INTERNATIONAL STANDARD

ISO 4635

Second edition
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Rubber, vulcanized — Preformed joint seals for use between concrete paving sections of highways — Specification

Caoutchouc vulcanisé — Joints d'étanchéité préformés utilisés entre les dalles en béton des routes — Spécifications

Reference number
ISO 4635:2011(E)

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 4635 was prepared by Technical Committee ISO/TC 45, *Rubber and rubber products*, Subcommittee SC 4, *Products (other than hoses)*.

This second edition cancels and replaces the first edition (ISO 4635:1982), which has been technically revised.

The main modifications are as follows:

— The hardness classes have been changed from IRHD 55, IRHD 60, IRHD 65 and IRHD 70 to IRHD 40, IRHD 50, IRHD 60, IRHD 70 and IRHD 80. Hardness tolerances have been added. Requirements have been added for compression set at low temperature, stress relaxation in compression and protection against over-extension.

— Clauses have been included on functional testing for cold climates, the effect of water, and marking, labelling and packaging.

— The requirements for recovery at low and elevated temperatures have been changed. In addition, the ozone resistance is now measured only under normal conditions (50 pphm ozone) and not under the alternative severe conditions (200 pphm ozone).

— The temperature at which the compression set at elevated temperature is measured has been changed from 100 °C to 70 °C.

Rubber, vulcanized — Preformed joint seals for use between concrete paving sections of highways — Specification

CAUTION — Manufacturers shall ensure that emissions from their products of substances which could be hazardous to health or to the environment are not in excess of the legally permitted level in the country of use.

1 Scope

This International Standard specifies requirements for material for preformed vulcanized rubber joint seals used between concrete paving sections of highways.

It is applicable to seals for joints in new concrete highways as well as to maintenance work on such highways.

It does not cover the design or dimensions of seals, but general requirements for finished seals are given.

NOTE This International Standard is based on experience with chloroprene (CR) rubber and ethylene-propylene-diene monomer (EPDM) rubber.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

ISO 48:2010, *Rubber, vulcanized or thermoplastic — Determination of hardness (hardness between 10 IRHD and 100 IRHD)*

ISO 188, *Rubber, vulcanized or thermoplastic — Accelerated ageing and heat resistance tests*

ISO 815-1:2008, *Rubber, vulcanized or thermoplastic — Determination of compression set — Part 1: At ambient or elevated temperatures*

ISO 815-2:2008, *Rubber, vulcanized or thermoplastic — Determination of compression set — Part 2: At low temperatures*

ISO 1431-1, *Rubber, vulcanized or thermoplastic — Resistance to ozone cracking — Part 1: Static and dynamic strain testing*

ISO 1817, *Rubber, vulcanized — Determination of the effect of liquids*

ISO 2230, *Rubber products — Guidelines for storage*

ISO 2285, *Rubber, vulcanized or thermoplastic — Determination of tension set under constant elongation, and of tension set, elongation and creep under constant tensile load*

ISO 3302-1:1996, *Rubber — Tolerances for products — Part 1: Dimensional tolerances*

ISO 3384:2005[1)], *Rubber, vulcanized or thermoplastic — Determination of stress relaxation in compression at ambient and at elevated temperatures*

ISO 3387, *Rubber — Determination of crystallization effects by hardness measurements*

ISO 5893, *Rubber and plastics test equipment — Tensile, flexural and compression types (constant rate of traverse) — Specification*

ISO 23529, *Rubber — General procedures for preparing and conditioning test pieces for physical test methods*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
joint
vertical discontinuity between the adjacent faces of paving slabs in a concrete highway, formed for the purpose of providing some movement capability

3.2
joint chamber
cut made in the upper part of the joint to offer a seating for a preformed joint seal

NOTE The width of the chamber depends on the movement capability required of the preformed joint seal. The bottom of the chamber supports the preformed joint seal, enabling it to withstand the vertical forces caused by traffic.

3.3
preformed joint seal
extruded (preformed) and vulcanized elastic rubber profile that, when inserted by special machines into the joint chamber, is compressed by the adjacent surfaces of the paving slabs, thus filling the joint and preventing the ingress of water

NOTE A fibre reinforcement can be incorporated in the preformed joint seal as additional protection against over-extension.

