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**Physical testing methods for
molded products of thermosetting
polyurethane elastomers**

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Physical testing methods for molded products of thermosetting polyurethane elastomers

1 Scope This Japanese Industrial Standard specifies the physical testing methods for molded products of thermosetting polyurethane elastomers⁽¹⁾ (hereafter, referred to as "elastomers").

Note ⁽¹⁾ The molded products of thermosetting polyurethane elastomers mean the whole of casting types containing ordinary temperature setting type or the like.

Remarks 1 The units and numerical values given in { } in this Standard are based on the traditional units and are appended for informative reference.

2 The standard cited in this Standard are shown in Attached Table 1.

2 Definitions For the main terms used in this Standard the definitions in JIS K 6200 and JIS K 6900 apply, and the rest of terms shall be as follows:

(1) **blister** Blister is such a phenomenon that the lining part of rubber, resin, etc. is partially peeled off, accommodates water and expands due to abnormally quick absorption of water and chemicals if the liquid side is at a high temperature and the structural materials of metal or the like is cooled when a temperature gradient exists in the said lining parts.

(2) **abrasive wheel** An abrasive wheel is such one that the abrasive cloth specified in JIS R 6251 is stuck to a disk grindstone or a drum.

The disk grindstone is also called a grinding wheel, which is a kind of abrasives.

(3) **abrading force of abrasive cloth** Abrasive ability of an abrasive cloth used for an abrasion test, which is represented by abraded mass when a reference test piece is abraded with the abrasive cloth.

3 Test items Test items specified in this Standard are as stated below.

- (1) Tensile test
- (2) Tear test
- (3) Hardness test
- (4) Low elongational stress test
- (5) Compression test
- (6) Rebound resilience test
- (7) Hysteresis loss test

- (8) Friction coefficient test
- (9) Tension permanent set test
- (10) Compression permanent set test
- (11) Hardness and tensile tests under high and low temperatures
- (12) Low temperature torsion test
- (13) Low temperature impact brittleness test
- (14) low temperature compression permanent set test
- (15) Air oven aging test
- (16) Resistance to ozone cracking test
- (17) Effect of liquid test
- (18) Adhesion test with structural material of metal or the like
- (19) Accelerated weathering test
- (20) Abrasion test
- (21) Flex cracking test

4 General conditions for test

4.1 Standard condition of test laboratory The standard condition of the test laboratory shall be such that the temperature is $(23 \pm 2) ^\circ\text{C}$ and the relative humidity is desirable to be $(50 \pm 5) \%$. Both of test temperature and test humidity shall be recorded on the test record.

4.2 Sample and test piece The sample and test piece shall be as follows:

- (1) **Storage period of sample** The storage period of samples to be subjected to a test shall, as a rule, be within three months after manufacture.
- (2) **Standard condition of test piece** Test pieces shall, as a rule, be placed in the test laboratory under standard conditions for at least 168 h before the test.

4.3 Sampling and preparation of test piece Test pieces shall, as a rule, be sampled and prepared by the method stated below. However, test pieces in which foreign matters are mixed, bubbles exist, and flaws are found shall not be used for the test.

4.3.1 When test pieces are sampled and prepared from product The procedures for sampling and preparation of test pieces from the product, shall be as stated below.

(1) **Sheet test piece** Sheet test pieces shall be as follows:

- (a) Slice off elastomer layer of a suitable width as flat as possible from a product, and prepare test pieces therefrom.

When a cloth is stuck thereto, cut out sample of a suitable width as the cloth is stuck thereto, and slice off the cloth or peel off by using a knife or other suitable tool so that as little tension is given to the elastomer as possible, and a smooth elastomer surface can be obtained as far as possible.

For a patterned surface, slice off the elastomer layer as flat as possible so that as little tension is given to the elastomer as possible in the similar way as stated above.

When the original thickness of the elastomer layer of the sample is thicker than the thickness of the test piece specified in the appropriate test method, the thickness of the elastomer layer to be sliced off shall be a thickness close to the specified thickness near thereto. When the original thickness of the sample is thinner, it shall be a thickness close to the original thickness. When the cloth is inevitably peeled off by using solvent, use No. 1 gasoline specified in JIS K 2201, leave it at rest for at least 1 h after peeling, and use the test piece after sufficient drying.

- (b) Grind the test piece so as to be as smooth as possible with a grinder on both unsmooth sides.

Carry out grinding so that heat is generated as little as possible, and not too excessively.

- (c) When the test piece is prepared with a punching die, use leather, rubber belt, paper board, or other sheet having resiliency as an underlay, and complete punching by one hit or one action. In that case, punch the test piece after grinding. When previous grinding is impossible, allow to grind after punching.

(2) **Block test piece** Block test pieces shall be as follows:

- (a) Cut off a suitable sized block from a product, and adjust it to a specified thickness. In this procedure, make both upper and lower surfaces parallel to each other.

- (b) Then, cut it out to a specified diameter by using a rotary edge. When the rotary edge is not used, cut it out to a size near the specified diameter by using a knife or the like, and then prepare it to the specified size with a grinding machine so as to minimize generation of heat.

When a cloth is stuck thereto, remove the cloth before cutting out the test piece. Carry out this operation similar to that of 4.3.1 (1) (a).

4.3.2 When test piece is prepared by forming die When a sheet test piece or a block test piece is prepared by a forming die, it shall be prepared by the same forming method and forming condition as those for the test pieces from product as far as possible.

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4.4 Measurement of thickness, width, and diameter The measurement of the thickness, width, and diameter of a test piece shall be as follows:

- (1) The thickness gauge shall be of two kinds i.e. sheet-service one and a block-service one, and shall, as a rule, comply with the requirements given in Table 1. In this case, thickness gauges other than those in Table 1 may be used as agreed upon between the purchaser and supplier.

Table 1 Conditions for thickness gauge

Unit : mm

Items	Kinds	
	For sheet	For block
Shape and dimensions at tip of probe	Columnar shape $\phi 5 \pm 1$	Hemispherical shape $\phi 6 \pm 1$
Pressurizing force of probe and its permissible variation width within measuring range	$0.8 \pm 0.1 \text{ N (82} \pm 10 \text{ gf)}$ $\pm 15\%$	
Shape and dimensions of probe receiving stand	Flat disk about $\phi 40$	Anvil shape $\phi 9.5 \pm 0.5$
Minimum scale of dimension	0.01	

- (2) **Measurement of thickness of test piece** The measurement of the thickness of a test piece shall be as follows:
 - (a) Measure at several positions of the test piece for a sheet one, take the median for odd measuring positions and the mean value of two values between which the center falls for even ones, as its thickness. When the center of the pressurizing surface of the thickness gage is outside the edge of the test piece, preliminarily measure the thickness at that position before punching the test piece, and take it as the thickness of the test piece.
 - (b) For a block one, take the value at a central position of a test piece as the thickness of the test piece.
- (3) For the width of a test piece, use the size of the width (the interior width of an edge) of a punching die as it is.
- (4) For the diameter of a test piece, measure the test piece by using the vernier caliper specified in JIS B 7507 across its center.

4.5 Test temperature The test temperature shall be, as a rule, selected from among those given in Table 2.

The tolerance of the test temperature shall be as specified in the conditions of each test.

Table 2 Test temperature

Unit : °C

-75	, -55,	-40,	-25,	-20,	-10,	0,
23 ⁽²⁾ ,	40,	55,	70,	85,	100,	120

Note (2) This indicates the temperature specified in JIS Z 8703.

4.6 Rounding off of test result The test results obtained by each test shall be rounded off in accordance with JIS Z 8401, and represented by the number of the digits given in Table 3.

Table 3 Rounding off of test results

Test item	Measured value	The result to be obtained
Tensile strength MPa (kgf/cm ²)	Integral place	Integral place
Elongation at break %	Integral place	Two significant figures
Tear strength N/mm (kgf/cm)	One place of decimal	Integral place
Hardness (scale)	Integral place	Integral place
Low elongation stress MPa (kgf/cm ²)	One place of decimal	One place of decimal
Compression strain and compressive stress % and MPa (% and kgf/cm ²)	Integral place	Integral place
Rebound resilience %	Integral place	Integral place
Hysteresis loss %	One place of decimal	One place of decimal
Friction coefficient	Two places of decimals	Two places of decimals
Tensile permanent set %	One place of decimal	Integral place
Compression permanent set %	One place of decimal	Integral place
Low temperature torsion °C	Integral place	Integral place
Impact brittleness temperature °C	Integral place	Integral place
Low temperature compression permanent set %	One place of decimal	Integral place
Cracking length mm	One place of decimal	One place of decimal
Rate of change in mass and volume %	One place of decimal	One place of decimal
Peel strength N/m (kgf/cm)	One place of decimal	One place of decimal
Abrasion loss mg or mm ³	One place of decimal	Integral place

Remarks : The unit symbol and SI unit are based on JIS Z 8202 and JIS Z 8203.

5 Tensile test

5.1 Purpose This test is carried out for measurement of maximum stress which results in breaking of elastomers (hereafter, referred to as tensile strength), elongation at break and stress at specific elongation (hereafter, referred to tensile stress).

