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Test methods for chemical fibre tire cords

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JAPANESE INDUSTRIAL STANDARD J I S

Test methods for chemical fibre tire cords L 1017-1995

1. Scope This Japanese Industrial 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).

Remarks: The standards cited in this Standard are listed as follows.

JIS K 0050	General rules for chemical analysis
JIS K 0557	Water used for chemical 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	Rules for rounding off of numerical values
JIS Z 8806	Humidity – Measurement methods

2. Definitions For the purpose of this Standard, in addition to those 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 (one D equals to 1.111 dtex).

3. Items Items shall be as follows.

(1) Cord gauge

(2) Moisture percentage

(3) Fineness based on corrected mass

(4) Twist

(5) Breaking strength and elongation percentage

(6) Load at constant elongation

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(7) Elongation percentage at constant load

(8) Resistance to incipient tension

(9) Strength after heating

(10) Dry-heat shrinkage percentage

(11) Shrinkage stress in dry-heat condition

(12) Creep percentage

(13) Water absorption

(14) Shrinkage percentage after dipping in boiling water

(15) Dip pickup

(16) Solvent extract

4. Marking method of fineness, chord structure, and twist

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

4.2 Marking method of chord structure Chord structure shall be marked as follows.

Example 1. Case of double twist by 1400 dtex 1400 dtex/2

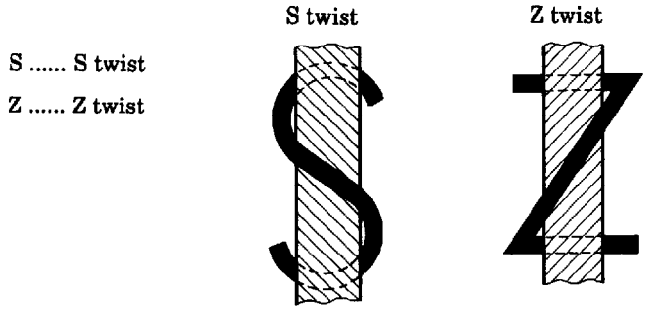
Example 2. Case of only first twist by 1400 dtex single yarn ... 1400 dtex/1

Example 3. Case of first twist by 1400 dtex double yarn and then double twist (final twist) 1400 dtex//2/2

4.3 Marking method of twist

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

Fig. 1. Direction of twist



(2) The direction of twist shall be marked by "first twist direction × final twist direction".

(3) 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.

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(4) When marking concurrently the direction of twist and the twist number, follow the next way:

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

5. Sampling and preparation of specimen

5.1 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 at random.

5.2 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 in 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 made for predrying.

(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, the situation shall be additionally stated.

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6. Test condition

6.1 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 standard condition, the temperature and relative humidity at the time of the test shall be annexed.

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

6.3 Official regain Official regain shall follow JIS L 0105.

6.4 Initial tension Initial tension shall be number of indicated dtex × 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 1400 dtex × 2

$1400 \times 2 \times 0.45 = 1260\ \text{mN} \fallingdotseq 1.3\ \text{N}$

6.5 Measurement of temperature and humidity Temperature and humidity shall be measured as follows: measure temperature by using a Meteorological Agency type or Assmann ventilated psychrometer, specified in JIS Z 8806, and obtain relative humidity from the humidity chart based on Sprung's formula.

7. Method

7.1 Cord gauge For test of cord gauge, prepare a set of specimen composed of 4 cords from sample at 5., 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 1670 ± 30 mN of load (when the leg on the base), and measure by dropping from about 6.5 mm height.

7.2 Moisture percentage For test of moisture percentage, take about 5 g of specimen from the sample at 5., 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 when taken (g)

m': absolute dry mass of specimen (g)

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

(1) 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 5. 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 get a whole number according to JIS Z 8401.

$$d = \frac{m' \times 10000 \times \left(1 + \frac{R_c}{100}\right)}{L}$$

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 annexed.

(2) Cord For measuring the fineness based on corrected mass of cord, apply initial tension to the specimen of 5., 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 (1), and calculate the fineness based on corrected mass.

(3) Tire fabric For measuring the fineness based on corrected mass of tire fabric, take 20 pieces of cord from 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 (1), and calculate the fineness based on corrected mass.

7.4 Twist For testing twist, employ a twist counter, apply initial tension to the specimen of 5., 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 get the first decimal place according to JIS Z 8401.

In order to avoid fluctuation in the twist number, make measurements in the case of a hank, 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.

(1) 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.

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(2) Final twist number of cord Completely untwist final twist, divide the untwisted number by 2.5, and calculate the final twist number per 10 cm interval.

(3) First twist number of cord Subsequent to the operation of (2), cut all cords but remain 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 remained 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.

(4) 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 (3), and calculate the percentage of an increment to its original length (25 cm).

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

(1) Test in standard condition Apply an initial tension to the specimen taken as shown in 5. 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 specimen when the specimen is broken to the nearest $\frac{1}{2}$ of the smallest graduation, concurrently measure 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 get the first decimal place according to JIS Z 8401. When other breaking test conditions than those in Table 1 are employed, annex 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)

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(2) Test in absolute dry condition Make the specimen prepared at 5. into absolute dry condition, then, take it out from dryer (8), and measure breaking strength and elongation percentage in dry condition with similar method to (1) within a defined duration (9). In case of synthetic fibre (nylon, vinylon, polyester, and aramid), specimen dried in a vacuum desiccator containing desiccant for 24 h or longer to make into an absolute dry condition without heating may be used. Try this test 10 times to obtain their average, and round it off to get 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 ensure uniform heating. In this case, wind the fibers 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 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, a statement to that effect shall be made.

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 the absolute dry specimen prepared by vacuum drying, the condition shall be stated.

7. For the time being, a tensile tester whose stress is marked with traditional unit may be used.

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

(1) Test in standard condition Carry out the test on the specimen prepared at 5. similarly to the method in 7.5 (1), 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 get the first decimal place according to JIS Z 8401.

On the test result, annex elongation percentage.

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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.

(2) Test in absolute dry condition Make the specimen prepared at 5. absolute dry condition, and measure the tensile load at constant elongation shown in Table 3 with the similar method shown in 7.5 (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 get the first decimal place according to JIS Z 8401.

On the test result, annex 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

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

(1) Test in standard condition Carry out the test on the specimen prepared at 5. similarly to the method in 7.5 (1), 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 get the first decimal place according to JIS Z 8401.

On the test result, annex 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)

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Table 4. Standard fineness of each fibre

Unit: dtex

Kind of fibre	Original yarn	Cord
Rayon	1840	3680
Nylon	940	1880
Vinylon	1330	2660
Polyester	1100	2200
Aramid		

(2) Test in absolute dry condition Make the specimen prepared at 5. absolute dry condition, and carry out the test with the similar method shown in 7.5 (2), and calculate the elongation percentage in constant load according to the formula (1). Try this test 10 times, obtain their average, and round it off to get the first decimal place according to JIS Z 8401.

