

JIS

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JAPANESE INDUSTRIAL STANDARD

Testing Methods for Man-Made
Filament Yarns

JIS

L1013-1981



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Translated

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JAPANESE INDUSTRIAL STANDARD

J I S

Testing Methods for Man-Made Filament Yarns L 1013-1981
(Reaffirmed: 1987)

1. Scope

This Japanese Industrial Standard specifies testing methods for man-made filament yarns. However, except bulky finished yarns and other special yarns.

Remark: In this Standard the units and numerical values shown in { } are in accordance with the International System of Units (SI) and are appended for informative reference.

2. Definitions

For the purpose of this Standard following definitions apply:

- (1) standard condition of test room The condition of standard temperature and humidity of Class 2 (temperature $20 \pm 2^{\circ}\text{C}$, relative humidity $65 \pm 2\%$) of JIS Z 8703.
- (2) standard condition of sample The condition where preliminarily drying is carried out in a dryer at a temperature of $40 \pm 5^{\circ}\text{C}$ and after making moisture content not more than the official regain, left in a test room or apparatus at standard condition to be moisture equilibrium.

- Remarks
1. In the case of viscose rayon, cuprammonium rayon, acetate, the drying temperature shall be $65 \pm 5^{\circ}\text{C}$.
 2. In the case of promix, and synthetic fibers, these shall be left in test room or apparatus for not less than 24 h for the length of yarns to be stabilized.
 3. For fibers of 0 % in official regain, preliminarily drying shall not be carried out.

- (3) moisture equilibrium The condition of sample in the case where the sample is left at a definite condition of test room, weighed in mass at interval of not less than 1 h, and when the difference of masses before and after has become within 0.1 % of the after mass.
- (4) absolute dry condition of sample The condition when the sample is left in dryer of hot wind at a temperature of $105 \pm 2^{\circ}\text{C}$ to be constant quantity.

Remark: Concerning fibers of 0 % in official regain, take the standard condition as the absolute dry condition.

Applicable Standards and Reference Standards: See pages 49 and 50.

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- (5) absolute dry mass The mass at absolute dry condition.
- (6) constant mass condition The condition in the case where it is heated at definite conditions in dryer or the like, its mass is weighed at intervals of not less than 15 min and the mass difference before and after it, has become within 0.1 % of the after mass.
- (7) constant mass The mass when made constant mass condition.
- (8) official regain The moisture regain specified officially.
- (9) corrected mass The absolute dry mass added by mass equivalent to official regain.
- (10) fineness The unit to express thickness of fiber. The fineness used in this Standard shall be as follows:
 - (a) denir The mass per 9000 m in length expressed by number of grams.
 - (b) tex The mass per 1000 m in length expressed by number of grams. 1 denir corresponds to 0.11 tex.
- (11) apparent fineness Fineness at optional condition.
- (12) fineness at corrected mass The fineness at the condition containing moisture corresponding to the official regain.
- (13) initial load The load of such degree that the yarn becomes linear without elongation.

3. Marking of Fineness, Number of Filaments and Twist

3.1 Marking of Fineness The fineness shall be marked as follows:

- (1) In the Case of Using Denir

120 denir 120 D

- (2) In the Case of Using Tex The marking shall be in accordance with 7. Marking Method of JIS L 0101.

3.2 Marking of Number of Filaments The number of filaments shall be marked as follows:

- (1) Number of filaments 24 24 F

3.3 Marking of Twists

3.3.1 The direction of twists shall be marked by S and Z as shown in Fig. 1.

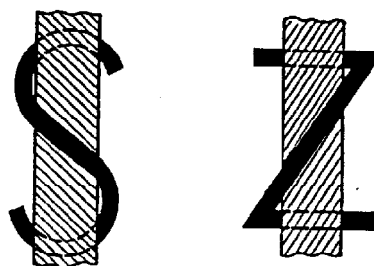
S S twist

Z Z twist

Fig. 1

S twist

Z twist



3.3.2 The number of twists shall be marked by numerical value between 1 m and, appended with the unit.

Example: 40 T/m

3.3.3 In the case where both the number of twists and the direction of twist are marked, these shall be marked as follows:

Example: S 40 T/m, Z 60 T/m

4. Preparation of Sample

The sample to be used for test⁽¹⁾ to be influenced by temperature and humidity, shall be skein⁽²⁾ or single yarn and it shall be in the standard condition before test. However, the sample to be used for moisture regain and adhering moisture regain, a suitable amount from the raw sample shall be taken quickly and, stored in a tightly sealed device.

