2012 Continuing Education

Why Floors Fail

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Objectives

Our session today relates to substrate awareness:

- The primary causes of floor failure
- How moisture and alkalinity affect floors
- Moisture and alkalinity testing methods
- External and internal intrusion causes

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WHY FLOORS FAIL

Most floor failures are caused by improper substrate preparation

Moisture Maladies

Flooring failures due to excess moisture in substrates cause:

- Disruption to building operations
- Expensive repairs
- Loss of facility use
- Unsafe conditions

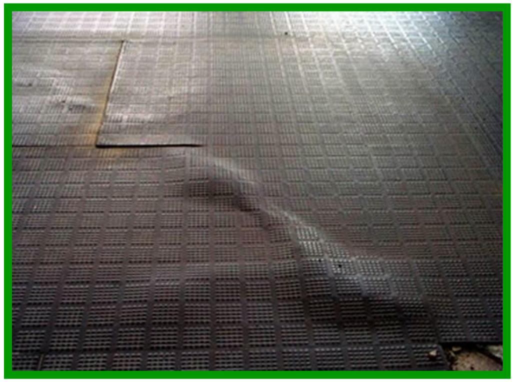
Manufacturer Specifications

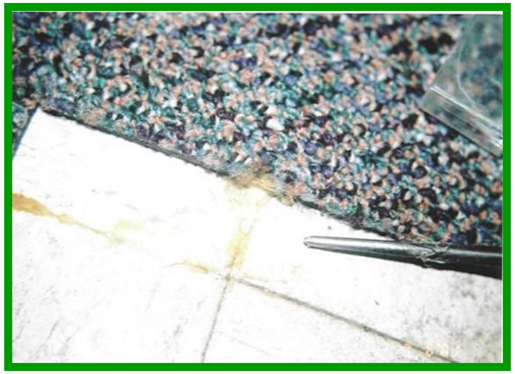
Flooring manufacturers have standards for acceptable moisture content of the substrate that will host the flooring

Manufacturers also recommend the preferred method of moisture testing

Moisture and Alkalinity Awareness

Moisture, and its rate of movement through a substrate, is a critical factor in the success or failure in the application of flooring materials.





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Moisture and Alkalinity Awareness

One obvious result of excessive moisture is the failure of an adhesive to bond the flooring to the substrate.

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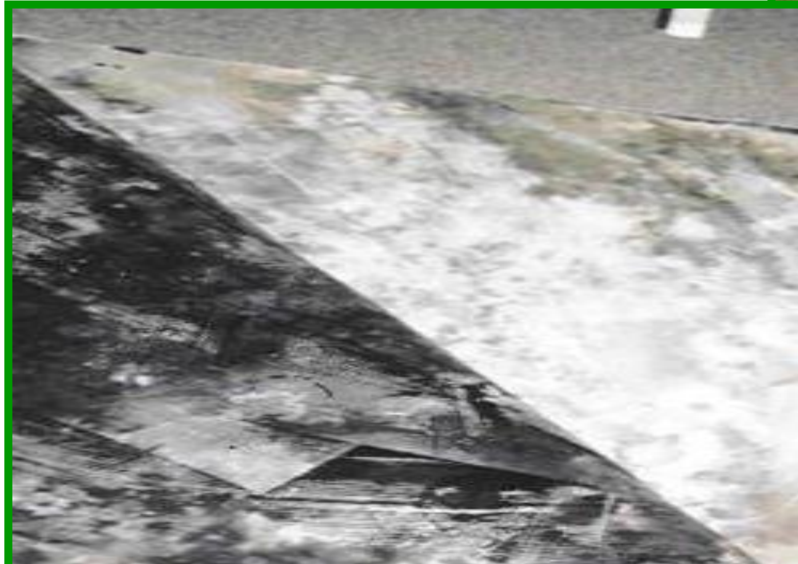
Moisture and Alkalinity Awareness

Mold and bacteria issues can arise from excessive moisture.



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Moisture and Alkalinity Awareness

Increased knowledge of moisture migration will lead to understanding bond breakers, such as excessive alkalinity, that are directly correlated to moisture.

Moisture and Alkalinity Awareness

- Excessive moisture issues are not exclusive to on-grade or below grade floors.
- Moisture can be introduced from these sources:

  - original water-to-cement ratio

  - ground water exposure

  - cleaning or maintenance procedures

Even suspended lightweight concrete floors can have moisture problems!

