# भारतीय मानक ब्यूरो
**BUREAU OF INDIAN STANDARDS**

*Draft for comments only* Doc No.: TXD 13 (26488)
2024



भारतीय मानक मसौदा

# वस्त्रादि — एयरोस्पेस उद्देश्यों के लिए प्लास्टिक लैमिनेट्स के लिए बुने हुए ग्लास फाइबर कपड़े — विशिष्टि

## भाग 1 करघा-स्टेट कपड़े

[ *आई एस 5746 (भाग 1) का तीसरा पुनरीक्षण* ]

*Draft Indian Standard*

# TEXTILES — WOVEN GLASS FIBRES FABRICS FOR PLASTIC LAMINATES FOR AEROSPACE PURPOSES — SPECIFICATION

## PART 1 LOOM-STATE FABRICS

[ *Third Revision of* IS 5746 (Part 1) ]

**ICS: 59.100.10**

---

Textile Materials for Aeronautical and Related Products Sectional Committee, TXD 13

last date for receipt of comments is 4 Nov 2024

**FOREWORD**

(*Formal clauses will be added later*)

This standard was first published in 1970 and subsequently revised in 1983 and 1987. This revision has been made to incorporate the following changes:

a) Marking clause has been modified; and
b) References to standards have been updated.

The fabrics covered in this specification are intended for use, after further treatment, for the reinforcement of rigid plastic mouldings and laminates with resin or resin systems.

This standard is published in three parts. The others part in the series are:

Part 2 Desized fabrics.
Part 3 Finished Fabric

While preparing this standard, considerable assistance has been derived from BS 3396 : Part 1 : 1982 ‘Woven glass fibre fabrics for plastic reinforcement: Part 1 Specification for loom-state fabrics’ issued by the British Standards Institution.

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, shall be rounded of 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.

## 1 SCOPE

This standard (Part 1) prescribes the requirements for loom-state glass fibre fabrics for aerospace purposes in a range of thickness and weaves, and woven from continuous filament yarns of ‘E’ type glass.

## 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, the following definitions shall apply.

**3.1 ‘E’ Type Glass** — A low alkali glass containing not more than 1 percent of alkali metal oxides, expressed as $Na_2O$.

**3.2 Filament** — A single glass fibre as drawn.

**3.3 Strand** — A plurality of filaments bonded with size.

**3.4 Yarn** — A number of strands put together with twist.

**3.4.1** *Single Yarn* — One or more strands with applied twist.

**3.4.2** *Plied Yarn* — Two or more singles yarns with applied twist.

**3.5 Size** — A mixture of organic materials applied to the strand during manufacture to facilitate yarn processing and weaving.

## 4 MANUFACTURE

### 4.1 Yarn

The fabric shall be woven from continuous filament yarns of 'E' type glass conforming to IS 11916.

### 4.2 Fabric

The fabric shall be uniformly woven. The selvedges shall be well made, substantially straight and even, and shall have approximately the same tension as the remainder of the fabric.

## 5 DESIGNATION

**5.1** The designation of the fabric shall be derived from the following details of its construction:

a) Number of warp ends required;
b) Number of weft ends required;
c) Linear density of the warp yarn and the diameter of the strand filament;
d) Linear density of the weft yarn and the diameter of the strand filament; and
e) Type of weave, for example, plain, twill, 8-shaft satin and mock leno.

NOTE — If the construction is one of those listed in Table 1, the appropriate designation code given in column 2 of the table may be used as an alternative to stating the full constructional details.

## 6 REQUIREMENTS

**6.1** The fabric shall comply with the requirements as given in Table 1 and **6.1.1** to **6.1.9**.

**6.1.1** *Mass per unit area* — The mass per square metre, when determined in accordance with Annex B shall not differ by more than ± 6 percent from the nominal value given in Table 1.

NOTE — The nominal values of mass per square metre for the constructions not covered in Table 1 may be calculated as described in Annex C.

**6.1.2** *Ends and Picks* — The number of ends and picks shall not differ by more than ± 2.5 percent from the average values for the construction (*see* Table 1).

**6.1.3** *Breaking Strength* — The average breaking strength of the fabric in the warp and weft directions, when determined in accordance with Annex D, shall not be less than the minimum

values given in Table 1.

**6.1.4** *Width* — The width of the fabric including selvedge shall be 91 cm or as agreed and when determined according to IS 1954 it shall not be less than that stated by the manufacturer or exceed it by more than 1.5 percent or 2.5 cm, whichever is less.