3.4
international rubber hardness degree
IRHD
measure of hardness, the magnitude of which is derived from the depth of penetration of a specified indentor into a test piece under specified conditions

NOTE 1 The reaction forces produced by compressed preformed joint seals depend on the geometry and hardness of the seal. The higher the IRHD value, the higher the reaction force. The lower the IRHD value, the better the lips of the rubber profile grip the surfaces of the joint chamber.

NOTE 2 ISO 48 specifies a method of measuring hardness in terms of IRHD values.

4 Classification

The hardness of materials for preformed joint seals shall be divided into five classes, as given in Table 1.

Table 1 — Hardness classification

Hardness class	40	50	60	70	80
Range of IRHD	> 35 but $\leqslant 45$	> 45 but $\leqslant 55$	> 55 but $\leqslant 65$	> 65 but $\leqslant 75$	> 75 but $\leqslant 85$

1) Under revision as ISO 3384-1.

5 Test pieces and temperature of test

5.1 Unless otherwise specified, the test pieces shall be cut from the finished product by the method specified in ISO 23529. If the test pieces specified in a particular test method cannot be prepared from the finished seals, they shall be taken from moulded test slabs of suitable dimensions, made from the same batch of material as used for the seal, and vulcanized under conditions which are comparable with the conditions used in production.

5.2 Unless otherwise specified, the test shall be carried out at a standard laboratory temperature in accordance with ISO 23529.

6 Requirements

6.1 General

6.1.1 The seal materials shall be made from an ozone-resistant rubber (see 6.11) and shall not depend for ozone resistance solely on surface protection, as this can be removed by abrasion, detergents or other means.

6.1.2 The material shall be black.

6.2 Dimensional tolerances

The dimensions shall be determined in accordance with ISO 3302-1 and the result shall conform to class E1 or E2 as defined in ISO 3302-1:1996.

6.3 Imperfections and defects

Imperfections and defects shall be determined by visual inspection. The surfaces of preformed seals shall be free of surface defects or irregularities, as these can affect their proper functioning.

6.4 Hardness

6.4.1 The hardness shall be determined in accordance with ISO 48:2010, method M. The result shall conform to the relevant value given in Table 2, line 1.1.

6.4.2 In addition, make five measurements at points distributed at random over a 5 m length of the preformed joint seal. The difference between the minimum and the maximum hardness shall not be more than 5 IRHD. Each value shall be within the range specified for the relevant hardness class (see Table 2, line 1.2).

6.5 Tensile strength and elongation at break

6.5.1 These tests shall be carried out on test pieces from the product, with the textile material removed, using the technique specified in ISO 23529, where appropriate.

6.5.2 The tensile strength and elongation at break shall be determined in accordance with ISO 37, preferably using a type 2 dumb-bell test piece. The tensile strength and the elongation at break shall conform to the relevant values given in Table 2, lines 2 and 3.

Table 2 — Requirements for preformed joint seals

Line No.	Property	Unit	Sub-clause	Requirements for hardness classes				
				40	**50**	**60**	**70**	**80**
1.1	Hardness	IRHD	6.4	> 35 but ⩽ 45	> 45 but ⩽ 55	> 55 but ⩽ 65	> 65 but ⩽ 75	> 75 but ⩽ 85
1.2	Hardness tolerance	IRHD	6.4	⩽ 5				
2	Tensile strength	MPa	6.5	⩾ 9				
3	Elongation at break	%	6.5	⩾ 400	⩾ 375	⩾ 300	⩾ 200	⩾ 125
4	Compression set, 22^{+2}_{0} h		6.6					
	— at +70 °C	%	6.6.2	⩽ 20				
	— at −25 °C		6.6.3	⩽ 60				
5	Accelerated ageing in air, 72^{+2}_{0} h at 100 °C		6.7					
	— change in hardness, max. limits	IRHD		±5				
	— change in tensile strength, max. limits	%		−20/+40				
	— change in elongation at break, max. limits	%		−30/+10				−40/+10
6	Stress relaxation in compression, 100 days at 50 °C	%	6.8	50			55	
7	Recovery at low and elevated temperatures		6.9					
	— at −25 °C[a]	%		⩾ 65				
	— at +70 °C			⩾ 80				
8	Hardness increase after 168^{+2}_{0} h at −10 °C[a]	IRHD	6.10	+15 max.			+10 max.	
9	Ozone resistance		6.11	No cracking				
10	Effect of water (volume change after 168^{+2}_{0} h)	%	6.12	0/+5				
11	Protection against over-extension		6.13					
	— elongation at which fibre first starts to act	%		⩽ 2				
	— elongation at 300 N tensile force	%		⩽ 2				
	— tensile force at which fibre breaks	N		⩾ 300				
12	Functional testing for cold climates; minimum compressive force	kN/m	6.14	⩾ 0,03				

[a] These low-temperature tests are optional in the case of usage in tropical countries.

