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**Rubber, vulcanized or
thermoplastic—Determination of
tensile stress-strain properties**

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Contents

	Page
Introduction	1
1 Scope	1
2 Normative references	1
3 Terms and definitions	2
4 Principle	4
5 General	4
6 Test pieces	5
6.1 Selection of test pieces	5
6.2 Dumb-bell test pieces	6
6.3 Ring test pieces	8
7 Apparatus	8
7.1 Punching dies and cutters	8
7.2 Thickness gauge	10
7.3 Cone gauge (internal diameter gauge)	10
7.4 Tensile-testing machine	10
7.5 Test rig for ring test pieces	11
8 Number of test pieces	12
9 Sampling and preparation of test pieces	12
9.1 Dumb-bell test pieces	12
9.2 Ring test pieces	12
9.3 Selection of test pieces	13
10 Conditioning of samples and test pieces	13
10.1 Period from vulcanization or curing to testing	13
10.2 Protection of samples and test pieces	13
10.3 Conditioning of samples	13
10.4 Conditioning of test pieces	13
11 Marking of dumb-bell test pieces	13
12 Measurement of test pieces	14
12.1 Dumb-bell test pieces	14
12.2 Ring test pieces	14
12.3 Median thickness	14
13 Procedure	14
13.1 Dumb-bell test pieces	14

13.2	Ring test pieces	15
13.3	Measurement for determination of tensile strength, tensile strength at break and elongation at break	15
13.4	Measurement for determination of tensile stress at a given elongation	15
13.5	Measurement for determination of tensile stress at yield and elongation at yield	15
14	Temperature of test	16
15	Calculation of results	16
15.1	Dumb-bell test pieces	16
15.2	Ring test pieces	17
16	Expression of results	19
17	Precision	19
18	Test report	19
Annex A (informative)	Precision	20
Annex B (informative)	Analysis of ITP data and dumb-bell shape	24
Annex JA (informative)	Comparison table between JIS and corresponding International Standard	29

Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee as the result of proposal for revision of Japanese Industrial Standard submitted by The Japan Rubber Manufacturers Association (JRMA)/Japanese Standards Association (JSA) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law applicable to the case of revision by the provision of Article 14. Consequently **JIS K 6251**:2010 is replaced with this Standard.

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Attention is drawn to the possibility that some parts of this Standard may conflict with patent rights, applications for a patent after opening to the public or utility model rights. The relevant Minister and the Japanese Industrial Standards Committee are not responsible for identifying any of such patent rights, applications for a patent after opening to the public or utility model rights.

Rubber, vulcanized or thermoplastic— Determination of tensile stress-strain properties

Introduction

This Japanese Industrial Standard has been prepared based on **ISO 37:2011**, Edition 5, with some modifications of the technical contents.

The vertical lines on both sides and dotted underlines indicate changes from the corresponding International Standard. A list of modifications with the explanations is given in Annex JA.

1 Scope

This Standard specifies the determination method for the tensile stress-strain properties of vulcanized rubbers and thermoplastic rubbers.

The properties to be determined shall be the tensile strength, elongation at break, stress at a given elongation, elongation at a given stress, tensile stress at yield and elongation at yield. The measurement of the tensile stress at yield and the elongation at yield applies only to vulcanized rubbers and thermoplastic rubbers having a yield point.

NOTE : The International Standard corresponding to this Standard and the symbol of degree of correspondence are as follows.

ISO 37:2011 *Rubber, vulcanized or thermoplastic—Determination of tensile stress-strain properties* (MOD)

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standard and **JIS** are IDT (identical), MOD (modified), and NEQ (not equivalent) according to **ISO/IEC Guide 21-1**.

WARNING 1 Persons using this Standard should be familiar with normal laboratory practice. This Standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this Standard to establish appropriate safety and health practices.

WARNING 2 Certain procedures specified in this Standard might involve the use or generation of substances, or the generation of waste, that could constitute a local environmental hazard. Reference should be made to relevant laws and regulations on safe handling and disposal after use.