**6.1.5** *Length* — The length of fabric shall be as agreed or declared and when determined according to IS 1954, it shall not be less than agreed or declared value.

**6.1.6** *Freedom from Defects and Impurities* — The fabric shall be reasonably free from yarn defects and defects of weaving. Holes, smashes, streaks, stains, oil and grease spots or other contaminations, torn selvedges, excessive ends out, missing picks and other permanent distortions which are detrimental to the use of fabric shall be classified as major defects.

**6.1.7** *Diameters of Filaments* — For the manufacture of fabric in accordance with the designation codes in co1 (2) of Table 1, the diameters of the filaments in the strands shall be those listed in Table 2.

**6.1.8** *Colour* — The colour of the fabric shall be uniform and characteristic of natural glass fabric.

**6.1.9** *Storage* — To ensure quality stability of glass fabric during storage, it shall be stored in dry, if possible, air-conditioned room in original unopened packing. Direct sunlight shall be avoided. The rolls shall be stored horizontally avoiding external pressure to the glass fabric. Under these conditions, the storage life of the finished fabric is normally one year, unless the contrary is stated by the manufacturer.

## 7 PACKING

The fabric shall be packed in the form of rolls weighing not more than 100 kg. No roll shall contain more than 3 pieces. The fabric shall be rolled evenly on tubes of sufficient length and strength to produce firm packages so as to prevent collapsing or telescoping during transit, storage or handling. Both ends of the roll shall be suitably protected to prevent damage to the edges of the cloth and the whole shall be packed in moisture proof containers.

## 8 MARKING

**8.1** Each roll of fabric shall be marked with the following:

a) Designation of the fabric (*see* **5.1**);
b) Word ‘loom-state’;
c) Manufacturer’s identification code; and
d) Date of manufacture.

### 8.1.1 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 products may be marked with the Standard Mark.

## 9 SAMPLING

A sample not less than 3 metres long and of full width of the fabric shall be taken from each lot of 1 000 metres or fractions thereof from the fabric of one particular designation submitted for acceptance at one time.

## 10 CRITERIA FOR CONFORMITY

The sample fabric selected according to **9** shall be tested for all requirements given in **6**. There shall be no failure in respect of any of the requirements, if lot is to be accepted.

**Table 1 Requirements for woven Glass Fibre Fabrics for Plastic Laminates— Loom-State Fabrics**

(*Clauses* 6.1, 6.1.1, 6.1.2, 6.1.3 *and* 6.1.7)