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Moisture and Alkalinity Awareness

Moisture in wood substrates is often overlooked, but is a factor in the installation of direct glue flooring.

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Moisture and Alkalinity Awareness

It is important to understand the terminology, testing procedures, and manufacturer's limitations concerning moisture.

Moisture issues plague the flooring industry and cause untold losses to manufacturers, retailers, installation contractors and end users.

It is critical to understand its impacts, identify its characteristics, and limit liability by withholding installation until substrate conditions are within proper parameters.

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Moisture and Alkalinity Awareness

Moisture emissions and pH readings are telltale signs of flooring installation success and failure percentages. Both inherent to concrete, neither can be fully eliminated.

Understanding their role and impact is vital to the successful installation of flooring materials over concrete.

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Testing

- The American Society for Testing and Materials (ASTM) F 710…

"Standard Practice for Preparing Concrete Floors to Receive Resilient Floor Coverings"

…describes tests used in the construction industry to help determine if unacceptable moisture is present in, or emitting from, concrete slabs.

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Testing

There are two categories of moisture tests:

Qualitative: Testing helps determine the elements or ingredients of a compound

Quantitative: Testing measures the amounts or percentages of the various components of a compound.

Qualitative* *tests determine if moisture is present.

Quantitative tests reveal how much moisture is present.

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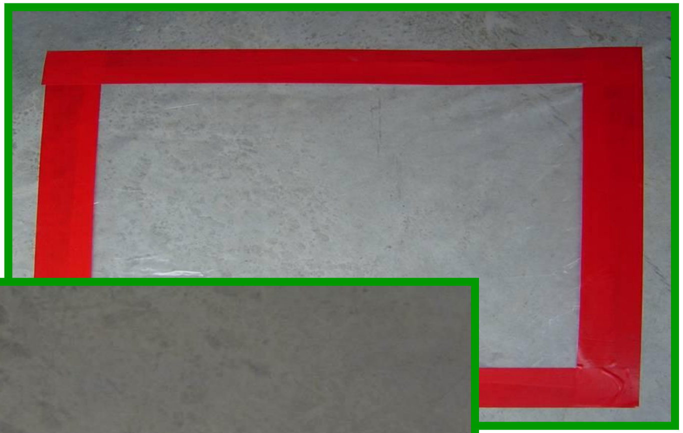
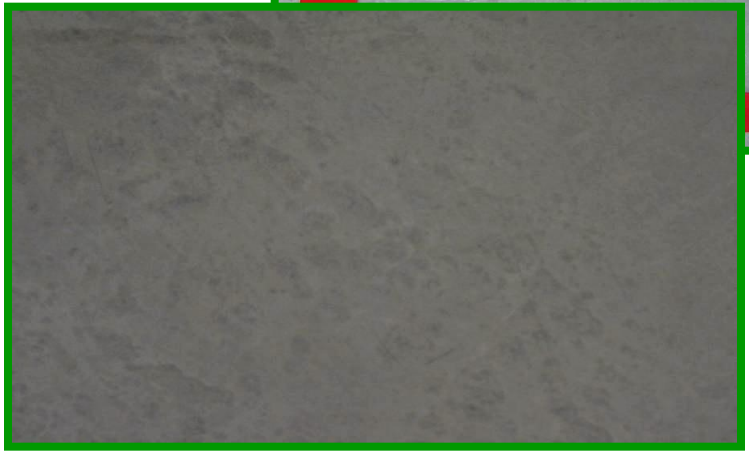
Qualitative Polyethylene Sheet Test





- Duct tape an 18” x 18” plastic sheet to the concrete surface.
- After a minimum of 16 hours, visually inspect for darkening of the substrate, or moisture droplets on the substrate or underside of the sheet.

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Qualitative Matt Bond Test

This test is often used to judge adhesion rather than to identify a single bonding problem.

This is a subjective test, and procedures can vary according to which materials are being installed.

Electrical Resistance Test

A specific type of meter is used to determine the concrete moisture content by measuring the electrical conductivity of concrete between the meter probes.

Electrical Impedance Test

A specific type of meter is used to determine the concrete moisture content by measuring conductance and capacitance.

Primer/Adhesive Strip Test

Select several areas (24” x 24”) and apply adhesive or primer to the slab and wait 24 hours.

If the samples can be easily peeled from the floor using a putty knife, the concrete has unacceptable conditions, including possible moisture problems.

