भारतीय मानक **IS 2508 : 2024**

Indian Standard

(*Superseding IS 10889 : 2004*)

पॉलीइथीलीन फिल्म और शीट — विशिष्टि

(चौथा पुनरीक्षण)

Polyethylene Films and Sheets — Specification

(Fourth Revision)

ICS 83.080.20

भारतीय मानक ब्यूरो
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Plastics Sectional Committee, PCD 12

FOREWORD

This Indian Standard (Fourth Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Plastics Sectional Committee had been approved by the Petroleum, Coal and Related Products Division Council.

This standard was first published in 1963 and subsequently revised in 1977, 1984 and 2016. This revision has been undertaken in view of the developments in the polyethylene resin manufacturing technologies and to align it with the latest technology and trade practices.

The major modifications in this revision are as follows:

a) Composition clause has been modified;

b) Requirement of final product density has been included;

c) Amendments have been incorporated;

d) Cross-referred standard has been updated; and

e) Editorial corrections have been made.

Polyethylene films are extremely low permeability sheets/liners/geo-membrane used as a barrier to control liquid (fluid) or gas migration. The original use of polyethylene films is for water proofing of various structures in water management, waste management, agriculture and infrastructure.

Polyethylene films are very popular since long due to their various unmatched property like flexibility, non-toxicity, wider width, high chemical resistance, impermeability, inert material, good weld ability and U.V. resistibility.

As IS 2508 and IS 10889 had similar scope, the Committee responsible for the preparation of these standards decided to merge both the standards and decided that IS 2508 shall supersede IS 10889.

The composition of the Committee responsible for the formulation of this standard is given in Annex F.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 2022 Rules for rounding off numerical values (*second revision*). The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

POLYETHYLENE FILMS AND SHEETS — SPECIFICATION

(Fourth Revision)

1 SCOPE

1.1 This standard prescribes the requirements and methods of sampling and test for natural and black colour (carbon black pigment) polyethylene (PE) films/sheets intended for canal lining, agricultural operations, post-harvest uses, cap covers, tarpaulins, vermiculture, construction/ infrastructure work, dunnage, pond lining, water reservoirs, aquaculture, road application and waste management including solid and liquid and relief shelter and disaster management.

1.2 This standard covers flexible, unsupported flat or tubular films made from polyethylene materials of thickness and width as specified in **3**.

1.3 Coloured films other than black shall be as agreed to between the supplier and the purchaser.

2 REFERENCES

The standards listed in Annex A contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subjected to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent edition of these standards.

3 TYPES

Based on the thickness, width and density, the polyethylene film/ sheet shall be of the following types:

a) *Type* I (LDPE/LLDPE) — Nominal thickness from 100 µm to 450 µm and width from 4 m to 15 m;

b) *Type* II (HDPE) — Nominal thickness from 100 µm to 450 µm and width from 4 m to 9 m;

c) *Type* III (LDPE/LLDPE) — Nominal thickness from 500 µm to 1 500 µm and width from 5 m to 9 m; and

d) *Type* IV (HDPE) — Nominal thickness from 500 µm to 1500 µm and width from 5 m to 9 m.

NOTES

1 Type II and Type IV can be called HDPE at the final product stage in view of addition of compound density.

2 Type I and III can be called as LDPE and LLDPE.

4 COMPOSITION

4.1 Natural Polyethylene Material

The raw material used for manufacturing natural film/sheet shall consist of only polyethylene resins conforming to IS 7328.

4.2 Black Polyethylene Compound

4.2.1 The black compound for polyethylene film/sheet shall consist of polyethylene resins conforming to IS 7328.

4.2.2 *Carbon Black*

The relevant specification for carbon black used in polyethylene films/sheets are IS 7497, IS 8134, IS 10357 and IS 10358.

4.2.3 *Carbon Black Masterbatch*

4.2.3.1 Carbon black masterbatch shall be manufactured from a mixture of the following:

4.2.3.1.1 Polyethylene, which may include copolymers of ethylene and higher α olefin with density 0.910 g/ml to 0.930 g/ml at 27 ºC, in which the higher olefin constituent does not exceed 10 percent (m/m).

4.2.3.1.2 The constituents used shall conform to IS 16738 and shall not cause any toxic hazard. It shall not give rise to an unpleasant taste, odour, cloudiness or discoloration of water and shall not support microbial growth.

4.2.3.1.3 Masterbatch shall be filler free. In the Masterbatch, loading of carbon black shall not exceed 50 percent (m/m) and the ash content shall be less than 2.0 percent.

4.2.3.1.4 Carbon black used in carbon black masterbatch shall comply with the following requirements:

a) Density — 1.0 g/cc to 2.0 g/cc at 27 ºC;

b) Toluene Extract, *Max* — 0.1 percent (m/m);

c) Volatile Matter, *Max* — 0.9 percent (m/m);

d) Carbon Black Particle Size — less than 0.025 µ (25 nm); and

e) Tint Strength, ≥ 105.

