Concrete in Practice

What, why & how?

NRMCA®

CIP 29 - Vapor Retarders Under Slabs on Grade

WHAT are Vapor Retarders?

Vapor retarders are materials that will minimize the transmission of water vapor from the sub-slab support system into a concrete slab. Vapor retarders are typically specified according to ASTM E 1745 and have a permeance of less than 0.3 US perms (0.2 metric perms), when tested by ASTM E 96. Low-density polyethylene film is commonly used and a minimum thickness of 10 mils (0.25 mm) is recommended for reduced vapor transmission and durability during and after its installation. Membrane material specifically designed for use as true vapor barriers with permeance ratings of 0.0 perms per square foot per hour, as measured by ASTM E 96, are also available.

WHY are Vapor Retarders Used?

Vapor retarders are frequently specified for interior concrete slabs on grade where moisture protection is desired. Protection from moisture 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.

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 into the slab and into the occupied building space. For many years, vapor retarders were specified only for floor slabs intended to receive floor coverings. However, even floors intended for "bare" use in service, such as warehouses, mechanical rooms, and unfinished expansion areas, often are converted to other uses and then moisture-sensitive flooring is installed. 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 when placing exterior slabs on grade.

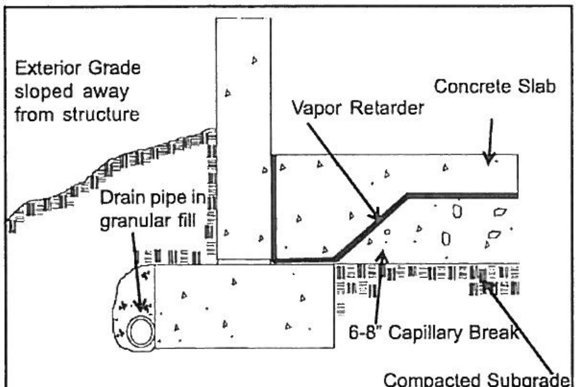

Figure 1 Typical Detail of Slab on Grade with Vapor Retarder

Vapor retarders do not prevent migration of residual moisture from within the concrete slab to the surface. It is important to use a concrete mixture with the lowest water content that will afford adequate workability. Chemical and mineral admixtures are generally used to minimize the water content in a concrete mixture and provide adequate workability for placement. After proper curing, the concrete slab should be allowed to dry out and tested to ensure that moisture is not being transmitted through the slab prior to installing flooring materials (CIP 28).

HOW to Place Concrete on Vapor Retarders?

Current recommendation of ACI Committee 302 is to place a concrete slab directly on top of a vapor retarder when the concrete slab surface will receive a vapor sensitive floor covering. If environmental conditions exist for increased possibility of plastic shrinkage cracking, placing concrete directly on the vapor retarder can help alleviate the plastic shrinkage cracking somewhat by enhancing bleed water.

Placing concrete directly on the vapor retarder can also create potential problems. If environmental conditions do not permit rapid drying of bleed water from the slab surface then the excess bleeding can delay finishing operations. Bleed water trapped below a finished surface can cause delaminations (CIP 20) or blisters (CIP 13) if finishing operations are not performed at the correct time after bleedwater has disappeared from the surface. Concrete may stiffen slower, which means that trowel finishing operations must be delayed; thus increasing the susceptibility of plastic shrinkage cracking. Curling (CIP 19) can occur due to differential drying and related shrinkage at different levels in the slab. Most of these problems can be alleviated by using a concrete with a low water content, moderate cement factor, and well-graded aggregate with the largest possible size. 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 adequately compacted. 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.

If recommended in the geotechnical evaluation of the jobsite, 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 subgrade. A vapor retarder is still required above a capillary break.

If a capillary break layer of coarse stone is used, choke the top surface with 2-in. of graded, fine-grained compactable fill to prevent damage to the vapor retarder from sharp corners of the coarse stone. Place 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, grade beams, footings, and foundation walls.

If an interior concrete slab will not have a vapor-sensitive floor covering but will be located in a humidity controlled area it may be placed over the granular fill/blotter layer provided the slab and base material is placed with waterproof roof membrane in place. Further the granular material should not be subject to future moisture infiltration.

When the choice is made to place the concrete over a granular blotter layer, a minimum 4 inch [100 mm] layer of compactable, easy-to-trim, granular fill material should be used. A "crusher-run" material graded from 1½ in. [37.5 mm] to dust size works well. If this is not practical, cover the vapor retarder with 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. The granular layer should ideally be placed under cover and should be dry prior to concrete placement to function as a blotter and remove water from the fresh concrete.

References

1. ASTM Standards E96-00, Standard Test Methods for Water Transmission of Materials, ASTM International, West Conshohocken, PA, www.astm.org.
2. ASTM E1745-97, *Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs*, ASTM International, West Conshohocken, PA, www.astm.org.
3. *Guide to Floor and Slab Construction,* ACI 302.1R, American Concrete Institute, Farmington Hills, MI.
4. ASTM E1643, *Standard Practice for Installation of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs*, ASTM, West Conshohocken, PA.
5. Slabs on Grade, Concrete Craftsman Series - CCS-1, 2nd edition, American Concrete Institute, Farmington Hills, MI.
6. R. H. Campbell, *Job Conditions Affect Cracking and Strength of Concrete In-Place,* et al., ACI Journal, Jan 1976, pp.10 - 13.
7. C. Bimel, *No Sand, Please*, The Construction Specifier, June 1995, pp. 26.
8. Robert W. Gaul, *Moisture-Caused Coating Failures: Facts and Fiction,* Concrete Repair Digest, February – March, 1997.

Follow These Rules When Using Vapor Retarders

1. Provide a vapor retarder directly under all interior floor slabs.
2. Place the vapor retarder on a smooth base and ensure it is vapor tight to moisture sources below the slab and at its edges and at penetrations.
3. Order a concrete mixture designed for minimum shrinkage and follow good concrete practices for finishing and curing to reduce potential water vapor emission. If the concrete slab will receive a vapor-sensitive floor covering, cure the concrete under plastic sheeting for 3 days and in no case moist cure the concrete for more than 7 days.

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