INTERNATIONAL STANDARD

ISO 6446

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Rubber products — Bridge bearings — Specification for rubber materials

Produits en caoutchouc — Appuis de pont — Spécification des matériaux en caoutchouc

Reference number
ISO 6446:1994(E)

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 6446 was prepared by Technical Committee ISO/TC 45, *Rubber and rubber products*, Subcommittee SC 4, *Miscellaneous products*.

Annex A forms an integral part of this International Standard. Annex B is for information only.

International Organization for Standardization
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Introduction

This International Standard has been prepared in order to assist national standards organizations and other bodies wishing to devise a material specification for rubbers used in elastomeric bridge bearings. It represents a consensus viewpoint, and in doing so recognizes that practices and conditions of service are not the same, and in many cases cannot be the same, in all areas of the world. For this reason, it includes a number of options among its requirements, for example with regard to low-temperature performance. The intention is that the user of this International Standard will select and specify the options most appropriate to his particular needs.

The requirements of this specification may be divided into two general categories, namely basic and optional.

The basic requirements are those relating to choice of rubber type, overall hardness range, specification of shear modulus or nominal hardness, ozone resistance and source and preparation of test pieces. Furthermore, an ability to form a strong adhesion bond is an essential requirement of a rubber used in a laminated bearing. These requirements are essential for a material specification based on this International Standard, although there is an option within each requirement. In addition, tensile strength, elongation at break, compression set and an accelerated-ageing test are specified as quality control requirements; in these cases, the test conditions and limits vary with rubber type.

Those tests relating to tear strength and resistance to creep are optional and may be added to the specification as appropriate.

It is acknowledged that requirements for the rubber constitute only part of a specification for elastomeric bridge bearings. A complete specification will include statements on the characteristics and quality of reinforcement in laminated bearings and on sampling and frequency of testing as well as load/deflection tests conducted on the complete bearing.

Rubber products — Bridge bearings — Specification for rubber materials

1 Scope

This International Standard specifies requirements for rubber materials used in elastomeric bridge bearings, which may be of the plain-pad or laminated type. It also specifies methods of test and describes procedures for the preparation of test pieces from finished bearings.

This International Standard does not contain aspects relating to design properties and quality control of the complete bearing, except where the complete bearing is used as the source of samples and test pieces to determine properties of the rubber material. Dimensions and tolerances are therefore not included in this International Standard.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 34-1:1994, *Rubber, vulcanized or thermoplastic — Determination of tear strength — Part 1: Trouser, angle and crescent test pieces.*

ISO 36:1993, *Rubber, vulcanized or thermoplastic — Determination of adhesion to textile fabric.*

ISO 37:1994, *Rubber, vulcanized or thermoplastic — Determination of tensile stress-strain properties.*

ISO 48:1994, *Rubber, vulcanized or thermoplastic — Determination of hardness (hardness between 10 IRHD and 100 IRHD).*

ISO 188:1982, *Rubber, vulcanized — Accelerated ageing or heat-resistance tests.*

ISO 471:—[1], *Rubber — Times, temperatures and humidities for conditioning and testing.*

ISO 812:1991, *Rubber, vulcanized — Determination of low-temperature brittleness.*

ISO 813:1986, *Rubber, vulcanized — Determination of adhesion to metal — One-plate method.*

ISO 815:1991, *Rubber, vulcanized or thermoplastic — Determination of compression set at ambient, elevated or low temperatures.*

ISO 1431-1:1989, *Rubber, vulcanized or thermoplastic — Resistance to ozone cracking — Part 1: Static strain test.*

ISO 1827:1991, *Rubber, vulcanized or thermoplastic — Determination of modulus in shear or adhesion to rigid plates — Quadruple shear method.*

ISO 4661-1:1993, *Rubber, vulcanized or thermoplastic — Preparation of samples and test pieces — Part 1: Physical tests.*

ISO 8013:1988, *Rubber, vulcanized — Determination of creep in compression or shear.*

3 Definitions

For the purposes of this International Standard, the following definitions apply.

