भारतीय मानक ब्युरो

BUREAU OF INDIAN STANDARDS

DRAFT FOR COMMENTS ONLY

Doc. No: TXD 30 (25076) WC
March 2024

(Amalgamating IS 15910 : 2010, 16391 : 2015, IS 16392 : 2015, IS 16393 : 2015)

भारतीय मानक मसौदा

भुकृत्रिम – जल निकासी, अलगाव, निस्पंदन, कटाव नियंत्रण और स्थिरीकरण अनुप्रयोगों के लिए भूवस्त्रादि – विशिष्टि

(आई ऍस 16362 *का दूसरा पुनरीक्षण)*

Draft Indian Standard

GEOSYNTHETICS — GEOTEXTILES FOR DRAINAGE, SEPARATION, FILTRATION, EROSION CONTROL AND STABILIZATION APPLICATIONS — SPECIFICATION

(Second Revision of IS 16362 *)*

ICS 59.080.70

Not to be reproduced without permission of BIS or used as Standard

Last date for receipt of comment is **17 April, 2024**

Geosynthetics Sectional Committee, TXD 30

FOREWORD

(*Formal clauses shall be added later*)

This standard was first published in 2015. The first revision of the standard was undertaken in 2020 to modify the requirement of CBR puncture strength and exclude the requirement for burst strength, pullout interaction coefficient and coefficient of direct shear.

Following standards were published on geotextiles for different applications including subgrade separation, permanent erosion control, subsurface drainage and geotextiles for highways application, the committee responsible for the formulation of these standards has decided to amalgamate these standards in a single standard:

a) IS 15910 : 2010 Geosynthetics for highways — Specification
b) IS 16391 : 2015 Geosynthetics — Geotextiles used in sub-grade separation in pavement structures – Specification
c) IS 16392 : 2015 Geosynthetics — Geotextiles for permanent erosion control in hard armor systems – Specification
d) IS 16393 : 2015 Geosynthetics — Geotextiles used in subsurface drainage application — Specification

After the publication of this standard above standards stand withdrawn and relevant parts, varieties and their requirements have been covered in this standard. Additionally, two new varieties of geotextiles namely Class 1R (for its application on top of subgrade or prepared subgrade before laying blanket or anywhere within the embankment) and Class 2R (for its applications and below the ballast and above the blanket layer) have been included in this standard on the recommendation of RDSO, Lucknow to extend the applicability of standard for railway applications. In formulation of this standard, considerable assistance has been derived from 'RDSO/2018/GE: IRS-0004 - Part-I Specification of Non-woven Geotextile to be Used as Separator/Filtration in Railway Formation' published by RDSO, Lucknow.

Geotextiles are mainly made from polyester (PET) or polypropylene (PP). PP is lighter than water, strong and very durable. PET is heavier than water, has excellent strength and creep properties, and is compatible with most common soil environments. Geotextiles are mainly of two types, namely, woven and non-woven geotextiles. Knitted and stitch bonded geotextiles are occasionally used in the manufacture of specialty products. Non-woven geotextiles are highly desirable for subsurface in planer drainage, and erosion control applications as well as, for road stabilization over wet moisture sensitive soils. Out of woven geotextiles, slit film fabrics geotextiles are commonly used for sediment control, that is silt fence and road stabilization applications but are poor choices for subsurface drainage and erosion control applications. Monofilament woven geotextiles have better permeability making them suitable for certain drainage and erosion control applications. High strength multifilament woven geotextiles are primarily used in reinforcement applications. The followings are the major applications of geotextiles:

1) **Subsurface drainage:**

Effective water control is vital for structures like buildings and pavements. Traditional drainage methods using costly graded aggregates can now be replaced with geotextiles, offering a cost-

effective and efficient solution. Geotextiles are being used in lieu of select grades of sand for effective dewatering to accept seepage and act as properly graded filter to prevent piping of subgrade soil because they are less expensive, provide more consistent properties and are much easier to install. These fabrics, whether non-woven or woven polypropylene or polyester, serve as permeable separators, preventing soil erosion and allowing fluid passage. Geotextiles must possess strength and durability, and their characteristics influence filter functions. Efficient edge drain systems with geotextiles have proven to extend the service life of pavements significantly, showcasing the practical benefits of this approach. The geotextile shall also have the strength and durability to survive construction and long-term conditions for the design life of the drain. Additionally, construction methods have a critical influence on geotextile drain performance.

2) Subgrade separation and Stabilization:

Geotextiles and geogrids play a pivotal role in enhancing the performance and longevity of both paved and unpaved roads. When serving as separators, geotextiles prevent fines from migrating into the base course or aggregate from penetrating the subgrade. Their soil retaining properties align with drainage and filtration requirements, ensuring efficient water control. Geosynthetics provide valuable solutions for subgrade stabilization, functioning either as separators or for lateral restraint and aggregate confinement based on subgrade California Bearing Ratio (CBR). The separator application is limited to soils which either in initially or seasonably have a CBR > 3 but < 8. For temporary roads, non-woven geotextiles or biaxial geogrids are recommended, while permanent roads with high traffic volumes benefit from geotextiles or geogrids designed for separation or reinforcement, depending on soil conditions. Geosynthetics also find utility in interlayers for distressed road surfaces, offering moisture barrier capabilities and aiding in rehabilitation efforts.

