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BUREAU OF INDIAN STANDARDS
(NEW DELHI)

AGENDA

GEO-SYNTHETICS SECTIONAL COMMITTEE, TXD 30 **30th Meeting**

Date/Day	Time	Venue
28 December, 2023 (Thursday)	1100 h	Through Video Conferencing

Chairman: Dr. A. N. Desai, SITRA Council, Coimbatore

Member Secretary: Shri Himanshu Shukla, Scientist-B, Textile Department

Item 0 WELCOME AND INTRODUCTORY REMARKS BY THE CHAIRMAN

Item 1 CONFIRMATION OF MINUTES OF LAST MEETINGS

1.1 The minutes of the 29th meeting of TXD 30 held on 20th July 2023 were circulated vide letter No. TXD 30/A2.29 dated 01th August 2023. No comments have been received.

1.1.1 The committee may **APPROVE** the minutes as circulated.

Item 2 SCOPE AND COMPOSITION OF TXD 30

2.1 The present scope and composition of TXD 30 is given in **Annex 1** (**Pages 5 to 8).**

2.1.1 The committee may **REVIEW**.

2.2 Co-option request has been received from Shri Shivaji Walunj, Fastrack Dealcomm Pvt Ltd, Silvassa. The CV and authorization letter as received are given at **Annex 2 (Pages 9 to 17).**

2.2.1 The committee may **NOTE** and **DECIDE**.

2.3 Resignations have been received from Shri J. T Nashikkar, In personal capacity and Shri V. K . Patil, In personal capacity and the same is given in **Annex 3 (Page 18).**

2.3.1 The committee may **NOTE** and **DECIDE**.

Item 3 ISSUES ARISING OUT OF THE PREVIOUS MEETING

3.1 A summary of actions on the various decisions taken during the 29th meeting is given in **Annex 4 (Pages 19 to 20).**

3.1.1 The committee may **NOTE and DECIDE**.

Item 4 DRAFT STANDARD FOR FINALIZATION

4.1 As decided by the committee in the last meeting, the following draft standard was issued in wide circulation for two month for eliciting technical comments from stake holders vide our letter reference no.- TXD 30/22876 dated 10-07-2023.

i) Geosynthetics — Geotextile Tubes for Coastal and Waterways Protection —Specification [Doc TXD 30 (22876)]

Comments have been received from Garware Technical Fibers Ltd, Pune and Terre Armee, New Delhi and are given in **Annex 5 (Pages 21 to 24)**. Draft standard as issued in wide circulation is given in **Annex 6(P-11).**

4.1.1 The committee may **DELIBERATE** and **DECIDE.**

Item 5 AMALGAMATION OF INDIAN STANDARDS ON GEOTEXTILES

5.1 As decided by the committee in the last meeting, a panel meeting under the convenorship of Dr. Swapan Ghosh, Department of Jute and Fibre Technology, Kolkata University, Kolkata was conducted on 12 December, 2023 to deliberate on amalgamation of IS 16391 : 2015, IS 16392 : 2015, IS 16393 : 2015, IS 16362 : 2020 and IS 15910 : 2010 into a single standard.

After deliberation, the panel decided the followings:

i) To prepare a single standard specifying the Index and Durability Properties in a single table for all classes i.e. Class 1, Class 2 and Class 3.

ii) To provide separate requirements for structural integrity (permittivity and Apparent opening size) for various applications i.e. subsurface drainage, subgrade separation, and stabilization.

iii) To also include requirement for geotextiles used separation and filtration in railway formation. Reference shall be made to RDSO/2018/GE: IRS-0004-Part-I.

The draft revision as prepared after deliberation in the meeting is given in **Annex** 7 (**Pages 44 to 63**).

5.1.1 The committee may **DELIBERATE** and **DECIDE.**

Item 6 COMMENTS ON PUBLISHED INDIAN STDNARDS

6.1 Coments has been received from Manak Manthan conducted by SUBO on the following standards:

i) IS 16391: 2015 ‘Geosynthetics — Geotextiles used in sub-grade separation in pavement structures — Specification’
ii) IS 16392 : 2015 ‘Geosynthetics — Geotextiles for permanent erosion control in hard armor systems - Specification’
iii) IS 16393 : 2015 ‘Geosynthetics — Geotextiles used in subsurface drainage application — Specification’
iv) IS 16362 : 2020 ‘Geosynthetics — Geotextiles used in subgrade stabilization in pavement structures — Specification (first revision)’

v) IS 16090 : 2013 ‘Geo-synthetics — Geo-textiles used as protection (or cushioning) materials — Specification’.

The comments as received from SUBO, BIS on aforementioned standards are given in **Annex 8 (Page 64).**

6.1.1 The committee may **DELIBERATE** and **DECIDE.**

6.2 Comment has been received from Tencate Geosynthetics, Gurgaon on the following Indian Standard:

i) IS 18309 : 2023 Geosynthetics — Prefabricated Vertical Drains for Quick Consolidation for Very Soft Plastic Soil — Specification

The comment as received from Tencate Geosynthetics, Gurgaon has been given in **Annex 9** (**Pages 65 to 67**).

6.2.1 The committee may **DELIBERATE** and **DECIDE.**

6.3 Comment has been received from Polyon Textiles Pvt. Ltd, Mumbai on ‘IS 17371: 2020 Geosynthetics — Geogrids for flexible pavements — Specification’.

The comment as received from Polyon Textiles Pvt. Ltd, Mumbai has been given in **Annex 10 (Pages 68 to 70).**

6.3.1 The committee may **DELIBERATE** and **DECIDE.**

Item 7 REVIEW OF STANDARDS

7.1 As decided by the committee in the last meeting, the following pre-2000 documents/standards were circulated to the respective members whom the standards were alloted for reviewing thoroughly by the experts of relevant field in today’s context , to suggest suitable modification/changes. Inputs have been received from BTRA, Mumbai, Landmark Material Testing and Research Laboratory Private Limited, Jaipur and Geosynthetics Testing Services Pvt Ltd, Ahemdabad on the following standards:

Sl. No.	IS Number	Title	Reviewed by/Allocated to
1	IS 13325 : 1992	Determination of tensile properties of extruded polymer geogrids using the wide strip - Test method	BTRA, Mumbai
2	IS 13326 : Part 1 : 1992	Evaluation of interface friction between geosynthetics and soil method of test: Part 1 modified direct shear technique	-do-
3	IS 14293 : 1995	Geotextiles - Method of test for trapezoid tearing strength	-do-
4	IS 14294 : 1995	Geotextiles - Method for determination of apparent opening size by dry sieving technique	Landmark Material Testing and Research Laboratory Private Limited, Jaipur
5	IS 14324 : 1995	Geotextiles – Methods of test for determination of water permeability	-do-

		– Permittivity	
6	IS 14706 : 1999	Geotextiles - Sampling and preparation of test specimens	-do-
7	IS 14714 : 1999	Geotextiles - Determination of abrasion resistance	Geosynthetics Testing Services Private Limited, Ahmedabad
8	IS 13162 : Part 2 : 1991	Geotextiles – Methods of test Part 2 Determination of resistance to exposure of ultraviolet light and water (Xenon-arc type apparatus)	-do-
9	IS 13162 : Part 4 : 1992	Geotextiles – Methods of test Part 4 Determination of puncture resistance by falling cone method	-do-

The inputs/comments as received alongwith the draft is given at **Annex 11 (Pages 71 to 135).**

7.1.1 The committee may **DELIBERATE** and **DECIDE.**

1

Item 8 NEW WORK ITEM PROPOSAL

8.1 The new proposal has been received from Terre Armee, New Delhi to formulate a new standard on the subject **'Fabric Form Concrete Mattress'.** The details of the subject as received from Terre Armee, New Delhi is given at **Annex 12 (Pages 136 to 139).**

Item 9 RESEARCH AND DEVELOPMENT ACTIVITY IN STANDARDIZATION

9.1 BIS competent authority has decided that research & development projects must be seamlessly integrated into standardization, to ensure that standards remain adaptable and relevant by incorporating in-depth field-level studies alongside traditional research methods, addressing the complexities and innovations in the field. A detailed guideline for research & development projects for formulation and review of standards is given in **Annex 13 (Pages 140 -151).** Draft term of reference for R&D project on the subject 'Revision of IS 14986' as prepared is given in **Annex 14 (Pages 152 - 156).**

9.1.1 The committee may **NOTE** and **DECIDE.**

Item 10 ANY OTHER BUSINESS

ANNEX 1
(*Item* 2.1)

COMPOSITION AND SCOPE OF GEO SYNTHETICS SECTIONAL COMMITTEE, TXD 30

SCOPE: a) To formulate Indian standards on terminology, testing, specifications and codes of practices for identification, handling, storage and installation, etc. of all geo- synthetic products including geo-textiles, geo-membranes, geo-grids, geo-foams, geo- composites, clay liners and other geo-synthetic related products.

b) To liaise with the work of ISO/TC 221 Geo-synthetics Technical Committee as a participating member.

Chairman- Dr. A N Desai, Scientific Member, SITRA Council

SL.No	*Organization*	*Representative(s)*	
1.	The South India Textile Research Association Council, Coimbatore	Dr A. N. Desai (***Chairman***)	3/3
2.	Ahmedabad Textile Industry's Research Association, Ahmedabad	Smt Deepali Plawat Shri Jigar Dave (*Alternate*)	2/3
3.	Andhra University, Visakhapatnam	Prof. K Rajagopal	0/0
4.	Best Geotechnique Pvt Ltd, Mumbai	Shri Satish Naik	2/3
5.	Central Coir Research Institute, Alappuzha	Dr. S. Radhakrishnan Smt Sumy Sebastian (*Alternate*)	3/3
6.	Central Road Research Institute, New Delhi	Dr. P. S. Prasad Dr. Pankaj Gupta (*Alternate*)	2/3
7.	Central Soil and Materials Research Station New Delhi	Dr R. Chitra Dr Manish Gupta (*Alternate*)	2/3
8.	Charankattu Coir Mfg. Co. (P) Ltd, Kerala	Shri C. R. Devraj Shri C. D. Athul Raj (*Alternate*)	3/3
9.	Department of Jute and Fibre Technology, Kolkata	Dr. Swapan Ghosh Prof (Dr) A. K. Samantha (*Alternate*)	2/3
10.	DKTE Centre of Excellence in Nonwovens, Ichalkaranji	Shri Aniket S. Bhute	1/3

11.	Ganga Flood Control Commission, Patna	Shri M. K. Srinivas Shri Amitabh Prabhakar (*Alternate*)	2/3
12.	Garware Technical Fibers Ltd, Pune	Shri Tirumal Kulkarni Shri Rajendra Ghadge (*Alternate*)	3/3
13.	Geosynthetics Testing Services Pvt Ltd, Ahmedabad	Shri Ravikant Sharma	3/3
14.	ICAR- National Institute of Natural Fibre Engineering & Technology, Kolkata	Dr. Sanjoy Debnath Dr. Kartick Samanta (*Alternate)*	3/3
15.	Indian Geotechnical Society, New Delhi	Dr. Bappaditya Manna Dr Debayan Bhattacharya(Alternate)	2/3
16.	Indian Institute of Technology, Gandhinagar	Prof. Amit Prashant	3/3
17.	Indian Institute of Technology, Delhi	Prof. A.K. Ghosh	0/3
18.	Indian Institute of Technology, Madras	Prof. Dalli Naidu Arnepalli	3/3
19.	Indian Jute Industries' Research Association, Kolkata	Dr. Mahuya Ghosh Shri Palash Paul (*Alternate*)	3/3
20.	Indian Jute Mills Association, Kolkatta	Shri S. K. Chandra Shri J. K. Behera (*Alternate*) Shri Bhudipta Saha (YP)	1/3
21.	Indian Technical Textile Association, Mumbai	Dr. Anup Rakshit Smt. Ruchita Gupta (*Alternate*)	3/3
22.	International Geosynthetics Society, India Chapter, New Delhi	Shri M. Venkataramn Dr G. P. Patel (*Alternate)*	2/3
23.	Kusumgar Corporates, Mumbai	Shri Y. K. Kusumgar Dr M. K. Talukdar (*Alternate*)	3/3
24.	Landmark Material Testing and Research Laboratory Pvt. Ltd, Jaipur	Dr. Anil Dixit Shri Harsh Kumar Chittora	2/3
25.	Macaferri Environmental Solutions Pvt Ltd, Navi Mumbai	Dr. Ratnakar Mahajan Smt Minimol Korulla	3/3
26.	Ministry of Road Transport & Highways,	Shri Sanjiv Kumar	0/3

	New Delhi		
27.	Municipal Corporation of Greater Mumbai, Thane	Dr. Vishal Ramesh Thombare Shri Mandar Bhalchandra Pingle (*Alternate)*	0/3
28.	National Highways Authority of India, Ghaziabad	Shri Rakesh Prakash Singh Shri Mudit Garg *(Alternate)*	0/3
29.	National Jute Board, Kolkatta	Shri M. Dutta	2/3
30.	Office of The Jute Commissioner, Kolkatta	Shri R. K. Roy Shri Soumyadipta Datta (*Alternate*)	1/3
31.	Office of The Textile Commissioner, Mumbai	Shri Sivakumar S Shri Sanjay Charak (*Alternate*)	0/3
32.	Premier Polyfilms Ltd, Ghaziabad	Shri Amitaabh Goenka Shri Praveen Kumar (*Alternate*)	3/3
33.	Rajadhani Institute of Engineering & Technology, Trivandrum	Dr. K. Balan	2/3
34.	RDSO, Lucknow	Shri Sanjay Kumar Awasthi Shri Santosh Kumar Ojha (*Alternate*)	2/3
35.	Reliance Industries Ltd, New Delhi	Shri V Ravikanth Shri Rajendren Subramanian	2/3
36.	Sahastra Engineers Pvt Ltd, Noida	Shri Vankata Mayur	0/3
37.	Strata Geosystems (I) Pvt Ltd, Mumbai	Shri Narendra Dalmia Shri Shahrokh Bagli (*Alternate*) Shri Suraj Vedpathak (YP)	3/3
38.	Techfab India, Mumbai	Shri Anant Kanoi Shri Saurabh Vyas (*Alternate*)	3/3
39.	The Bombay Textile Research Association, Mumbai	Dr. Sreekumar Shri G. R. Mahajan (*Alternate*)	3/3
40.	The Synthetics & Art Silk Mills Research, Association, Mumbai	Dr. Manisha Mathur Shrimati Ashwini Sudam (*Alternate*)	2/3
41.	In Personal Capacity	Dr. G V Rao	2/3
42.	In Personal Capacity	Shri V. N. Gore	2/3
43.	In Personal Capacity	Shri V. K. Patil	1/3

44.	In Personal Capacity	Shri Jayant Nashikkar	3/3
45.	In Personal Capacity	Shri P. K. Choudhury	1/3

ANNEX 2
(*Item* 2.2)

CO-OPTION REQUEST FROM SHIVAJI WALUNG, FASTRACK DEALCOMM PVT LTD, SILVASSA

Authorization letter

FASTRACK DEALCOMM PRIVATE LIMITED
Synthetic & Polymer
CIN No.: U51109DL2006PTC299417
GST No.: 24AAACF9937C1ZR
Factory Address : Survey No.: 1314-1, Village : Raipur, Taluka : Kadi, Dist. Mehsana, Pin Code : 382740 (GUJARAT). M. : 7623006908, 9904808816

Date: - 06.11.2023

To,
The Director,
BIS Ahmedabad.

Subject: - Authorisation Letter for Mr. Shivaji Walunj.

Dear Sir/Madam,
We hereby certify that, **MR. SHIVAJI WALUNJ, VICE PRESIDENT** at **FASTRACK DEALCOMM PVT. LTD.** is hereby authorized to sign relevant documents related to **BUREAU OF INDIAN STANDARDS** on behalf of our company **FASTRACK DEALCOMM PVT. LTD.**

He is also authorised to join in technical committee of BIS Standards like IS7903, IS15351, IS2508, IS17216, IS16627, IS16202 any other standard related etc. for the updates on standards, testing, developments, and systems related to BIS.

BEST REGARDS,
FOR, FASTRACK DEALCOMM PVT. LTD.

Fastrack Dealcomm Private Limited Rajpur Dist. Mehsana

MR. AMIT TANEJA.
DIRECTOR.
PLACE: AHMEDABAD.

Curriculum Vitae

Shivaji B. Walunj.

Professional Experience of 25 years in the PP/HDPE Woven Sack, FIBC/JUMBO BAGS, Coated Products, HDPE/LDPE PondLiners, Geomembranes, Weed Mats, Slit Fence like Technical Textiles, HDPE & LDPE Multilayer Tarpaulins, Blown Film, Mulching Films, Polymer Product's Industry; among these I had an experience of more than 16years to work on Senior Administrative Positions where I led the Units/Organizations and built the teams of talents whose continual efforts tookthe organization towards great success and profitability.

KEY STRENGTHS: –

1. Better understanding of several products in this industry like various types of Woven Sacks, HDPE & LDPE Multilayer Tarpaulins, Sheets, FIBCs (Jumbo Bags), Pond Liners/Dam Liners, Geo-membranes, Weed Mats, Shade Nets, Blown Films, Mulching Films, Liners, Shopping Bags, Industrial Packing like Polyethylene Woven VCI Fabrics, Woven Lumber Covers, Roof Underlayment etc.

2. Well experienced in handing of various areas like Product Development, Production/Manufacturing, Quality Assurance, Maintenance, Procurement, Vendor Development, Dispatches, Sales & Marketing, HR/Admin, Commercial etc. and strong Administration skills to set co-ordination between them.

3. Multi-skilled and hands on self-expertise in well planning to achieve optimum efficiency, better process control on Tape Plant, Looms, Lamination, Sealing, Stitching, Stitching, Film, Printing, Recycling, and various converting process etc. along with better quality control with various testing.

4. Fluent in various specialized testing besides regular tests like Carbon Black Content, Carbon Black Dispersion, Ash Content, Tounge Tear, Wing Rip Tear Test, Elmendorf Tear Test, Trapezoid tear Test, UV Retention Tests, Pin Puncture test, Ball Burst Puncture Test, Bursting Strength Tests, Flammability tests, Dart Impact Resistance Test, Hook Type Tear Tests, Opacity Tests, Cyclic Top Lift Test and Load to Failure Test for FIBCs, and many more etc.

5. Fluent in fault findings as well as mechanical, electrical & electronics maintenance on various machines. Well Expertise in implementing the Preventive Maintenance system for the better performance and better life of the machinery and equipment. This also includes the experience and expertise to handling maintenance of Indigenous as well as Non-Indigenous Machines.

6. Fluent in Cost Analysis of various Product of this industry, Development of Product as per customer's specification and their requirements, Raw Material Recipe Design, & Effective Cost Control by means of maintaining the various types of the Raw Material Recipes, optimization of direct/indirect resources like manpower, effective control on waste generation, REDUCE-RECYCLE-REUSE of the waste and many more to get better

profitability.

7. Well aware about Modern Technology as well as positive approach towards Automation, Operation & Control of the PLC, Microprocessor & Scada based Control System of the machines, prepared to take new challenges on process, Product Characteristics, Cost Controls, Productivity etc. which is already implemented effectively in previous assignments.

8. Better contacts to obtain desired Manpower, Manpower Optimization, Manpower Handling, and Human Resources with Development skills by giving in desired training to the peoples at various processes to build the well performing team as well as create a skilled manpower from raw peoples and thus huge savingsobtained in Manpower Costs.

9. Hands on experience in Implementation of various systems like ISO, Social Awareness/SCR, Compliance of Rules Governed by Local Government in various regions of Indian as well as documentation requirement of their system. Well expertise in implementation of effective customized system through solid documentation within the organization in all processes was an added advantage to get highly accurate MIS Data, Stocks, Inputs Vs. Outputs, establish systems for procedures for Receiving Inspection, In-process Inspection, Final/Finish Product Inspection etc. etc. to monitor the performance of the individual Processes like TapePlant, Looms, Lamination, Finishing etc. in terms of cost of production, power, manpower, maintenance etc. as well we the overall organization closely.

10. Well conversant with various computer software/hardware, real time machine monitoring systems etc. Fluent in MS Office, well awareness about ERP/SAP Systems its implementation.

11. Well aware about Project/Project Implementation, Construction, Layouts, Erection & Installation of machines as worked with several organizations in project right from the selection of the machine, project implementation to the successful set up and establish the unit as a profit-making center.

12. Well experience of Liaising with various Govt./Non-Govt. Depts. like Electricity Board, GIDC, Bureau of Indian Standards (BIS), IIP, CIPET, ISO Certification Bodies, Various Indian as well as well-known Globally recognized Testing and Inspection Agencies like NEL, Intertek, Baltic, Crown Agents, TUV, Bureau Vertis, SGS etc.

13. Well experience in documentation of e-tendering for Vendor Empanelment at various Government departments in Agriculture & Horticulture various states of India like Maharashtra, Madya Pradesh, Rajasthan, Karnataka etc.

14. Well experience to handle the Clients independently as a Business DevelopmentPerson is an added advantage where I achieved a goal to build the good volume ofvarious products with various clients in India as well as on the global level like United Kingdom (UK), United states of America (USA), African Region etc.

15. Good Contacts in Global Level for Better Sourcing of Machinery, Equipment of Latest Technology, Raw Materials, Products, Innovations etc. getting updated information in the Global Players in the similar industry which is always helpful to keep ourselvesupdated and ready to implement new requirements.

SOME OF THE MAJOR ACHIEVEMENTS: -

1. Developed various fabric weaving patterns in Circular compared to Waterjet and Sulzer looms from 5x5 to 16x16mesh with various fabric weight categories.
2. Developed and well implemented a simple MIS system to record the data from Security Gate Inn to Dispatch/Sales Out where effective monitoring performance of all KEY DEPARTMENTS in the organization for perfect monitoring of PRODUCTIVITY, COSTS, CONSUMPTIONS, QUALITY CONTROL, WASTE, REJECTION, etc.
3. Reduction Product Manufacturing Cost by 24.90% by updating Raw Material Recipes and Processing Methods and Techniques.
4. More than 37.20% reduction in Manpower by development of Advanced SPM with latest Automation.
5. Saving's in Electricity Consumption by 52.40% with increase in efficiency of machines and upgrading them with operations with AC Inverters/Drives. (VFD) in weaving section.
6. Increase efficiency of Operators by 7.50% implementing best practices in Staff/Workers to utilize their maximum time in productivity.
7. Increase in the output of the Extrusion Line by 28.50% with upgraded with latest technology equipment.
8. Member of the team who developed Bopp Printed (ONE/BOTH SIDE) Woven Sacks in Indian Market.
9. ISO9001:2008 Certifications with Design Scope.
10. SOCIAL COMPLIANCE/SCR compliance in the organization.
11. FLAME RETARDENT TARPS as per UNHCR Requirements.
12. 95% and above Uv stability (Retention) Tarpaulins.
13. IS7903 Certified Tarps & IS15351 Certified Pond Liner with Circular and Sulzer fabric.
14. First Indian TARP MFG Company for TARP supply to US Supermarkets.
15. International Certifications for FIBCs in various Safer Working Loads and Safety Factor Ranges
16. International Certifications for Tarpaulins in various GSM Range for UN REGUGEE Agencies.
17. Specialty Tarpaulins/Sheets with Reinforced Bands and Hook Test Passed as per IFRC/ICRC & IOM.
18. Development of Machineries like Semi-Automatic palletization Machine, Packing Line for Tarpaulins was one of most prestigious as normally we hardly think on the packing

quality but the same plays a major role in the control of the volume of the products as well as the aesthetic of the product at first sight at the customer.

FINISH PRODUCTS HANDLED: -

1. PP/HDPE Woven Sacks of various types like Cement Bags, Fertilizer Bags, Sugar Bags, Multicolor Printed Both Side Bopp Bags, Box Type Bags for special purpose, Aluminum Foil coated bags for Milk Powder Packing, Coated or Uncoated Type, With or Without Polyethylene Liner inserted, Anti-slip Laminated/Un-laminated Bags, Box Bags. and many products related to this Industry etc.

2. HDPE Tarpaulins, Sheets like Flame Retardant Tarpaulins for UN, Band Type Tarpaulins for IFRC/ICRC, etc., ISI MARK Tarpaulins.

3. Geo & Agriculture Products like ISI MARK Pond Liners/Dam Liners, Geo-membranes, Vermi-Beds, Slit Fence, Weed Mats, Shade Nets etc.

4. FIBCs (Jumbo Bags) like Builder Bags, Circular Woven Cross Corner Loop Bags, Baffle (Q – Bag) Bags, Draw Belt Bags, Garden Bags, Double Layer FIBC Bags, Sift proof FIBC Bags; Tunnel Bag, Conductive FIBC Bags, etc.

5. Blown Films like Mulching Films, Liners, Shopping Bags, Multi-layer PE Tarpaulins etc.

6. Industrial Packing materials like Polyethylene Woven VCI Fabrics, Metal Wraps as well as Roof-Liners etc.

PROCESS MACHINEY HANDLED: -

1. Tape Plants & Blown Film Plants - KABRA EXTRUSION MAKE, JP MAKE, LOHIA MAKE, HENGLI MAKE, YONGMING MAKE etc. with 150kg/hr to 900kg/hr production capacity.

2. Looms – GCL MAKE, JAIKO MAKE, LOHIA MAKE, CIRWIND MAKE, QINGDAO DIGNITY MAKE etc. having 4shttle, 6shuttle, 8shuttle etc. in various width in Circular and WATERJET LOOMS also.

3. Lamination – JP MAKE, HENGLI MAKE, YONGMING MAKE, SEN YANG MAKE, BOND MACHINERY, YENSHANG MAKE, etc. from 900mm Tandem to 5200mm Tandem with Co- EX Technology.

4. Printing Machines of various widths 900mm to 2200mm multi colors of Manual and Rollto Roll Type.

5. Cutting Machines, Various type of Stitching Machines and various type of Conversion machines for making bags with manual type, semi-automatic type, automatic type from India, China, Taiwan.

6. Automatic Sealing, Cutting & Eyeleting Line, Sealing, Cutting Machines, Eyeleting/Riveting and Various Conversion machines for making tarpaulins with Manual type, semi-automatic type, automatic type etc. etc.

7. Various Ancillary Machines like Recycle (JP Make, Hengli Make, Polystar Make, Doll- Plast Make, RR Make), Slitting, Punching, Automatic Packing, etc.

