

**Under Slab Vapor Retarders/Barriers:**

**Perm Ratings and Puncture Resistance –  
Striking the Right Balance for Optimum Performance**

## OVERVIEW:

The use of under slab vapor retarders/barriers has long been regarded as an effective, economical way to control moisture migration through concrete. The proper installation of an effective vapor retarder/barrier beneath the concrete has been proven to reduce or eliminate issues that arise when moisture migrates into interior spaces, including the adverse effects such moisture has on floor covering and coating systems, as well as compromised indoor air quality due to the development of fungus, mildew and mold.

W. R. MEADOWS was the innovator that identified the problem early on relating to vapor permeance and membranes getting punctured during installation. In the 1950s, we pioneered the exclusive PREMOULDED® MEMBRANE WITH PLASMATIC® CORE that is still in use today when your retarder/barrier absolutely has to be tough enough. While low permeability, high strength and durability are all important selection and specification criteria for under slab vapor retarders/barriers, there is some speculation about which of these performance characteristics is most important when choosing the right vapor retarder/barrier for a project. This paper explores the industry standards governing under slab vapor retarder/barrier performance and identifies critical product characteristics that should be considered when determining what level of under slab vapor protection to specify for a particular application.

## VAPOR BARRIER vs. VAPOR RETARDER

Let's first look at the terms used in the industry.

Is it a vapor retarder or is it a vapor barrier? This is a difficult question to answer as these terms are used interchangeably in the construction industry.

For example, within ASTM E1745: Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs, a vapor barrier is defined as "*a material or construction that impedes the transmission of water vapor under specified conditions.*" It does not define the term vapor barrier.

ACI approaches this a little differently:

- ACI 302.1R: Guide for Concrete Floor and Slab Construction states "*A number of vapor retarder materials have been incorrectly referred to and used by designers as vapor barriers. True vapor barriers are products that*

*have a permeance (water-vapor transmission rating) of 0.00 perms when tested in accordance with ASTM E 96".*

- ACI 302.2R: Guide for Concrete Slabs that Receive Moisture-Sensitive Flooring Materials states *"historically, the construction industry used the term vapor barrier to describe a polyethylene-based material below a concrete slab. Polyethylene, however, does not completely stop the transmission of water vapor. These products only reduce or retard water vapor transmission. It was therefore considered more appropriate to call these products vapor retarders instead of vapor barriers."* The same ACI committee has made a recommendation that *"if it is determined that a vapor retarder meeting the ASTM E1745 for vapor permeance requirements is not sufficient to protect the flooring material to be installed, then a vapor barrier with a perm rating of .01 or less should be specified."* While this statement implies that a material with a 0.01 or less perm rating may be considered a vapor barrier, it does not define a vapor barrier to be a product that has a permeance of less than 0.01 perms.

Confusing so far ?

In addition when we start to look at categorizing vapor retarders, materials can be separated into three general classes based on their permeance and are defined in the International Building Code (IBC):

Class I vapor retarder 0.1 perm or less

Class II vapor retarder 1.0 perm or less and greater than 0.1 perm

Class III vapor retarder 10 perms or less and greater than 1.0 perm

Anything above 10 perms is defined as a vapor permeable membrane.

So what is a vapor barrier? Many people in the industry typically defines it as being a Class I vapor retarder. However, when looking at the current International Building Code (and its derivative codes), there are no specific performance requirements when it comes to underslab vapor protection. The term vapor retarder is still used. Section 1907.1 of the 2012 IBC calls for 6-mil polyethylene or *"other approved equivalent methods or materials shall be used to retard vapor transmission through the floor slab"*.

So, what should be done?

We need to get away from using the term vapor barrier and vapor retarder and actually define what performance characteristics the material is required to meet based on the actual project requirements. This is worded nicely within ACI 302.1

R, "The committee recommends that each proposed installation be independently evaluated as to the moisture sensitivity of subsequent floor finishes, anticipated project conditions, and the potential effects of slab curling, crusting, and cracking. The anticipated benefits and risks associated with the specified location of the vapor retarder should be reviewed with all appropriate parties before construction."

