

Moisture Mitigation for Floor Slabs

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Introduction & Affiliations

► Construction or Service Issues

- Materials
- Flatwork
- Structural
- Mass concrete
- Moisture



New Concrete Slabs



Existing Concrete Slabs



Concrete Slab Moisture Mitigation

- ▶ **Background**
- ▶ Moisture Sources
- ▶ Evaluation and Testing
- ▶ Remediation Approaches

Floor Coverings

- ▶ Environmental regulations
 - Lower VOCs
 - Solvent-based to water-based
 - Moisture and alkalinity
- ▶ Low-permeability floor covering materials
- ▶ Construction timelines
- ▶ Industry continues to evolve & learn

Floor Covering Moisture Problems



Modes of Concrete Floor Moisture Failures

- ▶ Adhesive breakdown
- ▶ Debonding
- ▶ Osmotic blisters
- ▶ Alkali attack
- ▶ Microbials
- ▶ Contaminants
- ▶ Alkali-aggregate reactions
- ▶ Flooring expansion
- ▶ Incompatibles
- ▶ Staining
- ▶ Efflorescence
- ▶ Condensation
- ▶ Curling/warping

Dewpoint Condensation



Moisture Sensitive Product Storage



Concrete Slab Moisture Mitigation

- ▶ Background
- ▶ **Moisture Sources**
- ▶ Evaluation and Testing
- ▶ Remediation Approaches

Moisture Sources

▶ Liquid & Vapor

- Concrete
- Groundwater
- Fill Course (cushion or blotter layer)
- Irrigation
- Broken Pipes
- Condensation (dewpoint or “adsorption”)
- Adhesives
- Maintenance



Moisture in New Concrete



How much free water ?

Concrete Moisture

- ▶ Typical 4000 psi SOG concrete
 - Water-to-cement ratio 0.50
 - 32 gal of water/cu yd = 267 lbs/cu yd
 - Water needed for hydration w/c 0.25 = 133.5 lbs
 - Leaves 133.5 lbs free water/yd
 - **1,650 lbs free-water/1,000 sq ft (4" slab)**