8. Various utilities like compressors, chilling plants etc.

9. And various machines from India and other regions like China, Korea, Taiwan, Italy etc.

TESTING EQUIPEMNTS/MACHINERY AND VARIOUS TEST HANDLED: -

1. Denier Tester/Wrap Reel.
2. Various Thickness Testers.
3. Tensile Strength and Elongation Tester.
4. GSM Tester.
5. Carbon Black Content, Carbon black Dispersion Tester.
6. Ash Content Tester.
7. Universal Testing Machines for various tests like Tounge Tear Test, Wing Rip Tear Test, Trapezoid Tear Test, Pin Puncture Test, Ball Burst Puncture Test, etc.
8. Elmendorf Tear Tester.
9. Accelerating Weatherometer for UV Retention Tests, etc.
10. Xenon Arc Weatherometer.
11. Hydro Static Bursting Strength Tester.
12. Flammability Tester CPAI84.
13. Dart Impact Resistance Tester.
14. Opacity Tester.
15. MFI Tester.
16. Cyclic Top Lift Test and Load to Failure Test.
17. Resistance to Penetration to Water by Static Pressure Head Test.
18. Water Repellency by Cone Test.
19. Aging & Shrinkage Test.
20. Mullen Burst Test.

MAJOR and SOME IMP TEST STANDARDS EXECUTED: -

1. Determination of Tensile Strength and elongation at break - ISO1421:1998.
2. Determination of Tear Resistance - BS EN ISO4674-1:2003.
3. Rubber or Plastics – coated fabrics – Determination of Tear resistance - BS EN ISO4674-2:1998.
4. Determination of Bursting Strength and bursting distention of fabrics - BS4768:1972.
5. Tarpaulins Made from High Density Polyethylene Woven Fabric - IS7903:2011 and its related standards.
6. Laminated High Density Polyethylene (HDPE) Woven Fabric (GEO-MEMBRANE) ForWater-Proof Lining IS15351:2008, IS15351:2015 and its related standards.
7. Polyethylene Films and Sheets IS2508:2019.
8. Polyethylene Mulch Films for Agriculture And Horticulture IS17216:2019.
9. Practice for Operating Light- and Water-Exposure Apparatus (Fluorescent UV-Condensation Type) – ASTM G54/93.
10. Flame Retardant Fabrics - CPAI84 Section 5 & 6 and VTM class.

11. Special Hook Test Passed as per IFRC/ICRC & IOM TARPS.
9. Tests for Color Fastness - L. a. b. Coordinates under ISO 105J01.
10. Opacity measured as minimum reflection and maximum transmission in the range of visible light and near infrareds - ISO 14368-1.
11. Cyclic Load Tests for Various FIBC Bags.
12. Drop Tests for CEMENT, FERTILIZER Bags.
13. Aging Effects on Woven coated, uncoated Finish Product with Actual Aging Method.

WORK EXPERIENCE DETAILS: -

PRESENT EMPLOYER: -
Currently working with Fastrack Polyfab, Ahmedabad from SEP-2022 as a Vice President.

PREVIOUS EMPLOYERS: -
During a prolonged tenure in this Industry, I worked Majorly with Techno Tarp & Polymers Pvt. Ltd. Sarigam, Gujarat as a General Manager for Eleven Years; here I joined as a Factory Manager and Promoted till General Manager cum Profit Centre Head of 100% EOU Unit with Global Footprint.
Besides this I was also associated in past with Gen-Nxt Plastic Technologies Pvt Ltd. as a Director (Operations & Business Development) for Two Years, Lamifabs & Papers, Aurangabad as a Vice President for One Year, Inter Weave India LLP, Silvassa for Two Years as a Vice President (Operations), Emmbi Industries Ltd. for One Year as a Manager – Q. A. & Product Development.
Apart from this my tenure with Saaj Overseas Pvt. Ltd. Pune as a Production In-charge for Five Years was a very significant as a foundation of my carrier in this industry, whereas I started my carrier in this PP/HDPE Woven Sack Industry with Pravara Packers Ltd. Akole, Ahmednagar as a QA Supervisor about Two Years.

INTERNATIONAL ASSIGMNETS/EXIBITIONS: -
I done multiple visits at China, Korea, Taiwan for assignments related to cost reduction, training & awareness of latest technology, sourcing of best process machinery, latest automation as well as trails & testing of the same for our segment. In line with the same, I also visited K2016 in Germany, Interplastica-2017 in Moscow; this has contributed a lot in achievements of cost reduction, product development as per International Standards etc., good sourcing capabilities, as mentioned on Page 02.

EDUCATIONAL QUALIFICATION: -

SR. NO.	EXAM	INSTITUTE	BOARD	YEAR OF PASSING	% OF MARKS	GRADE
1.	S.S.C.	Pravara V. Indori Tal: - Akole.	Pune.	March - 1994	79.85 %	Distinction.
2.	D.M.E. (III)	P. L. Govt. Polytechnic, Latur.	B. T. E. Mumbai.	April- 1997	62.42 %	First Class.
3.	BE Mechanical.	IIBMT, Delhi.	Delhi.	August-2003	76.75%	Distinction.
4.	Computer Applications and Software.	Aptech Computer Education, Akole	Aptech	March- 2000	83.00%	Distinction.

ACADEMIC AWARDS: -

a. Rank **"A"** student in the in Higher Secondary School and Rank **"B"** in the TahsilLevel in SSC.
b. I was awarded by **"MR. APTECH AKOLE 2000"** during a learning at and byAptech Computer Education, Akole.

ADDITIONAL QUALIFICATION: -

"INTERNAL AUDITOR" from "V. P. Productivity & Quality Management Services Nashik" (V. P. Oak Registered Lead Auditor-*IRCA ENGLAND*), for **ISO 9001:2000 Quality Management Systems.**

LINGUISTIC ABILITIES: English, Hindi, Gujarati & Marathi.

ANNEX 3
(*Item* 2.3)

RESIGNATION FROM SHRI J. T. NASHHIKKAR

From : jtnashikkar@gmail.com
Subject :

BIS - Geosynthetics Sectional Committee, TXD 30

To : Textiles BIS Reply To : jtnashikkar@gmail.com Email Textiles BIS
TXD 30 Wed, Sep 20, 2023 01:19 PM

Dear Sir I wish to inform you that I will not be able to devote sufficient time to the work of the Textile Committee due to other preoccupations. I, therefore, tender my resignation as a member of this committee. This will help you in getting another person from the Textile field as a member for better participation. I am thankful to all for giving me the opportunity to work with this committee. I wish all the success to the committee in its endeavour. Pl acknowledge the receipt of this email

With regards
Jayant T.Nashikkar
Fmr Secretary PWD GOM

RESIGNATION FROM SHRI V. K. PATIL

Dear Sir,

I would like to point out that I am a member of the TX 30 Committee as in person capacity. But nowadays I cannot work on time in the standardized process due to health reasons.

Also ENT specialist has advised to avoid strictly the use of headphones due to hearing impairment. Therefore, even if I wanted to, I would not be able to devote enough time to this committee. However, I request you to release me from this committee. Thank you for your cooperation so far and having given me the opportunity to work for BIS standardization of specs and test methods in Geotech field !

Best regards,
V. K. Patil

ANNEX 4
(*Item* 3.1)

SUMMARY OF ACTIONS TAKEN ON THE DECISIONS TAKEN IN THE LAST AND PREVIOUS MEETING

Item No.	Decision Taken	Action Taken
3	Review of composition of TXD 30	Updated composition of TXD 30 is given in Annex 3.
5	**Draft standards/amendment for finalization** The committee finalized the following draft amendment for publication 'Amendment No.1 to IS 16362 : 2020 Geosynthetics — Geotextiles used in subgrade stabilization in pavement structures — Specification (first revision) [Doc TXD 30 (21617)].	Under publication
6.1	**Comments on published indian standards** i) IS 16391 : 2015 Geosynthetics — Geotextiles used in sub-grade separation in pavement structures – Specification ii) IS 16392 : 2015 Geosynthetics — Geotextiles for permanent erosion control in hard armor systems – Specification iii) IS 16393 : 2015 Geosynthetics — Geotextiles used in subsurface drainage application — Specification iv) IS 16090 : 2013 Geo-synthetics — Geo-textiles used as protection (or cushioning) materials – Specification v) IS 16362 : 2020 Geosynthetics — Geotextiles used i in subgrade stabilization in pavement structures — Specification (first revision) editorial changes in the draft amendments if required.	Amendments were issued to IS 16391 : 2015, IS 16392, IS 16393, IS 16090 and IS 16362 and are under publication.
6.2	**Comments on published Indian Standards** The committee decided to issue an amendment to following Indian Standard: i) IS 17373 : 2020 Geosynthetics – Geogrids used in reinforced soil retaining structures – Specification	Under publication

7	**Revision of 'IS 14986 : Guidelines for Application of Jute Geotextile for Rain Water Erosion Control in Road and Railway Embankments and Hill Slopes.** After detailed deliberation, the committee decided that tensile strength and elongation will be tested as per IS 16635 and fresh samples provided by IJMA, Kolkata will be used for generating empirical test data for all parameters specified in IS 14986.	Coming for discussion under Agenda Item **9.1**.
8.2	**REVIEW OF STANDARDS** The committee decided that following standards will be reviewed by BTRA, Mumbai, Landmark Material Testing and Research Laboratory Private Limited, Jaipur and Geosynthetics Testing Services Pvt Ltd, Ahemdabad as per the latest Industrial Practices and sharing their comments: i) IS 13325 : 1992 Determination of tensile properties of extruded polymer geogrids using the wide strip — Test method ii) IS 13326 (Part 1) : 1992 Evaluation of interface friction between geosynthetics and soil method of test: Part 1 modified direct shear technique iii) IS 14293 : 1995 Geotextiles — Method of test for trapezoid tearing strength iv) IS 14294 : 1995 Geotextiles — Method for determination of apparent opening size by dry sieving technique v) IS 14324 : 1995 Geotextiles — Methods of test for determination of water permeability — Permittivity vi) IS 14706 : 1999 Geotextiles — Sampling and preparation of test specimens vii) IS 14714 : 1999 Geotextiles — Determination of abrasion resistance viii) IS 13162 : Part 2 : 1991 Geotextiles – Methods of test Part 2 Determination of resistance to exposure of ultraviolet light and water (Xenon-arc type apparatus) ix) IS 13162 : Part 4 : 1992 n Geotextiles – Methods of test Part 4 Determination of puncture resistance by falling cone method	Coming for discussion under Agenda Item **7.1**.

ANNEX 5
(*Item* 4.1)

COMMENTS ON GEOSYNTHETICS — GEOTEXTILE TUBES FOR COASTAL AND WATERWAYS PROTECTION — SPECIFICATION [DOC TXD 30 (22876)

Commentor: Garware Technical Fibres Ltd., Pune

Comment:

Item, Clause Sub-Clause No. Commented upon (Use Separate Box afresh)	**Comments**	**Specific Proposal (Draft clause to be add/amended)**	**Remarks**	**Technical References on which (2), (3), (4) are based**
(1)	(2)	(3)	(4)	(5)
4.1 Material of Geotextile Tubes Table 1 Requirements of Polypropylene and Polyester Geotextile Tube (*Clause* 4.1.1)	Type 4 Wide width Tensile strength The Tensile Strength in Machine direction and cross Machine direction to be reduced to 200 kN/m	Type 4 Wide width tensile strength, kN/m, *Min*: a) Machine direction- 200 kN/m a) Cross Machine direction- 200 kN/m	Maximum achievable strength is up to 200 kN/m in both directions	The maximum strengths given in most of the national & international specifications are up to 200 kN/m (GRI etc)
4.1 Material of Geotextile Tubes Table 1 Requirements of Polypropylene and Polyester Geotextile Tube (*Clause* 4.1.1)	Apparent opening size (AOS), mm, 0_{90}, *Max*, IS 14294 need to modify	Apparent opening size (AOS), mm, 0_{95}, *Max*, IS 14294	Standard IS 14294 says O95 value	IS 14294
Table 3, Table 4 and Table 5 Dimensions (*Clause* 4.4)	Tolerance to be modified from +3 % to +5%	*Tolerance on Length and Diameter, Percent* : +5 percent with no negative tolerance	Difficult to maintain +3 percent	Manufactures design specifications

Commentor: Terre Armee, New Delhi

Comment:

Sl. No	Item, Caluse, Sub-Clause No. commented upon	Comments	Specific Proposal
1	Clause 4.1.1, Table 1 Requirements of Polypropylene and Polyester Geotextile Tube	Definition of requirement corresponding to Type 1, 2, 3 and 4 not mentioned.	Define Type 1, Type 2, Type 3 and Type 4.
2	Clause 4.1.1, Table 1 Requirements of Polypropylene and Polyester Geotextile Tube. A i) Polymer Type		Polymer type shall be limited to Polypropylene.
3	Clause 4.1.1, Table 1 Requirements of Polypropylene and Polyester Geotextile Tube. A iii)Elongation at designated tensile strength, percent, Max. (a) and (b)	Low geotextile elongation ensures minimal shape deformation during filling process, and throughout geotextile tube serivce life.	Limit MD and CMD elongation to maximum 12%.
4	Clause 4.1.1, Table 1 Requirements of Polypropylene and Polyester Geotextile Tube. A v)Trapezoidal tear strength, kN, Min. (a) and (b)		Trapezoidal tear strength can be limited to maximum 1.5 kN in both directions.
5	Clause 4.1.1, Table 1 Requirements of Polypropylene and Polyester Geotextile Tube. A vi)CBR puncture resistance, kN, Min	Higher puncture resistance results in to greater geotextile tube survivability during installation and unexpected event.	Minimum puncture resistance should be 10 kN.
6	Clause 4.1.1, Table 1 Requirements of Polypropylene and Polyester Geotextile Tube. B i)Water permeability at 50 mm water head, l/m2/s, Min	High permeability is required to allow effluence dissipate out from the tube faster, to speed up construction process.	Increase water permeability to 10 l/m2/s to allow effluence dissipate out from the tube faster, to speed up construction process.
7	Clause 4.1.1, Table 1 Requirements of Polypropylene and Polyester Geotextile Tube. B ii) Apparent opening size (AOS), mm, 090, Max	High permeability is required to allow effluence dissipate out from the tube faster, to speed up construction process.	Increase O90 to 0.6 mm max to allow higher permeability.
8	Clause 4.1.1, Table 1 Requirements of Polypropylene and Polyester Geotextile Tube. B iii) UV resistance after 500 h, Retained tensile strength	High UV resistance is recommended to ensure geotextile tube fabric strength still	Increase UV resistance to 90%, flatten tensile strength degradation curve, to ensure geotextile tube fabric strength

	in machine and cross direction, Percent, Min	remain sufficient throughout its service life.	still remain sufficient throughout its service life.
9	Caluse 4.1.2, Table 2 Requirements of Inner Layer (Nonwoven) of Geotube i) Material		Polymer type shall be limited to Polypropylene.
10	Caluse 4.1.2, Table 2 Requirements of Inner Layer (Nonwoven) of Geotube ii) Mass, g/m2 ,Min	Since Mass per unit area is an index property and not performance property, it can be eliminated. This parameter is not included in Table 1. So why it is included in Table 2 only?	Remove (ii) Mass, g/m2, Min from Table 2.
11	Caluse 4.1.2, Table 2 Requirements of Inner Layer (Nonwoven) of Geotube iv) Grab Tensile Strength, N, Min , (a) and (b)	High grab tensile strength required in both directions to maintain inner liner structure integrity during filling process.	Increase grab tensile strength to 500 N in both directions to maintain inner liner structure integrity during filling process.
12	Caluse 4.1.2, Table 2 Requirements of Inner Layer (Nonwoven) of Geotube v) Trapezoidal Tear Strength, N, Min, (a) and (b)	Normalized and nominal trapezoidal tear strength in both directions is sufficient to maintain inner liner structure during filling process	Trapezoidal tear strength to be to 200 N in both directions to maintain inner liner structure integrity during filling process.
13	Clause 4.3 Prefabrication of Geotextile Tubes	Replace "multifilament" with "monofilament"	Geotubes shall be prefabricated using white or black colour UV stabilized high strength polyester or polypropylene monofilament yarn.
14	Annx B-6 POST INSTALLATION PRECAUTIONS	In the coastal area especially near the estuaries the fising boates and trawlers spill oil near the coast.	Add a para : Adequate precaution to prevent oil spill near the construction site till installation and effluence dissipation processes is complete.

ANNEX 6
(*Item* 4.1)

DRAFT FOR COMMENTS ONLY

Doc. No: TXD 30 (22876) WC
July 2023

भारतीय मानक ब्युरो
BUREAU OF INDIAN STANDARDS

भारतीय मानक मसौदा
भुकृत्रिम – तटीय और जलमार्ग संरक्षण के लिए भुवस्त्रादी नली – विशिष्टी
Draft Indian Standard

GEOSYNTHETICS — GEOTEXTILE TUBES FOR COASTAL AND WATERWAYS PROTECTION — SPECIFICATION

ICS 59.080.70

Last date for receipt of comment is **08 September 2023**

FOREWORD
(*Formal clauses will be added later*)

Geotextile tubes find wide usage in riverbank, beach protection, sludge dewatering and offshore breakwaters for coastal and waterways protection. Geotextile tubes made from polypropylene (PP) or polyester (PET) monofilament, multifilament or fibrillated woven geotextiles, has been used for protecting riverbanks and hydraulic structures from severe scouring and erosion. Geotextile tubes have also been used as revetments, breakwaters, etc., to build structural erosion protection measures. Such tubes provide stability and prevent soil and coastal erosion. Geotextile tubes technology possesses minimal impacts on fish resources and facilitates fishing activities. It facilitates the algal community to grow. The technology has been popular worldwide due to its easier installation, cost effectiveness, their technical efficiency and environmental friendliness in comparison to the conventional erosion protection work using cement concrete block, gravel, hard rock, etc.

Worldwide it has been seen that erosion protection work using geotextile tubes requires less installation and maintenance cost, light weight equipment, less space for construction work, much less transportation cost and less energy requirement. The constructing materials of Geotextile tubes are locally available and cost-effective compared to importing boulders from other sites. The Geotextile tubes are lighter in weight than the traditional materials and their manufacturing and quality control are easy as compared to the cement concrete blocks and boulders. Geotextile tubes are filled with dredged material and are generally used when sea shores or bunds adjacent to rivers are to be protected in case of an emergency.

For best performance, Geotextile tubes have to be filled to maximum volume and density with dredged material based on design. These are installed in a pattern-placed arrangement that greatly improves their overall stability and performance. Filling task can be efficiently done by using water to compact the dredged material (hydraulically filling the dredged material into a

tube). Filled density and volume are important from the view point of maximizing the stability, minimizing the effects of fill liquefaction and loss of shape of the Geotextile geotubes. To ensure that the contained fill is maintained in its dense state, the geo-textile sheet shall have adequate tensile strength.

One major advantage of Geotextile tubes is that these units can be used to construct hydraulic and marine structures that require adherence to designed geometrical shape accurately. Geotextile tubes' designs feature significantly larger dimensions and use higher strength woven geotextile. Sometimes nonwoven fabrics are used as inner lining of the tubes. The construction allows large amount of sludge and silt to be easily removed without having to constantly change or replace bags. Geotextile tubes sizes can be custom made to your required location and surface area.

This Geotextile tubes can be used for a range of hydraulic and marine applications as given below:

Harbour & Shoreline Remediation

- Submerged Breakwater
- Detached Breakwater
- Groin
- Harbor Basin Sludge Dredging
- Channel Sediment Dredging

River/Wetland Remediation

- Riverbed protection
- River channel Dredging
- Wetland Remediation

Coastal Infrastructure Protection

- Cofferdam construction
- Reclamation works

Guidelines for installation of geotextile tubes are given in Annex B for information only.

1 SCOPE

This standard specifies requirements for geotextile tubes made from polypropylene (PP) or polyester (PET) monofilament, multifilament or fibrillated woven geotextiles, used for sludge dewatering, coastal and waterways protection applications such as revetments, river training, construction of groynes and artificial reefs, etc., in order to minimize soil erosion and control floods.

NOTES

1 The survivability/durability of geotextile tubes depends upon water pressure, soil condition, type of contents of geotextile tubes that is sand or gravels, water *p*H and temperature etc.

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

2 REFERENCES

The standards listed in Annex A contain provisions which through reference in this text, constitute provision 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 indicated in Annex A.

3 TERMINOLOGY

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

3.1 Minimum Average Value (MAV) – MAV is the minimum average value of geotextile tubes.

3.2 Scour Apron – An apron of geotextile designed to protect the foundation of the main geotextile tube from the undermining effects of scour. In coastal and riverbed applications, scour can occur at the base of the tube due to wave and current action. Scour aprons may be on both sides of the main tube, or on only on the water front side. Scour aprons also reduce local erosion and scour caused during the hydraulic filling process of the main tube. Scour aprons are typically anchored by a small tube at the water's edge or by sandbags attached to the apron.

3.3 Fill Port – Also called a fill spout or fill nozzle, fill ports are sleeves sewn into the top of the geotextile tube into which the pump discharge pipe is inserted. Ports are typically 300 mm to 450 mm in diameter and 1.0 m to 1.5 m length. Ports are spaced along the top of the tube to provide access to the contractor. Spacing is usually no closer than 7.5 m to accommodate sand slurry but can be as far apart as 30 m for some viscous fill materials. Fill ports are fabricated from the same geotextile as the main tube. There must be another safety pocket outer to spout/port so that it can be kept safely inside this cover/sack after filling to avoid floating/laying in the geotextile tube.

4.1 Material of Geotextile Tubes

4.1.1 Geotextile tubes shall be made from monofilament, multifilament or fibrillated woven fabric manufactured from ultraviolet stabilized polypropylene or polyester, depending upon the end use requirements and shall conform to requirements as specified in Table 1. The geotextile tubes shall be inert to commonly encountered chemicals, resistant to rot and mildew and shall have no tear or defects which adversely affect or alter its physical properties.

4.1.2 The standard geotextile tube is made of soil tight, permeable and high strength woven geotextile sheets sewn along the edges with inlets sewn at regular intervals. If required, the tubes can be designed as inner and outer tube. The inner tube (if required) can be of nonwoven fabric that acts as a filter to retain the fine-grained material requirements and shall conform to requirements as specified in Table 2. An outer layer of high strength woven fabrics designed to contain the weight of the fill material and pumping pressure required to fill the tube to the required height.

4.1.3 All property values except elongation and apparent opening size in this standard represent minimum values. Average of test results from any sampled tube in a lot shall meet or exceed the minimum values specified in this standard. In case of elongation and apparent opening size, shall represent the maximum value.

4.2 Geotextile tubes shall be dimensionally stable and able to retain their geometry under manufacture, transport, and installation.

Table 1 Requirements of Polypropylene and Polyester Geotextile Tube

(*Clause* 4.1.1)

Sl No.	**Characteristic**	**Requirement**				**Method of Test, Ref. to**
		Type 1	Type 2	Type 3	Type 4	
A.	**Mechanical Properties:**					
i)	Polymer type	Polypropylene or Polyester				IS 667
ii)	Wide width tensile strength, kN/m, *Min*:					IS 16635

	a) Machine direction	75	125	175	250	
	b) Cross machine direction	75	125	175	250	
iii)	Elongation at designated tensile strength, percent, *Max*					IS 16635
	a) Machine direction	25	25	20	20	
	b) Cross machine direction	25	25	20	20	
iv)	Seam strength, Percent of actual fabric strength, *Min*	70	70	70	70	IS 15060
v)	Trapezoidal tear strength, kN, *Min*					IS 14293
	a) Machine direction	1.0	1.5	2.5	3.2	
	b) Cross machine direction	1.0	1.5	2.5	3.2	
vi)	CBR puncture resistance, kN, *Min*	7	10	12	20	IS 16078
B.	**Hydraulic Properties:**					
i)	Water permeability at 50 mm water head, $l/m^2/s$, *Min*	5	5	5	3	IS 14324
ii)	Apparent opening size (AOS), mm, 0_{90}, *Max*	0.30	0.25	0.25	0.20	IS 14294
iii)	UV resistance after 500 h, Retained tensile strength in machine and cross direction, Percent, *Min*	70	70	70	70	IS 13162 (Part 2)
iv)	Chemical Resistance after 72 h immersion in chemicals, Retained tensile strength, Percent,	70	70	70	70	IS 16351

	Min					
v)	Abrasion Resistance by sliding block method, Retained tensile strength in machine and cross direction after 250 cycles, Percent	70	70	70	70	IS 14714

Table 2 Requirements of Inner Layer (Nonwoven) of Geotube

(*Clause* 4.1.2)

Sl No.	**Characteristic**	**Requirements**	**Method of Test, Ref. to**
i)	Material	Polypropylene or Polyester	IS 667
ii)	Mass, g/m^2 , *Min*	150	IS 14716
iii)	Ultimate Tensile strength, kN/m, *Min*		IS 16635
	a) Machine direction	6.0	
	b) Cross machine direction	7.5	
iv)	Grab Tensile Strength, N, *Min*		IS 16342
	a) Machine direction	320	
	b) Cross machine direction	450	
v)	Trapezoidal Tear Strength, N, *Min*		IS 14293
	a) Machine direction	210	
	b) Cross machine direction	290	
vi)	Apparent Opening Size,	250	IS 14294

	$O_{95,}$ Micron, *Max*		
vii)	Water permeability at 50 mm waterhead, $l/m^2/s$, *Min*	90	IS 14324
viii)	UV Resistance retained strength after 500 hrs of UV exposure, Percent , *Min*	70	IS 13162 (Part 2)

4.3 Prefabrication of Geotextile Tubes

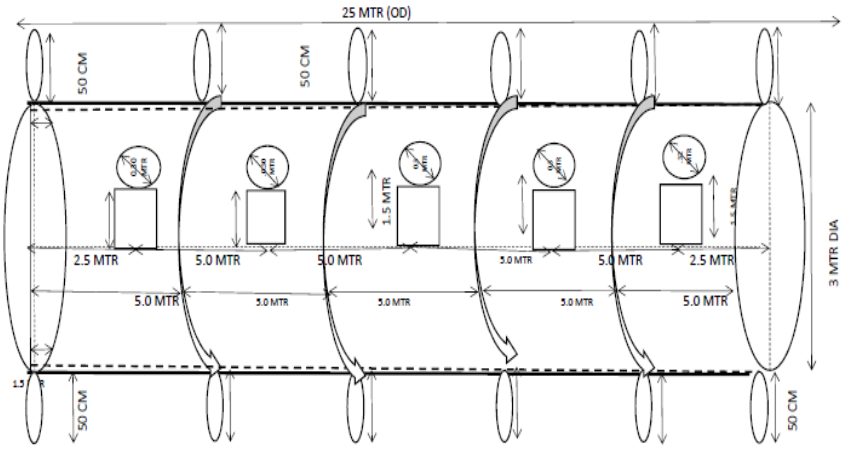
Geotubes shall be prefabricated using white or black colour UV stabilized high strength polyester or polypropylene multifilament yarn. The geotubes shall have seam with six line parallel chain stitch along the edges on the two sides with a minimum stitch density of 12 stitches/dm. Number of stitches is chosen in such a way that seam strength is achieved at least 70 percent of its original strength. The stitching yarn shall be UV resistance such that, retained tensile strength after 500 h exposure shall not be less than 50 percent of its original value.

