RESEARCH REPORT

Basement Condensation: Field Study of New Homes in Winnipeg: Summary Report

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BASEMENT CONDENSATION:

FIELD STUDY
OF NEW HOMES
IN WINNIPEG

SUMMARY REPORT

Prepared for

Project Implementation Division
Policy, Research and Programs
Canada Mortgage and Housing
Corporation

by

UNIES Ltd
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This summary report is one of the many items of information published by CMHC with the assistance of federal funds. Copies of the full report may be obtained by writing Project Implementation Division, CMHC, 682 Montreal Road, Ottawa, Ontario K1A 0P7.

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1.0 DESCRIPTION OF THE PROJECT

The Manitoba Homebuilders' Association and the New Home Warranty Program of Manitoba Inc. have reported many instances of homeowners experiencing basement condensation problems in new homes. Floor coverings, furnishings, wall finishes, and other possessions can be damaged by the excessive moisture, but there is a divergence of opinion on causes and solutions. A field investigation of Winnipeg houses was carried out during the May to September period of 1987 with the following three objectives: determine the causes of excessive basement condensation in new homes; recommend appropriate remedial action; suggest construction practices which would avoid or reduce such problems.

Fourteen houses which either exhibited a moisture problem or illustrated some other detail relevant to the condensation question were examined. Nine of these were houses with wet basements and were identified as houses to be examined because they had been experiencing a moisture problem. They were constructed between 1984 and 1987 to current applicable local building codes, and represented conventional construction practices. This included full-height interior insulation of the foundation wall, covered with polyethylene which was stapled in place without caulk. It also turned out that all nine houses were built in winter or early spring.

Of the other five houses, two were more than 30 years old and typical of conventional houses which have functioned satisfactorily. Two were built in 1986 with foundation insulation on the exterior. The final test house was started and completed in the summer of 1987.

Visual inspections of the grounds, exterior and interior of each house were made, particular attention being directed to drainage, the foundation, the basement interior, and the condensation problem. Spot measurements and continuous recordings of air temperature and moisture in the basement, on other interior levels, and outdoors were made. To determine the causes of the condensation, the air temperature/moisture conditions were compared with temperatures measured on the surfaces of the concrete walls and floor, and with the locations of surfaces where condensation was and was not occurring.

2.0 BASEMENT CONDENSATION IN NEW HOUSES

If air losing heat to a nearby colder object is cooled below its "dewpoint" temperature, some of the moisture present as a vapour in that air will be removed by conversion into liquid water or, in other words, by the process of condensation. Droplets of water will form on the cold surface. This is what often happens on the interior side of a window during cold weather, and it is also what can happen on cool concrete surfaces in house basements.

The test houses with summer basement condensation had concrete wall surface temperatures about the same as those of similarly insulated and uninsulated older and drier conventional basements. Temperatures on the lower part of the concrete wall were not very far from the dewpoint temperatures of normal basement air in any of the houses, dry or wet.

Basement air moisture levels were also similar to or only slightly higher than seasonal outdoor values for all but the wettest basements. In the wet ones, with concrete exposed and after standing water on the floor had disappeared and batt insulation was no longer damp, the air moisture levels remained higher than outdoors by as much as 10 to 30 percent. It was possible to reduce these levels to the typical seasonal values measured in other houses through simple means such as ventilation. However, even with near-normal temperatures and air moisture levels, condensation on the lower walls and in the corners persisted in the test houses for weeks to months.

A bird's eye view of typical condensation patterns for new Winnipeg house basements which exhibit the problem is shown in Figure 1.

The field observations suggest that many Winnipeg houses, old and new, operate for part of the year with some interior concrete surfaces cool enough to promote condensation, yet little or no condensation occurs. However, new houses constructed during cold weather according to conventional building practices, with basement insulation applied on the interior over the full height of the concrete foundation wall, are susceptible to a significant condensation problem. The problem is worst during the first summer of occupancy.

The difference appears to be in the amount of drying experienced by the concrete since the time of construction. Prairie manufacturing of housing in winter using cast-in-place concrete foundations is not new. However, the recent practice of insulating the foundation on the interior for the full height and applying a vapour-retarding membrane appears to have slowed down the normal process of removal of excess moisture from the concrete. This is especially the case if the construction takes place during cold weather.

In typical older houses, the concrete would have been exposed for some time prior to insulating, thus permitting drying. In those houses and in some newer houses where the walls have been opened up, the insulation removed and ventilation applied, the problem either has never occurred, or, if it has, it now does not come back or is minor at worst.

The major problem source of the moisture in the new houses was not identified during the project, but it is most likely

(a) humid basement air from new building materials or occupancy, which is supplied to the cool wall because of the incomplete air/vapour barrier which is stapled in place according to conventional local building practices, or

(b) unbound water given up by the fresh concrete, or

(c) a combination of the above.

Regardless of the source, non-saturated concrete may have some capacity to absorb and store short-term excesses of moisture in the air contacting it, similar to the behaviour of wood. This is thought to be the reason for the lack of visible surface condensation on concrete in houses where it would be predicted from the temperature and air moisture levels. Saturated concrete does not have significant excess-moisture storage capacity and, similarly, nor does any other low permeance material placed on the cold side of the insulation for dampproofing or other purposes.

