भारतीय मानक

Indian Standard

IS 11320 : 2023

वस्त्रादि — पॉलिएस्टर, फेनोलिक, विनाइल एस्टर और एपॉक्साइड थर्मोसेट रेजिन सिस्टम के सुदृढीकरण के लिए ग्लास फाइबर रोविंग — विशिष्टि

(दूसरा पुनरीक्षण)

Textiles — Glass Fibre Rovings for the Reinforcement of Polyester, Phenolic, Vinyl Ester and of Epoxide Thermoset Resin Systems — Specification

(Second Revision)

ICS 59.100.10

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High Performance Fibres, Fibrous Structure and Textile Components of Composites Sectional Committee, TXD 40

FOREWORD

This Indian Standard (Second Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the High Performance Fibres, Fibrous Structure and Textile Components of composites Sectional Committee had been approved by the Textiles Division Council.

Rovings are broadly classified into single end roving and multi end roving.

Some of the thermoset resin based moulding processes and applications and/or products are given for reference where single end rovings are used:

a) Filament winding process to manufacture mainly axisymmetric products such as tanks and pipes, but not limited to axisymmetric products in some cases;
b) Pultrusion process to manufacture products mainly sections which are uniform in nature along the length. Some of the applications include sections for cable trays, central strength members for cables, assembled gratings for chemical industry, etc; and
c) Hand lay-up process to strengthen the corners of product, gratings, etc.

Some of the thermoset based moulding processes and applications and/or products are given for reference where multi end rovings are used:

a) Filament winding process in combination of single end roving;
b) Spray-up process to mould large and relatively less complex parts to speed-up the moulding process and where one side finish is acceptable. Typical applications are water slides, large domes, etc;
c) To manufacture sheet moulding compound (SMC), which in turn used to manufacture two side finished products for automotive, sectional panels for water tank, partition, etc. using hydraulic/electric press where metal match mould is used; and
d) Using mechanised chopping and manufacturing process for applications such as automotive headliners, translucent/pigmented sheets, etc.

Single end rovings and multi end rovings are used individually and in combination to manufacture reinforcements. Some of the reinforcements which are further used in various thermoset resin moulding processes are listed for reference:

a) Single end rovings: woven roving, multi-axial fabrics;
b) Multi end rovings: stitched chopped strand mat; and
c) Single and multi end rovings: combination mat.

Directions for ordering glass fibre rovings has been given for guidance in Annex A of the standard. It is also strongly recommended that the intended use of the rovings should be fully discussed with the suppliers before ordering. It is necessary that the roving construction and roving tex requirements be carefully looked into while using this specification.

This standard was originally published in 1985 and was subsequently revised in 1997. This revision has been made in the light of experience gained since its publication and to incorporate the following changes:

a) Title of the standard has been modified;
b) Scope clause has been modified;
c) Grades designation clause has been modified;
d) Packing and marking clause has been modified;
e) All amendments have been incorporated; and
f) References to Indian Standards have been updated.

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

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

Indian Standard

TEXTILES — GLASS FIBRE ROVINGS FOR THE REINFORCEMENT OF POLYESTER, PHENOLIC, VINYL ESTER AND OF EPOXIDE THERMOSET RESIN SYSTEMS — SPECIFICATION

(Second Revision)

1 SCOPE

This standard prescribes requirements and the methods of sampling and test for glass fibre rovings made from 'E' and 'ECR' glass intended for the reinforcement of polyester, phenolic, vinyl ester and of epoxide thermoset resin systems, and for use in accordance with the roving suppliers recommendations. Some rovings are suitable for use with multiple resin systems, whilst others are only for one or the other.

2 REFERENCES

The standards given below 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 edition of these standards:

IS No.	*Title*
IS 2828 : 2019/ ISO 472 : 2013	Plastics — Vocabulary (*second revision*)
IS 4905 : 2015/ ISO 24153 : 2009	Random sampling and randomization procedures (*first revision*)
IS 6746 : 1994	Unsaturated polyester resin systems — Specification (*first revision*)

3 TERMINOLOGY

For the purpose of this standard, the definitions given in IS 2828 and the following definitions shall apply.