2 Normative references

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

JIS K 6200 Rubber—Vocabulary

JIS K 6250 *Rubber—General procedures for preparing and conditioning test pieces for physical test methods*

NOTE : Corresponding International Standard: ISO 23529 *Rubber—General procedures for preparing and conditioning test pieces for physical test methods* (MOD)

JIS K 6272 *Rubber—Tensile, flexural and compression test equipment (constant rate of traverse)—Specification*

NOTE : Corresponding International Standard: ISO 5893 *Rubber and plastics test equipment—Tensile, flexural and compression types (constant rate of traverse)—Specification* (MOD)

JIS Z 8401 Guide to the rounding of numbers

3 Terms and definitions

For the purposes of this Standard, the terms and definitions given in JIS K 6200, and the following apply.

See Figure 1 for illustration of terms for tensile test.

3.1 tensile stress, S

stress applied to extend the test piece, calculated as the applied force per unit area of the initial cross-section of the test piece

3.2 elongation, E

tensile strain produced in the test piece by tensile stress

NOTE 1 Test length is gauge length for dumb-bell test pieces and internal circumference for ring test pieces.

NOTE 2 Elongation is expressed as a percentage (%) of the initial test length.

3.3 tensile strength, T

maximum tensile stress recorded in extending the test piece to breaking point, divided by the area of the initial cross-section of the test piece

NOTE : See Figure 1 a) to Figure 1 c).

3.4 tensile strength at break, T_b

tensile stress recorded at the moment of test piece rupture, divided by the area of the initial cross-section of the test piece

NOTE 1 See Figure 1 a) to Figure 1 c).

NOTE 2 The values of T and T_b may be different if, after yielding at S_y , the elongation continues along the drop in stress resulting in T_b being lower than T [See Figure 1 c)].

3.5 elongation at break, E_b

elongation at breaking point of the test piece

NOTE 1 Elongation at break is expressed as a percentage (%) of the initial test length.

NOTE 2 See Figure 1 a) to Figure 1 c).

3.6 elongation at a given stress, E_s

elongation when the test piece is subjected to a given tensile stress

NOTE 1 Elongation at a given stress is expressed as a percentage (%) of the initial test length.

NOTE 2 A given stress is a stress value suitable for determination of a particular property.

3.7 stress at a given elongation, S_e

tensile stress required to produce a given elongation to the test piece, divided by the area of the initial cross-section of the test piece

NOTE 1 In the rubber industry, this definition is widely identified with the term “modulus”; and care should be taken to avoid confusion with the use of “modulus” in other industries to denote the slope of the stress-strain curve at a given elongation.

NOTE 2 Generally, stress at 100 % or 300 % elongation is used.

NOTE 3 A given elongation is an elongation value suitable for determination of a particular property.

3.8 tensile stress at yield, S_y

tensile stress at the first point where some further increase in elongation occurs without any increase in tensile force before the test piece is broken

NOTE : This corresponds to the inflection point [see Figure 1 b)] or the maximum point [see Figure 1 c)].

3.9 elongation at yield, E_y

elongation at the first point where some further increase in elongation occurs without any increase in tensile force before the test piece is broken

NOTE 1 Elongation at yield is expressed as a percentage (%) of the initial test length.

NOTE 2 See Figure 1 b) and Figure 1 c).