6.6 Compression set in air

6.6.1 General

If the test piece is taken from a seal, the measurement shall be carried out as far as possible in the direction of compression of the seal in service.

6.6.2 Compression set at elevated temperature

6.6.2.1 The compression set after 22^{+2}_{0} h at 70 °C shall be determined in accordance with ISO 815-1:2008 using a type B test piece. Where, however, the cross section is too small to allow type B test pieces to be taken from the product, the tension set at constant elongation shall be determined using the method specified in ISO 2285 at a strain of 50 %. The same length of time and the same temperature shall be used as for compression set.

6.6.2.2 The compression set at 70 °C shall conform to the relevant value given in Table 2, line 4. If the tension set is determined, it shall meet the same requirement.

6.6.3 Compression set at low temperature

6.6.3.1 The compression set after 22^{+2}_{0} h at low temperature (–25 °C) shall be determined in accordance with ISO 815-1:2008 using a type B test piece. Where, however, the cross section is too small to allow type B test pieces to be taken from the product, the tension set at constant elongation shall be determined using the method specified in ISO 2285 at a strain of 50 %. The same length of time and the same temperature shall be used as for compression set.

6.6.3.2 The compression set at –25 °C shall conform to the relevant value given in Table 2, line 4. If the tension set is determined, it shall meet the same requirement.

6.7 Accelerated ageing in air

After ageing the test pieces in air for 72^{+2}_{0} h at 100 °C by the method specified in ISO 188, the changes in hardness, tensile strength and elongation at break shall be within the relevant limits given in Table 2, line 5.

6.8 Stress relaxation in compression

The stress relaxation shall be determined by method B of ISO 3384:2005, using cylindrical test pieces after mechanical and thermal conditioning.

If the test piece is taken from a seal, the measurement shall be carried out as far as possible in the direction of compression of the seal in service.

The stress relaxation after 100 days at 50 °C shall conform to the relevant value given in Table 2, line 6.

6.9 Recovery at low and elevated temperatures

The recovery at low and elevated temperatures shall be determined in accordance with Annex A. The recovery at low and elevated temperatures shall conform to the relevant values given in Table 2, line 7.

6.10 Low-temperature hardness change

This low-temperature requirement is optional in the case of usage in tropical countries.

Where applicable, the low-temperature hardness change shall be determined in accordance with the method specified in ISO 3387. The increase in hardness, after 168^{+2}_{0} h at –10 °C, compared with the hardness at –10 °C shall conform to the relevant value given in Table 2, line 8.

6.11 Ozone resistance

6.11.1 The ozone resistance shall be determined by the method for static strain testing specified in ISO 1431-1, using test pieces taken from the seal and under the following conditions:

- ozone concentration: (50 ± 5) pphm;
- temperature: (40 ± 1) °C;
- length of conditioning in the strained state: (72 ± 2) h;
- exposure time: (96 ± 1) h;
- elongation for > 35 IRHD but ⩽ 75 IRHD: (20 ± 2) %;

— elongation for > 75 IRHD but ⩽ 85 IRHD: (15 ± 2) %;

— standard relative humidity in accordance with ISO 23529.

6.11.2 The ozone resistance shall meet the requirement given in Table 2, line 9.

6.12 Effect of water

6.12.1 The effect of water shall be determined in accordance with ISO 1817 as the change in volume after immersion in water for 168^{+2}_{0} h at a standard laboratory temperature.