Irregardless of the term, it is the function of the material that needs to be evaluated - to control the entry of water vapor into the building by vapor diffusion.

## **STANDARDS:**

ASTM, a global leader in the development and delivery of international voluntary consensus standards, has established three standards for underslab vapor retarders. Two are material specifications with specific criteria that the material has to meet; both applicable to new materials as well as materials that are conditioned or exposed to simulate service conditions. The third standard addresses the placement and installation of the vapor retarder.

- **ASTM E1993:** Standard Specification for Bituminous Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs
  - This covers bituminous membrane water vapor retarders and specifies requirements for water vapor permeance, tensile strength, puncture resistance, and thickness.
  
- **ASTM E1745:** Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs
  - This covers plastic water vapor retarders and classifies the material into either Class A, B, and C based on:
    - water vapor permeance
    - tensile strength
    - puncture resistance

*\* it is important to note that classification of a material is based on its puncture resistance and tensile strength and not vapor permeance as this is consistent at 0.1 perms across all three classes.*
  
- **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

**Water Vapor Permeance** requirements per ASTM E1745-11 call for a vapor retarder material to have a maximum permeance rating of 0.1 perms. However, as

stated above, the American Concrete Institute's ACI 302.2R-06, Guide for Concrete Slabs that Receive Moisture Sensitive Flooring Materials, has suggested that use of materials having 0.01 perms or less in situations where extremely sensitive flooring materials require protection lower than the requirements stated in ASTM E1745 may be a good idea. In theory, a lower perm rating equals better protection against moisture; however, a low perm rating alone does not make an effective vapor retarder.

### **Beyond permeance**

While the importance of permeance in vapor retarder/barrier performance cannot be ignored, there is increasing emphasis being placed on the material's overall strength and puncture resistance – and with good reason. During construction, these materials are exposed to foot traffic and other conditions that can lead to punctures and tears. The reality is, even small holes in the vapor retarder/barrier can result in significant increases in water-vapor emissions through concrete floor slabs, leading to potential floor covering failures, delays in floor covering installation, and a host of other costly problems.

Multiple studies have been conducted to evaluate what happens when a vapor retarder/barrier is punctured or improperly installed. One such widely-referenced study by **The Aberdeen Group** determined that a 1/8-inch-diameter nail hole created an average moisture-emission rate of 1.3 lbs./1,000 ft.<sup>2</sup>/24 hours – essentially rendering the material equal to a vapor retarder with a .93 perm rating which is well outside recommended industry performance standards.

The same study also showed that a 5/8-inch-diameter stake hole caused the average moisture-emission rate to increase to 3 lbs./1,000 ft.<sup>2</sup>/24 hours. This represents the maximum moisture transfer rate allowed by the flooring industry's specifications and the equivalent of a vapor retarder with a 2.2 perm rating.

#### **Sources of Vapor Retarder/Barrier Leaks**

##### Punctures caused by:

- Finishers poking holes in the vapor barrier to hasten slab drying time. Placing concrete directly on the vapor barrier (instead of a more absorptive base) may increase curing time.
- Accidental punctures caused by workers placing edge forms and rebar supports.
- Equipment and foot traffic before/during the pour which can rip the material or cause underlying aggregates to puncture them.

##### Openings:

- Unsealed edges along laps or unsealed penetrations.
- Floor-wall joints (barrier should be pulled up at sides and sealed to the footing or foundation wall).

