Research & Development Highlights

Technical Series 95-207

Development of an Interior Dampproofing Strategy to Prevent Basement Wall Condensation During Curing

Introduction

Condensation and pooling of water on interior insulated basement walls is a problem in new homes, particularly in the first year of completion.

A previous investigation, involving fourteen case studies of basement condensation problems in Winnipeg, provided a basis for possible causes.

These included:

- Cold weather construction followed by moist summer weather conditions.
- Higher than ambient relative humidities of basement air, combined with concrete surface temperatures at the dew point of that air.
- Circulation of moist basement air behind the insulated wall cavity due to poor air barrier detailing.

Further research was needed because builders considered all proposed solutions to be unproved or impractical.

This project was initiated to further examine the mechanisms involved in basement condensation and to test possible solutions.

Research Program

The water-cement ratio of freshly poured concrete decreases significantly after curing due to evaporative drying. This is believed to be the source of wall condensation problems. If the construction and finishing of basement walls is done in spring or early summer, the excess moisture in the concrete will be subject to a temperature gradient. A higher temperature will be experienced at the top and outside of the wall due to solar effects and ambient air conditions, while the lower inside wall will remain cooler due to the mass effect of the earth.

This concept led to the hypothesis that, as a result of the inward and downward temperature gradient in the saturated wall in spring and summer, excess water would be diffused through the interior insulation to the vapour barrier surface and to the bottom of the concrete wall.

A computer model developed at the Florida Solar Energy Center (FSEC) was used to test this hypothesis and assess the relative performance of a number of dampproofing strategies. This model is used to solve generalized multi-dimensional heat, air and moisture flow problems and simulate complex building science problems.

The dampproofing strategies tested had to resolve the problem and meet the concerns and requirements of the building community. Eleven simulations were conducted under different conditions, which included:

- basement temperature,
- basement relative humidity,
- depth of water table,
- solar gains,
- type of membrane between insulation and concrete, and
- type of vapour barrier used.

Nine cases were run for 1200 hours or 50 days while two cases were run for 8760 hours (a full year) to assess the dampproofing strategies under winter conditions.

Temperature and moisture contents for locations at the wall top, middle and bottom (as well as for the insulation at the inner face, next to the polyethylene) were recorded every four simulated hours. Average temperatures and water contents were recorded for the above-grade and below-grade portion of the wall, the concrete slab, the building paper and the insulation layer.

Hourly weather data for Montreal (including ambient air temperature, relative humidity, and incident solar radiation) were used for this investigation.

It is important to note that (a) no air flow was modelled and (b) the modelled cavity had no wood studs. It is likely that wood studs will have an impact on the moisture balance in the cavity.

Findings

The results of the model for the test case B3 suggest that the hypothesis is correct. Condensation in basement wall insulation is due to vapour diffusion driven by inward and downward temperature gradients in the wall.

The four simulations for dampproofing strategies (figure 1) resulted in lower moisture levels compared to the test case and differed in performance from each other.

Case B4 maintaining the basement temperature at 25C to keep the insulation and vapour barrier above the cavity air dewpoint — was susceptible to warm ambient air conditions as the summer progressed.

The use of building paper between the insulation and concrete provided good results for cases B I and B2, suggesting that vapour diffusion control is an effective measure. Shading from solar gains was found to have little merit once the ambient temperature became warmer. The use of building paper instead of polyethylene sheeting as a vapour barrier in case B5 provided the optimum results. The permeability balance on both sides of the cavity resulted in a steady, low moisture content which fell below all other strategies.

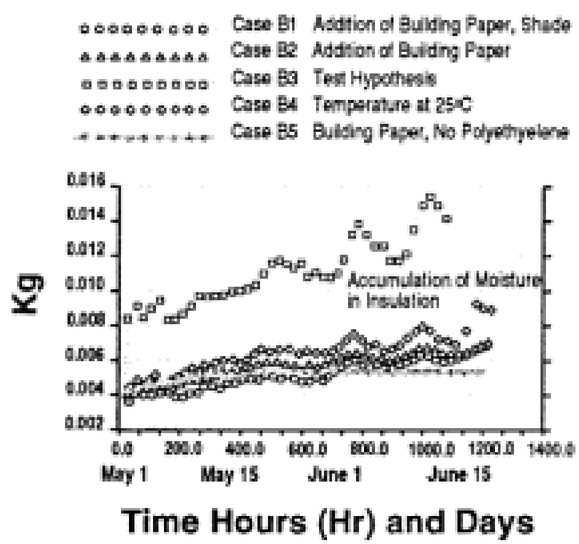

Figure 1

Using no vapour barrier and no moisture barrier was effective during the summer months, but the system experienced saturation problems the following winter. Simulation *B5,* however, found that the wall cavity moisture level rose only slightly and did not reach saturation in winter.

Implications for the Housing Industry

Many factors contribute to the problem of basement wall condensation and should be noted by the building industry. These factors include:

- Spring or early summer construction followed by rapid basement wall finishing.
- Absence of a building paper membrane between the insulation and concrete below grade. It is possible that the recent rash of condensation problems in full height basement insulation is actually a result of this absence rather than anything else.
- A significant temperature gradient between the exterior wall and interior basement, due to a high water table or exposure to solar gains.

Strategies to reduce basement condensation problems include:

- Vapour diffusion control — utilizing a building paper membrane or installing an inside layer of impermeable extruded polystyrene down to the footing before the slab is cast, to provide a drainage path for moisture condensing at the interface.
- Minimizing the temperature gradient by heating the basement while watching out for rapid, uneven slab drying.
- Allowing the concrete to dry for as long as possible before finishing. Use exterior insulation to reduce temperature gradients in the concrete.

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