NOTE — A test report or confirmative certificate shall be obtained from the carbon black masterbatch manufacturer.

5 REQUIREMENTS

5.1 General

5.1.1 *Appearance*

The film/sheet shall be uniform in colour, texture and finish. The material shall be substantially free from pin-holes, dispersed raw materials, streaks and particles of foreign matter. There shall be no other visible defects, such as holes, tears or blisters. The edges shall be free from nicks and cuts visible to unaided eye.

5.1.2 *Film Form*

The film/sheet shall be furnished in the form of flat sheet/rolls/flat film folded bundles or in the form of flat tubing or in any other form as agreed to between the supplier and the purchaser.

5.1.3 *Odour*

The film/sheet shall be free from any objectionable odour.

5.1.4 *Density*

The density of the film/sheet shall be as prescribed in Sl No. (i) of Table 1, Table 2, Table 3 and Table 4.

5.1.5 *Melt Flow Index*

The polymer polyethylene film/sheet shall have a melt flow index between 0.10 g/10 min to 2.0 g/ 10 min when determined in accordance with IS 13360 (Part 4/Sec 1/Subsec 1) or IS 13360 (Part 4/Sec 1/Subsec 2) under test conditions (190 °C, 2.16 kg).

5.1.6 *Black Film*

When tested in accordance with:

a) Annex B, the percentage of carbon black in material shall be 2 percent to 3 percent by mass;

b) Annex B, ash content shall be less than 0.2 percent; and

c) Clause **16** of IS 2530, the dispersion of the carbon black shall be satisfactory.

5.2 Dimensional Requirements

5.2.1 *Nominal Thickness and Nominal Width*

5.2.1.1 Nominal thickness is the theoretically desired thickness of a film/sheet for a particular application.

5.2.1.2 Nominal width is the theoretically desired width of a film/sheet for a particular application.

5.2.2 *Tolerance on Thickness*

When tested in accordance with Annex C, tolerance on nominal thickness at any given point and the average thickness of polyethylene film/sheet for various thicknesses shall be as follows:

Nominal Thickness	*Tolerance, Percent*
100 µ to 1 500 µ	– 10 + 20

5.2.3 *Tolerance on Width* — It shall be as given below:

Sl No.	*Nominal Width,* mm	*Tolerance,* mm
(1)	(2)	(3)
i)	4 000 and up to 9 000	+ 100, – 50
ii)	Above 9 000 and up to 12 000	+ 150, – 75
iii)	Above 12 000 and up to 15 000	+ 200, – 100

6 TYPE I (LDPE/LLDPE) POLYETHYLENE FILM/SHEET

Type I (LDPE/LLDPE) polyethylene (PE) film/ sheet shall comply with the requirements given in Table 1 when tested as prescribed in co1 (15) of Table 1.

7 TYPE II (HDPE) POLYETHYLENE (PE) FILM/SHEET

Type II (HDPE) polyethylene (PE) film/sheet shall comply with the requirements given in Table 2 when tested as prescribed in co1 (15) of Table 2.

8 TYPE III (LDPE/LLDPE) POLYETHYLENE (PE) FILM/SHEET

Type III (LDPE/LLDPE) polyethylene (PE) film/sheet shall comply with the requirements given in Table 3 when tested as prescribed in co1 (7) and col (8) of Table 3.

9 TYPE IV (HDPE) POLYETHYLENE (PE) FILM/SHEET

Type IV (HDPE) polyethylene (PE) film/sheet shall comply with the requirements given in Table 4 when tested as prescribed in co1 (7) and col (8) of Table 4.

Table 1 Requirements for Type I (LDPE/LLDPE) Polyethylene (PE) Film/Sheet

(*Clause* 6)

Sl No.	Characteristic	Thickness of Film/Sheet, µm												Method of Test, Ref to IS No./Annex
		100	125	150	175	200	225	250	275	300	350	400	450	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
i)	Final product density, kg/m^3	910 to 940 @ 23 °C or 908 to 938 @ 27 °C												IS 13360 (Part 3/ Sec 10), IS 13360 (Part 3/Sec 11) and IS 13360 (Part 3/Sec 12)
ii)	Tensile strength at break, *Min*, kg/cm^2:													IS 13360 (Part 5/Sec 1) and IS 13360 (Part 5/ Sec 3) **Test Conditions for 100 µm to 225 µm** – Specimen Type 2, test speed 500 mm/min **Test Conditions for 250 µm to 450 µm** – Specimen Type 5, test speed 100 mm/min
	a) Machine direction	200	200	200	200	200	200	200	200	200	200	200	200	
	b) Transverse direction	190	190	190	190	190	190	190	190	190	190	190	190	
iii)	Elongation at break, *Min*, percent:													-do-
	a) Machine direction	460	460	460	460	460	460	600	600	600	600	600	600	
	b) Transverse direction	615	615	615	615	615	615	700	700	700	700	700	700	
iv)	Ageing test at (70 ± 1) ºC for 7 days	Tensile strength retention shall be more than 70 percent of the original value.												Clause **5** of IS 7016 (Part 8) followed by IS 13360 (Part 5/ Sec 1) and IS 13360 (Part 5/ Sec 3) [**Test Conditions for 100 µm to 225 µm** – Specimen Type 2, test speed 500 mm/min and **Test Conditions for 250 µm to 450 µm** – Specimen Type 5, test speed 100 mm/min)
v)	Dart impact strength, *Min*, gmf	230	288	345	403	460	518	575	633	690	805	920	1 035	Method B of IS 13360 (Part 5/ Sec 6), Height 1.50 m, Dart Diametre 50 mm