7.8 Resistance to incipient tension The test for resistance to incipient tension shall be as follows; carry out the test on the specimen prepared at 5. similarly to the method in 7.5 (1), 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 get 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)

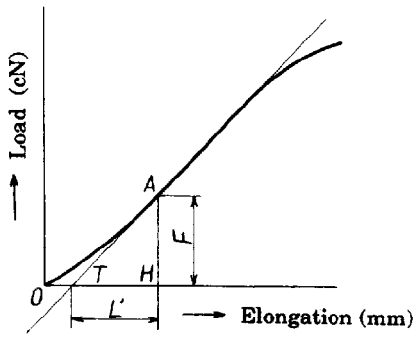
F: load at the point A giving the maximum tangent angle (cN)

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.)

Fig. 2. Load-elongation curve



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Remarks 1. In order to lessen measurement error, it is preferable to control the chart speed to make the angle about 45 degrees between the tangent at point A and elongation axis on the initial load-elongation curve.

2. The relation between the resistance to incipient tension and apparent Young's modulus is shown in the following formula.

$$E' = 100 \times \rho \times R_d$$

where, E': apparent Young's modulus (N/mm²)

R_d: resistance to incipient tension (cN/dtex)

ρ: density of fibre (g/cm³)

3. Tester, principally, shall be the constant rate extension type tensile tester, and the tensile conditions shall be annexed. When other type of tester is used, however, its type and tensile conditions shall be annexed.

7.9 Strength after heating The test for strength after heating shall be as follows.

(1) Strength after heating in absolute dry condition (method A) Wind the specimen prepared at 5. around a heat resistant test spool ([11]), put it in a dryer kept at the specified temperature ([12]), heat it for the specified duration ([12]), transfer immediately it into a dryer at 105 ± 2°C, allow it to stand for 30 min or more, and calculate the strength after heating in absolute dry condition similarly to the method in 7.5 (2). Try this test 10 times, obtain their average, and round it off to get the first decimal place according to JIS Z 8401. Thereafter, calculate the ratio on strength after heating according to the following formula, and round it off to get a whole number according to JIS Z 8401.

$$S_r = \frac{S_h}{S_d} \times 100$$

where, S_r: ratio on strength after heating (%)

S_h: strength after heating in absolute dry condition (N)

S_d: strength in absolute dry condition (N)

Notes ([11]) 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 the specimen being heated and ensure uniform heating.

([12]) Heating temperature and duration for heating shall be chosen out of the following.

(1) At 180 ± 3°C for 4 h

(2) At 180 ± 3°C for 2 h

(3) At 160 ± 3°C for 5 h

(4) At 140 ± 3°C for 24 h

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(2) Strength after heating in standard condition (method B) Wind the specimen prepared at 5. around a heat resistant test spool ([11]), put it in a dryer kept at specified temperature ([12]), heat it for specified duration ([12]), allow it to stand in the laboratory under standard condition until it attains moisture equilibrium, and calculate the strength after heating in standard condition similarly to the method in 7.5 (1). Try this test 10 times, obtain their average, and round it off to get the first decimal place according to JIS Z 8401. Thereafter, calculate the ratio on strength after heating according to the following formula, and round it off to get a whole number according to JIS Z 8401.

$$S_r = \frac{S_h'}{S_d'} \times 100$$

where, S_r : ratio on strength after heating (%)

S_h' : strength after heating in standard condition (N)

S_d' : strength in standard condition (N)

Remarks: Annex testing conditions.

7.10 Dry-heat shrinkage percentage The test for dry-heat shrinkage percentage shall be as follows.

(1) Dry-heat shrinkage percentage in heating (method A) Take 300 mm or longer specimen from the sample at 5., apply an initial tension to it while its one end is fixed, and measure accurately the length of original yarn while keeping it from untwisting. Next, put it in a dryer at specified temperature ([13]) while the initial tension is being applied, allow it to stand for specified duration ([13]), and measure its length in heating condition. Calculate dry-heat shrinkage percentage in heating according to the following formula, obtain the average of 5 test values, and round it off to get the first decimal place according to JIS Z 8401.

$$AC_r = \frac{L - L_1}{L} \times 100$$

where, AC_r : dry-heat shrinkage percentage in heating (%)

L : length of original yarn (mm)

L_1 : length of yarn in heating (mm)

Note ([13]) Specified temperature and duration for heating shall be chosen out of the following.

(1) At 150 ± 3°C for 30 min

(2) At 160 ± 3°C for 30 min

(3) At 180 ± 3°C for 30 min

Remarks 1. Tester shall be equipped with both the device to apply the definite load to and the device to read the change in length of specimen.

2. Annex the conditions for measurement.

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(2) Dry-heat shrinkage percentage after heating (method B) Take 300 mm or longer specimen from the sample at 5., apply an initial tension to it while its one end is fixed, and measure accurately the length of original yarn while keeping it from untwisting. Next, put it in a dryer at specified temperature ([13]) applying no load, and heat it for specified duration ([13]). After heating, take out the specimen from the dryer, allow it to stand in a laboratory kept at standard condition for at least 30 min, and measure the length of the yarn while applying an initial tension. Calculate dry-heat shrinkage percentage after heating according to the following formula, obtain the average of 5 test values, and round it off to get the first decimal place according to JIS Z 8401.

$$BC_r = \frac{L - L_1}{L} \times 100$$

where, BC_r: dry-heat shrinkage percentage after heating (%)
L: length of original yarn (mm)
L_1: length of yarn after heating (mm)

Remarks: Annex the conditions for measurement.

7.11 Shrinkage stress in dry-heat condition The test for shrinkage stress in dry-heat condition shall be as follows.

(1) Fasten one end of the specimen prepared at 5. to an upper grip, and fix it after applying initial tension to it.

(2) Then, put it in a dryer kept at specified temperature ([14]), and after allowing it to stand for 5 min or longer, read the maximum value generated by this procedure.

(3) Calculate the shrinkage stress in dry-heat condition according to the following formula, obtain the average of 5 test values, and round it off to get the second decimal place according to JIS Z 8401.

$$S_f = \frac{F - F'}{d}$$

where, S_f: shrinkage stress in dry-heat condition (cN/dtex)
F: stress generated on specimen (cN)
F': initial tension (cN)
d: fineness based on corrected mass (dtex)

Note ([14]) The specified temperature shall be 160 ± 3°C, but other conditions may be used. In this case, the adopted temperature shall be annexed.

Remarks: Tester shall be the one equipped with device capable of reading the change in stress generated on the specimen.

7.12 Creep percentage The test for creep percentage shall be as follows.

(1) Take 300 mm or longer specimen from the sample at 5., fix one end of the specimen, apply an initial tension while keeping it from untwisting, and measure accurately the length of original yarn.

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(2) Then, apply specified tension (15) to it, allow it to stand at specified temperature (16) for 60 min, and measure the length of the yarn.

(3) Calculate creep percentage according to the following formula, obtain the average of 5 test values, and round it off to get the first decimal place according to JIS Z 8401.

$$C_r = \frac{L_2 - L}{L} \times 100$$

where, C_r: creep percentage (%)

L: length of original yarn (mm)

L_2: length of yarn after tensioning (mm)

Notes (15) The specified tension shall be the value obtained by multiplying indicated fineness by 0.0088, and its unit is N.

(16) The specified temperature shall be ordinary temperature or 135°C.

Remarks: Annex the conditions for test.