1) To be published. (Revision of ISO 471:1983 and ISO 1826:1979)

3.1 elastomeric bridge bearing: A block of vulcanized rubber, with or without internal reinforcement, that is placed between the bridge deck and bridge support for the purpose of accommodating potentially damaging movements of the bridge deck resulting from the thermal expansion or contraction, the action of traffic, wind and other effects.

3.2 plain-pad bearing: A bearing consisting wholly of rubber.

3.3 laminated bearing: A bearing consisting of rubber with one or more reinforcing layers embedded in, and bonded to, the rubber.

3.4 reinforcing layer: A rigid or inextensible layer sandwiched between rubber layers in a laminated bearing for the purpose of increasing the compressive stiffness of the bearing without increasing its shear stiffness. The layer is usually a steel plate or textile fabric.

3.5 rubber polymer: The polymer type upon which the vulcanized rubber is based.

NOTE 1 In this International Standard, the terms "rubber" and "rubber material" refer to the compounded and vulcanized material used in the bearing.

4 Materials

4.1 Composition

Unless otherwise specified, the rubber material used in the bearing shall be vulcanized and shall be made of chloroprene rubber (CR) or natural rubber (NR). If other rubbers are used, their nature shall be disclosed. No reclaim rubber or vulcanized waste shall be used. The performance requirements to be met are given in tables 1 and 2 and the quality control requirements for chloroprene rubber (CR) and natural rubber (NR) are given in table 3. Suggested quality control requirements for other rubbers are given in annex B.

NOTE 2 Most practical experience with elastomeric bearing pads has been established with chloroprene rubber (CR) and natural rubber (NR) and the requirements for quality control are based on these rubbers. It is intended that the tentative values given in annex B for other rubbers will be included in table 3, in the light of experience, in subsequent editions of this International Standard.

4.2 Load/deflection characteristics

The rubber shall have load/deflection characteristics lying within prescribed limits. These characteristics shall be indicated in terms of either a given shear modulus (4.2.1) or a given hardness (4.2.2). Irrespective of the method used, the hardness of the rubber shall lie within the overall range of 45 IRHD to 75 IRHD.

Because the correlation between hardness and shear modulus is inexact, only hardness or shear modulus shall be specified, but not both.

NOTE 3 Shear modulus is one of the properties determining the load/deflection characteristics of the finished bearing. The customer therefore may require bearings which have been designed using a rubber of specific shear modulus or require bearings of specific stiffness. For many purposes, however, the supply of a rubber of a given hardness is often sufficient.

For a given type of rubber, it is possible to establish an approximate relationship between hardness and shear modulus, but a close agreement independent of compounding variations should not be assumed. The following correlation at room temperature for chloroprene rubber (CR) and natural rubber (NR) is given for guidance purposes. It is not necessarily valid for other types of rubber.

Hardness, IRHD	50	60	70
Shear modulus, MPa	0,65	1,0	1,35

4.2.1 Shear modulus

If shear modulus is requested, the rubber shall be supplied to a shear modulus specified by the customer. For quality control purposes, the shear modulus tolerance shall meet the requirements given in table 3.

4.2.2 Hardness

If hardness is requested, the rubber shall be supplied to a nominal hardness of 50, 60 or 70 IRHD. The hardness tolerance shall meet the requirements given in table 1.

4.3 Environmental resistance

The rubber shall have adequate weathering resistance (4.3.1) and shall remain serviceable over the range of temperatures to which the bearing is exposed (4.3.2).

4.3.1 Ozone resistance

The rubber shall be suitably compounded against the effects of ozone. Alternative test severities are specified in 6.1.3 in recognition of the wide global variations in ambient ozone concentration.

4.3.2 Low-temperature resistance

Five grades related to low-temperature resistance are defined. The grades and typical operating-temperature conditions for each are as follows:

Grade 1: Temperatures down to + 5 °C.

Grade 2: Sub-zero temperatures occurring at night and occasionally persisting for up to but no more than two days.

