

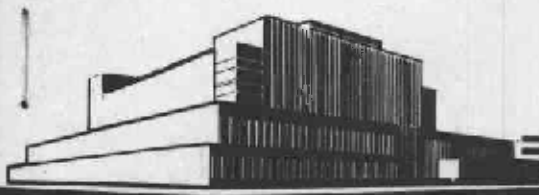
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# Alternative Methods of Test for SUITABILITY OF MATERIALS USED AS VAPOR BARRIERS UNDER CONCRETE SLABS AND AS GROUND COVER IN CRAWL SPACES

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UNITED STATES DEPARTMENT OF AGRICULTURE  
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In Cooperation with the University of Wisconsin

TENTATIVE METHODS OF TEST FOR  
SUITABILITY OF MATERIALS USED AS VAPOR BARRIERS UNDER  
CONCRETE SLABS AND AS GROUND COVER IN CRAWL SPACES

By

U. S. Forest Products Laboratory,<sup>1</sup> Forest Service  
U. S. Department of Agriculture

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Introduction

Concrete slabs bearing upon soil are now widely used in basementless houses, schools, gymnasiums, and some commercial buildings. Gravel or crushed rock is generally used over the natural soil as a base for the slab. Moisture rising from the soil through the concrete slab may cause damage to the finish floor, to the adhesives used to cement the flooring to the slab, and may affect humidity control in the rooms above the floor. Fines from the concrete at the time it is poured may work into the gravel and adversely affect the properties of the slab.

A highly waterproof membrane should be laid over the gravel base before the concrete is poured to act as a vapor barrier and to prevent fines from getting into the gravel. Such a barrier must be of a type having high resistance to damage from alternate wetting and drying, exposure to long-time wetting, shrinkage, decay, abrasion, and elevated temperatures such as would occur in floor radiant heating systems. It should also have adequate tensile strength when wet.

It is difficult and often impossible to ventilate adequately the crawl space under basementless houses, and moisture rising from the soil has been responsible for extensive damage from decay in the joist, sills, and other wood framing members. Expansion and buckling of finish floors are not uncommon. The closing of the foundation wall ventilator openings in cold weather to prevent freezing of water pipes and cold floors contributes to the overall hazard.

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<sup>1</sup>Prepared as a tentative standard.

A tough, durable, highly vapor-resistant membrane over the soil has been found to be very effective in reducing the moisture problem. With suitable soil covers, ventilation requirements may be met without causing any problem.

The purpose of the test methods here described is to cover accelerated test procedures for vapor barriers under concrete slabs and soil covers in crawl spaces under conditions that will as nearly as possible simulate conditions of installation and service and to obtain data for evaluation of materials for the purpose intended but it is not the purpose to establish minimum standards of acceptability.

### Scope

1. These methods of test cover procedures to be used in determining the properties of flexible membranes that have a bearing on their strength and serviceability as vapor barriers, particularly when used as vapor barriers under concrete slabs and as ground cover in crawl spaces. The methods are applicable to such materials as asphalt-treated papers and felts, plastic films and flexible sheets. Eight test procedures are provided to cover the various exposure conditions under which the desired properties are to be measured.

Procedure 1 Water vapor transmission test.

Procedure 2 Resistance to deterioration from alternate wetting and drying.

Procedure 3 Resistance to deterioration from long-time soaking.

Procedure 4 Resistance to excessive shrinkage.

Procedure 5 Wet tensile strength.

Procedure 6 Resistance to decay.

Procedure 7 Resistance to abrasion.

Procedure 8 Resistance to plastic flow and elevated temperature.

### Significance

2. (a) The basic property desired for vapor barrier materials to be used under concrete slabs resting on ground or as a ground cover in crawl spaces under basementless houses is high resistance to water-vapor transmission. During installation and in service, the vapor barrier is subjected to conditions that may affect its proper functioning. It is important, therefore, that the barrier material have certain other physical properties, including strength and resistance to deterioration, to permit long service life.

(b) The purpose of these tests is to provide a means of obtaining, by relatively simple apparatus, reliable data for the rate of water-vapor transmission of sheet materials that have been exposed to conditions

simulating those encountered during installation and service, and to provide an evaluation of other properties relating to strength and serviceability.

### Sampling

3. (a) Test specimens shall be obtained from three separate rolls or packages of each type of material being tested. When more than three test specimens are required, duplicates may be taken from one roll or package. Samples shall be representative of the material being tested and shall be of uniform thickness. If the samples are of nonsymmetrical construction, the two faces shall be designated by distinguishing marks. (For example, on a sample coated on one side, I for the coated side, and II for the uncoated side.)