7.13 Water absorption For measurement of water absorption, pass the specimen prepared (17) at 5. through the compensator of the device shown in Fig. 3, apply load of about 0.64 N to it, give it tension via a inductive roller, and insert it between rollers. Place 20 ± 2°C water into a 500 ml beaker to get 18 ± 0.5 cm of immersion length, pull the specimen at the rate of 4.5 m per minute while letting the water (18) drip from a buret and simultaneously while letting the beaker balance on an even balance (with 0.1 g of reciprocal sensibility), and measure the amount of dripped water (18) while 45 m of specimen has been passed through. Calculate water absorption according to the following formula, and round it off to get the first decimal place according to JIS Z 8401.

$$A_r = \frac{P}{m} \times 100$$

where, A_r: water absorption (%)

P: amount of water (18) dripped from buret (ml)

m: mass of 45 m long specimen in standard condition (g)

Notes (17) The specimen shall be prepared as follows. Using a sizing reel, take a length of 9 m as inducing part prior to measurement, put a mark at the point of 9 m, then take 45 m for the part of measurement, put a mark at the point, and take further 9 m for inducing part after measurement to make about 63 m hank totally. After letting the hank attain moisture equilibrium, calculate the mass of 45 m long specimen in standard condition. The specimen shall be subjected to the test after rewinding around a small wooden bobbin or cheese bobbin.

(18) Employ the water specified in JIS K 0557.

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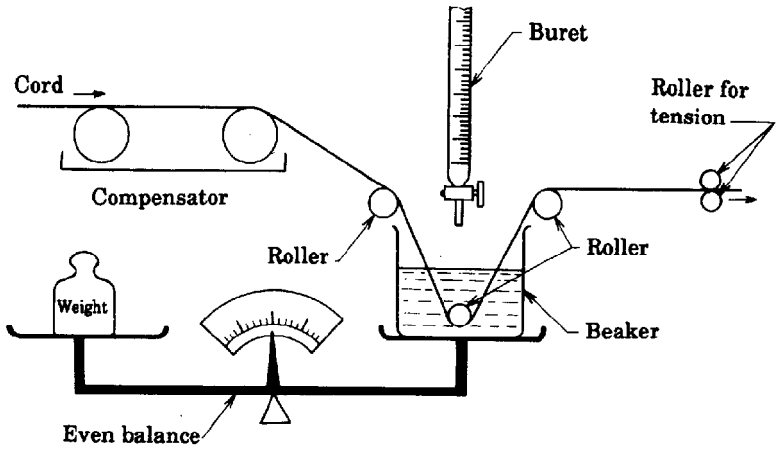
Fig. 3. Measuring apparatus for water absorption



7.14 Shrinkage percentage after dipping in boiling water The test for shrinkage percentage after dipping in boiling water shall be as follows.

(1) Taking care of the specimen of 5. not to allow to untwist, prepare a loop specimen of at least 300 mm long, fix its one end, and measure accurately the length of original yarn while applying initial tension.

(2) Then, immerse it with no load in boiling water, and allow it to stand for 30 min. Let filter paper absorb sufficiently water for specimen, allow it to stand for at least 3 h in a laboratory at standard condition, and measure its length after applying initial tension to it.

(3) Calculate shrinkage percentage after dipping in boiling water according to the following formula, obtain the average of 5 test values, and round it off to get the first decimal place according to JIS Z 8401.

$$WC_r = \frac{L - L_3}{L} \times 100$$

where, WC_r: shrinkage percentage after dipping in boiling water (%)

L: length of original yarn (mm)

L_3: length of yarn after dipping (mm)

7.15 Dip pickup The test for dip pickup shall be as follows.

(1) Dissolving method Adopt any of the following according to the kind of fibre.

(a) Case of nylon Cut about 3 g of specimen prepared at 5. into 5 mm or less in length, unweave it sufficiently, transfer into a dryer at 105 ± 2°C, allow it to stand until it attains constant weight, and weigh accurately its mass after allowing it to cool in a desiccator. Put it into a 500 ml beaker, add 250 ml of formic acid (19), dissolve it while stirring it at room temperature, and filtrate it through a glass filter (1G2 or the equivalent) whose mass is known. Wash twice its residue with 25 ml of formic acid (19), after filtration of the formic acid (19), wash

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4 times with total about 100 ml of water, and filtrate it. Transfer the glass filter containing residue into a dryer kept at 105 ± 2°C, allow it to stand until it attains constant weight, and weigh accurately its mass after allowing it to cool in a desiccator. Calculate the dip pickup according to the following formula, obtain the average of 2 test values, and round it off to get the first decimal place according to JIS Z 8401.

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

where, D_i : dip pickup (%)

m : absolute dry mass of specimen (g)

m' : absolute dry mass of residue (g)

Note (19) Employ guaranteed grade specified in JIS K 8264.

(b) Case of polyester Cut about 3 g of specimen prepared at 5. into 5 mm or less in length, unweave it sufficiently, transfer into a dryer at 105 ± 2°C, allow it to stand until it attains constant weight, and weigh accurately its mass after allowing it to cool in a desiccator. Transfer it into a 50 ml Erlenmeyer flask in which 30 mg of zinc chloride (20) and zeolite has been placed, and add 25 ml of ethylene glycol (21) with a transfer pipet. Attach a cooler (for instance, Liebig condenser), heat it on a heating device for 2.5 h while agitating often it after starting to boil, and dissolve it. After dissolving, remove from the heating device, stopper it, allow it to cool, and filtrate it through a glass filter (1G2 or the equivalent) whose mass is known. Add 10 ml of 0.5 mol/*l* hydrochloric acid (22), stir it with a glass rod, and filtrate it again. Then, wash it with 500 ml of 60°C water, and filtrate it. Thereafter, carry out the procedures similarly to (a), and calculate the dip pickup.

Some kind of adhesive may require a correction factor.

Notes (20) Employ guaranteed grade specified in JIS K 8111.

(21) Employ guaranteed grade specified in JIS K 8105.

(22) Employ guaranteed grade specified in JIS K 8180.

(c) Case of rayon Cut about 3 g of specimen prepared at 5. into 5 mm or less in length, unweave it sufficiently, transfer into a dryer at 105 ± 2°C, allow it to stand until it attains constant weight, and weigh accurately its mass after allowing it to cool in a desiccator. Transfer it into a 300 ml beaker, add 150 ml of sulfuric acid (70% to 72%) (23) at 25°C to 30°C while stirring it, after dissolving agitate for another 20 min, and filtrate it through a glass filter (1G2 or equivalent) whose mass is known. Wash the residue with water until it gives no acidic reaction (judge it by methyl red). Thereafter, carry out the procedures similarly to (a), and calculate the dip pickup.

Note (23) Employ guaranteed grade specified in JIS K 8951.

(d) Case of vinylon Cut about 3 g of specimen prepared at 5. into 5 mm or less in length, unweave it sufficiently, transfer into a dryer at 105 ± 2°C, allow it to stand until it attains constant weight, and weigh accurately its mass after allowing it to cool in a desiccator. Transfer it

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into a 500 ml Erlenmeyer flask, add 200 ml of 10% hydrochloric acid ([22]), put zeolite, place it on a sand bath, attach a cooler (for instance, Liebig condenser), and heat it on a heating device for at least 2 h to dissolve it. After dissolving, filtrate it through a glass filter (1G2 or equivalent) whose mass is known. Wash three times the residue with 100 ml to 200 ml of hot water at 70°C to 80°C. Thereafter, carry out the procedures similarly to (a), and calculate the dip pickup.