5.2 Testing machine The testing machine shall, as a rule, be in accordance with JIS B 7721.

5.2.1 Mechanism of tester A tester shall be equipped with a device indicating maximum tensile force, and an automatically fastening gripper for a dumbbell test piece or a device revolving the test piece while it is stretched for a ring test piece.

5.2.2 Weighing capacity of tester The weighing capacity of the tester shall be such that the maximum tensile force in testing falls within a range of 20 % to 100 % of the weighing capacity.

5.2.3 Pulling speed of tester As for the pulling speed of the tester, the travel speed of the gripper for the test piece shall comply with the requirements specified in 5.4.1 (2).

5.2.4 Diameter of pulley The diameter of the pulley, when a ring test piece is mounted thereto, shall be as follows:

- (1) The pulley diameter for No. 1 ring test piece 25 mm
- (2) The pulley diameter for No. 2 ring test piece 4.5 mm

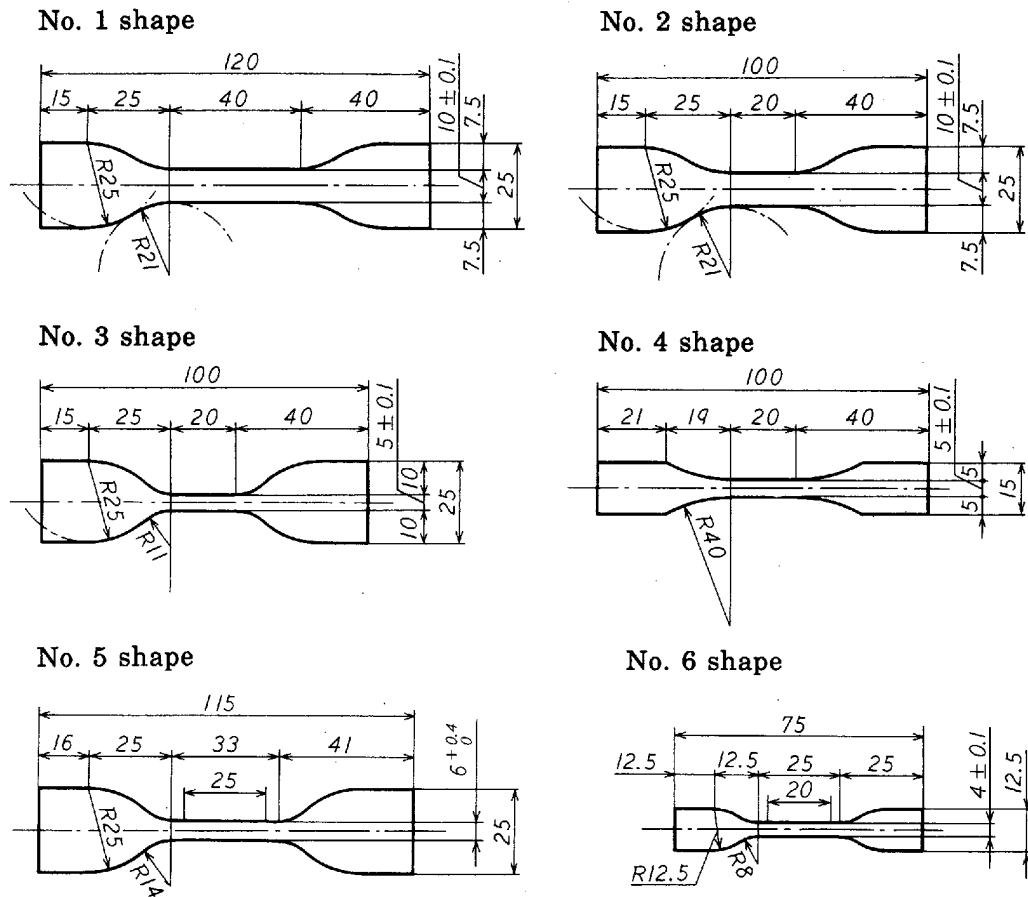
5.2.5 Tolerance on load scale of tester The tolerance on the load scale of the tester shall be ± 1 %.

5.3 Test piece Test pieces shall be as follows:

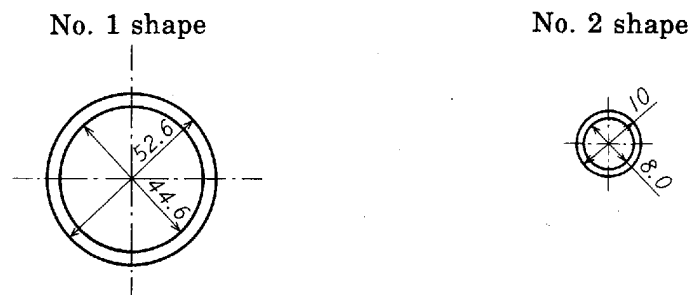
5.3.1 Shape and dimensions of test piece The shape and dimensions of a test piece shall be as given in Fig. 1, Table 4-1, and Table 4-2.

- Remarks
- 1 In dumbbell test pieces, No. 3 test piece and No. 5 test piece shall be the standard test pieces. No. 1 test piece is applicable to samples of little elongation, No. 2 test piece to samples of little tensile strength, No. 4 test piece to samples of at most 1 mm thickness, and No. 6 test piece to samples from which the standard test piece can not be taken because of its narrow width.
 - 2 In ring test pieces, No. 1 test piece shall be the standard test piece. No. 2 test piece is used when the standard test piece can not be sampled.
 - 3 When the specified test pieces can not be taken, strip test piece, filiform test piece or the like may be used subject to agreement between the purchaser and the supplier. In that case, the shape and dimensions of the used test piece shall be recorded.
 - 4 Since the same data can not always be obtained if the shape and dimensions of the test piece are different, the same shaped test piece shall be used for a comparison test.

Unit : mm



(1) Dumbbell test piece



(2) Ring test piece

Fig. 1 Shape and dimensions of tensile test piece

- Remarks 1** The thickness and gauge length of the parallel part of a dumbbell test piece shall be as given in Table 4-1.
- 2** The width and thickness of a ring test piece, and the inner periphery of the test piece shall be as given in Table 4-2.

Table 4-1 Dimensions of dumbbell test piece

Unit : mm

Shape	Dimensions of main parts			
	Width of parallel part	Length of parallel part	Thickness of parallel part	Gauge length
No. 1 shape	10 ± 0.1	40	2.0 ± 0.2	40
No. 2 shape	10 ± 0.1	20	2.0 ± 0.2	20
No. 3 shape	5 ± 0.1	20	2.0 ± 0.2	20
No. 4 shape	5 ± 0.1	20	1.0 max.	20
No. 5 shape	$6^{+0.4}_0$	33	2.0 ± 0.2	25
No. 6 shape	4 ± 0.1	25	2.0 ± 0.2	20

Table 4-2 Dimensions of ring test piece

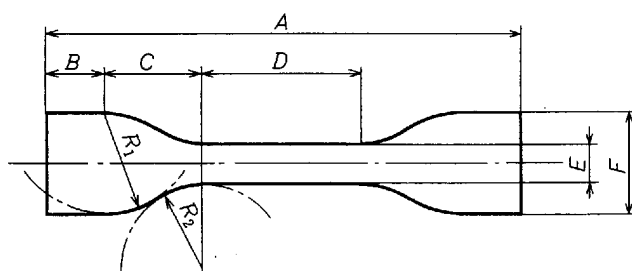
Unit : mm

Shape	Outer diameter	Inner diameter	Width	Thickness	Inner periphery of test piece
No. 1 shape	52.6	44.6	4.0 ± 0.2	4.0 ± 0.2	70
No. 2 shape	10.0	8.0	1.0 ± 0.1	1.0 ± 0.1	12.6

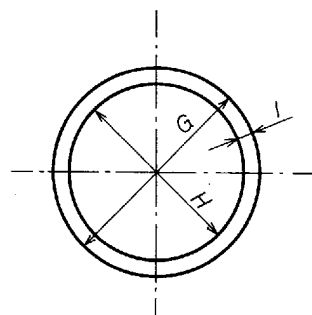
5.3.2 Sampling and preparation of test piece The sampling and preparation of test pieces shall be, as a rule, as described in 4.3.

5.3.3 Number of test pieces The number of test pieces shall be at least three.

5.3.4 Punching die of test piece Various shaped test pieces are given in Fig. 2, Table 5-1, and Table 5-2. The test piece shall be punched with the punching die corresponding to each shape. For a ring test piece, a rotary knife may be used.



(1) Dumbbell test piece



(2) Ring test piece

Fig. 2 Shape of punching die of test piece

Table 5-1 Dimensions of dumbbell punching die

Unit : mm

Shape	Size-measuring position							
	A	B	C	D	E	F	R ₁	R ₂
No. 1 shape	120	15	25	40 ⁺² ₀	10.0±0.1	25.0±0.5	25 ±2.0	21 ±2.0
No. 2 shape	100			20 ⁺² ₀				
No. 3 shape					21	19	15.0±0.5	—
No. 4 shape								
No. 5 shape	115	16	25	33±2	6.0 ^{+0.4} ₀	25.0±1.0	25 ±2.0	14.0±1.0
No. 6 shape	75	12.5	12.5	25±1	4.0±0.1	12.5±1.0	12.5±1.0	8.0±0.5

Table 5-2 Dimensions of ring punching die

Unit : mm

Shape	Size-measuring position		
	G	H	I
No. 1 shape	52.6	44.6	4.0±0.2
No. 2 shape	10.0	8.0	1.0±0.1

Remarks 1 For dimensions of dumbbell *E* and ring *I* given in the Table, deviation of the edge width of the punching die shall not exceed 0.05 mm.