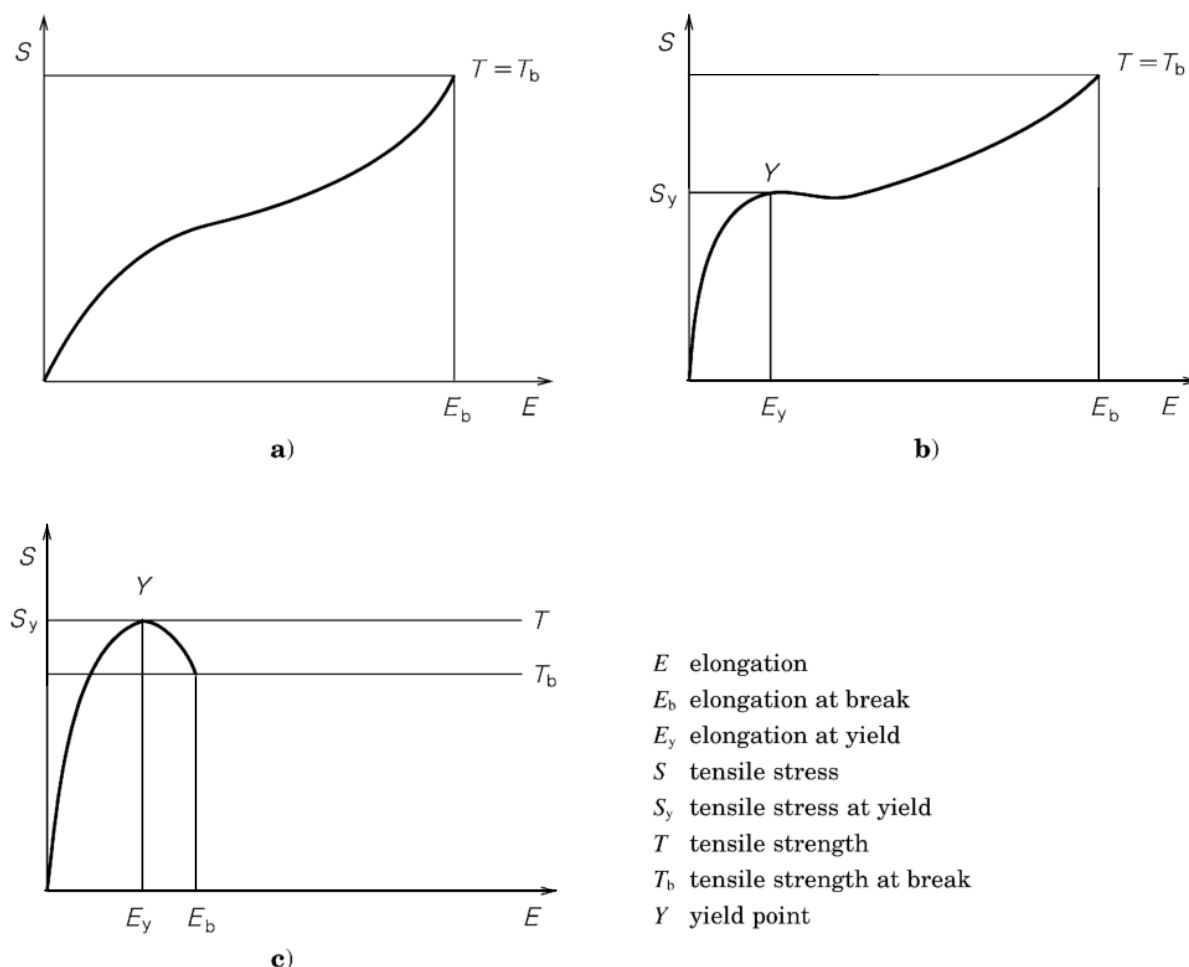


Figure 1 Illustration of terms for tensile test

3.10 test length of a dumb-bell (gauge length)

initial distance between reference points within the length of the narrow portion of a dumb-bell test piece used to measure elongation (see Figure 2)

NOTE : This test length is generally marked with two gauge marks given on the dumb-bell test piece; it is hereafter referred to in this Standard as gauge length.

4 Principle

Standard test pieces, either dumb-bells or rings, are stretched in a tensile testing machine at a constant rate of traverse of the driven grip or pulley. Readings of tensile force and elongation are taken as required during the uninterrupted stretching of the test piece and when it breaks.

5 General

The dumb-bell and ring test pieces do not necessarily give the same values for their respective stress-strain properties. This is mainly because in stretched rings the stress is not uniform over the cross-section. A second factor is in the existence of "grain" which might cause dumb-bell test pieces to give different values depending on whether their length is parallel or at right angles to the grain.

The main points to be noted in choosing between the dumb-bell and the ring test pieces are as follows.

- a) **Tensile strength** Dumb-bell test pieces are preferable for determination of tensile strength. Ring test pieces give lower, sometimes much lower, values than dumb-bell test pieces.
- b) **Elongation at break** Ring test pieces give approximately the same values as dumb-bell test pieces, provided that the dumb-bell test pieces are cut at right angles to the grain.