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Qualitative Anhydrous Calcium Chloride Test

Pour anhydrous calcium chloride on the concrete. Cover, and seal a plastic canopy over it.

After 72 hours, remove the canopy and observe calcium chloride for moisture. It will become darker or cake together when moisture is present.

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Quantitative Anhydrous Calcium Chloride Test

Most floor covering manufactures require testing the moisture emission rate by using the quantitative anhydrous calcium chloride test.

While this test has been the workhorse of the industry, humidity testing should be also done to complement this test

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Anhydrous Calcium Chloride Test

Use this test method to obtain a quantitative value indicating the rate of moisture vapor emission from the surface of a concrete floors and whether or not that floor is acceptable to receive resilient flooring.

The test area should be clean and free of all foreign substances.

All adhesives, curing compounds, sealers, paints, floor coverings, etc. should be removed using approved OSHA work practices.

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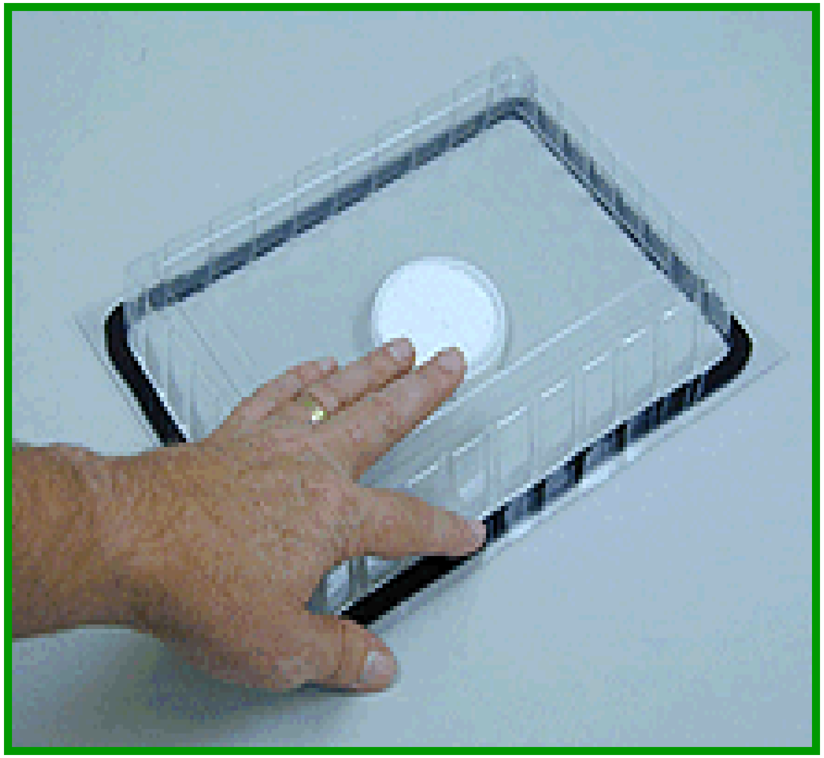
Anhydrous Calcium Chloride Test

- The test should be at the same temperature and humidity expected during normal use.
- 75 +/- 10deg F
- 50 +/- 10% RH
- Maintain conditions for 48 hours prior to test
- 60 to 72 hrs needed to test



Anhydrous Calcium Chloride Test

- Distribute tests uniformly; 3 for the first 1000 sq. ft. and 1 for each additional 1000 sq. ft. of floor.
- Protect tests from damage.
- Documented results should be confirmed and saved.

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Influencing Factors

The aforementioned testing techniques measure moisture at or near the surface of the concrete and may not reveal internal moisture content. After an impervious floor covering is applied, the moisture content near the surface is likely to change if the internal moisture level is elevated. Uncombined water from deeper in the slab can migrate towards the surface.

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Influencing Factors

Because the moisture distribution changes, moisture emission rates also change, and may increase to a level high enough to cause a flooring failure. This can be addressed by measuring moisture with the relative humidity probes, or alternative testing techniques, placed at varying depths throughout the slab. This provides an accurate moisture profile of the concrete substrate.

