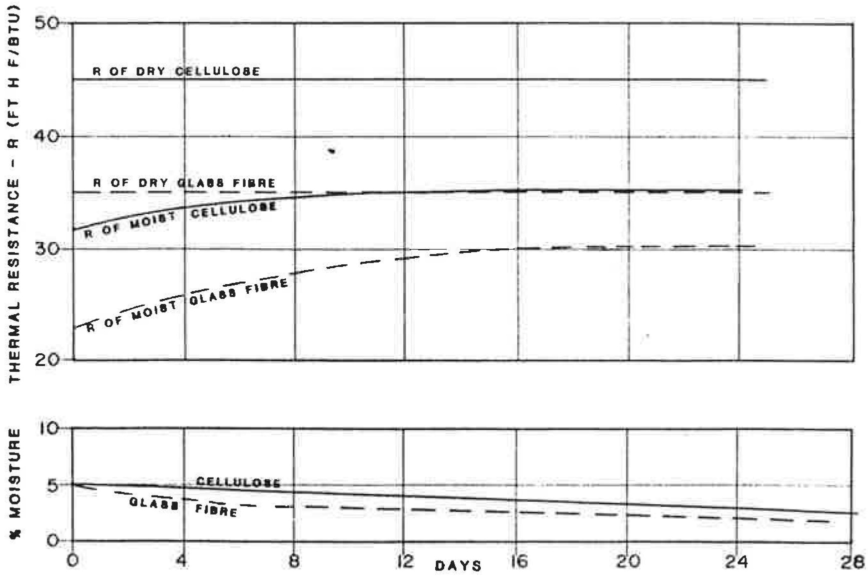
* measured the dry density of blown samples of cellulose fibre and glass fibre insulation;
* vibrated the samples to simulate installed conditions and to measure the density;
* measured the R values of the samples of cellulose fibre and glass fibre under dry 'as received' conditions;
* measured the R values of of cellulose fibre and glass fibre containing 5% moisture content (MC) by volume. This simulated wet condition was obtained by misting the samples, then sealing and storing for five days allow the moisture to penetrate evenly.
* exposed the samples tested at 5% MC to atmospheric conditions for five days, measured the density, then redetermined the R values.

To find out how much moisture would be absorbed, a sample was placed in an aquarium tank and wetted. Observations noted during the tests included:

The absorption of moisture by the cellulose fibre was accompanied by a considerable volume reduction (5% MC caused a 10% volume reduction)

Only 2% MC was adsorbed by the glass fibre before droplets appeared on the sides and bottom of the aquarium.

The moisture (5% MC) applied slowly in the form of a mist to the cellulose fibre penetrated six inches in the first four or five days and little additional penetration was obtained after that period.



THERMAL RESISTANCE VS DRYING TIME AND MOISTURE CONTENT

Upward migration of moisture from the bottom of the aquarium in cellulose fibre was extremely slow - four to five weeks for a six-inch penetration.

With the low density of glass fibre in loose fill no upward moisture movement was observed.

The major finding was that although the absolute values of the R values were higher for cellulose fibre under all conditions, the percentage recovery of the thermal resistance for the glass fibre was greater. After a 25 day drying period under normal environmental conditions (20°C and 30% RH), the thermal resistance of the glass fibre was 86% of the dry, "as received" thermal resistance while thermal resistance the cellulose fibre of was 78% of the dry value after drying under identical conditions.

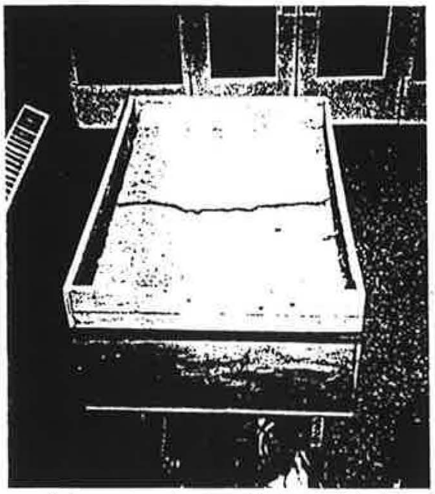
It was noted that loose-fill attic insulations (cellulose and glass fibre) when wet (5% MC by volume) will not dry during winter conditions in climatic conditions similar to those encountered in Manitoba, that is at a ceiling temperature up to 27°C and attic temperature of 0°C.

In other words, no drying of wet insulation will happen during the winter. It was also noted that at least two months is required to dry wet insulation in the summer under normal environmental conditions. Undoubtedly drying would be accelerated when attic temperatures reach 120° F (50°C) as often the case in the summer months.

The drying process appears to be completed within 25 days and there is little significant moisture retained to perpetuate any further damage to building materials.

However, shrinkage of the cellulose fibre samples was observed. It is possible that channelling of moisture would occur upon successive wettings if no maintenance was performed. Channelling of moisture was observed with less then 5% MC by volume in the glass fibre with both the aquarium investigations and the prototype samples.

Although the shrinkage with the encrustation of the cellulose fibre loose-fill insulation prototype samples is considered undesirable, the total thermal resistance is still greater than for fibre glass exposed to the same moisture content (5% by volume) and the moisture retention after drying is only slightly greater than for the glass fibre loose-fill insulation.



cellulose sample after 25 days of drying

Channelling of moisture through cellulose fibre layers will undoubtedly occur on rewetting after an initial 5% by volume exposure to moisture; the moisture retention of loose-fill glass fibre insulation is of the order of 3.5% by volume and channelling of moisture through a 15 in. layer has been observed to occur in glass fibre when exposed to the 5% MC.

Roof Trusses, which have many metal truss plates that are covered with thick layers of blown cellulose fibre insulation have raised concerns over the corrosiveness of insulation. Other items which can corrode are electric junction boxes and pipes exposed to treated insulation.

Cellulose products marketed in Canada are required to pass the corrosive tests outlined in an ASTM standard specification for cellulose fibre insulation. However, there is some question as to whether the ASTM test is a realistic measure of corrosion as it does not simulate field conditions.

This is underlined by preliminary results of testing which indicate that some fire retardant salts used in cellulose are highly corrosive.

Borax and borax/boric acid treated cellulose (the most commonly used salts) have almost negligible corrosion (0.03%) but aluminum and ammonia sulfates treated cellulose fibres are at least 10 times as corrosive as the borax compounds.

INSULATION DENSITY
(dry loose-fill samples)

cellulose	2.5 lb/ft^3
glass fibre	1 lb/ft^3

After exposure of samples to humid atmospheric conditions for five weeks and vibrating:

cellulose	3.5 lbs/ft^3
glass fibre	1.35 lbs/ft^3

R-VALUES
(R-value of the 15" sample under dry conditions)

cellulose	R45
glass fibre	R35

(under wet conditions - 5% MC)

cellulose (a 29% reduction)	R32
glass fibre (a 34% reduction)	R23

(R-value of samples exposed to summer conditions (21°C and 40 to 50% RH) for 25 days)

cellulose	R35
glass fibre	R30

This summarizes "An Evaluation of Cellulose Fibre loose-fill Attic Insulation for Manitoba Housing" prepared by Prof. R. E Chant, Dept. of Mechanical Engineering, University of Manitoba for the Manitoba Housing Corporation.