Dumb-bell test pieces should be used if it is required to study grain effects, as rings are not suitable for this purpose.

- c) **Elongation at a given stress and stress at a given elongation** Type 3, type 5 and type 6 dumb-bell test pieces are preferable.

Ring test pieces and dumb-bell test pieces give approximately the same values provided that

- the elongation of ring test pieces is calculated as a percentage of the median value of initial circumference and
- the average value is taken for dumb-bell test pieces cut parallel and at right angles to the grain.

Ring test pieces might be preferred in automated testing, due to the ease of handling of the test pieces, and in the determination of stress at a given elongation.

6 Test pieces

6.1 Selection of test pieces

For the tests specified in this Standard, seven types of dumb-bell test pieces are provided, i.e. dumb-bell-shaped types 1, 2, 3, 5, 6, 7, and 8, and two types of ring test pieces, i.e. ring-shaped types A and B.

Normally, for tensile tests, either type 3 or type 5 dumb-bell test pieces should be used.

Type 1 dumb-bell test pieces are used for samples with small elongation, type 2 dumb-bell test pieces are for samples with small tensile strength, and type 6 dumb-bell test pieces are for samples of small width.

Miniature type 7 and type 8 dumb-bell and type B ring test pieces shall be only used when tested material is insufficient in size to prepare larger test pieces. Miniature test pieces may give somewhat different, usually higher, values for tensile strength and elongation at break than the larger test pieces.

The results obtained for a given material are likely to vary according to the type of test piece used, the results obtained for different materials should therefore not be regarded as comparable unless the same type of test piece has been used. When preparation of test pieces requires buffing or thickness adjustment, test results may be affected.

NOTE : See Annex B for analysis of dumb-bell test pieces and inter-laboratory test programmes.

6.2 Dumb-bell test pieces

The dumb-bell test pieces shall have the outline shown in Figure 2.

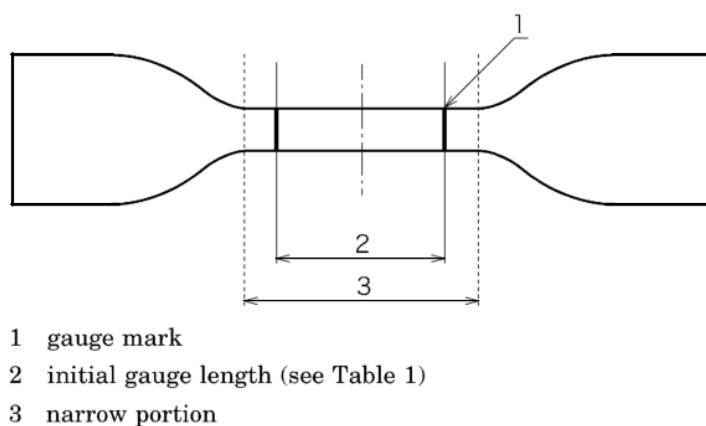


Figure 2 Shape of dumb-bell test pieces

The shapes and dimensions of different types of dumb-bell test pieces are shown in Figure 3 and Table 1. The initial gauge length shall be as specified in Table 1, and shall not exceed the length of narrow portion of the test piece.

The dumb-bell test pieces shall be prepared using appropriate punching dies (see Table 3).

For the non-standard test pieces prepared by cutting out from the product, the maximum thickness of the narrow portion shall be 3.0 mm for type 1, type 2, type 3 and type 5 dumb-bell test pieces, 2.5 mm for type 6 and type 8 dumb-bell test pieces, and 2.0 mm for type 7 dumb-bell test pieces.