Table 1 (*Concluded*)

Sl No.	Characteristic	Thickness of Film/Sheet, µm												Method of Test, Ref to IS No./Annex
		100	125	150	175	200	225	250	275	300	350	400	450	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
vi)	Tear resistance, *Min*, gmf:													IS 13360 (Part 5/Sec 23)
	a) Machine direction	700	875	1 050	1 225	1 400	1 575	1 750	1 925	2 100	2 450	2 800	3 150	
	b) Transverse direction	1 000	1 250	1 500	1 750	2 000	2 250	2 500	2 750	3 000	3 500	4 000	4 500	

NOTE — Machine direction (MD) and transverse direction (TD) average values should be on the basis of five test specimens in each direction.

Table 2 Requirements for Type II (HDPE) Polyethylene (PE) Film/Sheet

(*Clause* 7)

Sl No.	Characteristic	Thickness of Film/Sheet, µm												Method of Test, Ref to IS No./Annex
		100	125	150	175	200	225	250	275	300	350	400	450	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
i)	Final product density, kg/m^3	> 940 @ 23 °C or > 938 @ 27 °C												IS 13360 (Part 3/Sec 10), IS 13360 (Part 3/Sec 11) and IS 13360 (Part 3/Sec 12)
ii)	Tensile strength at break, *Min*, kg/cm^2 :													IS 13360 (Part 5/Sec 1) and IS 13360 (Part 5/ Sec 3)
	a) Machine direction	230	230	230	230	230	230	230	230	230	230	230	230	
	b) Transverse direction	220	220	220	220	220	220	220	220	220	220	220	220	**Test Conditions for 100 µm to 225 µm** – Specimen Type 2, test speed 500 mm/min **Test Conditions for 250 µm to 450 µm** – Specimen Type 5, test speed 100 mm/min
iii)	Elongation at break, *Min*, percent:													-do-
	a) Machine direction	450	450	450	450	450	450	615	615	615	615	615	615	
	b) Transverse direction	600	600	600	600	600	600	700	700	700	700	700	700	

Table 2 (*Concluded*)

Sl No.	Characteristic	Thickness of Film/Sheet, µm												Method of Test, Ref to IS No./Annex
		100	125	150	175	200	225	250	275	300	350	400	450	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
iv)	Ageing test at (70 ± 1) ºC for 7 days	Tensile strength retention shall be more than 70 percent of the original value.												Clause 5 of IS 7016 (Part 8) followed by IS 13360 (Part 5/Sec 1) and IS 13360 (Part 5/ Sec 3) [**Test Conditions for 100 µm to 225 µm** – Specimen Type 2, test speed 500 mm/min and **Test Conditions for 250 µm to 450 µm** – Specimen Type 5, test speed 100 mm/min)
v)	Dart impact strength, *Min*, gmf	250	313	375	438	500	563	625	688	750	875	1 000	1 125	Method A of IS 13360 (Part 5/Sec 6), Height 0.66 m, Dart Diametre 38 mm

NOTE — Machine direction (MD) and transverse direction (TD) average values should be on the basis of five test specimens in each direction.

Table 3 Requirements for Type III (LDPE/LLDPE) Polyethylene (PE) Film/Sheet

(*Clause* 8)

Sl No.	Characteristic	Thickness of Film/Sheet, µm				Method of Test, Ref to	
		500	750	1 000	1 500	IS No.	Annex
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
i)	Final product density, kg/m^3	910 to 940 @ 23 °C or 908 to 938 @ 27 °C				IS 13360 (Part 3/Sec 10), IS 13360 (Part 3/Sec 11) and IS 13360 (Part 3/Sec 12)	
ii)	Tensile properties[1)], *Min* Average:					IS 13360 (Part 5/Sec 1) and IS 13360 (Part 5/Sec 3) Test conditions – Specimen type 5 and test speed 51 mm/min	–
	a) Break strength, N/mm	13	20	27	40	-do-	
	b) Break elongation, percent	800	800	800	800	-do-	
iii)	Tear resistance, *Min Average*, N	50	70	100	150	–	D
iv)	Puncture resistance, *Min Average*, N	120	190	250	370	–	E

NOTES

1 Machine direction (MD) and cross-machine direction (TD) average values should be on the basis of 5 test specimens each direction. Break elongation is calculated using a gauge length of 50 mm.