Moisture in New Concrete

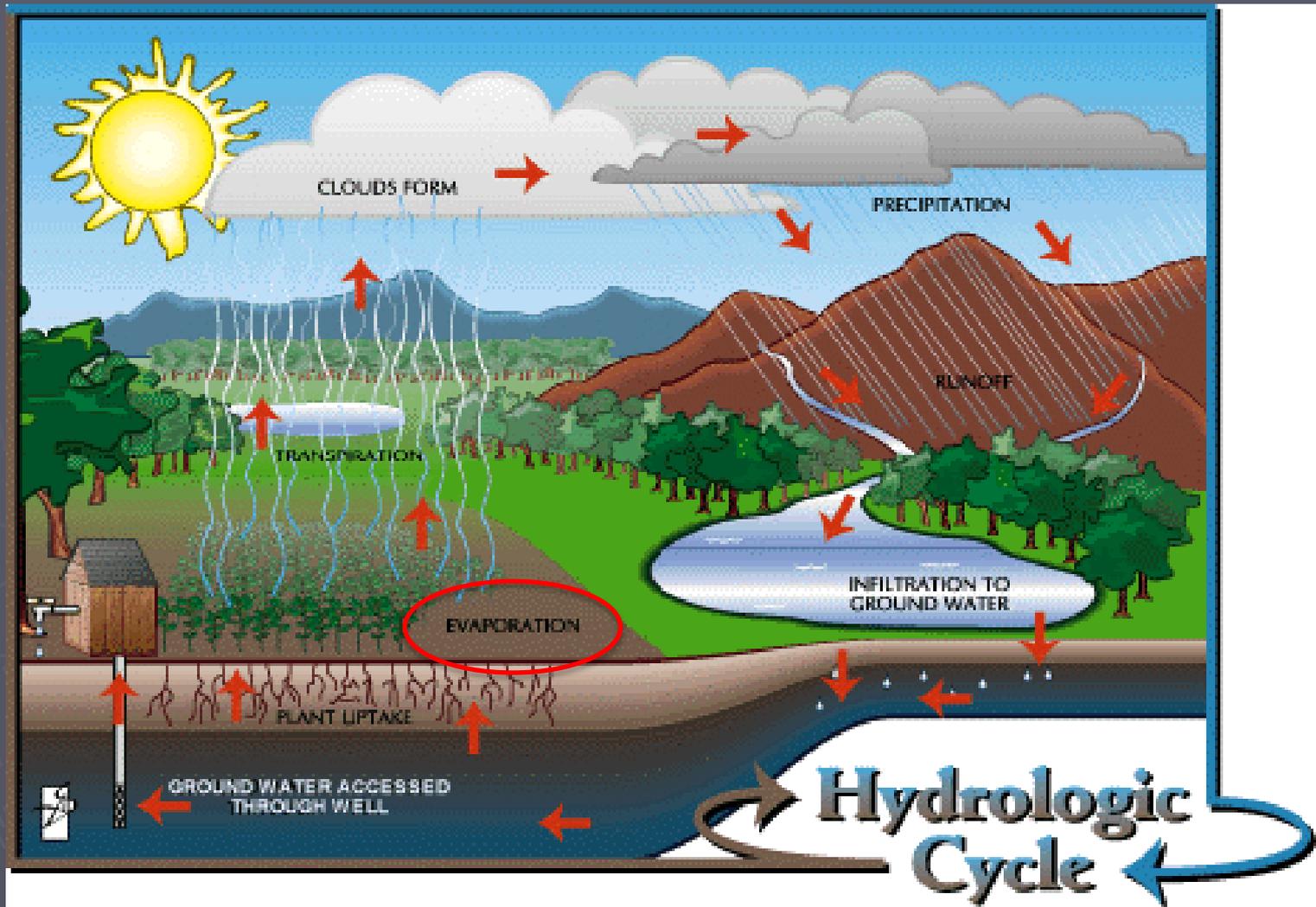


Every truckload delivers over 100 gallons