2 The dimension given in the Table without tolerance, means the basic size.

5.3.5 Measurement of thickness and width of test piece The measurement of the thickness and width of the test piece shall be as follows:

- (1) The thickness and width of the test piece shall be measured in accordance with 4.4.
- (2) The sectional area of the test piece shall be calculated according to the following formula:
 - (a) For dumbbell test piece Thickness (mm) × width of parallel part (mm)
 - (b) For ring test piece Thickness (mm) × width (mm)

5.3.6 Bench marks for measuring elongation of test piece The bench marks for measuring elongation (hereafter, referred to "bench marks") shall be marked on a dumbbell test piece by the following method:

- (1) The gauge length shall be as given in Table 4-1.
- (2) The bench marks shall be marked accurately and clearly on the parallel part of the test piece by taking its central part as the center.

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5.3.7 Selection of test piece In the parallel part of dumbbell test piece and in the whole part of ring test piece, test pieces whose deviation of the thickness and/or width exceeding 0.1 mm, shall not be used for the test.

5.4 Test method The test method shall be as follows:

5.4.1 Test conditions The test conditions shall be as follows:

- (1) **Test temperature** The test temperature shall be the temperature specified in 4.1.
- (2) **Pulling speed** The pulling speed shall be as follows:
 - (a) For No. 1 to 6 shape dumbbell test piece (8.3 ± 0.8) mm per second
 - (b) For No. 1 shape ring test piece (5.0 ± 0.5) mm per second
 - (c) For No. 2 shape ring test piece (1.7 ± 0.2) mm per second

Remarks : Pulling speed other than the specified ones may be used subject to agreement between the purchaser and supplier.

5.4.2 Operating methods The operating methods shall be as follows:

- (1) **Mounting of test piece** Mount the test piece correctly and accurately to the gripper so as not to generate distortion, breaking off of the gripper, and other inconveniences in the test.
- (2) **Measurement of tensile strength and elongation at break** For measurement of tensile strength, read the maximum tensile force which appears until the test piece reaches breaking, by using the testing machine of 5.2. For measurement of elongation at break, measure the distance between bench marks at break by a suitable method in the case of a dumbbell test piece. In the case of a ring test piece, measure the distance between grippers at break, and obtain the value corresponding to the gauge length.
- (3) **Measurement of tensile stress** For measurement of tensile stress, in the case of dumbbell test piece, read the tensile force when the distance between bench marks reaches a prescribed length by a suitable method.

In the case of ring test piece, read the tensile force when the test piece is elongated by n % as agreed upon between the purchaser and the supplier.

5.5 Calculation The calculation of tensile strength, elongation at break, and tensile stress shall be as follows:

5.5.1 Tensile strength Calculate the tensile strength of a dumbbell test piece and a ring test piece according to the following formulas (1) and (2).

(1) Dumbbell test piece $T_B = \frac{F_B}{A}$ (1)

(2) Ring test piece $T_B = \frac{F_B}{2A}$ (2)

where, T_B : tensile strength (MPa) {kgf/cm²}
 F_B : maximum tensile force (N) {kgf}
 A : sectional area of test piece (mm²) {cm²}

5.5.2 Elongation at break Calculate the elongation at break of dumbbell test piece and ring test piece according to the following formulas (3) and (4).

$$(1) \text{ Dumbbell test piece } E_B = \frac{L_1 - L_0}{L_0} \times 100 \dots\dots\dots (3)$$

where, E_B : elongation at break (%)
 L_0 : gauge length (mm)
 L_1 : distance between bench marks at break (mm)

$$(2) \text{ Ring test piece } E_B = \frac{I_1 - I_0}{I_0} \times 100 = \frac{2I + I_2 - I_0}{I_0} \times 100 \dots\dots\dots (4)$$

where, E_B : elongation at break (%)
 I : travel distance of center of pulley at break (mm)
 I_0 : initial inner periphery of test piece (mm)
 I_1 : inner periphery of test piece at break (mm)
 I_2 : circumference of pulley (mm)

5.5.3 Tensile stress Calculate the tensile stress of dumbbell test piece and ring test piece according to the following formulas (5) and (6).

$$(1) \text{ Dumbbell test piece } M_n = \frac{F_n}{A} \dots\dots\dots (5)$$

$$(2) \text{ Ring test piece } M_n = \frac{F_n}{2A} \dots\dots\dots (6)$$

where, $M_n^{(3)}$: tensile stress at n % elongation (MPa) {kgf/cm²}
 $F_n^{(3)}$: tensile force at n % elongation (N) {kgf}
 A : sectional area of test piece (mm²) {cm²}

Note (3) The (n) in M_n and F_n indicates the numerical value of a specific elongation n (%). For example, M_{300} and F_{300} indicate, respectively, tensile stress and tensile force at 300 % elongation.

5.6 Arrangement of test results The tests for tensile strength, elongation at break, and tensile stress shall be carried out on at least three test pieces, each median⁽⁴⁾ obtained by calculation in 5.5 shall be rounded off in accordance with JIS Z 8401 and the tensile strength and tensile stress shall be expressed by three significant figures and the elongation at break by two figures.

Note (4) The median means the central value, when the measured values arranged in the order of the magnitude are odd number, and the average of two values between which the center falls, when the measured values are even number.

5.7 Record The following items shall be recorded on the test results.

- (1) Tensile strength, elongation at break and tensile stress
- (2) Shape and dimensions of test piece
- (3) Method for sampling and preparation of test piece
- (4) The number of test pieces
- (5) Other necessary items

6 Tear test

6.1 Purpose This test is carried out for measuring the tear strength of elastomer.

6.2 Testing machine A machine shall, as a rule, be in accordance with JIS B 7721.

6.2.1 Mechanism of tester A tester shall be equipped with a device which indicates the maximum tear force and the grippers which fasten automatically the test piece as the tear force increases in the tear test. When a trouser test piece is measured, the tester shall be equipped with the device capable of recording automatically the tear force.

6.2.2 Weighing capacity of tester The weighing capacity of the tester shall be that the maximum tear force in the test falls within a range of 20 % to 100 % of the weighing capacity.

6.2.3 Pulling speed of tester The pulling speed of the tester shall be such that the travel speed of the test piece grippers complies with the requirements specified in (2) of 6.4.1.

6.2.4 Tolerance of tester The tolerance on the tear force scale of the tester shall be ± 2 % of each indicated value.

Remarks: The tester of grade 2 or better specified in 7 of JIS B 7721 shall be used.

6.3 Test piece The test piece shall be as follows:

6.3.1 Shape and dimensions of test piece The shape and dimensions of test pieces shall be (A) crescent test piece, (B) unnicked angle test piece, and (C) trouser test piece as given in Fig. 3.

Remarks 1 For a crescent test piece, cut a notch of (1.0 ± 0.2) mm length normally to the main axis of the test piece at the center of the dent of the test piece. Cut the notch in parallel to the thickness direction of the test piece (vertically to the up and down faces of the test piece) with a sharp cutter or razor blade.

- 2 For a trouser test piece, cut a notch of (40 ± 5) mm in parallel in the long side part at the center of the short side of the test piece. Cut the final about 1 mm of the notch in parallel to the thickness direction of the test piece (vertically to the up and down faces of the test piece) with a sharp cutter or razor blade.
- 3 Since the same data does not always be obtained when the dimensions and shape of a test piece are different, the same formed test piece shall be used in the case of a comparison test.

6.3.2 Sampling and preparation of test piece The sampling and preparation of test pieces shall, as a rule, be as described in 4.3.

6.3.3 Number of test pieces The number of test pieces shall be at least three.

6.3.4 Thickness of test piece The standard thickness of a test piece shall be (2.0 ± 0.2) mm. The thickness shall be measured at three or more positions of the tear part according to 4.4. The thickness of the test piece shall be the median at odd number of positions, and the mean of two values between which the center falls at even number of positions. The test pieces whose deviation in thickness exceeds 0.1 mm shall not be used.

6.4 Test method

6.4.1 Test conditions The test conditions shall be as follows:

- (1) **Test temperature** The test temperature shall be the temperature specified in 4.1.
- (2) **Tear speed** The travel speed of the test piece grippers in the tear test shall be as follows:
 - (a) For crescent test piece (8.3 ± 0.8) mm per second
 - (b) For unnicked angle test piece (8.3 ± 0.8) mm per second
 - (c) For trouser test piece (1.7 ± 0.2) mm per second

6.4.2 Operating method For measurement of tear strength, read the maximum tear force until break of the test piece for crescent test piece and unnicked angle test piece. Record the graph (waveformed curve) showing the relation between the tear force until break of the test piece and the tear time, and obtain the tear force according to Annex 1 from this graph.

