Designation: D 4434 – 96

Standard Specification for Poly(Vinyl Chloride) Sheet Roofing[1]

This standard is issued under the fixed designation D 4434; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This specification covers flexible sheet made from poly(vinyl/chloride) resin as the primary polymer intended for use in single-ply roofing membranes exposed to the weather. The sheet shall contain reinforcing fibers or reinforcing fabrics.

1.2 The tests and property limits used to characterize the sheet are values intended to ensure minimum quality for the intended purpose. In-place roof system design criteria, such as fire resistance, material compatibility, wind uplift resistance, in-situ shrinkage, among others, are factors that must be considered but are beyond the scope of this specification.

1.3 The values stated in SI units are to be regarded as the standard. The values stated in parentheses are for information only.

2. Referenced Documents

2.1 *ASTM Standards:*

D 570 Test Method for Water Absorption of Plastics[2]

D 638 Test Method for Tensile Properties of Plastics[2]

D 751 Test Methods for Coated Fabrics[3]

D 1004 Test Method for Initial Tear Resistance of Plastic Film and Sheeting[2]

D 1204 Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature[2]

D 2136 Test Method for Coated Fabrics—Low Temperature Bend Test[4]

D 3045 Practice for Heat Aging of Plastics Without Load[5]

D 5602 Test Method for Static Puncture Resistance of Roofing Membrane Samples[6]

D 5635 Test Method for Dynamic Puncture Resistance of Roofing Membrane Samples[6]

G 26 Practice for Operating Light-Exposure Apparatus (Xenon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials[7]

G 53 Practice for Operating Light- and Water-Exposure Apparatus (Fluorescent UV/Condensation Type) for Exposure of Nonmetallic Materials[7]

3. Classification

3.1 *Type II*:

3.1.1 *Grade 1*—Reinforced sheet in which fibers are incorporated into a production process, for example as a carrier, without appreciably affecting such physical property characteristics of the finished product as tensile strength or ultimate elongation, but may provide other desirable characteristics, such as dimensional stability.

3.1.2 *Grade 2*—Externally reinforced sheet utilizing a fabric backing.

3.2 *Type III*—Sheet that is internally reinforced with fabric and which may also have a fabric backing.

3.3 *Type IV*—Sheet that is internally reinforced with fabric and which may also have a fabric backing with minimum thickness of 0.91 mm (0.036 in.).

4. Materials and Manufacture

4.1 The sheet shall consist of poly(vinyl chloride) resin in amounts greater than 50 % of the total polymer content suitably compounded with plasticizers, stabilizers, fillers, pigments, and other ingredients to satisfy the physical property requirements and accelerated durability tests.

4.2 To make seams and repairs, the sheet shall be capable of being bonded watertight to itself during the design service life of the sheets. The manufacturer shall recommend a suitable method. Design service life is defined as the designated time period of intended system performance.

5. Physical Requirements

5.1 The sheet shall conform to the physical requirements prescribed in Table 1.

6. Dimensions

6.1 The width and length of the sheet shall be agreed upon between the purchaser and the supplier as part of the purchase

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[1] This specification is under the jurisdiction of ASTM Committee D08 on Roofing, Waterproofing, and Bituminous Materials and is the direct responsibility of Subcommittee D08.18 on Nonbituminous Organic Roof Coverings.

Current edition approved Nov. 10, 1996. Published January 1997. Originally published as D 4434 – 85. Last previous edition D 4434 – 95.

[2] *Annual Book of ASTM Standards*, Vol 08.01.

[3] *Annual Book of ASTM Standards*, Vol 09.02.

[4] *Annual Book of ASTM Standards*, Vol 09.01.

[5] *Annual Book of ASTM Standards*, Vol 08.02.

[6] *Annual Book of ASTM Standards*, Vol 04.04.

[7] *Annual Book of ASTM Standards*, Vol 14.02.

TABLE 1 Physical Requirements for Poly(Vinyl Chloride) Sheet

Property	Type II		Type III	Type IV
	Grade 1	Grade 2		
Overall thickness of PVC sheet, min, mm (in.)	1.14 (0.045)	1.14 (0.045)	1.14 (0.045)	0.91 (0.036)
Tensile strength at break, min, MPa (psi):				
Machine direction	10.4 (1500)	...	...	...
Cross-machine direction	10.4 (1500)	...	...	...
Breaking strength, min, kN/m (lbf/in.)	...	35 (200)	35 (200)	48 (275)
Elongation at break, min, %:				
Machine direction	250	15	15[A]	25[A]
Cross-machine direction	220	15	15[A]	25[A]
Seam strength, min, % of tensile or breaking strength	75	75	75	75
Retention of properties after heat aging:				
Tensile strength, min, % of original	90	...	...	...
Breaking strength, min, % of original	...	90	90	90
Elongation, min, % of original	90	90	90	90
Tear resistance, min, N (lbf)	45.0 (10.0)	...	...	...
Tearing strength, min, N (lbf)	...	200 (45.0)	200 (45.0)	400 (90.0)
Low temperature bend	pass	pass	pass	pass
Accelerated weathering test:				
Cracking (7× magnification)	none	none	none	none
Crazing (7× magnification)	none	none	none	none
Linear dimensional change, max, %	0.1	0.1	0.5	0.5
Change in weight after immersion in water, max, %	±3.0	±3.0	±3.0	±3.0
Static Puncture Resistance	pass	pass	pass	pass
Dynamic Puncture Resistance	pass[B]	pass[B]	pass[B]	pass[B]

[A] For reinforcing fabric only; elongation of PVC material shall be the same as Type II, Grade 1.