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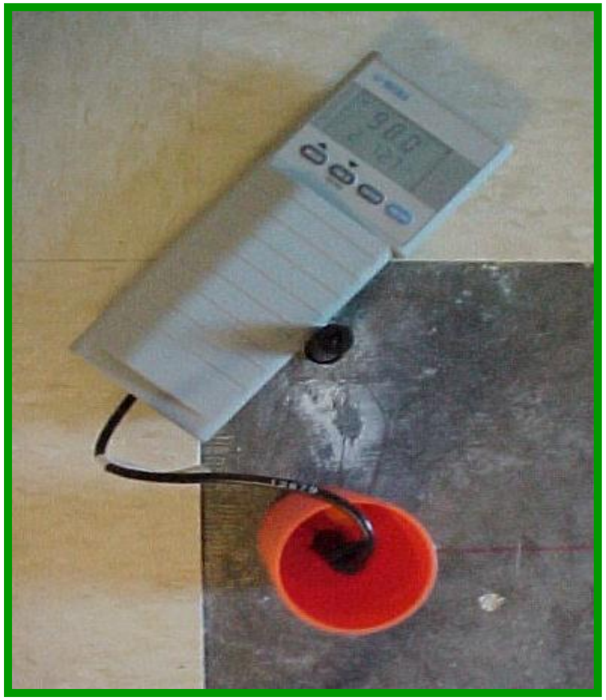
Relative Humidity or Hygrometer Test

Place a relative humidity measuring device on the concrete slab and cover with a plastic canopy. Allow 72 hours before taking a reading, continuing at 24 hour intervals until two consecutive readings show no change.



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Testing

- The American Society for Testing and Materials (ASTM) F 2170…

"Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes.

This test method covers the quantitative determination of percent relative humidity in concrete slabs for field or laboratory tests.

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Testing

- The American Society for Testing and Materials (ASTM) F 2170…

"Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes."

The probe has to reach temperature equilibrium with the slab prior to reading. Readings must not drift more than 1% over 5 minutes.

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Testing

- The American Society for Testing and Materials (ASTM) F 2170…

“Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes.”

Document all pertinent data and include in Report Of Relative Humidity In Concrete

Influencing Factors

Testing is done to determine the current condition of the concrete. No test can reveal what the condition of the concrete will be long term. Many uncontrollable factors influence the slab. The instability of these factors compounds the necessity to create as optimal an installation condition as possible.

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Alkalinity

As portland cement hydrates, calcium hydroxide and other alkaline hydroxides are formed. When excess moisture migrates through the slab, it can carry excess salts to the surface. Excess alkalinity can crystallize creating an extreme bond breaker.

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Alkalinity

- The pH of wet concrete is extremely alkaline, typically around 12 to 13. The surface of concrete will naturally react with atmospheric carbon dioxide to produce a calcium carbonate in the cement paste, which reduces the pH of the surface.
- A thin layer of carbonation (approximately .04” thick) typically produces a pH range from 8 to 10.
- If the pH of the concrete surface is above 10, consult the flooring and/or adhesive manufacturer.

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Alkalinity

- Acid washing re-wets the surface and increases the drying time.
- Shot blasting, grinding, and sanding also remove the carbonated layer, often exposing higher alkaline concrete below.
- Specific barrier coats can be an alternative to avoid acid washing.

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pH Test

Test paper comes in several forms Always use the color chart supplied with the test paper.

pH Test

Clean the area to remove any oil, dirt, dust, floor coatings, or sealers prior to testing. It may be necessary to remove primers, sealers or old adhesives by lightly grinding, sanding or bead blasting. Do not remove more than 0.04” of concrete. This test is designed to test the surface that will come in contact with the adhesive.

pH Test

- Pour a small amount of distilled water on the substrate. After about 30 seconds, place a pH strip into the fluid for 10 seconds.
- Remove and match test strip to color chart after 15 seconds, but before 25 seconds, to determine the pH reading.

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pH Test

Digital pH testers are also available. Verify that the floor covering manufacturer will accept the testing procedure used.

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External Water Intrusion

- When drying time is critical, the slab should be protected from external moisture sources. Studies show that re-wetted mature concrete dries much slower than newly poured concrete.

- For example, adding water to the surface after the 46 day of the drying period increased the emission to 15 lbs, and 5 additional weeks of drying time were required to return to 3 lbs.

External Water Intrusion

Sources of moisture from the top side can include rain, acid washing, and pressure washing. Drainage and grade issues contribute to moisture introduction both above and below the slab.