6.5 Calculation The tear strength shall be calculated according to the following formula.

$$T_R = \frac{F}{t}$$

where, T_R : tear strength (N/mm) {kgf/cm}
 F : maximum tear force for crescent test piece and
unnicked angle test piece, or tear force obtained by
Annex for trouser test piece (N) {kgf}
 t : thickness of test piece (mm) {cm}

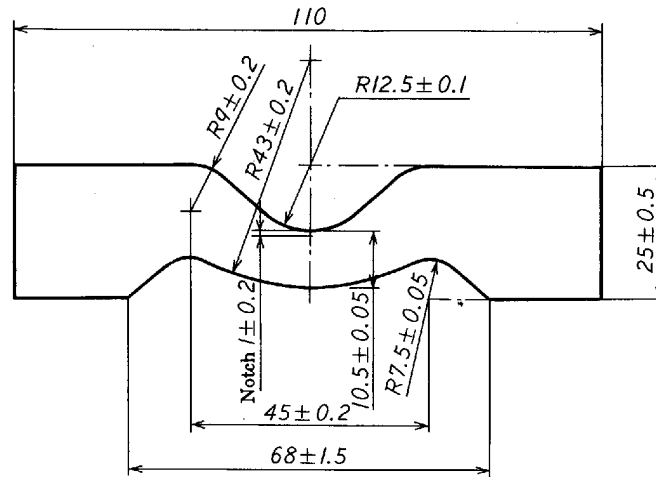
6.6 Arrangement of test results The median⁽⁵⁾ of the values obtained on at least three test pieces shall be rounded off to one place of decimal in accordance with JIS Z 8401, and expressed as the tear strength.

Note (5) The median means the central value, when the measured values arranged in the order of the magnitude are odd number, and the average of two values between which the center falls when the measured values are even number.

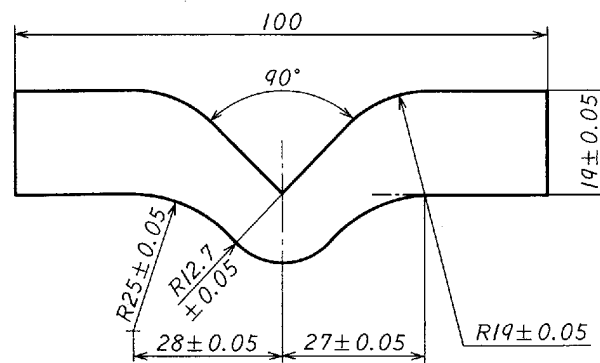
6.7 Record The following items shall be recorded on the test results.

- (1) Tensile strength
- (2) Shape and dimensions of test piece
- (3) Methods for sampling and preparation of test piece
- (4) Number of test pieces
- (5) Other necessary items

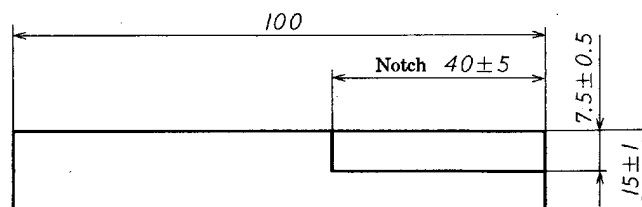
Unit : mm



(A) Crescent form



(B) Unnicked angle form



(C) Trouser form

Fig. 3 Shape and dimensions of test piece

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7 Hardness test

7.1 Purpose The test shall be carried out for measuring the hardness of elastomer.

7.2 Type of test The type of test shall be the spring hardness test and selected from among type A⁽⁶⁾, type C and type D⁽⁷⁾.

- Remarks
- 1 For the type A test piece whose hardness exceeds 95, the type D is recommended.
 - 2 For the type A test piece whose hardness is less than 10, the type C is recommended.
 - 3 The type C shall be in accordance with Annex 2.

Notes ⁽⁶⁾ This type A is equal to the type A of durometer hardness test specified in JIS K 6253.

⁽⁷⁾ This type D is equal to the type D of durometer hardness test specified in JIS K 6253.

7.3 Tester The tester shall be composed of the pressurizing surface which presses the test piece surface, the indenter protruding from the hole provided on the pressurizing surface by means of a spring pressure, and the scale which indicates the distance of return of the indenter due to pushing of the test piece surface as the hardness.

7.3.1 Pressurizing surface A pressurizing surface shall be a plane normal to the indenter. The hole through which the indenter passes as given in Fig. 4 exists on the surface. The surface shall have a size of at least 6 mm from the center of the indenter.

7.3.2 Indenter The indenter shall be made of materials difficult to be abraded and not corroded, and its shape and dimensions shall be given as in Fig. 4. The indenter shall be correctly mounted to the center of the hole on the pressurizing surface, and the tip at zero scale shall be protruding from the pressurized surface by $2.54_{-0.05}^0$ mm for the types A and C and by (2.50 ± 0.04) mm for the type D. The tip surface at scale 100 shall be on the same plane as the pressurizing surface.

7.3.3 Spring The reference line indicating the relation between the motion of the scale and the indenter is given in Fig. 5. The tolerance on the reference line shall be ± 80 mN (± 8 gf) for the types A and C, and ± 0.45 N (± 45 gf) for the type D.

There shall be no play between the motion of the indenter and the motion of the indicator.

7.3.4 Scale The scale shall be graduated 0 to 100 at equal intervals.

7.4 Test piece Test pieces shall be as follows:

7.4.1 Shape and dimensions of test piece Test pieces of at least 12 mm thickness shall be, as a rule, used for the type A, and that of under 12 mm shall be made 12 mm or over as far as possible by laminating. For the type D, that of 6 mm or over in thickness shall be used, and that of under 6 mm shall be made 6 mm or over as far as possible by laminating. For the type C, that of 10 mm or over in thickness shall be used, and that of under 10 mm shall be made 10 mm or over as far as possible by laminating. The measuring plane of the test piece shall have a size so that the pressurizing surface of the tester is at least within the measured surface.

The measuring plane of the test piece, if not smooth, shall be ground so as to be smooth.

7.4.2 Sampling and preparation of test piece The sampling and preparation of test pieces shall be as described in 4.3.

7.5 Test method The tester is kept vertical, the pressurizing surface is brought to come in close contact to the measuring plane of the test piece so that the indenter becomes normal thereto, and the scale is immediately read to obtain the hardness of the test piece. When the scale is read after a specified time from close contact of the pressurizing surface, it is desirable that the tester is kept vertical, and an appropriate auxiliary device is used so that the indenter becomes normal to the measuring plane before the test. In that case, the tester is pressurized vertically by a force of about 10 N (about 1 kgf) for the types A and C and by a force of about 50 N (about 5 kgf) for the type D, and time from close contact to reading the value shall be recorded. The number of measuring points shall be five, and the measurement is carried out five times at positions at least 6 mm apart from other contact point by the indenter point.

7.6 Arrangement of test results The test results shall be expressed by the median of five measured values appended by the test type or its symbol [Hs (A, C or D)].

If the value is read after specified time from close contact of the pressurizing surface, the time (s) appended by "/" shall be recorded thereafter.

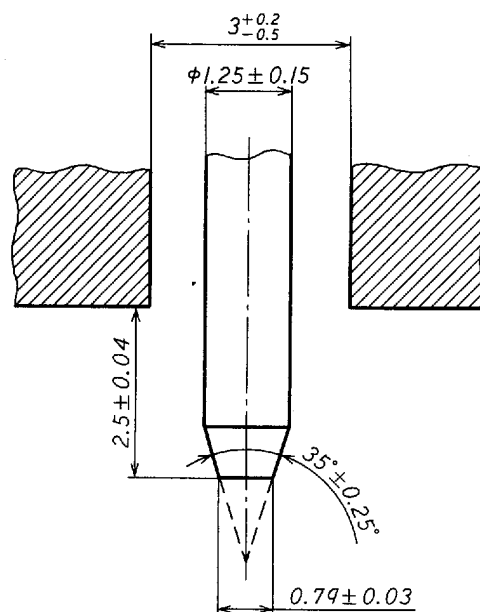
Example 1 HsD50 : This means that the reading of hardness just after close contact of the pressurizing surface in type D hardness test is 50.

Example 2 HsA89/30 : This means that the reading of hardness after 30 s from close contact of the pressurizing surface in type A hardness test is 89.