The sewing shall be done by using a UV stabilized high strength polyester or polypropylene multifilament yarn in circumferential or longitudinal stich pattern, as the case may be of minimum linear density 2000 Denier. The distance between the two row of stitches shall be 10 mm.

Stitch on both lines of the geotextile tube shall continue beyond the tube's open mouth and end in a loose loop of thread of length 25 mm to 50 mm. The stitching shall be uniform without any loose thread or knot.

4.4 Dimensions

Geotube may be either longitudinal or circumferential in shape as shown in Fig. 1 and Fig. 2 respectively. The typical dimensions of the geotube, spout/filling port and loop is given in Table 3, Table 4 and Table 5 respectively. The geotubes may be made to other shapes and dimensions as per agreement between buyer and seller.



Tube Spec. Details

Tube Size:- 25 X3 ØMtr (OD)

Spout:- 1.50X0.30 Mtr Ø X 5 Nos. with 1 meter length tie each

Loop:-50 Cm.(Height) X12 Nos.(6+6)

FIG. 1 TYPICAL SECTION OF CIRCUMFERENTIAL GEOTEXTILE TUBE OF 25 M × 3 M DIMENSION

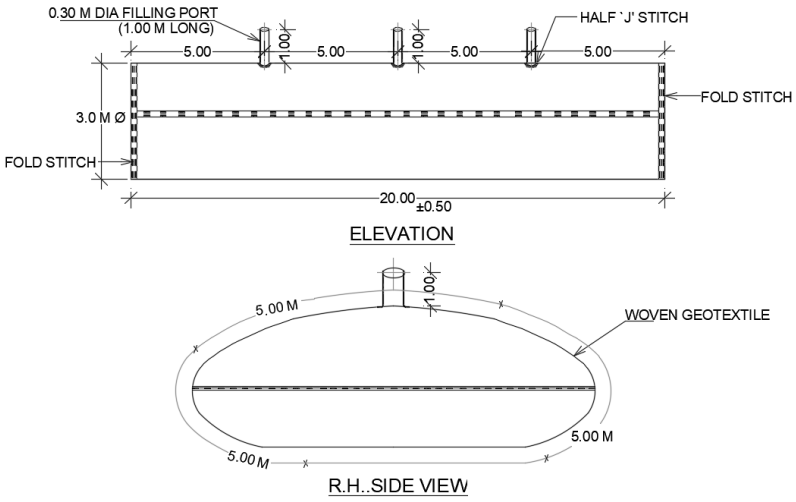


FIG.2

TYPICAL SECTION OF LONGITUDINAL GEOTUBE OF 20 M ×3 M DIAMETER

4 REQUIREMENTS

Table 3 Dimensions for Geotubes

(*Clause* 4.4)

Geotube type	*Length (m)*	*Diameter(m)*	*Tolerance on Length and Diameter, Percent*
20x2m	20.00	2.00	+3 percent with no negative tolerance
20x3m	20.00	3.00	
20x5m	20.00	5.00	
25x2m	25.00	2.00	
25x3m	25.00	3.00	
25x5m	25.00	5.00	
30x2m	30.00	2.00	
30x3m	30.00	3.00	
30x5m	30.00	5.00	

Table 4 Dimensions for Spout/filling port

(*Clause* 4.4)

Length (m)	*Diameter (m)*	*Tolerance on Length and Diameter, Percent*
1.00	0.30	+3 percent with no negative tolerance
1.00	0.35	
1.50	0.30	
1.50	0.35	

Table 5 Dimensions for Loop

(*Clause* 4.4)

Length (cm)	*Width(inch)*	*Tolerance on Length and Width, Percent*
20.00	1.00	+3 percent with no

20.00	2.00	negative tolerance
50.00	1.00	
50.00	2.00	

5 MARKING AND LABELLING

5.1 The geotextile tubes shall be marked with the following by attaching the printed labels:

a) Manufacturer's name, initials or trade-mark;

b) Identification of the geotextile tubes material as per manufacturer's recommendation, for example, polypropylene woven geotextile tubes for coastal/ waterways protection;

c) Type of geotextile tubes/mass in g/m^2, of fabric used for manufacture of geotextile tubes;

d) Dimensions (length and width) of geotextile tubes;

e) Lot number and date of manufacture;

f) The country of origin;

g) Any other information/instruction provided by the manufacturer/required under law.

5.2 BIS Certification Marking

The geotextile tubes may also be marked with the Standard Mark.

5.2.1 The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act*, 2016 and Rules and Regulations made thereunder. The details of conditions under which the license for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

6 PACKING

Each bundle shall be labeled or tagged to provide product identification sufficient for field identification as well inventory and quality control purpose.

Bundles shall be stored in a manner which protects them from adverse impact of weather. If stored outdoors, they shall be elevated and protected with a waterproof cover. Geotextile tubes are laid flat in a HDPE tube or wrapped in a HDPE film of minimum thickness of 60 microns and tied with a HDPE/PP

tape so as to remove excess air and to prevent it from the adverse impact of heat and moisture, oil, grease, dirt, dust and other stains as well as to extended ultra-violet exposure during shipment and storage prior to deployment and placement.

7 IDENTIFICATION, DELIVERY, STORAGE AND HANDLING

7.1 The finished geotextile tube and its associated scour apron shall be rolled on a stable core or accordion folded into a bundle for handling, storage and shipment. The geotextile tube and/or scour apron is to be protected by an outer wrapping or plastic bag. The manufacturer's identification label shall be clearly visible on the outer wrapping and in a manner consistent with the established policy of the manufacturer.

7.2 Geotextile tubes and scour aprons shall be labeled, shipped, stored, and handled in accordance with IS 17421 and as specified herein. Each segment of geotextile tube and scour apron shall be wrapped in an opaque layer of plastic during shipment and storage. The plastic wrapping shall be placed around the unit in the manufacturing facility and shall not be removed until deployment. Each packaged segment of geotextile tube and/or scour apron shall be labeled with the manufacturers name, geotextile type, lot numbers, roll numbers, and dimensions (length, width, gross weight). For the purposes of inventory and shipping, bar code system may be followed.

7.3 During storage, Geotextile tubes shall be elevated off the ground and adequately protected 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 60°C;
f) Excessive mud, wet concrete, epoxy, or other deleterious materials coming in contact with and affixing to the geotextile material;
g) Any other environmental condition that may damage the physical property values.

7.4 The geotextile tubes shall be stored at temperatures above 10°C and below 40°C.

7.5 The geotextile tubes shall be laid flat.

7.6 The geotextile tubes shall not be directly exposed to sunlight for a period longer than the period recommended by the manufacturer.

7.7 The geotextile tubes shall be kept dry until installation, and shall not be stored directly on the ground.

8 SAMPLING AND CRITERIA FOR CONFORMITY

8.1 Lot

The number of geotextile tubes of the same size, type and quality delivered to a buyer against one dispatch note shall constitute a lot.

8.2 The number of geotextile tubes to be selected at random shall be according to col 2 and col 3 of Table 4. To ensure the randomness of selection, IS 4905 may be followed.

8.3 NUMBER OF TESTS AND CRITERIA FOR CONFORMITY

8.3.1 The number of geotextile tubes to be selected for length, width, and mass of sand to be filled and pre- fabrication requirements shall be in accordance with col 3 of Table 4. For tensile strength, elongation, seam strength and water permeability, the number of Geotextile tubes selected shall be in accordance with col 6 of Table 4.

NOTE – If agreed to between buyer and seller, the sampling at the consumer/user end at site shall be carried out for deciding the conformity of the lot.

8.3.2 All the geotextile tubes selected from the lot shall be tested for various requirements as per methods specified in relevant standards as specified in Table 1 and in **4.1.1**, **4.1.2**, **4.2** and **4.3**. A geotubes shall be declared defective, if it does not meet any of the requirements specified in Table 1 and in **4.1.1**, **4.1.2**, **4.2** and **4.3**. The lot shall be declared conforming to this standard, if the average of test results from sampled bags in a lot shall meet or exceed the minimum values specified in this standard against each requirement; except in case of elongation and apparent opening size where the average value of test results shall not be more than the value specified in Table 1. The lot shall also be declared as conforming to this standard, if the number of defective Geotextile tubes does not exceed the values specified in

col 4 of Table 6. In addition to above the lot shall meet the requirements of marking and labelling (*see* **5.1**), packing (*see* **6**) and storage and handling (*see* **7.1** to **7.5**).

Table 6 Sample Size

(*Clauses* 8.2, 8.3, 8.3.1 and 8.3.2)

Sl No.	**Lot Size (No. of bundles of 20 Geotextile Tubes)**	**Sample Size (No. of Geotextile Tubes)**	**Permissible Number of Non-conforming Geotextile Tubes**	**Sub-Sample Size (No. of Geotextile Tubes)**	**Sub-Sub-Sample Size (No. of Geotextile Tubes)**
(1)	(2)	(3)	(4)	(5)	(6)
i)	Up to 100	5	0	2	1
ii)	101 to 200	8	1	4	2
iii)	201 to 300	13	1	5	3
iv)	301 to 500	20	2	8	4
v)	501 to 1 000	32	3	10	5
vi)	1 001 and above	50	3	10	6

ANNEX A

(*Clause* 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*
IS 667 : 1981	Methods for identification of textile fibres (*first revision*)

IS 13162 (Part 2) : 1991	Geotextiles – Methods of test (Part 2): Determination of resistance to exposure of ultraviolet light and water (Xenon-arc type apparatus)
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 14714 : 1999	Geotextiles – Determination of abrasion resistance
IS 14716 : 2021	Geosynthetics – Test method for the determination of mass per unit area of geotextiles and geotextile-related products
IS 16237 : 2014	Geo-synthetics – Method for determination of apparent opening size by wet sieving
IS 16342 : 2015	Geosynthetics – Method of test for grab breaking load and elongation of geotextiles
IS 16351 : 2015	Geosynthetics – Standard practice for laboratory immersion procedures for evaluating the chemical resistance of geosynthetics to liquids
IS 17421 : 2020	Geosynthetics - Identification on site
IS 4905 : 2015 / ISO 24153: 2009	Random sampling and randomization procedures (*first revision*)
IS 13321 (Part 1) : 2022 / ISO 10318-1:2015	Geosynthetics (Part 1) : Terms and definitions (*first revision*)
IS 15060 : 2018 / ISO 10321:2008	Geosynthetics – Tensile test for joint seams by wide-width strip method (first revision)

IS 16078 : 2013 / ISO 12236:2006	Geosynthetics –Static puncture test (CBR Test)
IS 16635 : 2017 / ISO 10319:2015	Geosynthetics – Wide width tensile test

ANNEX B

(*Foreword*)

GUIDELINES FOR INSTALLATION OF GEOTEXTILE TUBES

B-1 PREAMBLE

B-1.1 Geotextile tubes are made up of high-strength Polypropylene Multifilament (PPMF) or Polyester Multifilament (PETMF) woven Geotextile fabric with specially designed hydraulic properties which allow water to pass through it while entrapping the soil inside the tube. The tubes are stitched with six lines of UV stabilized high strength polyester or polypropylene multifilament stitching thread to get desired seam strength. Geotextile tubes are resistant to UV and other microbiological organisms found in soil. The geotextile tubes are usually filled by the hydraulic pumping method with soil slurry.

B-2 PRODUCT DELIVERY, STORAGE AND HANDLING

B-2.1 Geotextile tube and related components shall be delivered to the project site in a protective cover. Each geotextile tube shall be clearly labelled for easy identification.

B-2.2 No hooks, tongs or other sharp instruments etc. should be used for handling the geotextile tube. The supplied geotextile tube should not be dragged along the ground. The geotextile tube should be placed in position as recommended by the manufacturer.

B-2.3 Geotextile tube shall be stored over a platform constructed in areas where water cannot accumulate, elevated off of the ground and protected from conditions that will affect the properties or performance of the geotextile. Geotextile tubes should not be exposed to temperatures over 60°C. The duration of storage time shall not exceed the manufacturer's recommendation.

B-3 SITE PREPARATION

Location at which geotextile tubes are to be placed, shall be checked properly to confirm any obstructions, which could damage the geotextile tubes, such as roots, sharp objects, debris and any other material shall be removed. Bb,

B-4 PLACEMENT OF GEOTEXTILE TUBE

B-4.1 Lay nonwoven geotextile for scour protection covering the entire area before placing the geotextile tube.

B-4.2 No portion of the geotextile tube shall be filled until the entire tube segment has been fully anchored along the correct alignment.

B-5 INJECTION OF FILL MATERIAL

B-5.1 After the placement of the geotextile tube and scouring apron, the sand slurry shall be filled in the tube according to the approved plan of construction. The discharge line of the dredge shall be fitted with a valve to allow control of the rate of filling. The valve system shall be fitted with an internal mechanism such as a gate, butterfly valve, ball valve or pinch valve, to allow the contractor to regulate the discharge into the geotextile tube. Any excess discharge shall be directed away from the tube into a designated area.

B-5.2 Typically, the diameter of the dredge discharge pipe should be in the range of 150 mm to 250 mm to ensure the adequate filling of the geotextile tube. Injection ports are typically 300 to 350 mm in diameter and 1.0 m to 1.5 m in length. Care should be taken not to overfill or over-pressurize the "anchor tube" that is incorporated into the scour apron.

B-5.3 The dredge discharge pipe shall be free of protrusions that could tear the fill port. The dredge discharge pipe shall be supported above the fill port in a manner, which reduces stress on the fill port seams. Excessive movement of the dredge discharge pipe during filling can result in damage to the fill port. The pump may be installed 50 to 100m far from the geotextile tube in position.

B-5.4 Geotextile tubes used in coastal and river erosion control applications are most often filled hydraulically with a slurry of sand and water. Upon filling the geotextile tube, the fill port sleeves shall be closed and attached to the geotextile tube in a manner sufficient to prevent movement of the sleeve by subsequent wave action or other disturbances. Tie the mouth of the port and place the same inside the safety pocket of the geotextile tube so that the port material/spout does not escape/float after filling.

B-5.5 The geotextile tube should not be filled up to its capacity through the filling ports at once because it may not allow the slurry to settle adequately. Therefore, the tube should be filled up to 40 percent to 50 percent of its capacity in the first step by allowing the water to drain out through the pores. In case there is any clogging at any of the ports before the tube is completely filled then water should be injected inside the port to remove the clogging allowing further space for filling.

B-5.6 The geotextile tube shall be completely filled to its design height as suggested by the engineer-in-charge and geotextile tube manufacturer.

B-6 POST INSTALLATION PRECAUTIONS

B-6.1 Immediately after installation, ensure the proper placement of geotextile tubes as per design and geometry of the site. If any abnormality is observed, correction or re-dumping shall be carried out.

B-6.2 Proper care shall be taken to avoid manual interference of civilians and animals which can cause damage to the material.

FORMAT FOR SENDING COMMENTS ON BIS DOCUMENT

(Please use A4 size sheet of paper only and type within fields indicated. Comments on each clause/sub-clause/table/fig. Etc. be stated on a fresh box. Information in Column 2 should include reasons for the comments and suggestions for modified wording of the clauses which the existing text is found not acceptable. Adherence to this format facilitates Secretariat's work)

NAME OF THE COMMENTATOR/ORGANIZATION …….
DOCUMENT NO : [Doc :TXD 30 (22876)]

Item, Clause Sub-Clause No. Commented upon (Use Separate Box afresh)	Comments	Specific Proposal (Draft clause to be add/amended)	Remarks	Technical References on which (2), (3), (4) are based
(1)	(2)	(3)	(4)	(5)

ANNEX 7
(*Item* 5.1)

AMALGAMATION OF GEOTEXTILE STANDARDS

FOREWORD

(*Formal clauses shall be added later*)

Geotextiles perform four major functions of separation, reinforcement, filtration and drainage. In this standard following sub-sections are covered:

a) Subsurface drainage;
b) Separation;
c) Sub-grade stabilization; and
d) Permanent erosion control.

1) Subsurface drainage:

Control of water is critical to the performance of buildings, pavements, embankments, retaining walls and other structures. Drains are used to relieve the hydrostatic pressure against underground and retaining walls, slabs and underground tanks and to prevent loss of soil strength and stability in slopes, embankments and beneath pavements. In transportation applications, if the base course does not drain rapidly enough, stress from the traffic loadings is transferred to the subgrade with little or no reduction, resulting in accelerated road failure. The removal of water shall be performed in a controlled fashion. Otherwise, severe erosion, piping, or settlement of soils may result in undermining adjacent structures. To accomplish this task the drainage system should fulfill two criteria:

a) Have maintained permeability by providing relatively unimpeded flow of water; and
b) Filtration of base soil by preventing the migration of soil fines into the drain.

These criteria can be met by using several layers of specially graded aggregates. This often proves to be extremely expensive requirement to meet. The same result can be achieved at a fraction of the cost by using selected geotextiles, which act as filters around the aggregate drainage system. The introduction of geotextile lined drainage systems has enhanced the technical benefits and economical application of blanket and trench drains under and adjacent to pavement structures. The excellent filtration and separation characteristics associated with geotextiles permits the use of a single layer of open graded aggregate base or trench aggregate enveloped in a geotextile.

The stability of the subgrade soils depends on groundwater table. Some clay soils can swell or shrink as their water content increases or decreases, respectively. Also, most soils are considerably weaker when they have high water contents or have not been drained prior to loading. This means that weather-related or seasonal fluctuations in groundwater levels can adversely affect permanent structures founded on undrained soils. Therefore, draining the saturated soils can increase their strength and stability. The lower the permeability of the subgrade soils, the closer together the drainage layers/zones shall be to provide effective dewatering.

The traditional methods of subgrade dewatering by digging a trench or providing a coarse aggregate drainage layer or a pipe system or use of fine sand as a filter are time consuming and costly and provide inconsistent properties. 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. Geotextiles have been used in toe drains of embankments where they are easily accessible if maintenance is required and where malfunction can be detected.

The excellent filtration and separation characteristics associated with filtration geotextiles permits the use of a single layer of an open graded base or trench aggregate enveloped in a geotextile. The thin filtration geotextile reduces the required excavation as well as the cost of the drained structural section. The increase in service life of flexible pavements by 25 percent and that of rigid pavements by 50 percent has been identified by use of an efficient functioning edge drain system using geotextile.

Filtration and separation fabrics are non-woven or woven polypropylene or polyester fabrics with specified strength characteristics used as permeable separators to restrain soil or other particles subjected to hydrodynamic forces while allowing the passage of fluids into or across a geotextile and to prevent inter-migration of adjacent soil layers of vastly different particle sizes and particle distributions. The primary geotextile characteristics influencing filter functions are opening size (as related to soil retention), flow capacity and clogging potential which are indirectly measured by the apparent opening size, permittivity and gradient ratio test. 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:

Sub-grade separation and stabilization applies geosynthetics to both unpaved and paved roads. When serving as a separator, the geotextile prevents fines from migrating into the base course and/or prevents base coarse aggregate from penetrating into the sub-grade. The soil retaining properties of the geotextile are basically the same as those required for drainage and filtration. Therefore, the retention and permeability criteria required for drainage shall be met. In addition, the geotextile shall withstand the stresses resulting from the load applied to the pavement. The nature of these stresses depends on the condition of the sub-grade, type of construction

equipment and the cover over the sub-grade. Since the geotextile serves to prevent aggregate from penetrating the sub-grade, it shall meet puncture, burst, grab and tear strengths required. At small rut depth, the strain in the geosynthetic is also small. In this case, the geosynthetic acts primarily as a separator between the soft sub-grade and the aggregate. Any geosynthetic that survives construction shall work as a separator. This application is limited to soils which either in initially or seasonably have a CBR > 3 but < 8. In this application the geotextile is a substitute for the choked subbase stone commonly used over plastic sub-grades. It is important to understand that this function may be required when geogrids are used to provide base reinforcement or confinement.

For larger rut depths, more strain is induced in the geosynthetic where the stiffness properties of geosynthetic are essential. A considerable reduction in aggregate thickness is possible by the use of geosynthetic having a high modulus in the direction perpendicular to the road centerline; however, the benefits of the geosynthetics are dependent on the membrane action achieved with a stiff geosynthetic as well as the lateral movement. For very weak sub-grades, it is often beneficial to combine the benefits of both separation and stabilization. The following general conclusion can be drawn relating to a typical road base:

a) A geosynthetic element that functions primarily as a separator (typically when the sub-grade CBR > 3) will increase the allowable bearing capacity of the sub-grade by 40 to 50 percent(*separation geotextiles*)

b) A geosynthetic element that functions primarily to provide confinement of the aggregate and lateral restraint to the sub-grade (typically when the sub-grade CBR < 3) will both increase the allowable bearing capacity of the sub-grade and provide an improved load distribution ratio in the aggregate. The combined benefits can enhance load carrying capacity of the road by well over 50 percent (*stabilization geogrids and geotextiles*).

The general rules for use of geogrids and geotextiles in roadway system are as follows:

a) Temporary roads — Used for hauling and access roads that are subject to low volume of traffic including working platform for permanent road construction:

    i) *Clayey or silty sub-grade with California Bearing Ratio (CBR) < 4* — If a clean base aggregate is used, then a non-woven separator geotextile shall be used. If a “choked aggregate” like general crusher run is used, then use either a geotextile or a biaxial geogrid that has good aperture stability and appropriate size for a design ESAL (Equivalent Single Axle Loading) less than 1 000, a woven geotextile designed for both separation and membrane roles may be used; that is, consider the geotextile’s modulus. For larger ESAL, use a woven or non woven geotextile designed simply for separation. The reinforcement role of the geogrid seems safe for approximately 10 000 ESAL.

ii) *Sandy sub-grade with CBR < 3* — Select a biaxial geogrid with good aperture stability and appropriate size or, a woven geotextile that has a reasonable interface friction with the sand and the aggregate. If a woven geotextile is considered, care shall be taken to ensure that it does not actually create a slick slip-plane beneath the aggregate, that is, look at the interface friction by using geotextiles with high surface roughness which leads to enhanced interface friction.

b) Permanent roads (ESAL > 200 000):

i) *Clayey or silty sub-grade with CBR < 3*— Consider building a working platform using the temporary road methods upon which conventional road can be constructed.

ii) *Clayey or silty sub-grade with 3 < CBR < 8* — If there is any potential for degradation due to water intrusion, frost heave, etc. then include a separator geotextile to protect the base aggregate during these periods.

iii) *Sandy sub-grades with CBR* < 3 — Use a biaxial geogrid that has good aperture stability and appropriate size to reinforce the base aggregate. This is particularly helpful when poor quality stone and small aggregate thickness is used, less than 25 cm.

Geosynthetics can also be used as inter layers by placing them below or within the overlay (asphalt concrete) and are thus helpful in rehabilitating distressed road surfaces. These may also provide a moisture barrier.

3) Permanent 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. The traditional system may use controlled thickness filter layers of graded sand which is very costly and difficult to construct especially on steep slopes.

Geotextiles with specific hydraulic and soil retention properties to complement the soil needing protection can be used as standard filter layers for hard armor systems as these can be installed with ease on slopes even under water and are cost effective. Depending upon the gradation of the bank soil, either a non-woven or a woven geotextile can be selected and used beneath hard armor system in an erosive environment.

The primary function of geotextile in permanent erosion control applications is filtration. Geotextile filtration properties are a function of site hydraulic conditions and the in-situ soil gradation, density, and plasticity.

Survivability of geotextiles is very important from the viewpoint of their long term durability and is defined as resistance to mechanical damage during construction and initial operation. The ability of a geotextile for permanent erosion control to survive installation and associated pressures during service shall be assured, if it is to perform as designed. Installation damage to a geotextile is a function of the following:

a) Geotextile thickness,
b) Type and weight of construction equipment used for fill spreading,
c) Grain size distribution of backfill,
d) Angularity of backfill,
e) Polymer used in the manufacture of geotextile, and
f) Geotextile manufacturing process.

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 issilt 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.

Indian Standard

GEOSYNTHETICS — GEOTEXTILES — SPECIFICATION

1 SCOPE

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

a) *Subsurface drainage applications*— drainage application such as subgrade dewatering, road base drainage and structure drainage by placing the geotextile against the soil to allow long-term passage of water into a subsurface drain system retaining the in-situ soil;

b) *Subgrade separation applications* — preventing mixing of a sub-grade soil and an aggregate cover material (subbase, base, select embankment, etc) in pavement structures. This specification is also applicable to situations other than beneath pavements where separation of two dissimilar materials is required but where water seepage through the geotextile is not a critical function;

c) *Subgrade stabilization applications* — wet and saturated soil conditions to provide the subgrade stabilization in pavement structures along with coincident functions of separation and filtration. In some installations, the geotextile can also provide the functions of reinforcement.

d) *Permanent erosion control applications* — between energy absorbing armor systems and the in-situ soil to prevent soil loss resulting in excessive scour and to prevent hydraulic uplift pressures causing instability of the permanent erosion control system. (permanent erosion control in hard armor systems).

e) Separation and Filtration in Railway Formation — 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 for its primary application as separation and secondary application as filtration.

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:

    i) *Subsurface drainage* — geotextile type, structure and associated details, shall be as shown on the contract drawings.
    ii) *Subgrade Separation* — geotextile type, cover material thickness, pavement cross-section and associated details, shall be as shown on the contract drawings.
    iii) *Subgrade Stabilization* — geotextile type, cover material thickness, pavement cross-section and associated details, shall be as shown on the contract drawings.
    iv) *Permanent 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 permanent 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:

   i) 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
   ii) 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

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 CLASSES

Geotextile material shall be of following three classes depending upon the survivability conditions:

a) *Class* 1 — For severe or harsh survivability conditions where there is a greater potential for geo-textile damage. Class 1 geotextiles are for applications where applied stresses are more severe, that is, very coarse shape angular aggregate is used, compaction is greater than 95 percent of maximum density as per IS 2720 (Part 15) or depth of trench is greater than 300 mm.

b) *Class* 2 — For typical survivability conditions; this is the default classification to be used in the absence of site specific information. Class 2 geotextiles are suitable for applications which are less severe, that is, smooth graded surfaces having no sharp angular aggregate, compaction is less than or equal to 95 percent of maximum density as per IS 2720 (Part 15).

c) *Class* 3 — For mild survivability conditions.

5 REQUIREMENTS

5.1 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.

5.2 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. The geo-textiles shall meet the requirements as given in Table 1.