2 The break strength is calculated by dividing the load N by the original minimum width of the specimen in mm that is 6mm. The result comes in Unit N/mm.

Table 4 Requirements for Type IV (HDPE) Polyethylene (PE) Film/Sheet

(*Clause* 9)

Sl No.	Characteristic	Thickness of Film/ Sheet, µm				Method of Test, Ref to	
		500	750	1 000	1 500	IS No.	Annex
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
i)	Final product density, kg/m^3	> 940 @ 23 °C or > 938 @ 27 °C				IS 13360 (Part 3/Sec 10), IS 13360 (Part 3/Sec 11) and IS 13360 (Part 3/Sec 12)	
ii)	Tensile properties[1)], *Min* Average					IS 13360 (Part 5/Sec 1) and IS 13360 (Part 5/Sec 3) Test conditions - Specimen type 5 and test speed 51 mm/min	–
	a) Yield strength, N/ mm	7	11	15	22	-do-	
	b) Break strength, N/ mm	13	20	27	40	-do-	–

	c) Yield elongation, percent	12	12	12	12	-do-	
	d) Break elongation, percent	700	700	700	700	-do-	
iii)	Tear resistance, *Min* Average, N	62	93	125	187	–	D
iv)	Puncture resistance, *Min* Average, N	160	240	320	480	–	E

NOTES

1 Machine direction (MD) and cross-machine direction (TD) average values should be on the basis of 5 test specimens each direction. Yield elongation is calculated using a gauge length of 33 mm. Break elongation is calculated using a gauge length of 50 mm.'

2 The yield strength and Break strength is calculated by dividing the load N by the original minimum width of the specimen in mm that is, 6 mm, the result comes in Unit N/mm.

10 PACKING AND MARKING

10.1 Packing

The roll/folded polyethylene film/sheet shall be packed as agreed to between the purchaser and the supplier.

10.2 Marking

10.2.1 Each roll/folded film/sheet shall be marked legibly with the following information:

a) Manufacturer's name and recognized trade-mark, if any;

b) Width of the roll/folded film/sheet;

c) Mass/Area of the roll/folded film/sheet;

d) Thickness of the film/sheet;

e) Batch number and date of manufacture; and

f) Any other statutory requirements.

10.2.2 *BIS Certification Marking*

The product may also be marked with Standard Mark.

10.2.2.1 The product(s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the *Bureau of Indian Standards Act*, 2016 and the rules and regulations framed thereunder, and the products may be marked with the Standard Mark.

11 SAMPLING

11.1 Lot

In any consignment, all rolls/flat film folded bundles/films/sheets of the same material shall be grouped together to constitute a lot.

11.1.1 Tests for determining the conformity of the lot to the requirements of the specification shall be done on each lot separately. The number of rolls/flat film folded bundles to be selected for this purpose shall be in accordance with col (1) and col (2) of Table 5.

11.1.2 The rolls/flat film folded bundles/sheets shall be selected at random from the lot. In order to ensure randomness of selection, procedures given in IS 4905, may be followed. In case this standard is not readily available, the following procedure may be adopted.

Starting from any roll/than film/sheet in the lot, count them in one order as 1,2,...., etc, up to r and so on, where *Y* is the integral part of *N/n*. Every r^{th} roll/than folded film/sheet thus counted shall be withdrawn till the required number of rolls/folded films/sheets are taken from the lot.

11.2 Number of Tests and Criteria for Conformity

11.2.1 From each of the rolls/flat film folded bundles/sheets should be selected according to **11.1.2**. The Sample size shall be agreed to between the buyer and the seller.

11.2.2 For BIS laboratory testing purpose, the size of sample drawn shall be of full width of the roll/than folded film/sheet and with a length of 1.5 times of width.

For example:

a) 6.0 m Width × 1.5 times of length = 6 m × 9 m; and

b) 15.0 m Width × 1.5 times of length = 15 m × 22.5 m.

The test specimens for the various tests shall be cut from different parts of the sample provided as above.

11.2.3 Each of the pieces as obtained in **11.2.1** from a lot shall be examined for appearance (*see* **5.1.1**), film form (*see* **5.1.2**), odour (*see* **5.1.3**) and dimensional requirements (*see* **5.2**). Any piece which does not meet the requirement of any of the above characteristics shall be considered as defective.

11.2.4 If the number of defectives found (*see* **11.2.3**) is less than or equal to the corresponding permissible number of defectives given in col (4) of Table 5, the lot shall be tested for the remaining requirements of the specification.

11.2.5 The lot having been found satisfactory according to **11.2.4** shall be tested for Tensile strength and elongation, impact resistance, tear resistance, puncture resistance, melt flow index, density, ash content, carbon black content and carbon black dispersion and ageing test.

For this purpose, the rolls/folded film/sheet already tested according to **11.2.1** and found satisfactory shall be used for testing of above characteristics and sample size shall be in accordance with col (3) of Table 5.