3) **Erosion Control:**

Soil banks or slopes exposed to constant concentrated flows, currents or waves cannot support vegetation and thus need to be protected from erosion by hard armor systems. These systems include fabric formed revetments, gabions, articulating concrete blocks and riprap. In a hard armor system, water can seep in or out of the bank or slope and gradually carries soil particles with it creating voids causing loss of armor support over time called piping and thus culminates in shifting, rolling or other instability in the armor system. Traditional methods involving graded sand filters can be costly and challenging, especially on steep slopes. Geotextiles offer a cost-effective solution as filter layers in hard armor systems. Their selection, either non-woven or woven, depends on the soil gradation. The primary function of geotextile in erosion control applications is filtration. Geotextile filtration properties are a function of site hydraulic conditions and the in-situ soil gradation, density, and plasticity.

For long-term durability, geotextile survivability is crucial, addressing factors like thickness, construction equipment, backfill characteristics, polymer type, and manufacturing processes.

4) **Separation/Filtration in Railway Formation:**

Geotextiles are increasingly utilized in railway track bed construction to improve performance, extend design life, and minimize maintenance. With the rise of heavy and faster trains in response to growing transportation demands, cyclic loading can cause progressive track deterioration. This is particularly evident in ballast layers, leading to excessive deformations and costly maintenance. Geotextiles address these challenges by preventing the penetration of granular particles into soft subgrades, preserving layer thickness and enhancing track longevity. For optimal performance, geotextiles must withstand concentrated stresses (tear, puncture, burst) and feature aperture sizes compatible with retained material particles. Geotextiles also serve as effective filters in preventing the transport of fines from subgrade into overlying granular layers caused by increased stress levels during train passage and pumping. To fulfill this filtration role, geotextiles must possess sufficient permeability, retention properties, and resistance to clogging, enabling water to pass through freely while retaining solid subgrade particles.

1 SCOPE

1.1 This standard specifies general and performance requirements for geotextiles made from polyolefins, polyesters or polyamides material used in:

a) subsurface drainage, subgrade separation, subgrade stabilization, erosion control applications
b) separation/filtration application in railway formation on top of subgrade or prepared subgrade before laying blanket or anywhere within the embankment or used below the ballast and above the blanket layer

NOTES

a) This is a material purchasing specification and design review of its use for intended applications is recommended. This is not a construction or design specification. Subsurface drainage, separation, stabilization, and erosion control in hard armor systems, are site specific design issue which should be addressed by site engineer. Engineers responsible for drainage structure design or pavement and embankment design, should address the following specifics:

    1) *Subsurface drainage* — geotextile type, structure and associated details, shall be as shown on the contract drawings.
    2) *Subgrade Separation* — geotextile type, cover material thickness, pavement cross-section and associated details, shall be as shown on the contract drawings.
    3) *Subgrade Stabilization* — geotextile type, cover material thickness, pavement cross-section and associated details, shall be as shown on the contract drawings.
    4) *Erosion control* — geotextile type and thickness, slope steepness, fill thickness and associated details, shall be as shown on the contract drawings.

b) This specification is not appropriate for embankment reinforcement where stress conditions may cause global sub-grade foundation or embankment failure.
c) This standard and specification are based on the minimum requirements of the geotextile to provide drainage, filtration, tensile reinforcement, and survivability from installation stress. The physical properties listed in Table 2 and Table 3 are applicable for a minimum backfill thickness of 150 mm. However, in general, the geotextile shall be placed at the proper elevation, location and orientation as detailed on the plans and specification. Unless otherwise specified in the project specification, the contractor shall follow the construction/installation guidelines in the relevant Indian Standard.
d) Additionally, the specification includes default geotextile selection criteria related to erosion control in hard armor layer for varying severity conditions of armor layer stone weights and drop heights, with or without an aggregate bedding layer:

1) Armor layer stone weights do not exceed 100 kg, stone drop height is less than 1 m and no aggregate bedding layer is required; and
2) Armor layer stone weights exceed 100 kg, stone drop height is less than 1 m and the geotextile is protected by a 150 mm thick aggregate bedding layer designed to be compatible with the armor layer.

2 REFERENCES

The following standards 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 subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards are listed in Annex A.

3 DEFINITIONS

For the purpose of this standard, the definitions given in IS 13321 (Part 1) and following definitions shall apply:

3.1 Minimum Average Roll Value (MARV) — The average value of roll minus two times the standard deviation. Statistically, it yields a 97.7 percent degree of confidence that any sample taken during quality assurance testing shall exceed value reported.

3.2 Sub-grade Improvement — It is defined as the improvement of the bearing capacity and mitigation of deformation of the sub-grade soil by placing a geotextile immediately over a soft sub-grade soil. The goal of this application may be to reduce undercut requirements, improve construction efficiency, reduce the amount of aggregate subbase/base material required, provide a stiff working platform for pavement construction, or combination of these.

3.3 Traffic Benefit Ratio (TBR) — It is also known as Traffic Improvement Factor or TIF and is defined as the ratio of reinforced load cycles to failure (excessive rutting) to the number of cycles that cause failure of an unreinforced road section. Thus it compares the performance of a pavement cross-section with a geotextile-reinforced base course to a similar cross-section without geotextile reinforcement, based on the number of cycles to failure. The failure is defined as a selected depth of rut through repetitive loading applied by a passing wheel load of at least 2 041.2 kg (4 500 lbs) per single wheel or 4 082.4 kg (9 000 lbs) per dual wheel.

3.4 Erosion versus Sedimentation — Erosion occurs when soil particles are displaced due to the impact of raindrops, moving water or wind. Sedimentation occurs when eroded particles (sediments), carried by water or wind, are deposited in another location where they can cause problems. Clearly, sediments (suspended eroded particles) and sedimentation (redeposited soil particles) cause the problems commonly associated with erosion. Erosion control can prevent

problems from ever starting. Sediment control can only attempt to minimize the extent of these problems.