7.7 Record The following items shall be recorded on the test results.

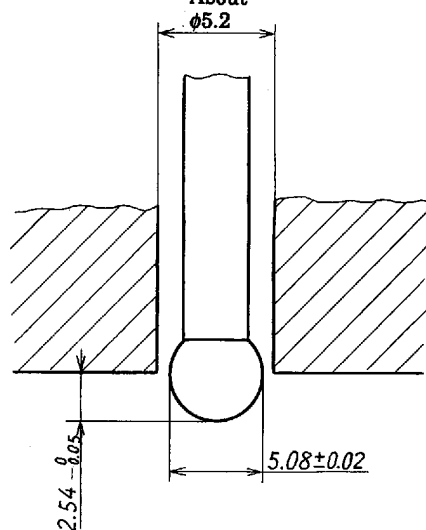
- (1) Test results
- (2) Classification of type
- (3) Shape and dimensions of test piece (when laminated, the number of sheets and its thickness)
- (4) Methods for sampling and preparation of test piece
- (5) Other necessary items

Unit : mm



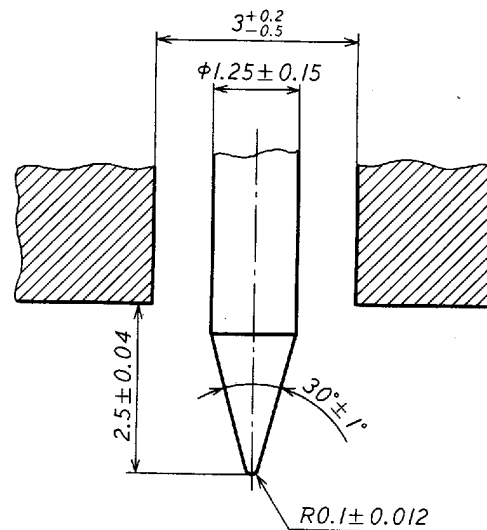
(1) Type A

About



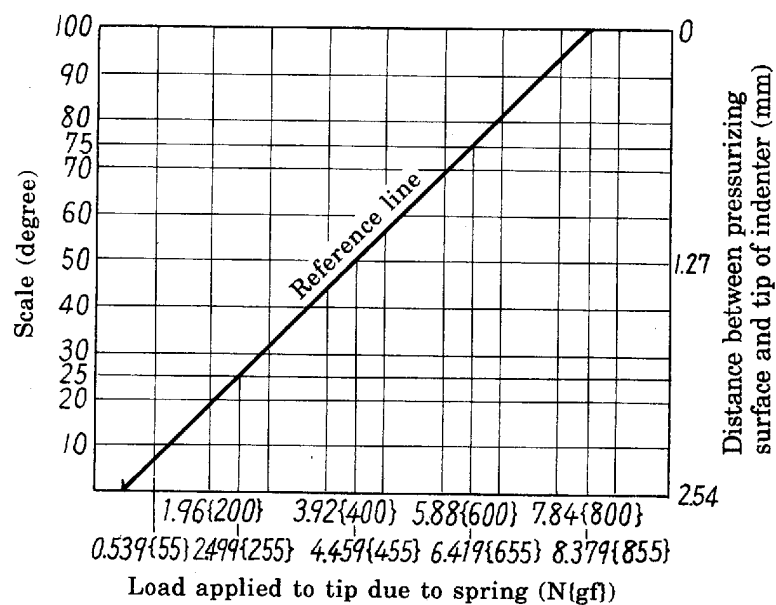
(2) Type C

Fig. 4 Shape and dimensions of tip of indenter



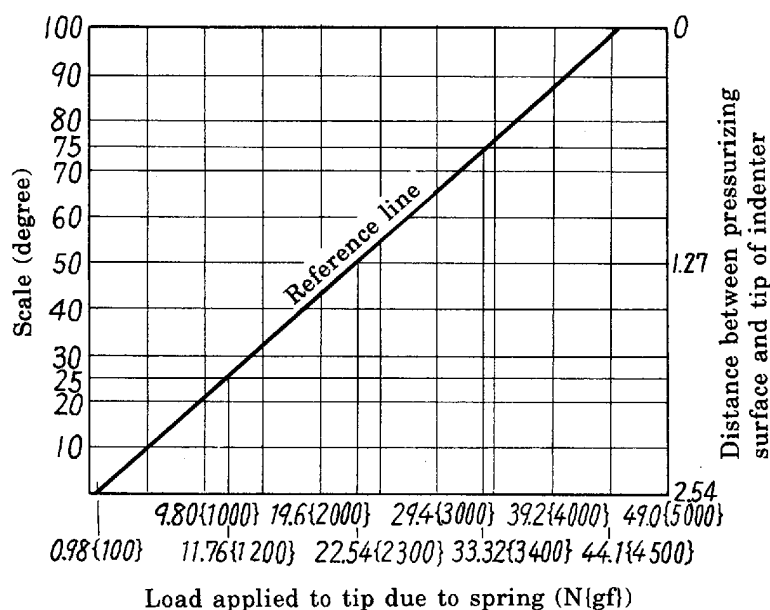
(3) Type D

Fig. 4 (continued)



(1) Type A and type C

Fig. 5 Reference line



(2) Type D

Fig. 5 (continued)

8 Low elongational stress test

8.1 Purpose The test is carried out for measurement of tensile stress in low elongation of elastomer (hereafter, referred to as low elongational stress), and static shear modulus.

8.2 Testing machine As the machine, the tensile tester conforming to the following conditions shall be used.

8.2.1 Mechanism of tester The tester shall be capable of mounting the test piece by means of the grippers, provided with an elongation measuring device capable of measuring the gauge length to the nearest 0.1 mm, and capable of displaying the tensile force with a tolerance $\pm 2\%$.

8.2.2 Capacity of tester Such a tester that the tensile force when the test piece is elongated to a specified elongation (%) is within a range of 20 % to 80 % of its capacity, shall be used.

8.2.3 Pulling speed The travel speed of the grippers of a test piece shall be, as a rule, 0.83 ± 0.08 mm per second.

8.3 Test piece Test pieces shall be as follows:

8.3.1 Shape and dimensions of test piece The shape and dimensions of a test piece shall be as given in Table 6.

Table 6 Shape and dimensions of test piece

Unit : mm

Shape		Dimensions of main parts			
		Width	Total length	Thickness	Gauge length
Strip	No. 1 shape	5	100	2.0 ± 0.2	40
Strip	No. 2 shape	10	60	2.0 ± 0.2	20
Dumbbell	No. 3 shape	5	100	2.0 ± 0.2	20

Remarks: In general, the strip No. 1 shape or the dumbbell No. 3 shape given in Table 6 shall be used. The strip No. 2 shape is used for the sample which is little in low elongation stress or from which sampling of the strip No. 1 shape is difficult.

8.3.2 Sampling and preparation of test piece The sampling and preparation of test pieces shall be, as a rule, as described in 4.3.

8.3.3 Number of test pieces The number of test pieces shall, as a rule, be two.

8.3.4 Punching die A dumbbell No. 3 shape test piece shall be, as a rule, punched off with the punching die as given in Table 5-1.

8.3.5 Measurement of thickness and width of test piece The thickness and width of a test piece shall be, as a rule, measured according to 4.4, and the sectional area of the test piece shall be calculated from the following formula:

$$\text{Sectional area of test piece (mm}^2\text{)} = \text{thickness (mm)} \times \text{width of parallel part (mm)}$$

8.3.6 Bench marks for measurement of elongation Bench marks for measurement of elongation (hereafter, referred to as bench marks) shall be marked on a dumbbell test piece by the following method:

- (1) Gauge length shall be as given in Table 6.
- (2) Bench marks shall be marked accurately and clearly on the parallel part of the test piece by centering the central part.

8.3.7 Selection of test piece The test pieces whose deviations in thickness and width of parallel part exceed 0.1 mm, shall not be used for the test.

Remarks: When the absolute value of low elongation stress is required, the width is measured on both up and down faces of the test piece, and the mean value is taken as the width of the test piece. When the test piece is manufactured without punching, the procedure is similar. For measuring the width, a 0.01 mm gradation reading microscope shall be, as a rule, used. The measured position of the width of one side shall be, as a rule, on the bench marks.

8.4 Test method The test method shall be as follows:

8.4.1 Test conditions The test conditions shall be as follows:

- (1) The elongation of the test piece may be any one within a range of 10 % to 50 %. However, 10 % is preferable.
- (2) The pulling and returning speed shall be (0.83 ± 0.08) mm per second.
- (3) The test temperature shall be as described in 4.5.

8.4.2 Operating method The operating method shall be as follows:

- (1) **Mounting of test piece** The test piece shall be accurately mounted to the grippers so that distortion, abscission of the grippers, and other inconveniences are not generated. The positions at which the test piece is mounted to the grippers, shall be equal distance from both sides of the bench marks, and the interval shall be at least two times the distance between the bench marks.
- (2) **Preliminary elongation** Elongation of 1.5 times the elongation in the main test shall be given preliminarily two times. For example, when 10 % elongation stress is measured, elongation from 0 % to $1.5 \times 10 = 15$ % is given two times. In this procedure, the operation is stopped for 30 s at each time of 0 % elongation and 15 % elongation.
- (3) **Main test** The main test (the third elongation) is carried out under the same conditions as those for preliminary elongation. However, the elongation of the test piece is set to prescribed elongation, for example 10 %, and the tensile force after an elapse of 30 s is measured.

8.5 Calculation Low elongation stress and static shear modulus shall be calculated as follows:

8.5.1 Low elongation stress Low elongation stress shall be calculated according to the following formula.

$$\sigma_{\varepsilon} = \frac{F_{\varepsilon}}{A}$$

where, σ_{ε} : ε % low elongation stress (MPa) {kgf/cm²}
 F_{ε} : ε % tensile force (N) {kgf}
 A : original sectional area of test piece (mm²) {cm²}

8.5.2 Static shear modulus Static shear modulus shall be calculated according to the following formula:

$$G_{\varepsilon} = \frac{\sigma_{\varepsilon}}{\alpha - 1/\alpha^2}$$

where, G_{ε} : ε % shear modulus (MPa) {kgf/cm²}
 σ_{ε} : ε % low elongation stress (MPa) {kgf/cm²}
 ε : elongation of test piece (%)

$$\alpha = 1 + \frac{\varepsilon}{100}$$

Informative reference : For $\varepsilon = 10$ %, $G_{10} = 3.655 \times \sigma_{10}$ is obtained.