Remarks: The apparatus used in the test shall follow the specification of JIS K 0050.

(2) Mass method In case of cord, calculate the dip pickup according to the following formula, and round off the value to get the first decimal place according to JIS Z 8401.

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

where, D_i : dip pickup (%)

m : absolute dry mass of untreated cord before dipping (g)

m' : absolute dry mass of cord treated with dipping (g)

Remarks: When the amount of desorption of oily matter applied on fibre can not be disregarded, it shall be corrected.

7.16 Solvent extract Employ any of the following methods according to the kind of fibre.

(1) Extract by alcohol-benzene (In cases of rayon, vinylon and aramid) Weigh accurately about 5 g of the specimen of 5. whose water content is known and, after putting it gently in a Soxhlet extractor ([24]) without extraction thimble, pour about 150 ml of alcohol-benzene mixture ([25]) (volume ratio 1 : 2) in an attached flask, set the extractor on a water bath, heat the extracting fluids barely enough to continue slightly boiling ([26]) for 4 h, return into the flask the solution kept in the space for specimen, condense the solution in the flask down to 10 ml to 15 ml or less (if necessary, filtrate through 1G1 or 3G1 glass filter), and transfer it into a weighing bottle whose constant weight is obtained in advance at 105 ± 2°C. Wash the extracting flask with warm alcohol-benzene mixture of 50°C to 60°C, and put together the washings (if a glass filter was used, after filtrating the washings through the abovementioned filter) and the solution in the weighing bottle. After evaporating the solvent on water bath, allow it to stand in a thermostat dryer at 105 ± 2°C for 1.5 h, and cool in a desiccator to weigh its mass. Extracted component shall be expressed by the percentage of the extract by alcohol-benzene mixture to the absolute dry mass. Test twice, and obtain the averaged value to the second decimal place according to JIS Z 8401.

Notes ([24]) Utilize the Soxhlet extractor specified in JIS R 3503.

([25]) Employ guaranteed grade specified in JIS K 8102 and in JIS K 8858. Before using recovered alcohol-benzene mixture, regulate its water content to 1.7 ± 0.5%.

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(26) Heat the extractor to the degree of one reflux through a siphon tube per 10 min.

(2) Extract by diethyl ether (Case of nylon) Weigh accurately about 5 g of the specimen of 5. whose water content is known and, after putting it gently in a Soxhlet extractor (24) without extraction thimble, pour about 150 ml of diethyl ether (27) into the attached flask, set the extractor on a water bath, heat the extracting fluids barely enough to continue slightly boiling (26) for 1.5 h, return into the flask the solution kept in the space for specimen, condense the solution in the flask down to 10 ml to 15 ml (if necessary, filtrate through 1G1 or 3G1 glass filter), and transfer it into a weighing bottle whose constant weigh is obtained in advance at 105 ± 2°C. Wash the extracting flask with diethyl ether, and put together the washings (if a glass filter was used, after filtrating the washings through the abovementioned filter) and the solution in the weighing bottle. After evaporating the solvent on a water bath, allow it to stand in a thermostat dryer at 105 ± 2°C for 1.5 h, and cool in a desiccator to weigh its mass. Extracted component shall be expressed by the percentage of the extract by diethyl ether to the absolute dry mass. Test twice, and obtain the averaged value to the second decimal place according to JIS Z 8401.

Note (27) Employ guaranteed grade specified in JIS K 8103.

(3) Extract by methanol (Case of polyester) Weigh accurately about 5 g of the specimen of 5. whose water content is known, put it gently in a Soxhlet extractor (24) without extraction thimble, pour about 150 ml of methanol (28) in attached flask, set the extractor on a water bath, heat the extracting fluids barely enough to keep slightly boiling (26) for 3 h, return to the flask the solution kept in the space for specimen, condense the solution in the flask down to 5 ml or less (if necessary, filtrate through 1G1 or 3G1 glass filter), transfer it into a weighing bottle whose constant weight is obtained in advance at 105 ± 2°C, wash the extracting flask with methanol, and put together the washings (if a glass filter was used, after filtrating the washings through the abovementioned filter) and the solution in the weighing bottle. After evaporating the solvent, allow it to stand in a thermostat dryer at 105 ± 2°C for 1.5 h, and cool in a desiccator to weigh its mass. Extracted component shall be expressed by the percentage of the extract by methanol to the absolute dry mass. Test twice, and obtain the averaged value to the second decimal place according to JIS Z 8401.

Note (28) Employ guaranteed grade specified in JIS K 8891.

Remarks: The apparatus used for testing shall conform to JIS K 0050.

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Informative reference 1 Test method for work-to-break by impact, fatiguing strength, adhesive strength, and dip pickup (aramid)

This Informative reference describes the typical examples of test methods for work-to-break by impact, fatiguing strength, adhesive strength, and dip pickup (in case of aramid), which are carried out for tire cord and tire cord fabric, and does not constitute a part of this Standard.

1. Work-to-break by impact For the test of the work-to-break by impact, employ a pendulum-type impact strength tester and, setting the distance between two grips 30 cm, let the pendulum fall from an angle of 60°C. Measure the angle at which the pendulum rebounds after being dropped respectively in two cases the test piece is set and is not set. Calculate the work-to-break from the following formula. Test ten times, and obtain the averaged value to the second decimal place according to JIS Z 8401.

$$A = F \cdot s\left(\cos\alpha - \cos\alpha_0\right)$$

where, A : work-to-break by impact (J)

F : force exerted when impact pendulum collides against test piece (N)

s : distance between gravity centre and fulcrum (m)

α_0 : ascending angle when using no test piece

α : ascending angle when test piece was broken

Remarks 1. Eliminate the result given when test piece is broken at the portion adjoining the cord grip.

2. The tester may be either of the type giving the impact to the test piece vertically or the type giving it horizontally at its centre. The type of the tester, however, shall be additionally stated.

3. If necessary, the values of "F", "s" and the diameter of the part of impact shall be additionally stated.

2. Fatiguing strength

2.1 Fatiguing strength by compression·bending Test for the fatiguing strength by compression·bending shall be classified into the following Firestone method (method A) and De Mattia method (method B).

(1) Firestone method (method A)

(a) Employ the compression·bending tester shown in Informative reference 1 Fig. 1, attach a pad for test (2) (3) in which a rubberized cord (1) made of a test piece is embedded, so that the test piece side of the pad contacts with the spindle face of the tester. Applying the specified load (4) at 71 ± 15°C, carry out the compression·bending treatment at the rate of 250 rpm.