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 Requirements for Geotextile of different classes

(*Clauses* 4, 5.1, 5.2, 5.3, 5.4 and 5.5)

Sl No.	**Property**	**Geo-Textile**						**Method of test, Ref to**
		Class 1		Class 2		Class 3		
		Strain < 50%	Strain > 50%	Strain < 50%	Strain > 50%	Strain < 50%	Strain > 50%	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
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)	Resistance to installation damage, percent retained strength, SC/SW/GP (*see* Note 2), *Min*	95/93/90						IS 17420
x)	Ultraviolet stability at 500 h, retained strength,	70						IS 13162 (Part 2)

	percent of original strength, Min		

NOTES

1 The parameter shall be tested, when product is supplied with seam. Refer to IS 16363 for stitch and overlap seam requirements.

2 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).

3 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.

4 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.

6 OTHER REQUIREMENTS

6.1 Sub-surface Drainage Requirements

6.1.1 The function of the drainage in this application refers to including a tensile member in the form of a geotextile against soil to protect coarse aggregate drains or used as a geotextile sandwiched aggregate blanket or as a three-dimensional plastic drainage core wrapped with a filtration geotextile.

6.1.2 The primary function of the geotextile is filtration. Geotextile filtration properties are a function of the in-situ soil gradation, plasticity and hydraulic conditions.

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

Table 2 Requirements of Geotextiles for Subsurface Drainage Applications
(*Clauses* 6.1.3 *and* 7.4)

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			
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

6.2 Subgrade Separation Requirements

6.2.1 The separation application is appropriate for pavement structures constructed over soils with
California Bearing Ratio greater than or equal to three (CBR ≥ 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.

6.2.2 The function of separation in this application refers to including 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.

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

Table 3 Requirements of Geotextiles for Separation Applications
(*Clauses* 6.2.3 *and* 7.4)

Sl No.	Property	Requirements	Method of test, Ref to
(1)	(2)	(3)	(4)
i)	Geo-textile class	Class 2 or Class 3	—
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.			

6.3 Subgrade Stabilization Requirements

6.3.1 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.

6.3.2 The function of stabilization in this application refers to including 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.

6.3.3 The design of geosynthetic-reinforced unpaved roadways has been simplified into design charts that relate aggregate thickness requirements to a range of subgrade strengths, based on standard highway design loading and various allowable rut depths.

6.3.4 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 Applications
(*Clauses* 6.3.4 *and* 7.4)

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.			

6.4 Permanent Erosion Control Requirements

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

6.4.2 The geo-textiles for permanent 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 Permanent Erosion Control Applications
(*Clauses* 6.4.2 *and* 7.4)

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			—

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

6.5 Separation and Filtration in Railway Formation Requirements

The non-woven geotextile to be used as separator/filtration layer (Primary role as separator and secondary role as filtration), shall meet the requirements as given in Table 6. The geotextile used as separator and filtration application can be devided into following two types:

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

Table 5 Requirements of Geotextiles for Separation and Filtration Applications
(*Clause* 6.5)

Sl No.	**Property**	**Requirements**		**Method of test, Ref to**
		Type 1	Type 2	
1	Type/Structure	Non-woven needle punched and mechanically or thermally bonded type or equivalent		-
2	**Mechanical**			
i)	Elongation at Failure, Percentage, *Min*	50		IS 16342
ii)	Grab Strength, N *Min*	700	1750	IS 16342
3	**Hydraulic Properties**			
i)	Apparent Opening size, Micron, *Max*	85		IS 14294
ii)	Water Flow Rate normal to the Plane, ltr/m^2/sec	20		IS 17179
4	**Survivability Properties**			
i)	Trapezoidal Tear Strength, N, *Min*	250	800	IS 14293

ii)	CBR Puncture Strength	1800	5800	IS 16078
5	**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 year service life)	50		IS 17360

7 SAMPLING AND CRITERIA FOR CONFORMITY

7.1 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.

7.2 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.

7.3 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.

7.4 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 or Table 5 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.

8 MARKING AND LABELLING

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

a) Identification of the geotextile material as per manufacturer's recommendation, for example, polyester multifilament woven geotextile for permanent erosion control;

b) Class of geotextile material, that is Class 1, Class 2 or Class 3;
c) Batch number, lot number and roll number;
d) Date of manufacture of geotextile material;
e) Any other information/instruction prescribed by the manufacturer or by the law in force;
f) Manufacturer's name, initials or trade-mark; and
g) The country of origin.

8.2 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.

9 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.

10 INFORMATION AND SAMPLES TO BE SUBMITTED BY THE MANUFACTURER

10.1 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.

11 STORAGE AND PROTECTION

11.1 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.

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

11.3 Lay the rolled materials flat or vertical on ends.

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

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

11.6 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 1670 : 1991	Textiles — Yarn – Determination of breaking load and elongation at break of single strand (*second revision*)
IS 1954 : 1990	Determination of length and width of woven fabrics — Methods (*second revision*)
IS 2720 (Part 15) : 1965	Methods of test for soils: Part 15 Determination of consolidation properties (*first revision)*
IS 6359 : 2023	Method for conditioning of textiles (*first revision*)
IS 13162 (Part 2) :	Geotextiles — Methods of test: Part2 Determination of resistance to

1991	the exposure of ultraviolet light and water (xenon-arc type apparatus)
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 16342:2015	Geosynthetics — Method of test for grab breaking load and elongation of geotextiles
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 17360 : 2020/ ISO 13438 : 2018	Geosynthetics Screening test method for determining the resistance of geotextiles and geotextile-related products to oxidation

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 ENVIORMENT 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 50 ml Flask

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.

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

ANNEX 8
(*Item* 6.1)

MANAK MANTHAN COMMENTS FROM SUBO ON 'IS 16391, IS 16392, IS 16393, IS 16362 AND IS 16090'

Commentator: MANAK MANTHAN

Comment:

COMMENT 'IS 16391 : 2015 GEOSYNTHETICS — GEOTEXTILES USED IN SUB-GRADE SEPARATION IN PAVEMENT STRUCTURES — SPECIFICATION'

Sl No	Clause No	Type of Comment	Comment	Mem Sec. Remarks
1	4.2	Editorial	UV stabilizer other than carbon black are also used.	
2	Table 1	Editorial	Elongation<50 % corresponds to woven and Elongation >50 % corresponds to non woven. Same should be clearly mentioned	
3		Editorial	Manak Manthan carried out on following five standards: IS16391 IS16392 IS16393 IS16362 IS16090 Above comments are related to all five standards	

ANNEX 9
(*Item* 6.2)

COMMENTS ON 'IS 18309 : 2023 GEOSYNTHETICS — PREFABRICATED VERTICAL DRAINS FOR QUICK CONSOLIDATION FOR VERY SOFT PLASTIC SOIL — SPECIFICATION'

Commentator: Tencate Geo Geosynthetics, Gurgaon

Comment:

COMMENTS ON 'IS 18309 : 2023 GEOSYNTHETICS — PREFABRICATED VERTICAL DRAINS FOR QUICK CONSOLIDATION FOR VERY SOFT PLASTIC SOIL — SPECIFICATION'

Kind attn: Mr.Himanshu Shukla
Scientist `B/ Assistant Director(Textile),BIS.

Sub: Request for Amendments in BIS document vide IS 18309: 2023

Geosynthetics - Prefabricated Vertical Drains for Quick Consolidation of Very Soft Plastic Soil

Dear Sir,

This is to briefly introduce ourselves as one of the leading Geosynthetics manufacturers having established plants to manufacture several Geosynthetics products across the world including USA, Europe & Asia.

We came to know that your good office has released IS Code for use of Prefabricated Vertical drains (PVD) for Quick Consolidation of Very Soft Plastic Soils vide IS 18309: 2023.

We wish to inform your good offices that we have been in the manufacturing of PVD's over few decades and have served several markets within Asia and other parts of the world. We have reviewed the IS Code 18309:2023 to check the most suitable PVD products we can offer by aligning to the requirement. The code (IS 18309:2023) is a very well drafted code with very useful technical insights. However, we have noted few corrections are essential in technical specifications Table -1 to enable most suitable products are offered to the projects at optimal cost and in a competitive environment. The details are presented below for your kind perusal:

1,Table — **1 : B) — Filter** ; **Clause-1** - Mass of the **Filter Jacket** : The properties mentioned in the Type-1 & Type 2 are on the high side considering the required mechanical properties (such as Wide width Tensile strength, Grab strength etc.).

Reason for Amendment: Mass is neither a design nor performance criterion. The filter Jacket can be as good as its mechanical and survivability characteristics such as Grab Tensile Strength etc. The present specification requiring the filter Jacket to comply 110 g/m2 in Type-1 & 120 g/m2 in Type-2 can only add cost burden on the exchequer without any contribution to the performance of the product.

Amendment required:

Mass may be either completely deleted off or amended as Type-1 : 70 g/m2 & Type-2 : 100g/m2

2, Table-1; A — **Clause I**v Elongation at Break percentage : The value mentioned shall have a range.

Reason for Amendment: The elongation of the overall drian shall not have unlimited elongation i.e > 40% as it will degrade the index properties. The elongation shall be within a range of 15%-50%.

Amendment Required: Elongation shall be given a range of 15% to 50%.

3. **Table-1. : B** — Clause iv : Grab Tensile Elongation: The value mentioned shall have a range

Reason for Amendment: The elongation of the Geotextile used for PVD shall not have unlimited elongation i.e > 40% as it will degrade the index properties. The elongation shall be within a range of 15%-50%.

Amendment Required : Elongation shall be given a range of 15% to 50%.

4. **Table-1 : A** — Clause V: Thickness for Type-1 : The value of thickness can range from 3mm to 5mm. For Type-1, the thickness can be 3mm as referred to in page-2, Clause 5.1 - IS 18309.

Reason for Amendment: The Thickness used for PVD's are in the range of 3mm to 5mm depending on the depth of the soft soil to be treated.

Amendment Required: Thickness for Type-1 shall be 3mm.

5**. Table-1 : A** — Clause VII: Roll length The Roll length is designed based on the optimal logistic arrangement and has no bearing on the performance of the drain.

Reason for Amendment: To accommodate optimal logistics arrangement to reduce cost.

Amendment Required: Roll length shall be 100m —300m

6. Table-1 : B — Clause VI: Trapezoidal Tear Strength : The value of Trapezoidal tear strength of 150N as mentioned for Type-2 is very high as can be desired technically or by any standards of design. In order to achieve Trapezoidal tear strength of 150N, the filter **Jacket has to be designed with a mass** > 1500172. This means a higher cost burden on the Project **without any positive impact on the performance** of the product nor rate of consolidation.
Reason for Amendment: To achieve safety, survivability, Performance and keep the cost of the product within optimal range, the value of Trapezoidal Tear strength of 100N (minimum) can be considered for Type-2.

Amendment Required: Trapezoidal Tear Strength of Filter Jacket in Type-2 can be amended as 100N instead of 150N.

We hereby request your good offices to review our submissions and consider amendments to the IS Code to enable projects to be designed to the most optimal scale and ensure technical excellence and economic sustainability.

Should you require any further information or clarifications on our above submission, please contact us

Yours sincerely,

K Nanda Kishore

Director and General Manager(Geosynthetics)

ANNEX 10
(*Item* 6.3)

COMMENT ON IS 17371: 2020 GEOSYNTHETICS — GEOGRIDS FOR FLEXIBLE PAVEMENTS — SPECIFICATION

commentator: POLYON TEXTILES PVT. LTD

comment:

COMMENT ON 'IS 17371: 2020 GEOSYNTHETICS — GEOGRIDS FOR FLEXIBLE PAVEMENTS — SPECIFICATION'

Request for Inclusion of Fibre Glass Geogrid in BIS 17371: 2020

Subject : Request for Inclusion of Fibre Glass Geogrid in BIS 17371: 2020

Further to the meeting with Dr Anup Rakshit of IITA at Mumbai and our earlier communication with you , we wish to highlight our concern on not including Glassgrid in BIS 17371 :2020 .

We understand that the mentioned code BIS 17371 is specifically on applications of Geogrids for Flexible pavements and hence request you to kindly consider including Glassgrid product in the mentioned code.

Currently in India ,Glassgrids are being extensively used in roads of National Highways , state PWDs and also major road concessionaires are using the product in maintenance projects .

Glassgrids are also being exported by Polyon Textiles to US, Europe and other Asian countries for road projects.

There are 3 manufacturers in India including Polyon Textiles that manufactures Glassgrid products and have their plants in India.

We shall be pleased to provide you technical details on the glassgrid product and the test methods that are being followed by Polyon to meet the quality requirements of the product.

We will be also keen to attend the future meetings that BIS and committee members may plan to address the mentioned subject matter.

Thank you and look forward to your kind reply .
Best regards,
Sudhir Ramakrishnan,

Polyon Textiles Pvt Ltd,
Mumbai
Email : sudhir@polyontextiles.com

From: sudhir@polyontextiles.com sudhir@polyontextiles.com
Sent: Wednesday, August 2, 2023 6:30 PM
To: txd@bis.gov.in
Cc: 'Deepak Polyon' <deepak@polyontextiles.com>; 'Dharmesh Harivallabhdas' <dharmesh@polyontextiles.com>

Subject: Request for Inclusion of Fibre Glass Geogrid in BIS 17371: 2020

Dear Mr Dharmbeer,

Greetings from POLYON Textiles -Arvind Group .

POLYON Textiles is the leading indigenous manufacturer of Glass Grid with the brand name **POLYGRID manufactured in India since 2017 under the Flagship brand Arvind Ltd.**

Polyon has been manufacturing and supplying the 'Glass grid'(branded as POLYGRID) with its manufacturing facility near Gandhinagar, Gujarat to various customers in India and Internationally for the last 6 years.

We have been actively working with Government Departments ,Large concessionaires and consultants providing value added technical solutions from design to installation using our POLYGRID Glass grid products for various applications that includes runways and road projects.

POLYGRID PT 1025 Self Adhesive Glass grid has been successfully used for resurfacing projects in Mumbai , Ahmedabad and Trivandrum Airport projects.
POLYGRID Glass grid has also been successfully used in roads in various projects of NHAI,PWD Delhi, PWD GMADA Punjab and RNB Gujarat in the country .

We wish to kindly inform that Fiberglass geogrids being widely used for flexible road pavement projects in the country has no mention in the relevant BIS 17371: 2020 Geogrids for flexible pavements . Presently the BIS 17371 : 2020 focuses only on PET and PP Geogrids that has limited applications in flexible pavements .

We will be highly obliged if you can kindly incorporate the Glassgrid product in the BIS 17371: 2020 standard to help us to promote our product and provide value added technical solutions and services to the Infrastructure sector in the country. There are 3 indigenous manufacturers of Glassgrids having their manufacturing plants in India .

We shall be pleased to provide any further details and clarifications regarding the glassgrid product and will be ready to meet in person on the above subject matter.

Please find attached our company profile for your kind consideration.

Thank you and look forward to your reply.

Best regards,
Sudhir Ramakrishnan

ANNEX 11
(*Item* 7.1)

INPUTS ON IS 13325 : 1992, IS 13326 : Part 1 : 1992, IS 14293 : 1995

Inputs from: The Bombay Textile Research Association, Mumbai

Inputs:

INPUTS ON 'IS 13325 : 1992, IS 13326 : Part 1 : 1992, IS 14293 : 1995'

Dear Sir,

As suggested, standards are reviewed thoroughly and changes are mentioned in track change mode. No change is required in IS 14293. Attached the standards with changes. Please feel free to ask if you have any questions.

Regards

IS 13325 : 1992 DETERMINATION OF TENSILE PROPERTIES OF EXTRUDED POLYMER GEOGRTDS USING THE WIDE STRIP - TEST METHOD

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Geosynthetics Sectional Committee had been approved by the Civil Engineering Division Council.

Use of Geosynthetics in the form of geotextiles, geogrid, geomembrane and Geocomposites, etc, are becoming popular in civil engineering applications mainly to improve or modify soil/rock behavior.

With a view to encourage the use of geosynthetic in the civil engineering problems, a number of Indian Standards are under preparation, based on the limited experience gained so far. This standard is one of this series.

In the formulation of this standard, assistance has been derived from the following:
BS 1610 Material testing machines and force verification equipments: Part 1 Specification for the grading of the forces applied by materials testing machines. British
Standards Institution.

ASTM D 76 Specification for tensile testing machine for textiles. American Society for Testing and Materials.

ASTM D 4595 Standard test method for tensile properties of geotextiles by wide-width strip method. American Society for Testing and materials.

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 ‘Rules for rounding off numerical values (*revised*)‘. 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

DETERMINATION OFTENSILE PROPERTIES OF EXTRUDED POLYMER GEOGRIDS USING THE WIDE STRIP-TEST METHOD

1 SCOPE

1.1 This standard covers the test method for the measurement of tensile properties of extruded polymer geogrids using a wide strip specimen.

1.1.1 Measurement of load and elongation characteristics and procedures for calculations of secant modulus; maximum load, breaking load, elastic limit, strain at maximum load and strain at breaking load are also covered in the test method prescribed.

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 editions of the standards indicated in Annex A.

3 TERMINOLOGY

3.1 The terms defined in IS 13321 (Part 1) shall apply.

4 PRINCIPLE OF WIDE STRIP TEST METHOD

4.1 A test specimen is held across the entire width in the jaws of a tensile testing machine which operates at a specified constant rate of extension and which applied a tensile force to the test specimen until the specimen ruptures. The tensile properties of the test specimen are calculated from machine scale, dials, autographic recording charts or an interfaced computer.

5 APPARATUS AND REAGENTS

5.1 Tensile Testing Machine

A constant rate of extension tensile testing machine which produces a rate of increase of specimen length that is uniform with time. While using the constant rate of extension type tensile tester, recorder must have adequate pen response to properly record the force elongation curve as specified.

5.2 Jaws

Jaws shall be sufficiently wide to hold the entire width of the specimen and shall have appropriate means to prevent slippage damage. Each jaw shall have face measuring at least the width of the specimen, 200 mm, or greater (Fig. 1).

5.3 Jig Plates

For conducting the index tensile strength test it is required to hold the geogrids between the clamps. For this it is necessary to cement upper and lower ribs of geogrid specimen metal strips with the help of a binder before their placement in the clamps. In order to ensure that the metal strips are perfectly parallel to one another special jig plates are required and should be fabricated for a particular geogrid. In this the geogrids are placed between the aluminium (Fig. 2) strips (200 × 30 × 6 mm) coated with epoxy resin and curved for 24 hours under a dead load of 20 kg. This is found to provide support proper bond between the strip and the geogrid.

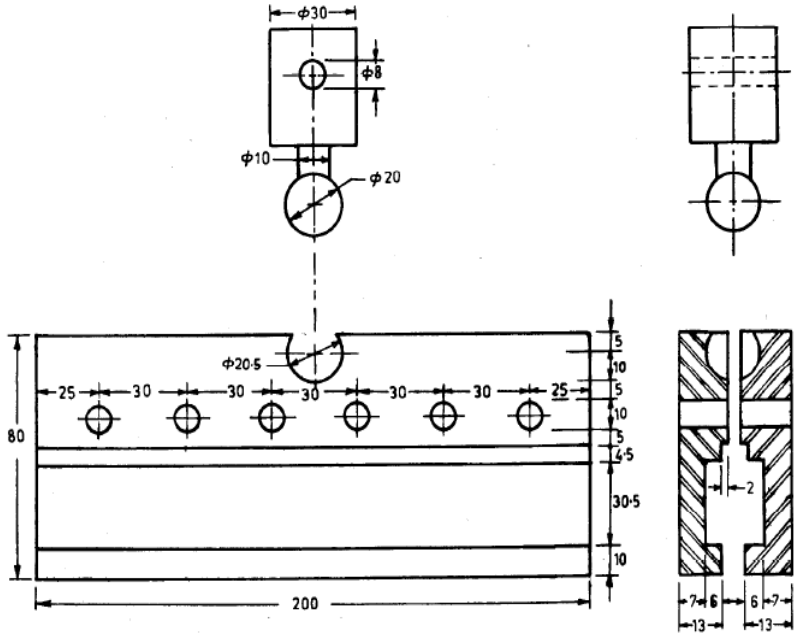
5.3.1 An assembly diagram is shown in Fig. 3.

6 TEST SPECIMENS

6.1 Number of Test Specimens At least five test specimens in both the machine direction and the cross machine direction are required to be tested.

6.2 Selection of Test Specimens

Specimens shall be selected at random from the laboratory samples. Choose those for the measurement of the machine-direction tensile properties from different positions across the width of the sample and those for the measurement of the cross-machine-direction tensile strength from different positions along the length of the sample, unless otherwise agreed. No specimen shall be taken nearer than 100 mm from the selvedge or edge of the sample.



All dimensions in millimetres.

FIG. 1 TYPICAL WIDE-WIDTH JAWS

6.3 For extruded geogrids, prepare specimen at least 200 mm wide and sufficiently long to ensure a gauge length of at least 100 mm measuring within ± 3 mm.

NOTE— The gauge length of geogrid is the distance between the centre-line of the elements to be contained within the jaws.

6.4 The test specimen shall contain at least five complete tensile elements within the width of the test specimen and at least one row of nodes or cross-members, excluding the nodes or cross-members by which the test specimen is held in the jaws. Cut all ribs at least 10 mm away from any node.

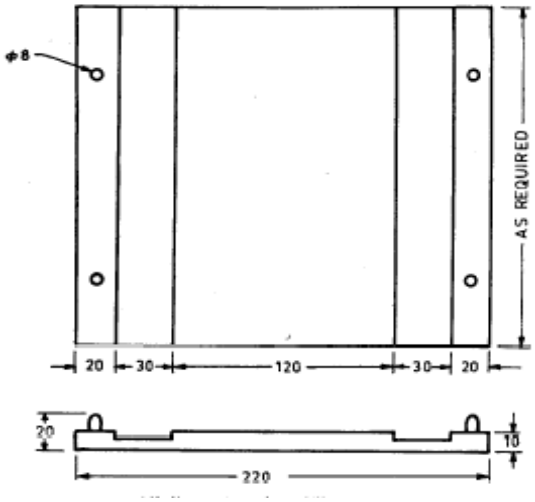
7 PROCEDIJRE

7.1 Setting up of Tensile Testing Machine

Adjust the distance between the jaws/clamps at the start of the test to give a gauge length of l00+/-3 mm or as appropriate for geogrids. Select the force range of the tensile testing machine such that the break occurs between 10 percent and 90 percent of full-scale force. Set the machine to a strain rate of 7 percent per minute to 13 percent per minute.

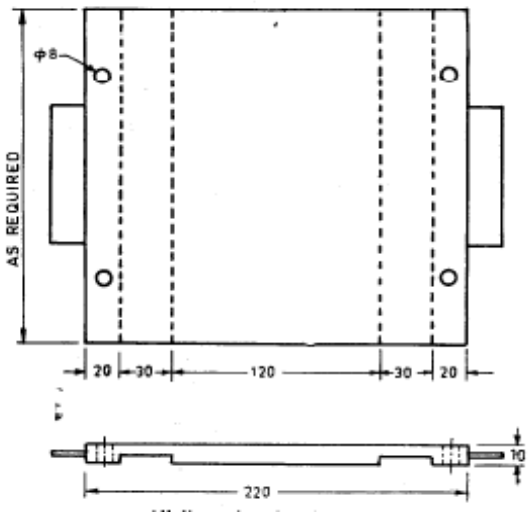
7.2 Insertion of Test Specimen in Jaws/Clamps

Mount the test specimen centrally in the jaws with approximately the same length of test specimen extending beyond the jaws at each end, ensuring that the specimen length in the machine and cross-machine direction tests is parallel to the direction of applied force. This shall be done by having the two lines, which are previously drawn at 100 +/-3 mm apart across the width of the specimen positioned adjacent to the inner edges of upper and lower jaws.



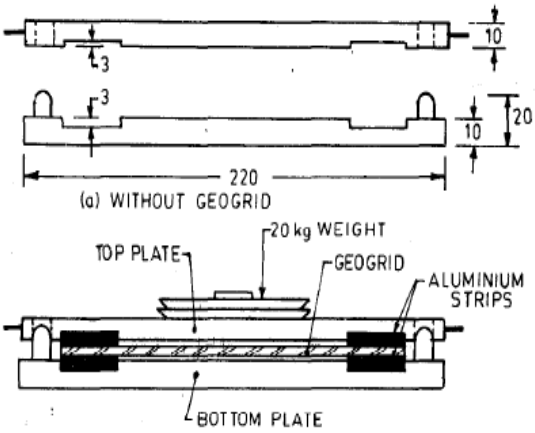
All dimensions in millimetres.

FIG. 2A TYPICAL JIG PLATE-BOSOM



All dimensions in millimetres.

FIG. 2B TYPICAL JIG PLATE-TOP



(b) WITH GEOGRID

FIG. 3 TYPICAL ASSEMBLYO F JIG PLATES

7.3 Measurement of Tensile Strength

7.3.1 Start the tensile testing machine and the area measuring device, if used. Continue running test to rupture. Stop the machine and reset the initial gauge position. Record the load to the nearest 0.1 kN/m and the strain to the nearest 0.1 percent.

7.3.2 For fixed clamping systems such as compressive or profiled jaw, or where specimens are set in epoxy resin or metal, determine the strain from the transverse head movement.

7.3.3 For frictional clamping systems, measure the strain by extensometer and adjust the transverse head movement to give a strain rate of 7 percent per minute to 13 percent per minute**.**

7.3.4 If the test specimen slips at the edge of/ or in the jaws, for any reason attributed to faulty operation, the result fails markedly below average for the set of specimens, discard the result and test another specimen. Continue until the required number of acceptable break have been obtained. Do not discard any other break unless the test is known to be faulty.

7.3.5 If a test specimen slips in the jaws or if more than one-quarter of the specimens break at a point within 5 mm of the edge of the jaw, then it is permissible for the jaws to be padded; the test

specimen to be coated under the jaw face area; or the jaw face to be modified. If any of these modifications are used, state the method of modifications in the test report.

7.4 Measurement of Strain

7.4.1 Measure the strain at any stated force by means of a suitable autographic recording device, at the same time as the breaking load is determined, unless otherwise agreed upon. Measure the increase in length to an accuracy of 0.1 percent.

7.4.2 A measured strain within the specimen can be obtained from jaw to jaw measurement by gauging along the central axis between the jaws across the central 76 mm of the specimen. These measurements can be made using a scaled rule taped on a line on the upper end of the specimen, in the gauge area, and recording the change in length as measured from a line spaced 76 mm below the upper line. In addition, the centre portion of the specimen can be gauged using Linearly Variable Differential Transover (LVDT) or mechanical gauges. By comparing it can be determined if slippage is occurring in the clamps.