Many suppliers of vapor retarders/barriers publish test results attesting to the low perm ratings of their products. However, it appears simply having a low perm

rating is not enough when it comes to real-life conditions. Vapor retarders/barriers must also be tough enough to endure the rigors of construction, since this will determine their true long term ability to protect against water vapor intrusion. Unfortunately, many products that are promoted for their low perm rating today also exhibit reduced puncture-resistance properties. This is recognized in a quote by a concrete floor specialist, *"I have learned from polymer chemists that currently with plastic films one must choose a main objective. You either design a material to achieve the lowest permeance possible, or you design it for strength. Gain on one and you lose on the other."*

## **CONCLUSIONS:**

A Specifier of vapor retarder/barrier materials has several different options available to them when selecting a material for a particular project. It is important for the Specifier to understand the project requirements, as well as the performance criteria of the material and make the selection accordingly. A product with a high puncture resistance but less than adequate permeance is of no value, just as is a product with very low permeance that is more likely to get punctured during the installation. Even, a few relatively small punctures, that are not properly repaired, can remove any advantage that the low permeance material would have otherwise provided. A balance of low vapor permeance and high puncture resistance provides a vapor retarder/barrier that performs during installation and construction, as well as providing the long term protection required today. Vapor permeance, puncture resistance and tensile strength are all vital functions of a vapor retarder/barrier and a balance between these will enable a material to perform both during and after construction.

It is important for the Specifier to inquire whether both the permeance and puncture properties listed on a manufacturer's data sheet have been independently tested by a laboratory accredited to perform the testing. In addition, all testing must be performed on samples from the same product roll as required within Section 8.1 of ASTM E1745, *"For each complete set of tests, obtain all samples from a single production roll of material. Samples shall be representative of the material being sold to the end user."* W. R. MEADOWS feels that to ensure that this testing is from the same sample roll, a single independent test report shall be inclusive of all the required test results.

Key Points for specifiers when comparing materials:

- Are the test methods the same for the products?
- Request current independent testing for all criteria of ASTM E1745 on the same sample. (A single independent accredited laboratory should do all of

the tests or coordinate the testing to insure that the same material was used to test all of the properties.)

- Ensure that the current material is from the same source as the tested material
- Compare products on all of the critical factors (perms, puncture, tensile), not just vapor permeance.
- Are the products clearly labeled for onsite identification?

Underslab vapor retarders/barriers such as PERMINATOR 10 and 15 mil now offer some of the lowest vapor permeance values, along with the highest puncture resistance ratings available. PERMINATOR's puncture resistance – combined with its low perm rating – means it is a complete, reliable underslab vapor retarder/barrier. In critical applications where the lowest possible permeance and the absolute toughest material needs to be installed, consider PREMOULDED MEMBRANE VAPOR SEAL WITH PLASMATIC CORE (PMPC), the original choice in below-slab protection, or PRECON®, both of which contain the time-tested exclusive W. R. MEADOWS plasmatic core and have the lowest perm ratings available on the market.

W. R. MEADOWS has been the trusted name in vapor retarder/barrier protection for over 60 years. With billions of square feet installed, W. R. MEADOWS is a name you can trust for true, honest facts.

#### **RESOURCES:**

Please call W. R. MEADOWS at **800-342-5976** for more information or visit our website at [www.wrmeadows.com](http://www.wrmeadows.com)

ACI 302.1R-04: Guide for Concrete Floor and Slab Construction.

ACI 302-2R-06: Guide for Concrete Slabs that Receive Moisture-Sensitive Flooring Materials.

ASTM E1643-11: Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill under Concrete Slabs.

ASTM E 1745-11: Standard for Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs.

ASTM E1993-98 (2013): Standard Specification for Bituminous Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs.

*Concrete Construction*, December 1998 – “Don’t puncture the vapor retarder” by Bruce A. Suprenant and Ward R. Malisch.

*Concrete Construction*, July 2000 – “Examining Puncture Resistance” by Bruce A. Suprenant and Ward R. Malisch.

*Concrete Construction*, March 2005 – “Vapor barriers: nuisance or necessity?” by Peter Craig.

*Concrete Construction*, January 2013 – “Keeping Moisture Out of Slabs” by William D. Palmer Jr.