भारतीय मानक

Indian Standard

IS 4910 (Part 12) : 2023

कृत्रिम रेशों से निर्मित टायर सूत, डोरी और टायर डोरी कपड़ा — परीक्षण के तरीके

भाग 12 पोलिएमाइड से निर्मित टायर सूत,डोरी और टायर डोरी कपड़ा के लिए नमूनाकरण

(पहला पुनरीक्षण)

Tyre Yarns, Cords and Tyre Cord Fabrics Made from Man-Made Fibres — Methods of Test

Part 12 Sampling for Tyre Yarns, Cords and Tyre Cord Fabrics Made from Polyamide

(First Revision)

ICS 83.160; 59.060.01

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Technical Textiles for Mobiltech Applications Sectional Committee, TXD 38

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Technical Textiles for Mobiltech Applications Sectional Committee had been approved by the Textile Division Council.

This standard (Part 12) was first published in 1981. The first revision of this standard has been made in the light of experience gained since its last revision and to incorporate the following major changes:

a) The title of the standard has been modified; and
b) References to the Indian standards have been updated.

This standard has been published in various parts. The other parts under this series are:

Part 1 Definition of terms
Part 2 Linear density
Part 3 Load and elongation characteristics
Part 4 Dip pick-up
Part 5 Heat shrinkage and heat shrinkage force
Part 6 Wet contraction and wet contractile force
Part 7 Heat degradation
Part 8 Thickness
Part 9 Sampling of tyre yarns, cords and tyre cord fabrics made from rayon
Part 10 Creep
Part 11 Commercial mass
Part 13 Static adhesion of textile tyre cord to vulcanized rubber

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

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 : 2022 ‘Rules for rounding off numerical values (*second revision*)’.

Indian Standard

TYRE YARNS, CORDS AND TYRE CORD FABRICS MADE FROM MAN-MADE FIBRES — METHODS OF TEST

PART 12 SAMPLING FOR TYRE YARNS, CORDS AND TYRE CORD FABRICS MADE FROM POLYAMIDE

(First Revision)

1 SCOPE

This standard prescribes the methods for sampling of tyre yarns, tyre cords and tyre cord fabrics for determination of various physical characteristics, namely, linear density, breaking load, elongation at break, thickness (gauge), twist, heat shrinkage, heat shrinkage force and heat degradation. It gives the number of tests for determination of various characteristics with specified degree of accuracy. It also lays down the criteria for ascertaining the conformity to the specified requirements.

2 REFERENCES

The standards listed below 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 edition of these standards:

IS No.	*Title*
IS 4910 (Part 1) : 2023	Tyre yarns cords and tyre cord fabrics made from man-made fibre — Methods of test: Part 1 Definition of terms (*second revision*)
IS 4905 : 2015/ ISO 24153 : 2009	Random sampling and randomization procedures (*first revision*)

3 TERMINOLOGY

For the purpose of this standard, in addition to the terms defined in the IS 4910 (Part 1) of this standard, the following definitions shall apply.

3.1 Consignment — The quantity of tyre yarn, tyre cord or tyre cord fabrics delivered to a buyer against a despatch note.

3.2 Lot — All packages of tyre yarn or tyre cord or rolls of tyre cord fabrics of definite type and quality belonging to a consignment.

3.3 Limit of Error of Mean — The maximum difference between the sample mean and its true value (that would be obtained if all the units in the lot were tested) at a given probability level.

3.4 Mean — The sum of observations divided by the number of observations (*see* Annex A).

3.5 Probability Level — A measure of probability associated with the sample size and limit of error of estimate. It expresses the probability that the difference between the estimate based on the sample of a particular size and its true value does not exceed the specified limit of error.

3.6 Range — The difference between the largest and the smallest observations in the sample (*see* Annex A).

NOTE — In case the number of results in the sample is ten or more, they shall be divided into sub-groups of five test results each taking them consecutively in the same order as obtained. The range of each sub-group shall then be determined with a view to obtaining the mean range (*see* **3.7**).

3.7 Mean Range — The mean of a set of ranges calculated for subgroups in the sample (*see* **3.6** and Annex A).

3.8 Sample — Collection of packages of tyre yarn or tyre cords or tabbies from rolls of tyre cord fabrics selected for inspection from a lot.

