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**Test methods for chemical fibre
tire cords**

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Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee in accordance with the Industrial Standardization Law. Consequently **JIS L 1017 : 1995** is replaced with **JIS L 1017 : 2002**.

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Test methods for chemical fibre tire cords

Introduction This Japanese Industrial Standard to which no International Standards correspond was developed in 1953 as the test methods for chemical fibre tire cords in Japan.

In the revision on this occasion, the title of the standards which applied to this Standard as the normative references were changed along with their revision and the form of presentation was also changed in accordance with **JIS Z 8301**.

1 Scope This Standard specifies the test methods for tire cords, tire cord fabrics, and their original yarn made of chemical fibres (filament yarn of rayon, nylon, vinylon, polyester, and aramid).

2 Normative references The following standards contain provisions which, through reference in this Standard, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS K 0050 *General rules for chemical analysis*

JIS K 0557 *Water used for industrial water and wastewater analysis*

JIS K 8102 *Ethanol (95)*

JIS K 8103 *Diethyl ether*

JIS K 8105 *Ethylene glycol*

JIS K 8111 *Zinc chloride*

JIS K 8180 *Hydrochloric acid*

JIS K 8264 *Formic acid*

JIS K 8858 *Benzene*

JIS K 8891 *Methanol*

JIS K 8951 *Sulfuric acid*

JIS L 0101 *Tex system to designate linear density of fibres, yarn intermediate, yarns and other textile materials*

JIS L 0105 *General principles of physical testing methods for textiles*

JIS L 0208 *Glossary of terms used in textile industry—Testing*

JIS R 3503 *Glass apparatus for chemical analysis*

JIS Z 8401 *Guide to the rounding of numbers*

JIS Z 8806 *Humidity—Measurement methods*

3 Definitions For the purposes of this Standard, in addition to the definitions given in **JIS L 0208**, the following definition shall apply.

decitex (dtex) Unit by which thickness of yarn is expressed. The mass in grams per 10 km length of yarn. One dtex corresponds to 0.9 D (1 D equals 1.111 dtex).

4 Items Items shall be as follows.

- a) Cord gauge
- b) Moisture percentage
- c) Fineness based on corrected mass
- d) Twist
- e) Breaking strength and elongation percentage
- f) Load at constant elongation
- g) Elongation percentage at constant load
- h) Resistance to incipient tension
- i) Strength after heating
- j) Dry-heat shrinkage percentage
- k) Shrinkage stress under dry-heat condition
- l) Creep percentage
- m) Water absorption
- n) Shrinkage percentage after dipping in boiling water
- o) Dip pickup
- p) Solvent extract

5 Marking method of fineness, cord structure, and twist

5.1 Marking method of fineness Fineness shall be marked according to clause 7 of JIS L 0101.

5.2 Marking method of cord structure Cord structure shall be marked as follows.

- Example 1 Case of double twist by 1 400 dtex 1 400 dtex/2
- Example 2 Case of only first twist by 1 400 dtex single yarn 1 400 dtex/1
- Example 3 Case of first twist by 1 400 dtex double yarn
and then double twist (final twist) 1 400 dtex//2/2

5.3 Marking method of twist

- a) The direction of twist shall be marked by the symbols of "S" and "Z" as shown in Fig. 1.

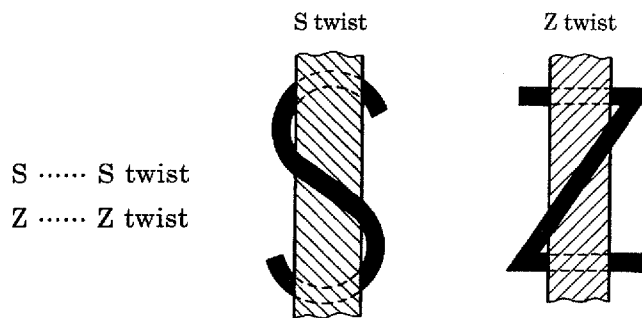


Fig. 1 Direction of twist

- b) The direction of twist shall be marked by “first twist direction × final twist direction”.
- c) The twist number shall be marked by the number of twists in 10 cm interval and is rounded off to the first decimal place according to **JIS Z 8401**.
- d) Concurrent marking of the direction of twist and the twist number shall be as follows:

Number of first twists (direction of twist) × Number of final twists (direction of twist)

Example : When single yarn cord is first-twisted by 37.0 turns per 10 cm interval in Z direction and then after doubling the two of them it is final-twisted by 39.0 turns per 10 cm interval in S direction, the twisting shall be marked as follows:

37.0 (Z) × 39.0 (S) T/10 cm

6 Sampling and preparation of specimen

6.1 Sampling In the case of original yarn, sample shall be taken after removing about 100 m from the yarn end of pirn, cheese or cone, and in the case of cord, after removing about 25 m from the cord end of a spool, bobbin or cone, as a rule.