11.2.5.1 The lot shall be deemed to have satisfied these requirements if all the test results for different characteristics given in **11.2.5** are found meeting the relevant requirements of the specification.

11.2.6 The lot shall be declared as conforming to the requirements of the specification, if the requirements for various characteristics as given in **11.2.4** and **11.2.5** are satisfied.

12 QUALITY OF REAGENTS

Unless specified otherwise, pure chemicals and distilled water (*see* IS 1070) shall be employed in tests.

NOTE — 'Pure chemicals' shall mean chemicals that do not contain impurities which affect the results of analysis.

Table 5 Scale of Sampling and Permissible Number of Defectives for Polyethylene Film/Sheet (Type I to IV)

(*Clauses* 11.1.1, 11.2.4 *and* 11.2.5)

Sl No.	Lot Size *N*	Number of Rolls/Folded Films/Sheets to be Selected *n*	Sub-Sample Size	Permissible Number of Defectives
(1)	(2)	(3)	(4)	(5)
i)	Up to 50	3	2	0
ii)	51 to 150	5	2	0
iii)	151 to 300	8	3	1
iv)	301 to 500	13	3	2
v)	501 and above	20	5	3

ANNEX A

(*Clause* 2)

LIST OF REFERRED STANDARDS

IS No.	*Title*
IS 245 : 2020	Specification for trichloroethylene, technical (*fourth revision*)
IS 1747 : 2023	Nitrogen, compressed gas and liquid — Specification (*second revision*)
IS 2530 : 1963	Methods of test for polyethylene moulding materials and polyethylene compounds
IS 4905 : 2015/ ISO 24153 : 2009	Random sampling and randomization procedures (*first revision*)
IS 7016 (Part 8) : 2023	Methods of test for rubber or plastics coated fabrics: Part 8 Accelerated ageing (*first revision*)
IS 7328 : 2020	Specification for polyethylene material for moulding and extrusion (*third revision*)
IS 7497 : 1985	Specification for high abrasion furnace [HAF] carbon black (*first revision*)
IS 8134 : 1996	Intermediate super abrasion furnace (ISAF) carbon black — Specification (*second revision*)
IS 10146 : 1982	Polyethylene for its safe use in contact with foodstuffs, pharmaceuticals and drinking water
IS 10357 : 1990	General purpose furnace [GPF(N660)] Carbon Black — Specification
IS 10358 : 1991	Carbon black, super abrasion furnace [SAF(N-110)] — Specification (*first revision*)
IS 13360	Plastics — Methods of testing:
(Part 3)	Physical and dimensional properties;
(Sec 10) : 2021/ ISO 1183-1 : 2019	Determination of density of non-cellular plastics — Immersion method, liquid pyknometer method and titration method (*first revision*)
(Sec 11) : 2021/ ISO 1183-2 : 2019	Determination of density of non-cellular plastics — Density gradient column method (*first revision*)
(Sec 12) : 2016/ ISO 1183-3 : 1999	Determination of density of non-cellular plastics — Gas Pyknometer Method
(Part 4)	Rheological properties:
(Sec 1)	Determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics,
(Subsec 1) : 2018/ISO 1133-1 : 2011	Standard method (*first revision*)
(Subsec 2) : 2018/ISO 1133-2 : 2011	Method for materials sensitive to time-temperature history and/or moisture (*first revision*)
(Part 5)	Mechanical properties,
(Sec 1) : 2021/ ISO 527-1 : 2019	Section 1 Determination of tensile properties — General principles (*second revision*)
(Sec 3) : 2022/ ISO 527-3 : 2018	Determination of tensile properties — Test conditions for film and sheets (*second revision*)
(Sec 6) : 1999/ ISO 7765-1 : 1988	Determination of impact resistance by the free-falling dart method — Staircase methods
(Sec 23) : 1996/ ISO 6383-2 : 1983	Determination of tear resistance of plastics film and sheeting — Elmendorf method
IS 16738 : 2018	Positive list of constituents for polypropylene, polyethylene and their copolymers for its safe use in contact with foodstuffs and pharmaceuticals

ANNEX B

[*Clause* 5.1.6 (a), (b)]

DETERMINATION OF CARBON BLACK AND ASH CONTENT

B-1 APPARATUS

B-1.1 Combustion Boat — made of porcelain or silica, having minimum dimensions of 75 mm length, 9 mm width and 8 mm height.

B-1.2 Combustion Tube — made of hard glass, of approximately 30 mm diameter and 400 mm ± 50 mm length.

B-1.3 Gas Flow Meter — for measuring and controlling the rate of flow of nitrogen within 1.7 l/min ± 0.3 l/min.

B-1.4 Thermometer — in the range 250 °C to 550 °C.

B-1.5 Furnace — to accommodate the combustion tube and to give temperatures up to at least 500 °C.