of free water = must dry out slab

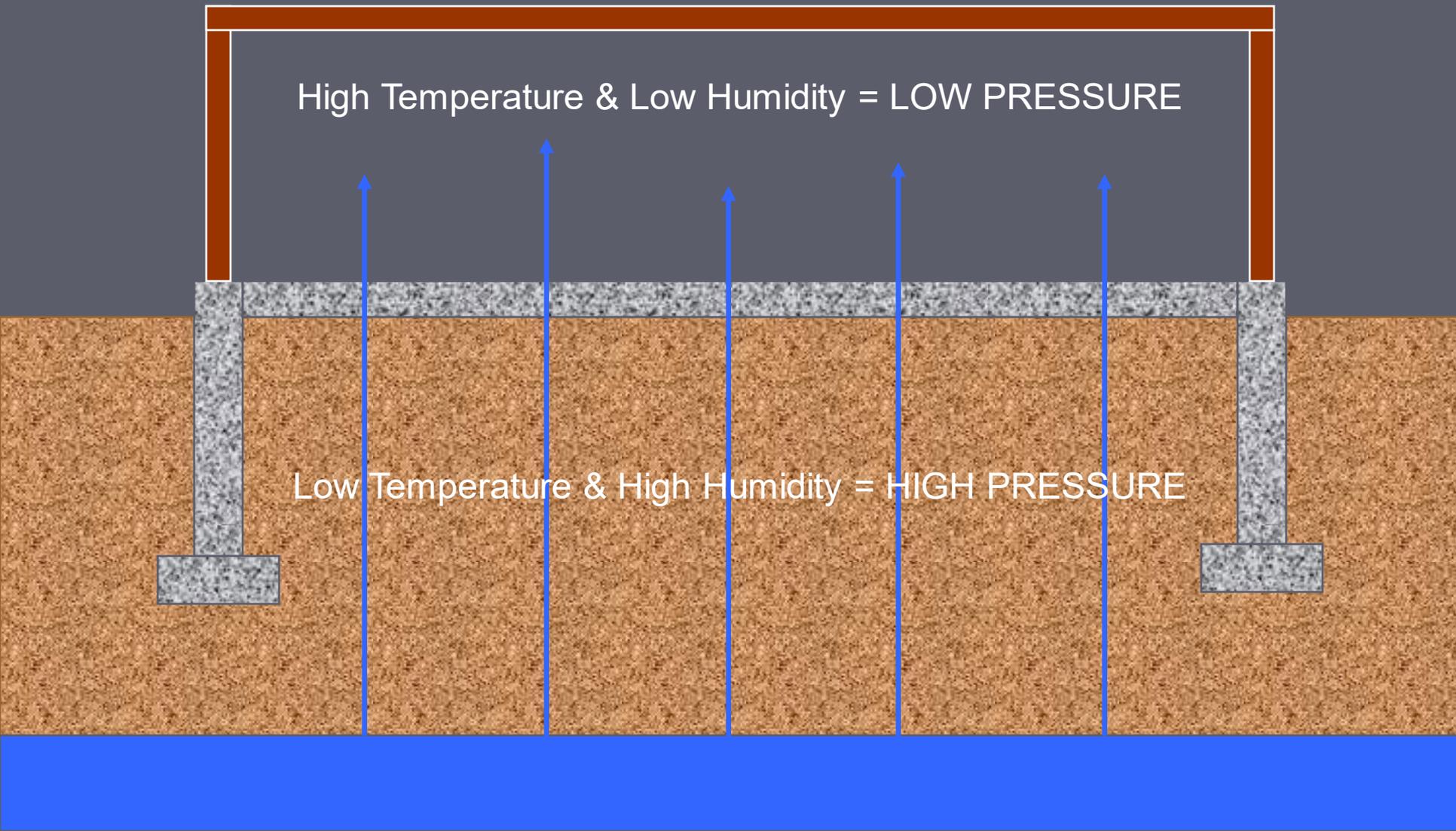
Moisture Sources

- ▶ Groundwater
 - Hydrostatic pressure