Notes ⁽¹⁾ The tests to be influenced by temperature and humidity mean the fineness, tensile strength and elongation rate, knot strength, loop strength, impact strength, elongation elastic modulus, primary tensile resistance, number of twists, definite length maximum twist number, cross-linking degree, shrinkage percentage, etc.

⁽²⁾ In case where hank is difficult, the skein may be sampled directly from cake, burn, cheese, cone, etc. However, samples to be used for tests of number of twists and definite length maximum twist number shall be taken directly.

Remark: In case where the test room or apparatus in standard condition is in possible to be used, place the sample in a tightly sealed container (containing 36 % sulfuric acid) to be at a constant temperature ($20 \pm 2^\circ\text{C}$). In this case, append the effect.

5. Test Conditions

5.1 Test Place The test⁽¹⁾ influenced by temperature and humidity shall be carried out in a room at the standard condition.

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Remark: In case where the test⁽¹⁾ influenced by temperature and humidity is carried out in a place other than test room at the standard condition, the temperature and humidity at the time of test shall be appended.

5.2 Absolute Dry Mass In the case of obtaining absolute dry mass, the infrared dryer, high frequency dryer, reduced pressure dryer, etc. may be used. In this case, the conditions shall be appended.

Further, in the case of fibers sensitive to temperature, a temperature lower than 105°C shall be used and, appended.

5.3 Official Regain The official regains relative to absolute dry mass shall be as shown in Table 1, respectively.

Table 1

Kind of fiber	Official regain %
Rayon	11.0
(polynosic)	11.0
Cuprammonium rayon	11.0
Acetate	6.5
(Triacetate)	3.5
Promix	5.0
Nylon	4.5
Vinylnon	5.0
Vinylidene	0
Polyvinyl chloride	0
Polyester	0.4
Polyethylene	0
Polypropylene	0
Acrylic	2.0
Benzoate	0.4

5.4 Initial Load The following load shall be used.

Rayon, cuprammonium rayon, acetate

At standard time number of grams of 1/30 of marked denir
number {2.94 mN of marked tex number}

At wet time number of grams of 1/60 of marked denir
number {1.47 mN of marked tex number}

Promix, nylon, vinylnon, polyvinyl
chloride, polyester, polyethylene,
polypropylene, acrylic, benzoate

At standard time, at wet time number of grams of 1/30 of
marked denir number {2.94 mN
of marked number of tex}

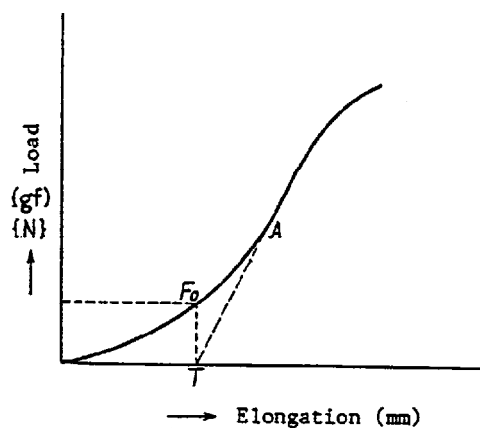
Vinylidene

At standard time, at wet time number of grams of 1/40 of
marked denir number {2.21 mN
of marked tex number}

However, in case where this load is not suitable, draw the initial load-extension curve as shown in Fig. 2, draw a vertical line from point T of intersecting point of tangent at point A of the maximum of load variation relative to elongation variation at nearly origin (the maximum point of tangential angle) and use the load corresponding to point F_0 at intersecting with load-extension curve.

Remark: This applies to tests of tensile strength and elongation percentage, knot strength, loop strength, extension elastic modulus, initial tensile resistance, shrinkage percentage, etc.

Fig. 2



5.5 Measurement of Temperature and Humidity For measurement of temperature and humidity, the Meteorological Agency type or Assmann psychrometer specified in JIS Z 8806 shall be used, and the relative humidity, obtained according to the humidity table of Sprung type.