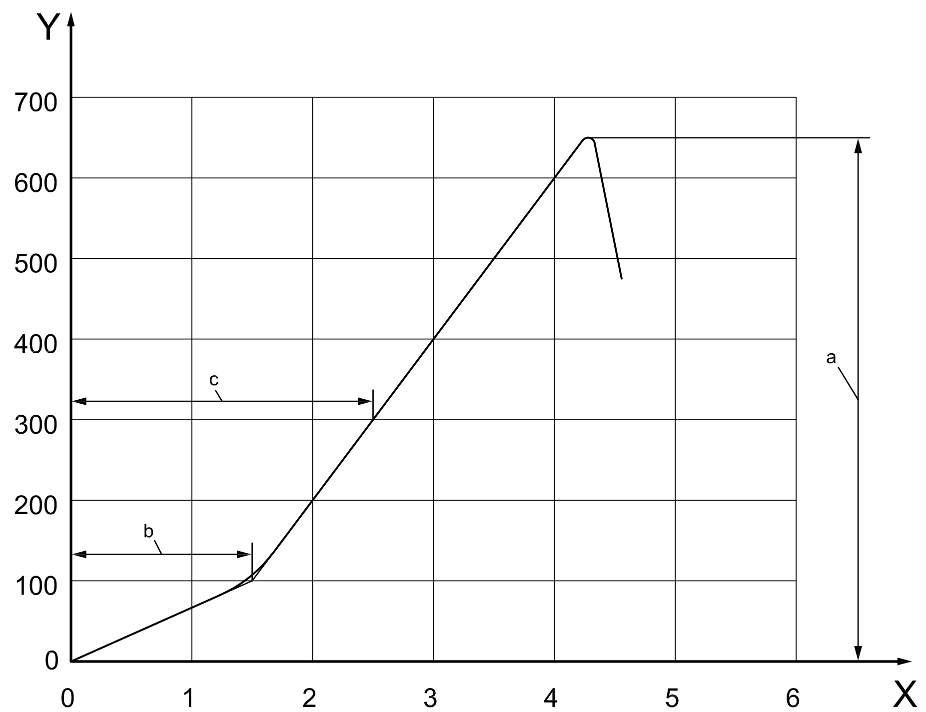
6.12.2 The change in volume shall be within the limits given in Table 2, line 10.

6.13 Protection against over-extension

6.13.1 This test applies to preformed joint seals containing a glass reinforcement fibre designed to prevent over-extension of the profile during installation.

6.13.2 The effectiveness of the protection against over-extension shall be determined as follows.

Take from the seal a test piece of length 1 000 mm and mount it at a standard laboratory temperature (see ISO 23529) between two clamps so that the free length between the clamps is 500 mm. Extend the test piece at 50 mm/min until the glass fibre breaks. The elongation of the fibre at the point at which the fibre first starts to act (i.e when the slope of the force/elongation curve changes), the elongation at 300 N and the tensile force at break are determined (see Figure 1).



Key

X elongation, in per cent

Y tensile force, in newtons

[a] Tensile force at point when fibre breaks.

[b] Elongation at point when fibre first starts to act.

[c] Elongation at 300 N.

Figure 1 — Example of force/elongation curve

6.13.3 The elongation at the point when the fibre first starts to act, the elongation at 300 N and the tensile force at the point when the fibre breaks shall conform to the relevant values given in Table 2, line 11.

6.14 Functional testing for cold climates

6.14.1 When the seal is intended to be used in cold climates in which the temperature can go below −25 °C, the minimum compressive force during compression/expansion and simultaneous temperature cycling shall be determined in accordance with Annex B.

6.14.2 The compressive force shall conform to the relevant value given in Table 2, line 12.

6.14.3 As the width of joints changes with temperature, the profile should be flexible enough to compensate for dimensional changes over a broad temperature range, including temperatures as low as −30 °C. In this context, particular attention should be paid to the cyclic mechanical stresses and to the compression set of the material.

7 Marking, labelling and storage

7.1 Each container of preformed joint seals shall be clearly and indelibly marked with at least the following information:

- the manufacturer's name and address;
- the nominal joint width;
- the identification number of the seal;
- the identification number of the rubber compound used in its manufacture;
- the hardness class;
- the date of manufacture;
- the number and year of publication of this International Standard (i.e. ISO 4635:2011);
- guidelines for storage and disposal.

7.2 At all stages between manufacture and use, the seals shall be stored in accordance with the recommendations given in ISO 2230.

Annex A
(normative)

Recovery at low and elevated temperatures

A.1 Principle

Test pieces taken from preformed joint seals are compressed between two parallel plates for a defined time at low or elevated temperature. After release, the degree of recovery is determined.