3.9 Test Specimen — A specific portion of the yarn or cord selected from a package of yarn or cord or a tabby for performing a single test.

4 SAMPLING OF TYRE YARN OR TYRE CORD

4.1 Unless otherwise agreed to between the buyer and the seller, the number of packages of yarn or cord to be taken from a lot shall be five for lot size of 1 000 or less packages and ten otherwise.

4.2 The packages shall be selected at random from a lot.

4.2.1 When the sample is selected before the packages are packed in cases, the procedure of sampling shall be simple random sampling or

systematic sampling as given in **3.1.17** or **3.1.18** respectively of IS 4905.

4.2.2 When the packages are to be selected from the cases, the procedure of sampling shall be two-stage sampling given in **8.13** of IS 4905.

4.3 Number of Tests

4.3.1 The minimum number of tests to be made for various characteristics shall depend upon the accuracy with which the characteristics are to be determined. Table 1 gives the number of tests necessary for the tyre yarn and tyre cord manufactured in the country for determination of linear density, breaking load, elongation at break, twist, heat shrinkage, heat shrinkage force and heat degradation for varying limits of error. The probability level for number of tests given in Table 1 varies between 95 percent and 98 percent.

4.3.1.1 For knowing the limit of error of mean corresponding to a particular number of tests carried out for determination of a quality characteristic, Table 1 has been recast and given in Annex B with number of tests appearing in first column, while the entries in subsequent columns give the corresponding limit of error of mean for various quality characteristics.

4.3.2 Unless otherwise agreed to between the buyer and the seller, 20 tests for linear density and twist, 50 tests for breaking load and elongation at break, 15 tests for heat shrinkage, heat shrinkage force and heat degradation and 10 tests for thickness (gauge) shall be made for all routine testing.

4.3.2.1 As far as possible equal number of test specimens shall be drawn from each package drawn according to **4.1** and **4.2** The number of test specimens taken from each package shall be determined by dividing the number of tests to be conducted (*see* Table 1) by the number of packages selected (*see* **4.1**). If it comes out to be a fractional number, its maximum integral part (say i) shall be taken and i or (i + 1) specimens shall be taken from each selected package so as to obtain the requisite number of test specimens. In case the number of tests is less than the number of packages selected, at least one test specimen may be drawn from each selected package. For example, when there are 1 500 packages in the lot, 10 packages are selected for testing. According to **4.3.2** for routine testing, the number of tests for breaking load is 50, while it is 10 for thickness (gauge). For drawing test specimens for breaking load test, 50 test specimens are to be taken from 10 packages. Thus, 5 (= 50/10) test specimens are taken out from each of 10 packages. In the case of thickness (gauge), the number of p ackages drawn (10) is equal to the number of test specimens (10) required. Hence one test specimen is drawn from each of the 10 packages for inspection of thickness (gauge).

5 SAMPLING OF TYRE CORD FABRICS

5.1 Unless otherwise agreed to between the buyer and the seller, one tabby shall be taken for each creel load in a lot.

5.2 The number of cords taken out from a lot shall depend on the desired limit of error of mean for the determination of the characteristic.

5.2.1 Unless otherwise agreed to between the buyer and the seller, 10 tests for linear density and twist, 15 tests for breaking load, elongation at break, heat shrinkage, heat shrinkage force and heat degradation and five tests for thickness (gauge) shall be made.

Table 1 Number of Tests

(*Clause* 4.3.1)

Sl No.	Characteristics	Limit of Error of Mean, Percent							
		0.8	1	1.5	2	3	4	5	7
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	Linear density	20	15	10	5	—	—	—	—
ii)	Breaking load	55	35	15	10	5	—	—	—
iii)	Elongation at break	—	—	—	60	30	15	10	5
iv)	Twist	55	35	15	10	5	—	—	—
v)	Heat shrinkage	—	—	—	60	30	15	10	5
vi)	Heat shrinkage force	—	—	—	60	30	15	10	5
vii)	Heat degradation	55	35	15	10	5	—	—	—

5.3 For selection of cords from tabby, the tabby shall be divided into suitable number of parts by leaving approximately 10 cm from both ends and cutting the tabby across the weft yarn. From each part, as far as possible, equal number of cords shall be taken so as to get the requisite number of cords for testing as given in **5.2.1**.