| Sl No. | Designation Code | Approximate Thickness (For Guidance Only) | Nominal Mass Unit Area ($g/m^2$) | Weave | Ends/dm | Picks/dm | Yarn Designation ISO Tex (For Guidance Only) | | Minimum Average Breaking Strength* (N, per 10 mm Width) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Wrap | Weft | Wrap | Weft |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) |
| i) | P1/11 | 0.08 | 79.3 | Plain | 177 | 173 | EC 5 11 Z × 2S 160 | EC 5 11 Z × 2S 160 | 134 | 131 |
| ii) | P2/11 | 0.08 | 96.3 | | 252 | 173 | EC 5 11 Z × 2S 160 | EC 5 11 Z × 2S 160 | 191 | 131 |
| iii) | P4/11 | 0.13 | 132 | | 252 | 165 | EC 5 11 Z × 2S 160 | EC 5 11 Z2 × 2S 160 | 191 | 249 |
| iv) | P5/22 | 0.18 | 171 | | 59 | 67 | EC 7 22 Z2 × 3S 160 | EC 7 22 Z2 × 3S 160 | 252 | 286 |
| v) | P5/34 | 0.18 | 177 | | 59 | 67 | EC 9 34 Z2 × 2S 160 | EC 9 34 Z2 × 2S 160 | 227 | 258 |
| vi) | P5/68 | 0.18 | 177 | | 59 | 67 | EC 9 68 Z × 2S 160 | EC 9 68 Z × 2S 160 | 327 | 258 |
| vii) | P6/11 | 0.15 | 182 | | 142 | 126 | EC 5 11 Z2 × 3S 160 | EC 5 11 Z2 × 3S 160 | 222 | 286 |
| viii) | P6/22 | 0.15 | 182 | | 142 | 126 | EC 7 22 Z × 3S 160 | EC 7 22 Z × 3S 160 | 303 | 269 |
| ix) | P6/34 | 0.15 | 188 | | 142 | 126 | EC 9 34 Z × 2S 160 | EC 9 34 Z × 2S 160 | 273 | 242 |
| x) | P8/22 | 0.23 | 235 | | 142 | 102 | EC 7 22 Z × 3S 160 | EC 7 22 Z × 3S 160 | 303 | 436 |
| xi) | P8/34 | 0.23 | 242 | | 142 | 102 | EC 9 34 Z × 2S 160 | EC 9 34 Z × 2S 160 | 273 | 392 |
| xii) | P8/34/68 | 0.23 | 242 | | 142 | 102 | EC 9 34 Z × 2S 160 | EC 9 34 Z × 2S 160 | 273 | 392 |
| xiii) | P11/22 | 0.36 | 397 | | 75 | 71 | EC 7 22 Z3 × 4S 160 | EC 7 22 Z3 × 4S 160 | 641 | 607 |
| xiv) | P14/34 | 0.48 | 546 | | 67 | 63 | EC 9 34 Z3 × 4S 160 | EC 9 34 Z3 × 4S 160 | 773 | 727 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| xv) | P14/136 | 0.48 | 546 | | 67 | 63 | EC 9 136 Z × 3S 160 | EC 9 136 Z × 3S 160 | 773 | 727 |
| xvi) | P32/11 | 0.05 | 49.1 | | 252 | 181 | EC 5 11 Z 40 | EC 5 11 Z 40 | 95.3 | 68.4 |
| xvii) | P38/34 | 0.13 | 127 | | 181 | 181 | EC 9 34 Z 40 | EC 9 34 Z 40 | 174 | 174 |
| xviii) | P40/34/5.5 | 0.25 | 420 | | 299 | 24 | EC 9 34 Z2 × 2S 160 | EC 5 5.5 Z 40 | 1 151 | 4.5 |
| xix) | P40/68/5.5 | 0.25 | 420 | | 299 | 24 | EC 9 68 Z × 2S 160 | EC 5 5.5 Z 40 | 1 151 | 4.5 |
| xx) | P41/68 | 0.18 | 207 | | 173 | 122 | EC 9 68 Z × 40 | EC 9 68 Z × 40 | 333 | 235 |
| xxi) | T2/22 | 0.15 | 182 | 2/2 Twill | 142 | 126 | EC 7 22 Z × 3S 160 | EC 7 22 Z × 3S 160 | 303 | 269 |
| xxii) | T3/22 | 0.28 | 321 | 2/2 Twill | 118 | 118 | EC 7 22 Z2 × 3S 160 | EC 7 22 Z2 × 3S 160 | 504 | 504 |
| xxiii) | T3/34 | 0.28 | 331 | 2/2 Twill | 118 | 118 | EC 9 34 Z2 × 2S 160 | EC 9 34 Z2 × 2S 160 | 454 | 454 |
| xxiv) | T3/68 | 0.28 | 331 | 2/2 Twill | 118 | 118 | EC 9 68 Z × 2S 160 | EC 9 68 Z × 2S 160 | 454 | 454 |
| xxv) | S2/22 | 0.23 | 297 | 8 Shaft Satin | 224 | 213 | EC 7 22 Z × 3S 160 | EC 7 22 Z × 3S 160 | 478 | 455 |
| xxvi) | S2/34 | 0.23 | 306 | 8 Shaft Satin | 224 | 213 | EC 9 34 Z × 2S 160 | EC 9 34 Z × 2S 160 | 431 | 410 |
| xxvii) | S11/22/11 | 0.20 | 286 | 4 Shaft Satin | 189 | 126 | EC 7 22 Z2 × 3S 160 | EC 7 22 Z2 × 3S 160 | 807 | 95.3 |
| xxviii) | S12/34 | 0.38 | 441 | 4 Shaft Satin | 189 | 126 | EC 9 34 Z2 × 2S 160 | EC 9 34 Z2 × 2S 160 | 727 | 485 |
| xxix) | S12/68 | 0.38 | 441 | 4 Shaft Satin | 189 | 126 | EC 9 68 Z × 2S 160 | EC 9 68 Z × 2S 160 | 727 | 485 |
| xxx) | S13/11 | 0.10 | 105 | 4 Shaft Satin | 236 | 228 | EC 5 11 Z × 2S 160 | EC 5 11 Z × 2S 160 | 178 | 172 |
| xxxi) | OS 1/5.5 | — | 66.4 | 6 × 6 Mock-leno | 299 | 287 | EC 5 5.5 Z × 2S 160 | EC 5 5.5 Z × 2S 160 | 113 | 108 |
| xxxii) | OS 11/34 | 0.46 | 353 | 6 × 6 Mock-leno | 150 | 102 | EC 9 34 Z2 × 2S 160 | EC 9 34 Z2 × 2S 160 | 577 | 392 |
| xxxiii) | OS 11/68 | 0.46 | 353 | 6 × 6 Mock-leno | 150 | 102 | EC 9 68 Z × 2S 160 | EC 9 68 Z × 2S 160 | 577 | 392 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| xxxiv) | Tolerance, Percent | — | ± 6 | — | ± 2.5 | ± 2.5 | — | — | — | — |
| xxxv) | Method of Test, Ref to | — | Annex B | — | IS 1963 | | — | — | Annex D | |
| | NOTE— Fabrics emboding filament diameters other than those listed in Annex B can be manufactured but they should be ordered as given in **5.1**.<br>*No negative tolerance is permitted on the average value but a tolerance of -20 percent is permitted on individual values. | | | | | | | | | |