NOTE This procedure is a quick test to check the profile quality in cases when a joint opens while in service. The stress-relaxation test (see 6.8) is used to check the long-term behaviour of a profile.

A.2 Apparatus and materials

A.2.1 Compression-testing machine, meeting the requirements of ISO 5893, with two parallel, flat, highly polished plates made of chromium-plated or stainless steel or another corrosion-resistant material. The compression plates shall be flat to within 0,01 mm.

A.2.2 Stainless-steel spacers, to adjust the distance between the compression plates so that it corresponds to the normal joint width at the place of use of the seal.

A.2.3 Measuring device, to measure the dimensions of the test piece.

A.2.4 Air oven, in accordance with ISO 188, that can be maintained at a temperature of (70 ± 1) °C.

A.2.5 Enclosure, that can be maintained at a temperature of (–25 ± 2) °C.

A.3 Procedure

A.3.1 At each test temperature, three segments, each 125 mm in length, of the seal shall be compressed, using the stainless steel spacers, in the compression-testing machine to the normal joint width at the place of use.

For the –25 °C test, keep the compressed test pieces in the compression-testing machine at –25 °C for 24 h ± 15 min and then remove them from the machine and allow them to remain at –25 °C in the relieved state for 1 h ± 5 min.

For the 70 °C test, keep the compressed test pieces in the compression-testing machine at 70 °C for 72 h ± 15 min and then remove them from the compression-testing machine and allow them to remain at a standard laboratory temperature in the relieved state for 1 h ± 5 min.

A.3.2 After these times, measure the width of the recovered test piece using the measuring device.

A.4 Calculation and expression of results

Calculate the degree of recovery as follows:

Recovery (%) = (Recovered section width/original section width) × 100

Annex B
(normative)

Functional testing for cold climates

B.1 General

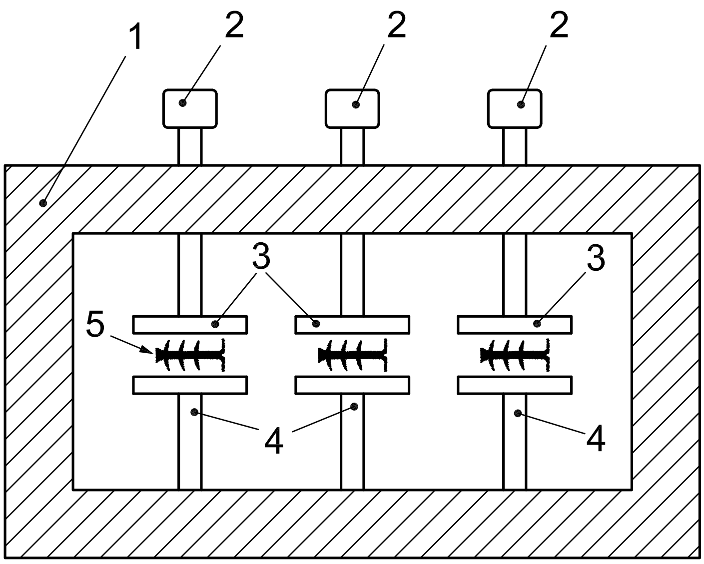
This test is intended to measure the ability of preformed joint seals to retain their elastic properties at low temperatures.

B.2 Apparatus

The test shall be carried out in a climatic chamber (see Figure B.1) capable of regulating the temperature between +30 °C and −30 °C with an accuracy of ±2 °C.

A tensile and compression test rig shall be fitted inside the chamber, with at least three pairs of plates so as to allow simultaneous testing of three test pieces. The plate ends shall consist of parallel, flat, highly polished stainless-steel plates between which the test pieces are compressed. The plates shall be sufficiently rigid to withstand the stress without bending and of sufficient size to ensure that the compressed test piece lies within the area of the plates.

The test rig shall be motor-driven without significant slip or backlash, giving a constant rate of movement. The rate of movement shall be 0,60 mm/h ± 10 %. Three load cells connected to electronic data-collection equipment shall be used to measure and record the compression force with an accuracy of ±2 % of the minimum compression force applied to each system.