8.6 Arrangement of test results The test results shall be expressed by low elongation stress and static shear modulus with the average of measured values on two test pieces as a rule.

Remarks : In the case where the difference between the two measured values is 10 % or more, one more test shall be carried out to obtain average of the nearest two measured values among the three measured values.

8.7 Record The following items shall be recorded on the test results.

- (1) Test results
- (2) Shape and dimensions of test piece
- (3) Method for sampling and preparation of test piece
- (4) Elongation of test piece in main test (elongation rate: %)
- (5) Capacity of tester
- (6) Other necessary items

9 Compression test

9.1 Purpose The test is carried out for measurement of the relation between compressive stress of elastomer and its compressive strain.

9.2 Testing machine The machine shall be as follows:

9.2.1 Compression tester The compression tester shall be as specified in JIS B 7733 and should be capable of recording continuously and automatically compressive force and compressive strain. When an automatic recorder is not equipped, the tester shall be equipped with a displacement gauge for measuring of strain.

9.2.2 Displacement gauge The displacement gauge used for measuring strain shall be as specified in JIS B 7503.

9.2.3 Thickness gauge The thickness gauge shall be as specified in 4.4.

9.3 Test piece

9.3.1 Shape and dimensions of test piece The test piece shall be of a right cylinder of (12.5 ± 0.5) mm thickness and (29.0 ± 0.5) mm diameter.

9.3.2 Sampling and preparation of test piece The sampling and preparation of a test piece shall be, as a rule, as described in 4.3. When a sample bonded to a metal piece is used, the operation shall be as described in 4.3.1.

9.3.3 Number of test pieces The number of test pieces shall be, as a rule, three.

9.3.4 Measurement of thickness and diameter of test piece The thickness and diameter of the test piece shall be, as a rule, measured as described in 4.4.

9.4 Test method The test method shall be as follows:

9.4.1 Test conditions The test conditions shall be as follows:

- (1) **Compressive speed** The compressive speed of the test piece shall be (0.17 ± 0.02) mm per second.
- (2) **Test temperature** The test temperature shall be as described in 4.1.

9.4.2 Operating method The operating method shall be as follows:

- (1) **Mounting of test piece** Mount the test piece at the center of a compression tester or a compressive jig, and place abrasive paper to prevent lateral displacement on both compressive faces of the test piece⁽⁸⁾.

Note (8) The abrasive paper of about No. 800 specified in JIS R 6253 shall be used, the abrasion surface of which shall be slightly larger than the test piece and faced to the test piece.

- (2) **Preliminary compression** Compressive strain of 1.05 times the compressive strain in the main test shall be given continuously and preliminarily two times to the test piece prior to the main test.
- (3) **Main test** The main test (the third compression) is carried out successively after preliminary compression. After ending of the preliminary compression, initial compression of at most 1 % of the second load is applied to the test piece, and the strain measuring displacement gauge at that time is set to zero point. Then, the force is applied until it reaches the specified strain, and compressive force at that instance is recorded. The stress (or compressive force) and the displacement shall be continuously recorded. When an automatic recorder is not equipped, the tester may be stopped every time when the test piece is deformed by 5 %, and the compressive force is also recorded. The time to be stopped in this case shall be within 10 s.
- (4) **Measurement of compressive force at prescribed strain** In the main test, compress the test piece to the prescribed strain, measure the compressive force, and obtain the compressive stress.
- (5) **Measurement of strain due to prescribed stress (or compressive force)** Compress the test piece to the prescribed stress (or compressive force) in the main test, and measure the strain to obtain the compressive strain. Calculate the prescribed compressive force by multiplying the prescribed stress by the sectional area of the test piece.

9.5 Calculation Compressive stress and compressive strain shall be calculated as follows:

- (1) **Compressive stress** Calculate compressive stress according to the following formula:

$$M_c = \frac{P - P_0}{A_0}$$

where, M_c : compressive stress (MPa) {kgf/cm²}
 P_0 : force when test piece is compressed initially (N) {kgf}
 P : compressive force when prescribed strain is applied (N) {kgf}
 A_0 : sectional area of test piece before test (mm²) {cm²}

- (2) **Compressive strain** Calculate compressive strain according to the following formula:

$$C = \frac{d_0 - d_1}{d_0} \times 100$$

where, C : compressive strain (%)
 d_0 : thickness of test piece when initially compressed (mm)
 d_1 : thickness of test piece when compressed at prescribed stress (mm)

9.6 Arrangement of test results The test results shall be expressed by compressive stress at prescribed compressive strain or the compressive strain at prescribed compressive stress, and the mean value on three test pieces shall be, as a rule, taken.

Further, the curve of stress – strain should be drawn.

9.7 Record The following items shall be recorded on the test results.

- (1) Test results
- (2) Dimensions of test piece
- (3) Methods for sampling and preparation of test piece
- (4) Test temperature
- (5) Curve of stress – strain
- (6) Type of tester
- (7) Other necessary items

10 Rebound resilience test

10.1 Purpose The test is carried out for measurement of the rebound resilience of elastomer.

10.2 Tester A rebound tester of structure illustrated in Fig. 6 shall be used as the tester⁽⁹⁾. The iron bar is suspended horizontally by four hanging strings, its blow end is a semisphere having (12.50 ± 0.05) mm diameter, and the other end shall be equipped with a pointer. The iron bar shall be a round bar of about 356 mm length, about 12.5 mm diameter, and (0.35 ± 0.01) kg mass. The suspension height of the iron bar is 2000 mm, and its height of fall is 100 mm.

direction. The test piece support is firmly fixed as given in Fig. 7, and will not cause vibration or the like due to the blow of the iron bar. The scale plate shall have 625 mm horizontal length and 2000 mm radius of circular arc, and its scale shall show such amount that the bar vertical height of 100 mm is equally divided into 100. When the iron bar is freely suspended, the pointer shall be at the position of zero scale, and adjusted so that the blow end comes just in contact to the surface of the test piece.

Note (9) This tester shall be similar to that specified in JIS K 6255.

10.3 Test piece Test pieces shall be as follows:

10.3.1 Shape and dimensions of test piece The shape and dimensions of test pieces shall be as described in 9.3.1. When sampled by cutting out from the product, if the thickness does not reach the prescribed one, the piled two test pieces may be used.

10.3.2 Sampling and preparation of test piece The sampling and preparation of test pieces shall be as described in 4.3.

10.3.3 Number of test pieces The number of test pieces shall be two.

10.4 Test method For measurement, set the pointer of iron bar to a position of 100 on the scale plate of the pointer, let the iron bar fall freely from that position, and read the height when the bar is rebounded by means of the position of the pointer on the scale plate. Repeat this operation continuously 3 times to 7 times. After the rebounding height comes almost constant, successively measure three times, and take the median of three measurements as the rebound resilience of the test piece.

10.5 Calculation Rebound resilience shall be calculated according to the following formula.

$$R_B = \frac{h}{H} \times 100$$

where, R_B : rebound resilience (%)

h : rebound height (mm)

H : height of fall (mm)

10.5 Arrangement of test results The test results shall be expressed by the mean of measured values on two test pieces.

10.6 Record The following items shall be recorded on the test results.

- (1) Test results
- (2) Methods for sampling and preparation of test piece (when laminated, its thickness)
- (3) Other necessary items