## ANNEX A

(*Clause* 2)

## LIST OF REFERRED STANDARDS

| *IS No.* | *Title* |
|---|---|
| IS 1954 : 2024 | Textiles — Fabrics — Determination of width and length (*third revision*) |
| IS 1963 : 1981 | Methods for determination of threads per unit length in woven fabrics (*second revision*) |
| IS 11916 : 2001 | Textiles — Continuous filament glass yarn for aerospace and other purposes — Specification (*first revision*) |

## ANNEX B

(*Clause* 6.1.1 *and Table* 1)

## METHOD FOR DETERMINATION OF AVERAGE MASS PER UNIT AREA

### B-l CONDITIONING

**B-1.1** Condition the specimen for not less than 6 hours in an atmosphere of 65 percent ± 2 percent relative humidity and 27 °C ± 2 °C temperature. Carry out all measurements and weighing without removal of the material from the conditioning atmosphere.

NOTE — It is recognized that within the temperature range of 22 °C to 29 °C and relative humidity from 48 percent to 67 percent, the difference in the results of testing will not be significant.

### B-2 PROCEDURE

**B-2.1** Lay the sample flat and free from applied tension. Cut a specimen as large as is convenient but not less than 30 cm × 30 cm; avoid cutting portions nearer than 2.5 cm from the selvedges.

**B-2.2** Measure the dimensions of the specimen to an accuracy of ± 1.5 percent and weigh the specimen to an accuracy of ± 1.5 percent. Calculate the mass per unit area in $g/m^2$.

## ANNEX C

(*Clause* 6.1.1)

## METHOD FOR CALCULATION OF MASS PER SQUARE METRE AND BREAKING STRENGTH FOR LOOM-STATE GLASS FABRICS

**C-l** The single yarns used in the fabrics set out in Table 1 have the linear densities, approximate filament diameters and minimum average breaking strength given in Table 2

**Table 2 Standard Factors for Basic Single Yarns**

(*Clauses* 6.1.7 *and* C-l)

| Sl No. | Yarn Linear Density | Approximate Filament Diameter | Minimum Average Breaking Strength, *k* |
|---|---|---|---|
| | ISO tex | mm | N |
| (1) | (2) | (3) | (4) |
| i) | EC 5 5.5 Z 40 | 0.005 | 2.15 |
| ii) | EC 5 11 Z 40 | 0.005 | 4.30 |
| iii) | EC 7 22 Z 40 | 0.007 | 8.82 |
| iv) | EC 9 34 Z 40 | 0.009 | 13.23 |

| | | | |
|---|---|---|---|
| v) | EC 9 68 Z 40 | 0.009 | 24.20 |
| vi) | EC 9 136 Z 40 | 0.009 | 49.00 |

**C-2** The mass per square metre and breaking strengths for loom-state fabrics shall be calculated as follow:

Minimum average warp breaking strength

( N per l0 mm width ) = $\frac{x\ a\ b\ k}{10}$

Minimum average weft breaking strength

( N per l0 mm width ) = $\frac{y\ c\ d\ k}{10}$

Mass ( g/m$^2$ ) = $\frac{(x\ a\ b\ c_A + y\ c\ d\ c_B}{100} \times 1.03$

where

*x* = number of warp ends per 100 mm;
*y* = number of weft picks per 100 mm;
*k* = minimum average breaking strength factor for basic single yarn (N) (*see* Table 2);
*a* = number of warp yarns, primary doubling (folding);
*b* = number of warp yarns, secondary doubling (cabling);
*c* = number of weft yarns, primary doubling (folding);
*d* = number of weft yarns, secondary doubling (cabling);
$C_A$ = basic single warp count (tex); and
$C_B$ = basic single weft count (tex).

