



Designation: **D7613 – 17** **D7613 – 17 (Reapproved 2019)**

Standard Specification for Flexible Polypropylene Reinforced (fPP-R) and Nonreinforced (fPP) Geomembranes¹

This standard is issued under the fixed designation D7613; 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 polypropylene reinforced (fPP-R) and nonreinforced (fPP) geomembranes made from flexible polypropylene as the principal polymer prepared by the polymerization of propylene with or without other alpha olefin monomers.

1.2 The tests and property limits used to characterize the sheet are values intended to ensure minimum quality. In-place system design criteria, such as field-seaming strength and material compatibility, among others, are factors that should be considered but are beyond the scope of this specification.

1.3 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.4 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*²

D573 Test Method for Rubber—Deterioration in an Air Oven

D751 Test Methods for Coated Fabrics

D883 Terminology Relating to Plastics

D1004 Test Method for Tear Resistance (Graves Tear) of Plastic Film and Sheeting

D1204 Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature

D2136 Test Method for Coated Fabrics—Low-Temperature Bend Test

D4439 Terminology for Geosynthetics

~~D4833~~D4833/D4833M Test Method for Index Puncture Resistance of Geomembranes and Related Products

D5199 Test Method for Measuring the Nominal Thickness of Geosynthetics

D5538 Practice for Thermoplastic Elastomers—Terminology and Abbreviations

D5884 Test Method for Determining Tearing Strength of Internally Reinforced Geomembranes

D6636 Test Method for Determination of Ply Adhesion Strength of Reinforced Geomembranes

D6693 Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes

~~D7004~~D7004/D7004M Test Method for Grab Tensile Properties of Reinforced Geomembranes

G151 Practice for Exposing Nonmetallic Materials in Accelerated Test Devices that Use Laboratory Light Sources

G154 Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials

G155 Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials

¹ This specification is under the jurisdiction of ASTM Committee D35 on Geosynthetics and is the direct responsibility of Subcommittee D35.06 on Geosynthetic Specifications.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the specification's Document Summary page on the ASTM website.

3. Terminology

3.1 *Definitions*—For definitions of terms used in this specification, refer to Terminologies **D883** and **D4439** and Practice **D5538**.

4. Materials and Manufacture

4.1 The sheet shall be capable of being heat welded, fused, or adhesively bonded to itself for making watertight field splices and repairs.

4.2 Geomembrane can be nonreinforced or reinforced with fabric or scrim.

5. Chemical Composition

5.1 The geomembrane shall be formulated from virgin flexible polypropylene, in amounts greater than 85 %, by weight of the total polymer content. The remaining 15 % shall be comprised of compatible polymers or pigments (or both), stabilizers, and colorants that are suitably compounded to satisfy the physical requirements in the specification (see Practice **D5538** for definitions).

NOTE 1—The compound shall not contain postconsumer (PCR) components containing bitumen or any other ingredients that could interfere with the long-term stability of the geomembrane. No more than 10 % rework resin is allowed for the production of the membrane and shall be fully compatible with the parent material.

6. Properties

6.1 Each sheet specimen shall meet or exceed the property requirements prescribed in **Table 1** (fPP-R) or **Table 2** (fPP).

6.2 The tolerance for time conditions (aging, weathering, and so forth) is ± 15 min or ± 1 % of the period, whichever is greater, unless otherwise specified.

6.3 The tolerance for temperature conditions (aging and so forth) is ± 2 °C of the specified temperature, unless otherwise specified.

7. Dimensions, Mass, and Permissible Variations

7.1 The width and length of the sheet shall be agreed upon between the purchaser and the supplier.

7.2 The tolerance for both width and length shall be +3 %, –1 %.

7.3 The thickness tolerance shall be +15 %, –10 % of thickness agreed upon by the purchaser and supplier, but in no case shall the thickness be less than the minimum in **Table 1** or **Table 2**.

8. Workmanship, Finish, and Appearance

8.1 The sheet, including factory seams, if present, shall be watertight and free of pinholes, particles of foreign matter, protruding fibers or reinforcement, undispersed raw material, nicks and cuts, voids, thin areas, delaminations, or other manufacturing defects that might adversely affect serviceability.

9. Test Methods

9.1 *Dimensions*—Test Methods **D751** for reinforced and nonreinforced, after permitting the sheet to relax at 23 °C for 1 h.

9.2 *Thickness*—Test Method **D5199** for reinforced and nonreinforced.

TABLE 1 Property Requirements for Flexible Polypropylene Reinforced (fPP-R)

Property Requirements	Method	Nominal Thickness, mm [in.]			
		0.76 [0.030]	0.91 [0.036]	1.14 [0.045]	1.52 [0.060]
Thickness, minimum average, mm [in.]	D5199	0.68 [0.027]	0.82 [0.032]	1.03 [0.040]	1.35 [0.054]
Thickness over scrim, minimum, mm [in.]	Annex A1	0.20 [0.008]	0.25 [0.010]	0.33 [0.013]	0.46 [0.018]
Breaking strength, minimum, N [lbf]	D7004	750 [170]	890 [200]	1100 [250]	1400 [250]
Breaking strength, minimum, N [lbf]	D7004/D7004M	750 [170]	890 [200]	1100 [250]	1100 [250]
Elongation at break, minimum, %	D7004	15	15	15	15
Elongation at break, minimum, %	D7004/D7004M	15	15	15	15
Tearing strength, minimum N [lbf]	D5884	220 [50]	244 [55]	310 [70]	310 [70]
Low-temperature bend, °C [°F]	D2136	–40 [–40]	–40 [–40]	–40 [–40]	–40 [–40]
Properties after heat aging & weathering	D573, G151, G154, G155				
Retention of breaking strength, minimum, %		85	85	85	85
Retention of elongation at break, minimum, %		85	85	85	85
Retention of tearing strength, minimum, %		60	60	60	60
Visual inspection, no cracks or crazing (10×)		Pass	Pass	Pass	Pass
Linear dimensional change, maximum change, %	D1204	1.0	1.0	1.0	1.0
Puncture resistance, minimum, N [lbf]	D4833	220 [50]	330 [75]	378 [85]	400 [90]
Puncture resistance, minimum, N [lbf]	D4833/D4833M	220 [50]	330 [75]	378 [85]	400 [90]
Factory prepared, ply adhesion strength, minimum, N/m [lbf/in.]	D6636	2630 [15]	2630 [15]	2630 [15]	2630 [15]

