

Concrete in Practice

What, why & how?



CIP 29 - Vapor Retarders Under Slabs on Grade

WHAT are Vapor Retarders

Vapor retarders are sheet materials that minimize the transmission of moisture or water vapor from the sub-slab support system into a concrete slab. Vapor retarders are typically specified in accordance with ASTM E1745, which requires that the permeance of the material be no greater than 0.1 US perms, when tested by ASTM E96 or ASTM F1249. Low-density polyethylene sheets that were commonly used in the past have been replaced by stronger, less permeable materials that conform to ASTM E1745. A minimum thickness of 10 mils (0.25 mm) is recommended for reduced vapor transmission and for required durability during and after installation. Membrane materials with after-conditioning permeance levels less than 0.01 perms are referred to as vapor barriers rather than retarders.

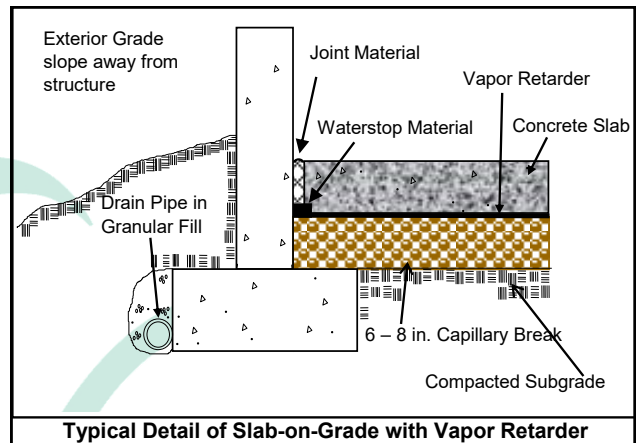
WHY are Vapor Retarders Used

Vapor retarders are frequently specified for interior concrete slabs on grade where moisture protection is desired. Protection from slab substrate moisture migration is required when floors will be covered with carpet, tile, wood, resilient, and seamless polymeric flooring, or when moisture-sensitive equipment or products will be placed on the floor. Permeation of water vapor through concrete slabs can cause failure of moisture-sensitive adhesives or coatings resulting in delamination, distortion or discoloration of flooring products, trip-and-fall hazards, and possibly fungal growth and odors. See CIP 28.

Low-permeability membranes below floor slabs on grade, in conjunction with sealed joints, also provide a barrier to radon penetration into enclosed spaces when such conditions exist.

WHAT Conditions Require Vapor Retarders

A floor is part of the building envelope and should be constructed to eliminate moisture infiltration through the slab into the occupied building space. It is common to specify the use of vapor retarders for floor slabs intended to receive floor coverings. However, floors intended for use without coatings or coverings, such as warehouses, mechanical rooms, and unfinished expansion areas, are often converted to other uses that may require the installation of moisture-sensitive flooring. Such *adaptive re-use* cannot be predicted during design and construction of a new building. Therefore, it is sensible planning to include a vapor retarder under every interior floor slab in every building. Vapor retarders are generally not necessary for



exterior slabs on grade.

Other sources of moisture that cannot be controlled by the use of vapor retarders need to be separately addressed in contract documents to achieve the moisture emission levels required by flooring manufacturers. Exposure to moisture and re-wetting during construction will take a long time to dry out when the slab is eventually subjected to service ambient conditions with the HVAC system. The same is true for residual moisture within concrete slabs. The concrete slab should be properly cured and allowed to dry out before testing for moisture emissions. (CIP 28) Concrete mixtures with lower moisture emission can be supplied by the concrete producer. These mixtures can include supplementary cementitious materials and specialty chemical admixtures designed to control moisture emission.

HOW Should Vapor Retarders be Installed

ACI Committee 302 recommends that concrete be placed directly on top of a vapor retarder when the concrete slab surface will receive a moisture-sensitive floor covering. A durable and good quality vapor retarder that complies with ASTM E1745 should be used and installed in accordance with ASTM E1643.

When environmental conditions cause a higher rate of evaporation, the possibility of plastic shrinkage cracking increases. Placing concrete directly on the vapor retarder can help alleviate this condition as bleed water will rise to the surface to reduce the chance of this cracking.