Unit: mm

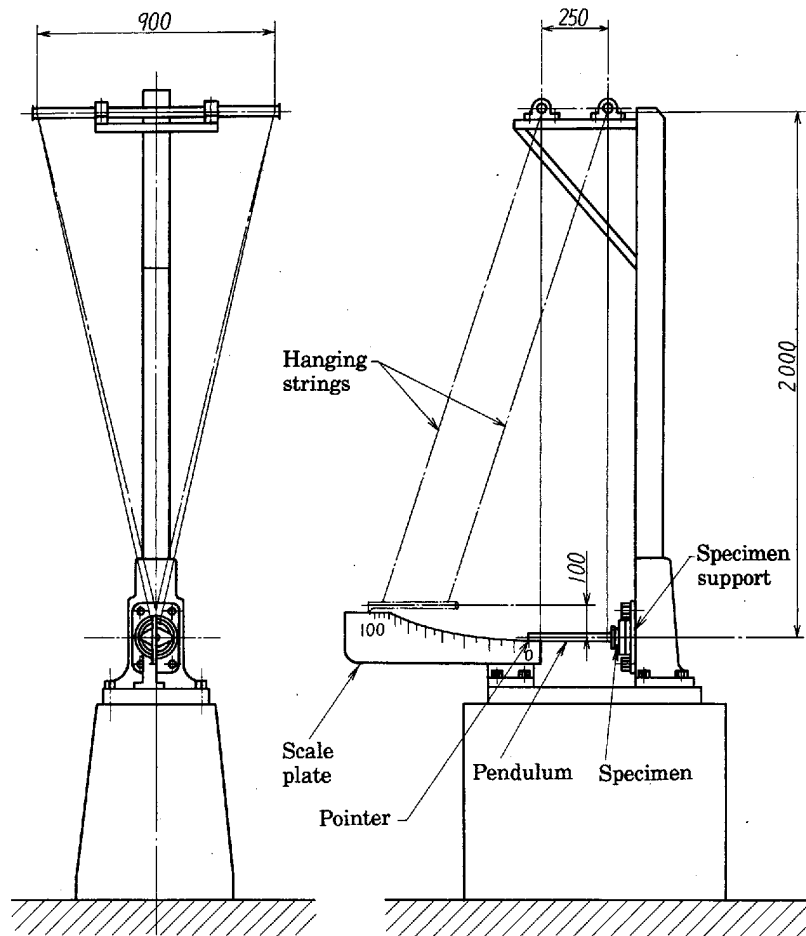
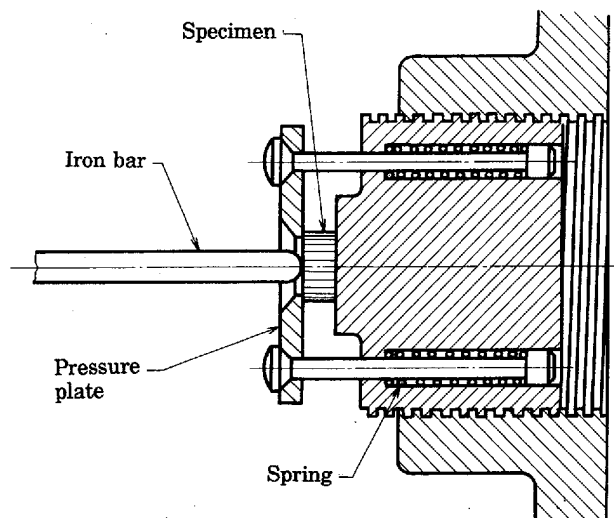


Fig. 6 Example of rebound resilience tester



Remarks : The pushing force of the pressure plate shall be 29.4 to 39.2 N {3 to 4 kgf} and the hole diameter shall be 24 mm.

Fig. 7 Test piece support (enlarged drawing)

11 Hysteresis loss test

11.1 Purpose The test is carried out for measurement of the hysteresis loss of elastomer. The test includes two types of tension method and compression method.

11.2 Tensile hysteresis loss test The tensile hysteresis loss test shall be as follows:

11.2.1 Tester The tester shall be, as a rule, that specified in JIS B 7721, which can pull a test piece at a constant speed and can return it to the original position at a constant speed. It shall be equipped with a device capable of recording automatically the stress and strain.

11.2.2 Test piece Test pieces shall be as follows.

- (1) **Shape and dimensions of test piece** The shape and dimensions of test pieces shall be the dumbbell No. 3 shape test piece or the ring No. 1 shape test piece as indicated in Fig. 1, Table 4-1 and Table 4-2.
- (2) **Sampling and preparation of test piece** The sampling and preparation of test pieces shall be, as a rule, as described in 4.3.
- (3) **Number of test pieces** The number of test pieces shall be two.
- (4) **Thickness of test piece** The thickness of a test piece shall be (2.0 ± 0.2) mm as standard. The thickness shall be measured as described in 4.4.

11.2.3 Test method The test method shall be as follows:

- (1) **Pulling speed** The pulling speed shall be, as a rule, (0.83 ± 0.08) mm per second.
- (2) **Measuring part** Bench marks for measuring elongation shall be marked on a test piece as specified in Table 4-1 (for dumbbell No. 3 shape test piece).
- (3) **Measuring method** Pull the test piece until it reaches the target elongation (50 % unit), and immediately return it to the original state at the same speed. Record the curve of stress – strain at this time. Repeat this operation three times on the same test piece.

11.2.4 Calculation Calculate the hysteresis loss according to the following formula from the curve of stress – strain obtained at the third measurement.

$$H_e = \frac{A}{A+B} \times 100$$

where, H_e : hysteresis loss (%)

A and B : areas as given in Fig. 8. In the actual measurement, cut off respective parts of A and B , weigh the masses to the nearest 1 mg, and use the masses so measured.

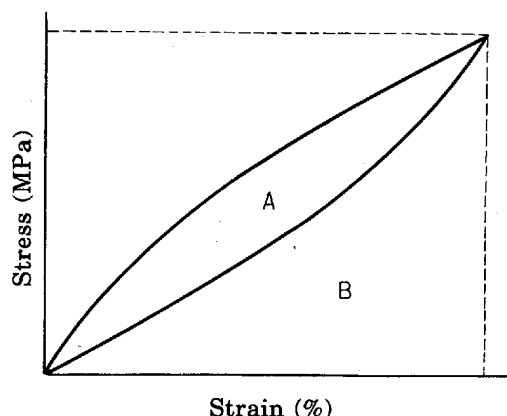


Fig. 8 Curve of stress – strain

11.3 Compressive hysteresis loss test The compressive hysteresis loss test shall be as follows:

11.3.1 Tester The tester shall be that specified in JIS B 7733, which can compress a test piece at a constant speed and can return it to the original state at a constant speed. It shall be equipped with a device recording the stress and strain automatically at that time.

11.3.2 Test piece Test pieces shall be as follows:

- (1) **Shape and dimensions of test piece** The shape and dimensions of test pieces shall be as described in 9.3.1.
- (2) **Sampling and preparation of test piece** The sampling and preparation of test pieces shall be, as a rule, as described in 4.3.
- (3) **Number of test pieces** The number of test pieces shall be two.

11.3.3 Test method The test method shall be as follows:

- (1) **Compressive speed** The compressive speed shall be, as a rule, (0.17 ± 0.02) mm per second.
- (2) **Measurement of thickness** The thickness shall be measured as described in 4.4.
- (3) **Measuring method** Compress the test piece to the target compressibility (5 % unit), and immediately return it to the original state at the same speed. Record the curve of stress-strain at that time. Repeat the operation three times on the same test piece.

11.3.4 Calculation Calculate the hysteresis loss by the same method as that in 11.2.4.

11.4 Arrangement of test results The test results shall be expressed by the mean value of hysteresis losses on two test pieces.

11.5 Record The following items shall be recorded on the test record.

- (1) Test results
- (2) Type of hysteresis loss (tension, compression)
- (3) Shape and form type of test piece
- (4) Elongation rate and compressibility
- (5) Other necessary items

12 Friction coefficient test

12.1 Purpose The test is carried out for measurement of static friction coefficient and dynamic friction coefficient between elastomers mutually or elastomer and other substance.

12.2 Tester In the test, a tensile tester is used. A flat plate fitted to the cross-head is moved at a constant speed, and a test piece stuck to a metal slide is slid on the test piece located on a flat plate to detect friction force with a strain gauge. The following apparatuses are used and assembled as given in Fig. 9, so that the measurement stated above is possible.

12.2.1 Metal slide The metal slide is so structured that a hook is fitted to one end of a square smooth metal plate of 6 mm thickness and 63.5 mm one side.

12.2.2 flat plate The flat plate is so structured that a glass plate having a smooth surface is piled on a polished plastic, wood, or metal plate of 1 mm thickness, 150 mm width, and 300 mm length.

12.2.3 Fixed table The fixed table is a device for supporting the flat plate, made of a smooth wood or metal plate of 200 mm width × 300 mm length, and has necessary strength and rigidity for fixing its position in order to be fitted to the cross head of the tensile tester.

12.2.4 Tensile tester The tensile tester shall be equipped with an automatic recorder of tensile force, shall have a performance capable of detecting $\pm 5\%$ difference in friction force, and its pulling speed can be adjusted to (2.5 ± 0.5) mm per second.

12.2.5 Nylon yarn Nylon yarn has a (0.33 ± 0.05) mm diameter and can withstand tensile force of 35 N {3.5 kgf}.

12.2.6 Low friction pulley The low friction pulley is made of phenolic resin and equipped with a quenched steel-made bearing.

12.3 Test piece Test pieces shall be as follows:

12.3.1 Shape and dimensions of test piece There are the following two kinds of test pieces according to the shape and dimensions of test pieces.

- (1) **Travel test piece** For a travel test piece, a sheet or a block material having a square smooth surface of 63.5 mm in one side, and at least 0.25 mm thickness, is used. In the case of sheet test piece, it is stuck to a metal slide with a double-sided adhesive tape and then used. When the sheet is flexible and deformed, the metal slide is covered with sponge rubber⁽¹⁰⁾ and used. For the block test piece, a hook may be fitted directly to the body and used.

Total mass of the test piece shall be (200 ± 5) g.

Note ⁽¹⁰⁾ The sponge rubber shall have 3.2 mm thickness and 63.5 mm width.

- (2) **Fixed test piece** A sheet or a film test piece having a rectangular smooth surface of 130 mm width and at least 250 mm length is stuck to a glass plate on the fixing stand as it is with a double-coated tape or a cellophane adhesive tape and then used.