B-2 REAGENTS

B-2.1 Nitrogen — gas (*see* IS 1747)

B-2.2 Trichloroethylene (*see* IS 245)

B-3 PROCEDURE

B-3.1 Heat the combustion boat to red heat, allow it to cool in a desiccator for at least 30 min and weigh to the nearest 0.000 1 g. Place about 1 g of the sample of the polyethylene compound, accurately weighed, in the boat. Place the boat with the sample in the middle of the combustion tube. Insert a stopper carrying a thermometer and a tube for the admission of nitrogen into one end of the combustion tube. The thermometer shall be so adjusted that its bulb is in contact with the boat. Pass nitrogen through the combustion tube at a rate of 1.7 litre/min ± 0.3 litre/min and maintain the same rate of flow during the subsequent heating. Place the combustion tube in the furnace and connect its outlet to two cold traps in series, both containing trichloroethylene and the first being cooled with solid carbon dioxide. Put the outlet tube from the second trap to a fume hood or to the outside atmosphere.

B-3.2 Heat the furnace to 500 °C ± 5 °C and maintain this temperature for 10 min. Disconnect the outlet tube from the cold traps. Withdraw the combustion tube containing the boat from the furnace and allow to cool for 5 min, maintaining the flow of nitrogen at the same rate as before. Remove the boat from the nitrogen inlet side of the combustion tube, allow it to cool in the desiccator for 20 min to 30 min and weigh to the nearest 0.000 1 g (W_1). Heat the boat strongly in air to constant weight (W_2).

B-4 CALCULATION

B-4.1 Carbon black content, percent by weight

$$= \frac{(W_1 - W_2)}{W_3} \times 100$$

B-4.2 Ash content, percent by weight

$$= \frac{(W_2 - W_4)}{W3} \times 100$$

where

W_1 = mass, in g, of the boat before heating in air,

W_2 = mass, in g, of the boat after heating in air,

W_3 = mass, in g, of the material taken for the test, and

W_4 = mass, in g, of empty boat.

ANNEX C

(*Clause* 5.2.2)

DETERMINATION OF THICKNESS

C-1 APPARATUS

C-1.1 A dead weight dial micrometer with a flat anvil of 6 mm diameter or larger in area and 4.8 mm diameter flat surface on the head of the spindle or a spring dial micrometer (dial thickness gauge) which has been calibrated against a dead weight dial micrometer shall be used. In case of dispute, only dead weight dial micrometer shall be used and the reading shall be taken between 15 s and 2 min after the load is applied.

C-2 SPECIMENS

Test five specimens, at least 5 cm × 5 cm in area, taken uniformly across the width of the test piece.

C-3 PROCEDURE

Dry and clean the surface of the anvil and spindle head, and of the specimen. Place the specimen on the anvil and lower the spindle head on to it slowly. The total load applied by the spindle shall be 110 g. Make one measurement on each specimen approximately at the centre of the specimen. Take mean of the measurements of all the specimens of a sample to obtain the average thickness of the sample.

C-4 ACCURACY

This method is capable of producing measurements with a maximum error of ± 0.000 25 cm.

ANNEX D

[*Tables* 3 *and* 4, *Sl No.* (iii)]

TEST METHOD FOR INITIAL TEAR RESISTANCE

D-1 PRINCIPLE

This test method covers the determination of the tear resistance of film/sheet at very low rates of loading, 51 mm/min. This test method is designed to measure the force to initiate tearing. The specimen geometry of this test method produces a stress concentration in a small area of the specimen. The maximum stress, usually found near the outset of tearing, is recorded as the tear resistance in newton.

D-2 APPARATUS

D-2.1 Tensile Testing Machine — of the constant rate of extension (CRE) type.

D-2.2 Grips — A gripping system that minimizes both slip-page and uneven stress distribution on the specimen shall be used.

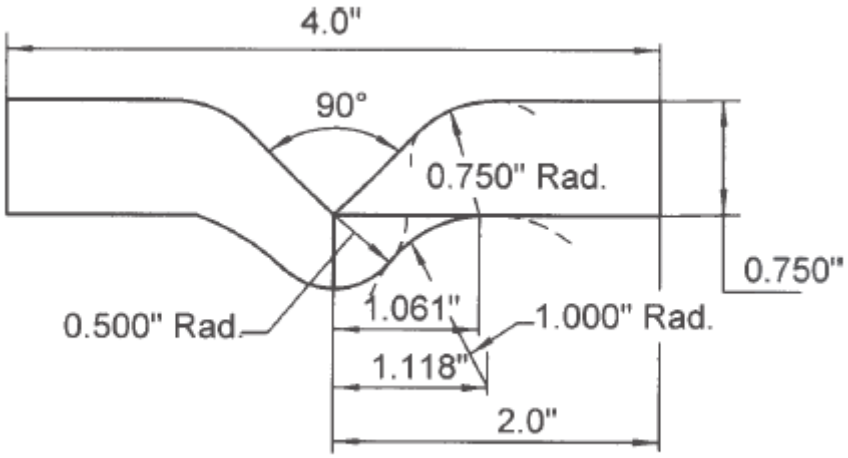
D-2.3 Die — A die having the dimensions shown in figure shall be used to cut all specimens. The 90º angle should be honed sharp with no radius or have a minimum practical radius. The cutting edge of the die shall have a 5º negative rake, and shall be kept sharp and free from nicks to avoid leaving ragged edges on the specimen. Cutting may be facilitated by wetting the surface of the sample and the cutting edges of the die with water. The sample shall rest on the smooth, slightly yielding surface that will not injure the die blade. Light-weight cardboard or a piece of leather belting is suitable. Care should be taken that the cut edges of the specimen are perpendicular to its other surfaces and that edges have a minimum of concavity.