Grade 3: Occasional periods of up to 2 weeks continuously below zero temperature.

Grade 4: Up to 6 weeks of continuous sub-zero temperature, with occasional periods of up to 3 days below − 25 °C.

Grade 5: Sub-zero temperatures down to − 40 °C, persisting for several months each year, with up to 2 months continuously below − 15 °C.

The rubber shall meet the test requirements specified in 6.1.4.

4.4 Adhesion (laminated bearings only)

The rubber used in a laminated bearing shall form, with the aid of suitable bonding agents, a strong, durable bond to reinforcing layers. Adhesion strength shall be determined by one of the methods specified in 6.1.5.

NOTE 4 Although influenced by the composition of the rubber, adhesion strength also depends on the nature of the reinforcement, the bonding system and the manufacturing technique, each of which falls outside the scope of this International Standard.

5 Test pieces

All test pieces for requirements given in tables 1 to 3 shall be prepared in accordance with ISO 4661-1.

All test pieces for specification compliance requirements given in tables 1 and 2 shall be taken from a finished bearing.

All test pieces for quality control requirements given in table 3 shall be taken either from a finished bearing or from a special test bearing prepared and vulcanized in the same manner as a finished bearing, except that no bonding agent shall be used and steps shall be taken to facilitate the separation of rubber and reinforcing layers.

Test pieces for the determination of compression set, hardness (as specified in 6.1.2 and table 1) and low-temperature hardness, shear modulus and, if required, resistance to creep shall be taken from near the centre of the bearing. Quadruple-shear test pieces for the determination of shear modulus shall have the dimensions specified in ISO 1827, but shall be made using a suitable post-vulcanization bonding method.

NOTE 5 It may be possible to obtain these test pieces from a finished bearing by means of a cored sample.

Test pieces for the determination of hardness for quality control purposes (as specified in 6.2.1 and table 3), tensile strength, elongation at break, accelerated ageing, ozone resistance, low-temperature brittleness and, if required, tear strength and oil resistance shall include part of the outer surface of the bearing.

The adhesion between rubber and reinforcing layers in a laminated bearing shall be assessed on a complete bearing or on a portion of a complete bearing, depending on the method.

6 Test requirements

Unless otherwise specified, the test shall be carried out at a standard temperature in accordance with ISO 471.

6.1 General performance requirements

6.1.1 Shear modulus

The shear modulus of the rubber shall be determined by means of a quadruple-shear test in accordance with ISO 1827. It shall be calculated by multiplying the shear stress at a shear strain of 25 % by 4. For quality control purposes, the shear modulus shall comply with the specified value within the tolerance given in table 1.

6.1.2 Hardness

The hardness of test pieces from the centre of the bearing shall be determined by the method specified in ISO 48 and shall comply with the requirements given in table 1.

6.1.3 Ozone resistance

When tested in accordance with the method specified in ISO 1431-1, for 96 h at 40 °C under 20 % elongation at an ozone concentration of 25 pphm or 50 pphm, test pieces shall comply with the requirements given in table 1. The test ozone concentration

shall be selected according to the natural level of ozone in which the bearing is to be used.

Examination of ozone cracking shall be made only on the surface of the test piece that represents the outer rubber surface of the bearing.

6.1.4 Low-temperature resistance

The grade required shall be selected from the list given in 4.3.2.

Test requirements for grades 2 to 5 are given in tables 1 and 2. There are no low-temperature resistance requirements for grade 1.

When applicable, low-temperature brittleness shall be determined by the method specified in ISO 812. At the appropriate test temperatures given in table 2, test pieces shall comply with the requirements given in table 1.

Low-temperature hardness shall be measured at the appropriate test temperature given in table 2 after conditioning for 22 h at this test temperature. The increase in hardness over the hardness measured at standard temperature (6.1.2) shall comply with the requirements given in table 1.

NOTE 6 A bridge bearing pad in service is subject to cyclic movements due to changes in temperature and traffic. These reduce the possible effects of low-temperature crystallization. It is recognized that there are no suitable tests available at present that reflect these conditions.