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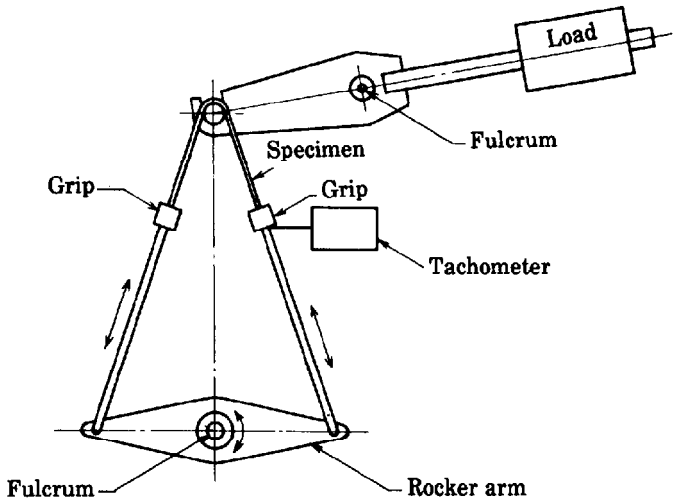
Informative reference 1 Fig. 1. Compression•bending tester of Firestone method (method A)



Notes (1) Stick a test piece together with rubber whose material has been agreed between the parties concerned with delivery, and make its size about 15 cm in width, about 35 cm in length, and 0.114 cm to 0.127 cm in thickness. In this case, the cord density of the test piece shall be stated additionally in the record.

(2) The pad for test shall be constructed as shown in Informative reference 1 Fig. 2 (showing only side view because width is always 15 cm), and shall be used after standing for 24 h or more in room or apparatus under standard condition from its vulcanization.

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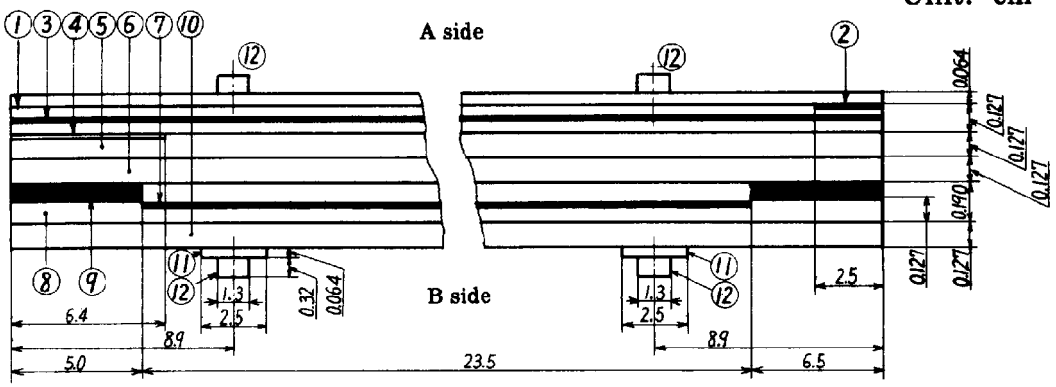
Informative reference 1 Fig. 2. Example of a pad for test

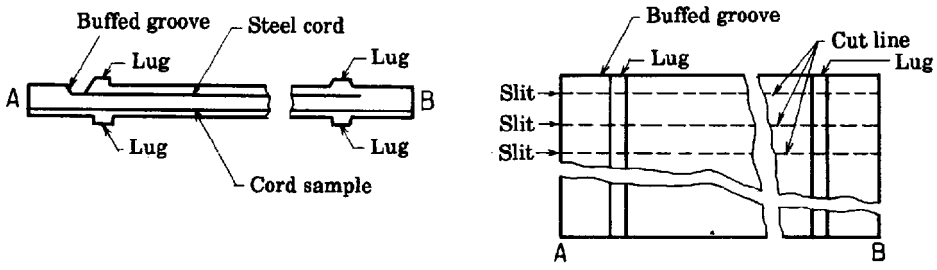
Unit: cm



① Rubber layer of 35.0 cm in length and 0.064 cm in thickness
② Cellophane of 2.5 cm in length
③ Rubberized cord of 35.0 cm in length and 0.127 cm in thickness
④ Cellophane of 6.4 cm in length
⑤ Rubber layer of 35.0 cm in length and 0.127 cm in thickness
⑥ Rubber layer of 35.0 cm in length and 0.127 cm in thickness
⑦ Rubberized steel cord of 23.5 cm in length and 0.19 cm in thickness
⑧ Rubber of 0.127 cm in thickness, which is removed after putting ⑦
⑨ To be left void after putting ⑦ and ⑧
⑩ Rubber layer of 35.0 cm in length and 0.127 cm in thickness
⑪ Rubber strip of 2.5 cm in length and 0.064 cm in thickness, which is put under the lug of B side
⑫ Rubber lug of 1.3 cm in length and 0.32 cm in thickness, which is put in the groove of a mould before vulcanization

(3) The steel cord side of the pad for test shall be buffed to reach the steel cord as shown on "buffed groove" of Informative reference 1 Fig. 3. Then, count 5 steel cords (about 0.64 cm) from one end of the pad for test, slit from buffed part to "A" end, and cut longitudinally the pad for test from the each slit.

Informative reference 1 Fig. 3. Buffed groove



(4) The load applied to the spindle shall be agreed between the parties concerned with delivery.

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(b) Then, peel (5) both untreated pad for test and the pad for test which has been treated by compression·bending (hereafter referred to as "untreated test pad" and "treated test pad"), take 10 cords and 5 cords respectively from each test pad, and carry out the test to find tensile strength at absolute dry condition according to 7.5 (2) of this Standard.

Note (5) Peeling method of test pad Untreated test pad and treated test pad shall be peeled as follows, and cords be taken out.

(1) At each test pad, take ① and ③ in Informative reference 1 Fig. 2 for A, and ⑤, ⑥, ⑦ and ⑩ for B, remove ④, grasp A by a vise, pull B, and separate A from B.

(2) Then, take out one by one the cords kept in A.

(c) Employ the test piece which used standard tire cords (6) (hereafter referred to as "standard cords test piece") and carry out the operations shown in (a) and (b).

Note (6) The tire cords have been prepared by the agreement between the parties concerned with delivery.

(d) Calculate fatigue percentage by compression·bending according to the following formulas.

$$F_r = \frac{NF_e}{NF_c} \times 100$$

provided that, $$NF_e = \frac{TA_e - TF_e}{TA_e - TB_e} \times NR_e$$

$$NF_c = \frac{TA_c - TF_c}{TA_c - TB_c} \times NR_c$$

where, F_r: fatigue percentage by compression·bending (%)

NF_e: number of compression·bendings until test piece reaches fatiguing limit strength

NF_c: number of compression·bendings until standard cord test piece reaches fatiguing limit strength

TA_e: tensile strength, at absolute dry condition, of cord taken from untreated test pad in which test piece has been embedded (N)

TA_c: tensile strength, at absolute dry condition, of cord taken from untreated test pad in which standard cord test piece has been embedded (N)

TF_e: fatiguing limit strength of test piece (N)

TF_c: fatiguing limit strength of standard cord test piece (N)

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TB_e : tensile strength, at absolute dry condition, of cord taken from treated test pad in which test piece has been embedded (N)

TB_c : tensile strength, at absolute dry condition, of cord taken from treated test pad in which standard cord test piece has been embedded (N)

NR_e : number of compression·bendings of test piece

NR_c : number of compression·bendings of standard cord test piece

(2) De Mattia method (method B) Employ the compression·bending tester shown in Informative reference 1 Fig. 4, make a test piece into a condition of rubberized cord (7), attach the rubberized cord test piece which has adhered on a sample base (8), to the grip which can move up and down by 7.0 cm stroke, so that the sample side of the rubberized test piece is to be subjected by compression·bending actions (9), and carry out the treatment of compression·bending for specified duration (subject to the agreement between parties concerned) at the rate of 400 rpm.