NOTES

**1** The factor 1.03 represents the contractions of yarn due to crimp in weaving. In case of certain fabrics, some adjustment of this factor may be required. Such adjustment should be the subject of agreement between the purchaser and the supplier.
**2** The factor 1 is used where there are no primary or secondary doublings to given values to *a*, *b*, *c* or *d*.

Examples 1 and 2 show the uses of these formulae.

*Example* 1:
A plain weave fabric woven with 142 ends per 100 mm and 126 picks per 100 mm of 22 × 1 × 3 tex glass yarn shall have the following properties:

a) Minimum average warp breaking strength

= $\frac{142\times3\times1\times8.82}{10}$

= 375.73 N per 10 mm width

b) Minimum average weft breaking strength

$$= \frac{126 \times 3 \times 1 \times 8.82}{10}$$

= 333.4 N per 10 mm width

c) Mass ($g/m^2$)

$$= \frac{(142 \times 3 \times 1 \times 22) + (126 \times 3 \times 1 \times 22) \times 1.03}{100}$$

=182

*Example* 2:

A unidirectional fabric woven with 299 ends per 100 mm of 68 tex × 2 tex glass and 24 picks per 100 mm of 5.5 tex glass shall have the following properties:

a) Minimum average warp breaking strength

$$= \frac{299 \times 2 \times 1 \times 24.2}{10}$$

= 1 447 N per 10 mm width

b) Minimum average weft breaking strength

$$= \frac{24 \times 1 \times 1 \times 2.15}{10}$$

= 5.16 N per 10 mm width

c) Mass ($g/m^2$)

$$= \frac{(299 \times 2 \times 1 \times 68) + (24 \times 1 \times 1 \times 5.5) \times 100}{100}$$

= 420

## ANNEX D

(*Clause* 6.1.3 *and Table* 1)

## METHOD FOR DETERMINATION OF BREAKING STRENGTH

### D-l SPECIMEN PREPARATION AND CONDITIONING

**D-l.1** Cut six specimens not less than 65 mm wide from the test sample in the direction of the warp, and six similar specimens in the direction of the weft. Each specimen shall be 350 mm ± 50 mm long, and no two specimens cut in the same direction shall contain the same longitudinal threads.

**D-l.2** Prepare the ends of each specimen either as in **D-l.4** or **D-1.5**. In case of dispute, the method given in **D-l.4** shall be used.

**D-l.3** Fray each specimen by removing lengthways threads equally from each side of each specimen until the width of the specimen is reduced to 50 mm leaving the cross threads undisturbed.

**D-l.4** Lay the specimen, before fraying, on stiff paper and impregnate each end of each specimen with and attached to the paper by a suitable cement, leaving an untreated length of not less than 200 mm in the middle of each specimen. After the cement has dried, remove lengthways threads equally from each side of each specimen by careful cutting and fraying, until the width of each specimen is reduced to 50 mm in the untreated portion. When the specimen has been fixed in the jaws of the testing machine (*see* **D-2.2**), cut the paper across the middle.

NOTE — Examples of suitable cement are:
a) adhesives based on natural rubber or polychloroprene;
b) solution of polybutylmethacrylate in xylene; and
c) solution of polymethylmethacrylate moulding powder in diethyl ketone or butanone.

**D-l.5** Lay each specimen, already frayed to 50 mm width, on a flat surface with each end laid between two sheets of polyvinyl butyral so as to leave a 20 mm length uncovered at the middle of each specimen. Cover the sheets of polyvinyl butyral with a medium mass paper and apply an electric iron to soften the polyvinyl butyral and cause it to penetrate and adhere to the test specimen.

**D-l.6** Condition each specimen prior to testing in an atmosphere of 65 percent ± 2 percent relative humidity and 27 °C ± 2 °C temperature for not less than 6 hours and test them without removal from that atmosphere (*see* Note under **B-l.1**).

### D-2 PROCEDURE

**D-2.1** Fix each specimen in the jaws of a tensile testing machine so that the unsupported length between the jaws is 200 mm.

**D-2.2** Open the jaws of the testing machine until wider than the testing specimen and with edges parallel to each other and at right angles to the direction of pull. Pack the jaws with suitable material such as chamois leather to assist in gripping the specimen without causing damage.

**D-2.3** Apply the load to the specimen at a substantially constant rate such that a load equivalent to the minimum specified breaking strength is reached in 60 s ± 10 s.

**D-2.4** Report the average breaking strength of each set of six specimens as the average breaking strength in N per 10 mm width.