3.1 Roving — Collection of parallel strands assembled without intentional twist.

NOTE — By reason of the method of the manufacture strands generally contain small amount of twist not exceeding 4 turns/metre.

3.2 Strand — A plurality of filaments bonded with size.

3.3 Filament — A single glass fibre as drawn.

3.4 Size — The material applied to glass fibre during the course of their manufacture to facilitate processing and use.

3.5 Coupling Agent — Additive in the size to improve performance of the roving in use.

3.6 Type of Glass

3.6.1 *'E' Glass* — A type of glass which does not contain more than 1 percent by mass of alkali (calculated as Na_2O) which is commonly referred to as 'low alkali' glass.

3.6.2 *'ECR' Glass* — A modified version of 'E' Glass, which is boron free. 'ECR' Glass gives better corrosion resistance than 'E' Glass for most acids.

3.7 Tex — The mass in g per kilometre length.

3.8 Single End Roving — Roving obtained by winding a large and determined number of filaments directly from a bushing. This roving has one end. It is also termed as direct roving as it is directly drawn from the bushing.

3.9 Multi End Roving — A collection of parallel strands assembled in secondary process without intentional twist. Multi end roving is also termed as assembled roving/chop roving/choppable roving/ spray-up roving.

NOTE — This is sometimes referred to as an assembled roving.

4 GRADES DESIGNATION

The grades designation should capture salient information like type of glass (E or ECR), type of roving (single or multi end roving), roving tex, filament diameter for easy identification.

Additional information such as relevant standard to which the roving comply, the resin compatibility, number of ends and strand tex in case of multi end roving, manufacturing date can be provided as agreed between supplier and customer as part of test certificate.

5 REQUIREMENTS

5.1 Manufacture

The rovings shall be constructed, either directly or indirectly, from glass strands of the same filament diameter designation. The filament diameter designation used shall be as given in Table 1 with filament diameter determined in accordance with Annex B. A volan or silane coupling agent shall be incorporated in a size applied to the filaments during manufacture.

Table 1 Filament Diameter Designation

(*Clause* 5.1)

Sl No.	Filament Diameter Designation	Corresponding Mean Filament Diameter Designation	
		From µm	Up to but not Including µm
(1)	(2)	(3)	(4)
i)	6	5.5	6.5
ii)	7	6.5	7.5
iii)	8	7.5	8.5
iv)	9	8.5	9.5
v)	10	9.5	10.5
vi)	11	10.5	11.5
vii)	12	11.5	12.5
viii)	13	12.5	13.5
ix)	14	13.5	14.5
x)	15	14.5	15.5
xi)	16	15.5	10.5
xii)	17	16.5	17.5
xiii)	18	17.5	18.5
xiv)	19	18.5	19.5
xv)	20	19.5	20.5
xvi)	21	20.5	21.5
xvii)	22	21.5	22.5
xviii)	23	22.5	23.5
xix)	24	23.5	24.5
xx)	25	24.5	25.5

5.2 Tex Count

5.2.1 The tex count shall be specified as 150, 300, 640, 1 120, 2 400 and 4 800.

5.2.2 The count of rovings, as indicated in grams per 1 000 m length (tex), and the variation of the tex shall be as given in Table 2 shall be determined in accordance with Annex C of this standard.

Table 2 Tex Count

(*Clause* 5.2.2)

Sl No.	Tex Count	Nominal Count	Variation of Tex
		Tex	Percent
(1)	(2)	(3)	(4)
i)	150	150	10
ii)	300	300	10
iii)	640	640	10
iv)	1 120	1 120	10
v)	2 240	2 240	8
vi)	2 400	2 400	8
vii)	4 800	4 800	8

Other tex counts (not mentioned in the above) shall be as agreed to between the purchaser and the supplier.

