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Vapor Pressure and Flooring Installation

Introduction

A major cause of flooring failure is excessive moisture in the underlying slab. Moisture can migrate through the slab as water vapor can become trapped between the slab and impervious flooring. The trapped vapor can condense, causing flooring to cup, buckle, and blister, leading to adhesive failure and mold growth. Before flooring is installed, it is necessary to understand the causes of vapor migration and confirm acceptable slab conditions.

Vapor Pressure

Vapor pressure is the natural tendency of moisture to seek equilibrium by migrating from areas of high concentration to areas of low concentration in the form of water vapor. The vapor emission rate is the rate at which water is released from a slab via vapor pressure.

Reducing Moisture in Slabs

Moisture in slabs should be controlled to below the levels the flooring manufacturer indicates as acceptable for installation of their products. This can be achieved by:

- Using appropriate concrete mixes with the minimum water necessary for placement. Admixtures can be used to increase workability and reduce the amount of water used.
- Providing sufficient curing time. Over time, the water in a concrete mix reacts with cement and admixtures, resulting in less free internal moisture.
- Completing the building enclosure to provide protection from the elements. Concrete is porous, and environmental water will penetrate and raise the internal moisture level.
- Operating the HVAC systems. Temperature and humidity control can reduce moisture content.
- Providing well-designed grading and landscaping, which can divert surface water and groundwater from slabs.
- Installing vapor barriers that block the movement of moisture from the soils below slabs installed on grade. To be effective, a vapor barrier must be a continuous, impermeable system, installed with sealed joints, and free of damage and penetrations.
- Providing dewatering measures below slabs as required in areas with high, seasonally high, or perched water tables.

Testing

It is important to determine the moisture content of a slab to identify it is appropriate for the installation of a new flooring. Two of the more common moisture testing methods are the calcium chloride test and the internal relative humidity probe.

The calcium chloride test measures the vapor emission rate of the slab. This is done by placing a test kit containing a quantity of calcium chloride ion on a slab to measure moisture near the surface. After a determined time, the kit is retrieved and weighed, and the weight gain is attributed to moisture from the concrete. The results can be used to calculate the estimated vapor emission rate of the slab.

The advantages of this test are that it is widely accepted by flooring manufacturers and relatively easy to perform, and it does not require testing equipment. The disadvantages are that it only measures the free moisture near the surface of a slab, and that both the test and the analysis take time.

The relative humidity probe measures the internal relative humidity of the slab. The test requires drilling holes to a depth of 40% of the slab's thickness and inserting capped plastic sleeves. After waiting for a duration defined by the test, a probe is placed in the sleeve and reads the humidity at the bottom of the hole.

The advantages of this test are that the humidity is measured near the center of the slab, the instruments can be independently calibrated, and the results are acquired quicker than with the calcium chloride test. The disadvantages are that it is less widely accepted by flooring manufacturers, and that the probe and calibration require more financial investment.

Conclusion

It is important to avoid excess moisture in slabs and to test them to ensure acceptable conditions prior to flooring installations; both the calcium chloride test and the relative humidity probe provide the necessary data. Tests should be conducted after HVAC systems are operating and the slab has been acclimated to final environmental conditions. It is important that tests be conducted in accordance with their respective ASTM test method (see Additional Information, below). This will include such factors as proper temperature and humidity, the proper number of tests and test locations, and proper subfloor preparation. If these conditions and recommendations are not strictly adhered to, then no test method will ever present an accurate assessment of the concrete's vapor emission rate.

Additional Information

ASTM F-1869-10, *Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride*
ASTM F-2170-11, *Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs using in situ Probes*
ASTM F-710 *Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring.*