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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 ± 2) °C and the relative humidity is desirable to be (50 ± 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.

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 ± 0.1 N {82 ± 10 gf} ± 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.

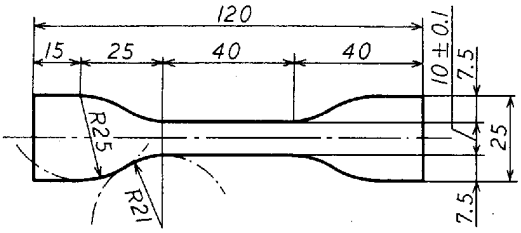
2 In ring test pieces, No. 1 test piece shall be the standard test piece. No. 2 test piece is used when the standard test piece can not be sampled.

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.

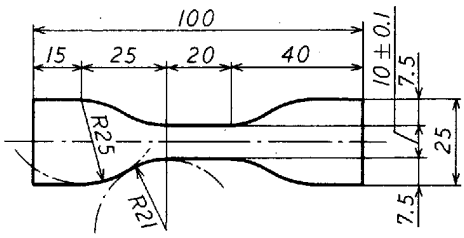
4 Since the same data can not always be obtained if the shape and dimensions of the test piece are different, the same shaped test piece shall be used for a comparison test.

Unit : mm

No. 1 shape



No. 2 shape



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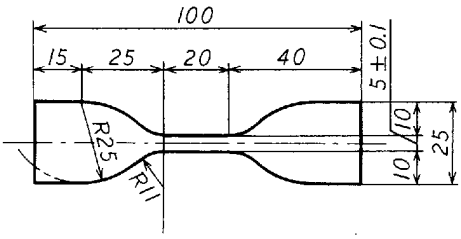

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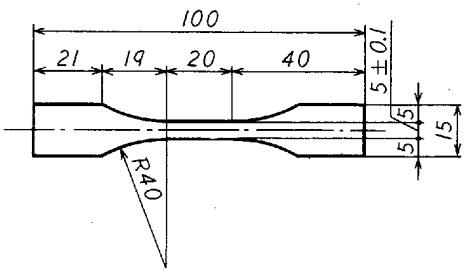

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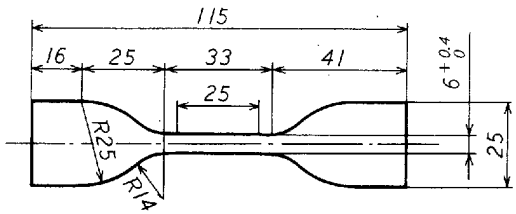

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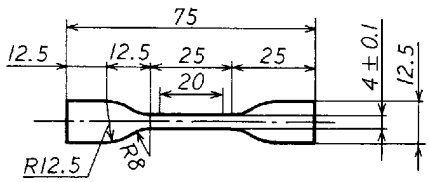
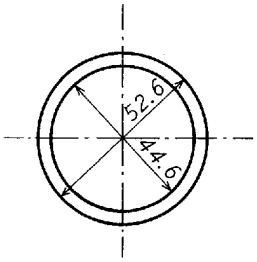
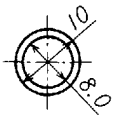


(1) Dumbbell test piece

No. 1 shape



No. 2 shape



(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.