3.5 Filtration — The long-term free flow of water from the subgrade through the geotextiles into a subsurface drain system retaining the *in-situ* soil solid particles

4 MATERIALS

4.1 The geotextiles shall be inert to commonly encountered chemicals, resistant to rot and mildew, and shall have no tears or defects which adversely affect or alter its physical properties.

4.2 Polymers used in the manufacture of geotextiles, and the mechanical fasteners or threads used to join adjacent rolls, shall consist of long chain synthetic polymers, composed of at least 95 percent by weight of polyolefins (polyethylene or polypropylene), polyesters or polyamides when tested as per dissolution method in respective solvents as specified in IS 667. They shall be formed into a stable network such that the ribs, filaments or yarns retain their dimensional stability relative to each other, including selvedges. Polyolefin material shall be made resistant to ultraviolet light by adding 2-3 percent carbon black with uniform dispersion and if required a suitable UV stabilizer may be added. Recycled polyester shall not be used in the manufacture of geotextiles and only virgin polyester shall be used for manufacture of polyester containing geotextiles. The isophthalic acid content of the virgin polyester shall be nil when tested according to the method prescribed in Annex B.

5.3 Geotextiles shall be dimensionally stable and able to retain their geometry under manufacture, transport and installation. Woven slit film geotextiles (that is, geotextiles made from yarns of a flat, tape-like character) shall not be used.

6 STRENGTH AND DURABILITY REQUIREMENT FOR GEOTEXTILE USED IN SUBSURFACE DRAINAGE, SUBGRADE SEPARATION, SUBGRADE STABILIZATION, EROSION CONTROL APPLICATIONS

6.1 Geotextiles shall be of following three classes depending upon the survivability conditions:

a) *Class* 1H — For severe or harsh survivability conditions, where there is a greater potential for geo-textile damage.
b) *Class* 2H — For typical survivability conditions; this is the default classification to be used in the absence of site specific information.
c) *Class* 3H — For mild survivability conditions, where there is lower risk of geotextile damage.

6.2 The geo-textiles used for subsurface drainage, separation, stabilization and erosion control application shall meet the strength and durability requirements as given in Table 1 and specific requirements as given at **7,** based on their applications.

NOTES

1 All numeric values in Table 1, Table 2, Table 3, Table 4, Table 5 and Table 6 except Apparent Opening Size (AOS), represent MARV in the weakest principal direction. Values for AOS represent maximum average roll values.

2 The property values in Table 1, Table 2, Table 3, Table 4, Table 5 and Table 6 represent default values which provide for sufficient geotextile reinforcement and survivability under most construction conditions.

3 Average of test results from any sampled roll in a lot shall meet or exceed the minimum values specified in Table 1, Table 2, Table 3, Table 4, Table 5 and Table 6.

Table 1 Strength and Durability Requirements for Geotextile of Different Classes
(*Clauses* 6.2 *and* 9.4)

Sl No.	**Property**	**Requirement**						**Method of test, Ref to**
		Class 1H		Class 2H		Class 3H		
		Strain < 50%	Strain > 50%	Strain < 50%	Strain > 50%	Strain < 50%	Strain > 50%	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
a)	**Index properties**							
i)	Type of geotextile	Woven/non-woven						-
ii)	Roll length, m, *Min*	50 or 100 or as agreed						IS 1954
iii)	Roll width, m, *Min*	2.0 or 5.0 or as agreed						IS 1954
iv)	Grab strength, N, *Min*	1 400	900	1 100	700	800	500	IS 16342
v)	Sewn seam strength, N, *Min* (*see* Note 1)	1 200	810	990	630	720	450	IS 15060
vi)	Trapezoidal Tear strength, N, *Min*	500	350	400	250	300	180	IS 14293
vii)	CBR Puncture strength, N, *Min*	2 800	2 000	2 200	1 400	1 700	1 000	IS 13162 (Part 4)
viii	Burst strength, kPa, *Min*	3 500	3 500	2 700	1 300	2 100	950	IS 1966 (Part 2)

ix)	Abrasion strength (*see* Note 2)	550	400	350	-	-	-	IS 14714
b)	**Durability properties**							
i)	Resistance to installation damage, percent retained strength, SC/SW/GP (*see* Note 3), *Min*	95/93/90						IS 17420
ii)	Ultraviolet stability at 500 h, retained strength, percent of original strength, *Min*	70						IS 13162 (Part 2)

NOTES

1 The parameter shall be tested, when product is supplied with seam. Refer to IS 16344, IS 16345 and IS 16363 for stitch and overlap seam requirements based on the different geotextile applications.

2 Abrasion strength shall be tested for the geotextiles used in erosion control applications only. After abrading the geotextiles for 250 cycles, the grab strength shall be calculated by the method specified in IS 16342.

3 Resistance to installation damage (loss of load capacity or structural integrity) when subjected to mechanical installation stress in clayey sand (SC), well graded sand (SW) and crushed stone classified as poorly graded gravel (GP).

4 Class 2 geotextile may be specified for trench drain application based on field experience, laboratory testing and visual inspection of a geotextile sample removed from a field test section or when the subsurface drain depth is less than 2 m and drain aggregate is less than 30 mm.

5 In addition to the above default filtration property value of permittivity and AOS, site specific geotextile design may be performed if one or more of the following problematic soil environments is encountered: unstable or highly erodible soils such as non-cohesive silts, gap graded soils, alternating sand/silt laminated soils, dispersive clays and/or rock flour.

7 SPECIFIC REQUIREMENTS BASED ON APPLICATIONS

7.1 Subsurface Drainage Application

7.1.1 The function of sub-surface drainage refers to placing a geotextile against a soil to allow for long term passage of water into a subsurface drain system retaining the *in situ* soil. The primary function of the geotextile in subsurface drain system is filtration. Geotextile filtration properties are a function of the in-situ soil gradation, plasticity and hydraulic conditions.