Then, peel (10) both untreated rubberized cord and treated rubberized cord, take respectively 10 test pieces from each rubberized cord, measure breaking strength according to 7.5 (2) of this Standard, and calculate the durability percentage by compression·bending according to the following formula.

$$T_r = \frac{T_b}{T_a} \times 100$$

where, T_r : durability percentage by compression·bending (%)

T_a : breaking strength of test piece taken from untreated rubberized cord (N)

T_b : breaking strength of test piece taken from treated rubberized cord (N)

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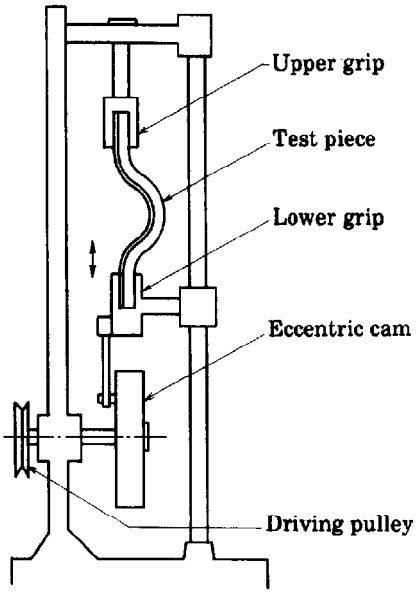
Informative reference 1 Fig. 4. Compression·bending tester of De Mattia method (method B)



Notes (7) Stick a test piece on the rubber whose material has been specified between the parties concerned with delivery, and make its size 20 cm in width, and 46 cm in length. In this case, annex the density of test piece on record.

(8) Rubberized cord test piece is composed of, as shown in Informative reference 1 Fig. 5, rubberized cord and a sample base (4 sheets of rubberized cord are adhered rectangularly to each other), then elongated by giving a tension at "A" and "B" ends, and vulcanized as it is fixed. The condition of vulcanization shall follow the agreement between the parties concerned with delivery.

Rubberized cord test piece shall be stood in a room or apparatus under standard condition for at least 24 h from its vulcanization.

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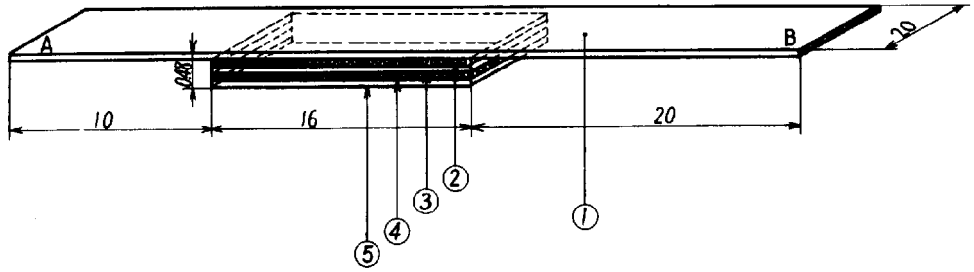
Informative reference 1 Fig. 5. Rubberized cord test piece

Unit: cm



① Rubberized cord of 20 cm in width and 46 cm in length

②④ Rubberized cord of 16 cm in width, 20 cm in length, and 0.90 mm to 0.92 mm in thickness

③⑤ Rubberized cord of 20 cm in width, 16 cm in length, and 0.90 mm to 0.92 mm in thickness

Remarks: Width means longitudinal direction of cord, and length means lateral direction of cord.

([9]) Eliminate about 2.5 cm both ends of rubberized cord test piece, and collect 6 test pieces, measuring 2.5 cm wide each, from its central part, for the tester. Then, take 3 test pieces out of these 6 to cut the part from "B" end to the sample base as shown in Informative reference 1 Fig. 5, and attach vertically the cut end to the lower grip so as to make sample cord face to inside (bent side). In this case, attach 3 test pieces, having each 2.5 cm width, side by side at the same time. Fold the "A" end of rubberized cord, and attach the other end of its sample base to the upper grip. Set the distance between upper and lower grips to be 10 cm.

([10]) When peeling, 10 cords shall be simultaneously peeled from sample base at central part of the test piece.

2.2 Fatiguing strength by extension·compression

2.2.1 Fatiguing strength with tube-type test piece (Goodyear method) The test for fatiguing strength with tube-type test piece (Goodyear method) shall be as follows.

(1) Employ the extension·compression fatigue tester as shown in Informative reference 1 Fig. 6, attach ([12]) the rubber tube-type test piece ([11]), in which the test piece has been buried in parallel to the axis, in a form being bent by angle of 90°, then rotate ([13]) it by the inner pressure of compressed air, and record the number of rotations made before the tube breaks owing to the fatigue by extension·compression.

(2) Next, record the number of rotations made before breaking of rubber tube-type standard test piece prepared similarly to rubber tube-type test piece ([11]) using standard tire code ([6]).

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In both cases of rubber tube-type test piece and rubber tube-type standard test piece, carry out test on 6 test pieces respectively, calculate durability percentage by extension·compression, and calculate the average of 6 results.

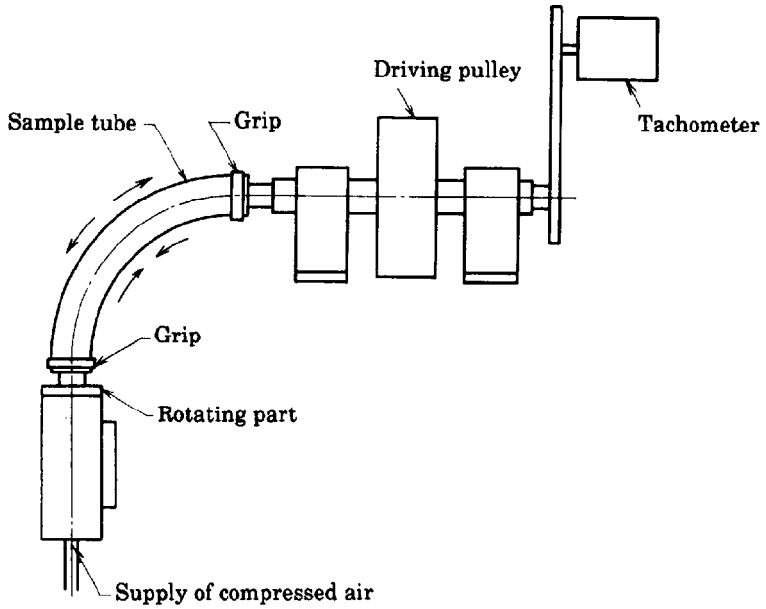
$$N_r = \frac{NR_e}{NR_c} \times 100$$

where, N_r: durability percentage by extension·compression (%)

NR_e: number of rotations of sample cord

NR_c: number of rotations of standard cord

Informative reference 1 Fig. 6. Extension·compression fatigue tester of Goodyear method



Notes (11) Prepare a rubber tube-type test piece according to the following procedures.

Its structural drawing is shown in Informative reference 1 Fig. 7.

(1) Make a test piece into a rubberized cord using a lapping drum.