6.1.5 Adhesion strength (laminated bearings only)

The adequacy of the bond between the rubber and reinforcing layers shall be assessed by one of three methods, as described below.

6.1.5.1 A direct-peel test using the method described in ISO 813 (for rubber-to-metal adhesion) or ISO 36 (for rubber-to-textile-fabric adhesion). Test pieces shall be cut from the finished bearing. The peel bond strength shall be not less than 7 N/mm.

6.1.5.2 An overload deflection test conducted on a completed bearing using an agreed procedure. A recommended procedure is to increase the load in compression to 1,5 times the design load. The tested bearing shall be examined in both the strained and unstrained states for visible faults. Distortion of the rubber profile may be an indication of bond failure. The holding fixtures and the means of loading shall be suitably designed to prevent damage to the bearing rubber or reinforcing layers.

6.1.5.3 A "shear-break" test using the procedure described in annex A.

6.2 Quality control requirements

NOTE 7 For tolerance on shear modulus, see 6.1.1.

6.2.1 Hardness

The hardness of the tensile test pieces (see 6.2.2) shall be determined by the micro-method specified in ISO 48 and shall comply with the requirement given in table 3.

NOTE 8 This additional hardness measurement is specified in order to determine the change in hardness after accelerated ageing (6.2.4). The measurement made under 6.1.2 is not suitable for this purpose since the hardness at the centre of the bearing may not be the same as that of the surface of the bearing. The micro-test is specified because a thin piece is required for uniform ageing at the temperature specified in table 3.

6.2.2 Tensile strength and elongation at break

When determined in accordance with the method specified in ISO 37, using a type 2 dumb-bell test piece, the tensile strength and elongation at break shall comply with the requirements of table 3 for the rubber polymer used and for the appropriate hardness range.

6.2.3 Compression set

When determined in accordance with the method specified in ISO 815, the compression set shall comply with the requirements of table 3.

6.2.4 Accelerated ageing

After test pieces have been aged in air in accordance with the method specified in ISO 188, the changes in hardness, tensile strength and elongation at break shall comply with the requirements of table 3. The change in hardness shall be the difference between the aged hardness and the unaged hardness determined in accordance with 6.2.1.

The ageing time and temperature shall be those given in table 3.

NOTE 9 Chloroprene rubber does not normally soften on accelerated ageing. The potential 3 IRHD loss permitted allows for problems of reproducibility of measurement.

6.3 Optional requirements

Each of the following is optional and shall be carried out only if expressly specified by the customer.

6.3.1 Tear strength

Tear strength shall be determined by method A (trouser test piece) described in ISO 34-1.

It is recommended that the tear strength should not be less than 6 kN/m.

NOTE 10 Specification of resistance to tearing may be advisable for materials with which experience is limited (see annex B) and for certain designs of bearing in order to prevent tears developing during manufacture, installation and service.

6.3.2 Resistance to creep

Resistance to creep shall be determined in accordance with ISO 8013 at standard temperature.

NOTE 11 Chloroprene rubber and natural rubber materials meeting the requirements of 6.1 and 6.2 should have satisfactory resistance to creep and thus need not be tested in this way. The test is primarily intended for use with materials with which experience is limited.

7 Details required for a specification

A material specification based upon the provisions of this International Standard shall include the following minimum details:

a) a rubber polymer (or rubber polymers) in accordance with 4.1;

b) a shear modulus or hardness requirement in accordance with 4.2;

c) a grade of low-temperature resistance in accordance with 4.3.2 and the appropriate test requirements taken from 6.1.4;

d) an ozone-resistance test using one of the two test ozone concentrations specified in 6.1.3;

e) appropriate quality control requirements for the specified rubber polymer and hardness range in accordance with 6.2;

f) the source of test pieces, using the procedure specified in clause 5.

In addition, one of the adhesion tests specified in 6.1.5 shall be included in any specification applicable to laminated bearings.