7.1.2 The geo-textiles used for subsurface drainage applications shall meet the requirements as given in Table 1 and Table 2.

Table 2 Requirements of Geotextiles for Subsurface Drainage Application
(*Clauses* 7.1.2 *and* 9.4)

Sl No.	Property	Requirements	

					Method of test, Ref to
		Course soil	Medium soil	Fine soil	
(1)	(2)	(3)	(4)	(5)	(6)
i)	Geo-textile class	Class 2 or Class 3			*see* Table 1
ii)	Permittivity[1)], s^{-1}, *Min*	0.5	0.2	0.1	IS 14324
iii)	AOS[2,3)], mm, *Max*	0.43	0.25	0.22[3)]	IS 14294

[1)] In addition to default permittivity value, the engineer may require geo-textile permeability and/or performance testing in problematic soil environments.

[2)] Site specific geo-textile design should be performed, if unstable or highly erodable soils such as non-cohesive silts; gap-graded soils; alternating sand/silt laminated soils; dispersive clays; and/or rock flour are encountered.

[3)] For cohesive soils with a plasticity index greater than 7, minimum average roll value shall be 0.30 mm.

NOTE — The structural integrity properties of geotextile is affected by the in-situ soil gradation. Geotextile fabric selection is determined by the presence of coarse, medium, or fine soil particles at the installation site. Soil classification into these categories is based on the percentage of particles passing through a 0.075 mm (200 mesh) sieve:

a) Course soil: *In situ* soil passing <15 percent
b) Medium soil: *In situ* soil passing 15 to 50 percent
c) Fine soil: *In situ* soil passing >50 percent

7.2 Subgrade Separation Application

7.2.1 The function of separation in this application refers to using a tensile member in the form of a geotextile between the aggregate cover material and the soft sub-grade soil with the intent of either increasing the structural support capacity of that component of the pavement structure and hence its life or reduce the initial cost. The geotextile separator may provide one or more of the following functions:

a) A filter to allow water but not soil to pass through it;
b) A separator to prevent the mixing of the soft soil and the granular material; and
c) A reinforcement layer to resist the development of rutting.

7.2.2 The separation application is appropriate for pavement structures constructed over soils with California Bearing Ratio greater than or equal to three (CBR $\geq$ 3) and shear strength greater than approximately 90 kPa. It is appropriate for unsaturated sub-grade soils. The primary function of a geotextile in this application is separation.

7.2.3 The geo-textile meant for separation shall meet the requirements of Table 1 and Table 3.

Table 3 Requirements of Geotextiles for Separation Application
(*Clauses* 7.2.3 *and* 9.4)

Sl No.	Property	Requirements	Method of test, Ref to
(1)	(2)	(3)	(4)
i)	Geo-textile class	Class 2 or Class 3	*see* Table 1
ii)	Permittivity, s^{-1} , *Min*	0.02	IS 14324
iii)	AOS, mm, *Max*	0.60	IS 14294
NOTE — Permittivity of the geo-textile should be greater than that of the soil.			

7.3 Subgrade Stabilization Application

7.3.1 The function of stabilization in this application refers to using a tensile member in the form of a geotextile between the aggregate cover material and the soft subgrade soil with the intent of either increasing the structural support capacity of that component of the pavement structure and hence its life or reduce the initial cost. The geotextile may also serve to stabilize the sub-grade provided the geotextile conforms to the requirements for separation and filtration as prescribed in relevant specifications. The stabilization function of geotextile is applicable to pavement structures constructed over existing subgrade soils with a California Bearing Ratio between 1 and 3 ($1 < CBR < 3$), and shear strength between approximately 30 to 90 kPa. The stabilization application is appropriate for subgrade soils which are saturated due to a high ground water table or due to prolonged periods of wet weather.

7.3.2 The geo-textile for the purpose of subgrade stabilization shall meet the requirements as given in Table 1 and Table 4.

Table 4 Requirements of Geotextiles for Stabilization Application
(*Clauses* 7.3.2 *and* 9.4)

Sl No.	Property	Requirements	Method of test, Ref to
(1)	(2)	(3)	(4)
i)	Geo-textile class	Class 1 or Class 2 or Class 3	*see* Table 1
ii)	Permittivity, s^{-1} , *Min*	0.05	IS 14324
iii)	AOS, mm, *Max*	0.43	IS 14294
NOTE — Permittivity of the geo-textile should be greater than that of the soil.			

7.4 Erosion Control Requirements

7.4.1 The function of erosion control in this application refers to use of geotextile between energy absorbing armor systems and the *in situ* soil to prevent the soil loss resulting in excessive scour and to prevent hydraulic uplift pressures causing instability of the erosion control systems.

NOTE — This standard does not apply to other types of geosynthetic erosion control materials such as turf reinforcement mats.

7.4.2 The primary function the geotextile serves in erosion control applications is filtration. Geotextile filtration properties are a function of hydraulic conditions and *in situ* soil gradation.

7.4.3 The geo-textiles for soil erosion applications shall meet the requirements as given in Table 4. Average of test results from any sampled roll in a lot shall meet or exceed the minimum values specified in Table 1 and Table 5.