5.3.1 The above procedure can be illustrated by the following example. Suppose the total width of the tabby is 150 cm. Cut out 10 cm from both ends. Divide the remaining 130 cm width of tabby in 5 equal parts of 26 cm each cutting it across the weft. For carrying out tests for determination of breaking load, 15 test specimens are required according to **5.2.1**. Thus, we select three cords from each part of the tabby for carrying out tests for breaking load.

6 CRITERIA FOR CONFORMITY

6.1 For ascertaining the conformity of the lot to the specification requirements, the procedure given in **6.1.1** and **6.1.2** shall be adopted. It may be noted that the criteria given in **6.1.1** and **6.1.2** are applicable when the specification limit refers to the individual test result and hence should not be applied in cases where specification limit is referring to average of the lot. The procedure for determining conformity of the lot is illustrated in examples given in **7.1**.

6.1.1 *One-Sided Specification Limit*

The lot shall be declared as conforming to the specification if:

a) the value of the expression $(\bar{x} - kR)$ or $(\bar{x} - k\bar{R})$ is greater than or equal to L, when the lower specification limit, L is given:

OR

b) the value of the expression $(\bar{x} + kR)$ or $(\bar{x} + k\bar{R})$ is less than or equal to U, when the upper specification limit, U, is given.

where the values of the factor k are given in Table 2 for different sample sizes, and U and L refer to the specification limits for individual test results.

6.1.2 *For Two-Sided Specification Limits*

The lot shall be declared as conforming to the specification if:

a) the value of the expression $R/(U - L)$ or $\bar{R}/(U - L) \leq B$;

b) the value of the expression $(\bar{x} + kR)$ or $(\bar{x} + k\bar{R}) \leq U$; and

c) the value of the expression $(\bar{x} - kR)$ or $(\bar{x} - kR) \geq L$.

where the values of the factors B and k are given in Table 2 for different sample sizes, and U and L refer to the specification limits for Individual test results.

Table 2 Values of the Factors

(*Clauses* 6.1.1 *and* 6.1.2)

Sl No.	Sample Size	Coefficient of R, (k)	
(1)	(2)	(3)	(4)
i)	(n)		B
ii)	5	0.3	1.0
iii)	10	0.4	0.9
iv)	15 and above	0.5	0.8

7 ILLUSTRATIVE EXAMPLE

7.1 When Specification Limit Refers to Individual Test Result

A consignment of polyamide tyre yarn of 1 260 D designation containing 4 000 packages was delivered to a buyer. The buyer desires to ascertain the conformity of the lot to the requirement of linear density of 1 260 denier with tolerance of ± 3 percent.

The number of packages to be chosen according to **4.1** from the lot of 4 000 packages is 10 and the number of tests to be made for linear density according to **4.3.2** is 20.

Suppose the packages are packed in cases. Out of the cases in the lot, 10 cases should be selected at random and from each case, two packages shall be drawn for inspection. One test specimen of desired length shall be taken out and tested from each of the packages selected. The observations obtained in denier are as follows:

1 280	1 296	1 281	1 285
1 282	1 282	1 281	1 282
1 296	1 283	1 283	1 280
1 274	1 266	1 298	1 267
1 281	1 282	1 283	1 290

The mean of the test results shall be calculated as follows:

The mean linear density ($\bar{x}$) = 1 280 + 1 282 + ...1 267 + 1 290

$$= \frac{25\ 652}{20}$$

= 1 282.6

The mean range *R* of test results calculated by taking the ranges of four groups each consisting of five consecutive test results shall be:

$$\bar{R} = \frac{22 + 30 + 17 + 23}{4}$$

$$= \frac{92}{4}$$

= 23.0

Applying the criteria given in **6.1.2**:

We have:

a) $\frac{R}{U-L} = \frac{23.0}{75.6} = 0.3 \leq 0.8\ (B)$

b) $\bar{x} + k\bar{R}$ = 1 282.6 + 0.5 × 23.0
= 1 282.6 + 11.5
= 1 294.1
> 1 222.2 (*U*)

c) $\bar{x} - k\bar{R}$ = 1 282.6 - 0.5 × 23.0
= 1 282.6 - 11.5
= 1 271.1
> 1 222.2 (*L*)

Where the values of B and k are given in Table 3.