Unit: mm

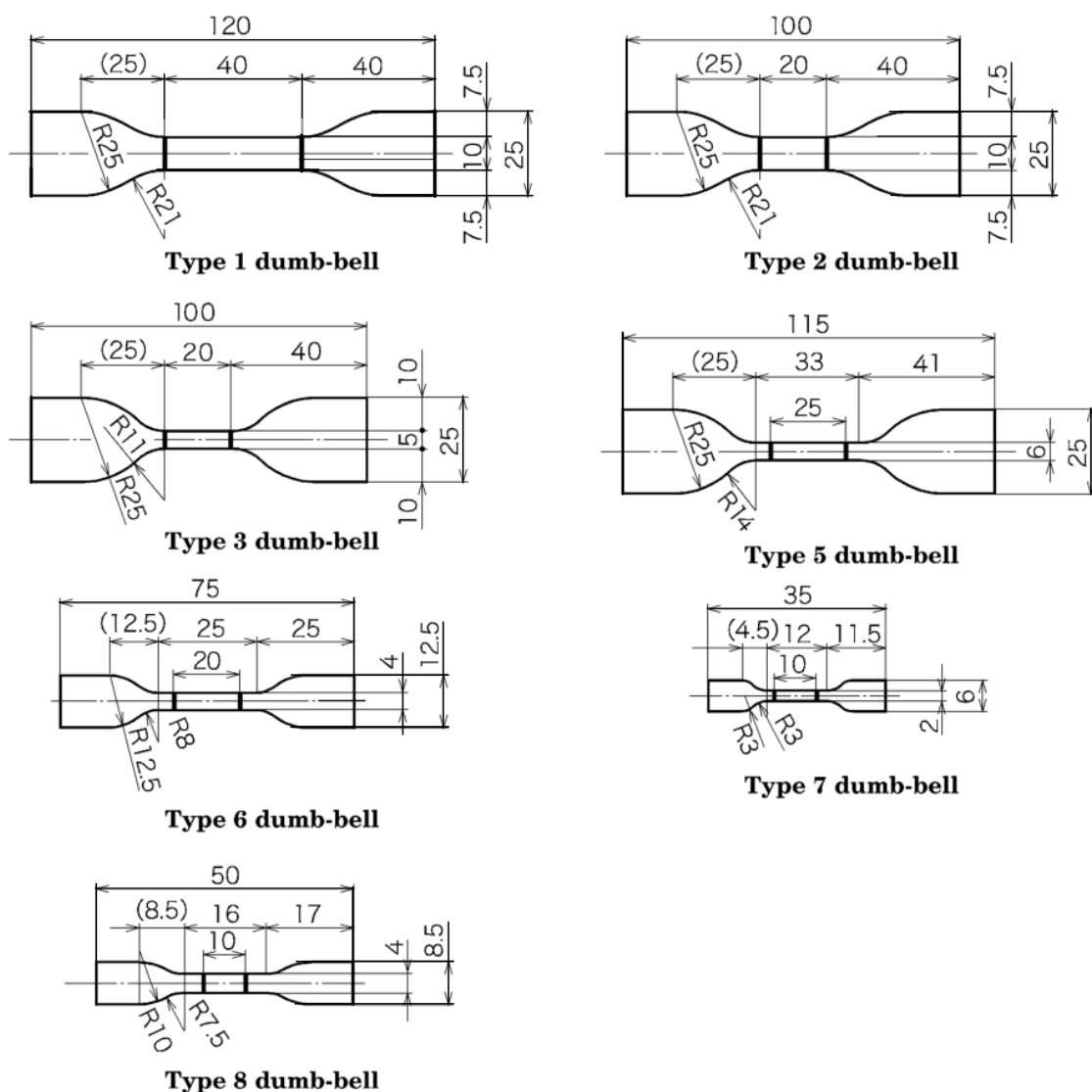


Figure 3 Shapes and dimensions of dumb-bell test pieces

Table 1 Shapes and dimensions of dumb-bell test pieces

Unit: mm

Type	Thickness of narrow portion (standard value)	Initial gauge length	Designation in corresponding International Standard
Type 1 dumb-bell	2.0 ± 0.2	40 ± 0.5	—
Type 2 dumb-bell	2.0 ± 0.2	20 ± 0.5	—
Type 3 dumb-bell	2.0 ± 0.2	20 ± 0.5	Type 1A
Type 5 dumb-bell	2.0 ± 0.2	25 ± 0.5	Type 1
Type 6 dumb-bell	2.0 ± 0.2	20 ± 0.5	Type 2
Type 7 dumb-bell	1.0 ± 0.1	10 ± 0.5	Type 4
Type 8 dumb-bell	2.0 ± 0.2	10 ± 0.5	Type 3