D-3 TEST SPECIMEN

D-3.1 The test specimens shall conform to the dimensions shown in Fig. 1 and shall not vary by more than 0.5 Percent from these dimensions.

D-3.2 Ten specimens, 5 in machine/lengthwise direction and 5 in transverse/crosswise direction shall be tested for each sample.

D-3.3 Data from specimens which break at some obvious flaw or which break in or at the edges of the grips shall be discarded and retests made.



Tolerance ± 0.002°
Tolerance ± 0.5°

FIG. 1 DIE FOR TEAR TEST SPECIMEN

Sl No.	*Inch*	*mm*
(1)	(2)	(3)
i)	4.0	101.60
ii)	0.750	19.05
iii)	1.061	26.95
iv)	1.000	25.40
v)	1.118	28.40
vi)	2.0	50.80
vii)	0.002	0.051
viii)	0.500	12.70

D-4 CONDITIONING

Condition the test specimens for not less than two hours at a 65 percent ± 5 percent relative humidity and 27 ºC ± 2 ºC temperature.

D-5 PROCEDURE

D-5.1 A jaw separation of 25.4 mm shall be used. The rate of travel of the power activated grip shall be 51 mm/min ± 5 mm/min and shall be uniform at all times.

D-5.2 Measure the thickness of the specimen at several points and record the average thickness in micron or in mm.

D-5.3 Place the specimen in the grips of the testing machine so that the long axis of the enlarged ends of the specimen is in line with the points of attachment of the grips to the machine.

D-5.4 Start the machine at 51 mm/min rate of grip separation. After complete rupture of the specimen, the maximum tearing load in Newton (N) shall be noted from the dial scale or recorder and recorded. Calculate the average resistance to tearing from all specimens tested in each direction of orientation. Record data as Newton (N) of tearing resistance.

ANNEX E

[*Tables* 3 *and* 4, *Sl No.* (iv)]

TEST METHOD FOR INDEX PUNCTURE RESISTANCE

E-1 PUNCTURE RESISTANCE

The inherent resisting mechanism of the test specimen to the failure by a penetrating or puncturing object.

E-2 PRINCIPLE

A test specimen is clamped without tension between circular plates of a ring clamp attachment secured in a tensile testing machine. A force is exerted against the centre of the unsupported portion of the test specimen by a solid steel rod attached to the indicator until rupture of the specimen occurs. The maximum force recorded is the value of puncture resistance of the specimen.

E-3 APPARATUS

E-3.1 Tensile/Compression Testing Machine — of the constant-rate-of extension (CRE) type.

E-3.2 Ring Clamp Attachment — consisting of concentric plates with an open internal diameter of 45 mm ± 0.025 mm capable of clamping the test specimen without slippage. A suggested clamping arrangement is shown in Fig. 2. The external diameter is suggested to be 100 mm ± 0.025 mm. The diameter of the six holes used for securing the ring clamp assembly is suggested to be 8 mm and equally spaced at a radius of 37 mm. The surfaces of these plates can consist of grooves with a rings or coarse sandpaper bonded onto opposing surfaces.

E-3.3 Solid Steel Rod — with a diameter of 8 mm ± 0.01 mm having a flat end with a 45° × 0.8 mm chamfered edge contacting the test specimen's surface (*see* Fig. 2 and Fig. 3).

E-4 SAMPLING

E-4.1 Laboratory Sample

For the laboratory sample take a swatch extending the full width of the product, of sufficient length along the selvage from each sample roll so that the requirements of **D-3.2** can be met.

E-4.2 Test Specimens

Select from the laboratory sample, sufficient number of samples each having a minimum diameter of 100 mm to facilitate clamping. Space the specimens along a diagonal on the unit of the laboratory samples. Take no specimens nearer the edge of the sample.

E-5 CONDITIONING

Condition the test specimens for not less than two hours at a (65 percent ± 5 percent) relative humidity and 27 °C ± 2 °C temperature.

E-6 PROCEDURE

E-6.1 Select the load range of the tensile/ compression testing machine such that the rupture occurs between 10 percent and 90 percent of the full-scale load.

E-6.2 Centre and secure the specimen between the holding plates ensuring that the test specimen extends to or beyond the outer edges of the clamping plates.