5.3 The glass fibre rovings shall have proper stiffness of strands and dispersion property and shall be free from unevenness of binder, contamination, combination of monofilaments with larger diameter, etc.

5.4 Tensile Breaking Load

Tensile breaking load of glass fibre rovings shall be as given in Table 3 and shall be determined on a constant rate of traverse type universal tensile testing machine having a grip of distance of 250 mm and at a drawing of 300 mm per minute ± 20 mm per minute.

5.5 The rovings shall be free from oil and grease spots and any other contamination and shall be uniform in colour.

5.6 The rovings of all types and grades shall also comply with the requirements given in Table 4.

5.7 Keeping Properties

Unless otherwise agreed to, the rovings shall comply with the requirements of this standard for a period of not less than one year, from the date of manufacturing, when stored at a temperature not exceeding 27 °C and a relative humidity not exceeding 65 percent.

Table 3 Tensile Breaking Load

(*Clause* 5.4)

Sl No.	Tex Count	Tensile Breaking Load kgf (N)
(1)	(2)	(3)
i)	150	Over 3 (30)
ii)	300	Over 6 (59)
iii)	640	Over 12 (118)
iv)	1120	Over 23 (225)
v)	2240	Over 45 (440)
vi)	2400	Over 48 (470)
vii)	4800	Over 96 (940)

NOTE — 1 kgf = 9.806 6 N.

6 TESTS

6.1 Tests shall be conducted as prescribed in the appropriate Annexes.

6.2 Test Specimens

Test pieces shall be cut from the samples in the required number and in appropriate manner as specified in the individual methods of test.

7 PACKING AND MARKING

7.1 Packing

The rovings shall be packed in closed polyethylene bags and then in containers in such a manner as to give adequate protection during transport.

Table 4 Requirements for Glass Fibre Rovings for the Reinforcement of Polyester, Phenolic, Vinyl Ester and of Epoxide Thermoset Resin System

(*Clause* 5.6)

Sl No.	Characteristics	Requirements	Methods of Test, Ref to Annex of this Standard
(1)	(2)	(3)	(4)
i)	Moisture content, percent by mass, *Max*	0.3	D
ii)	Loss on ignition, percent by mass	± 20 percent from the nominal value stated or ± 0.2 from the nominal values stated whichever is the greater tolerance	E
iii)	Cross breaking strength, reinforced polyester rod, MPa, *Min*: a) dry b) Wet or Reinforced epoxy rod, MPa, *Min*: a) dry b) Wet	 585 490 585 363	F F
iv)	Conductivity of water extract, mS/m, *Max*	12.5	G

NOTES

1 1 MPa = 10.2 kgf/cm^2.

2 1 mS/m = 10 micro mhos/cm.

7.2 Marking

The material shall be marked with the following:

a) Indication of the source of manufacture, or trade-mark;
b) Type and grade designation of the rovings;
c) Month and year of manufacture; and
d) Batch No. or code No.

NOTE — Additional information such as resin compatibility, type of winding that is, internal or external can be provided as agreed between supplier and customer as part of test certificate.

7.3 BIS Certification Marking

The product 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 may be marked with the Standard Mark.

8 SAMPLING AND CRITERIA FOR CONFORMITY

8.1 Sampling

8.1.1 *Lot*

All the containers of a single consignment of the material of the same type, designation and from a single batch of manufacture shall constitute a lot.

8.1.2 Samples shall be tested for each lot separately for ascertaining the conformity of the material to the requirements of the specification.

8.1.3 The number of containers to be selected from the lot shall depend on the size of the lot and shall be in accordance with Table 5.

8.1.4 These containers shall be selected at random from the lot. In order to ensure the randomness of selection, procedure given in IS 4905 may be followed.

8.2 Number of Tests and Criteria for Conformity

8.2.1 From each of the containers selected according to **8.1.3**, the required number of test samples shall be prepared and tested for various requirements.

8.2.2 Each of the sample obtained from a lot shall be examined for visual defects (*see* **5.5**), roving tex and moisture content, and if found satisfactory, further tests as specified shall be carried out.