One or more of the optional tests (6.3) for the determination of tear strength and resistance to creep may be included in the specification as appropriate.

Test methods, test conditions and limits shall be as specified in this International Standard.

Table 1 — Specification for performance properties

Property	Unit	Requirement
Permitted overall hardness range	IRHD	45 to 75
Shear modulus[1]		As specified
(For tolerance, see table 3)		
or		
Nominal hardness[2]	IRHD	50, 60, 70
Permissible tolerance on specified nominal hardness	IRHD	± 5
Ozone resistance		
25 pphm or 50 pphm ozone, 20 % elongation, 96 h at 40 °C		No cracking
Low-temperature brittleness		
Grades 3, 4, 5 only, at temperature specified in table 2		No failures
Low-temperature hardness		
Grades 2 to 5 only, after 22 h at temperature specified in table 2, maximum increase	IRHD	15

1) See 4.2.1.
2) See 4.2.2.

Table 2 — Low-temperature test conditions

Test parameter	Grade				
	1	2	3	4	5
Low-temperature brittleness test temperature, °C	N/A[1)]	N/A[1)]	− 25	− 25	− 40
Low-temperature hardness test temperature, °C	N/A[1)]	− 10	− 25	− 25	− 40

1) N/A = not applicable.

Table 3 — Specification for quality control properties

Property	Unit	Requirements for	
		CR	NR
Overall hardness range	IRHD	45 to 75	45 to 75
Tolerance on specified nominal shear modulus	MPa	± 15 %	± 15 %
Tensile strength, min.	MPa	13	15,5
Elongation at break, min.			
45 IRHD to 55 IRHD	%	400	450
56 IRHD to 65 IRHD	%	400	400
66 IRHD to 75 IRHD	%	300	300
Compression set, after 22 h at 70 °C, max.	%	20	30
Accelerated-ageing resistance			
Ageing time	h	70	168
Ageing temperature	°C	100	70
Maximum change from unaged values			
— hardness	IRHD	$^{+15}_{-3}$	± 10
— tensile strength	%	− 15	− 15
— elongation at break[1)]	%	− 40	− 20

1) As percentage of unaged value.

Annex A
(normative)

Assessment of adhesion in laminated bridge bearings

A.1 Principle

A portion of a laminated bridge bearing is subjected to a shear deflection in excess of the maximum design deflection, and the rubber and bond are examined for signs of breakdown or separation. The test is sometimes known as the "shear-break" test.

A.2 Test pieces

Two test pieces each containing no fewer than three layers of rubber shall be cut from the finished bearing. Depending on the thickness of the bearing, the dimensions of each test piece shall be not less than 50 mm × 100 mm, and not more than 100 mm × 200 mm. Two opposite ends of each test piece shall be bevelled to an angle of 45°.

A.3 Procedure

Between the two test pieces, insert a central loading plate and place the assembly between two suitable mounting supports (see figure A.1). The loading plate and mounting supports shall be appropriately designed to prevent slippage of the test pieces during the test.

Apply a vertical (compressive) force F_V equivalent to a compressive stress of 4 MPa. Then gradually apply a horizontal (shear) force F_H to the central loading plate until the specified shear stress or deflection is reached. Examine the test pieces for evidence of cracking or peeling both in the strained and unstrained state.

NOTE 12 The applied maximum shear stress will depend on the nature of the rubber and on the construction of the bearing. For steel-laminated bearings containing chloroprene rubber materials in the hardness range 56 IRHD to 65 IRHD, a shear stress of 7 MPa is considered suitable for this test.

A.4 Expression of results

If neither test piece shows evidence of peeling or separation at or near the interface between the rubber and reinforcing layers, the bearing shall be concluded to have satisfactory adhesion.