Table 5 Requirements of Geotextiles for Erosion Control Application
(*Clauses* 7.4.3 *and* 9.4)

Sl No.	**Property**	**Requirements**			**Method of test, Ref to**
		Course soil	Medium soil	Fine soil	
(1)	(2)	(3)	(4)	(5)	(6)
i)	Geo-textile class	Class 1 or Class 2			*see* Table 1
ii)	Permittivity, s^{-1} , *Min*	0.7	0.2	0.1	IS 14324
iii)	AOS, mm, *Max*	0.43	0.25	0.22[1)]	IS 14294

1) For cohesive soils with a plasticity index greater than 7, maximum average roll value for apparent opening size for geotextile material shall be 0.3 mm.

NOTE — The structural integrity properties of geotextile is affected by the in-situ soil gradation. Geotextile fabric selection is determined by the presence of coarse, medium, or fine soil particles at the installation site. Soil classification into these categories is based on the percentage of particles passing through a 0.075 mm (200 mesh) sieve:

a) Course soil: *In situ* soil passing <15 percent
b) Medium soil: *In situ* soil passing 15 to 50 percent
c) Fine soil: *In situ* soil passing >50 percent

8 REQUIREMENTS FOR GEOTEXTILE USED IN SEPARATION/FILTRATION APPLICATIONS IN RAILWAY FORMATION

8.1 The non-woven geotextiles to be used as separator/filtration layer (primary role as separator and secondary role as filtration) in railway application are either used on top of subgrade or prepared subgrade before laying blanket or anywhere within the embankment or used below the ballast and above the blanket layer. The non-woven geotextile used as separator/filtration application shall be of following two types:

a) *Class* 1R — Geotextiles which are used on top of subgrade or prepared subgrade before laying blanket or anywhere within the embankment
b) *Class* 2R — Geotextiles which are used below the ballast and above the blanket layer

8.2 The non-woven geotextile used as separator/filtration application in railway formation shall meet the requirements as given in Table 6.

Table 6 Requirements of Geotextiles for Separation/Filtration Applications
(*Clauses* 8.2 *and* 9.4)

Sl No.	**Property**	**Requirements**		**Method of test, Ref to**
		Class 1R	Class 2R	
a)	**Index Properties**			
i)	Type of geotextile	Non-woven (needle punched and mechanically or thermally bonded type or equivalent)		-
ii)	Roll length, m, *Min*	50 or 100 or as agreed		-
iii)	Roll width, m, *Min*	5.0 or as agreed		-
iv)	Elongation at break, Percentage, *Min*	50		IS 16342
v)	Grab strength, N, *Min*	700	1 750	IS 16342
vi)	Trapezoidal tear strength, N, *Min*	250	800	IS 14293
vii)	CBR puncture strength, N, *Min*	1 800	5 800	IS 16078
b)	**Hydraulic Properties**			
i)	Apparent opening size, Micron, *Max*	85		IS 14294
ii)	Water flow rate normal to the plane, ltr/m^2/sec, *Min*	20		IS 17179
c)	**Durability Properties**			
i)	Abrasion strength, percentage retained strength in breaking load, *Min*	80		IS 14714
ii)	Resistance to UV light weathering, Percentage retained strength in breaking load after 500h UV exposure, *Min*	70		IS 13162 (Part 2)

iii)	Minimum retained ultimate tensile strength (for 100 years service life), Percent	50	Annex C

9 SAMPLING AND CRITERIA FOR CONFORMITY

9.1 Lot

The quantity of the same class of geotextile manufactured from the same polymer under identical conditions and supplied to a buyer against one dispatch note shall constitute a lot.

9.2 Sampling for tests shall be done in accordance with IS 14706 from each lot. Acceptance shall be based on testing of conformance samples obtained using procedure given in IS 14706.

9.3 Testing of samples shall be performed in accordance with the methods referred to in this standard for the indicated requirement(s). The number of specimens to test shall be as specified in each test method. Product acceptance shall be determined by comparing the average test results of all the specimens within a given sample to the specified MARV.

9.4 Criteria for Conformity

The geotextile shall be tested for all the requirements as specified in Table 1 or Table 2 or Table 3 Table 4, Table 5 or Table 6 and **4.1** to **4.3** of this standard. When any individual sample fails to meet any specification requirement, that roll shall be rejected and two additional sample rolls shall be selected from the same lot. The lot shall be declared conforming to the requirements of this standard, if neither of these two additional samples fails to comply with any part of this specification, otherwise the entire quantity of rolls represented by that sample shall be rejected.

10 MARKING AND LABELLING

10.1 The geotextile material shall be marked with the following by attaching the printed labels:

a) Manufacturer’s name, initials or trade-mark;
b) Identification of the geotextile material as per manufacturer’s recommendation, for example, polyester multifilament woven geotextile for erosion control;
c) Class of geotextile material, that is Class 1H, Class 2H or Class 3H, Class 1R or Class 2R;
d) Batch number, lot number and roll number;
e) Date of manufacture of geotextile material;
f) The country of origin; and
g) Any other information/instruction prescribed by the manufacturer or by the law in force.

10.2 BIS Certification Marking

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 product(s) may be marked with the Standard Mark.

11 PACKING

The geotextile shall be packed in rolls or as per the contract or order. Each roll or package shall be protected by wrapping it in a LDPE film of minimum thickness of 40 µ to prevent it from the adverse impact of heat and moisture, oil, grease, dirt, dust and other stains during shipment and storage prior to deployment.

12 INFORMATION AND SAMPLES TO BE SUBMITTED BY THE MANUFACTURER

The manufacturer shall submit to the purchaser the following:

a) Geotextile product sample approximately one square metre or larger;
b) Geotextile product data sheet and certification from himself or by third party certification such as the use of the Standard Mark stating that the geotextile product supplied meets the requirements of this standard; and
c) Manufacturer's installation instructions and general recommendations.

