Crawlspaces Matter

A Commentary On The Performance Of Crawlspaces In Saskatchewan

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Photo 1. Wet crawlspace ground indicates wicking of moisture through the sand. Poor drainage caused rain water to flow towards the building and then seep down and under the foundation walls. Exposed, wetted materials provide a source of moisture.

Photo 2. A roof drain leader discharging adjacent to the crawlspace wall resulted in water and sand entering the crawlspace through the gap between the crawlspace door panel and jamb. Entering water pooled on the ground cover material, providing a source of moisture.

Understanding Moisture Movement

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In the previous edition of *Crawlspaces Matter*, we looked at why measuring and monitoring air and surface temperatures and relative humidity levels within crawlspaces is essential to understanding crawlspace conditions.

In this edition we discuss potential sources of moisture, flow mechanisms and driving forces.

Forms of Moisture

Water can exist in several different forms or states: solid (e.g., frost, ice), liquid, gaseous (vapour) and adsorbed. The adsorbed state is characterized by water molecules that are bound to the internal surfaces of porous materials such as wood. Adsorption occurs due to the electrical polarity of water molecules which behave as tiny magnets.

Moisture Sources

Moisture within crawlspaces can originate from a variety of sources, including:

- Precipitation (rain, melt water)
- Moist outdoor air (infiltration, ventilation and make-up air)
- Mechanical systems (humidification)
- Occupants and their activities (e.g., cooking, showering)
- Ground water
- Open sump pits
- Irrigation
- Plumbing systems (discharges, leaks, overflows)
- Moist materials brought into a building

Flow Mechanisms

Moisture moves into, out of and within buildings, including crawlspaces, by different mechanisms.

Liquid water flows due to:

- Gravity.
- Capillary suction (wicking).
- Air pressure gradients that force water through openings and along surfaces.
- Hydrostatic pressure that forces water through pores, openings and along surfaces.
- By surface diffusion from areas of higher relative humidity to areas of lower relative humidity due to a thermal gradient.

Water vapour flows:

- By diffusing from areas of higher partial water vapour pressure to areas of lower partial water vapour pressure due to a concentration gradient.
- When moist air is displaced due to stack effects, wind pressure and mechanical (supply and exhaust air) systems.
- When water vapour molecules adsorb to, or desorb from, hygroscopic surfaces due to changes in the relative humidity of the air in contact with the surfaces. When the relative humidity rises, hygroscopic materials gain moisture and vice-versa.

Water Vapour Diffusion

Water vapour moves by diffusion through still air and by surface diffusion through porous building materials. The vapour flow rate through a material, or an assembly of materials, is dependent on the concentration gradient of partial water vapour pressure and the ability of the material or assembly to resistance the passage of water vapour.

If the partial water vapour pressure in a crawlspace is higher than the partial water vapour pressure in the occupied storey above then water vapour will want to migrate from the crawlspace to the occupied space. If no partial water vapour pressure gradient exists then there is nothing compelling water vapour to move.

Some materials such as glass are impermeable to water vapour but common building materials such as wood, fibre insulation and gypsum board are not. The greater the water vapour permeability of a material, the easier it is for water vapour to diffuse through it.

Capillary Suction

Once a hygroscopic material has adsorbed onto or into the cavity walls all the water vapour molecules that it can, the outer, more loosely bound, layers of water vapour molecules transform into liquid water through capillary condensation. As cavities become filled, liquid water is drawn into adjacent cavities through capillary suction. At a high enough relative humidity level, the adsorption and capillary suction processes will continue until all cavities are water filled.

When porous materials come into contact with liquid water or wetted materials, water absorbs into the drier material and may also travel to non-contact areas through capillary suction.

Photo 3. Snow melting in the adjacent space absorbed into the concrete slab on grade, moved laterally to below the bottom wall plate and then upward into the wall assembly where it caused blistering of the wall finish.

Water Vapour Flow by Air Movement

Water vapour may be introduced to a crawlspace when air containing water vapour is supplied to a crawlspace for heating or ventilation purposes. Leakage from unsealed ducts mounted in a crawlspace may also inadvertently introduce water vapour.

Water vapour may also be transported in air that infiltrates through the floor assembly above or through the above-ground portion of the crawlspace walls. This could occur when the crawlspace is at a lower air pressure relative to the occupied space above or to the outdoors due to air being exhausted from the crawlspace.

Multiple Mechanisms at Work

Often, a variety of mechanisms are at work in parallel and in series. Rain, melt or irrigation water may wet and then wick through the soil and porous building materials such as concrete. The stored water is then available to be adsorbed into the crawlspace air or absorbed into other materials such as wood framing or gypsum board.

The water vapour in the air may then diffuse or be transported in displaced air to other areas causing the moisture content of materials susceptible to mould to reach threshold levels.

Air that has been humidified to provide a suitable indoor environment for occupants that is also supplied to a crawlspace may be adding moisture to the crawlspace.

When the sustained relative humidity of the air in a crawlspace is high enough and the temperatures of surfaces in a crawlspace are low enough, fungi, corrosion and other issues are more likely to occur.

To prevent these and other problems from occurring, a crawlspace must be kept both warm and dry.

Next Edition

The next edition of *Crawlspaces Matter*, **Controlling Crawlspace Relative Humidity** looks at what can be done to prevent moisture from entering and accumulating in existing crawlspaces and what measures can be taken (and when) to maintain the relative humidity at an acceptable level.

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.