Dimensions in millimetres

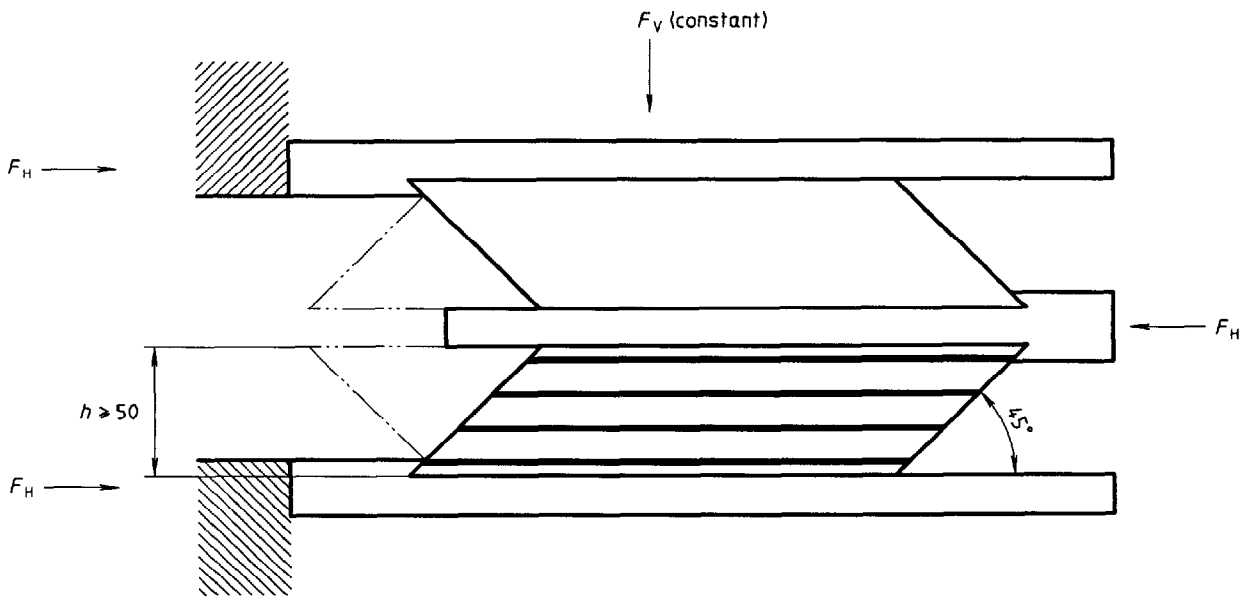

Figure A.1 — Shear-break test piece and test

Annex B
(informative)

Alternative rubber materials

B.1 Rubber materials based on the following rubber polymers are in limited use in bridge bearings in various parts of the world:

Terpolymer of ethylene, propylene and a diene with the residual unsaturated portion of the diene in the side chain (EPDM)

Isobutene-isoprene copolymer (butyl-rubber — IIR)

Chloro-isobutene-isoprene (chlorobutyl rubber — CIIR)

B.2 Tentative quality control requirements for rubber materials based on EPDM, IIR and CIIR are given in table B.1. These values relate to tests carried out on test pieces specifically moulded for test purposes and not on test pieces cut from bearings.

Table B.1 — Tentative quality control requirements for alternative rubber polymers

Property	Unit	Requirements for		
		EPDM	IIR	CIIR
Hardness range	IRHD	60 to 75	55 to 65	55 to 65
Tolerance on specified nominal shear modulus	MPa	± 15 %	± 15 %	—
Tensile strength, min.	MPa	15	16,5	16,5
Elongation at break, min.				
55 IRHD	%	—	600	500
60 IRHD	%	400	550	450
65 IRHD	%	350	550	400
70 IRHD	%	300	—	—
Compression set, after 22 h at 70 °C, max.	%	25	25	20
Accelerated-ageing resistance; max. change from unaged values after 70 h at 100 °C				
— hardness	IRHD	+ 10	± 10	+ 10
— tensile strength	%	− 15	− 25	− 15
— elongation at break[1)]	%	− 40	− 25	− 25

1) As percentage of unaged value.

ICS 83.140.00; 93.040.00

Descriptors: rubber, rubber products, bridges, supports, specifications, materials specifications, tests.

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