13 STORAGE AND PROTECTION

13.1 During storage, elevate the geotextile rolls off the ground and adequately protect them from the following:

a) Site construction damage;
b) Excessive precipitation;
c) Extended exposure to sunlight;
d) Aggressive chemicals;
e) Flames or temperatures in excess of 71°C;
f) Excessive mud, wet concrete, epoxy, or other deleterious materials coming in contact with and affixing to the geotextile material; and
g) Any other environmental condition that may damage the physical property values of reinforcement.

13.2 Store the geotextile material at temperatures above -20°C.

13.3 Lay the rolled materials flat or vertical on ends.

13.4 Do not leave the geotextile material directly exposed to sunlight for a period longer than the period recommended by the manufacturer.

13.5 Each geotextile roll shall be wrapped with a material that will protect it from damage due to shipment, water, sunlight and contaminants.

13.6 Keep geotextile dry until installation, and do not store directly on the ground.

ANNEX A
(*Clause* 2)

LIST OF REFERRED INDIAN STANDARDS

IS No	*Title*
IS 667 : 1981	Methods for identification of textile fibres (*first revision)*
IS 1070:2023	Reagent grade water — Specification (*fourth Revision*)
IS 1954 : 1990	Determination of length and width of woven fabrics — Methods (*second revision*)
IS 13162 (Part 2) : 1991	Geotextiles — Methods of test: Part 2 Determination of resistance to the exposure of ultraviolet light and water (xenon-arc type apparatus)
IS 13162 (Part 4) : 1992	Geotextiles — Methods of test: Part 4 Determination of puncture resistance by falling cone method
IS 14293 : 1995	Geotextiles — Method of test for trapezoid tearing strength
IS 14294 : 1995	Geotextiles — Method for determination of apparent opening size by dry sieving technique
IS 14324 : 1995	Geotextiles — Methods of test for determination of water permeability permittivity
IS 14706 : 1999	Geotextiles — Sampling and preparation of test specimens
IS 14714 : 1999	Geotextiles — Determination of abrasion resistance
IS 16078 : 2013	Geosynthetics — Static puncture test (CBR test)
IS 16344 : 2015	Geosynthetics — Guidelines for installation of geotextile for permanent erosion control in hard armor systems
IS 16345 : 2020	Geosynthetics — Guidelines for installation of geotextile used in subgrade separation in pavement structures (*first revision*)
IS 16342 : 2015	Geosynthetics — Method of test for grab breaking load and elongation of geotextiles

IS 16363 : 2015	Geosynthetics — Guidelines for installation of geotextile used in subsurface drainage application
IS 1966 (Part 2): 2022/ ISO 13938-2:2019	Textiles — Bursting properties of fabrics Part 2: Pneumatic method for determination of bursting strength and bursting distension (*third revision*)
IS 13321 (Part 1) : 2022/ ISO 10318-1:2015	Geosynthetics — (Part 1) : Terms and definitions
IS 15060 : 2018 / ISO 10321 : 2008	Geosynthetics — Tensile test for joint seams by wide-width strip method (first revision)
IS 17179 : 2019 ISO 12958 : 2010	Geotextiles and geotextile-related products — Determination of water flow capacity in their plane
IS 17360 : 2020/ ISO 13438 : 2018	Geosynthetics — Screening test method for determining the resistance of geotextiles and geotextile-related products to oxidation
IS 17420 : 2020 ISO 10722 : 2019	Geosynthetics — Index test procedure for the evaluation of mechanical damage under repeated loading — Damage caused by granular materials (Laboratory test method)

ANNEX B

(*Clause* 4.2)

METHOD OF TEST FOR ISOPHTHALIC ACID CONTENT OF THE VIRGIN POLYESTER FIBRE

B-1 PRINCIPLE

This method is applicable to measure isophthalic acid content in polyethylene terephthalate sample. The polymer sample is digested in benzyl alcohol, depolymerized then esterified to dibenzyl isophthalate, dibenzyl terephthalate and glycol's. Isopropyl titanate is added as a depolymerization catalyst. The sample is analyzed by gas chromatography and the peak areas of the two esters are used to estimate the weight percentage dimethyl isophthalate using an internal standard.

B-2 POTENTIAL ENVIRONMENT ISSUE

B-2.1 In case of spillage, it can lead to pollution near the workplace area and environment hazard. After analysis sample is disposed as per laid down procedure.

B-2.2 Hydrogen, nitrogen and instrument air are used during analysis. The hydrogen gas has no adverse ecological effects are expected. Hydrogen does not contain any Class I or Class II ozone

depleting chemicals. However, hydrogen is explosive. Gaseous nitrogen is an inert non- flammable gas. High concentration in air may cause deficiency of oxygen with the risk of unconsciousness and death. Chloroform in high concentration in air can kill most animals in few minutes.

B-3 POTENTIAL SAFETY, OCCUPATIONAL HEALTH ISSUES

B-3.1 Proper PPE's like safety goggles, apron, surgical hand gloves to be used.

B-3.2 Glassware is to be handled with care.

B-3.3 Leak check to be carried out while handling of gas cylinder.

B-3.4 Glassware is to be handled with care.

B-3.5 Inhalation of chloroform causes dilation pupils with reduced reaction to light as well as reduced intraocculat pressure. Irritation of mucous membrane, conjunctiva. If contacted with skin and eyes cause irritation. Seek medical advice if inhaled.

B-3.6 Use leather hand gloves while handling hot apparatus and equipments.

B-4 APPARATUS

B-4.1 Gas Chromatograph (GC), with flame ionization detector.

B-4.2 Capillary Column, 60 m length and 0.53 mm ID MXT ® - 1

B-4.3 Dispensette or Pipette, 2 ml, 5 ml and 10 ml.