8 CALCULATION

8.1 Maximum Load

Calculate the maximum load per unit width α_f expressed in kN/m directly from the information obtained from the tensile testing machine using the following equation:

$$\alpha_f = F_f \times C$$

where

F_f is the observed maximum load in kN.
C is a constant obtained as:

$$C = N_m / N_s$$

where

Nm is the number of tensile elements within 1 m width of the product being tested.
Ns is the number of tensile elements within the test specimen.

8.2 Breaking Load

Calculate the breaking load per unit width W, expressed in kN/m directly from the information obtained from the tensile testing machine using the following equation:

$$\alpha_b = F_b \times C$$

where

F_b is the observed breaking load in kN, as at point G in Fig. 4.
C is a constant obtained as in **8.1**.

8.3 Elastic Limit

Record the elastic limit in kN/m and the strain in percent at the elastic limit.

8.4 Offset strain

Calculate the offset strain in percent (*see* Fig. 4).

8.5 Strain at Maximum Load

Record the strain in percent at the maximum load (*see* Fig. 4).

8.6 Strain at Breaking Load

Calculate the offset strain in percent (*see* Fig. 4).

8.7 Offset Modulus

For geosynthetics with a linear load-strain relationship [*see* Fig. 4(a)]. Extrapolate the linear region (CD) to the zero load axis (B). Calculate the offset modulus from the following equation:

$$J = \frac{F}{e \times W} \times 100$$

where

J is the offset modulus (in kN/m) at strain *e*.
F is the determined load at strain e (in kN).
e is the corresponding strain (in percent) [e is equal to BH in Fig. 4(a)].
W is the specimen width (in m).

8.8 Secant Modulus

For geosynthetics with a non-linear load-strain relationship [*see* Fig. 4(b)] determine the load for the specified strain. If not specified, determine the secant modulus at a strain of 10 percent. Calculate the secant modulus using the following equation:

$$J = \frac{F}{e \times W} \times 100$$

Where

Where

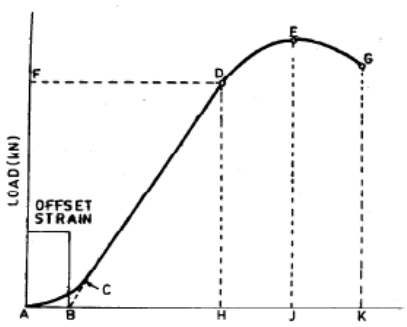
J is the secant modulus (in kN/m) at the specified strain e;

F is the determined load at strain e in kN.
e is the corresponding strain (in percent [e is equal to AN in Fig. 4(b)]; and
W is the specimen width (in m).

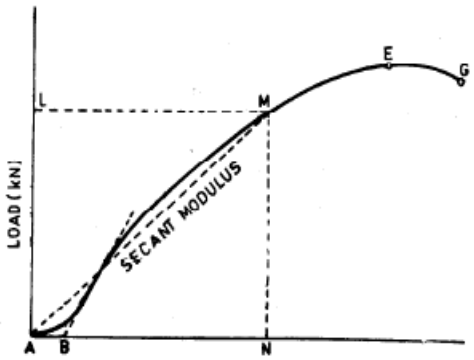
9 TEST REPORT

9.1 The test report shall include the following particulars:

a) the number and date of this standard;
b) identification of the sample tested and size;
c) the mean elastic limit, breaking load and maximum load in both the machine direction and cross-machine direction, expressed as in **8**;
d) the mean strain and offset strain at a specified load in both the machine direction and cross-machine direction, expressed as in **8;**
e) the mean offset modulus and/or the mean secant modulus expressed as it in **8**;
f) the condition of the test specimens, i.e. wet or dry;
g) the number of test specimens tested in each direction;
h) the make and model of tensile testing machine;
j) the type of jaw, including the dimensions of the jaws and the type of jaw faces used;
k) the standard deviation or coefficient of any of the properties determined;
m) a load-strain curve; and
n) details of any deviations from the specified procedure.



STRAIN (%)
(a) LINEAR BEHAVIOUR



STRAIN (%)

(b) NON-LINEAR BEHAVIOUR

,

FIG. 4 TYPICAL LOAD-STRAIN GRAPHS

ANNEX A

(*Clause* 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*
IS 13321 (Part 1) :2022	Geosynthetics Part 1: Terms and definitions

IS 13326 : PART 1 : 1992 EVALUATION OF INTERFACE FRICTION BETWEEN GEOSYNTHETICS AND SOIL METHOD OF TEST: PART 1 MODIFIED DIRECT SHEAR TECHNIQUE

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Geosynthetics Sectional Committee had been approved by the Civil Engineering Division Council.

Coefficient of interface friction between a given soil (including aggregate and ballast) and a geosynthetic (geotextile/geogrid/geomembrane/geocomposite) used for reinforcement purposes is a design parameter in several applications like embankments on soft foundations, road construction, reinforced walls and embankments for slope protection. This coefficient is a

function of the nature of the geosynthetic surface, the soil and the normal stress. The total shearing resistance may be a combination of sliding and rolling friction and interlocking of the grains in the geosynthetic. The method of test does not distinguish between the mechanism for comparison purposes tests shall be performed using the same soil and in the same normal stress range. The tests may be conducted in dry or wet condition.

In all these applications stated above, the geosynthetic is required to carry load, through the friction developed between the soil and geosynthetic. This method of test is also applicable for assessing the friction between a geomembranes and the natural or compacted soil in order to analyse the stability of the canal/reservoir linings.

At present there are two types of test methods for the determination of interface friction between soil and geosynthetic that are in use the world over. These are the modified direct shear test and the pull out test. In the former, the soil is allowed to slide over the geosynthetic and the test is conducted in a manner similar to that of conventional direct shear test. In the second type of test, the geosynthetic is pulled out after it is embedded in soil.

This part deals with the modified direct shear test method.

In the formulation of this standard, assistance have been derived from the following publications:

i. "Geotextile Engineering Manual", published by Federal High Way Administration (FHWA) — 84, Catalog No. PB 86-149457, March 1985.
ii. "Technical Memorandum (Bridges) BE 3/78 Reinforced Earth Retaining Walls and Bridge Abutments for Embankments," issued by Department of Transport, U. K. (1978)
iii. "Test Methods and Physical Properties of Tensar Geogrids" published by Netton Ltd Black Burn, U. K. (1986).

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 ‘Rules for rounding off numerical values (*revised*).’ 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

EVALUATION OF INTERFACE FRICTION BETWEEN GEOSYNTHETICS AND SOIL — METHOD OF TEST

PART 1 MODIFIED DIRECT SHEAR TECHNIQUE

1 SCOPE

This standard covers the method of determination of the coefficient of interface friction between a soil (including aggregate and ballast) and a geosynthetic be the modified direct shear technique.

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 editions of the standards indicated in Annex A.

3 TERMINOLOGY

3.1 Terms and definitions as covered in IS 13321 (Part 1) shall apply.

4 APPARATUS

4.1 Apparatus to be used for the test shall conform to IS* (*under preparation*). However shear box conforming to IS 11593 may also be used subject to the following modifications.

a) The bottom half of the box should have facility to be made into a solid block by placement of mild steel (chromium plated) spacer 300 × 300 × 75 mm. Once the spacer is placed the top of this half of the box should be plane.
b) Two mild steel strips 350 × 25 × 5 mm which can be clamped into the two outer sides of the bottom half of the shear box by six screws, in order to hold the geosynthetic test fabric securely in the direction of shear.

Clause* **2.2 to **2.7** (except 2.2 (c) of IS 2720 (Part 39/Sec 1) : 1977 (including amendment No. 1) may be referred till such time, an Indian Standard on the apparatus is prepared.

NOTE — In case the 15 D85 of the soil to be tested is less than 60 mm size then the small shear box, i.e. 60 × 60 × 24 mm conforming to IS 11229 can be made use of with appropriate modification, as suggested in **4.1** (a) and (b).

4.2 Miscellaneous equipment as required for trimming geosynthetic specimens may be used.

5 SAMPLING

5.1 Number of samples and their location shall be in accordance with the relevant specification. However, in the absence of any stipulation, at least three samples from locations near each end and the centre of the lot under investigation, shall be selected. All samples shall be cut with a sharp device to minimise ravelling, tearing, or undue strain of the sample; marked to show the machine direction; labelled; and stored and handled in such ways as to protect the fabric from damage or deterioration prior to testing.

6 PREPARATION OF SPECIFICATION -

6.1 Geosynthetic specimens in the required direction shall be cut large enough to fit loosely over the soil containeis with sufficient excess for clamping. Enough specimens shall be cut to provide a new specimen for each test, with a particular normal stress. If the specimens are to be tested wet, they shall be soaked for 24 hours.

6.2 The soil to be used for the test can be the same as is likely to be used in the field. Standards and conforming to IS 651 may also be used.

7 PROCEDURE

7.1 The spacer is fitted into the bottom half of the shear box. Then the geosynthetic test specimen is fixed on its top so that the top face of the material is flush with the top edge of the lower half of the box. Geotextile needs to be fixed on two sides whereas geogrid is fixed only on one side opposite to the direction of shearing.

7.2 The top half of the shear box is then assembled and the soil is filled to the required density and the loading plate positioned.

7.3 The shear box is placed in the container carefully.

7.4 The required normal load is then applied. The test is usually conducted at normal stresses of 50, 100 and 200 KPa. The maximum normal stress shall be equal to the maximum vertical pressure in the fill as obtained from the design calculations. Flood the container with water, if wet test is desired.

7.5 The upper half of the box is lifted up slightly to leave a gap of about 1 mm between the two parts of the box.

7.6 The shear strain should be applied using a deformation rate of 0.20 mm/min.

7.7 The shearing is continued until the shearing load becomes essentially constant or until a displacement of 60 mm is reached whichever is larger.

7.8 During the shearing, the shearing loads and vertical deformation shall be measured at regular intervals of shear deformation.

7.9 After the completion of the test, the apparatus is dismantled, the geosynthetic is removed and its condition is observed.

7.10 The test is repeated for all the three normal stress levels.

8 CALCULATIONS

8.1 The results of test may be recorded as shown in Annex B. For each test, the ratio of the peak shear stress to the corresponding normal stress is calculated. The mean of the three ratios so obtained is reported as the coefficient of interface friction between the fill and the geosynthetic.

9 REPORT

9.1 The following shall be included in the report:

a) Specimen identification;
b) Soil description/identification;
c) Description of test apparatus;
d) Applied normal stress, KPa;
e) Peak shear stress, KPa;
f) Strain at peak shear stress, %;
g) Plots of shear stress versus shear strain at different normal stresses;
h) Plots of maximum shear stress vs normal stress;
j) Plots of vertical deformation vs shear strain at different normal stresses; and
k) Coefficient of interface frictions.

ANNEX A

(*Clause* 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*
IS 651 : 2007	Glazed stoneware pipes and fittings - Specification (*Sixth Revision*)

IS 11229 : 1985	Shear box for testing for soils specification
IS 11593 : 1986	Shear box (large) for testing of soils — specification
IS 13321 (Part 1) : 2022	Geosynthetics Part 1: Terms and definitions

ANNEX B

(*Clause* 8.1)

PROFORMA FOR RECORDING TEST RESULTS

Project... . . . . Location of sample . . . . . .
Rate of shear strain . . . . . Sample No . . . . . .
Weight of loading frame . . . . . Proving ring No . . . . . .
Normal load applied . . . . . Proving ring constant . . . . . .
.

Geosynthetic Specimen Measurements

Dimensions... . . . .., ... Area . . . . . .
……
Colour .., ...,... . .,. .,..... . . . . . Thickness ……
……..
Grid aperture .,...,. . . . . Trade Mark . . . . . .

Direction of shear . . . . . .
Machine or cross machine

Soil Specimen Measurements

Dimensions . . . . Area of specimen . . . . . .
Initial wet mass of specimen . . . . . Volume of specimen . . . .
Water content..... Final wet mass of specimen . . . .
Bulk density..... Water content at the shear zone . . . . . .

Recording Shear Stage

i) Thickness of specimen…… mm ii) Area of cross-section of specimen…….. cm^2
iii) Rate of shearing…….mm/min iv) Normal stress applied ……... kg/cm^2

Date and time	**Shear Displacement Dial Reading**	**Shear Displacement**	**Proving Ring Reading**	**Shear Force**	**Shear Stress**	**Vertical Dial Reading**	**Vertical Displacement**
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Plot — shear stress versus shear displacement and find: a) Maximum shear stress at the peak of curve, and b) Corresponding shear displacement.							

Recording Summary for Results

Test No.	**Normal Stress**	**Shear Stress at Failure**	**Shear Displacement at Failure**	**Initial Water Content**	**Final Water Content**	**Remark**
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Plot — shear stress versus normal stress relationship to obtain: a) Cohesion intercept, and b) Angle of shearing resistance.						

IS 14293 : 1995 GEOTEXTILES - METHOD OF TEST FOR TRAPEZOID TEARING STRENGTH

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Geotextiles Sectional Committee had been approved by the Textile Division Council.

In the preparation of this standard assistance has been drawn from ASTM Designation: 4533-85 'Standard test method for trapezoid tear strength of geotextiles', issued by the American Society for Testing and Materials, USA.

In reporting the result of a test or analysis made in accordance with this standard, if the final value,
observed or calculated, is to be rounded off, it shall be done in accordance with IS 2 'Rules for rounding off numerical values (*revised*)'

Indian Standard

GEOTEXTILES — METHOD OF TEST FO TRAPEZOID TEARING STRENGTH

1 SCOPE

1.1 This test method is used to measure the tearing strength of woven or non-woven geotextiles by the trapezoid method.

1.2 This test method may be used with constant-rate-of-traverse (CRT) or constant-rate-of-extension (CRE) type tension machines. However, there may be no overall correlation between the results obtained with the CRT machine and the CRE machine. Consequently, these two tension testers cannot be used interchangeably. In case of controversy, the CRE machine shall prevail.

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 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 indicated in Annex A.

3 TERMINOLOGY

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

4 PRINCIPLE

An outline of an isosceles trapezoid is marked on a rectangular specimen cut for the determination of tearing strength (*see* Fig. l), and the non-parallel sides of the trapezoid marked on the specimen are clamped in parallel jaws of a tensile testing machine. The separation of the jaws is continuously
increased so the tear propagates across the specimen. At the same time, the force developed is recorded. The tearing strength, which is the maximum value of the tearing force, is obtained from the autographic force-extension curve (*see* Fig. 2).

5 APPARATUS

5.1 Tensile Testing Machine, of the constant-rate-of-extension (CRE) or constant-rate-of-traverse (CRT) type with autographic recorder.

5.2 Clamps, of sufficient width to accommodate the full width of a test piece.

5.3 Trapezoidal Template-having the dimensions as shown in Fig. 1.

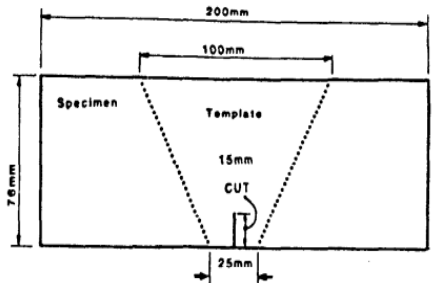
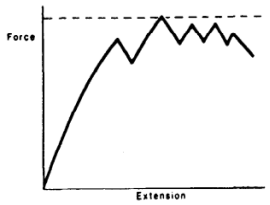
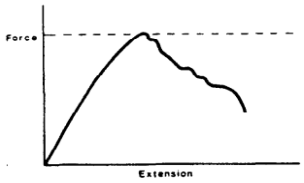


FIG:1 TRAPEZOIDALTEMPLATE FORTRAPEZOIDTEAFUNGSTRENGTHTEST



2A Fabric Exhibiting Several Maxima



2B Fabric Exhibiting Single Maximum

FIG. 2 TYPICAL TEARING FORCE-EXTENSION CURVES FOR INDIVIDUAL TEST SPICEMENS

6 PREPARATION OF TEST SPECIMEN

6.1 For woven fabrics, take the specimens to be used for the measurement of the tearing strength of machine direction yarns from different sets of machine direction yarns and the specimens to be
used for the measurement of the tearing strength of cross-machine direction yarns from different sets of cross-machine direction yarns and, when possible, from fabric woven from different bobbins. In case of non-woven fabrics take the specimens for the measurement of the machine direction tearing strength from different positions across the fabric and for the measurement of the cross-machine direction tearing strength from different positions along the length of the fabric.

6.2 Cut rectangular specimens of 76 mm × 200 mm in such a way that no specimens are taken nearer the selvedge or edge of the fabric than 1/20th of the fabric width or, 150 mm whichever is smaller. Cut the specimens to be used for the measurement of the tearing strength in the machine direction (or warp yarns), with the longer dimension parallel to the machine direction (or warp yarns). Cut the specimens to be used for the measurement of the tearing strength in the cross-machine direction (or weft yarns) with the longer dimension parallel to the cross-machine direction (or weft yarns). Mark each specimen with an isosceles trapezoid template (*see* Fig.1). Make a preliminary cut 15 mm long at the centre of the 25 mm edge, as shown in Fig. 1.

6.3 The number of specimens shall be as agreed to between the buyer and the seller subject to a minimum of 5 in each direction.

7 CONDITIONING

7.1 Bring the specimens to moisture equilibrium in the atmosphere for testing textiles as specified in IS 6359.

7.2 Specimens to be tested in the wet condition shall be immersed in water maintained at a temperature of 27 ± 2°C. The time of immersion shall be sufficient to wet out the specimens thoroughly; this is indicated by no significant change in strength or elongation following a longer period of immersion, and shall be at least 2 minutes. To obtain thorough wetting, it may be

necessary and advisable to add not more than 0.05 percent of a non-ionic neutral wetting agent to the water.

8 PROCEDURE

8.1 Test the conditioned specimens in the standard atmosphere for testing as defined in IS 6359.

8.2 Test the thoroughly wet specimen in the normal machine setup within 2 minutes after removal from the water.

8.3 Set the distance between the clamps at the start of the test at 25 ± 1 mm. Select the load range of the testing machine such that the maximum load occurs between 15 and 85 percent of full-scale load. Set the machine to operate at a speed of 300 ± 10 mm/min.

8.4 Secure the test specimen in the machine, clamping along the non-parallel sides of the trapezoid so that the end edges of the clamps are in line with the 25 mm long side of the trapezoid, and the cut is halfway between the clamps. Hold the short edge tight and let the remaining fabric lie in folds.

8.5 Start the machine and record the tearing force on the autographic recorder. The tearing force may not increase to a simple maximum value, but may show several maxima and minima, as shown in Fig. 2A. Record the maximum force obtained in Newtons, as illustrated in Fig. 2A and 2B.

8.6 If a fabric slips in the jaws or if 25 percent or more of the specimens break at a point within 5 mm of the edge of the jaw, then (a) the jaws may be padded; (b) the fabric may be coated under the jaw face area; or (c) the jaw face may be modified. If any of the modifications listed above are used, state the method of modification in the report.

8.7 If an individual test result deviates 25 percent or more from the average test result of a swatch, it shall be discarded and an additional specimen tested. Calculate the average excluding outlier values.

9 CALCULATION

Calculate separately the average of the maximum tearing strengths of the machine direction (or warp) specimens and the average of the maximum tearing strengths of the cross-machine direction (or weft) specimens.

10 REPORT

The report shall include the following:

a) State that the tests were performed as directed in this test method. Describe the material(s) or product(s) sampled and the method of sampling used.

b) Report the following information for each sample:

1) Average of the maximum tearing strengths in Newtons for each direction,
2) Number of specimens tested for each direction,
3) Coefficient of variation of the observed tearing strength of individual specimens, if required, and
4) Condition of the specimens (dry or wet).

ANNEX A

(*Clause* 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*
SP 45 : 1988	Handbook on glossary of textile terms
6359 : 2023	Method for conditioning of textiles (*first revision*)
3321 (Part 1) : 2022	Geosynthetics Part 1: Terms and definitions

INPUTS ON IS 14294 : 1995, IS 14324 : 1995, IS 14706 : 1999

Inputs from: Landmark Material Testing and Research Laboratory Private Limited, Jaipuron

Inputs:

INPUTS ON 'IS 14294 : 1995, IS 14324 : 1995, IS 14706 : 1999'

IS 14294 : 1995 GEOTEXTILES - METHOD FOR DETERMINATION OF APPARENT OPENING SIZE BY DRY SIEVING TECHNIQUE

AMENDMENT NO. 1 JULY 2003
TO
IS 14294 : 1995 GEOTEXTILES — METHOD FOR DETERMINATION OF APPARENT OPENING SIZE BY DRY SIEVING TECHNIQUE

(*Page* 1, *clause* **1**) — Substitute the following for the existing clause:

'**1 SCOPE**
This Indian Standard specifies method to determine apparent opening size (AOS) by dry sieving technique. This method is suitable for AOS 60 microns and above'

(*Page* 1, *clause* **4**, *line* 4) — Delete the word 'laterally'.

[*Page* 1, *clauses* **4**, **5.3**, **6.3**, **7.3**, **7.4**, **7.6**, **7.7**, **8.1**, **8.2**, **8.3**, **9(b), 9(c),**
Notes under clauses **7.6** and **8.4**, and Table under Annex A)] — Substitute the words 'beads' or 'glass beads' wherever existing by the words 'glass beads or graded sand particles'.

(*Page* 1, *clause* **5.3** *line* 1) — Substitute '**Spherical Glass Beads or Graded Sand Particles' for 'Spherical Glass Beads'**

(*Page* 1, *clause* **5.3**, *line* 5) — Substitute 'fractions' for 'beads'.

(*Page* 1, *clause* **5.7**) — Substitute the following for the existing:

'**5.7 Pan, for Collecting Sieved Beads or Graded Sand Particles**'

(*Page* 2, *clause* **7.5**) — Substitute the following for the existing clause:

'**7.5** Place cover and pan on sieve frame and place it in sieve shaker. Shake the sieve horizontally as well as vertically for 10 min.'

(*Page* 2, *Note under clause* **7.8**) — Delete the word 'bead' or 'beads' or 'glass beads' wherever exist

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Geotextiles Sectional Committee had been approved by the Textile Division Council.

Using a geotextile as a medium to retain soil particles necessitates compatibility between it and the adjacent soil. This test method is used to indicate the apparent opening size of a geotextile, which reflects the approximate largest opening dimension available for soil to pass through.

In the preparation of this standard assistance has been drawn from ASTM Designation : D4751-87 'Standard test method for determining apparent opening size of a geotextile', issued by the American Society for Testing and Materials, USA.

In reporting the results of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS 2 'Rules for rounding off numerical values (*revised*)' .

Indian Standard

GEOTEXTILES — METHOD FOR DETERMINATION OF APPARENT OPENING SIZE BY DRY SIEVING TECHNIQUE

1 SCOPE

This Indian Standard specifies method to determine apparent opening size (AOS) by dry sieving technique. This method is suitable for AOS 60 microns and above.

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 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 indicated in Annex A.

3 TERMINOLOGY

For the purpose of this standard definitions as given in IS 13321 (Part 1) shall apply.

4 PRINCIPLE

A specimen of geotextile is placed in a sieve frame and sized glass beads are placed on the geotextile surface. The geotextile and frame are shaken so that the jarring motion will induce the beads to pass through the test specimen. The procedure is repeated on the same specimen with various size glass beads until its apparent opening size has been determined.

5 APPARATUS

5.1 Mechanical Sieve Shaker — A mechanical sieve shaker, if used, shall impart a vertical, or lateral and vertical, motion to the sieve, causing the particles thereon to bounce and return so as to
present different orientations to the sieving surface.

5.2 Pan, Cover and 200 mm Diameter Sieves

5.3 Spherical Glass Beads or Graded Sand Particles, in size fractions in accordance with Table 1. It is only necessary to have on hand the glass beads size fractions necessary for the range of geotextiles for which testing is anticipated. The sizing of all beads shall be verified prior to each use by sieving on the pairs of selves shown in Table 1. Prepare at least 50 g of each size beads to be used prior to beginning the test.

5.4 Balance, having a capacity adequate for the mass of samples anticipated and accurate to ± 0.05 g.

5.5 Static Elimination, to prevent the accumulation of static electricity when the beads arc shaken on the surface of geotextile. Commercially available devices or 'anti-static' sprays are acceptable.

5.6 Drying Oven

5.7 Pan, for Collecting Sieved Beads or Graded Sand Particles

5.8 Flexible Rubber Ring

Commented [p1]: New added

Table 1 Glass Bead Sizes
(*Clause* 5.3)

Sl No.	Bead Size Rang		Bead Size Designation IS Sieve, mm
	Passing IS Sieve, mm	Retained IS Sieve, mm	
(1)	(2)	(3)	(4)
i)	2.0	1.70	1.7
ii)	1.4	1.18	1.18
iii)	1.00	0.850	0.850
iv)	0 .710	0.600	0.600
v)	0 .500	0.425	0.425
vi)	0 .355	0.300	0.300
vii)	0. 250	0.212	0.212
viii)	0 .180	0.150	0.150
ix)	0 .125	0.106	0.106
x)	0.090	0.075	0.075

Commented [p2]: Correct decimal places

6 PREPARATION OF TEST SPECIMEN

6.1 Cut five specimens from sample of geotextile with each specimen being cut to fit the appropriate sieve pan.

6.2 Weigh the specimens and then submerge them in distilled water for 1 hour at the standard atmosphere specified in IS 6359.

6.3 Dry the specimens and glass beads at 30°C until no weight (mass) change is recorded. Probable time required may be between 12 and 24 hours.

Commented [p3]: Use the following sentence inplace of dry the specimens-
Bring the specimen to moisture equilibrium condition at ambient temperature. The drying process may be accelerated with the use of fan. The specimen shall not be dried in oven or by exposing them to elevated temperature.

7 PROCEDURE

7.1 Carryout the test at the standard atmosphere for testing textiles in such a manner that stauc electricity is prevented from affecting test results. If standard atmosphere cannot be maintained and static electricity is observed, any of the following methods may be used to prevent static electricity.

Commented [p4]: This should be static

7.1.1 Install static eliminating devices equally spaced along the circumference of sieve and one on centre of cover, or

7.1.2 Apply commercially available 'anti-static' spray uniformly to the geotextile.

7.2 Secure the geotextile between two sieves. It is important that the geotextile be supported so that it is light, without wrinkles or bulges. The geotextile shall not be stretched or deformed such that it changes or distorts the openings in the fabric. Two systems may be used to secure the geotextile sample

7.2.1 Wedge between two sieve frames.

7.2.2 Secure with hoop inside sieve frame,

7.3 Prior to each use, sieve the glass beads in the laboratory to verify size of glass beads

7.4 Start with the smallest diameter glass beads that will be tested. Place 50 g of one size glass beads on the centre of the geotextile.

7.5 Place cover and pan on sieve frame and place in shaker. Shake the sieve horizontally as well as vertically for 15 min.

