Designation: D 6754 – 02

Standard Specification for Ketone Ethylene Ester Based Sheet Roofing[1]

This standard is issued under the fixed designation D 6754; 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.

1. Scope

1.1 This specification covers flexible sheet made from ketone ethylene ester (KEE) as the primary polymer intended for use in single ply roofing membrane exposed to the weather. The sheet shall be reinforced with fabric.

1.2 In-place roof system design criteria, such as fire resistance, field-seaming strength, material compatibility, uplift resistance, in-situ shrinkage, among others, are factors that must be considered, but are beyond the scope of this specification.

1.3 The following precautionary caveat pertains to the test methods portion only, Section 8, of this specification: *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory requirements prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 471 Test Method for Rubber Property—Effect of Liquids[2]

D 751 Test Methods for Coated Fabrics[3]

D 1079 Terminology Relating to Roofing, Waterproofing, and Bituminous Materials[4]

D 1204 Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature[4]

D 2136 Test Method for Coated Fabrics—Low-Temperature Bend Test[2]

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

D 3389 Test Method for Coated Fabrics Abrasion Resistance (Rotary Platform, Double-head Abrader)[3]

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

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

G 21 Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi[7]

G 151 Practice for Exposing Nonmetallic Materials in Accelerated Test Devices that Use Laboratory Light Sources[7]

G 154 Practice for Operating Florescent Light Apparatus for UV Exposure of Nonmetallic Materials[7]

G 155 Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials[7]

3. Terminology

3.1 *Definitions*—Terminology D 1079 shall apply to this specification.

3.2 *ketone ethylene ester (KEE), n*—a high molecular weight thermoplastic copolymer of ethylene, containing carbon monoxide and either vinyl acetate or acrylate monomer which are incorporated to provide softness and polarity.[8]

3.3 *polymer content, n*—in this specification, polymer content shall be defined as polymeric materials which are in the solid state at room temperature, and are high (greater than 50 000 Mw) in molecular weight. Other ingredients, known to the art of polymer compounding, such as certain waxes, stabilizers, and other additives, while polymeric in nature are not considered to be part of the base polymer system.

4. Materials and Manufacture

4.1 The sheet shall be formulated from the appropriate polymers and other compounding ingredients. The KEE polymer shall be a minimum of 50 % by weight of the polymer content of the sheet.

4.2 The sheet shall be reinforced internally with a fabric.

4.3 To make seam 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 Properties

5.1 The sheet shall conform to the physical requirements

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

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

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

[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 14.04.

[8] Ester groups of the vinyl acetate or acrylate are pendant from the ethylene backbone and reduce crystallinity, which provides flexibility. Carbon monoxide groups within the polymer backbone provide polarity. The KEE polymer is therefore a flexible polymer, which is miscible with other polymers of similar polarity.

prescribed in Table 1.

5.2 Individual specimens must meet or exceed table values.

6. Dimensions and Permissible Variations

6.1 The width and length of the sheet shall be agreed upon between the purchaser and the supplier as part of the purchase contract. The width and length tolerance shall be +3 % -0 % after permitting the sheet to relax 1 h at 23 ± 1°C (73 ± 2°F).

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

7. Workmanship, Finish, and Appearance

7.1 The sheet, including factory seams if present, shall be watertight and be visually free of pinholes, particles of foreign matter, undispersed raw materials, protruding reinforcement, and other manufacturing defects that might affect serviceability.

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

7.3 Edges of the sheet shall be straight and flat so that they may be seamed to one another.

8. Test Methods

8.1 *Thickness, Overall*—Test Method D 751.

8.2 *Thickness, Coating Over Reinforcement Optical Method*—see Annex A1, Optical Method for Measurement of Thickness of Coating.

8.3 *Breaking Strength*—Test Method D 751, Procedure B Strip Method.

8.4 *Elongation at Break*—Test Method D 751.

TABLE 1 Physical Requirements of the KEE-Reinforced Membrane

Property	
Thickness, min., mm (in.)	0.79 (0.031)
Thickness over fiber, min., mm (in.)	0.15 (0.006)
Breaking strength, strip , N (lbf)	1175 (265)
Elongation at break, strip, min., %	15
Tearing strength, min., N (lbf)	335 (75)
Lineal dimension change, max., %	1.3
Fabric adhesion, min., N/m (lbf/in.)	225 (13)
Retention of properties after heat aging:	
Breaking strength, strip, min., % of original	90
Elongation at break, strip, min., % of original	90
Low-temperature bend after heat aging	pass
Low-temperature bend	pass
Change in weight after exposure in water, max, %	0.0, +6.0
Factory seam strength, min., N (lbf)	1780 (400)
Hydrostatic resistance, min., MPa (psi)	3.5 (500)
Static puncture resistance	pass
Dynamic puncture resistance	pass
Accelerated weathering test after 5000-h xenon arc light exposure	
Cracking (7× magnification)	none
Crazing (7× magnification)	none
Accelerated weathering test after 5000-h fluorescent light exposure	
Cracking (7× magnification)	none
Crazing (7× magnification)	none
Fungi resistance	
Sustained growth	no growth
Discoloration	none
Abrasion test, min., cycles	1500