B-4.4 Volumetric Flask, 100 ml, 500 ml.

B-4.5 Beaker

B-4.6 Funnel

B-4.7 Flask, 50 ml

B-4.8 Heating Mental, to maintain temperature of 250°C

B-4.9 AR Grade Dimethyl Isopthalate (DMI)

B-4.10 AR Grade Benzyl Alcohol

B-4.11 AR Grade Chloroform

B-4.12 AR Grade Isopropyl Titnate

B-4.13 AR Grade Dimethyl Suburate

B-5 PREPARATION OF STANDARD SOLUTIONS

B-5.1 Stock Dibenzyl Suburate (Internal Standard) Solution

Take 1.0 ± 0.01 g of dimethyl suburate (DMS). Add 100 ml of benzyl alcohol and 6 to 7 drops of isopropyl titnate digest it for 2 h. Allow it to cool up to room temperature then make the volume to 500 ml by carefully rinsing the flask by isopropyl alcohol. Dimethyl suburate will get converted into dibenzyl suburate (DBS). Mark the stock solution as DBS per 2ml ≈ X·XXXX mg

B-5.2 Stock Dimethyl Isopthalate (DMI) Solution

Take 0.2 ± 0.01 g of dimethyl isopthalate (DMI). Add 40 ml of benzyl alcohol and 6 to 7 drops of isopropyl titnate digest it for 2 h. Allow it to cool up to room temperature then make the volume to 100 ml by carefully rinsing the flask by isopropyl alcohol. This will be converted to dibenzyl isopthalate (DBI). Mark the stock solution as DBI per 2 ml ≈ X·XXXX mg.

B-5.3 Standard Solution for Response Factor

Take 2 ml of solution prepared in **B-5.1** and 2 ml of solution prepared in **B-5.2**. Add 10 ml of chloroform.

B-5.4 2.0 Percent Standard IPA Stock Solution

Weigh out accurately 0.200 ± 0.005 g of pure DMI powder into round bottom flask, add 30 ml of benzyl alcohol and 3 drops of isopropyl titante, reflux the solution for 5 h reagent and dilute to 100 g by isopropyl alcohol, calculate actual DMI concentration by considering its purity and label the flask with actual weight taken. Consider this weight during calculation of IPA by GC.

B-5.5 2.0 Percent Standard IPA Solution for GC Injection

Take 2.0 ml IPA stock solution and add 2 ml internal standard (*see* **B-5.1**) and further add 10 ml of chloroform, same bottle to be labelled as 2.0 percent IPA Inject 1 µl in GC.

B-6 CALIBRATION FOR PERFORMANCE CHECK – TWICE /MONTH STANDARD CHIPS

B-7 ANALYTICAL PROCEDURE

Inject 1 µl of standard solution for response factor (*see* **B-5.3**) and calculate response factor. Inject 1 µl of 2 percent standard IPA solution. If value of 2.0 percent standard IPA solution is varying in the range of 0.01 percent, then there is no need for change in response factor. If there is deviation in value then rerun standard solution for response factor (*see* **B-5.3**). Weight 0.2 ± 0.02 g of chips into the round bottom flask. Add 2 ml of benzyl alcohol. Add 3 drops of isopropyl titanate. Digest the solution for 1 h. Allow it to cool up to room temperature. Add 10 ml of chloroform. Add 2 ml of internal standard solution that is solution prepared. in **B-5.1** and shake vigorously. Inject 1 µl of sample solution into gas chromatograph.

B-8 CHROMATOGRAPH SETTINGS

Injector temperature	: 300°C
Detector temperature	: 320°C
Oven temperature	: 270°C

Gas flow rates

Nitrogen	: 20 psig
Hydrogen	: 30 ± 10 ml/min
Air	: 300 ± 20 ml/min
Attenuation	: – 4
Range	: 1

B-9 CALCULATION

$$\text{Response factor (RF)} = \frac{A_1 \times W_2}{A_2 \times W_1}$$

where

A_1 = area of dibenzyl suburate (DBS) (internal standard) solution;
W_1 = weight of DBS in solution, in mg;
A_2 = area of DBI in standard solution; and
W_2 = weight of DBI in standard solution, in mg.

$$\text{Percent IPA} = \frac{\text{RF} \times \text{mg Internal Standard} \times \text{Area of IPA in sample} \times 100}{\text{Weight of sample, in mg} \times \text{Area of internal standard in sample}}$$

ANNEX C

(*Table* 6)

METHOD FOR DETRMINATION OF DURABILITY OF GEOTEXTILES

C-1 GENERAL

C-1.1 Service life

The provisions and assessment methods of this annex are based upon the intended use of geotextiles, and their foreseen service life in years. They are based upon the current state of the art, knowledge and experience. The service life refers to the period during which the geosynthetic retains the required properties of this annex, assuming it was properly installed, used and maintained. For a geosynthetic which satisfies the requirements of this annex the service life represents a minimum indication. The real service life, for normal conditions of use, may turn out to be considerably longer without major degradation affecting the essential requirements of the works. The indicated service life of the geosynthetic cannot be interpreted as a guarantee given by the manufacturer but should be regarded only as a tool for selecting a product suitable for the anticipated working life. The tests described in this annex do not allow the determination of reduction factors. The tests described in this annex are screening tests to show the ability of a product to serve for a certain time. The reference strength and retained strength of products investigated in this Annex C shall be determined in the same way in accordance with IS 16342.

C-1.2 Initial and Repeat Testing of Durability

C-1.2.1 A product shall be submitted to an initial testing of its durability in accordance with this annex. A product that is unchanged shall be tested again after 5 years. A product is considered unchanged if the raw material supply, the production technology and the process and stabilization of the product have not been subject to a significant process change. If a product has been subject to a significant process change, then it shall be tested in the same manner as a new product.