Since the criteria given under **5.1.2** are satisfied, we conclude that the lot meets the specification requirements.

NOTE — In case the specification limit refers to the average of the lot, the concepts of AQL, LQL, producer's risk and consumer's risk are not applicable as such. However, the limit of error of mean given in Table 1 can be made use of for determining the conformity of the lot, as illustrated in the example given below (*see* **7.2**).

7.2 When Specification Limit Refers to Average of the Lot

A consignment of 1 260 D × 2 Nylon 6 tyre cord fabrics containing a creel load was delivered to a buyer who desires to ascertain the conformity of the lot to requirement of average breaking strength of minimum 21 kg.

The number of tabbies to be selected according to **5.1** from the lot of a creel load is one and the number of tests to be made for breaking strength according to **5.2** is 15.

Following the procedure given in **4.3**, three cords are drawn from each of five parts of the tabby to get a total of 15 cords. The observations obtained are as follows:

21.9	22.5	22.6
21.5	22.7	21.6
22.7	22.8	22.2
22.0	22.9	22.4
22.3	22.2	21.8

The mean of the test results shall be calculated as follows:

The mean breaking strength, kg =

$$\frac{21.9 + 21.5 + \cdots + 22.4 + 21.8}{15}$$

$$= \frac{333.3}{15}$$

= 22.2

From Table 1, we note that 15 tests correspond to l.5 percent error of determination of mean. Thus, the observed average minus the error of determination, that is, 21.9 (= 22.2 - 0.3) is greater than the minimum specified value of 21 kg and hence the lot is accepted.

ANNEX A

(*Clauses* 3.4, 3.6 *and* 3.7)

GLOSSARY OF SYMBOLS

$\bar{x}$ Mean; if $x_1, x_2 \ldots\ldots\ldots\ldots\ldots x_n$ are the n measurements of the items in a sample,

$$\text{then } \bar{x} = \frac{x_1 + x_2 \ldots\ldots\ldots\ldots\ldots + x_n}{n}$$

R Range; if x_1, x_2 .....x_n are the measurements of items in a sample arranged in the ascending order of magnitude, then $R = x_n - x_1$.

$\bar{R}$ Mean range; if $R_1, R_2 \ldots\ldots R_m$ are the range of m sub-groups of five observations each (so that the sample size z = 5m), then

$$\bar{R} = \frac{R_1 + R_2 \ldots\ldots\ldots\ldots\ldots\ldots + R_m}{m}$$

k Coefficient of R or R for the criteria for conformity.

B Maximum value for the expression $\frac{R}{U-L}$ or $\frac{\bar{R}}{U-L}$ in criteria for conformity for two-sided specification limits.

U Upper specification limit.

L Lower specification limit.

≤ Less than or equal to.

≥ Greater than or equal to.

ANNEX B

(*Clause* 4.3.1.1)

LIMIT OF ERROR OF MEAN CORRESPONDING TO DIFFERENT NUMBER OF TESTS FOR VARIOUS QUALITY CHARACTERISTICS

B-1 Table 3 gives the limit of error of mean corresponding to different number of tests carried out for various quality characteristics. The probability level for the limit of error of mean given in Table 3 varies between 95 and 98.

Table 3 Limit of Error of Mean

(*Clauses* 4.3.1.1 *and* C-1)

Sl No.	Number of Tests	Characteristics		
		Linear Density	Breaking Load, Twist and Heat Degradation	Elongation at Break, Heat Shrinkage and Heat Shrinkage Force
(1)	(2)	(3)	(4)	(5)
i)	5	2	3	7
ii)	10	1.5	2	5
iii)	15	1	1.5	4
iv)	20	0.8	—	—
v)	30	—	—	3
vi)	35	—	1	—
vii)	55	—	0.8	—
viii)	60	—	—	2

ANNEX C

(*Foreword*)

COMMITTEE COMPOSITION

Technical Textiles for Mobiltech Applications Sectional Committee, TXD 38

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