8.5 *Tearing Strength*—Test Method D 751, Procedure B Tongue Tear Method, 200-mm (8-in.) by 250-mm (10-in.) specimen size. Test at 5.0 mm/s (12 in./min).

8.6 *Linear Dimensional Change*—Test Method D 1204, 1 h at 100 ± 2°C (212 ± 5°F).

8.7 *Fabric Adhesion*—Test Method D 751, 5.0-mm/s (12-in./min) jaw speed.

8.8 *Heat Aging*—Practice D 3045, at 80 ± 2°C (176 ± 4°F) for 56 days ± 2 h.

8.8.1 *After Heat Aging Low Temperature Bend*—Test Method D 2136, at -35 ± 1°C (-30 ± 2°F).

8.9 *Low Temperature Bend*—Test Method D 2136 at -35 ± 1°C (-30 ± 2°F).

8.10 *Water Absorption*—Test Method D 471, Procedure for exposure to one side only in water, at 70 ± 2°C (158 ± 4°F) for 166 h.

8.11 *Factory Seam Strength*—Test Method D 751, Grab Method.

8.12 *Hydrostatic Resistance*—Test Method D 751, Method A, Procedure 1.

8.13 *Static Puncture Test*—Test Method D 5602, at a load of 45 kg (99 lbf) min. at 23 ± 1°C (73 ± 2°F).

8.14 *Dynamic Puncture Test*—Test Method D 5635, at energy of 10 J min. 23 ± 1°C (73 ± 2°F).

8.15 *Accelerated Weathering Test*—Practice G 155, 5000 h xenon arc light exposure. Practice using daylight filter 0.35 W/m^2 at 340 nm; deionized water; 102-min light exposure, 18-min light and spray; black panel temperature (63 ± 2°C) relative humidity (50 ± 5 %).

8.16 *Accelerated Weathering Test*—Practice G 154, 5000 h fluorescent lamp UVA-340, cycle 8-h light at 70 ± 3°C (158 ± 5.5°F), 4-h condensation at 50 ± 3°C (122 ± 5.5°F).

8.17 *Fungi Resistance*—Practice G 21, 28 days.

8.18 *Abrasion Test*—Test Method D 3389, using the H-18 Wheel and 1000-g load. Run until fabric is visible.

8.19 *Dimensions*—Test Method D 751, after unrolling or unfolding and permitting the sheet to relax for 1 h at 23 ± l°C (73 ± 2°F).

9. Inspection and Special Testing

9.1 The manufacturer shall inspect and test the product to assure compliance of the product with this standard.

9.2 The purchaser may, in the contract, order special tests, which 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 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, and KEE. The type of identification is at the manufacturer's option. Such identification shall occur at intervals not to exceed 3 m (9 ft 10 in.) in the long direction. The identification shall be applied in such a manner as to be legible five years from installation. Identification shall not be required when so specified by the 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 container shall be marked with the name of the material, the stock and lot numbers, and the ASTM designation number, the size and quantity, the name of the manufacturer or the supplier, and the number of the contract or order.

13. Keywords

13.1 flexible sheet; KEE; reinforcing fabrics; reinforcing fibers; roofing; seams; single-ply roofing membrane

ANNEX

(Mandatory Information)

A1. OPTICAL METHOD FOR MEASUREMENT OF THICKNESS OF COATING

A1.1 Scope

A1.1.1 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, a small high-intensity lamp may also be used.

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 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). Increasing the number of divisions measured may optimize the calibration.

A1.2.3.5 Repeat the calibration three times and average the results. A calibration example is given below:

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

$$1\ (RD) - 4.5/4\ (MD) \text{ or } (RD) = 1.125(MD)$$

Since 1 micrometer division is also equal to 25.4 µm (0.001 in. or 1.0 mil), therefore:

1 (RD) = 28.6 µm (0.001 125 in. or 1.125 mils) or the calibration factor

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

A1.3.1 Multiply the number of reticle divisions representing the thickness of the coating by the calibration factor. Report the average results from three 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, no statement on bias is being made.