6. Test Items

The test items shall be as follows:

- (1) Moisture regain and percentage of free water
- (2) Equivalent moisture regain
- (3) Fineness based on corrected mass
- (4) Number of filaments
- (5) Tensile strength and elongation percentage
- (6) Knot strength

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- (7) Loop strength
- (8) Impact strength
- (9) Extension elastic modulus
- (10) Initial tensile resistance
- (11) Number of twists
- (12) Definite length maximum twist number
- (13) Cross-linking degree
- (14) Specific gravity and density
- (15) Shrinkage percentage
- (16) Melting point and heat shrinkage temperature (applies to synthetic fibers)
- (17) Weather resistance
- (18) Light resistance
- (19) Medicine resistance
- (20) Whiteness
- (21) Glossiness
- (22) Ash content
- (23) Titanium oxide
- (24) Solvent extract content
- (25) Skin ratio (applies to rayon)
- (26) Sulfur content (applies to rayon)
- (27) Average degree of polymerization (applies to rayon, cuprammonium rayon)
- (28) Degree of acetization (applies to acetate)
- (29) Level dyeing property (applies to rayon, cuprammonium, acetate)
- (30) Colour fastness

7. Testing Methods7.1 Moisture Regain and Percentage of Free Water

7.1.1 Moisture Regain Take the sample about 20 g, weigh its mass and absolute dry mass, and calculate the moisture regain (%) according to the following formula. Carry out the test twice, and express by the average value (to one place of decimal).

$$\text{Moisture regain (\%)} = \frac{W - W'}{W'} \times 100$$

where W : mass of sample at taking (g)

W' : absolute dry mass of sample (g)

7.1.2 Percentage of Free Water Take the sample about 20 g, weigh its mass and mass in the standard condition, and calculate the percentage of free water (%) according to the following formula. Carry out the test twice, and express by the average value (to one place of decimal).

$$\text{Percentage of free water (\%)} = \frac{W - W'}{W'} \times 100$$

where W : mass of sample at taking (g)

W' : mass of sample at standard condition (g)

- Remarks 1. In the case of sample other than skein, at the time of sampling, remove the outer layer part of about 1/50 of its mass.
2. In the case of fibers other than 0 % in official regain, use the moisture regain, and in the case of fibers of 0 % in official regain, use the percentage of free water.

7.2 Equivalent Moisture Regain After reaching the equivalent moisture, take the sample about 5 g, weigh its mass and absolute dry mass and calculate the equivalent moisture regain (%) according to the following formula. Carry out the test twice, and express by its average value (to one place of decimal).

$$\text{Equivalent moisture regain (\%)} = \frac{W - W'}{W'} \times 100$$

where W : mass of sample at taking (g)

W' : absolute dry mass of sample (g)

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7.3 Fineness Based on Corrected Mass Apply a definite load⁽⁴⁾ to the sample by using a sizing reel⁽³⁾ of 1.125 m in frame periphery, wind return at a speed of 120 turns/min to make a small skein of a definite yarn length⁽⁵⁾, weigh the mass and obtain the apparent fineness. Calculate the fineness based on corrected mass (D) by using separately measured equilibrium moisture regain according to the following formula. Carry out the test by 5 times, and express by the average value (to one place of decimal).

$$\text{Fineness based on corrected mass (D)\{tex\}} = D \times \frac{100+R_e}{100+R_o}$$

where D : apparent fineness (D)\{tex\}

R_o : official regain (%)

R_e : equivalent moisture regain (%)

Notes (3) A winding-return machine having equivalent performance may be used.

(4) The load given in Table 2 shall be used.

(5) The yarn length shall be that given in Table 3.

Table 2

Kind of fiber Thickness of fiber	Rayon, cuprammonium rayon	Acetate	Promix, synthetic fiber (except vinylidene)	Vinylidene
40 D{4.4 tex} max.	5 gf{ 49 mN}	2 gf{19.6 mN}	1/10 to 1/30 gf of marked denir number {8.82 to 2.94 mN of marked tex number}	About 1/40 gf of marked denir number {about 2.21 mN of marked tex number}
Over 40 D{4.4 tex} up to and including 75 D{8.4 tex}	10 gf{ 98 mN}	3 gf{29.4 mN}		
Over 75 D{8.4 tex} up to and including 150 D{16.7 tex}	20 gf{196 mN}	5 gf{49 mN}		
Over 150 D{16.7 tex}	30 gf{294 mN}	10 gf{98 mN}		

Table 3

Kind of fiber Thickness of fiber	Rayon, cuprammonium rayon, acetate	Promix, synthetic fiber
20 D{2.2 tex} max.	450 m	900 m
Over 20 D{2.2 tex} up to and including 210 D{23 tex}	450 m	450 m
Over 210 D{23 tex} up to and including 410 D{46 tex}	180 m	180 m
Over 410 D{46 tex}	90 m	90 m

- Remarks 1. In the case of obtaining coefficient of variation of fineness, the number of test times shall be 20 times.
2. Concerning the fiber of 0 % in official regain, the apparent fineness shall be taken as the fineness based on corrected mass.