### Test Specimens

4. (a) The number and size of test specimens of each material are given separately in each test procedure. Great care should be taken to protect the test area of the specimen against damage or contamination.

### Procedure 1: Water Vapor Transmission Test

5. (a) Make water vapor transmission tests on at least four specimens of each test material according to ASTM Standard Method E96-53T, procedure A or C.

### Procedure 2: Resistance to Deterioration from Alternate Wetting and Drying

6. (a) Cut and prepare five specimens, 12 by 12 inches; of each material to be tested and condition in a cabinet having a temperature of  $73^{\circ}$  F.  $\pm 3^{\circ}$  and a relative humidity of  $50 \pm 2$  percent to a constant weight. Record final weight of the specimens.

(b) Immerse the specimens in clear water controlled at  $73^{\circ}$  F.  $\pm 3^{\circ}$  for 16 hours (overnight) and dry in a cabinet controlled at  $140^{\circ}$  F.  $\pm 3^{\circ}$  for 8 hours. Repeat the wetting and drying cycle for a total of 5 cycles. Immerse in water over a weekend (64 hours) and repeat the wetting and drying cycle 5 more days, then condition to a constant weight again at  $73^{\circ}$  F.  $\pm 3^{\circ}$  and relative humidity of  $50 \pm 2$  percent. Weigh specimens separately to determine weight loss during soaking test.

(c) Determine extent of delamination and record in percentage of area of the specimen.

(d) Cut three of the original five specimens in half, parallel to the machine direction (parallel to the long dimension as taken from the roll or package). Bend three of the halves with one surface up and the other three with the opposite surface up at an angle of  $90^\circ$  over a  $3/4$ -inch round mandrel in a period of 2 seconds. Flexure tests shall be made at a temperature of  $73^\circ \text{ F.} \pm 3^\circ$ . The bend shall be across the narrow width of the specimen. Record evidence and extent of delamination or cracking.

(e) Determine the water-vapor transmission of specimens cut to include the bent portion, with the surface that was concave at the time of bending facing the desiccant, following the test method described in procedure 1.

#### Procedure 3: Resistance to Deterioration from Long-Time Soaking

7. (a) Cut and prepare five specimens, 12 by 12 inches, of each material to be tested and condition to a constant weight in a cabinet having a temperature of  $73^\circ \text{ F.} \pm 3^\circ$  and a relative humidity of  $50 \pm 2$  percent. Record final weight of the specimens.

(b) Immerse the specimens in clear water controlled at  $73^\circ \text{ F.} \pm 3^\circ$  for 60 days, then condition to a constant weight again at  $73^\circ \text{ F.} \pm 3^\circ$  and a relative humidity of  $50 \pm 2$  percent. Weigh the specimens separately to determine the weight loss due to soaking.

(c) Cut three of the original five specimens in half, parallel to the machine direction (parallel to the long dimension as taken from the roll or package). Bend one of the halves of each specimen with one surface up and the other with the opposite surface up at an angle of  $90^\circ$  over a  $3/4$ -inch round mandrel in a period of 2 seconds. The bend shall be across the narrow width of the specimens. Record evidence of delamination or cracking.

(d) Determine the water-vapor-transmission rate of specimens cut to include the bent portion, with the surface that was concave at the time of bending facing the desiccant, following the test method described in procedure 1.

#### Procedure 4: Resistance to Excessive Shrinkage

8. (a) Cut and prepare five specimens, 18 by 24 inches, with the long direction across the machine direction (at a right angle with the long dimension as taken from the roll or package). Immerse the specimens in clear water controlled at  $73^\circ \text{ F.} \pm 3^\circ$  for 7 days. Remove the specimens from the water and clamp all edges of each specimen into a rigid metal

frame designed so that the exposed portion of the specimen shall be at least 17 by 23 inches. Condition the specimens in the frame in a cabinet controlled at 73° F. ±3° and 30 ±2 percent relative humidity for 7 days.

(b) Remove specimens from the frames and determine water-vapor transmission, following the test method described in procedure 1.

#### Procedure 5: Wet Tensile Strength

9. (a) Cut and prepare ten specimens, 1 inch wide and 8 inches long, with the long direction parallel with the long dimension as taken from the roll or package and ten specimens cut at a right angle with the first set. Immerse in water at 73° F. ±3° for 7 days in such a manner that water has free access to all surfaces and edges of the specimens. Remove the specimens from the water one at a time, lightly blot the free water from both surfaces, and immediately determine tensile strength according to ASTM test procedure Designation D 828-48.