Commented [p5]: It should be 10 minutes instead of 15 min.

7.6 Place the glass beads still on the surface of the specimen in a pan and weigh. Include beads that fall off as a result of turning the specimen over and lapping the rims of the sieves.

NOTE — The step provides information concerning the amount of glass beads trapped within the geotextile and the amount of any glass beads lost during testing

7.7 Weigh the glass beads that pass through the specimen, and record data on a worksheet (*see* Annex B for a sample worksheet).

7.8 Repeat **7.3** through **7.7** using the next larger bead size fraction. Repeat the trial using succeedingly larger bead size fractions until the weight of beads passing through the specimen is 5 percent or less. Perform the trials such that the percent passing decreases from a value greater than 5 percent to a value less than or equal to 5 percent.

NOTE — All size are sieved through a single specimen of geotextile. Geotextile variability would make it difficult to obtain consistent results by sieving each size through a separate specimen

7.9 Repeat **7.2** to **7.8** for all five specimens.

8 CALCULATIONS

8.1 For each size of glass beads tested with each specimen, compute to the nearest percent the glass beads passing through the specimen using the following equation:

$$B = 100\ PIT$$

where

B = beads passing through specimen, percent;
P = mass of glass beads in the pan, g, and
T = total mass of glass beads used, g.

8.2 Record calculations and percent glass beads passing (*see* Annex B).

8.3 For each specimen, plot the values of percent passing (ordinate) versus bead size, mm (abscissa) percent passing (ordinate) versus bead size, mm (abscissa) on semi-log graph. Draw a straight line connecting the two data points representing the bead sizes that are immediately on either side of the 5 % passing ordinate. The particle size in millimetres (abscissa) at the intersection of the straight line plotted and the 5 % passing ordinate is the AOS of the specimen in millimetres, that is, the theoretical bead size that would result in exactly 5 % passing the specimen.

Commented [p6]: Newly added

8.3 Assign the AOS for each specimen as the size designation in millimetres (*see* **5.3**) of the glass beads of which 5 percent or less pass.

8.4 Determine the AOS for the sample by averaging the AOS values of the five specimens.

NOTE — It is often desirable to compare the data from each specimen by plorting the percentage glass beads passing the specimen versus glass beads size for each of the glass beads sizes used for each specimen and to evaluate the consistency of the testing operation for internal quality control Plotting is also desirable when the results of two laboratories differ and it is desired to compare the data from each laboratory to pinpoint the cause of the discrepancy

Commented [p7]: ploting

9 REPORT

Report shall include the following information:

a) IS number of the method followed for testing;
b) Glass Beads size range (in millimetres) used;
c) Plots of glass bead size versus percentage beads passing for each specimen, if required;
d) The average apparent opening size (AOS = O95) in millimetres;
e) When requested, AOS in terms of sieve number, that is, having nominal openings, in millimetres, next larger than or equal to the AOS, m millimetres; and
f) Deviation, if any.

ANNEX A

(Clause 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*
460 (Part 1) : 2020	Test Sieves — Specification Part 1 Wire Cloth Test Sieves (*Fourth Revision*)
(Part 2) : 2020	Test Sieves — Specification Part 2 Perforated Plate Test Sieves (*Fourth Revision*)
(Part 3) : 2020	Test Sieves — Specification Part 3 Methods of Examination of Apertures of Test Sieves (*Fourth Revision*)
6359 : 2023	Method for conditioning of textiles (*first revision*)

ANNEX B

(*Clauses* 7.7 *and* 8.2)

SAMPLE WORKSHEET DETERMINATION OF APPARENT OPENING SIZE OF GEOTEXTILE

DATE
TEST BY
COMP BY
CHECK BY

Range (mm) IS Sieve	Minimum Dia (mm)	Wt. F+G+ Glass Beads	Wt. F+G	Wt. Glass Beads	% Retained	Wt. Pan +Glass Beads	Wt. Pan	Wt. Passing Glass Beads	% Passing	Wt. F+G Before Test	Wt F+G After Test	Wt. Retained in Geotextile	% Retained in Geotextile
2.0-1.70	1.70												
1.4-1.18	1.18												
1.0-0.850	0.850												
0.710-0.60	0.600												
0.50-0.425	0.425												
0.355-0.30	0.300												
0.25-0.212	0.212												
0.18-0.15	0.150												
0.125-0.106	0.106												
0.09-0.075	0.075												

Commented [p8]: Correction in decimal places

*F = Frame G = Geotextile	

IS 14324 : 1995 GEOTEXTILES – METHODS OF TEST FOR DETERMINATION OF WATER PERMEABILITY – PERMITTIVITY

FOREWORD

This Indian Standard was the Geotextiles Sectional adopted by the Bureau of Indian Standards, after the draft finalized by Geotextile Sectional Committee had been approved by the Textile Division Council.

Water permeability is the rate of flow of water under a differential pressure through a material. However, as geotextiles of various thicknesses are used, their evaluation in terms of coefficient of permeability can be misleading. In many instances, it is more significant to evaluate the volumetric flow rate of water per unit cross-section per unit head under laminer flow conditions in the normal directions and is expressed as permittivity.

If the permeability of an individual geotextile is of 'importance, a nominal coefficient of permea-
bility, as related to geotextile engineering, may be computed by multiplying permittivity with the
nominal thickness of the geotextiles.

In the preparation of this standard, assistance has been drawn fiomtASTM1 Designation: D 4491- 89 'Standard test methods for water permeability of geotextiles by permittivity'; issued by American Society for Testing and Materials, USA.

In reporting the results of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS 2. 'Rules for rounding-off 'numerical values '(*revised*)'.

Indian Standard

GEOTEXTILES- METHODSOFTESTFOR DETERMINATIONOFWATER PERMEABILITY — PERMITTIVITY

Commented [p9]: Insert space

1 SCOPE

This Indian Standard specifies methods for determining the water permeability of geotextiles in terms of permittivity under standard testing conditions, in the uncompressed state. The standard covers two procedures-the constant head method and the falling head method.

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 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 indicated in Annex A.

3 TERMINOLOGY

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

4 PRINCIPLE OF TEST METHODS

4.1 Constant Head Test

A head of 50 mm water is maintained on the geotextile throughout the test. The quantity of flow is measured versus time. The constant head test is used when the flow rate of water

through the geotextile is so large that it is difficult to obtain readings of head change versus time in the falling head test.

4.2 Falling Head Test

A column of water is allowed to flow through the geotextile and reading of head changes versus time is taken. The flow rate of water through the geotextile shall be slow enough to obtain accurate readings.

NOTE — Data has shown agreement between the falling and constant head methods of determining permittivity of geotextiles and as such any test method may be used.

5 APPARATUS

5.1 The apparatus shall conform to one of the following arrangements:

a) The apparatus shall be capable of maintaining a constant head of water on the geotextile being tested, or

b) The apparatus shall be capable of being used of failing head apparatus.

5.2 In addition, the apparatus shall not be the controlling agent for flow during the test. Accordingly, it will be necessary to establish a calibration curve of volumetric flow rate versus head for the apparatus alone in order to establish compliance with this requirement (*see* **9.1.6**).

5.3 The device consists of an upper and lower unit which fasten together as shown in Fig. 1. The geotextile specimen is positioned in the bottom of the upper unit. There is a standpipe for measuring the constant head value. The rotating discharge pipe allows adjustment of the head of water at the bottom of the specimen.

5.4 Closed Specimen Holder:-The specimen flow area shall be 25 to 50mm diameter. Smaller diameter device are not acceptable.

Commented [p10]: Newly added

6 SAMPLING

Take a full width sample of geotextile of sufficient length from each sample roll of the geotextile so that the requirements of 8.1 can be met. The sample shall exclude material from the outer wrap of the roll or the inner wrap around the core unless the sample is taken at the production site, at which point inner and outer wrap material may be used.

7 PREPARATION OF TEST WATER

7.1 To ensure reproducible test results, the test water shall be de-aired under a vacuum of 710 mm of mercury (Hg) for a period of time to bring the dissolved oxygen content down to a maximum of 6 parts per million. The dissolved oxygen content may be determined by either commercially available chemical kits or by a dissolved oxygen meter.

NOTE — The de-airing system may be either a commercially available system or one consisting of a vacuum pump capable of removing a minimum of 150 litres/min of air in connection with a non-collapsible storage tank with a large enough storage capacity for the test series, or at least one specimen at a time.

7.2 The de-aired water be allowed to stand in a closed storage tank under a slight vacuum until room temperature is attained.

8 SPECIMEN PREPARATION

8.1 In order to obtain a representative value of permittivity, take specimens from each 1 m2 sample.

Commented [p11]: Replace with the following:-
full width sample of geotextile of sufficient length

8.2 Select four specimens, *A*, *B*, *C*, and *D*, as follows:

- Take specimen *A* at the centre of the sample *B* at one corner (centre located 200 mm from the corner 1, *C* midway between *A* and *B*, and *D* the same distance from *A* as *C*, located on a line with *A*, *B* and *C*, as shown in Fig. 2.

- Cut specimens shall fit the testing apparatus, for example, 73 mm in diameter for the device illustrated in Fig. 1.

8.3 Condition the specimen by soaking in a closed container of de-aired water, at room conditions, for a period of 2 hours. The minimum specimen diameter shall be 25 mm.

Commented [p12]: It should be 50mm

NOTE — If the illustrated device is used, the specimens are attached to the specimen ring by contact cement.

9. Apparatus and Operator Process Control

9.1 Water Flow Apparatus via No. 200 Sieve Mesh:
9.1.1 Prepare one specimen of a 75 micron IS sieve mesh to fit the test apparatus.
9.1.2 Perform Test on the 75 micron IS sieve mesh specimen.
9.1.2.1 The tests may be performed with a 25 mm diameter flow opening in lieu of 50 mm.

Commented [p13]: Newly Added

10 PRQCEDUBE AND CALCULATION

Commented [p14]: PROCEDURE

10.1 Constant Head Method

10.1.1 Assemble the apparatus with the specimen in place. Open the bleed valve and backfill the system through the standpipe or discharge pipe, with de-aired water. Backfilling in this manner forces any trapped air out of the system and the geotextile.

NOTE — The water should be at the bottom level of the specimen at the time of specimen installation.

10.1.2 Close the bleed valve once water flows from it. Continue to fill the apparatus with de-aired water until the water level reaches the overflow.

10.1.3 With water flowing into the system through the water inlet, adjust the discharge pipe along with the rate of water flowing into the apparatus to obtain a 50 mm head of water on the geotextile under which the test will be performed initially.

10.1.4 Submerge a tube attached to a source of vacuum to the surface of the geotextile and move the tube gently over the surface while applying a slight vacuum to remove any trapped air which may be in or on the specimen. If necessary, readjust the head to 50 mm after removing the vacuum.

10.1.5 Record the values of time (t), quantity of flow (Q) as collected from the discharge pipe, and water temperature (X), holding the head at 50 mm. Make at least five readings per specimen and determine an average value of permittivity for the specimen.

NOTE — The quantity of flow may be measured in millilitres and then converted to cubic millimetres for the computation of permittivity (1 ml = 1 000 mm^3).

10.1.6 After the first specimen has been tested under a 50 mm head, using the same specimen, start with a 10 mm head and repeat the procedure. Increase the head by 5 mm after every five readings. Increase the head until a 75 mm head is reached Use this data to determine the region of laminar flow. Plot volumetric flow rate, v (where v equals Q/At, values defined in **9.1.8.1**) versus head. The quantity of flow (Q) should be corrected to 27°C. The initial straight line portion of the plot defines the region of laminar flow. If the 50 mm head is outside the region of laminar flow, repeat the test procedure using the head of water in the mid region of laminar flow.

10.1.6.1 Compare the data from **9.1.6** with the apparatus calibration curve referred to in **5.2**. If the specimen curve intersects the calibration curve, the apparatus is controlling the flow through the geotextile rather than the structure of the geotextile itself. In such an instance, modify the apparatus by enlarging the discharge pipe so that the device does not control the flow.

10.1.7 Repeat **10.1.1** through **10.1.6** on the three remaining previously conditioned specimens.

10.1.8 *Calculation*

10.1.8.1 Calculate the permittivity, ψ, as follows:

$$\psi = QR_t/hA_t$$

where

ψ = permittivity, s^{-1};
Q = quantity of flow, mm^3;
h = head of water on the specimen, mm;
A = cross-sectional area of test area of specimen, mm^2;
t = time for flow (Q), s; and
R_t = temperature correction factor determined using the following equation:

$$R_t = u_t/u27c \quad \ldots\ldots\ldots \quad (1)$$

where

u_t = water viscosity at test temperature in millipoises, as determined from Table 1; and

$u27c$ = water viscosity at 27°C, millipoises.

10.1.8.2 Calculate the permittivity for the five sets of readings per specimen at the 50 mm head.

10.1.8.3 Determine the average permittivity for the individual specimen tests.

10.1.8.4 Determine the average permittivity for the four specimens tested.

10.1.8.5 Determine the standard deviation and coefficient of variation for the four specimens tested.

10.2 Falling Head Test

10.2.1 Proceed as in **10.1.1** through **10.1.4**.

10.2.2 Adjust the discharge pipe so that its outlet is below the level of the specimen.

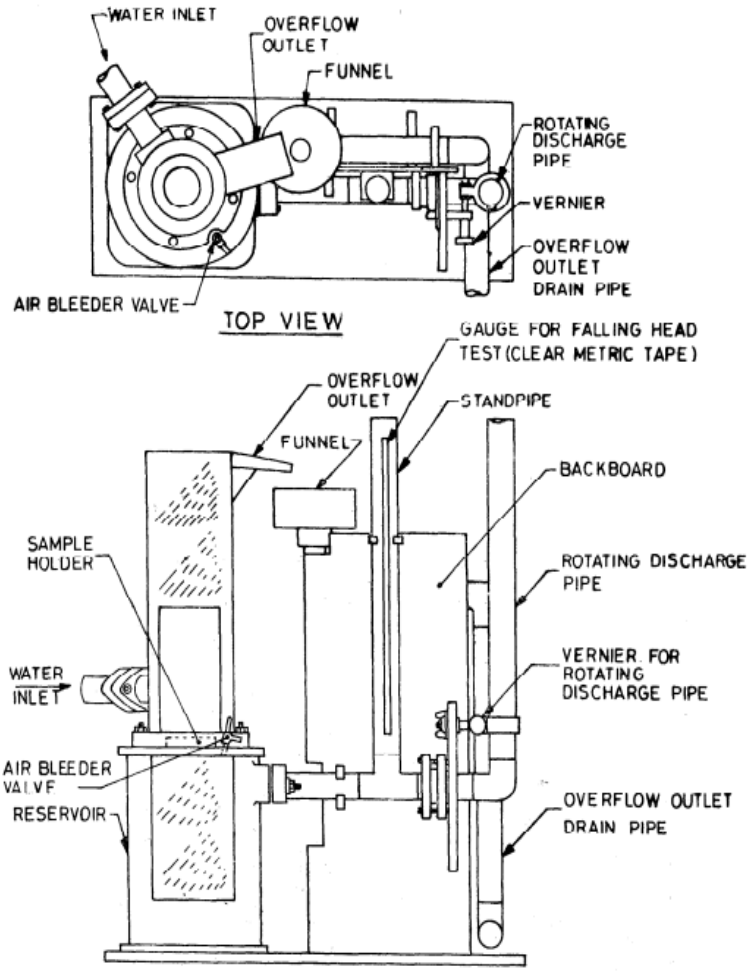


FIG. 1 CONSTANT AND FALLING HEAD PERMEABILITY APPARATUS

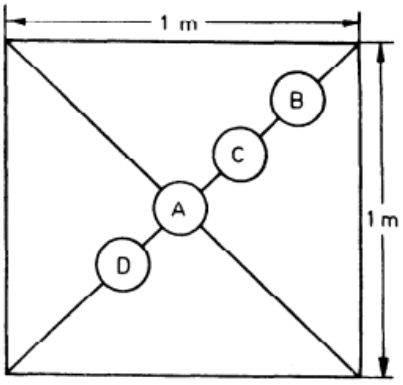


FIG. 2 SAMPLING PATTERN

10.2.3 Adjust the water level to 150 mm. Once the water is at this level, shut off the water supply and allow the water level to fall to 80 mm. At this point, start the stop watch and determine the time for the water level to fall to the 20 mm level. Record the inside diameter (*d*) of the upper unit, the diameter (*D*) of the exposed portion of the specimen, and the water temperature (*T*). Make at least five readings per specimen.

10.2.4 Repeat the procedure on the three remaining previously conditioned specimens.

10.2.5 *Calculation*

10.2.5.1 Calculate the permittivity, ψ as follows:

$$\psi = [(a/At) \text{ In } (h_0/h_1)] R_t$$

where

$a = \pi d_2/4$ — cross-sectional area of standpipe above specimen;
$A = \pi D_2/4$ — cross-sectional test area of specimen, mm2;
t = time for head to drop from h_0 to h_1, s;
h_0 = initial head (80 mm);
h_1 = final head (20 mm); and
R_t = temperature correction mined from Eq 1.

10.2.5.2 Repeat calculations for the five sets of data per specimen. Determine the average permittivity for the individual specimens tested.

Table 1 Viscosity of Water Versus Temperature

(*Clause* 9.1.8.1)

Sl No.	**Temperature, °C**	**Viscosity (millipoise)[1])**
(1)	(2)	(3)
i.	0	17.94
ii.	1	17.32
iii.	2	16.74
iv.	3	16.19
v.	4	15.68
vi.	5	15.19
vii.	6	14.73
viii.	7	14.29
ix.	8	13.87
x.	9	13.48
xi.	10	13.10
xii.	11	12.74
xiii.	12	12.39
xiv.	13	12.06
xv.	14	11.75
xvi.	15	11.45
xvii.	16	11.16
xviii.	17	10.88
xix.	18	10.60
xx.	19	10.34
xxi.	20	10.09
xxii.	21	09.84
xxiii.	22	09.61
xxiv.	23	09.38
xxv.	24	09.16
xxvi.	25	08.95
xxvii.	26	08.75
xxviii.	27	08.55
xxix.	28	08.36

xxx.	29	08.18
xxxi.	30	08.00
xxxii.	31	07.83
xxxiii.	32	07.67
xxxiv.	33	07.51
xxxv.	34	07.36
xxxvi.	35	07.21
[1)]Poise = kg s^{-1} m^{-1} = Nsm		

11 REPORT

The report shall include the following:

a) Procedure used;
b) Any deviations from the standard test method, such as a head other than 50 mm for the constant head procedure;
c) Average permittivity;
NOTE—To express permittivity in litres per unit area per unit head per time (l/m^3/min) multiply the results obtained in **9.1.8.4** or 9.**2.5.2** by 6×10^7.
d) Standard deviation for the individual observations;
e) Coefficient of variation for the four observations; and
f) A plot of flow rate versus head for the laminar flow test in the constant head procedure.

Commented [p15]: It should be 6×10^4

IS 14706 : 1999 GEOTEXTILES - SAMPLING AND PREPARATION OF TEST SPECIMENS

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards after the draft finalized by the Geotextiles and Industrial Fabrics Sectional Committee had been approved by the Textile Division Council.

This standard is technically equivalent to IS0 9862:1990 ‘Geotextiles — Sampling and Preparation of Test Specimen’ issued by the International Organization for Standardization (ISO).

This standard has been developed simultaneously in Hindi also and hence has been published bilingually. In case of dispute in interpretation English text shall be authentic.

Indian Standard

CEOTEXTILES - SAMPLING AND PREPARATION OF TEST SPECIMENS

Commented [p16]: GEOTEXTILES

1 SCOPE

1.1 This Indian Standard provides general principles for sampling of geotextiles and preparation of test specimens from the samples.

1.2 The principles are applicable to all geotextiles supplied in rolls.

2 PROCEDURE

2.1 Sampling

2.1.1 *Selection of Rolls*

2.1.1.1 The number of rolls from which samples are cut shall be as agreed to between the parties involved.

2.1.1.2 Each roll selected shall not be damaged and the wrapping, if any, shall be intact except in case the roll has been subjected to tests in connection with the claims of the manufacturer.

2.1.2 *Cutting*

2.1.2.1 Information regarding the number of test specimens, their shape and any other requirement shall be obtained for all tests to be made on the sample.

2.1.2.2 The first two turns of the roll shall not be used for sampling.

2.1.2.3 Cut from the roll, over its full width, perpendicular to the machine direction (production direction-roll length direction), the length necessary to obtain all the specimens required, distributed in accordance with the principles described in **2.2**.

2.1.2.4 Since specimens shall not contain damaged parts as defined in **2.2.2**, either such parts shall be avoided in selecting the sample, or the sample shall be cut large enough to obtain the necessary number of acceptable specimens.

2.1.3 *Identification of Sample*

2.1.3.1 When the two faces of the geotextile are significantly different, the sample shall be marked to show inside and outside face.

2.1.3.2 Another mark (for example, an arrow) shall be used to indicate the machine direction of the sample.

2.1.3.3 The sample shall be marked for identification purposes with the following information:

— brand/producer/supplier;
— type description, for example, quality number or grade;
— roll number or other identification if more than one roll of the same type is sampled;
— date of sampling.

2.1.3.4 If not being cut into specimens immediately, the sample shall be kept in a dry, dark place, free from dust, at ambient temperature and shall be protected against chemical and physical damage. The sample may be rolled up but not folded.

2.2 Preparation of Specimens

2.2.1 For each type of test, the required number of specimens shall be cut from positions evenly distributed over the full width and length of the sample but not closer than 100 mm to the selvedge.

2.2.2 Except for specimens in respect of tests to be made in connection with claims (*see* **2.1.1.2**), specimens shall not contain any dirt, irregular areas, creases, holes or other visible defects of accidental origin produced subsequent to manufacture.

2.2.3 For the same type of test, the same longitudinal or tranverse position of two or more specimens shall be avoided. If unavoidable (for example due to narrow roll width), a note to this effect shall be included in the sampling report as well as in the test report.

2.2.4 Except when additional tests are required, the specimens shall be cut along the machine and transverse directions. When the test procedure calls for the specimen to be

marked with the machine direction, the marking indicating the machine direction on the sample shall be transferred to the specimen, or the specimen shall be kept separate in such a way that there is no risk of a misunderstanding.

2.2.5 The specimens shall be cut to the accuracy required for the particular test. In tests, where accuracy of dimensions is of special importance, the specimens may be cut to an oversize and shall be cut or frayed to the exact dimensions only after conditioning.

2.2.6 The identification markings of the sample shall be carefully transferred to all test specimens.

2.2.7 Before cutting structured geotextiles, detailed instructions for cutting shall be laid down, and these instructions shall be followed with great care.

2.2.8 If the cutting causes fragments of the geotextiles to become loose, or if accidental fraying occurs, all loose fragments shall be kept with the specimen until the test is carried out. If the loosening of fragments cannot be avoided and this is likely to influence the test result, the fact that loosening has occurred shall be reported in the sampling report as well as in the test report.

2.2.9 The specimens shall be kept in a dry, dark place free from dust, at ambient temperature and shall be protected against chemical and physical damage until the test is performed.

3 SAMPLING REPORT

The sampling report shall include the following particulars:

a) A statement that the sampling and preparation of specimens was performed in accordance with this standard;
b) Details of any special observations made during the selection, sampling or preparation of specimens, such as:
— an unusually high number of defects,
— loosening of fragments from the geotextile,
— the necessity for taking specimens for the same test in longitudinal or transverse direction only,
c) Details of any deviation from the specified sampling procedure; and
d) The date of cutting of the sample, and the reference numbers of the rolls selected.

INPUTS ON IS 14714 : 1999, IS 13162 : Part 2 : 1991, IS 13162 : Part 4 : 1992

Inputs from: Geosynthetics Testing Services Private Limited, Ahmedabad

Inputs:

INPUTS ON 'IS 14714 : 1999, IS 13162 : Part 2 : 1991, IS 13162 : Part 4 : 1992'

IS 14714 : 1999 GEOTEXTILES - DETERMINATION OF ABRASION RESISTANCE
FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by Geotextiles and Industrial Fabrics Sectional Committee had been approved by Textile Division Council.

In the preparation of this standard considerable assistance has been derived from ASTM D4886 - 23.

In reporting the results of a test or analysis made in accordance with this standard, if the final value, observed or calculated is to be rounded off, it shall be done in accordance with IS 2.

Indian Standard

GEOTEXTILES — DETERMINATION OF ABRASION RESISTANCE

1 SCOPE

This test method covers determination of resistance of geotextiles to abrasion using an abrasion tester. The test method is applicable to all geotextiles and is not suitable for other geosynthetics like Geogrid, Geomembrane, Geonet etc.

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 editions of the standards indicated in Annex A.

3 TERMINOLOGY

In addition to definitions given in SP 45, following shall apply.

3.1 Geotextiles

Any permeable textile used with foundation, soil, rock, earth, or any other geotechnical engineering related material as an integral part of a man-made project structure, or system.

4 PRINCIPLE

A test specimen, mounted on a stationary horizontal platform is rubbed by a uniaxial motion of an abradant having specified surface characteristics under controlled conditions of pressure and abrasive action. Resistance to abrasion is expressed as a percentage loss of breaking load of the original sample (control sample).

5 APPARATUS

5.1 Abrasion Tester shall have the essential parts as described in **5.1.1** to **5.1.3**.

5.1.1 *Balanced Head and Block Assembly*

The assembly shall be two parallel, smooth plates, one of which makes a reciprocating motion. The speed of the reciprocating plate shall be adjustable between 10 and 115 double strokes per minute. The stroke length shall be 25 mm. The second plate is rigidly supported by a double-level assembly to provide free movement in a direction perpendicular to the reciprocating plate. This plate is stationary during the test and shall be well balanced so that a vertical load can be maintained by means of dead weights. Both plates are equipped with clamps at each end to hold the test sample and the abrasive medium. The clamps have adequate gripping surface to prevent slippage of the specimen or the abrading material during the test.

5.1.2 *Indicator*

Device shall be provided for indicating the number of cycles (1 cycle = 1 double stroke).

5.1.3 *Weights*

Weights shall be provided for applying a vertical load to the specimen.

6 SAMPLING

6.1 Lot SampIe

For sampling of lot, the number of rolls from which samples are to be cut shall be as agreed to between the buyer and the seller. For details of sampling procedure reference may be made to IS 14706.

NOTE — Abrasion testing is not a routine quality control test for geotextiles and shall not normally be performed on every lot by the manufacturer or supplier. When testing for abrasion is performed, however, the sampling should be as described in 6.

6.2 Laboratory Sample

For laboratory sample, take a swatch extending the width of the fabric and approximately 1 m along the selvedge from each roll in the lot sample. The swatch may be taken from the end portion of a roll provided there is no evidence that it is distorted or different from other portions of the roll. In case of dispute, take a swatch that will exclude fabric from the outer wrap of the roll or the inner wrap around the core.