Simple Method Apply initial load to take 20 samples of correctly 90 cm in length, weigh the absolute dry mass and calculate the fineness based on corrected mass (D) according to the following formula. Carry out the test twice, and express by the average value (to integer place).

Fineness based on corrected mass (D){tex}

$$= 9000 \times \frac{W}{L} \times \frac{100+R_e}{100} \left\{ 1000 \times \frac{W}{L} \times \frac{100+R_e}{100} \right\}$$

where

L : length of sample (m)

W : absolute dry mass of sample (g)

R_e : official regain (%)

Remark: Concerning the fiber of 0 % in official regain, obtain the fineness based on corrected mass according to the following formula:

Fineness based on corrected mass (D){tex}

$$= 9000 \times \frac{W}{L} \left\{ 1000 \times \frac{W}{L} \right\}$$

7.4 Number of Filaments Number of filaments constituting the yarn shall be counted.

7.5 Tensile Strength and Elongation Percentage

7.5.1 Test at Standard Time In a condition where the sample is stretched loosely, attach to grip of tensile testing machine, and carry out the test under either conditions of Table 4. Read the elongation when the initial load is applied as loosening (mm), further pull the sample to measure the load (gf){N} and elongation (mm) when the sample is broken, and calculate the tensile strength (gf/D){N/tex} and elongation percentage (%) according to the following formula. Carry out the test by specified number of times⁽⁶⁾, and express by the average value (for tensile strength, to the two places of decimals, and for elongation percentage, to one place of decimal).

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Table 4

Type of test- ing machine	Grip interval	Tensile speed
Definite speed stretching type	50 cm	50 ± 3 cm/min
	25 cm ⁽⁷⁾	30 ± 2 cm/min
	30 cm	30 ± 2 cm/min
Definite speed load type	25 cm ⁽⁷⁾	In the case of 10 kgf{ 98 N} in capacity, 10 kgf/20 s, { 98 N/20 s} In the case of 20 kgf{196 N} in capacity, 20 kgf/20 s, {196 N/20 s}
Definite speed extension type	20 to 50 cm	Extension speed of about 100 % or about 50 % of grip interval per minute
	25 cm ⁽⁷⁾	30 ± 2 cm/min

$$\text{Tensile strength (gf/D)\{N/tex\}} = \frac{SD}{d}$$

where SD : strength at rupture (gf)\{N\}

d : fineness based on corrected mass (D)\{tex\}

$$\text{Elongation percentage (\%)} = \frac{E_2 - E_1}{L + E_1} \times 100$$

where E_1 : loosening (mm)

E_2 : elongation at rupture (mm) or elongation at the
maximum load (mm)

L : grip interval (mm)

Notes ⁽⁶⁾ For rayon, cuprammonium rayon 30 times, and for others, 10 times.

⁽⁷⁾ This applies to filament yarn of thick fineness such as
tire cord raw yarn.

- Remarks 1. Carry out the test under either conditions of the above-mentioned, and append the type, capacity, grip interval and tensile speed of used testing machine.
2. By attaching to grips in the condition where the sample is applied with the initial load, the test may be carried out. In this case, the loosening becomes 0 mm.
3. In the case required, carry out the test by adjusting the speed so that the time until rupture becomes 20 ± 3 s.

4. In the case where the breaking strength is not the highest strength (that is in the case where the breaking strength is smaller than the highest strength), measure the highest strength and the elongation at the time.
5. In case where the yarn is broken at grip part at the test, except the test.
6. In the case of multifilament of thick fineness such as tire cord raw yarn without twist, measure by applying 8 times twisting per 10 cm.