C-1.2.2 A significant process change is defined as any of the following:

a) a change in the chemical formulation (CAS No);

b) reduced active ingredient concentration levels of raw materials in the polymer recipe;

c) substitution of any polymer in the recipe, irrespective of any change in concentration.

C-1.2.3 After the durability tests specified in **C-2** the test specimens are subjected to tensile test given in IS 16342. The retained tensile strength is compared to the original tensile strength of reference specimens (result expressed in percentage retained strength).

C-1.2.4 The lightest product variant in a family shall be the variant selected for durability testing. If a manufacturer produces a lighter variant after the initial type testing, it is the responsibility of the manufacturer to decide whether the change is of sufficient magnitude to require the product to be tested as a new product. If the manufacturer decides the change is significant, he shall test the light variant as a new product. If the manufacturer decides this change is not significant, he can use his existing durability data to make a statement for the new product.

C-2 TESTS FOR SPECIFIC MATERIALS

C-2.1 Polyester (PET)

C-2.1.1 A non-reinforcing product consisting solely of PET shall be tested for resistance to internal hydrolysis following test given in **Annex D**.

C-2.1.2 The minimum retained strength shall be 50 percent.

C-2.2 Polypropylene (PP) and Polyethylene (PE)

C-2.2.1 A product consisting solely of PP or PE shall be tested for resistance to oxidation following IS 17360 (method A), with the following modifications:

a) The test specimen shall be stored in water (Grade 2 according to IS 1070) at 80 °C for 28 d before testing. The medium shall be changed every 7 day and moved once per day;

b) Test temperature: 100 °C;

c) Test duration: 112 d.

C-2.2.2 The minimum retained strength shall be 50 percent.

C-2.3 Polyamide (PA)

C-2.3.1 Oxidation resistance

C-2.3.1.1 A product consisting solely of PA-6 or PA-6.6 shall be tested for resistance to oxidation following IS 17360 (method B) with the following modifications:

a) The test specimen shall be stored in water (Grade 2 according to IS 1070) at 80 °C for 28 d before testing. The medium shall be changed every 7 day and moved once per day;

b) Test temperature: 100 °C;

c) Test duration: 112 d.

C-2.3.1.2 The minimum retained strength shall be 50 percent.

C-2.3.2 Hydrolysis resistance

C-2.3.2.1 A product consisting solely of PA-6 or PA-6.6 shall be tested for resistance to hydrolysis according to **Annex D**.

C-2.3.2.2 The minimum retained strength shall be 50 percent.

ANNEX D
(*Annex* C)

METHOD FOR DETERMINATION OF RESISTANCE TO HYDROLYSIS IN WATER

D-1 PRINCIPLE

The test and control specimens are immersed in hot water for specified durations and at a specified temperature. The properties of the specimens are determined after immersion. Both the machine and cross machine direction shall be tested unless otherwise agreed.

D-2 REAGENT

Water, according to IS 1070, class 3.

D-3 APPARATUS

D-3.1 Container

Container having the following properties shall be used:

a) The container shall be made of a material which is inert under the conditions of test such as stainless steel or borosilicate glass.

b) The total volume of the test specimens shall not exceed 10 percent of the free space in the container. The test specimens shall be suspended free of significant load and shall be exposed to the test medium on both sides.

c) The container shall be provided with a means of heating and controlling the temperature to (80 ± 2) °C and a separate means of recording the temperature of the solution.

NOTE — Experience has shown that some types of glass are susceptible to hydrolysis. Make sure to regularly control that no corrosion in the container is occurring.

D-3.2 Thermometer

A thermometer capable of measuring the temperature with an accuracy of ± 1 °C.

D-4 PREPARATION OF THE TEST SAMPLE

D-4.1 Size and shape

Prepare specimens to the size and shape specified in IS 16342. If the requirements of IS 16342 cannot be met due to container capacity, then the relevant components should be tested individually.

D-4.2 Number of specimens

Prepare enough specimens to provide a minimum of five test specimens and five control specimens in each test direction.

It is recommended to expose additional specimens in case an extra mechanical test is required (*see* **D-6**).

D-5 PROCEDURE

a) De-ionized water as specified in **D-2** shall always be used in the tests.

NOTE — The quality of the water used as hydrolysing agent in this test is important for the reproducibility of the test results.

b) Expose the test specimens, free of significant load, on both sides to the test medium.

c) The test temperature shall be (80 ± 2) °C and recorded at least once a day.

d) Because shrinkage may occur during the test, all specimens should be mounted in such a way that not significant pre-tension occurs during the exposure to the water.

e) The ratio between the mass of water and the mass of the test specimens shall be at least 30 : 1. Cover the specimens completely with water. Do not treat materials differing in chemical composition in the same enclosure.

f) The test duration for service life of 100 years shall be as follows:

    i) For Polyester (PET) products: 56 days
    ii) For PA-6 or PA-6.6 products: 112 days

g) The control specimens shall be exposed to the same environment for 6 hours and then removed and stored in dark at room temperature.

D-6 DETERMINATION OF CHANGES IN PROPERTIES

The test and control specimens shall be conditioned for at least 16 h at (20 ± 2) °C and (65 ± 5) percent relative humidity before evaluation of the desired properties. For type of test method refer to IS 16342.

D-7 TEST REPORT

The test report shall at least include the following information:

a) a reference to this document;
b) a description of the material;
c) the procedure and conditions used;
d) changes in maximum tensile force as defined in IS 16342;
e) date of test; and
f) any deviation from this document or other factors that may influence the result of this test.