Placing concrete directly on the vapor retarder can also create problems. Excess bleeding that does not dissipate from the surface can delay finishing operations. Final finishing of the slab should not begin while bleed water is on the slab surface. Bleed water trapped below a

finished surface causes delaminations (CIP 20) or blisters (CIP 13). Concrete may stiffen at a slower rate, which means that trowel finishing operations must be delayed; thus increasing the susceptibility to plastic shrinkage cracking. Curling (CIP 19) can occur due to differential drying and related shrinkage at different levels in the slab. Concrete producers can develop mixtures with reduced shrinkage and reduced moisture emission. With the increased occurrence of moisture related floor covering failures, minor cracking of floors placed on a vapor retarder and other problems discussed here are considered a more acceptable risk than failure of floor coverings.

The sub-grade and base should be compacted to provide uniform support to the slab. The base should be well draining and stable to support construction traffic. A clean fine-graded, preferably crushed, material with about 10 to 30 percent passing the No. 100 [150-mm] sieve and free of clay or organic material is generally recommended. Concrete sand should not be used as it is easily displaced during construction.

Jobsite moisture conditions based on the geotechnical evaluation may require a capillary break to reduce moisture migration. Install a 6 to 8 inch [150 to 200 mm] layer of coarse gravel or crushed stone as a capillary break. Note that a coarse stone capillary break will not reduce moisture vapor transmission from the slab support system. A vapor retarder is still required above a capillary break.

If coarse stone is used as the capillary break, choke off the top surface with 2-in. [50-mm] of graded, fine-grained compactable fill to prevent damage to the vapor retarder. Install the vapor retarder on top of the smooth compacted fill.

Vapor retarder sheets should be overlapped by 6 inches [150 mm] at the seams and taped and sealed around utility or column openings, the face of grade beams, footings, and the slab or foundation walls. These details are addressed in ASTM E1643.

If an interior concrete slab will not have a moisture-sensitive floor covering but will be located in a humidity controlled area it may be placed over the granular fill/

blotter layer. The granular layer should be dry prior to concrete placement to function as a blotter and remove water from the fresh concrete. Moisture infiltration into the granular material should be prevented and the base and slab should be ideally constructed with a roof in place.

The granular/blotter layer should be a minimum 4 inch [100 mm] layer of compactable, easy-to-trim material. A “crusher-run” material graded from 1½ in. [37.5 mm] to dust size works well. Alternatively, use at least 3 inches [75 mm] of crushed stone sand. Do not use concrete sand. To reduce slab friction, top off the crusher-run layer with a layer of fine-graded material.

References

1. ASTM E96, *Standard Test Methods for Water Transmission of Materials*
ASTM F710, *Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring*,
ASTM F1249, *Standard Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor*,
ASTM E1745, *Standard Specification for 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*, ASTM International, West Conshohocken, PA. www.astm.org.
 2. *Guide to Floor and Slab Construction*, ACI 302.1R, American Concrete Institute, Farmington Hills, MI. www.concrete.org
 3. *Guide for Concrete Slabs that Receive Moisture-Sensitive Flooring Materials*, ACI 302.2R, American Concrete Institute, Farmington Hills, MI. www.concrete.org.
 4. Kanare, Howard M., *Concrete Floors and Moisture*, EB119, Portland Cement Association, Skokie, IL, www.cement.org
 5. R. H. Campbell et al., *Job Conditions Affect Cracking and Strength of Concrete In-Place*, ACI Journal, Jan 1976, pp.10 - 13.
 6. Bimel, C., *No Sand, Please*, The Construction Specifier, June 1995, pp. 26.
 7. Gaul, Robert W., *Moisture-Caused Coating Failures: Facts and Fiction*, Concrete Repair Digest, February – March, 1997.
 8. Craig, Peter, *Vapor Barriers, Nuisance or Necessity*, Concrete Construction, March 2004
 9. Concrete in Practice (CIP) Series, National Ready Mixed Concrete Association, Alexandria, VA, www.nrmca.org
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FOLLOW THESE RULES WHEN USING VAPOR RETARDERS

1. Provide a vapor retarder directly under and in contact with all interior floor slabs.
2. Use a sheet product with a minimum thickness of 10 mils that has a permeance less than 0.1 perms when tested by ASTM E96 or F1249. Vapor retarders should comply with ASTM E1745 and be durable to retain its properties during and after construction.
3. Place the vapor retarder on a smooth base and ensure it is vapor tight to moisture sources below the slab, at its edges, and at penetrations. Installation should be in accordance with ASTM E1643.
4. Order a concrete mixture designed for low shrinkage. Concrete mixtures with reduced moisture emission can be requested.
5. Follow good concrete practices for finishing and curing to reduce potential vapor emission. If the concrete slab will receive a moisture-sensitive floor covering, cure the concrete under plastic sheeting for 3 days and do not moist cure the slab for more than 7 days.

2004, 2017



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