 - Capillary action
 - Vapor diffusion

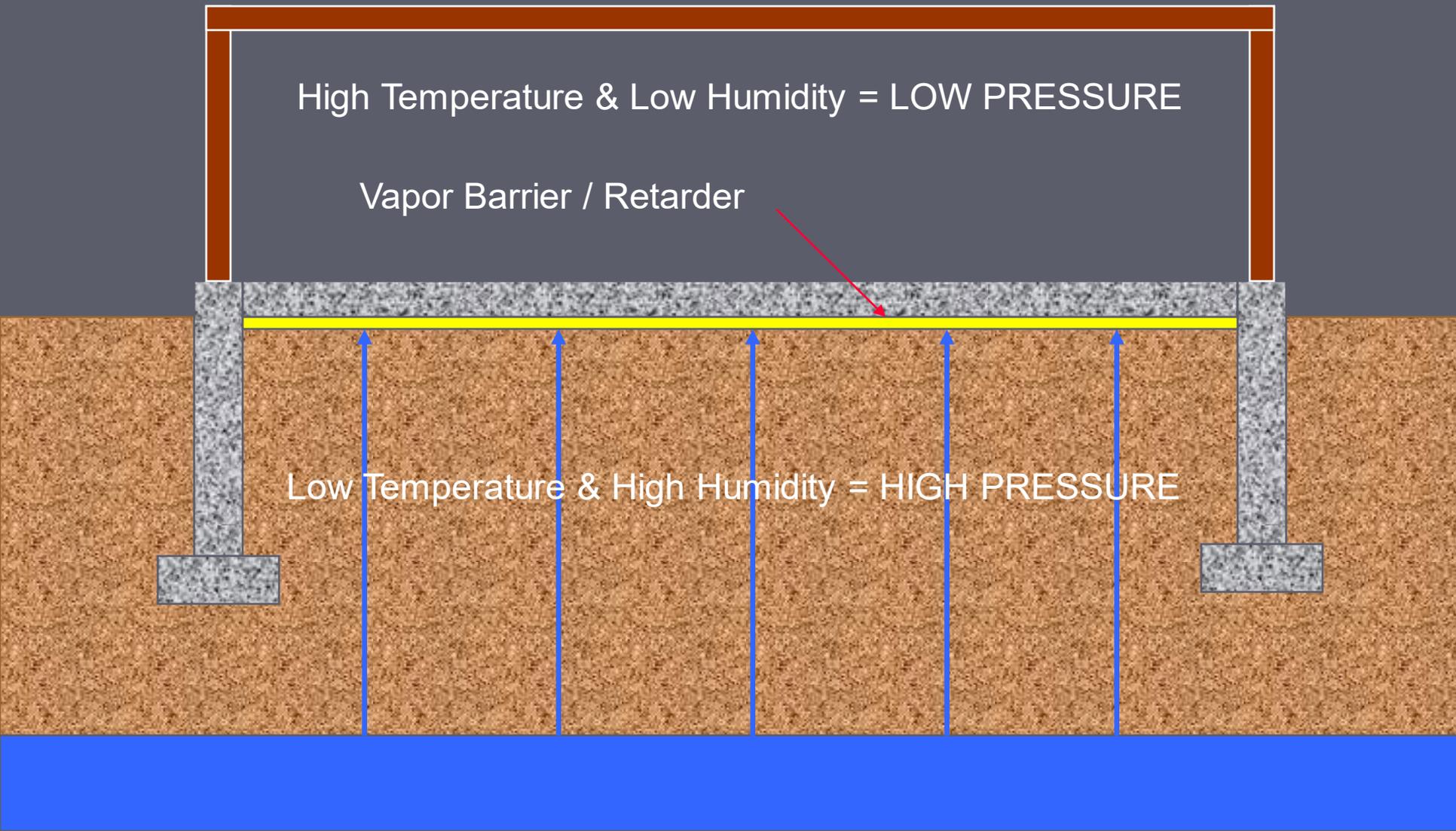
Vapor Diffusion



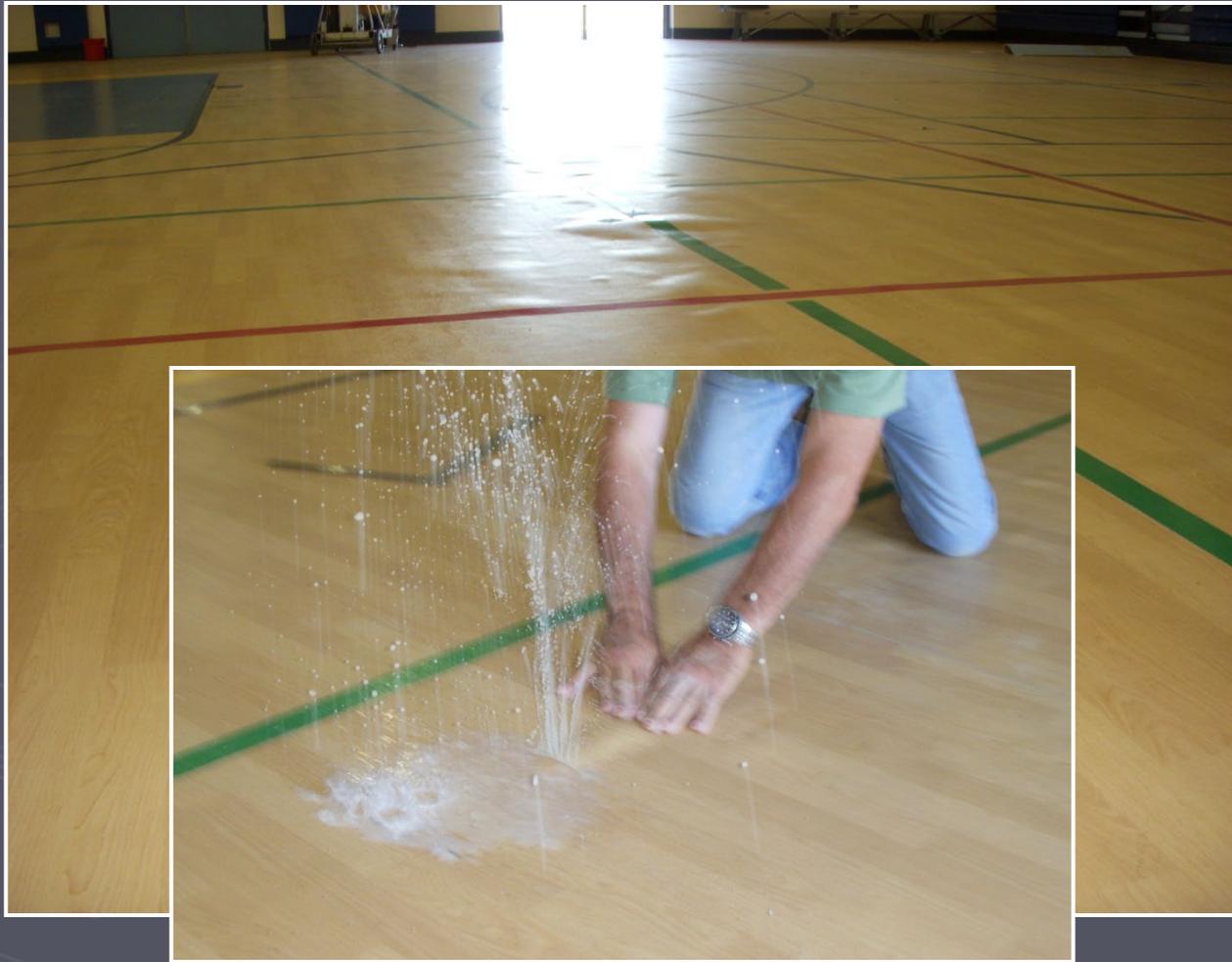
Water Vapor Pressure Differential (Vapor Diffusion)



Water Vapor Pressure Differential (Vapor Diffusion)