6.3 Test Specimens

From each swatch in the laboratory sample, prepare two sets of specimens each containing five specimens. Cut rectangular specimens (75 mm × 200 mm) ± 1 mm. Cut the set of specimens to be tested in the machine direction with the longer dimension parallel to the machine direction and set of specimens to be tested in the cross-machine direction with the longer dimension in the cross-machine direction. Take each set of specimens from a swatch along a diagonal so that they will be taken from different positions across the length and width of the swatch. No specimen shall be taken within 1/20th of the fabric width or 150mm from the selvedge whichever is the smaller.

7 CONDITIONING

7.1 Bring the specimens to moisture equilibrium in the atmosphere having 65 ± 5 percent relative humidity and 27 ± 2°C temperature. Equilibrium is considered to have been reached when the change in mass of the specimen in successive weighings made at intervals of not less than 2 h does not exceed 0.1 percent of the mass of the specimen. When it is not practically possible to frequently check weight to see if the sample reached moisture equilibrium or not; then a minimum 24-hour conditioning can be considered as acceptable.

Commented [RK17]: 65 ± 2 percent is difficult to maintain in practical condition

7.2 Immerse the specimens to be tested in the wet condition in water maintained at a temperature of 27 ± 2°C. The time of immersion must be sufficient to wet-out the specimens thoroughly, as indicated by insignificant change in strength or elongation following a longer period of immersion, and at least 2 min. To obtain thorough wetting, a nonionic neutral wetting agent not exceeding 0.05 percent may be added to the water.

8 PROCEDURE

8.1 Test the conditioned specimen in the standard atmosphere for testing geotextiles, as described in 7.

8.2 Place the sample to be tested in the upper (stationary) plate and secure it by means of the clamp at each end of the plate. Place the abrasive medium on the lower (reciprocating) plate and secure it by means of the clamp at each end of the plate. Use emery cloth equal to 100 grit as the abrading medium unless specified otherwise in a material specification.

NOTE — When testing nonwoven geotextiles, secure the edges of the test specimen to the stationary plate by using double-back tape or some other type adhesive. This prevents deformation (neckdown) of the specimen during the abrasion test.

8.3 Lower the top plate onto the bottom plate by releasing the support pin for the top plate and ensuring that the abrading medium and the specimen are properly aligned.

8.4 Load the top (pressure) plate with a total of 1 kg load (including weight of upper platen) unless specified otherwise.

8.5 Start the tester and operate at a speed of 30 cycles per minute unless specified otherwise.

8.6 Operate the tester at the specified speed for 250 cycles or as agreed upon in an applicable material specification or until the specimen ruptures.

NOTE — If a specimen ruptures before the specified number of cycles is reached, report that the specimen ruptured and the number of cycles completed at the time of rupture.

8.7 If the specimen or the abrading material slips or moved away in the clamps, discard the specimen and test another specimen.

8.8 Replace the abrasive medium for wear after 250 cycles (change after each specimen)

8.9 Determine the end point by the following method.

8.9.1 *Percentage Loss in Breaking Load*

Abrade the specimen for a specified number of cycles and then determine the breaking load using 50 mm ravelled-strip or cut-strip procedure given in IS 1969 with the exception of a gauge length of 100 mm and an extension rate of 300 mm /min. The abraded area of the specimen shall be placed midway between the clamps of the machine. Determine the breaking load unabraded portion of the sample under the similar conditions. Calculate the loss in breaking load and report to the nearest 1.0 percent using the following formula:

Loss in breaking load, percent = $100(A - B)/A$

where

A = breaking load before abrasion, and
B = breaking load after abrasion.

9 REPORT

The report shall include the following:

a) Average loss in breaking load, in percent, for each direction;
b) Deviation from test conditions specified in this standard;
c) Number of specimens tested from each direction; and
d) Number of specimens which ruptured, if any, before the specified number of cycles was reached and the number of cycles completed before rupture.
e) Mention if there is any deviation in specimen preparation or testing procedure other than describe in test method.

ANNEX A

(*Clause* 2)

LIST OF REFFRRED STANDARDS

IS No.	*Title*
IS 1969 : Part 1 : 2018	Textiles- Tensile Properties of Fabrics - Part 1 Determination of Maximum force and Elongation at Maximum Force Using the Strip Method
IS 14706 : 1999	Geotextiles — Sampling and preparation of test specimen
SP 45 : 1988	Handbook on glossary of textile terms

IS 13162 : PART 2 : 1991 GEOTEXTILES – METHODS OF TEST PART 2 DETERMINATION OF RESISTANCE TO EXPOSURE OF ULTRAVIOLET LIGHT AND WATER (XENON-ARC TYPE APPARATUS)

FOREWORD

This Indian Standard (Part 2) was adopted by the Bureau of Indian Standards, after the draft finalized by the Geotextiles Sectional Committee had been approved by the Textile Division Council.

Geotextiles are manufactured using a variety of processes and formulations of polymers and each geotextile varies in its sensitivity to ultraviolet radiation. Ultraviolet radiation from the sun varies with duration of exposure, angle of inclination of the sun, atmospheric conditions, topography, and geography. The Xenon-arc test cannot simulate all these variables, so it is not likely that Xenon-arc test results will relate directly to sunlight exposure test results for a specific fabric at a given site.

The method prescribed is suitable for comparative evaluation of geotextiles and is not recommended for acceptance testing of commercial shipments since information on inter-laboratory precision is incomplete.

Commented [RK18]: Check if Inter-laboratory possible now in India

In the preparation of this standard considerable assistance has been derived'

ASTM D4355/D4355M-21 Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture, and Heat in a Xenon Arc-Type Apparatus

issued by the American Society for Testing and Materials, USA.

In reporting the results of a test made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS 2 'Rules for rounding off numerical values (*revised*)'.

Indian Standard

GEOTEXTILES — METHODS OF TEST

PART 2 DETERMINATION OF RESISTANCE TO THE EXPOSURE OF ULTRAVIOLET LIGHT AND WATER (XENON-ARC TYPE APPARATUS)

1 SCOPE

1.1 This standard (Part 2) prescribes a method for the determination of resistance of geotextiles to the exposure of ultraviolet light , heat and moisture.

1.2 The light and water exposure apparatus employs a Xenon-arc light source.

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 editions of the standards indicated in Annex A.

3 PRINCIPLE

Specimens of geotextiles for the machine and cross directions are exposed for 0,150,300 and 500 hours of ultraviolet exposure in a Xenon-arc apparatus. The exposure consists of 120 minute cycles consisting of 90 minutes of light only, followed by - 30 minutes of water spray and light. After the exposure, the specimens are subjected to a cut strip tensile test as prescribed in IS 1969 Part-1 or wide width strip test as prescribed in) IS 16635. The test results are compared to the test results for unexposed specimens and the deterioration which has taken place due to ultraviolet exposure is assessed. This method will enable the user to develop a degradation curve for the geotextiles being tested to determine the tendency of a geotextile to deteriorate when exposed to ultraviolet light, heat and moisture.

4 ATMOSPHERIC CONDITIONS FOR CONDITIONING AND TESTING

4.1. Condition the test specimens to moisture equilibrium from the dry side in the standard atmosphere of 65 ± 5 percent relative humidity and 27 ± 2°C temperature (see also IS 6359 : 2023). When the specimens have been left in such an atmosphere so that both the faces are exposed to the standard atmosphere as far as possible for 24 hours, they shall be deemed to have reached the state of moisture equilibrium.

Commented [RK19]: Should 65 ± 5 (± 2 % humidity may be very difficult to maintain in practical condition)

5 PREPARATION OF TEST SPECIMENS

5.1 Take two pieces each of one square metre from each roll as selected in 9.2, one from machine direction and the other from cross machine direction.

5.2 Cut 20 test specimens from each of the machines and the cross directions from the test pieces obtained in **5.1**, that is, a total of 40 test specimens. Each specimen prepared should measure 50mm by 150mm (for IS 1969) or wide width strip tensile minimum 200mm by 200mm (for IS 16635). Longer specimen length may be required for roller clamps.

5.3 Specimens from a roll shall be cut from positions evenly distributed over the full width and length of the sample, but not closer than 150mm or 1/20th of width to the selvedges, whichever is smaller.

5.4 Specimens shall not contain dirt, irregular spots, creases, holes or other visible faults.

5.5 Any two specimens shall not contain the same longitudinal or transversal position. If it is not possible, it shall be reported.

5.6 Before cutting structured geotextiles exact instructions for cutting shall be laid down, and these shall be followed with great care.

5.7 If the cutting causes fragments of geotextile to loosen influencing the test results and if this cannot be avoided, this.fact shall be reported.

5.8 The specimens shall be kept free from dust, dry, kept in dark and protected against chemical and physical damage until the test is performed.

5.9. The top and bottom portion of specimen which goes inside grips should be rolled in weathering device to protect from exposure to the radiation while in weathering device to avoid jaw breaks during tensile testing.

6 APPARATUS

6.1 The working details of Xenon-arc apparatus are described in IS/ISO B02, ISO 4892-1

6.1.1 The apparatus should be capable of exposing the specimens to cycles of light only, followed by water spray and light under controlled atmospheric conditions.

6.1.2 The apparatus should be equipped with an inner and outer borosilicate filter glass as described in IS/ISO B02, ISO 4892-1.

6.2 Tensile strength testing machine as described for cut strip test in IS 1969 and Wide width test in IS 16635.

7 PROCEDURE

7.1 Operate the Xenon-arc apparatus as directed in ISO 4892-1 & ISO 4892-2 to provide 120 minute cycles as follows:

– 90 minutes of light only at 65 ± 3°C black panel temperature, and - 50± 5 percent relative humidity, followed by - 30 minutes of light and water spray.

7.1.1 Set the minimum level of irradiance at control point to achieve 0.35 W/m^2.nm (± 0.02 W/m^2.nm), at 340 nm (unless otherwise specified).

7.1.2 If the UV exposure device does not equipped with irradiance control, device manufacturer's recommendation should follow to produce required irradiance. Equivalent 300 nm to 400 nm or 300 to 800 nm broadband irradiance can also use and tolerance as per instrument manufacturer specification.

7.2 Randomly assign five specimens for each direction from each laboratory sample to each of the following exposure times, zero (unexposed), 150, 300 and 500 hours. Place 30 specimens (15 for each direction) out of the total 40 test specimens in the apparatus, such that the side most likely to be exposed to the effects of ultraviolet light will be exposed in the apparatus.
7.2.1 Rotate specimen position in chamber accordance with procedure ISO 4892-1

7.3 At the end of each exposure time, remove the appropriate five specimens for each direction for tensile test using cut strip test as given in IS 1969 or wide width strip test as given in IS 16635.

7.4 Select five unexposed specimens (zero exposure time) and five exposed specimens for each exposure time interval and direction, from a laboratory sample as per the method given in IS 1969.
Test these specimens for breaking strength on a constant-rate-of-extension (CRE) or a constant rate-of-traverse (CRT) type testing machine by cut strip test, as given in IS 1969 (*see* Note) or for wide width test as given in IS 16635. In case of controversy, the CRE method shall prevail.

NOTE — A specimen of 50mm width at a gauge length 75 ± 1 mm shall be used. If tested on a CRT machine, the traverse speed shall be 300 ± 15 mm/ min.

8 CALCULATIONS

8.1 Calculate the average breaking strength in kN/m for all exposed and unexposed specimens for each direction.

8.2 Calculate the percent loss of strength for the unexposed specimens for the average results of each exposure time for each direction.

9 SAMPLING

9.1 A random sample shall be selected from the lot. The sample selected should be homogeneous and representative of the lot.
9.2 The number of rolls to be selected from a lot shall be in accordance with the procedure laid down in the relevant material specification or as agreed to between the buyer and the seller.

10 REPORT

The test report shall include the following information:

a) Nature of geotextile being tested;
b) The average breaking strength for unexposed (control) specimens, and exposed specimens in each direction for each of the exposure period of 150, 300 and 500 hours;
c) Graph of average breaking strength between exposure time, for each direction;
d) A listing of the percentage of strength retained for each exposure time for each direction.
e) The roll number, roll width, roll length and colour of roll.
f) Type and Model of exposure device and light source used.

g) Type and position of black or white panel thermometer, if used.
h) If required, irradiance in W/(m^2.nm), or radiant exposure in J/m^2 , at the sample plane and wavelength region in which measurements were made.

ANNEX A

(*Clause* 2)

LIST OF REFFRRED STANDARDS

IS No.	*Title*
- IS 1969 : Part 1 : 2018	- Textiles- Tensile Properties of Fabrics - Part 1 Determination of Maximum force and Elongation at Maximum Force Using the Strip Method
- IS/ISO B02 :2014	 Textiles — Tests for Colour Fastness Part B02 Colour Fastness to Artificial Light : Xenon Arc Fading Lamp Test
ISO 4892-1:2016	Plastics Methods of exposure to laboratory light sources Part 1: General guidance
IS 6359 : 2023	Method for conditioning of textiles
- IS 16635 : 2017	 Geosynthetics - Wide-Width Tensile Test

IS 13162 : PART 4 : 1992 GEOTEXTILES – METHODS OF TEST PART 4 DETERMINATION OF PUNCTURE RESISTANCE BY FALLING CONE METHOD

FOREWORD

This Indian Standard (Part 4) was adopted by the Bureau of Indian Standards, after the draft finalized by the Geotextiles Sectional Committee had been approved by the Textile Division
Council.

Geotextiles used as separator and filter in earth constructions are normally subjected to dynamic impact. During the installation process, crushed rock or boulders are dropped onto a fabric supported by weak, water-saturated soil which may penetrate and thus damage the geotextile. It is, therefore, desirable that the geotextiles should resist the sudden impact and penetration of such particles.

In reporting the results of a test made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS 2 ‘Rules for rounding off numerical values (*revised*)‘.

Indian Standard

ISO 13433:2006
Geosynthetics
Dynamic perforation test (cone drop test)

Commented [RK20]: As per my knowledge, The instrument mentioned in this method is either not available or not in used in geosynthetic laboratories in India. Hence I suggest to withdraw this or modified as per equivalent ISO 13433:2006 method.

1 SCOPE

This standard (Part 4) prescribes a m:thod for determination of the size of the hola made by dropping a standard brass cone onto a geotextile, supported by water, and to provide an indication of the ability of that fabric to resist a sudden impact.

2 PRINCIPLE

2.1 A geotextile sample is clamped in the holding ring free of folds and without pre-stressing, which is placed on the testing frame. The grooves and edges of the holding rings must fit into each other. The holding rings have to be bolted or pressed together (e.g. mechanically pneumatically or hydraulically) in such a way, that the compressive stress on the geotextile sample, acting uniformly over the grooved area of the holding rings, is sufficient to keep the specimen in place during the test. No slipping of the specimen in the clamping rings shall be allowed during the test.

2.2 Water is added to the container secured to the lower clamping ring until it just touches the fabric. Any excess which may reach the upper surface of the fabric must be sponged away.

2.3 The cone is seated in its initial position in the release mechanism and the distance of 500 mm between the tip of the cone and the fabric upper side is checked. Then the cone is released and caused to fall onto the fabric. The resulting hole in the fabric is measured, using the gradation on the measuring cone.

3 APPARATUS

3.1 Specimen Sample Holder

3.1.1 The specimen sample holder (clamping rings) consists of metal rings which are clamped together with uniformly distributed stress. Dimensions and shape of the sample holder are shown in Fig. 1. The grooved rings must fit into each other. The internal diameter of the rings is 150 mm, the external at least 180 mm. The specimen holding rings are secured to the testing frame**.**

3.2 Water Container

3.2.1 A trough of water which must have a minimum depth of 200 mm and a volume of approximately 3.5 litres, and which can be fixed tightly to the lower clamping ring, shall be used.
The water is just allowed to touch the clamed fabric.

3.3 Testing Frame

3.3.1 The sample clamping ring, together with the water trough fixed to it, is supported by a frame, which holds the cone an3 its shift, in a trigger release mechanism positioned centrally above the clamped sample. The distance between the tip of the cone and the upper surface of the fabric shall be 500 ± 0.5 mm (*see* Fig. 2).

3.4 Fall Cone

3.4.1 The brass cone and its release shaft shall together have a mass of 1 000 ± 1 g. The head of the cone shall have; a point angle of 45° tapering to a maximum diameter of 50 ± 0.1 mm (*see* Fig. 3). To ensure a straight, vertical fall of the cone without roll, the point of gravity shall be situated near to the point of the cone head. To achieve this the cone shall be provided with filled core.

3.5 Penetration Measuring Cone

3.5.1 A cone which serves to measure the diameter of the hole made in the fabric sample by the impact, with a mass of 100 ± 1 g, and a point angle of 14° 15’ shall be used (*see* Fig. 4). The material of the cone shall be stable in respect of its dimensions and miss. The tapering wall of the cone shall be graduated in 2 mm stages at the cone diameters from 0-50 mm.

4 PREPARATION OF TEST SPECIMENS

4.1 Cut from each roll selected (**7.1** and **7.2**) over its full width perpendicular to roll length a sample having a minimum area of 10 m2 free from visible defects such as dirt, irregular spots, creases or holes, etc.

4.2 Cut from all the samples obtained in **4.1**, at least ten specimens of a minimum size with diameter 190 mm.

4.3 Specimens from a sample shall be cut from positions evenly distributed over the full width and length of the sample, but not closer than 100 mm to the selvedges.

4.4 Any two specimens shall not content the same longitudinal or transversal position. If it is not possible, it shall be reported.

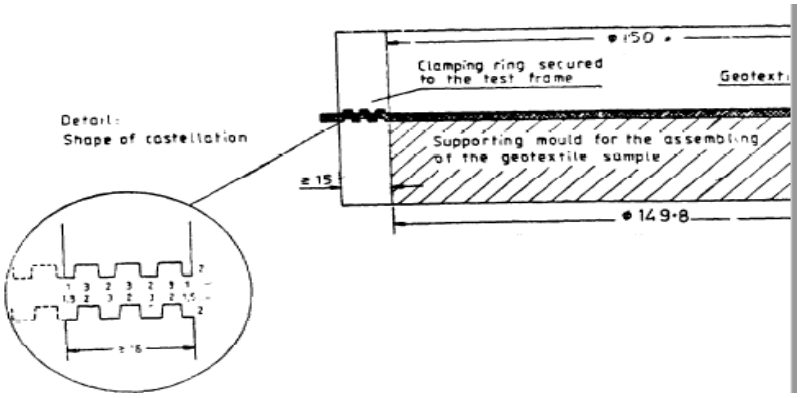


FIG. 1 SHAPE AND DIMENSIONS OF CLAMPING RINGS WITH MOUNTING MOULD

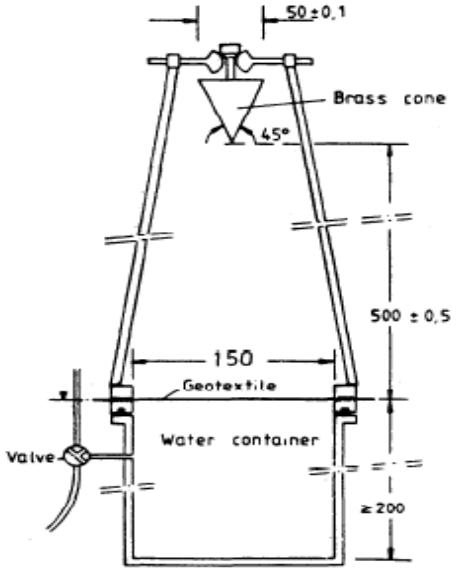


FIG. 2 PRINCIPLESO F TEST ARRANGEMENT

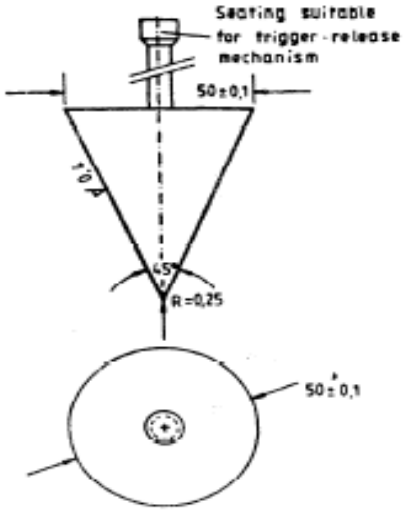


FIG. 3 STANDARDB RASSC ONE

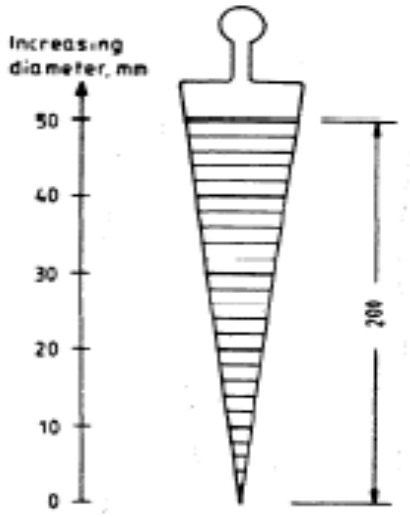


FIG. 4 PENETRATIONM EASURINGC ONE

4.5 Before cutting structured geotextiles, exact instructions for cutting shall be laid down, and these shall be followed with great care.

4.6 If the cutting causes fragments of geotextile to loosen and if this cannot be avoided causing influence on test results, this fact shall be reported.

4.7 The specimens shall be kept free from dust dry, at ambient temperature in dark and protected against chemical and physical damage until the test is performed.

5 PROCEDIJRE

5.1 Dry the samples in air under prevailing room conditions. Prepare, store and test the samples at prevailing room conditions.

5.2 Insert the support-mould into the lower clamping ring and ensure that the surface of the mould is levelled with the bottom level of the grooves in the clamping ring castellation.

5.3 Place the geotextile sample onto the lower clamping ring.

5.4 Assemble the upper clam-ping ring and bolt (or press) it to the lower clamping ring, ensuring that a uniform stress is acting on the fabric sample over the castellation of the rings.

5.5 Remove the support-mould and secure the clamping rings with the sample to the frame. Fix the water trough tightly to the lower clamping ring. Add water to the container until it just touches the fabric. Any excess, which may reach the upper surface of the fabric must be sponged away. Close any valve used for water level adjustments.

5.6 Seat the cone in its initial position in the trigger release mechanism, check and, if necessary, adjust the distance of 500 mm between the tip of the cone and upper surface of the fabric.

5.7 Pull the trigger to release the cone, causing the cone to fall onto the fabric. Remove the fall cone from the hole and measure the size of the hole with the penetration measuring cone.

5.8 Calculate the average hole size and the standard deviation for all the ten test specimens.

6 EXPRESSION OF RESULTS

6.1 Express the puncture resistance as the average size of the hole (in mm) made by dropping the fall cone onto the fabric and calculate the standard deviation for all the tests performed.

7 REPORT

7.1 The test report shall include the following information:

a) Description of the tested product;
b) Conditioning of the test specimens, environmental data during the test (temperature, pressure, RH, etc);
c) Test results (use SI units) i.e. average hole size and its Standard deviation; and
d) Any deviations from the test method;

8 SAMPLING

8.1 A random sample shall be selected from the lot. The sample selected should be homogenous and representative of the lot.

8.2 The number of rolls to be selected from a lot shall be in accordance with the procedure laid down in the relevant material specification or as agreed to between the buyer and the seller.

ANNEX 12
(*Item* 8.1)

FABRIC FORM CONCRETE MATTRESS

Fabric Form Concrete Mattress

1. Introduction:

fabric form concrete mattresses consist of a dual layer of durable synthetic fabric, typically woven from materials like nylon or polyester. These fabrics are meticulously sewn into a series of interconnected pillow-shaped compartments, which are linked internally by ducts. These compartments are then filled with concrete grout that flows seamlessly between them through the ducts. Mats are commonly stitched together or, less frequently, connected using specialized zips, straps, or ties before being filled. Once the grout solidifies, it creates a mattress comprising a grid of interconnected blocks.

fabric form concrete mattresses are classified depending upon the project requirement, design consideration and specific application. This technology is used to protect embankments (dry or wet), protect bridge abutments against scour, and used for flood bank and bed protection of major rivers and waterways, lining of canals and for mining and industrial erosion protection and lining applications. This system can be installed at rapid speed and under water without the need of dewatering.

2. Applications:

• River bank protection against erosion and scour
• Guide bund and spur/groyne protection
• A protection of abutments and piers of river bridge against scour
• Coastal defensive structures
• Impermeable lining works for reservoir or any water body.
• Protection of road and railway embankment slope
• Lining of industrial and solid waste landfill area against contamination.

3. Advantages of fabric form concrete mattress over other conventional solutions:

• Structural Strength: Superior stability and strength for erosion prevention.
• Customization: Tailored to project requirements to versatility.
• Flexibility: conforms to uneven terrains effectively.
• Permeability: Efficient drainage and reduced water buildup.
• Low Environmental Impact: Eco-friendly with minimal ecological footprint.
• Articulation: Adapts to ground shifts for sustained protection.
• Ease of Installation: Simplified installation, reducing time and costs.
• Proven Efficiency: Track record of success in various applications.
• Low Maintenance: Requires minimal upkeep over its lifespan.

• Longevity: Durable and Long-lasting erosion control solution.

4. Types of Fabric Form Concrete Mattresses:

i. Articulating Block Mattress:

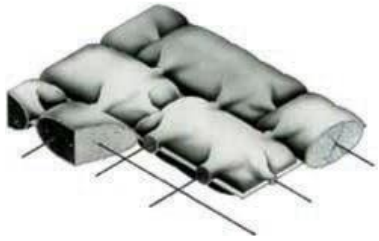


Figure A. Articulating Concrete Block Mattress

Articulating Block mattress consists of a series of compartments linked by an interwoven perimeter. Grout ducts interconnect the compartments, and high strength revetment cables are installed between and through the compartments and grout ducts. once filled, the AB Mats become a mattress of pillow-shaped, rectangular concrete blocks. The interwoven perimeters between the blocks serve as hinges to permit articulation. The cables remain embedded in the concrete blocks to link the blocks together and facilitate articulation. Some relief of hydrostatic pressure is accomplished through the filtration bands formed by the interwoven perimeters of the blocks.

Cables in Articulating block mattress shall be galvanized steel cables of minimum 6 mm diameter and the breaking strength of the cable shall not be less than 30 kN. Typically, the cables shall be laid in both direction of the mat when it is used as launching apron and the cables shall be laid in one direction when the mat is used for the protection of slope or river bank.

