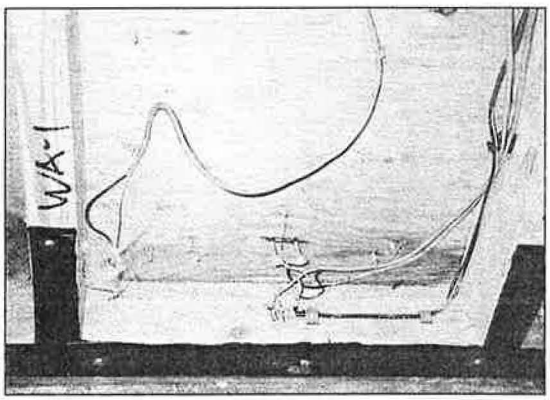
Diagnosing Wall Moisture

Pinpointing where water or air has leaked into an exterior wall—and why—are critical diagnostic steps to take before beginning remedial repairs. A report by the Research Division of Canada Mortgage & Housing Corporation describes three on-site exterior wall monitoring protocols for determining the occurrence and cause of air leakage, condensation, and rain and melt water penetration. Successful diagnostics can identify a problem and give a fix more of a chance of succeeding than treating symptoms alone.



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Moisture sensors determine if condensation is a problem.

Air Leakage Detection Method

Air leakage in an otherwise adequately insulated wall is the major cause of heat loss. The stack effect of rising hot air will further compound the effect of leakage in a multistory building.

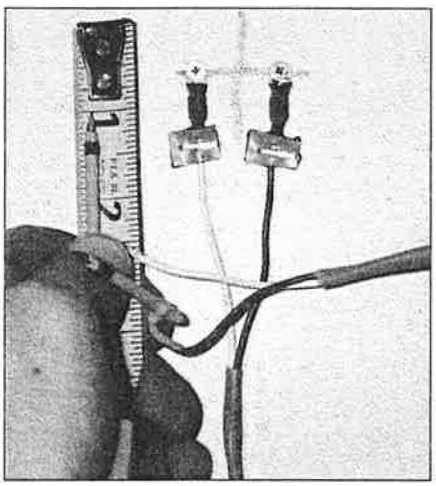
Temperature sensors, placed halfway up the wall and connected to a data logger, record the interior surface temperature, the temperature in the insulation cavity, and the exterior surface temperature. The diagnostician uses a pressure transducer to measure the pressure difference across the wall. The data is collected for one to two weeks between midnight and 6 a.m. to eliminate the effects of solar radiation.

The diagnostician can then calculate a temperature index—the fractional temperature drop in the wall due to conductive heat losses and the thermal resistance of the wall elements. This actual temperature index is then compared to the expected or theoretical temperature index. An actual index higher than the expected index indicates that indoor air is exfiltrating through the wall. Conversely, a temperature index lower than expected indicates that outdoor air is infiltrating through the wall to the inside. Since air leakage is driven by an air pressure difference, comparing the measured temperature index with the monitored air pressure difference will confirm if air leakage is occurring.

To demonstrate the method, a residential building in Montreal was instrumented and monitored. The results have been plotted in Figure 1. This graph indicates that the exterior wall is leaking air, and the spread of the index change over the pressure difference range indicates the magnitude of the leakage problem. If the exterior wall were airtight, the pressure difference would not induce changes in cavity temperature, and the temperature index would remain constant.

Condensation Detection Method

Besides reducing the effectiveness of insulation in stopping heat loss, moisture can start spalling in bricks and other materials if they get wet and are allowed to freeze and then warm up. The following method can be used to determine if condensation is the primary cause of a moisture problem. Temperature sensors record the interior and exterior temperatures and the temperatures in the cavity and on the exterior side of the cavity.



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The two-inch brass moisture pins are epoxy coated for electrical insulation.

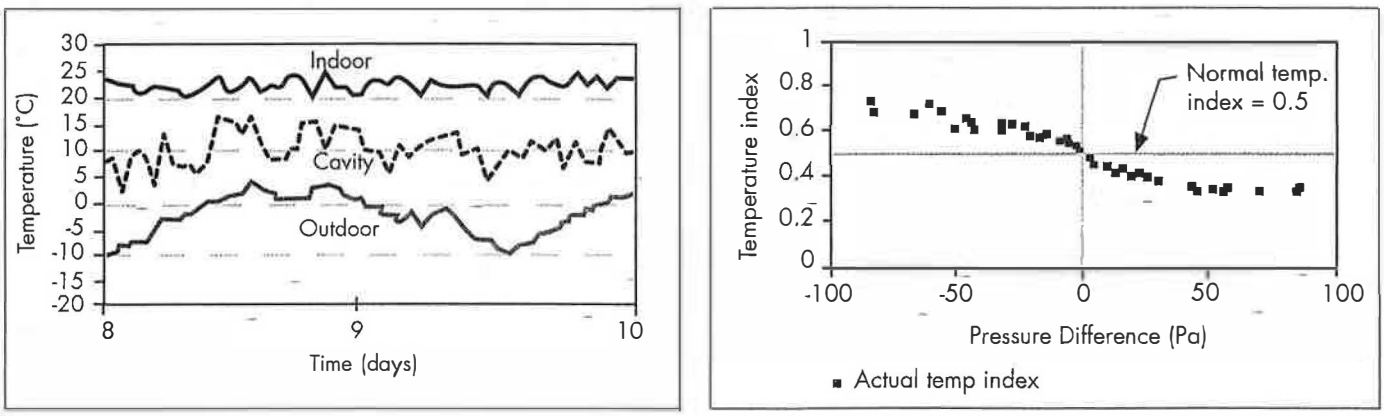

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Figure 1. These graphs indicate that the exterior wall is leaking air. The spread of the index change over the pressure difference range is indicative of the magnitude of the leakage problem.

The relative humidity in the cavity is also measured. The diagnostician uses a pressure transducer to measure the pressure difference across the wall. All sensors are connected to a data logger, which is set to a monitoring interval of 30 minutes for a minimum of three weeks.

The air temperature and relative humidity conditions in the cavity are converted to dew point temperatures, which are then compared to the cold-side cavity surface temperature. If the dew point is equal to or higher than the cavity surface temperature for prolonged periods of time, condensation is probably occurring.

Rain and Melt Water Detection Method

The following method can be used to determine if rain or melt water is the source of moisture in a wall. The area of most severe damage should be monitored. Temperature sensors record the interior, exterior, and cavity temperatures. Relative humidity is measured at the same locations. The cavity and exterior should be instrumented with pressure taps to measure pressure difference during rain events to discriminate between rain penetration by gravity and rain penetration by wind-driven rain. All sensors should be connected to a data logger set with a continuous loop and a monitoring interval of ten minutes.

Data can be retrieved after two or three rain or melt water events. Following an event, if the relative humidity in the cavity rises and remains high for days or even weeks, it is likely that rain or melt water has penetrated the wall construction and that it is not draining or drying out adequately.

—Rick Quirouette and Jacques Rousseau

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