Vapor Diffusion

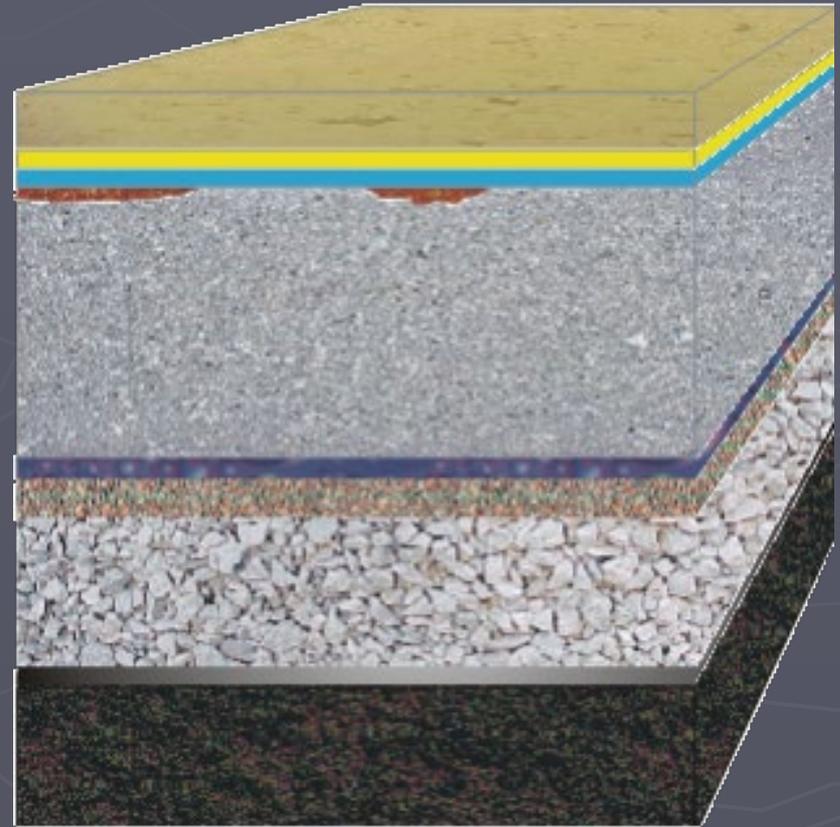


Concrete Slab Moisture Mitigation

- ▶ Background
- ▶ Moisture Sources
- ▶ **Evaluation and Testing**
- ▶ Remediation Approaches

Concrete Floor is a *System*

- ▶ Concrete slab needs drying time
- ▶ Vapor retarder under the slab
- ▶ Modify existing system
- ▶ Requires mitigation or treatment



Moisture Evaluation & Testing

▶ Moisture testing

- ASTM F710 Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring
- ASTM F1869 Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride
- ASTM F2170 Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes

▶ ICRI Certification

Moisture Testing

- ▶ Relative humidity
- ▶ Moisture vapor emission rate
- ▶ Surface pH
- ▶ Flooring material manufacturer requirements
- ▶ Dry: Time, temperature, air movement
- ▶ Snapshot



Concrete Slab Moisture Mitigation

- ▶ Background
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- ▶ Evaluation and Testing
- ▶ Remediation Approaches

Slab Moisture Remediation

▶ Vapor retarder sheet

- Directly below concrete
- Moisture testing
- Dry the floor

▶ Alternative finishes

- Polished, stained, bare concrete
- Less or non-moisture sensitive flooring/coating or adhesives

▶ Topical moisture retarders

- Preformed or sheet membrane
- Liquid applied or reactive penetrants

▶ Perpetual maintenance

Vapor Retarder Sheet

- ▶ ACI 302.1R-15 – Guide to Concrete Floor and Slab Construction
- ▶ ACI 302.2R-06 – Guide for Concrete Slabs that Receive Moisture-Sensitive Flooring Materials
- ▶ ASTM E1745 – Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs
- ▶ ASTM E1643 – Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs

Vapor Retarder Sheet

- ▶ ASTM E1745 – Standard Specification for Plastic Vapor Retarders
 - Class A, B, and C
 - Water vapor permeance – 0.1 perms
 - Tensile strength – 45 to 13 lbf/in.
 - Puncture resistance – 2200 to 475 g
- ▶ 10 or 15 mil (0.010 to 0.015 in.) thickness
- ▶ Polyethylene sheets