In the case of tire fabric, at first a sample with tabby not less than 50 cm from a roll shall be taken, and then small specimen shall be cut out at random.

6.2 Preparation of specimen The specimen to be submitted to the test⁽¹⁾ influenced by temperature or humidity shall be kept, after being made into a hank or a single yarn, under the standard condition⁽²⁾ ⁽³⁾ before testing. However, for a moisture percentage test, a suitable amount of the specimen quickly taken from original sample shall be kept in a hermetic container.

Notes ⁽¹⁾ The tests influenced by temperature or humidity are such as; fineness based on corrected mass, twist, breaking strength, elongation percentage, load at constant elongation, elongation percentage at constant load, resistance to incipient tension, dry-heat shrinkage percentage, shrinkage stress under dry-heat condition, creep percentage, and shrinkage percentage after dipping in boiling water.

- (2) When testing synthetic fibre (nylon, vinylon, polyester, and aramid), vacuum drying in a desiccator containing desiccant may be carried out for pre-drying.
- (3) As for rayon or aramid, which has no apprehension to be shrunk, after pre-drying in a dryer kept at 40 ± 5 °C, they may be kept in standard condition.

- Remarks 1 When a laboratory or apparatus in standard condition is not available, put specimen in a hermetic container (containing 36 % sulfuric acid), and then make it at 20 ± 2 °C. In this case, record its condition.
- 2 When original yarn or cord kept in a package like a pirn or bobbin is brought into standard condition as it is for a test, this shall be additionally recorded.

7 Test condition

7.1 Site for test The tests⁽¹⁾, influenced by temperature or humidity, shall be carried out in the laboratory kept in standard condition according to **JIS L 0105**.

Remarks : When the tests influenced by temperature or humidity are carried out in the place other than those in standard condition, the temperature and relative humidity at the time of the test shall also be recorded.

7.2 Absolute dry mass Absolute dry mass shall be obtained after the specimen is dried using a hot air dryer.

7.3 Official regain Official regain shall follow **JIS L 0105**.

7.4 Initial tension Initial tension shall be the number of indicated dtex $\times 0.45$ mN. In this case, the result shall be rounded off to 100 mN unit according to **JIS Z 8401**.

Remarks : When the initial tension of cord is calculated, obtain it by multiplying indicated dtex of original yarn by number of doubling.

Example : Case of 1 400 dtex $\times 2$

$$1\,400 \times 2 \times 0.45 = 1\,260 \text{ mN} \approx 1.3 \text{ N}$$

7.5 Measurement of temperature and humidity Temperature and humidity shall be measured by the method using the ventilated psychrometer specified in **JIS Z 8806**.

8 Method

8.1 Cord gauge For the test of cord gauge, prepare a set of specimen composed of 4 cords from the sample in clause 6, arrange them in parallel to keep them from slackening, measure each cord gauge at 5 spots with a specified dial gauge⁽⁴⁾, and calculate their average to the nearest 0.01 mm.

Note (4) Employ the dial gauge with a leg measuring 9.5 ± 0.03 mm in diameter and with $1\,670 \pm 30$ mN of load (when the leg is placed on the base), and measure by dropping from about 6.5 mm height.

8.2 Moisture percentage For the test of moisture percentage, take about 5 g of specimen from the sample in clause 6, measure its mass and absolute dry mass, and calculate moisture percentage according to the following formula. Test twice, obtain their average, and round it off to the first decimal place according to **JIS Z 8401**.

$$M_r = \frac{m - m'}{m'} \times 100$$

where, M_r : moisture percentage (%)
 m : mass of specimen at sampling (g)
 m' : absolute dry mass of specimen (g)

8.3 Fineness based on corrected mass The test of fineness based on corrected mass shall be as follows.

- a) **Original yarn** The fineness based on corrected mass of original yarn shall be measured as follows: employ a sizing reel⁽⁶⁾, whose reel circumference is known⁽⁵⁾, wind back the specimen of clause 6 at the rate of 120 turns/min while applying an initial tension, prepare a small hank with 50 m or 100 m yarn length⁽⁷⁾, and measure its mass. Then allow it to stand in a dryer at 105 ± 2 °C for at least 2 h, obtain absolute dry mass by drying to attain constant weight, calculate the fineness based on corrected mass according to the following formula, and round it off to a whole number according to **JIS Z 8401**.

$$d = \frac{m' \times 10\,000 \times \left(1 + \frac{R_c}{100}\right)}{L}$$

where, d : fineness based on corrected mass (dtex)
 R_c : official regain (%)
 m' : absolute dry mass of specimen (g)
 L : length of specimen (m)

Notes (5) Principally, the sizing reel has 1.250 m or 1.000 m of reel circumference.