TABLE 2 Property Requirements for Flexible Polypropylene Nonreinforced (fPP)

Property Requirements	Method	Nominal Thickness, mm [in.]		
		0.76 [0.030]	1.02 [0.040]	1.52 [0.060]
Thickness, minimum average, mm [in.]	D5199	0.68 [0.027]	0.90 [0.035]	1.35 [0.054]
Tensile strength, minimum, kN/m [lbf/in.]	D6693	10.5 [60]	10.5 [60]	17 [96]
Ultimate elongation, minimum, %	D6693	700	600	600
Tear resistance, minimum, N [lbf]	D1004	44 [10]	44 [10]	80 [18]
Low-temperature bend, °C [°F]	D2136	-40 [-40]	-40 [-40]	-40 [-40]
Properties after heat aging & weathering	D573, G151, G154, G155			
Retention of tensile strength, minimum, %		85	85	85
Retention of ultimate elongation, minimum, %		85	85	85
Retention of tear resistance, minimum, %		60	60	60
Visual inspection, no cracks or crazing (10×)		Pass	Pass	Pass
Linear dimensional change, maximum change, %	D1204	3	3	3
Puncture resistance, minimum, N [lbf]	D4833	110 [25]	110 [25]	180 [40]
Puncture resistance, minimum, N [lbf]	D4833/D4833M	110 [25]	110 [25]	180 [40]

9.3 *Thickness of Coating Over Scrim (Reinforcing Fabric)*—Optical method described in **Annex A1** for reinforced.

9.4 *Breaking Strength*—Test Method **D7004/D7004M** for reinforced.

9.5 *Tensile Strength*—Test Method **D6693** for nonreinforced.

9.6 *Elongation at Break*—Test Method **D7004/D7004M** for reinforced.

9.7 *Ultimate Elongation %*—Test Method **D6693** for nonreinforced.

9.8 *Tearing Strength*—Test Method **D5884** for reinforced.

9.9 *Tear Resistance*—Test Method **D1004** for nonreinforced.

9.10 *Low-Temperature Bend*—Test Method **D2136** at -40 °C for reinforced and nonreinforced.

9.11 *Heat Aging*—Test Method **D573** for reinforced and nonreinforced.

9.11.1 Age sheet specimens for 670 h at 116 °C.

9.11.2 After exposure, remove the sheet specimens from the oven.

9.11.3 Specimens are then cut from the aged sheet for testing of breaking or tensile strength, elongation at break or ultimate elongation, and tearing strength or resistance.

9.11.4 Specimens are then wrapped around a 75-mm diameter mandrel.

9.11.5 The specimens shall then be inspected for cracks or crazing at 10× magnification and be tested for breaking or tensile strength, elongation at break or ultimate elongation, and tearing strength or resistance, for reinforced or nonreinforced materials, respectively.

9.11.6 A specimen is rated “pass” if no cracks or crazing is observed using a 10× magnification and it meets the minimum property requirements prescribed in **Table 1** or **Table 2** for heat aging and weathering.

9.12 *Linear Dimensional Change*—Test Method **D1204** for reinforced and nonreinforced. Age specimen for 6 h at 70 °C or 1 h at 100 °C.

9.13 *Puncture Resistance*—Test Method **D4833/D4833M** for reinforced and nonreinforced.

9.14 *Ply Adhesion Strength*—Test Method **D6636** for reinforced.

9.15 *Weather Resistance*—Accelerated weathering tests shall be performed using exposures described in either **9.15.1** or **9.15.2**. Refer to Practices **G151**, **G154**, and **G155** for guidance regarding laboratory weathering. Choice of type of exposure shall be by mutual agreement among the interested parties. The two different types of exposure may produce different test results. Therefore, they cannot be used interchangeably without supporting data that demonstrates equivalency for the materials tested.

9.15.1 *Fluorescent UV/ Condensation Exposure*—Apparatus described in Practice **G154** shall be operated in accordance with the following conditions:

9.15.1.1 *Bulb Type*—Fluorescent UVA-340 lamp.

9.15.1.2 *Irradiance*—Apparatus with irradiance control shall be set at 0.78 W/(m²·nm) at 340 nm. The maximum allowable operational fluctuation of the irradiance setting is ±0.02 W/(m²·nm).

9.15.1.3 *Cycle*—20 h UV at an uninsulated black panel temperature set point of 70 °C alternating with 4 h condensation at an uninsulated black panel set point of 60 °C. The maximum allowable operational fluctuation of the temperature settings is ±2.5 °C.

9.15.1.4 *Specimen Repositioning*—Refer to Practice **G154**, subsection 9.5.

9.15.1.5 *Radiant Exposure*—23 400 kJ/(m²·nm) at 340 nm. (The apparatus is to be run for a total exposure of 10 000 h. This equates to 8336 h of UV at 70 °C and 1664 h of condensation at 60 °C.)

9.15.2 *Xenon-Arc Exposure*—Apparatus described in Practice **G155** shall be operated in accordance with the following conditions:

9.15.2.1 *Filter Type*—Daylight.