12.3.2 Conditioning of test piece The test piece shall be, as a rule, lightly washed with degreasing solvent such as toluene or the like to remove foreign matters, fats and oils on the surface. Then, after leaving at least for 40 h under conditions of (23 ± 2) °C temperature and (50 ± 5) % relative humidity, measurement is carried out under the same atmosphere. When measured values are dispersed, tolerances on temperature and relative humidity are respectively made ± 1 °C and ± 2 %, and the measurement is carried out.

12.3.3 Sampling and preparation of test piece The sampling and preparation of test pieces shall be as described in 4.3.

12.4 Test method The test method shall be as follows:

12.4.1 Adjustment of tensile tester Adjust the pulling speed, as a rule, to (2.5 ± 0.5) mm per second, fit nylon yarn to which a weight of known mass corresponding to 50 % to 75 % of the tensile force capacity is fitted, to the tensile tester via the low friction pulley on the fixing stand, and adjust the tester or apparatus so that total tensile force becomes ± 5 % of the mass of the weight.

12.4.2 Operating method Stick the test piece to the glass plate on the fixing stand so that there are at least 250 mm in tensile direction and at least 130 mm in lateral direction, and adjust the test piece surface horizontally with a level. In that case, do not touch the part of 100 mm width $\times$ 200 mm length at the center of the test piece with hands. Then, quietly place a travel test piece adjusted to (200 ± 5) g total mass by placing a weight or the like on the fixed test piece on the glass plate, fit one end of the nylon yarn to the hook and fit the other end to the tensile tester via the low friction pulley on the fixing stand. Then, carry out tensile test, record the maximum tensile force at start and the tensile force during travel of about 130 mm after start, and obtain the mean tensile force according to Annex 1.

12.5 Calculation Calculate static friction coefficient, dynamic friction coefficient, and standard deviation according to the following formulas:

Informative reference : The value of standard deviation is estimated ± 15 % of the value of friction coefficient.

(1) Static friction coefficient

$$\mu_s = \frac{A_s}{B}$$

where, μ_s : static friction coefficient
 A_s : reading of maximum tensile force at start (mN) {gf}
 B : gravity applied to travel test piece in measurement (mN) {gf}

(2) Dynamic friction coefficient

$$\mu_k = \frac{A_k}{B}$$

where, μ_k : dynamic friction coefficient
 A_k : reading of mean tensile force after start (mN) {gf}

(3) Standard deviation

$$S = \sqrt{\left(\sum X^2 - n\bar{X}^2 \right) / (n-1)}$$

where, S : standard deviation
 n : number of measurements
 X : measured value
 $\bar{X}$: mean value of measured values

12.6 Arrangement of test results The test results shall be expressed by the mean value on five test pieces.

The test piece once used shall be, as a rule, not used again.

12.7 Record The following items shall be recorded on the test results.

- (1) Mean value and standard deviation of static friction coefficient and dynamic friction coefficient
- (2) Details of test piece (model number, thickness, forming method, condition, surface state, elapsed time, and contents of conditioning)
- (3) Pulling speed
- (4) Details of sponge rubber (specific gravity, 25 % compressive strength, and material)
- (5) Type and name of tensile tester
- (6) Test temperature and relative humidity
- (7) Other necessary items

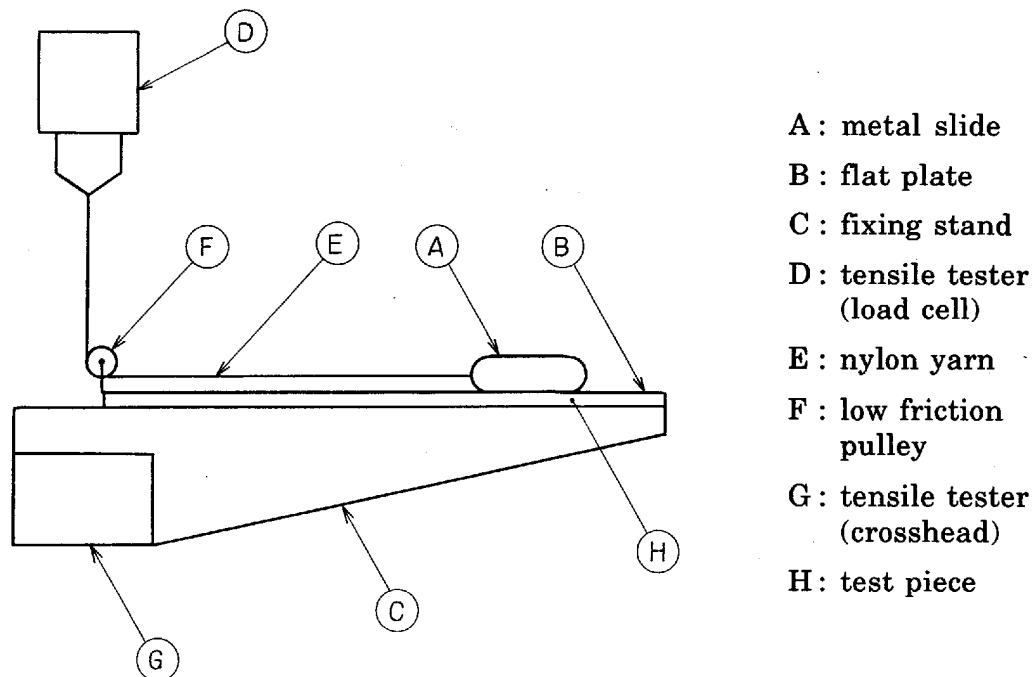


Fig. 9 Example of friction coefficient tester

13 Tension permanent set test

13.1 Purpose This test is carried out for measurement of permanent set due to tension under heating of elastomer used for a part which receives static tension.

13.2 Tester The tester is composed of an extending device, a length-measuring device, and a thermostatic chamber.

The extending device⁽¹¹⁾ and the length-measuring device shall be as specified in JIS B 7721.

The thermostatic chamber shall be a Gear oven aging tester or an air-circulating thermostatic chamber similar thereto.

Note (11) The extending device used for this test should be as small and light as possible, and designed so that the part of bench marks becomes normal to the flow of air in the thermostatic chamber when it is fitted therein.

13.3 Test piece Test pieces shall be as follows:

13.3.1 Shape and dimensions of test piece The shape and dimensions of test pieces shall be the dumbbell No. 1 shape test piece and No. 3 shape test piece as given in Fig. 1 and Table 4-1, and the (A) strip test piece and (B) I-formed test piece given in Fig. 10.

13.3.2 Sampling and preparation of test piece The sampling and preparation of test pieces shall be, as a rule, as described in 4.3.

13.3.3 Number of test pieces The number of test pieces shall be three.

13.3.4 Thickness of test piece The thickness of a test piece shall be (2 ± 0.2) mm as standard. The thickness shall be measured as described in 4.4.

13.3.5 Measuring part Elongation measurement bench marks of 40 mm gauge length are marked on the dumbbell No. 1 shape test piece and the strip test piece, and those of 20 mm gauge length are marked on the dumbbell No. 3 shape test piece as specified in Table 4-1.

Bench marks are not marked on the I-formed test piece, and the narrow part of 50 mm length shall be made the measuring part.

13.4 Test method The test method shall be as follows:

13.4.1 Test conditions The test conditions shall be as follows:

- (1) **Test temperature** The test temperature shall be, as a rule, selected from among those stated below⁽¹²⁾.

$(23 \pm 2) ^\circ\text{C}$ $(70 \pm 1) ^\circ\text{C}$ $(85 \pm 1) ^\circ\text{C}$ $(100 \pm 1) ^\circ\text{C}$ $(120 \pm 2) ^\circ\text{C}$

Note ⁽¹²⁾ Standard test temperature shall be $(70 \pm 1) ^\circ\text{C}$.

- (2) **Test time** The test time shall be, as a rule, selected from among those stated below⁽¹³⁾.

24_{-2}^0 h, 72_{-2}^0 h, 168_{-2}^0 h

Note ⁽¹³⁾ Standard test time shall be 24_{-2}^0 h.

- (3) **Elongation** Calculate the elongation⁽¹⁴⁾ at which the test piece shall be kept as elongated, according to the following formula:

$$L_x = \frac{L_1 - L_0}{L_0} \times 100$$

where, L_x : elongation (%)

L_0 : gauge length before test (mm)

L_1 : gauge length under elongation (mm)

Note ⁽¹⁴⁾ Standard elongation at which the test piece is kept as elongated, shall be $(100 \pm 10) \%$. The elongation may be selected from among those stated below, subject to agreement between the parties concerned with acceptance.

$(25 \pm 2) \%$, $(50 \pm 5) \%$, and $(200 \pm 10) \%$

- (4) **Elongation and shrinkage speed** When a test piece is elongated or shrunked, the speed shall be 2 mm to 10 mm per second.

13.4.2 Operating method After measuring the gauge length of a test piece to the nearest 0.1 mm, mount the test piece to the extending device, elongate it to a length corresponding to the prescribed elongation at the prescribed speed and keep it. In this procedure, take care not to give elongation exceeding the prescribed elongation. After 10 min to 20 min from being elongated to the prescribed elongation, measure the gauge length again, and confirm whether or not it is within a tolerable range. When it is outside the tolerable range, discard the test piece, and