[B] For Type II, Grade 1 products dynamic puncture shall be evaluated at an energy level of 10 J min. For Type II, Grade 2 and Type III products dynamic puncture shall be evaluated at an energy level of 20 J min.

contract. The width and length tolerance shall be + 3 %, − 0 % after permitting the sheet to relax for 1 h at 21 ± 3°C (70 ± 5°F).

6.2 The thickness and thickness tolerance shall be agreed upon between the purchaser and the supplier as part of the purchase contract subject to the requirements specified in Table 1.

6.3 Type II, Type III, and Type IV sheet shall have a minimum coating or laminant thickness of 0.40 mm (0.016 in.) above the cross points of any fabric or fiber and the surface exposed to the weather.

7. Workmanship, Finish, and Appearance

7.1 The sheet and any factory seams shall be watertight. It shall be visually free of pinholes, particles of foreign matter, undispersed raw material, protruding fibers or reinforcement, or other manufacturing defects that might affect serviceability.

7.2 The sheet shall be visually free of nicks and cuts, voids, thin areas, delaminations, or other defects.

7.3 Edges of the sheet shall be straight and flat to permit seaming to the adjacent sheet without fishmouths.

8. Test Methods

8.1 *Conditioning*—Condition the test specimens in accordance with the individual test methods.

8.2 *Overall Thickness*—Test Method D 638 for Type II, Grade 1 and Test Method D 751 for Type II, Grade 2, Type III, and Type IV. Unless otherwise noted, all thicknesses shall have tolerances of + 10 %, − 10 % of the specified nominal thickness.

8.3 *Tensile Strength at Break*—Test Method D 638 for Type II, Grade 1.

8.4 *Breaking Strength*—Test Methods D 751, A—Grab Method, for Type II, Grade 2, Type III and Type IV.

8.5 *Elongation at Break*—Test Method D 638 for Type II, Grade 1 and Test Methods D 751, A-Grab Method, for Type II, Grade 2, Type III and Type IV.

8.6 *Seam Strength*—Test Method D 638 for Type II, Grade 1 and Test Methods D 751, A-Grab Method, for Type II, Grade 2, Type III and Type IV. All testing shall be performed on seamed specimens with the passing criteria specified as a percent of either unseamed sample tensile strength at break or unseamed sample breaking strength, dependent on type.

8.7 *Heat Aging*—Practice D 3045 at 80 ± 1°C (176 ± 2°F) for 56 days ± 1 h.

8.8 *Tear Resistance*—Test Method D 1004, for Type II, Grade 1.

8.9 *Tearing Strength*—Test Methods D 751, B-Tongue Tear Method, for Type II, Grade 2, Type III, and Type IV. Specimen size shall be 200 mm × 200 mm (8 in. by 8 in.).

8.10 *Low Temperature Bend Test*—Test Method D 2136, at − 40°C (−40°F).

8.11 *Accelerated Weathering Test*—Perform accelerated weathering test for 5000 h. The following test procedures shall be permitted:

8.11.1 *Xenon Arc Light Exposure*—Practice G 26 with controlled humidity (Type B, BH or E), using natural sunlight filter (inner/outer borosilicate or equivalent); deionized water; 102 min light exposure, 18 min light and spray; black panel temperature (63 ± 3°C) (black standard thermometer 70 ± 3°C) relative humidity (30± 5 %). The intensity appropriate for this test shall be 0.35 W/m^2 at 340 nm.

8.11.2 *Fluorescent UV/Condensation Exposure*—Practice G 53 Type UVA-340; 8 h light exposure; 4 h condensation; black panel temperature (63 ± 3°C); condensation temperature 50°C.

8.12 *Linear Dimensional Change*—Test Method D 1204, 6 h at 80 ± 1°C (176 ± 2°F).

8.13 *Change in Weight After Immersion in Water*—Test Method D 570, except for 168 ± 1 h at 70 ± 1°C (158 ± 2°F).

8.14 *Static Puncture Resistance*—Test Method D 5602, at a load of 15 kg (33 lbf) min at 22.78 ± 1°C (73 ± 2°F).

8.15 *Dynamic Puncture Resistance*—Test Method D 5635, at an energy of 10 J min at 22.78 ± 1°C (73 ± 2°F) for Type II, Grade 1 and an energy of 20 J min for Type II, Grade 2, Type III and Type IV.

