Concrete slab moisture can cause problems with the adhesion of floor-covering material, such as tile, sheet flooring, or carpet and bond-related failures of non-breathable floor coatings. Adhesives used for installation of floor coverings are more water-sensitive due to restrictions on the use of volatile organic emissions (VOX) products. To warranty their products, manufacturers often require that the moisture emission from the hardened concrete slab be less than some threshold value prior to installing floor coverings or coatings. Fast-track construction schedules exacerbate the problem when floor-surfacing material is installed before the concrete slab has dried out to an acceptable level.

**WHAT are the Sources of Concrete Slab Moisture?**

Moisture in concrete slabs on grade can originate from:

a. Water due to hydrostatic pressure when the slab on grade is below a permanent or seasonal ground water table, or when the slab, particularly the edge, is in contact with wet soil from sources such as rain, irrigation systems, broken plumbing, or other recurring man-made source. The rate of moisture flow through the slab will depend on the hydrostatic pressure that causes it.

b. Water rising to the bottom of the slab from ground water by capillary action or wicking. The degree of saturation of the subgrade depends on the fineness of the soil and the depth of the water table. Capillary water will saturate the subgrade and move through the concrete slab. Fine-grained soils can draw water from considerable distances while coarse sand or gravel will not sustain this flow.

c. Water vapor from damp soil, which can diffuse through the concrete and condense on the slab surface when the subgrade has a higher concentration of water vapor than the slab surface. This generally occurs due to a vapor pressure gradient when the air on the concrete surface is cooler and at lower relative humidity than the damp soil below the slab.

d. Residual moisture in the slab from the original concrete mixing water. It may take anywhere from six weeks to one year or longer for a concrete slab to dry out to an acceptable level under normal conditions, as illustrated in Figure 1. Factors that affect the drying rate include the original water content of the concrete and the relative humidity and temperature of the ambient air during the drying period. This is the only source of moisture in elevated slabs.

**How Do You Avoid Problems?**

Avoiding problems associated with high moisture content in concrete can be accomplished by the following:

- Protect against ingress of water under hydrostatic pressure by ensuring that proper drainage away from the slab is part of the design.
- Use a 6 to 8 inch [150 to 200 mm] layer of coarse gravel or crushed stone as a capillary break in locations with fine-grained soil subgrades.
- Use a vapor retarder membrane under the slab to prevent vapor from collecting at the base of the slab when the soil conditions are conducive to moisture retention. Ensure that the vapor barrier is installed correctly and not damaged during construction. Cover the vapor retarder with a 4-inch layer of a compactible, self-draining granular fill, such as a crusher run material. This layer should be relatively dry prior to placing concrete. Concrete placed directly on a vapor retarder is susceptible to cracking (see CIP 29).
Follow These Rules to Avoid Problems with Slab Moisture

1. Evaluate the site to determine the potential for moisture migration and incorporate mitigative measures in the design phase.
2. Use a good quality concrete with a low water content and a low permeability to moisture.
3. Follow good concrete practices for placing, finishing, and curing.
4. Allow the slab to dry out and test the moisture emission rate prior to installing floor coverings or coatings.

Various qualitative and quantitative methods of measuring concrete slab moisture are described in ASTM E 1907. Test the moisture condition of the slab in the same temperature and humidity conditions as it will be in service. In general, test in three random sample locations for areas up to 1000 square feet [100 m²]. Ensure that the surface is dry and clean. Record the relative humidity and temperature at the time of testing. Some of the common tests are:

**Polyethylene Sheet Test** - is a simple qualitative test that is commonly used, where an 18 by 18 inch [450 by 450 mm] square plastic sheet is taped tightly to the concrete and left in place for a minimum 16 hours. The plastic sheet and the slab are then visually inspected for the presence of moisture.

**Mat Test** - where the adhesive intended for use is applied to a 24 by 24 inch [600 by 600 mm] area and a sheet vinyl flooring product is placed face down on the adhesive and sealed at the edges. A visual inspection of the condition of the adhesive is made after a 72-hour period.

**Anhydrous Calcium Chloride Test** - is a popular test chosen by several flooring manufacturers who specify criteria for flooring or carpet installation based on this method. A measured amount of anhydrous calcium chloride is placed in a sealed area on the surface and the amount of moisture absorbed by the salt in 60 to 72 hours is measured to calculate the moisture vapor emission rate (MVER). Maximum limits of vapor transmission generally specified are 3 to 5 pounds of moisture per 1000 square feet per 24 hours. This test is relatively inexpensive, yields a quantitative result, but is subject to errors when testing as the salt has a strong affinity for water.

**Hygrometer** – A test area of the floor is sealed off under a waterproof enclosure. The relative humidity of the pocket of air trapped above the slab is measured using a hygrometer or a relative humidity probe after at least 72 hours. Flooring can be installed if the relative humidity is less than 75%.

**Test Strip** – in which a test strip of the proposed primer or adhesive is evaluated for 24 hours to predict its behavior on the floor. This procedure is not very reliable.

References

1. *Guide to Concrete Floor and Slab Construction*, ACI 302.1R, American Concrete Institute, Farmington Hills, MI.