Vapor Retarder Sheet



Vapor Retarder Sheet



Vapor Retarder Sheet



Vapor retarder
below slab

No vapor retarder
below slab

Vapor Retarder Sheet

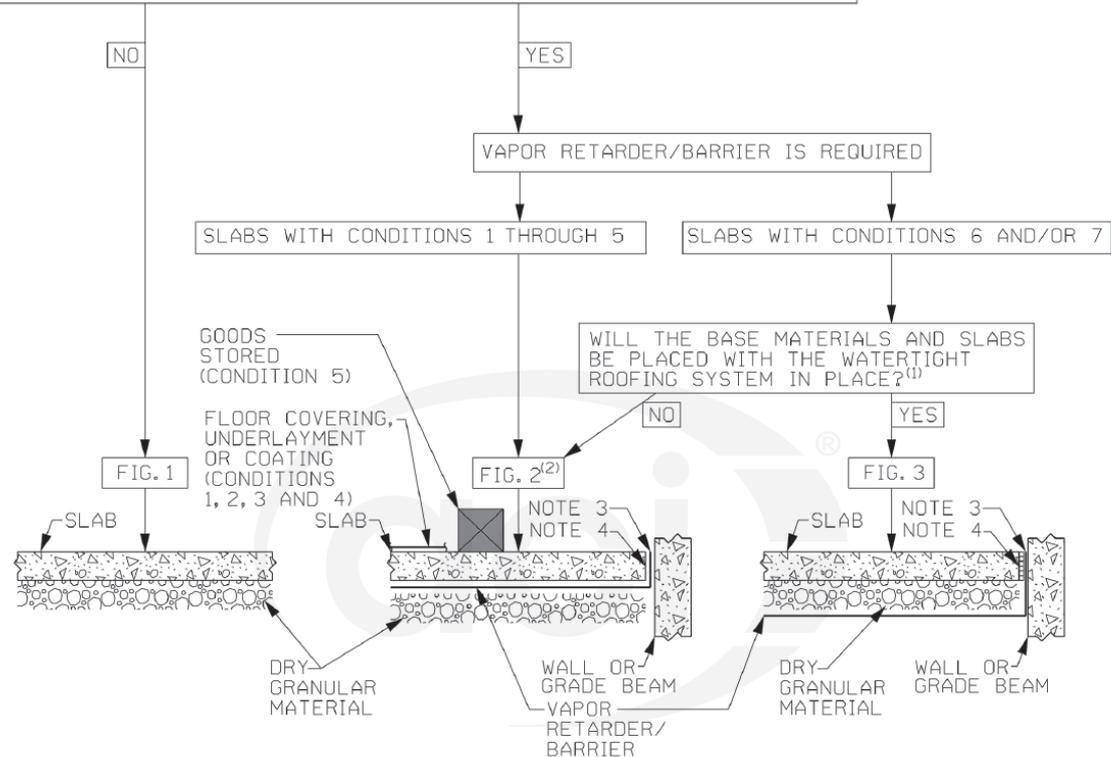
ACI 302.1R-15

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GUIDE TO CONCRETE FLOOR AND SLAB CONSTRUCTION (ACI 302.1R-15)

DOES THE SLAB-ON-GROUND HAVE ANY OF THE FOLLOWING CONDITIONS:

1. A MOISTURE-SENSITIVE FLOOR COVERING ON TOP OF THE SLAB
2. A MOISTURE-SENSITIVE FLOORING ADHESIVE
3. A MOISTURE-SENSITIVE UNDERLAYMENT ON TOP OF THE SLAB
4. A MOISTURE-SENSITIVE FLOOR COATING ON TOP OF THE SLAB
5. MOISTURE-SENSITIVE GOODS STORED IN DIRECT CONTACT WITH THE TOP OF THE EXPOSED SLAB SURFACE
6. A HUMIDITY CONTROLLED ENVIRONMENT ABOVE THE SLAB WITHOUT ANY OF THE 1 THROUGH 5 CONDITIONS INITIALLY, OR IN THE FUTURE
7. A CLIMATE-CONTROLLED COOLED ENVIRONMENT ABOVE THE SLAB WITHOUT ANY OF THE 1 THROUGH 5 CONDITIONS INITIALLY, OR IN THE FUTURE

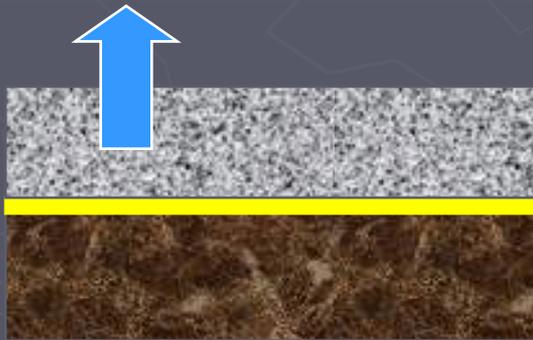


NOTES:

Vapor Retarder Sheet

► Increasing moisture mitigation required

Moisture
Emitting from
the concrete



**Vapor Retarder Directly
Below Concrete**



**Fill Layer Above
Vapor Retarder**



No Vapor Retarder

Moisture
Transmitting
through the
concrete

Vapor Retarder Sheet

- ▶ ACI 302.1R-04/15
- ▶ ACI 302.1R-96:

“If a vapor barrier or vapor retarder is required due to local conditions, these products should be placed under a minimum of 4 in. (100 mm) of trimable, compactible, granular fill (not sand).”