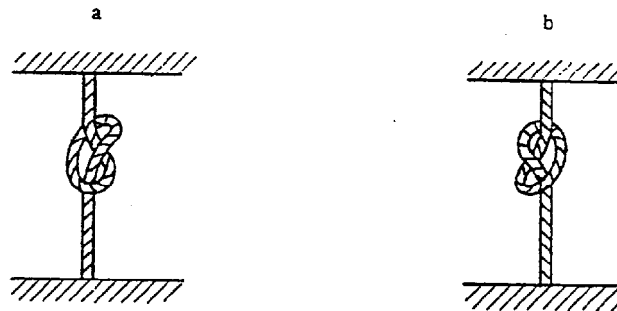
7.5.2 Wet Time Test Put the sample into a separately provided container, immerse in water ($20 \pm 2^\circ\text{C}$) for a specified time⁽⁸⁾ to wet sufficiently, and thereafter obtain the tensile strength (gf/D){N/tex} and elongation percentage (%) by the similar method to 7.5.1 (for tensile strength, to two places of decimals and for elongation percentage, to one place of decimal).

Note ⁽⁸⁾ The immersion time shall be not less than 2 min for rayon, acetate, and, not less than 30 min for promix, synthetic fiber.

7.6 Knot Strength

7.6.1 Standard Time Test Make knot at the middle of grips of sample as shown in Fig. 3 in the similar conditions to 7.5.1, measure the strength at breaking (gf){N}, and express by the average value (to integer place).

Fig. 3



- Remarks 1. In case where the yarn is broken at a part other than knot part at the time of test, except the test.
2. Because in the case of matter other than filament the knot strength is different according to the knotting methods as shown in a, b of Fig. 3, carry out the test on both knotting methods of a and b to average.

7.6.2 Wet Time Test Put the sample into a separately provided container, immerse in water ($20 \pm 2^\circ\text{C}$) for a specified time⁽⁸⁾ to be wet sufficiently, and thereafter obtain the knot strength (gf){N} according to the method similar to 7.6.1 (to integer place).

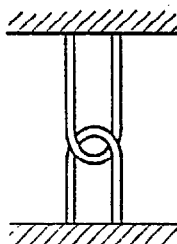
Remark: This applies mainly to synthetic fibers.

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7.7 Loop Strength

7.7.1 Standard Time Test Make loops at the middle between grips of sample as shown in Fig. 4 under conditions similar to 7.5.1, measure the strength at breaking (gf){N}, and express by the average value (to integer place).

Fig. 4



Remark: In case where the yarn is broken at a part other than loop part at the time of test, except the test.

7.7.2 Wet Time Test Put the sample into a separately provided container, immerse into water ($20 \pm 2^\circ\text{C}$) for a specified time⁽⁸⁾ to wet sufficiently, and thereafter obtain the loop strength (gf){N} according to the method similar to 7.7.1 (to integer place).

Remark: This applies mainly to synthetic fibers.

7.8 Impact Strength By using a pendulum type impact testing machine, let the distance between the grips be 25 cm, fall down the impact pendulum from an angle of 60° , measure the rising angles of impact pendulum in counter direction in respective cases of using no sample and of using sample, and calculate working amount (gf x cm){J} for impact breaking according to the following formula. Carry out the test by 10 times, and express by the average value (to one place of decimal).

$$\text{Impact breakage working amount (gf x cm)} = fl(\cos \alpha - \cos \alpha_0)$$

$$\text{Impact breakage working amount \{J\}} = 9.8 \times 10^{-5} fl(\cos \alpha - \cos \alpha_0)$$

where

l : distance between the centre of gravity and strut (cm)

α_0 : rising angle of pendulum in the case of no sample

α : rising angle of pendulum in the case of breaking the sample

f : gravity to impact pendulum (gf)

Remarks 1. Except the case where the yarn has been broken at the gripping part the time of test.

2. This applies mainly to synthetic fibers.

7.9 Extension Elastic Modulus

Method A Attach the sample at a definite grip interval⁽⁹⁾ under the condition where initial load is applied by using a definite extension type tensile testing machine with a self-recording apparatus, and extend until 3 %⁽¹⁰⁾ at a tensile speed of 10 % or 50 % of grip interval per minute. Immediately, remove the load at the same speed, and after standing as it is for 2 min, again extend to a definite elongation at the same speed. Measure the remaining elongation from the recorded load-extension curve (Fig. 5) and calculate the extension elastic modulus (%) according to the following formula. Carry out the test 5 times, and express by the average value (to integer place).

