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MOLD

Mold spores are ubiquitous in nature. Given the proper environmental conditions they can reproduce and grow. Proper environmental conditions include temperature, moisture and adequate nutrients. Residential and commercial buildings often have the proper conditions to promote the aggressive growth of molds. These conditions include moisture and organic food sources such as wood and adhesives. Unchecked mold growth has resulted in, or been implicated as the cause of sick building syndrome. It can also damage or destroy materials it grows on. Wide spread mold growth has resulted in the closing of schools and office buildings, and in liability claims from occupants for respiratory aliments.

Because most buildings have the proper substrates for mold growth, the predominant method for limiting its formation is to prevent the introduction of excessive moisture. The introduction of moisture can be from roof, wall, foundation and plumbing leaks, negative building pressures with respect to the outside or other high humidity areas, the improper use of vapor barriers, interior moisture production, poor HVAC design and/or maintenance and condensation on cold surfaces due to thermal bridging or damaged insulation.

Moisture

There are several common moisture sources in buildings, which include:

1. Liquid water from precipitation that directly leaks into a structure. For example from a roof leak.

2. Water vapor transfer into a building through the HVAC system, vapor drive through building materials and from moisture generating activities and processes in the building. Some common sources of moisture sources inside a building include natatoriums, kitchens, cleaning floors, people, locker rooms and hot tubs.
3. Liquid and vapor moisture transfer through foundation walls.
4. Moisture from the drying of building materials.
5. Plumbing leaks.
6. Condensation of moisture on cold surfaces such as on chilled water piping or domestic cold-water distribution piping.

HVAC Systems

Often water vapor is brought into the building by the HVAC system. It is introduced by insufficient dehumidification of the outside air. Or, the HVAC system may not be adequately designed to maintain a positive building pressure, and moist outside air is drawn into the building via a negative building pressure. The inability of a HVAC system to adequately dehumidify a structure is very common, and is often the cause of or contributory to the formation of molds. Standard indoor quality guidelines recommend that on average interior relative humidity be maintained below or at 60% RH. RDA's investigations of HVAC systems have found that many HVAC systems are inadequate to control indoor humidity or building pressure. Often the HVAC system was designed to provide proper interior conditions (temperature and humidity) on a hot or design day, but is inadequate to maintain proper interior humidity when the outside conditions are relatively cool but humid. RDA has also determined that many structures are negatively pressurized with respect to the outside and draw in warm humid outdoor air. This type of condition is often found in restaurants, building with locker rooms and laboratories that have large exhaust requirements.

Building Construction

Foundation walls are often porous to moisture. Moisture entering a building through foundation walls can cause condensation on cool surfaces. During the winter these surfaces may be interior walls and ceilings that are uninsulated or that have breaks (i.e., thermal bridging) in the insulation. This can lead to a uniform mold over the cold surface, or mold growing at locations where thermal bridging occurs. During warmer weather foundation wall moisture transfer can cause condensation on cold water lines and chilled water piping that are not properly insulated.

Improper design of exterior walls, and the improper use and placement of vapor barriers can lead to the formation of hidden molds. For example a block wall with an interior finish of drywall and vinyl wall covering can lead to extensive mold formation behind the wall covering. This problem frequently occurs in air conditioned hotels and nursing homes. Moisture flows from an

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area of higher pressure (the outside) to lower pressure (the inside). The difference in these pressures is often referred to as "vapor drive". Vapor drive follows Dalton's Law of Partial Pressures. In the wall construction discussed above, moisture drive occurs through the porous block wall and drywall and becomes trapped behind the vinyl wall covering. The vinyl wall covering glue provides an ample food source for the formation and growth of molds. Typically, a 1-dimensional steady state moisture analysis will verify that condensation is occurring behind the wall covering.

Attics

Residential buildings often include attics. In cold climates it is common for molds to form on the underside of roofs. Molds grow in these areas due to condensation of moisture on the cold roof surfaces. Sources of moisture include bathrooms vented into the attic, vapor drive through the ceiling due to a lack of an adequate vapor barrier, movement of warm air from the home into the attic through openings such as around attic doors, recessed lighting and other openings. Another source of attic moisture is from ice dams.

Snow and ice dams most often form after a substantial snowfall. The interior heat of the structure causes snow to melt and later freeze typically at the roof eaves to form an ice dam. As the snow near the roof melts, water flows down the pitch of the roof, and backs up behind the ice dam. Because sloped roofing shingles are for water shedding, not water proofing, this water forces its way under the shingles, and then through the roof deck, and eventually into the structure. This wetting of the plywood roof deck is what causes the formation of molds. Roof leaks also often occur in areas such as in valleys, around skylights, or near protrusions such as dormers. The primary effect of the ice dams includes stained walls and ceilings, mold growth and general water damage.

Under most building codes attic areas are required to have natural and/or mechanical ventilation. Codes typically require a minimum of 1/150 of ventilation free area (i.e., based on total attic floor area) split between the eaves and ridge. If the attic is equipped with a vapor barrier that provides less than a 1-perm performance, the free area can be reduced to 1/300. The attic ventilation serves several purposes that include, but are not limited to:

1. Ventilation of the attic in the winter reduces the buildup of moisture that diffuses from the home into the attic. This moisture has the potential of condensing on the cold roof surface (i.e., underside of the sloped plywood) and wetting the material.
2. Ventilation of the attic in the winter reduces the buildup of heat in the attic. The presence of heat in the attic space increases the probability of melting snow on the roof, and the potential for water backing-up under the roofing shingles, i.e., the formation of snow and ice dams.

Analysis

Analysis of mold and associated moisture problems involves a comprehensive review of a building's construction and its mechanical systems along with a visual inspection of the building's interior and exterior. Often an Industrial Hygienist accompanies the engineer during the site analysis phase so that mold samples can be taken to identify the molds, and determine the mold air concentration with respect to the outside. Often instrumentation is used in identifying conditions that promote molds. Some of the instruments used include infrared scanning of surfaces for thermal bridging, humidity and temperature measurements, airflow movement studies using cold smoke and pressure differential studies.

Once the cause of the mold growth has been determined, proper techniques, such as those written by the US EPA need to be followed for its remediation. With widespread growth of molds the underlying causes for its formation needs to be addressed so that the molds do not reoccur.

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