#### Procedure 6: Resistance to Decay

10. (a) Specimens may be 4-5/8 inches in diameter or if preferred cut to size to fit dishes used in making water vapor transmission tests. Five specimens of each test material shall be used for each species of fungus. Specimens should be surface sterilized in a plain dish or container by steaming or autoclaving at atmospheric pressure for 30 minutes. If the steaming procedure is too drastic for the material, it may be omitted and risk of contamination assumed. Feeder blocks shall be prepared of the sapwood of ponderosa pine, 1/4 inch thick and approximately the diameter of the specimens. Crystallizing dishes 150 millimeters in diameter and 3 inches deep with covers of heavy aluminum foil make suitable containers.

(b) Cultures are to be prepared as follows: Fill the dishes with Miami silt loam to a depth of about 1 inch and enough distilled water to bring the moisture content of the soil to 50 percent, oven-dry basis. Place the feeder block on top of the soil, cover the dishes with the foil, and autoclave for 30 minutes at 15 pounds pressure. When cooled, inoculate with the test fungi (one species per dish) and incubate in a space controlled at 80° F. ±3° and 70 ±2 percent relative humidity until the feeder blocks are well overgrown by the fungi.

(c) One test specimen shall be placed on the feeder block in each dish using aseptic technique, and incubated as before for an exposure period of 90 days. Remove the specimens and determine the water-vapor transmission, following the test method described in procedure 1.

(d) Fungi: Five specimens shall be exposed to each of at least three of the following species of wood-destroying fungi: (1) Lenzites trabea, Madison No. 617; (2) Poria monticola, Madison No. 698; (3) Poria

vaillantii, FP 98077-R; (4) Poria incrassata, Madison No. 563; (5) Coniophora puteana, Madison No. 515; and (6) Polyporus versicolor, Madison No. 697. Pure cultures of these fungi may be obtained from the U. S. Department of Agriculture, Division of Forest Disease Research, Beltsville, Maryland.

#### Procedure 7: Resistance to Abrasion

11. (a) Cut and prepare six specimens, 12 by 12 inches, of each material to be tested and condition in a cabinet having a temperature of 73° F.  $\pm 3^\circ$  and a relative humidity of 50  $\pm 2$  percent to a constant weight. Prepare six boxes, 13 by 13 inches inside dimension, about 4 inches deep and fill with 3/4-inch gravel to a depth of at least 2 inches. Place specimens on the gravel and apply a weight of 100 pounds having a smooth contact surface of 4 by 6 inches. The edges of the contact surface may be slightly rounded. Hold specimen in place and turn the weight through an angle of 90° and remove.

(b) Make a water vapor transmission test of each specimen which includes the area covered by the weight. Test three specimens with one surface up and three with the opposite face up, following the test method described in procedure 1.

#### Procedure 8: Resistance to Plastic Flow and Elevated Temperature

12. (a) Cut and prepare six specimens, 12 by 12 inches, of each material to be tested and condition in a cabinet having a temperature of 73° F.  $\pm 3^\circ$  and 50  $\pm 2$  percent to a constant weight, and weigh the specimens. Prepare six boxes, 13 by 13 inches inside dimension by about 4 inches deep, and fill with 3/4-inch gravel to a depth of at least 2 inches. Carefully level the gravel, place the specimen over the gravel and cover it with a 12- by 12-inch platen made of 3/4-inch plywood. Load the platen with a weight of 100 pounds. Place the assembly in a chamber heated to 150° F.  $\pm 5^\circ$  and relative humidity 30  $\pm 2$  percent for 30 days, then condition the samples as before to a constant weight.

(b) Weigh specimens separately.

(c) Make water vapor transmission test of each specimen. Test three specimens with one surface up and three with the opposite face up, following the method of test described in procedure 1.

#### Report

12. (a) The report shall record the test results as obtained under paragraphs:

- 5 (a) Water-vapor permeability.
- 6 (b) Average weight loss.
- 6 (c) Percent of delamination.
- 6 (d) Evidence of cracking or delamination.
- 6 (e) Water-vapor permeability.
- 7 (b) Average weight loss.
- 7 (c) Evidence of cracking or delamination.
- 7 (d) Water-vapor permeability.
- 8 (a) Evidence of rupturing.
- 8 (b) Water-vapor permeability.
- 9 (a) Tensile strength.
- 10 (c) Water-vapor permeability.
- 11 (b) Water-vapor permeability.
- 12 (b) Average weight loss.
- 12 (c) Water-vapor permeability.