(6) The warp beaming machine with the same performance may be used.

(7) The length of yarn used for measurement shall be recorded.

- b) **Cord** For measuring the fineness based on corrected mass of cord, apply initial tension to the specimen of clause 6, cut the specimen to make its total length 10 m or longer, and measure the length of specimen. Then, weigh accurately its mass, obtain its absolute dry mass similarly to a), and calculate the fineness based on corrected mass.
- c) **Tire fabric** For measuring the fineness based on corrected mass of tire fabric, take 20 pieces of cord from the sample, apply initial tension to them, cut out accurately to make their length 50 cm, and weigh the mass of all 20 pieces. Then, obtain absolute dry mass similarly to a), and calculate the fineness based on corrected mass.

8.4 Twist For testing twist, employ a twist counter, apply initial tension to the specimen of clause 6, make the distance between grips 25 cm, and carry out the measurements on the following items. Test 10 times on each item, obtain their average, and round off the result to the first decimal place according to **JIS Z 8401**.

In order to avoid fluctuation in the twist number, in the case of a hank, measure while turning a hank as it is set on a hank reel and, in the case other than a hank, measure principally as the cords are being set transversely.

- a) **Twist number of original yarn** Completely untwist original yarn, divide the untwisted number by 2.5, and calculate the twist number per 10 cm interval.
- b) **Final twist number of cords** Completely untwist final twist, divide the untwisted number by 2.5, and calculate the final twist number per 10 cm interval.
- c) **First twist number of cords** Subsequent to the operation of b), cut all cords except one piece among the first twist yarns which have been in parallel as a result of complete untwisting of final twist. While applying initial tension on the remaining first yarn, measure its length L to the nearest 0.1 cm and further untwist it. Divide the untwisted number by L and, after multiplying it by 10, calculate the first twist number per 10 cm interval.
- d) **Percentage of twist shrinkage of cord** Measure the increment of the length of the original yarn brought into a parallel state as the result of the complete untwisting of the first twist of c), and calculate the percentage of an increment to its original length (25 cm).

8.5 Breaking strength and elongation percentage The test of breaking strength and elongation percentage shall be as follows.

- a) **Test in standard condition** Apply an initial tension to the specimen taken as shown in clause 6 so as not to change twist number, and carry out the test under the tensile condition shown in Table 1. Measure the tension applied to the specimen when the specimen is broken to the nearest $\frac{1}{2}$ of the smallest graduation, concurrently measure the elongation to the nearest 0.1 cm, and calculate the breaking strength and elongation percentage in the standard condition according to the following formulas. Try this test 10 times, obtain their average, and round it off to the first decimal place according to **JIS Z 8401**. When other breaking test conditions than those in Table 1 are employed, record the condition.

Table 1 Tensile test condition

Type of tester	Distance between grips	Tension speed
Constant-rate extension type	25 cm	30 ± 2 cm/min

$$F_t = \frac{F_d}{d}$$

where, F_t : breaking strength (cN/dtex)
 F_d : strength when breaking (cN)
 d : fineness based on corrected mass of specimen (dtex)

$$E_r = \frac{E}{L} \times 100$$

where, E_r : elongation percentage (%)
 E : elongation when breaking (cm)
 L : distance between grips (cm)

- b) **Test in absolute dry condition** Make the specimen prepared in clause 6 into absolute dry condition, then, take it out from dryer⁽⁸⁾, and measure breaking strength and elongation percentage in dry condition by the similar method a) within a defined duration⁽⁹⁾. In the case of synthetic fibre (nylon, vinylon, polyester, and aramid), specimen dried in a vacuum desiccator containing desiccant for 24 h or longer to an absolute dry condition without heating may be used. Try this test 10 times to obtain their average, and round it off to the first decimal place according to **JIS Z 8401**.

Notes (8) Before winding the specimen around a spool (made of metal or plastics), wrap the spool with paper or cloth to keep the specimen from directly contacting the spool and to make possible the contraction of specimen being heated and to ensure uniform heating. In this case, wind the fibres in the transverse position to avoid the change of the twist number taking care not to cause winding collapse. Then, put the spool in a dryer and make it in absolute dry condition with the end of the yarn sticking out from the yarn outlet of the dryer. When the specimen is taken out, remove about 2 m from the yarn end and measure the specimen immediately.