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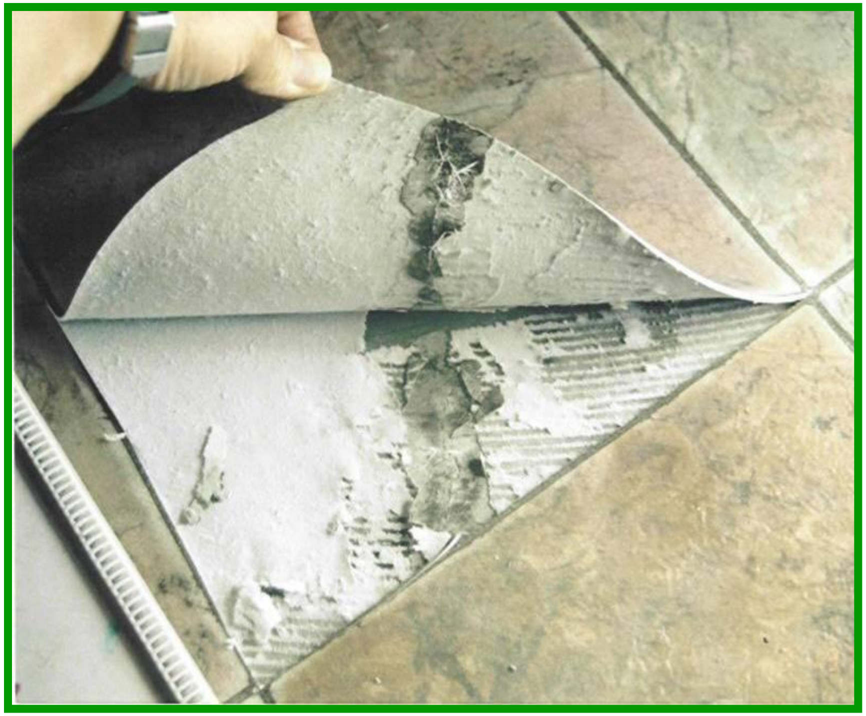
External Water Intrusion

Cracks in the slab allow moisture to travel to the surface unrestricted.



External Water Intrusion

- The use of a vapor retarder limits the amount of exposure to external water from below the slab. Many specifiers require that the vapor retarder meet ASTM E 1745. This defines classes A, B and C.
- All have the same 0.3 per water vapor permeance, but different tensile strength and puncture resistance.

Note: A vapor retarder is often misclassified as a vapor barrier.

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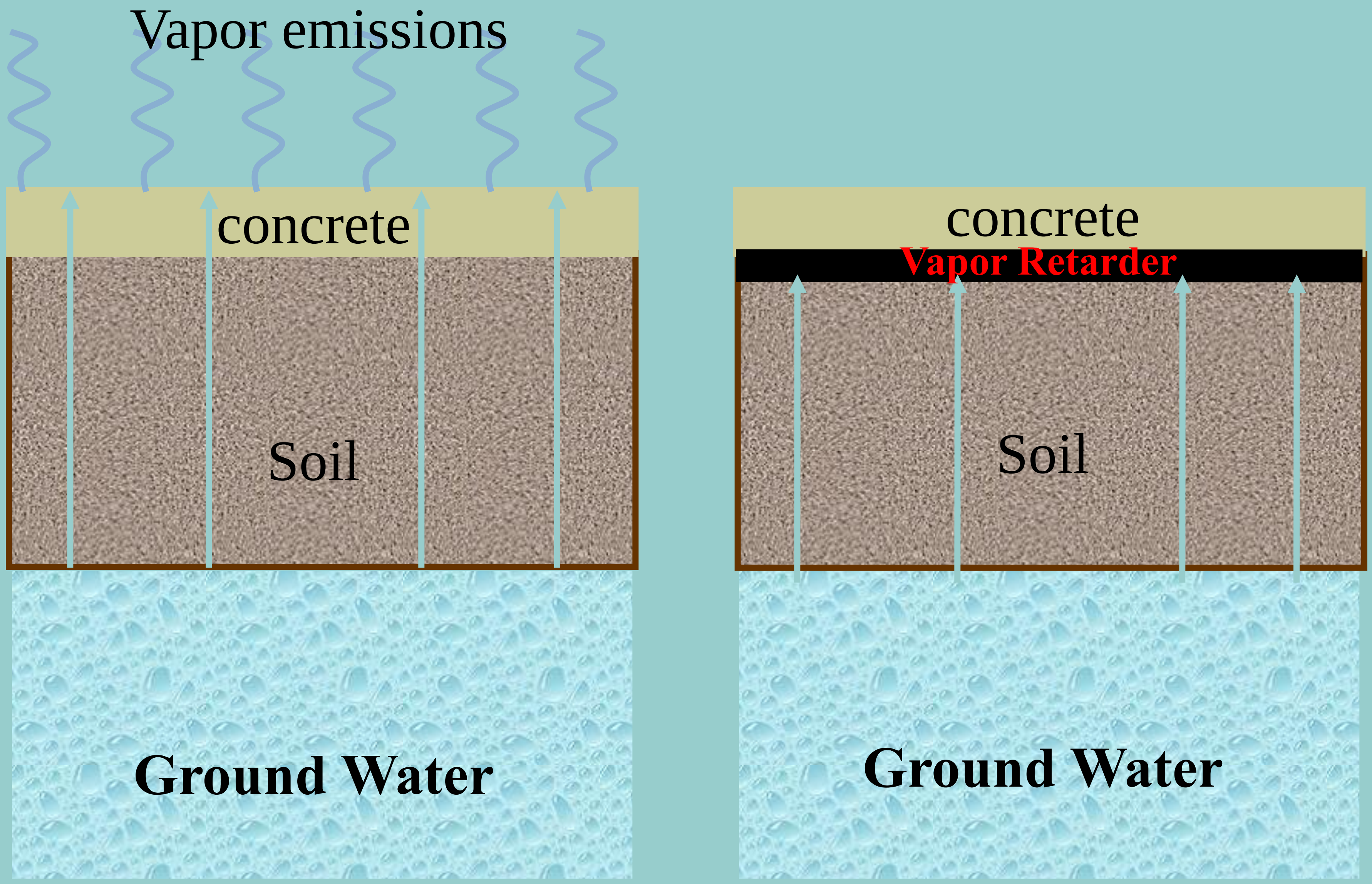
External Water Intrusion