8.2.3 The lot shall be declared as conforming to the requirements of the specification if the test results are found to be within limits of the specification when tested according to **8.2.1** and **8.2.2**.

Table 5 Scale of Sampling

(*Clause* 8.1.3)

Sl No.	Lot Size	No. of Containers to be Chosen		
		Moisture and Roving Tex	Loss on Ignition and Conductivity of Water Extract	Cross Breaking Strength
(1)	(2)	(3)	(4)	(5)
i)	1	1	1	1
ii)	2 to 15	2	2	1
iii)	16 to 50	3	2	1
iv)	51 to 100	5	2	1
v)	101 to 150	7	5	2
vi)	151 and above	10	7	2

ANNEX A

(*Foreword*)

DIRECTIONS FOR ORDERING

A-1 RECOMMENDATIONS

A-1.1 The purchaser after discussion with supplier shall state the requirements in respect of the following:

a) The number of this Indian Standard;
b) The intended end use;
c) Type of roving that is single end or multi end;
d) Roving tex and filament diameter;
e) The resin system with which the roving is to be used;
f) Type of unwinding internal or external that is whether the roving is wound on a cardboard tube or not;
g) Type of package that is palletised bobbins or individual bobbins packed in carton or combination of both; and
h) Weight of bobbin.

ANNEX B

(*Clause* 5.1)

DETERMINATION OF MEAN FILAMENT DIAMETER BY THE PROJECTION MICROSCOPE METHOD

B-0 This method should be carried out after the method described in Annex E.

B-1 APPARATUS

B-1.1 Projection Microscope

Comprising a light source, a light condenser, a stage supporting the slide carrying the fibres, an objective, an ocular and a circular screen. The stage shall be movable in two directions at right angles by means of a sliding mechanism and the circular screen shall have a scale graduated in millimetres and able to rotate about its centre in its plane.

B-1.2 Micrometer Scale

B-1.3 Mounting Medium

For example 50 percent concentration of ethylene glycol in water.

B-1.4 Microscope Slide and Cover Glass

B-2 CALIBRATION OF THE MICROSCOPE SCALE

Place the microscope scale on the microscope stage and, using low magnification, centre the micrometer scale image on the screen. Increase the magnification until one micron of the image is approximately equivalent to one millimetre on the screen scale. Align the image by means of the stage sliding mechanism with the screen and record how many millimetres, A, on the screen scale correspond to 50 µm on the micrometer scale.

Example:

If 50 µm of the micrometer scale image are 60 mm wide on the screen scale, $A = 60$.

Calculate the calibration factor C from the following equation:

$$C = 50/A$$

where

$C = 0.83$ in the example.

B-3 PREPARATION OF THE TEST SAMPLE

Take the sample of roving remaining following determination of loss on ignition in accordance with Annex E. Using a sharp blade, cut a length of 3 mm to 6 mm from the test sample and place it on to the microscope slide. Mix the fibres with a few drops of the mounting medium until they are evenly dispersed. Cover the slide with a cover glass.

B-4 PROCEDURE

Place the slide on the microscope stage and focus on the filaments. Using the screen scale, measure and record the width of the image of the filament to the nearest millimetre. Traverse the slide by means of the stage sliding mechanism until another filament is encountered and then measure and record the image width. To avoid repeated measurements of the same filaments, start at one edge of the slide and traverse in one direction only. Repeat the process until 100 measurements have been made. If an

insufficient number of measurements have been made from one slide, prepare a second and so on until 100 filaments have been measured.

B-5 CALCULATION

Mean filament diameter '*X*' (in µm) = $\frac{SC}{100}$

where

S = total of the 100 widths (in mm); and

C = calibration factor calculated in accordance with **B-2**.

ANNEX C

(*Clause* 5.2.2)

DETERMINATION OF ROVING TEX

C-1 PROCEDURE

C-1.1 Maintain a length of roving under sufficient tension to ensure that it is straight, cut off the length as per the table given below, measured with an accuracy of ± 1 percent. Weigh the cut length to the nearest 5 mg, and report this mass in grams as the roving tex.

