SPRI
SINGLE PLY ROOFING INDUSTRY

CONSTRUCTION-GENERATED MOISTURE AND ITS EFFECT ON ROOF SYSTEMS

Commercial roof assemblies in new construction and during extensive renovation work should always be designed to accommodate construction-generated moisture. Understanding and eliminating moisture intrusion into the roof assembly can improve the performance and life expectancy of the roof assembly, which not only benefits the building owner but also the building occupants.

For new construction projects with elevated levels of construction-generated moisture, it's vitally important that roofing specifiers develop a remediation plan to address the issue from the outset to accommodate, dissipate, or avoid large moisture loads. In hot and warm climate regions (ASHRAE Zones 0-3 – including sub-part A, B, C regions), construction-generated moisture may go unnoticed until musty air is detected, or may go unnoticed until musty air is detected and could create an environment that would allow unwanted organic growth. However, in colder climate regions (ASHRAE Zones 4-8 – including sub-part A, B, C regions), construction-generated moisture may first appear as water droplets inside the building, typically after the first freeze/thaw cycle, and be misinterpreted as a roof leak.

Construction Generated Moisture

Moisture associated with construction can be generated by a variety of trades and construction activities. According to *The Manual of Low Slope Roofing Systems* - 4th Edition, Griffin & Fricklas, 2006.

- A four-inch-thick concrete floor slab poured in an enclosed building generates about 240 gallons water per 1,000 square feet of concrete.
- Propane heaters for providing more comfortable working conditions or to help "dry" the construction also generate large quantities of moisture. In fact, every 200-pound tank of propane burned releases 30-gallons of water into the surrounding air.
- Oil-burning heaters produce 1 gallon of water for every gallon of oil burned.

Other contributors to construction-generated moisture and potential water accumulation in the roof assembly include paint, plaster, and drywall finishing.

Moisture Migration

Construction-generated moisture can contribute to excessive levels of relative humidity inside the structure when proper remediation measures are not taken. When the outside temperature drops, condensation can begin to form and appear on any surface with a temperature at or below the dew point, which can include the underside of skylight domes, uninsulated portions of the roof deck, roof insulation, or the underside of the roof membrane.

Warm, moisture-laden air migrating upward can infiltrate or “intrude” into the roof assembly through deck-to-wall joints, gaps around penetrations, or voids in the deck. The intruded air is then trapped within the roof assembly and cannot escape due to the air-impermeable roof cover. Condensation occurs as the air cools, and moisture collects on colder surfaces, turning to frost and ice at temperatures below freezing. The higher the level of interior relative humidity and the greater the temperature differential between the interior and the exterior of the building, the more moisture will collect.

In extreme cases, and especially with a single layer of insulation, ice build-up, due to condensation, can be identified by a “cracking” sound when walking on the roof membrane. Also, heavy ice formation along insulation joints can generate expansion forces that push laterally, causing insulation joints to widen. Condensation within the roof insulation may cause permanent damage, loss of R-value and loss of wind uplift resistance.

As the outside temperature rises and the roof assembly warms up, the frozen moisture begins to thaw, resulting in drips inside the building. The drips are not associated with rainfall or snow accumulation on the roof and are, in fact, more likely to occur on sunny days when roof surface temperatures warm to above freezing. Furthermore, the intensity of the drips is directly related to the amount of moisture that has intruded into, and condensed within, the roof assembly. Perhaps not surprisingly, the concentration of drips is more likely to be visible around the perimeter of the roof and at deck end-laps or openings .

Typically, when this occurs, the dripping is misdiagnosed as a roof leak, leading to extensive resources searching for a leak that does not exist.

Controlling Construction-Generated Moisture

To control construction-generated moisture, during the design process, roof design professionals must identify the sources of moisture and develop a remediation plan to be implemented during construction. To reduce the probability of condensation, buildings under construction must be adequately ventilated, particularly during concrete hydration and other high moisture-related construction activities.

Commercially available high-volume ventilation systems can be especially helpful when used during construction. Some of these systems include a dehumidification function, which is essential for removing large amounts of moisture from the air. The building’s HVAC system, which is designed to control the temperature inside the finished building, is not sufficient for removing construction-generated moisture.

Cold Climate Design

In cold climate regions (ASHRAE Zones 5-8), the following design recommendations should be considered as a matter of general practice. These recommendations are intended to supplement the measures taken to control construction-generated moisture and include some roofing-specific recommendations.

- Always avoid using wet materials, particularly in the roof assembly, and whenever possible, avoid materials with an excessive moisture content.
- Avoid incomplete construction without at least a temporary method to enclose completed areas that are sensitive to water and moisture migration.
- Include vapor retarders in the roof assembly to prevent moisture accumulation caused by air intrusion. The vapor retarder must be positioned within the roof assembly so that its temperature is always warmer than the dew point temperature. This prevents the warm, moist air from reaching the dew point, and thereby eliminating condensation. Consult a roof design professional or the roof materials manufacturer/supplier to ensure that the proper amount of insulation (R-value) is used to keep the vapor retarder "warm."
- Once the air or vapor barrier is installed, never penetrate that barrier.
- Install at least two layers of roofing insulation with staggered joints to help retard warm, moist airflow from the interior of a building up into the roof assembly.
- Always seal the deck-to-wall joints and gaps around roof penetrations to further limit air infiltration into the roof assembly.

Existing Condition Remedies

In buildings where drips frequently occur, measure the relative humidity of the interior space. If the interior humidity exceeds the outdoor humidity, a condensation problem may exist. The building should be adequately ventilated and dehumidified to remove excess moisture. Additionally, the following recommendations may help to eliminate dripping water.

- Verify that the design operating temperature of the facility has not been exceeded. The warmer the air, the more moisture it can hold.
- Provide air circulation using mechanical or electrical fans during the winter months to mix warmer and colder air, preventing moisture-laden air from accumulating beneath the roof deck.
- Check to ensure that the deck-to-wall joints and joints between the deck and roof penetrations have been sealed from the underside to prevent warm air intrusion from inside the building.

Conclusion

Buildings under construction should be adequately ventilated during concrete hydration and other high-moisture related construction activities. In cold climate areas the use of a vapor retarder should be considered as determined by a roof design professional. Consider adjusting the construction schedule and/or temporary enclosure/protection measures to control or avoid moisture intrusion and related damages. Eliminating moisture intrusion into the roof assembly during construction will improve the performance and life expectancy of the roof, which benefits the entire building industry.

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