(2) Wind rubber sheet on an axle core to get 2.1 cm in diameter using a rubber applier, then adhere rubberized cord on it, and further wind rubber sheet to get 2.5 cm in diameter.

(3) Then, wind lap cord using a spiral lapping device, transfer it to a rubber applier, and wind rubber sheet to get 2.75 cm in diameter.

Additionally, wind lapping tape on both ends.

(4) Press-vulcanize the produced at (3), and make its length 24.1 cm.

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(12) Subject it to a preflex machine for 2 min to give the sample preliminary treatment, and attach it to tester after bending by 90°.

(13) Test conditions shall be as follows.

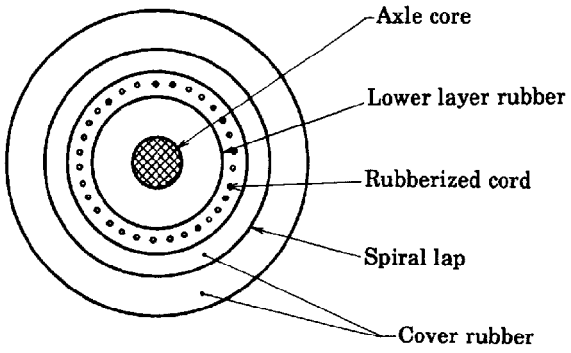
(1) Inner pressure 0.34 MPa

Remarks: For the time being, the instrument equipped with traditional units may be used for confirmation of pressure.

In this case, pressure shall be as 3.5 kgf/cm^2.

(2) Number of rotations 850 rpm, providing that the direction of rotation be changed every 30 min.

Informative reference 1 Fig. 7. Construction of rubber tube-type test piece



2.2.2 Fatiguing strength with disc-type tester (Goodrich method) The test for fatiguing strength with a disc-type tester (Goodrich method) shall be as follows.

(1) Employ the disc-type fatiguing strength tester shown in Informative reference 1 Fig. 8, attach the rubber block (14), in which a test piece has been buried, on the periphery of 2 discs which have eccentric rotating shaft axis in order to give the block the specified extension percentage and compression percentage (follow the agreement between the parties concerned with delivery).

Note (14) This is a rubber block measuring 5.0 cm to 8.0 cm in length and 1.0 cm to 1.5 cm in width and thickness, and contains a test piece in central position of longitudinal direction.

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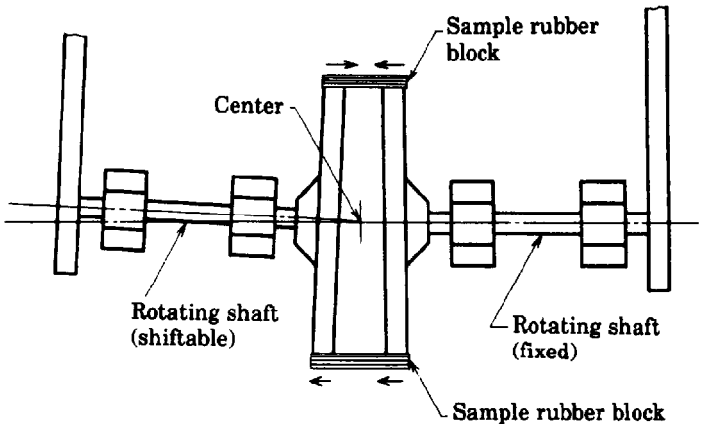
Informative reference 1 Fig. 8. Disc-type fatiguing strength tester



(2) Then, rotate it for 24 h to 72 h ([15]) with 1800 rpm to 2800 rpm at specified temperature ([16]), remove the test piece from the rubber block, and test its strength according to 7.5 (2) of this Standard.

Notes ([15]) This shall be subjected to agreement between the parties concerned with delivery within the range from 24 h to 72 h.

([16]) It shall follow the agreement between the parties concerned with delivery.

(3) Calculate durability percentage by compression·bending according to the following formula.

$$NF_r = \frac{T_d}{T_c} \times 100$$

where, NF_r: durability percentage by compression·bending (%)

T_c: breaking strength of test piece taken from untreated rubber block (N)

T_d: breaking strength of test piece taken from treated rubber block (N)

3. Adhesive strength

3.1 T test (method A) T test (method A) shall be carried out as follows.

(1) After cord has been treated with adhesive, put it into a light resistant container (for instance, black polyethylene bag) for protecting its adhesive property, seal it closely, then take 10 samples which have been kept at standard temperature, stretch the cord, while applying load, over the unvulcanized rubber embedded in a grooved vulcanization plate, cover it closely with unvulcanized rubber, and then vulcanize it with the test piece securely held not to move. Then prepare 10 embedded test pieces ([17]).

Note ([17]) The shape of embedded test piece is shown in Informative reference 1 Fig. 9.

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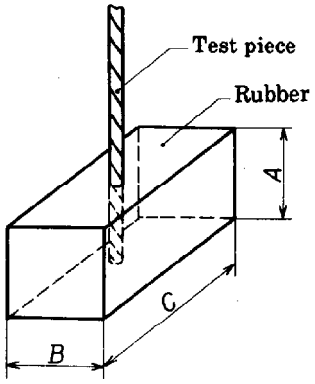
Informative reference 1 Fig. 9. Shape of embedded test piece



A : Length of cord embedded in rubber 5.0 mm to 10.0 mm

B : Width of embedded test piece 5.0 mm to 12.5 mm

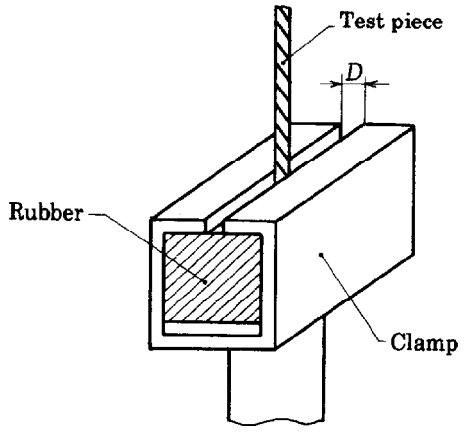
C : Length of embedded test piece 10.0 mm or more

(2) Measure adhesive strength after at least 30 min standing in standard condition from the completion of vulcanization.

(3) In laboratory kept in standard condition, pull out cord from the embedded test piece at the rate of, principally, 100 mm/min or 350 mm/min using a tensile tester equipped with a clamp ([18]) for pull-out test, and measure the maximum stress to the nearest 1 N.

Note ([18]) The appearance that an embedded test piece was set in a clamp for pull-out test is shown in Informative reference 1 Fig. 10.

Informative reference 1 Fig. 10. Embedded test piece set in a clamp for pull-out test



D : Slit width of clamp for pulling out 1.0 mm to 2.0 mm

Remarks: For the time being, the tensile tester in which stress is expressed with traditional unit may be used. In this case, the maximum stress shall be converted by the rate of 1 kgf = 9.80665 N, and then it be rounded off to get whole number according to JIS Z 8401.

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(4) Calculate the average of 10 measured values, and round it off to get whole number according to JIS Z 8401.