External Water Intrusion

- Some specifiers require concrete to be placed directly on the vapor retarder. Others require a granular blotter layer between the concrete and the vapor retarder.
- The American Concrete Institute has published a flow chart that is part of ACI 302.2R-06 that says slabs to receive moisture sensitive floor coverings should be placed directly over the vapor retarder.

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Internal Hydration

Water to cement (w/c) ratio has a significant effect on moisture migration through concrete slabs. A study of a 4” thick concrete specimen allowed to dry from one side, batched at a water to cement ratio of .45 typically takes 90 to 120 days to reach the commonly specified water-vapor emission rate of 3 lbs per 1000 sq. ft. per 24 hours. These studies produced no additional advantage to using a concrete with a lower w/c ratio.

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Internal Hydration

Concrete slabs with a water to cement ratio above .60 require an exceedingly long time to dry. Inadequate drying time will cause adhesives and/or floor coverings to fail, due to high moisture permeability. The importance of using a moderate or low water to cement ratio for concrete slabs to receive moisture-sensitive floor covering can not be overemphasized.

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Internal Hydration

Lightweight concrete with a water to cement ratio of .40 takes 183 days to reach an emission rate of 3 lbs per 1000 sq. ft. per 24 hours. Although lightweight concrete has its benefits, there is a significantly longer drying time.

Internal Hydration

- Cement hydration immobilizes some of the mixing water, so, well cured concrete contains less free water that must be evaporated before floor covering can be applied.
- Well cured concrete takes longer to dry.
- The practice of curing concrete with water or plastic sheeting is counter-productive for a floor that must dry before receiving floor covering.

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Admixtures

Additional chemicals such as calcium chloride, butyl stearate, and hydroxilated carbolylic acid are sometimes combined in the cement mix to enhance its performance properties. Based on the evidence available, there is no reason to specifically include or exclude the use of any admixtures, or high early strength cements, as a way of influencing drying times.

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Additional Physical Properties

Slump ratings, densities, and compression strengths are all measurable quality meters for concrete, but none are shown to produce a direct relationship to concrete drying or water-vapor emissions.

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Finishing Techniques

There is evidence to suggest that a power trowel finish dries more slowly than a normal trowel, or float finish. The surface is compacted and densified, making it more difficult for water to evaporate.

Summary

- Moisture and pH factors are major contributors to flooring failures.

- Moisture intrusion occurs through:
  - ✓ external sources
  - ✓ internal sources
  - ✓ maintenance procedures

- Use manufacturer-recognized testing methods.
- Follow test protocol precisely to obtain accurate reads.
- Rectify improper conditions before proceeding with installation.

Questions?

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