- (9) In the cases of rayon and vinylon, the duration shall be 30 s per test, and in the cases of nylon, polyester and aramid, 60 s.

- Remarks 1 In the case of non-twisted original yarn, carry out the test after applying 8 twists per 10 cm. When measuring with no twists, that shall be recorded.
- 2 When breaking takes place at the grip or within 3 mm from it, the measured value shall be eliminated.
- 3 When breaking at the gripped portion frequently takes place, wrap the specimen in soft paper or the like to avoid breaking at the grip.
- 4 Breaking strength shall include initial tension.
- 5 In testing the breaking strength and elongation percentage under standard condition, if the laboratory is not kept in standard condition, the temperature and humidity in the laboratory shall be recorded.
- 6 In the case of using the absolute dry specimen prepared by vacuum drying, the condition shall be recorded.
- 7 For the time being, a tensile tester whose stress is marked with traditional unit may be used.

8.6 Load at constant elongation The test for load at constant elongation shall be as follows.

- a) **Test in standard condition** Carry out the test on the specimen prepared in clause 6 similarly to the method in 8.5 a), and measure the tensile load at constant elongation shown in Table 2 to the nearest $\frac{1}{2}$ unit of the smallest graduation. Try this test 10 times, obtain their average, and round it off to the first decimal place according to JIS Z 8401.

On the test result, record elongation percentage.

Table 2 Condition for constant elongation

Unit: %

Kind of fibre	Elongation percentage ⁽¹⁰⁾ for untreated original yarn or cord	Elongation percentage ⁽¹⁰⁾ for dip-treated cord
Rayon	6	3
Nylon	14	7
Vinylon	4	2
Polyester	10	5
Aramid	1	1

Note ⁽¹⁰⁾ This means the percentage to the distance between grips of a tensile tester.

- b) **Test in absolute dry condition** Make the specimen prepared in clause 6 in absolute dry condition, and measure the tensile load at constant elongation shown in Table 3 by the similar method shown in 8.5 b) to the nearest $\frac{1}{2}$ unit of the smallest graduation. Try this test 10 times, obtain their average, and round it off to the first decimal place according to JIS Z 8401.

To the test result, record elongation percentage.

Table 3 Condition for constant elongation

Unit: %

Kind of fibre	Elongation percentage ⁽¹⁰⁾ for untreated original yarn or cord	Elongation percentage ⁽¹⁰⁾ for dip-treated cord
Rayon	6	3
Vinylon	4	2

8.7 Elongation percentage at constant load The test for elongation percentage at constant load shall be carried out as follows.

- a) **Test in standard condition** Carry out the test on the specimen prepared in clause 6 similarly to the method in 8.5 a), and calculate the elongation percentage at constant load according to the following formula. Try this test 10 times, obtain their average, and round it off to the first decimal place according to JIS Z 8401.

To the test result, record the loading conditions.

$$F = \frac{44 \times d_2}{d_1}$$

where, F : constant load (N)
 d_1 : standard fineness, given in Table 4 (dtex)
 d_2 : marked fineness of specimen (dtex)

Table 4 Standard fineness of each fibre

Unit: dtex

Kind of fibre	Original yarn	Cord
Rayon	1 840	3 680
Nylon	940	1 880
Vynylon	1 330	2 660
Polyester	1 100	2 200
Aramid		

- b) **Test in absolute dry condition** Make the specimen prepared in clause 6 in absolute dry condition, and carry out the test by the similar method shown in 8.5 b), and calculate the elongation percentage at constant load according to the formula in a). Try this test 10 times, obtain their average, and round it off to the first decimal place according to **JIS Z 8401**.

8.8 Resistance to incipient tension The test for resistance to incipient tension shall be as follows; carry out the test on the specimen prepared in clause 6 similarly to the method in 8.5 a), plot the load-elongation curve shown in Fig. 2. On this curve find the point "A" giving the maximum load variation to elongation variation (the maximum tangent angle) in the vicinity of original point, and calculate the resistance to incipient tension according to the following formula. Try this test 10 times, obtain their average, and round it off to the first decimal place according to **JIS Z 8401**.

$$R_d = \frac{F}{\frac{L'}{L} \times d}$$

where, R_d : resistance to incipient tension (cN/dtex)
 F : load at the point A giving the maximum tangent angle (cN)
 d : fineness based on corrected mass (dtex)
 L : length of specimen tested (mm)
 L' : length of TH (mm)
 (H is the foot of perpendicular line, and T is an intersecting point of tangent and abscissa.)