9. Inspection and Special Testing

9.1 The manufacturer shall inspect and test his production to ensure compliance of the product with this specification.

9.2 The purchaser may, in the contract, order special tests that the supplier shall be required to make beyond those described in Table 1.

9.3 If the results of any tests do not conform to the requirements of this specification, retesting to determine conformity shall be performed as agreed upon between the purchaser and the supplier.

10. Rejection and Resubmittal

10.1 Failure to conform to any one of the requirements prescribed in this specification shall constitute grounds for rejection. The seller shall have the right to reinspect the rejected shipment and resubmit the lot after removal of those packages not conforming to the specified requirements.

11. Product Marking

11.1 The sheet shall be identified on the side intended to be exposed to the weather with this ASTM designation, the name of the manufacturer or supplier, or PVC and its type and grade. The type of identification is at the manufacturer's option. Such identification shall occur at intervals not to exceed 3 m (9.84 ft) in the long direction of the sheet and shall be applied in such a manner as to be legible five years from installation. Identification shall not be required when so specified by purchaser.

12. Packaging and Package Marking

12.1 The material shall be rolled on a substantial core and packaged in a standard commercial manner unless otherwise specified in the contract or order.

12.2 Shipping containers shall be marked with the name of the material, the stock and lot numbers, the ASTM designation number, type and grade, the size and quantity as defined by the contract or order under which shipment is made, the name of the manufacturer or supplier, and the number of the contract or order.

13. Keywords

13.1 fillers; flexible sheet; physical properties; plasticizers; poly (vinyl/chloride) resin; PVC; reinforcing fabrics; reinforcing fibers; seams; single-ply roofing membrane; stabilizers

ANNEX

(Mandatory Information)

A1. OPTICAL METHOD FOR MEASUREMENT OF THICKNESS OF COATING OVER TYPES II, III, AND IV

A1.1 *Scope*—This is a method for measuring the thickness of the coating over fiber backing or reinforcing fabric.

A1.2 *Measurement Method:*

A1.2.1 *Principle*—The thickness of coating material over fiber, fabric, or scrim can be observed with a standard reflectance microscope. Measurement is made with a calibrated eyepiece.

A1.2.2 *Apparatus*:

A1.2.2.1 *Microscope*, 60× with reticle.

A1.2.2.2 *Light Source*—If light source on the microscope is not adequate, use a small high-intensity lamp.

A1.2.2.3 *Stage Micrometer*, 0.0254 mm (0.001 in.) divisions.

A1.2.3 *Calibration Procedure*:

A1.2.3.1 Place a standard reflectance stage micrometer in place of the specimen.

A1.2.3.2 Turn on microscope light source.

A1.2.3.3 Position the reticle eyepiece and the micrometer such that the scales are superimposed. Focus the reticle by turning the eyepiece. Focus the specimen and reticle by turning the vertical adjustment knob.

A1.2.3.4 Locate a point at which both scales line up. Count the number of micrometer divisions away. Measure to the nearest 0.0125 mm (0.0005 in. or 0.5 mil). The calibration can be optimized by increasing the number of divisions measured.

A1.2.3.5 Repeat the calibration three times and average the results. A calibration example is as follows:

If four reticle divisions (RD) are found equal to 4.5 µm divisions (MD), then:

$$1\ (\mathrm{RD}) = 4.5/4\ (\mathrm{MD}) \text{ or } 1\ (\mathrm{RD}) = 1.125\ (\mathrm{MD}) \qquad \text{(A1.1)}$$

Since 1 µm division is also equal to 25.4 µm (0.001 in. or 1 mil), therefore:

$$1\ (\mathrm{RD}) = 28.6\ \mu\mathrm{m}\ (0.001125 \text{ in. or } 1.125 \text{ mils}) \text{ or the calibration factor} \qquad \text{(A1.2)}$$

A1.2.4 *Specimen Analysis*:

A1.2.4.1 Carefully center a sharp single edge razor or equivalent over the fiber intersections along the x-x axis.

A1.2.4.2 Make a clean bias cut completely through the sheet.

A1.2.4.3 Remove the razor-cut section and mount in common putty with the cut surface facing upward.

A1.2.4.4 Observe the cut surface with the eyepiece reticle. Measure the thickness of the coating on either side of the thread intersection by counting the number of reticle divisions (to the nearest one-half division).

A1.2.4.5 Sample three areas of the coatings and average the results.

A1.3 *Calculation and Report*—Multiply the number of reticle divisions representing the thickness of the coating by calibration factor. Report the average results from the areas of the coating to the nearest 12.7 µm (0.0005 in. or 0.5 mils).

A1.4 *Precision and Bias:*

A1.4.1 *Precision*—Measurements are accurate to ±12.7 µm (0.005 in. or 0.5 mils) when the thickness is about 0.5 mm (0.020 in. or 20 mils).

A1.4.2 *Bias*—Since there is no accepted reference material suitable for determining the bias for measuring coating thickness; therefore, no statement on bias is being made.