The length of the samples should be as given in the table below:

Sl No.	*Nominal Linear Density, Tt* (*tex*)	*Length of Specimen* (*m*)
(1)	(2)	(3)
i)	Tt < 25	500
ii)	25 < Tt < 45	200
iii)	45 < Tt < 280	100
iv)	280 < Tt < 650	50
v)	650 < Tt < 2 000	10
vi)	2 000 < Tt	5

ANNEX D

[*Table* 4, *Sl No*. (i)]

DETERMINATION OF MOISTURE CONTENT

D-1 PROCEDURE

D-1.1 Weigh, to the nearest 5 mg, about 10 g of the sample. Place the sample in a forced draught oven at 105 °C ± 3 °C for 1 hour. Reweigh the sample either without removing from the oven but with the air flow stopped or cool in a desiccator and weigh after cooling.

D-2 CALCULATION

Moisture content, percent by mass = $\frac{A-B}{A} \times 100$

where

A = original mass in g of the sample; and

B = mass in g of the oven-dried sample.

NOTE — The dried roving shall be used for the determination of the loss on ignition.

ANNEX E

[*Table* 4, *SI No*. (ii)]

DETERMINATION OF LOSS ON IGNITION

E-1 PROCEDURE

E-1.1 Heat the sample of dried roving from the determination of the moisture content, at 625 °C ± 20 °C to ignite the size for 20 minutes. Cool in a desiccator and re-weigh to the nearest 5 mg.

E-2 CALCULATION

Loss on ignition, percent by mass = $\frac{B-C}{B} \times 100$

where

B = mass in g of the oven-dried sample; and

C = mass in g of the sample after ignition.

ANNEX F

[*Table* 4, *Sl No*. (iii)]

DETERMINATION OF CROSS BREAKING STRENGTH OF ROD SPECIMENS

F-1 PREPARATION OF TEST SPECIMENS OF GLASS REINFORCED POLYESTER RODS

F-1.1 Glass reinforced polyester test rods of circular cross section with diameter 6.00 mm ± 0.25 mm shall be made in moulds approximately 300 mm long open at both ends. With polyester resin, glass tubing with a nominal internal diameter of 6 mm has been found suitable as a mould.

F-1.2 A parallel assembly of rovings of a mass to give a glass content of 60 percent ± 3 percent shall be taken for each test rod. Using the above mould it has been found convenient that this assembly should be about 1.0 m long and weigh approximately 15 g.

The assembly shall be dried in a ventilated oven for one hour at 105 °C ± 2 °C, cooled in a desiccator and used immediately on removal. A catalysed or a catalysed and accelerated polyester resin complying with IS 6746 shall be prepared in accordance with the resin supplier's recommendations. Within these types not all resin systems are necessarily suitable. The system to be used shall be at the discretion of the roving supplier and declared at the request of the purchaser. The roving assembly shall be impregnated by immersion in a trough of resin or by other suitable means. When completely impregnated the assembly shall be folded at mid-point and drawn into the mould described above. The rod so formed shall be cured in accordance with the resin supplier's recommendations. The rod while still in the mould shall be given a post-cure at 105 °C ± 2 °C for 2 hours.

F-1.3 Five such rods shall be prepared and two test specimens each, at least, 130 mm long shall be cut from each, giving two sets of five specimens, each set containing one specimen from each rod.

F-1.4 Conditioning

F-1.4.1 *Dry Conditioning*

One set of specimens in the dry condition shall be tested as soon as it is convenient after preparation.

F-1.4.2 *Wet Conditioning*

One set of specimens shall be immersed in boiling distilled water for two hours, after which they shall be cooled in distilled water at ordinary room temperature for at least 15 minutes and at the most one hour. They shall then be dried with a clean cloth and tested as soon as possible.