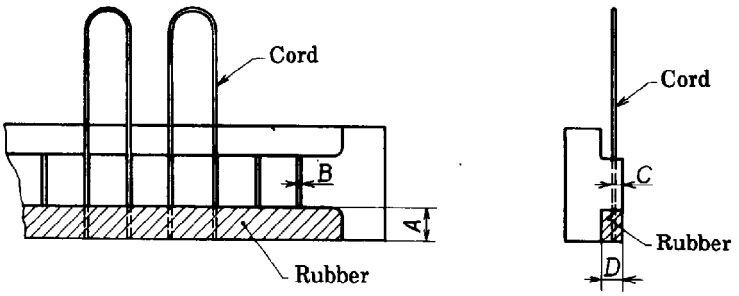
Remarks: On the record, such test conditions shall be annexed without fail, (as length of rubber embedded, width of embedded test piece, width of slit, tension speed, test temperature during pulling out, name of the rubber compound, conditions for vulcanization).

3.2 U test (method B) U test (method B) shall be carried out as follows.

(1) Stretch cord by applying a load on unvulcanized rubber ([20]) which has been previously embedded in a metal support ([19]) for embedded test piece, cover it with unvulcanized rubber, vulcanize it while the cord is being kept steady, and prepare embedded test piece.

Notes ([19]) The shape of metal support for embedded test piece, in which embedded sample has been prepared, is shown in Informative reference 1 Fig. 11.

Informative reference 1 Fig. 11. Shape of metal support for embedded test piece



A : Length of cord embedded in rubber 6.4 mm

B : Width of groove of metal support for embedded test piece 0.8 mm to 1.3 mm

C : Depth of groove of metal support for embedded test piece 1.6 mm to 1.8 mm or more

D : Thickness of rubber in embedded test piece 2.7 mm to 2.8 mm

([20]) The unvulcanized rubber shall be 1.9 mm thick for adhesive test of which one side is lined with adhesively treated plain weave that consists of nylon 940 dtex/1 in both warp and weft with a count of 30 per 5 cm.

(2) Measure adhesive strength after at least 30 min standing in standard condition from the completion of vulcanization.

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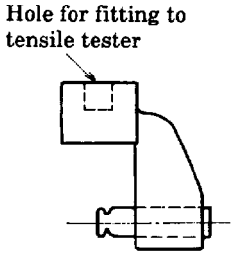
(3) Then, employ the tensile tester equipped with a hooking device ([21]) for pull-out test, and with a fixing device ([22]) for an embedded test piece having heating apparatus, preheat an embedded test piece of which preheating part is to be at, principally, 125°C for 3 min, immediately transfer it into a room for embedded test piece, pull out cord from the embedded test piece at the pull rate of 100 mm/min or 350 mm/min, and measure the maximum stress to the nearest 1 N.

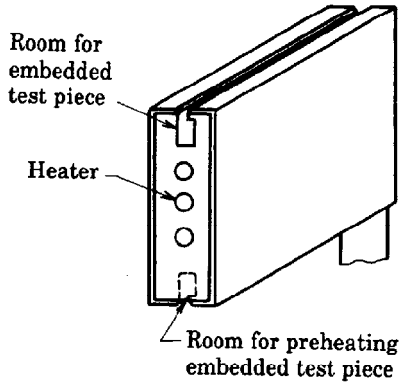
Notes ([21]) Hooking device is shown in Informative reference 1 Fig. 12.

Informative reference 1 Fig. 12. Hooking device



([22]) The fixing device for embedded test piece is shown in Informative reference 1 Fig. 13.

Informative reference 1 Fig. 13. Fixing device for embedded test piece



(4) Calculate the average of 10 measured values, and round it off to get whole number according to JIS Z 8401.

Remarks: On the record, such test conditions shall be annexed without fail (as length of rubber embedded, width of embedded test piece, width of slit, rate of pulling out, test temperature during pulling out, name of the compoundings in rubber, conditions for vulcanization).

4. Dissolving method by dip pickup (case of aramid) Cut about 3 g of specimen to make 5 mm long or less, unweave sufficiently them, transfer them into a dryer at 105 ± 2°C, allow it to stand until it get constant weight, cool them in a desiccator, and weigh accurately the mass. Put it into a 300 ml beaker, add about 50 ml of concentrated sulfuric acid, allow it to stand at room temperature for about 8 h while stirring it. Filtrate it through the glass filter (1G2 or the corresponding to it) whose mass is known.

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Wash 3 times the residue with 25 ml of concentrated sulfuric acid. Then, wash 4 times with each 25 ml of warm water at about 60°C. Moreover, wash 3 times the residue with 25 ml of 5% sodium carbonate solution, finally wash it with each 25 ml of warm water at about 60°C, 4 times, and filtrate it.

Transfer the glass filter containing the residue into a dryer at 105 ± 2°C, allow it to stand until it gets constant weight, and weigh accurately its mass after cooling in a desiccator. Calculate dip pickup according to the following formula, obtain the average of 2 measured values, and round it off to get the first decimal place according to JIS Z 8401.

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

where, D_i : dip pickup (%)

m : absolute dry mass of specimen (g)

m' : absolute dry mass of residue (g)

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Informative reference 2 Marking method for dealing of tire cord fabric

This Informative reference describes the marking method for dealing of tire cord fabric, and is not a part of this Standard.

1. Marking of tire cord fabric Each roll of tire cord fabric is marked with the following items. The items from (4) to (11), however, may be omitted.

(1) Mass

(2) Width

(3) Length

(4) Mass per unit area

(5) Cord density

(6) Total number of cords

(7) Density of weft

(8) Structure of cords

(9) Structure of weft

(10) Weft structure of tabby

(11) Weft density of tabby

(12) Length of tabby

2. Marking method Marking method is as follows.

(1) Mass Measure mass under ordinary condition, find official regain of each material making use of the moisture percentage in this time, calculate the corrected mass, which has been converted, to the nearest 0.1 kg, round it off to whole number according to JIS Z 8401, and mark this value.

(2) Width Measure the width of several points to the nearest 0.1 cm, obtain their average, round it off to whole number according to JIS Z 8401, and mark this value.

(3) Length Measure length to the nearest 0.1 m, round it off to whole number according to JIS Z 8401, and mark this value.

(4) Mass per unit area Calculate area by multiplying width by length, divide the mass by this area, convert it into grams per 1 m^2, round it off to whole number according to JIS Z 8401, and mark this value.

(5) Cord density Divide total number of cords by width, convert it into number per 5 cm, round it off to the first decimal place according to JIS Z 8401, and mark this value.

(6) Total number of cords Mark the total number of cords.

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(7) Density of weft Measure counts of weft at intervals of 25 cm at several points, obtain the density per 5 cm, calculate their average, and round off the figure in the first decimal place by counting fraction of 0.3 or more as a unit and discarding 0.2 or less, and mark this value.

(8) Structure of cords Mark the nominal fineness, number of single yarns, and number of doubling of the original yarns which are composing cord.

(9) Structure of weft Mark the thickness of weft and number of doubling.

(10) Weft structure of tabby Mark the thickness of weft of tabby and number of doubling.

(11) Weft density of tabby Divide the counts of weft of tabby by width of tabby, convert it to the number per 5 cm, round it off to whole number according to JIS Z 8401, and mark this value.

(12) Length of tabby Measure the length of tabby at the vicinity of its center and of both selvages to the nearest 0.1 cm, calculate their average, round it off to whole number according to JIS Z 8401, and mark this value.

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