E-6.3 Test at a machine speed of 30 mm/min ± 10 mm/min until the puncture rod completely ruptures the test specimen.

E-6.4 Measure the thickness of the specimen at several points and record the average thickness in micron or in mm.

E-6.5 Read the puncture resistance from the greatest force registered on the recording instrument during the test.

NOTE — The rate of testing specified is not an indication of the performance of the specimen for its end use.

E-7 CALCULATION

Calculate the average puncture resistance and standard deviation for all tests as read directly from the recording instrument.

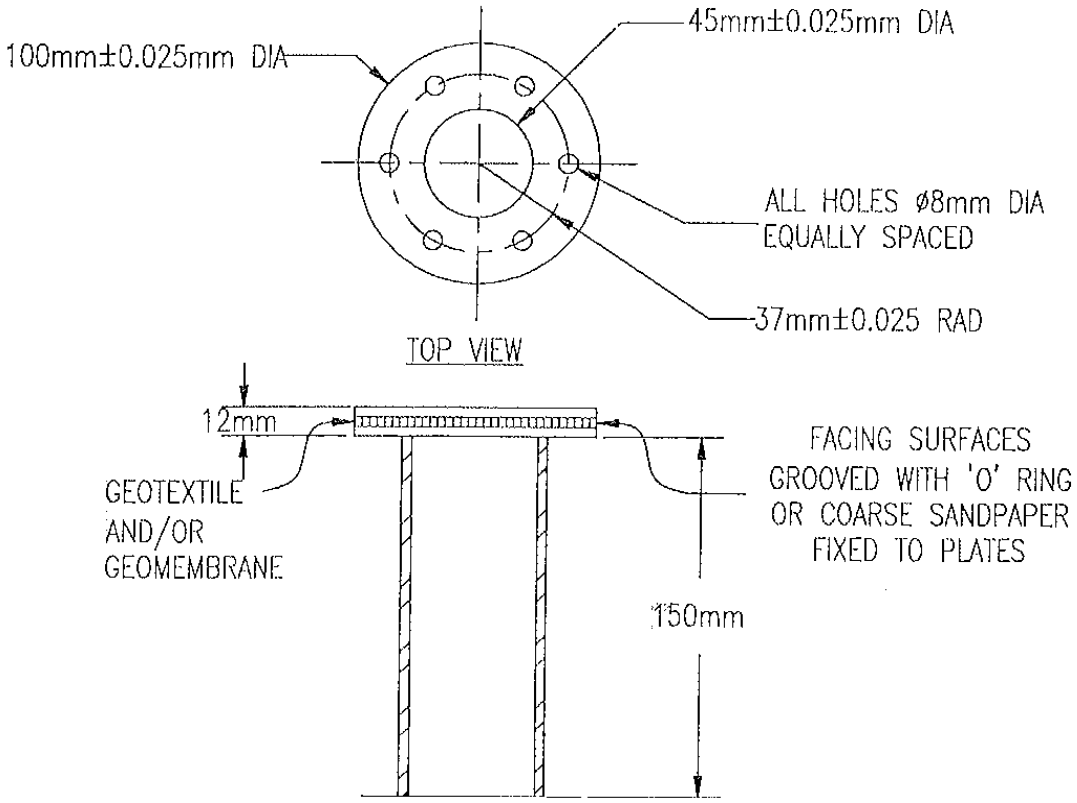


FIG. 2 TEST FIXTURE DETAIL (NOT TO SCALE)

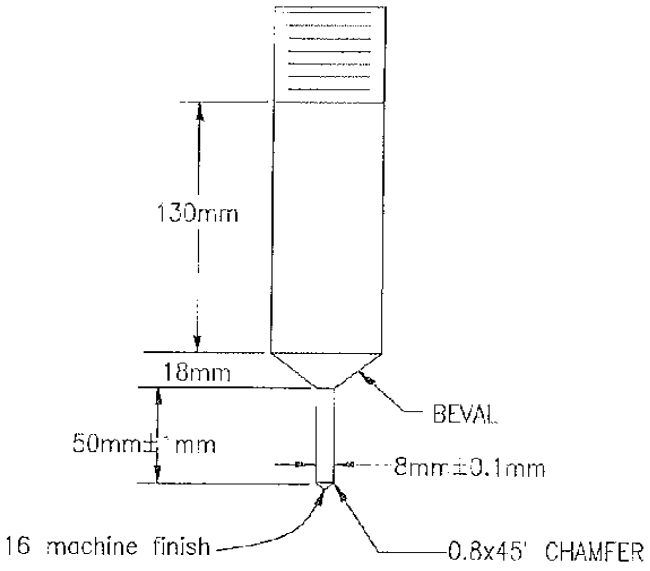


FIG. 3 TEST PROBE DETAILS (NOT TO SCALE)

ANNEX F

(*Foreword*)

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Amend No.	Date of Issue	Text Affected

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