Vapor Retarder Sheet Risk

- ▶ Concrete placement conditions, bleeding, finishing
- ▶ Curling/warping deformations
- ▶ Joint activation
- ▶ Dowel baskets

Slab Moisture Remediation

- ▶ Vapor retarder sheet
 - Directly below concrete
 - Moisture testing
 - Dry the floor
- ▶ **Alternative finishes**
 - Polished, stained, bare concrete
 - Less or non-moisture sensitive flooring/coating or adhesives
- ▶ Topical moisture retarders
 - Preformed or sheet membrane
 - Liquid applied or reactive penetrants
- ▶ Perpetual maintenance

Polished Bonded Topping



Breathable Urethane System



Non-Moisture Sensitive Coverings



Slab Moisture Remediation

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- ▶ **Topical moisture retarders**
 - Preformed or sheet membrane
 - Liquid applied or reactive penetrants
- ▶ Perpetual maintenance

Preformed Topical Systems

- ▶ Variety of membrane products
- ▶ Use limited to certain types of floor coverings
- ▶ Manufacturer recommendations



Liquid-Applied Topical Vapor Retarders

- ▶ Must be effective versus moisture and compatible with finished flooring system
- ▶ Many products on market
- ▶ Many manufacturers – floor systems
- ▶ How robust?
 - Epoxy
 - Primer
- ▶ Performance?
- ▶ Challenge



Liquid-Applied Topical Vapor Retarders

- ▶ Products & available performance information have continued to evolve
- ▶ ASTM F3010 – Standard Practice for Two-Component Resin Based Membrane-Forming Moisture Mitigation Systems for Use Under Resilient Floor Coverings
 - Properties, application and performance
 - ASTM E96 water vapor transmission (no greater than 0.10 perms)

Liquid-Applied Topical Vapor Retarders

▶ ASTM F3010

- Meet manufacturer installation requirements and follow installation instructions
- Pre-installation moisture testing
- Substrate preparation & crack treatment



Liquid-Applied Topical Vapor Retarders

- ▶ Product manufacturer resources
 - Underlayment and/or flooring systems
 - Performance warranties available – terms may vary
 - 0.10 / 0.01 perms
 - 98% / 100% R.H.
- ▶ Installer experience
- ▶ Risk evaluation
- ▶ Project basis



Dewpoint Condensation Mitigation

- ▶ Vapor retarder sheet
- ▶ Surface permeability
 - Finish
 - Cleanliness
- ▶ Non-conditioned spaces
 - Warm slab above dewpoint temperature
 - Manage quality air movement & exchanges
 - De-humidification units
- ▶ Perpetual maintenance



Slab Moisture Remediation

- ▶ Vapor retarder sheet
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 - Liquid applied or reactive penetrants
- ▶ **Perpetual maintenance**

Mitigation Summary

- ▶ Vapor retarder sheet
 - Limit to moisture *emission* rather than moisture *transmission*
- ▶ Appropriate floor coverings or finishes for project conditions
- ▶ Evaluation and Testing
- ▶ Mitigation systems – if needed

Mitigation Systems

► Robust system

- Stop or slow vapor movement to an acceptable level
- Moisture *emission* or *transmission*
- Capable of withstanding high pH levels that may develop beneath the system once the floor is covered

Mitigation Systems

- ▶ Manufacturer recommendations
 - Concrete moisture levels
 - Manufacturer representative site visit
 - Appropriate mitigation system for flooring and project conditions
 - Installation procedures & contractors
 - Warranty – Materials & Installation

Thank you!



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