Key

1 climatic chamber capable of regulating the temperature between +30 °C and −30 °C
2 load cells connected to electronic data-collection equipment for measuring and recording the compression force
3 fixed plates
4 moving plates
5 test piece

Figure B.1 — Sketch showing principle of test apparatus

B.3 Test pieces

For each test, cut at least three test pieces from a preformed joint seal. The preferred length for the test pieces is (70 ± 1) mm or (100 ± 1) mm.

B.4 Procedure

B.4.1 Functional test

B.4.1.1 Place the test pieces between the plates in the direction of compression of the seal in service and compress them to the nominal joint width as specified for the product by the manufacturer (for example 8 mm) ±2 %.

B.4.1.2 Place the assembly in an oven operating at (70 ± 1) °C and age the test pieces for 30 days.

B.4.1.3 After ageing, start the test at (11 ± 1) °C, with the gap between the plates equal to the nominal joint width.

B.4.1.4 Carry out a succession of compression/expansion cycles, at the same time varying the temperature. Start by compressing the test pieces and increasing the temperature, synchronizing the movement of the plates with the increase in temperature in such a way that a width of 80 % of the nominal width is reached at the maximum temperature of +25 °C. Next allow the test pieces to expand and reduce the temperature, again synchronizing the movement of the plates and the decrease in temperature in such a way that a maximum width of 150 % of the nominal width is reached at the lowest temperature of −25 °C. Then compress the test pieces again and increase the temperature to bring the test pieces back to their original width and the temperature back to 11 °C. A complete cycle shall take 24 h. Carry out three such cycles.

EXAMPLE If the nominal joint width is 8 mm, the minimum width will be 6,4 mm and the maximum width 12 mm. The rate of deformation has to be chosen so that the total change in width of 5,6 mm can be produced in 12 h. It will therefore have to be 5,6 mm/12 h, i.e. 0,47 mm/h. The tolerance applicable to this rate is ±10 %.

B.4.1.5 The degree of joint compression is calculated as the change in joint width, Δd, divided by the nominal joint width, d_0, expressed as a percentage:

$$\text{Degree of joint compression (\%)} = \frac{\Delta d}{d_0} \times 100$$

A plot of joint compression/expansion versus temperature for a complete cycle is shown in Figure B.2.

B.4.2 Calculation and expression of results

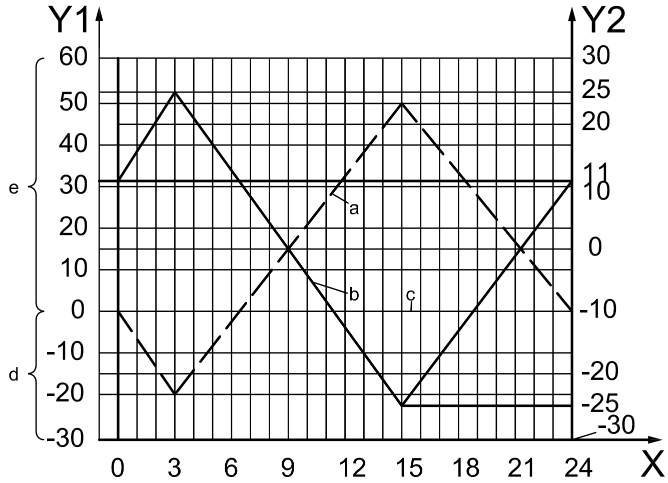
B.4.2.1 The compressive force, which varies as a function of temperature and joint width, shall be measured in kilonewtons per metre width. The results can be presented in the form of force-time curves showing the variation in the compressive force acting on the test pieces.

B.4.2.2 Determine the minimum compressive force (i.e. that at −25 °C) for each of the three cycles for each test piece.

B.4.2.3 Take as the test result the lowest value of the minimum compressive forces determined.

B.4.3 Precision

Data on the repeatability and reproducibility of this test method are not yet available but will be added when they do become available.



Key

X time, in hours

Y1 degree of joint compression (see B.4.1.5)

Y2 temperature, in degrees Celsius

[a] Degree of joint compression versus time.

[b] Temperature versus time.

[c] Nominal joint width (taken as 0 change in width).

[d] Plates closing (joint being compressed).

[e] Plates opening (joint being allowed to expand).

Figure B.2 — Test cycle

ICS 83.140.50; 91.100.50

Price based on 11 pages