F-2 PREPARATION OF TEST SPECIMENS OF GLASS REINFORCED EPDXIDE TEST RODS OF CIRCULAR CROSS SECTION

F-2.1 Glass reinforced epoxide test rods of circular cross section with a diameter of 6.00 mm ± 0.25 mm shall be made in moulds approximately 300 mm long, open at both ends. With epoxide resin, polytetrafluoroethylene (PTFE) tubing with a nominal internal diameter of 6 mm has been found suitable as a mould.

F-2.2 A parallel assembly of rovings of a mass to give a glass content of 50 percent ± 3 percent shall be taken for each test rod. Using the above mould it has been found convenient that this assembly should be about 1.0 m long and weigh approximately 12.5 g. The assembly shall be dried in a ventilated oven for one hour at 105 °C ± 2 °C, cooled in a desiccator and used immediately on removal. Use an epoxy resin of diglycidyl ether of bisphenol A (DGEBA) with a epoxy value of 5.2 eq/kg to 5.5 eq/kg. The hardener shall be hexahydophthalic anhydride and accelerator benzyl dimethyl amine (BDMA).

The roving assembly shall be impregnated by immersion in trough of resin or by other suitable means. When completely impregnated the assembly shall be folded at mid-point and drawn into the mould described above. The rod so formed shall be cured and post cured still in the mould, in accordance with the resin supplier's recommendations. Five such rods shall be prepared and two specimens each at least 130 mm long shall be cut from each, giving two sets of five specimens, each set containing one specimen from each rod.

F-2.3 Conditioning

F-2.3.1 *Dry Conditioning*

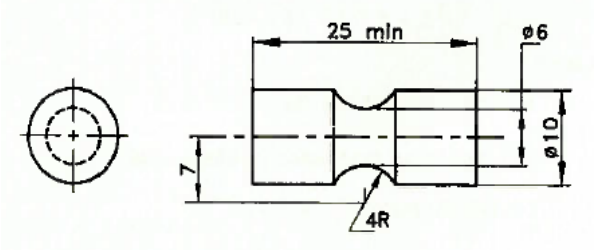
One set of specimens in the dry condition shall be tested as soon as it is convenient after preparation.

F-2.3.2 *Wet Conditioning*

One set of specimens shall be immersed in boiling distilled water for 24 hour, after which they shall be cooled in distilled water at ordinary temperature for at least 15 minutes at the most one hour. They shall be dried with a clean cloth and tested as soon as possible.

F-3 APPARATUS

F-3.1 Two parallel supports (*see* Fig. 1) of circular cross section and at least 25.0 mm long, into which a groove has been turned with a radius of 4 mm, thereby reducing the diameter of the rod at the centre to a diameter of 6 mm. These supports are placed 100 mm ± 0.25 mm apart. A third support of identical dimensions is placed parallel to the other two and midway between them (*see* Fig. 2). This third support is attached to the loading member of the testing machine.



All dimensions in millimetres.

FIG. 1 DIAGRAM OF SUPPORTS

F-4 PROCEDURE

F-4.1 Measure to the nearest 0.01 mm, perpendicular diameter at centre of the specimen. Place the specimen on the supports and apply the load, steadily increasing it from zero by the relative movement of the loading member so that the sample breaks in 15 s to 45 s. The load at fracture shall be noted.

F-5 CALCULATION

F- 5.1 The cross breaking strength of the rod shall be calculated as follows.

F-5.1.1 *Calculation in SI Units*

$$\text{Cross- breaking strength, MPa} = \frac{8WL}{d^3}$$

where

W = force in Newtons (N);

L = distance between supports in mm; and

d = diameter of the rod in mm.

F-5.1.2 *Calculation in Metric Units*

$$\text{Cross-breaking strength, kgf/cm}^2 = \frac{8WL}{d^3}$$

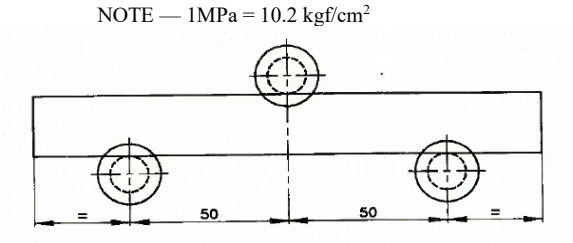
where

W= force in kgf;

L = distance between supports in cm; and

d = diameter of the rod in cm.