3.0 RECOMMENDATIONS

3.1 REMEDIAL MEASURES FOR NEW BASEMENTS WITH PROBLEM CONDENSATION

For new house basements in which problem condensation has occurred, it is recommended that the framed wall be opened up to expose the concrete. Good drying conditions should then be provided in the basement for at least one month and preferably for several months before the interior framed wall is restored. A favourable drying environment would include a temperature in the range of normal room temperatures or higher, and air moisture levels near to or lower than normal seasonal values. In summer, the latter can be provided simply by opening windows and encouraging natural exchange of air with outdoors.

When the interior wall is returned to a completed condition following a sufficiently long period of exposure of the concrete, it is also an opportunity to construct a properly sealed air/vapour barrier. This is advised in order to ensure that the summer condensation problem or winter ice build-up will not recur due to humid interior air reaching the cool concrete.

3.2 CONSTRUCTION PRACTICES FOR THE AVOIDANCE OF BASEMENT CONDENSATION

The basement condensation phenomenon could become more widespread if full-height insulation were to become more common across the country. It is recommended that, if the concrete wall is to be insulated on the interior, it should be left open for some time after construction (e.g., as much as one year) before completing the interior finish. It could be framed at the time of construction. Other practices which would contribute to mitigation or prevention of basement condensation in new homes include:

(a) insulation of foundations on the exterior,

(b) the maintenance of low interior moisture levels during winter construction through control of the use of water within the building shell, avoidance of the bringing in of damp materials, and use of construction heaters which produce less moisture than the propane-fired units now commonly employed,

(c) installation of a properly sealed air/vapour barrier in the basement, and

(d) if (c) is not practicable, provision of a barrier to air flow somewhere along the flow path of air through the wall cavity (Figure 2).

Trial application of some of the above principles is suggested in order to evaluate their usefulness in preventing or reducing the incidence of basement condensation in new homes.

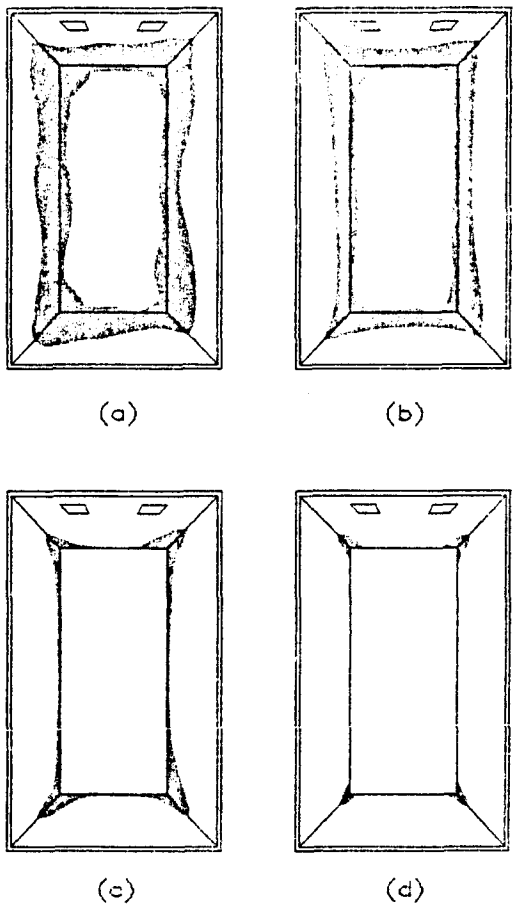

Figure 1. Basement Condensation in Winnipeg New Houses: Wetted Surfaces
(a) With insulation and polyethylene in place (irregular pattern),
(b) Several hours after insulation and polyethylene removed,
(c) After several days to several weeks of exposure of concrete,
(d) After several weeks to several months of exposure.

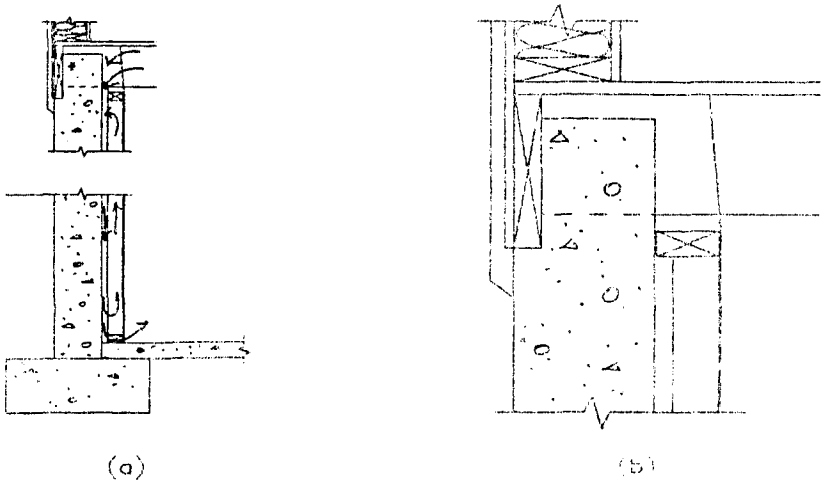

Figure 2. Basement Wall Cavity Air Circulation Pattern and Barrier:
(a) Normal air circulation (insulation removed for clarity),
(b) Air circulation barrier provided with oversize top plate.

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