$$\text{Extension elastic modulus (\%)} = \frac{l - l_1}{l} \times 100$$

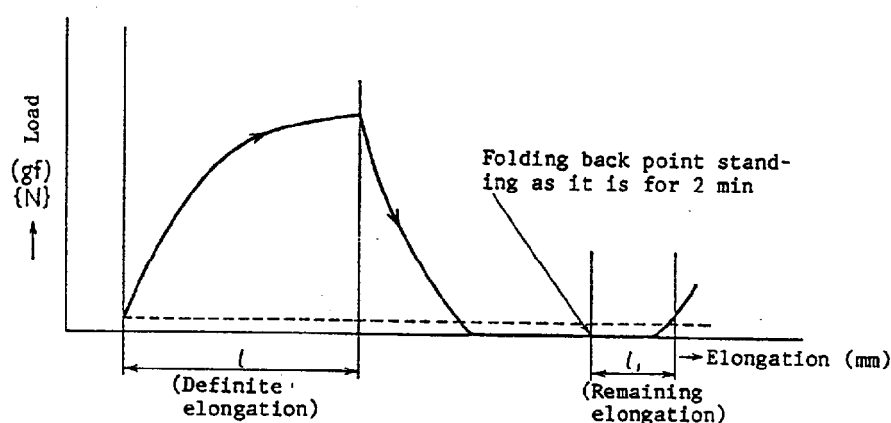
where l : elongation at 3 % extension (mm)

l_1 : remaining elongation (mm)

Notes (9) Rayon, cuprammonium rayon, and acetate shall be 50 cm, and promix and synthetic fiber, 20 cm.

(10) As required, it may be elongated to extension time of 2 % or 5 %.

Fig. 5

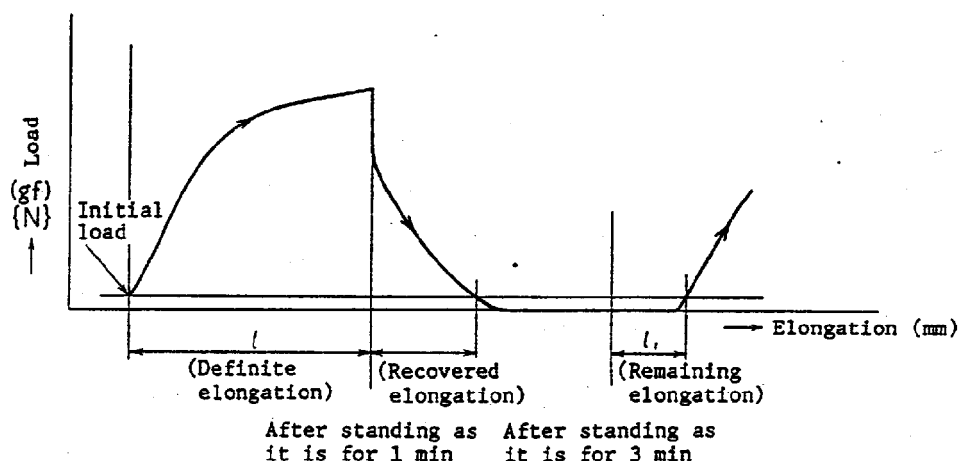


Method B Elongate the sample until 3 %⁽¹⁰⁾ of grip interval with making the grip interval 20 cm under the conditions similar to the Method A. After standing as it is for 1 min, remove the load at the same speed, and after standing as it is for 3 min, again elongate until a definite elongation at the same speed. Measure the remaining elongation from the recorded load-extension curve (Fig. 6), and calculate the extension elastic modulus (%) according to the following formula. Carry out the test 5 times, and express by the average value (to integer place).

$$\text{Extension elastic modulus (\%)} = \frac{l-l_1}{l} \times 100$$

where l : elongation at the time of 3 % extension (mm)
 l_1 : remaining elongation (mm)

Fig. 6



- Remarks 1. The type of test, testing conditions (grip interval, tensile speed, extension percentage) shall be appended.
2. The loading range of recording paper should preferably be at least 50 % of whole graduation when the load is at a definite elongation.
3. The speed of recording paper shall be so decided that a definite elongation corresponds at least to 5 cm on the recording paper.
4. Method A applies to all fibers, and Method B applies mainly to synthetic fibers.

7.10 Initial Tensile Resistance Degree Carry out the test on the sample according to the same method as 7.5.1 to draw load-extension curve as shown in Fig. 7, from this drawing obtain the maximum point A of load variation relative to extension variation at nearly origin (the maximum point of tangential angle), and calculate the initial tensile resistance degree (gf/D) {N/tex} according to the following formula. Carry out the test 10 times, and express by the average value (to integer place).