Volume 1, No. 3

Crawlspaces Matter

A Commentary On The Performance Of Crawlspaces In Saskatchewan

Photo 1. Exposed ground in a crawlspace is typically several degrees cooler than the crawlspace ambient air temperature. The bottom edges of floor joists exposed to the ground are typically within a few degrees of the ground surface temperature due to radiation dominated heat transfer. At these locations, the relative humidity is higher and the moisture content of the wood is elevated.

Photo 2. The darker area indicates moisture adsorbed from the air in the crawlspace into the concrete block. The concrete is cooled by the ground and the relative humidity of the air in contact with the concrete increases as it is cooled, driving the adsorption and absorption processes.

Understanding Crawlspace Conditions

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In the previous edition of *Crawlspaces Matter*, we looked at some potential symptoms and signs of moisture issues and at how building owners, operators and occupants may be impacted.

Understanding crawlspace conditions enables us to prevent problems and to develop appropriate solutions for existing problems. In this edition, we review what attributes and variables might be observed, measured or calculated when assessing the potential for, or diagnosing the causes of, moisture related problems.

Moisture and Materials

As noted in Volume 1, No. 1, the National Building Code of Canada wants us to limit the risk of injury and to limit the risk of illness through the design, construction and operation of our buildings. Illness may result when people are exposed to a threshold level of mould and injury may result if a building collapses due to decay of wood structural members or due to corrosion of steel structural elements. Mould spores require water and a food source to germinate and colonize. Electrochemical corrosion requires an electrolyte. Within a crawlspace water vapour in the air or liquid water that has condensed out of moist air onto surfaces serves as an electrolyte. If we can control the presence, quantity and dwell time of moisture in the air, on surfaces and in materials we can prevent problems and avoid a lot of grief.

Hygroscopic (water attracting) materials gain or lose moisture with changes in the relative humidity of the air in contact with these materials. Hygroscopic materials are characterized by having cells or cavities. Hygroscopic materials include wood products and concrete. Non-hygroscopic materials include glass and metals.

When dry wood is exposed to moist air it attracts and binds water vapour molecules to the cellulose fibers in the cell walls through a process call adsorption. Once the cell walls are completely saturated (the fiber saturation point), excess moisture fills the cell cavities as liquid water. As the relative humidity increases the moisture content of the wood increases. At a sustained moisture content of about 16%, wood is highly susceptible to germination and colonization of mould spores. At the fiber saturation point (typically 25% to 30% moisture content), wood becomes susceptible to rot when decay fungi are present.

What Mould Wants

Mould spores are probably present in most crawlspaces and they are able to germinate and colonize when there is food, moisture and a suitable surface temperature.

Moulds prefer to feed on the sugar glucose in the form of cellulose. Lumber contains cellulose fibers. Processing wood into oriented strand board, particleboard or paper makes it even easier for moulds to access the glucose. Mould can also grow on non-organic materials such as concrete, mineral fibre insulation and metal ductwork when dust or dirt that contains mould spores is deposited on these materials.

Attempting to identify and eliminate existing dormant mould spores within a crawlspace is generally not practical. What we can do, however, is to prevent mould spores from germinating, colonizing and spreading within the crawlspace and throughout the building.

Relative Humidity and Temperature

Under normal conditions, preventing mould spores from germinating effectively involves controlling the:

1. Temperature of surfaces, and
2. Relative humidity of the air that comes into contact with these surfaces.

A sample of moist air contains a certain amount of water vapour. Cold surface temperatures decrease the temperature of the air in contact with the surface which increases the relative humidity of the air in contact with the surface. *(Photo 1)*

For porous and hygroscopic materials such as wood, paper or concrete, as the relative humidity increases the amount of water vapour that is captured and stored in the material as bound or sorbed water increases. *(Photo 2)* This change in phase from vapour to bound water molecules and vice-versa is an ongoing process driven by the relative humidity level.

If moist air is cooled to its dew point temperature, moisture in the air will change in phase from vapour to liquid (condensation process) which is seen as dew, droplets or pools of liquid water on non-hygroscopic surfaces such as glass or metal ductwork.

For example, moist air being distributed by ductwork located in a crawlspace or underneath a floor slab may be inadvertently cooled to its dew point temperature causing condensate to form and collect inside the ductwork, potentially leading to mould growth and subsequent transport to other spaces.

However, when dealing with porous and hygroscopic materials, if moist air is cooled to its dew point temperature the nascent droplets of liquid may be absorbed into the material before they coalesce into visible droplets on the surface.

Thus, the moisture content of porous and hygroscopic materials can reach elevated levels unwittingly. At critical levels, mould, decay, corrosion and other types of degradation can occur.

Measuring and monitoring relative humidity and temperature is generally simpler and easier than directly measuring moisture content, watching for condensate or signs of elevated moisture levels. By knowing surface and air temperatures and the relative humidity within a crawlspace over an annual or even longer period, event and time-based risk profiles can be developed to aid in the identification of preventive measures or corrective measures where problems already exist.

Temperature and relative humidity data also enables calculation of other parameters such as the partial water vapour pressure which can be used to determine the quantity and direction of vapour flow within building assemblies and therefore the risk of moisture accumulation, damage to materials and mould formation.

Next Edition

The next edition of *Crawlspaces Matter*, Understanding **Moisture Movement**, looks at potential sources of moisture, transport mechanisms and driving forces. An understanding of these aspects is essential to determining preventive and corrective measures.

Notice

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If you would like to receive future editions of this newsletter, please contact Dan Kishchuk at dan@emscroscan.ca or 306 665-9098.