Typical Dimensions and weight:

Product and Sizes	**AB400**	**AB600**	**AB800**	**AB1000**	**AB1200**
Average Thickness, in (mm)	4 (102)	6 (152)	8 (203)	10 (254)	12 (305)
Mass per unit area, lb/ft^2 (kg/m^2)	45 (220)	68 (330)	90 (440)	113 (550)	135 (661)
Mass per block, lb (kg)	88 (39.8)	188 (85.2)	325 (148)	563 (255)	844 (382)
Nominal Block	20 x 14	20 x 20	20 x 26	30 x 24 (762 x	30 x 30 (762 x

Dimension, in (mm)	(508 x 356)	(508 x 508)	(508 x 660)	610)	762)
Concrete Coverage ft^2/yd^3 (m^2/m^3)	75 (9.1)	50 (6.1)	38 (4.6)	30 (3.6)	25 (3.0)
Shear Resistance, lb/ft^2 (kg/m^2)	8 (203)	10 (254)	12 (305)	14 (356)	16 (406)

ii. Filter Point fabric form Concrete:

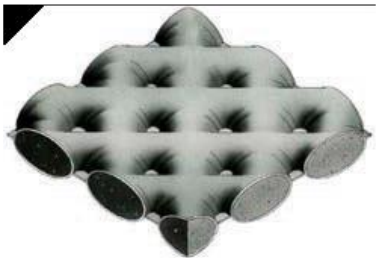


Figure B. Filter Point fabric form Concrete

Filter Point linings with filtration point (drains) provide an erosion resistant, permeable concrete lining having a cobbled surface and a relatively high coefficient of hydraulic friction in order to reduce water velocity and wave run-up. The spacing of the filter points determines the linings thickness and weight, while the specially designed filter points relieve hydrostatic pressure and reduce applied stress to the fabric form during pumping.

Typical Dimensions and weight:

Product and Sizes	**FP220**	**FP300**	**FP400**	**FP600**	**FP800**	**FP1000**	**FP1200**
Average Thickness, in (mm)	2.2 (56)	3 (76)	4 (102)	6 (152)	8 (203)	10 (254)	12 (305)
Mass per unit area, lb/ft^2 (kg/m^2)	25 (121)	34 (165)	45 (220)	68 (330)	90 (440)	113 (550)	135 (661)
Concrete Coverage ft^2/yd^3 (m^2/m^3)	136 (16.6)	100 (12.2)	75 (9.1)	50 (6.1)	38 (4.6)	30 (3.6)	25 (3.0)
Filter Point Spacing, in (mm)	5 (127)	6.5 (165)	8 (203)	10 (254)	12 (305)	14 (356)	16 (406)

iii. Uniform Section fabric form Concrete Lining

Figure C. Uniform Section Fabric form concrete Lining.

Uniform Section (US) Linings are similar to traditional concrete slope paving. They create a solid, high quality concrete lining with a relatively low hydraulic resistance and uniform cross section. These linings are used to reduce the infiltration or exfiltration of aggressive waste and chemical fluids into or out of open channels and basins. They are also used to reduce exfiltration in arid regions where open channels and basins require water tight linings.

Typical Dimensions and weight:

Product and Sizes	**US300**	**US400**	**US600**	**US800**	**US1000**
Average Thickness, in (mm)	3 (76)	4 (102)	6 (152)	8 (203)	10 (254)
Mass per unit area, lb/ft2 (kg/m2)	34 (165)	45 (220)	68 (330)	90 (440)	113 (550)
Concrete Coverage ft2/yd3 (m2/m3)	100 (12.2)	75 (9.1)	50 (6.1)	38 (4.6)	30 (3.6)
Drop Point Spacing, in (mm)	3.8 x 2.9 (97 x 72)	3.8 x 3.8 (97 x 97)	38 x 57 (97 x 145)	5.7 x 7.6 (145 x 193)	5.7 x 8.6 (145 x 217)

ANNEX 13
(*Item* 9
.1)

GUIDELINES FOR RESEARCH & DEVELOPMENT PROJECTS FOR FORMULATION AND REVIEW OF STANDARDS

1 INTRODUCTION

Bureau of Indian Standards (BIS), as the National Standards Body of India is responsible for formulating Indian Standards for products, processes and services. In the pursuit of this endeavour, it has so far developed more than 22000 Indian Standards. Action Research and Research & Development Projects have always been part of the standardization process. However, there has been a growing realisation in the context of the increasing diversification, innovation and complexities in the manufacturing sector and evolution of services and also due to the fast pace of changes in the manufacturing and services landscapes, research & development projects have to be made an integral part of the standardization process. The idea is that in principle no standard should be developed without intensive and insightful research work, which is not confined only to the review of the existing literature and focus group discussions on the subject chosen for standardization, but also covers the detailed field level study of the existing processes and practices in product manufacturing and service delivery. This requires a large network of domain area experts to carry out the research & development work. The existing network encompasses only a small segment of experts, who are either associated with technical committees as members or belong to some R&D organizations. The Memorandum of Understanding with the premier educational institutions imparting technical and professional education opens the window to the opportunities to expand this network substantially by utilizing the intellectual capital that resides with the faculty and the research scholars in these institutions. This association is conceived not only as a way to promote research & development work necessary for standards formulation but also to enrich the research ecosystem in these educational institutions.

2 OBJECTIVES

Objectives of this Scheme are to:

2.1 support and commission research & development projects to generate knowledge, empirical data and insights that would help in formulating new standards and updating & upgrading the existing Indian standards;

2.2 expand the network of domain area experts to carryout research & development projects in the areas related to standardization and conformity assessment; and

2.3 enrich the research ecosystem in the educational institutions imparting technical and professional education.

3 RESEARCH & DEVELOPMENT PROJECTS

3.1 Research & development projects under these guidelines are described as follows:

A project aimed at comprehensive, in depth and incisive study of a product, process or service or all taken together in respect of a subject under standardization, encompassing literature review, analysis of the data from secondary sources, collection and analysis of data from primary sources and stakeholder consultations.

3.2 The duration of a project shall not exceed six months counted from the date of the award of the project to acceptance of the final report by the Sectional Committee concerned, provided that the Sectional Committee must not take more than one month to give its decision on the final report. Further provided that the time taken by the Sectional Committee for giving its decision shall not be counted. The Sectional Committee may extend the duration but for not more than 2 months in special circumstances, the reasons for which shall be recorded in the minutes of meeting of the Sectional Committee.

3.3 The upper limit for expenditure for a project shall be Rs 10 lakhs (including taxes) only.

3.4 BIS will publish a list of research & development projects along with Terms of Reference (ToR) on Standardization portal or any other suitable digital platform.

3.5 If any organization or an expert on behalf of an institute wants to propose a research & development project on any new and emerging area in which they have expertise, they can do so through the same platform for the consideration of the Sectional Committee.

4 TERMS OF REFERENCE (ToR)

4.1 The ToR of Research& development project shall be prepared by the Sectional Committee concerned, and shall contain:

a) Title, background and objectives of the study;
b) Expected research methodology (brief information, for example, survey, testing, industry visits, etc.);

c) Scope of study;
d) Outline of the tasks and final deliverables expected from the Proposers;
e) Methods of review, schedule for submitting the 1st draft report and project completion report;
f) Any support or inputs to be provided to the Proposer; and
g) Maximum duration of project and timelines for submission of proposal.

4.2 While preparing the Terms of Reference (ToR) the sectional committee may consider the following points as a research & development project may include one or mix of the following:

a) Secondary research based on internet or published information including authentic data sources;
b) Survey based research (including industry visits) to ascertain prevailing market conditions and practices, standards in use, industry and consumer preferences, availability of infrastructure, technical capabilities, comparative trends, economic trends;
c) Ascertaining compliance to existing and proposed standards through testing, review of past test reports, other validation and verification checks; and
d) Basic and innovative research to establish normative criteria. Criteria may include performance, health, safety, environmental impact.

5 APPROVAL OF COMISSIONING OF THE RESEARCH AND DEVELOPMENT PROJECTS

5.1 There shall be a Review Committee for approving the projects recommended by the Sectional Committee. The composition of Review Committee shall be as follows:

DDG (SCMD)	: Chairperson
DDG (Standardization) concerned	: Member
DDG (Certification)	: Member
DDG (Labs)	: Member
Officer in-charge for research works in SCMD	: Member Secretary

5.2 The Head of Technical Department concerned and Member Secretary of the Sectional Committee shall apprise the review committee about the project and explain the rationale behind the proposed research & development project.

6 ELIGIBILITY CRITERIA

6.1 The following shall be eligible for carrying out research & development projects under the Scheme:

a) Academic institutions & universities having MoU with BIS and faculties and research scholars thereof;
b) Member(s) of Technical Committees of BIS.

6.2 Faculties and research scholars shall submit proposals through their institute. Members of technical committees belonging to any association/organization shall submit the proposals through their association/organization. Members of technical committees in personal capacity can submit their proposals directly to BIS, however if carrying out a research & development project requires collaboration with any institution/organization, concurrence of the same shall also be submitted.

7 PROCEDURE FOR APPLICATION

7.1 Submission of Proposal

7.1.1 Applications for undertaking research & development projects shall be submitted in the manner prescribed by the Bureau and within the prescribed timelines,

7.1.2 Proposer(s) shall submit their proposal in a "single stage - two envelope bid system" consisting of separately sealed "Technical and Financial proposals". The Technical Proposal shall be submitted as per format prescribed in Annex A and the Financial Proposal shall be submitted in the format prescribed as per Annex B, clearly specifying expected expenditure against each element such as manpower, equipment (shall not include computer hardware and software), travelling, testing, consumables, stationery, overheads, etc.

7.1.3 There shall be maximum one proposal from one institute on a given subject.

7.1.4 No contractual obligation whatsoever shall arise until a formal agreement is signed and executed between the Bureau and the Proposer.

7.2 The proposals shall inter-alia consist of the following:

7.2.1 In respect of the research & development projects put up by the Bureau:

a) Details of the Project team along with the organization/institution associated with;

b) The CV of the Project leader and expert/expert(s) to be associated with the project and a letter from organization authorizing Project Leader and expert/expert(s) to undertake the research as proposed.
c) A write up on the understanding of the scope and objectives of the project.
d) Methodology (sampling size, if applicable) to be adopted for the proposed study with a clear road map and time plan for completion of the project;
e) Stage wise timelines for completion of the project.

7.2.2 In respect of research & development projects proposed by any expert/organization:

a) Details of the Project team along with the organization/institution associated with;
b) The CV of the Project leader and expert/expert(s) to be associated with the projects and a letter from organization authorizing Project Leader and expert/expert(s) to undertake the study as proposed.
c) Objective that will be achieved and scope of the project clearly highlighting the need of such study and what would be the final deliverable;
d) Methodology (sampling size if applicable) to be adopted for the proposed study with a clear road map and time plan for completion of the project;
e) Details of infrastructure facilities available for the project, in the institution and additional facilities required (if any) for carrying out research.
f) Stage wise timelines for the completion of the project

7.3 The Head of the concerned institution while forwarding the application and nominating the project leader shall certify that:

a) the core facilities (land, buildings, laboratory, manpower and other infrastructure etc.) are available and will be provided to the Project Leader to work on the proposed project,
b) the organization will discharge all its obligations, particularly in respect of management of the financial assistance given, and
c) no other funding is being received/sought for the project proposed to be sanctioned by BIS.

8 PROCEDURE FOR APPROVAL WITHIN BIS

8.1 There shall be a Research Evaluation Committee (REC) to evaluate the proposals received, the composition of which shall be as follows:

DDG (PRT) :
Chairperson

Head (CMD) concerned : Member
Head (LPPD) : Member
Head of the Technical Department concerned : Member Director Finance : Member
Two Experts from the Sectional : Members Committee concerned
Head (SCMD) : Member Secretary

*The experts shall be nominated by the Sectional Committee and the nominated members shall give a declaration to the effect that there is no conflict of interest with respect to the project.

8.2 The evaluation and selection will be as per Quality and Cost Based Selection (QCBS) method (Rule 192, GFR 2017) which is explained in Annex C.

8.3 The criteria for evaluation of technical proposal shall be as under:

Sl No.	**Criteria**	**Max. Marks**	**Score by REC**
1	Profile of key individual/individuals to be associated with the research project	**10**	
2	Experience of the individual/organisation in conducting research projects in the relevant discipline	**20**	
3	Understanding of Scope, Objectives and deliverables	**15**	
4	Methodology	**30**	
5	Work plan/Execution strategy	**15**	
6	Chapterisation, contents and lay out of the proposed report	**10**	
	TOTAL	**100**	

Note: REC may call for a presentation by the proposers if deemed necessary.

8.4 The minimum qualifying marks shall be 70. All the proposals with marks below 70 shall be considered rejected.

8.5 REC may refer back, advise changes for reconsideration or reject any proposal.

8.6 REC shall open the financial proposals (bids) within 7 days from completion of technical evaluation.

8.7 A final score sheet of all the proposers shall be made as detailed in Annex C and the proposer getting the highest combined score shall be selected for awarding the project.

8.8 The member secretary (REC) shall send the selected proposals to DG/DDG Standardization concerned, as per their delegated powers, for consideration and approval for sanction of the project.

8.9 After the approval of project, the member secretary (REC) shall inform the concerned technical department and the proposer regarding the decision.

8.10 After the sanction of fund is approved, the draft agreement (prepared in line with model agreement given at Annex D, to be modified on case-to-case basis) shall also be prepared by the Member Secretary (Sectional Committee), clearly highlighting the payment term. The Head (Technical Department) shall sign the agreement on behalf of BIS in all cases.

8.11 In case the proposer to whom the project is awarded declines to take up the project, the Research project shall be awarded to the proposer getting the next highest combined score among the qualified proposers.

9 SIGNING OF AGREEMENT AND ISSUING OF SANCTION LETTER

9.1 After receipt of duly signed agreement from the proposer and after the receipt of the approval of competent authority, a sanction letter shall be issued by the concerned Head (Technical Department) to the organization/individual member. The project would be considered to have commenced from the date the sanction letter is issued.

10 FUNDING

10.1 The mode of payment for Research & development projects shall be as follows:

a) First instalment up to a maximum of 30 percent of the total approved project cost would be released after approval of the project.
b) Second instalment to the extent of 50 percent of the approved estimated cost would be released on the submission of progress report along with the report on utilization of the 75 percent of the fund and acceptance of the same by the Sectional Committee.
c) The balance amount shall be released after submission of the final project report along with utilization certificate for the fund released and its acceptance by the Sectional Committee.

10.2 Release of each instalment is subject to satisfactory progress, required stage - wise deliverables and submission of the Utilization Certificate (UC) as per Form GFR12-A of

GFR 2017 along with the statement of expenditure (SoE) issued by the Competent Authority.

11 PROGRESS REPORT AND MONITORING OF PROJECT

11.1 The relevant Sectional Committees of BIS will monitor the progress of project to ensure that the project is progressing as per the planned arrangement. However, member secretary of the concerned Sectional Committee under overall coordination of HoD would be the controlling/link officer for Research & Development projects and would constantly monitor the progress of the project every 30-45 days. Any delay in implementation of project should be duly justified by the Project leader and shall be put up to Research Evaluation Committee (REC) for approval.

11.2 The Sectional Committee shall review and give its acceptance of the progress reports submitted, within 3 weeks.

12 SUBMISSION OF FINAL PROJECT REPORT (FPR)

12.1 The FPR must be detailed and should include information about:

a) the original objective(s) of the project,
b) how far these objective(s) have been achieved, and
c) how the results will benefit the development of the national standard(s) and
d) a copy of final working draft of the concerned standard(s) (wherever applicable)
e) include clear inferences, recommendations regarding their use in the proposed standards,
f) all references used, raw data of surveys, sampling, testing and experiments,
g) undertaking that all the information presented is authentic.

12.2 FPR received in BIS would be put up to the concerned Sectional Committee, which will take necessary action for preparation/revision of standard appropriately. The Project leader shall assist in the disposal of comments received on the research project, draft standard and for the preparation of the finalized draft, as may be desired by the Sectional Committee.

12.3 The proposer shall submit the Project Completion Report (PCR), within one month of completion of project along with the Utilization Certificate of the fund released as per Form GFR 12-A of GFR 2017 and the statement of expenditure (issued by the Competent Authority -in case of Govt. organization / Charted Accountant in case of private organization).

13 RESULTS OF RESEARCH & DEVELOPMENT

13.1 Project Leader(s) would be encouraged to publish the results of research & development. While doing so, acknowledgement to the effect that financial assistance was received from BIS should be made in the research paper(s) published. BIS should be acknowledged in similar type of other published work/press reports.

13.2 One re-print of each research paper(s) published as a result of the work done under the BIS funds shall be sent to BIS as and when published.

14 INTELLECTUAL PROPERTY RIGHTS

14.1 Ownership of any intellectual property, including but not limited to confidential information, know-how, patents, copyrights, design rights, rights relating to computer software, and any other industrial or intellectual property rights, developed solely by Proposer shall be vested with that Party.

14.2 Ownership of any intellectual property, including but not limited to confidential information, know-how, patents, copyrights, design rights, rights relating to computer software, and any other industrial or intellectual property rights, developed solely by the Bureau shall be vested with that Party.

14.3 The Intellectual Property arising out as an outcome of research project undertaken under these guidelines shall be vested with Bureau.

15 OPERATION OF FUNDS

15.1 The utilization certificate of the funds received in previous instalment (if any) to BIS should be annexed with the Statement of all equipment, books, etc purchased out of the funds certified by the Head of the organization. The name, description of the equipment, cost in rupees, date of purchase, and the name of the supplier to be given in the list. The main purpose/function of the equipment may also be mentioned against each item.

15.2 Any unspent balance lying with the organization should be refunded to BIS after the finalization of the draft immediately, by means of demand draft or online transfer.

15.3 The Head of the concerned standardization department of BIS shall ensure that the project leader submits the utilization certificate in the manner prescribed in Form GFR 12-A of GFR 2017.

15.4 Head of the Standardization department shall also ensure that the operation of funds is monitored strictly as specified in Annex E. Further the Project Leader is also fully aware and shall adhere to the obligations of his/her as given in this procedure.

16 OTHER REQUIREMENTS

16.1 Organizations receiving financial assistance for research & development projects from BIS would have to maintain separate accounts for each research project.

16.2 In the event of a Project Leader's absence from his normal place of duty for two months at a stretch, the Head of the organization would need to immediately nominate an Alternate Project Leader(s) to supervise the implementation of the project and such a name has to be approved in advance by BIS. In any event, a Project Leader shall give prior notice to BIS of his intention to stay away from the project.

16.3 Items of equipment, etc should be purchased on the basis of the established rules and procedures of the entity/organization.

16.4 Stock register of all equipment, books, etc purchased out of the funds shall be maintained.

16.5 Any capital-intensive equipment/devices purchased using financial assistance from BIS for research & development projects shall be allowed to be retained by the proposer for their research activity etc.

16.6 The organization shall have to ensure that expenditure with respect to TA/DA are made only as per their own norms but under no circumstances the executive/business class air travel or stay in a five-star hotel is made. The overhead expenses should not be more than 20 percent of the cost of the project.

16.7 The Project Leader must ensure that the concerned organization's newsletter would carry information on the activities and accomplishments of the various projects funded by the BIS.

17 TERMINATION OF PROJECT:

The research & development project can be terminated in case of any of the following:

a) the approval of research & development project may be treated as withdrawn, if the sanctioned research & development project does not commence within one month from the date of receipt of the sanction letter, unless otherwise authorized by BIS;

b) A Proposer may request for the withdrawal of a research & development project even after commencement of the project. In such case the entire fund given till that date shall be refunded to the Bureau; and

c) if the Proposer fails to submit Progress report/Completed Project report within the prescribed timelines.

The REC shall take decision on all cases of termination.

18 RESOLUTION OF DISPUTES

Dispute Resolution: In case of any dispute that cannot be resolved amicably, it shall be referred to Sole Arbitrator appointed by the Director General of the Bureau of Indian standards, whose decision shall be final and binding upon both the parties. The provisions of the Arbitration and Conciliation Act, 1996, as amended from time to time, shall be applicable.

ANNEX 14
(*Item* 9.1)

TERMS OF REFERENCE FOR THE R&D PROJECTS

Technical Committee: Geosynthetics Sectional Committee, TXD 30

1. **Title of the Project:** To study the constructional and performance requirements for jute geotextiles used in rain water erosion control in road and railway embankment and hill slopes.

2. Background

Jute geotextiles are often used preventing surface runoff, reducing soil erosion, and promoting the growth of vegetation in roads and railway embankments and hill slopes. These geotextiles serve as a protective layer against erosion by stabilizing the soil and preventing it from being washed away by rainwater. They are placed over the soil surface to reinforce it, allowing water to pass through while minimizing soil movement and retaining its structure.

BIS has published IS 14986:2001 ‘Guidelines for application of Jute Geotextile for rain water erosion control in road and railway embankments and hill slopes’. The standard presently specify 3 types of JGT i.e. 730, 500 and 292 GSM JGT.

Following an Industry Interaction session on "Jute Geotextiles – A Sustainable Geotechnical Solution," feedback from Jute Stakeholders suggested the need to split the standard into two parts. One part will cover guidelines, while the other will address product requirements, specifically focusing on Open Weave JGT for rainwater erosion control in road and railway embankments and hill slopes.

Further a testing challenge was encountered in determining the minimum breaking load and maximum elongation at break, particularly with 20 yarns and a 20 cm grip length with Goodbrand Fabric Testing Machine, as outlined in the existing standard. In response to feedback, the technical committee decided to incorporate fresh results obtained from breaking load and elongation tests conducted in accordance with IS 16635, titled 'Wide Width Tensile Test.'

Additionally, the standard will undergo revisions to align with the latest industrial practices. It will also incorporate information on newer varieties of JGT, ensuring that the document reflects the evolving landscape of Jute Geotextile applications. This comprehensive revision aims to enhance the standard's relevance in today’s context.

The outcome of the R&D project will serve as the basis for revision of IS 14986:2001 ‘Guidelines for application of Jute Geotextile for rain water erosion

control in road and railway embankments and hill slopes' to incorporate the fresh requirements for constructional and performance requirements and revise the standard as per the latest industrial practices.

3. Scope

a) Undertake study and analyse the existing literature which include but not restricted to the following: -

   i) International standard and regulation,
   ii) Journals and research papers,
   iii) Standard operating procedures (SOPs)/guidelines of Ministry/regulator/users,
   iv) Studies/research conducted by any organization,
   v) Any other relevant published information.

b) Collection of the database for manufacturers (small, medium and large-scale), testing infrastructure and users in the country.
c) Collection of import and export data, type of standards and regulation being followed by domestic/foreign manufacturers, comparative analysis of these standards and regulation.
d) Undertake 2 visits to each of small, medium and large-scale manufacturer and collect the information on the following aspects: -

   i) Types/grades of raw material being used
   ii) Manufacturing process
   iii) In-process controls being exercised during manufacturing
   iv) Varieties being manufactured (based on Weave type, GSMs, thickness etc.)
   v) Standards being followed
   vi) Testing method being used
   vii) Testing infrastructure available
   viii) Post manufacturing quality/in-house data for safety, performance and constructional parameter for all the varieties being manufactured
   ix) Sampling plan being followed
   x) Marking and labelling of the product
   xi) Packaging practices being followed
   xii) Sustainability practices [sustainable raw material, energy efficient processes and methodologies, renewable energy sources, 3Rs (Reduce, Reuse and Recycle), waste management and disposal mechanisms]
   xiii) Focused group discussions with teams involved in production, testing, and R&D to address quality issues, discuss challenges faced, and gather suggestions for improvement

The feedback from other manufacturers (where visit is not carried out) shall be collected by circulating suitable questionnaire covering above information through email or any other digital means.

e) Undertake 2 visits to users and 2 visits to testing labs (one govt and one private NABL accredited lab) to collect information including but not restricted to the following: -

User

i) Standards and regulations being followed
ii) Compliance mechanism being followed (test certificate from supplier, third party testing)
iii) Installation methods/guidelines followed
iv) Focused group discussion on quality issues, challenges being faced and suggestions if any.

Lab

i) Standards and regulation being followed
ii) Testing methods being followed
iii) Testing infrastructure
iv) Focused group discussion on testing related issues, challenges being faced and suggestion

The feedback from users and labs (govt and private NABL accredited) where visit is not carried out shall be obtained through suitable questionnaire covering above information.

f) Purchase/collect samples and testing of samples for parameters including but not restricted to construction type, GSM, length, width, Ends/dm, Picks/dm, thickness, aperture size, minimum breaking load and maximum elongation (tested as per IS 16635 wide width elongation method in both machine and cross direction), as per following sampling plan:

Sl. No.	Number of samples	Type of Industry
1	02	Large scale
2	02	Medium scale
3	02	Small scale
Total	06 (03 samples to be tested in Govt Lab, 03 samples to be tested in Pvt. Lab)	

g) Preparation of a comprehensive project report covering all the above information.

4. Expected Deliverables

a) Final Analytical report, in hard copy format, covering all aspects mentioned in scope

b) Questionnaires, discussion and visit reports, test reports, to be appended with the final analytical report

5. Research Methodology: -

a) Collect and analyze the data/information as specified in the scope [4 (a), (b) and (c)].
b) Visit manufacturers, users and labs and collect data/information as specified in the scope [4 (d) and (e)].
c) Collect and test the samples as specified in the scope 4 (f).
d) Analysis the data/information and prepare a comprehensive project report.

6. Expected Deliverables: -

a) Comprehensive report in soft/hard form of study covering all the aspects detailed in the scope of the R & D project.
b) Questionnaire feedback, testing report, focussed group discussion report, other relevant documents and information shall be appended to the project report.

7. Requirement for the CVs: -

Graduate in textile technology or textile engineering or textiles chemistry or fibre science and technology or manmade fibre technology or carpet and textile technology.

8. Timeline and Method of progress Review: -

The duration of the project is 120 days from the date of the award of the project. The stagewise indicative timelines are as follows:

Indicative Time line	**Method of progress**
0 to 20 days	Literature review, desktop study, collection of data and information Note — The sampling plan for visit and collection of samples shall be discussed and finalized with nodal officer after literature survey and desktop research.
21 to 60 days	Visit to manufacturer, user, testing lab and collection of samples
60 to 100 days	Testing of samples (except long duration test with testing time more than 30 days) Preparation and submission of first draft report
100 to 120 days	Submission of the final project report

9. Support BIS will provide: -

a) All the relevant Indian Standards/ISO Standards or any other standards required during the project will be provided by BIS.
b) Facilitate/introduction of the project leader/organization to relevant Industry and industry association, testing lab, institute, academia, user, regulator/ministries.
c) Facilitate testing of samples in BIS Lab/BIS Recognized Lab.

10. Nodal Point

In case any queries/clarification, Shri Himanshu Shukla, Sc-B & Member Secretary, TXD 30 may be contacted on txd@bis.gov.in.