NOTE — 1MPa = 10.2 kgf/cm^2



All dimensions in millimetres.

FIG. 2 TEST ASSEMBLY

NOTE — For preparation of rods and determination of cross breaking strength (in case of phenolic and vinyl ester resins) resin manufacturer can be consulted.

ANNEX G

[*Table* 4, *Sl No*. (iv)]

DETERMINATION OF CONDUCTIVITY OF WATER EXTRACT

G-1 PROCEDURE

G-1.1 Hot Water Extraction

Condition the sample in the standard atmosphere for testing for at least 24 hours. Take from the convenient mass and transfer it to the flask. Add to the flask 20 ml water per gram ± 0.1 ml water per gram of specimen. Connect the flask to a reflux condenser, bring rapidly to boil and continue to boil the liquor gently for 60 min. Disconnect and remove the flask while the liquid is still boiling and close it immediately with a glass stopper fitted with a stopcock. Do not filter or make up to volume, but cool rapidly to 20 ºC ± 2 ºC. Do not remove or open the tap until ready to make conductivity measurement. Reject any extract unless there is a partial vacuum inside the flask immediately before it is opened.

G- 1.2 Measurement of Conductivity

Take the extract as prepared in **G-1.1**. Remove the stopper from the flask and transfer some of the extract to the conductivity cell. Wash the electrodes with two or three changes of extract, re-stoppering the flask as soon as possible.

NOTE — Use low conductivity water and thoroughly steam out the flask before use.

Measure electrical resistance with the meter. Record the temperature of the extract and calculate the conductivity.

G-1.3 Calculation

Conductivity at 20 ºC, micromhos cm

$$= \frac{10^8 K}{R\,(1 + 0.02)\,(t - 20)}$$

where

K = cell constant in cm^{-1};

R = measured resistance in ohms; and

t = temperature of extract in ºC.

ANNEX H

(*Foreword*)

COMMITTEE COMPOSITION

High Performance Fibres, Fibrous Structure and Textile Components of Composites Sectional Committee, TXD 40

Organization	*Representative(s)*
Vikram Sarabhai Space Centre, Thiruvananthapuram	DR SANTHOSH B. **(*Chairperson*)**
Ahmedabad Textile Industry's Research Association, Ahmedabad	SHRI BHUSHAN CHOUDHARY SHRI HITESH SOLANKI (*Alternate*)
Arvind Limited, Ahmedabad	SHRI PABITRA SAHOO MS PALAK KAKKAR (*Alternate*)
ASL (Advanced Systems Laboratory) DRDO, Hyderabad	DR G. RAMA RAO
Bhor Chemicals and Plastics Pvt Ltd, Mumbai	DR MILIND KHANDWE SHRI AKHIL HEBBAR (*Alternate*)
CSIR - National Aerospace Laboratories, Bangaluru	DR HEMANT KUMAR SHUKLA SHRI TARUN KUMAR PARDHI (*Alternate*)
Century Enka Limited, Pune	REPRESENTATIVE
Coir Board, Kochi	SHRIMATI ANITA JACOB SHRIMATI SUMI SABESTIAN (*Alternate*)
DuPont India, Mumbai	SHRI ATANU ACHARYA SHRI MANOJ JHAVER (*Alternate*)
Garware Technical Fibers Ltd, Pune	SHRI SACHIN P. KULKARNI
Goa Glass Fibre Limited, Goa	SHRI NITIN PANDURANG SOMAN SHRI LUCIANO LOBO (*Alternate*)
Grasim Industries Limited, Vadodara	DR ROHITASVA KUMAR
Hindustan Aeronautics Limited, Bangaluru	REPRESENTATIVE
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