INTERNATIONAL STANDARD

ISO 10619-1

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Rubber and plastics hoses and tubing — Measurement of flexibility and stiffness —

Part 1: Bending tests at ambient temperature

Tuyaux et tubes en caoutchouc et en plastique — Mesurage de la flexibilité et de la rigidité —

Partie 1: Essais de courbure à température ambiante

Reference number
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Foreword

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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 10619-1 was prepared by Technical Committee ISO/TC 45, *Rubber and rubber products*, Subcommittee SC 1, *Hoses (rubber and plastics*).

This first edition cancels and replaces ISO 1746:1998. It also incorporates the Technical Corrigendum ISO 1746:1998/Cor.1:1999. In particular, it specifies additional test methods.

ISO 10619 consists of the following parts, under the general title *Rubber and plastics hoses and tubing — Measurement of flexibility and stiffness*:

— *Part 1: Bending tests at ambient temperature*

— *Part 2: Bending tests at sub-ambient temperatures*

— *Part 3: Bending tests at high and low temperatures*

Rubber and plastics hoses and tubing — Measurement of flexibility and stiffness —

Part 1:
Bending tests at ambient temperature

WARNING — Persons using this part of ISO 10619 should be familiar with normal laboratory practice. This part of ISO 10619 does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user to establish appropriate safety and health practices and to ensure compliance with any national regulatory conditions.

1 Scope

This part of ISO 10619 specifies three methods for measuring the flexibility of rubber and plastics hoses and tubing (methods A1, B and C1), where the deformation of the hose or tubing is measured, and two methods for measuring the stiffness (methods A2 and C2) by measuring the force to bend the hose or tubing when rubber or plastics hoses or tubing are bent to a specific radius at ambient temperature.

Methods A1 and A2 are suitable for rubber and plastics hoses and tubing with inside diameter of up to and including 80 mm.

Method A1 allows the measurement of the flexibility of the hose or tubing by measuring the reduction in outside diameter when the hose is compressed between two plates.

Method A2 provides a means of measuring the force required to reach a specific bend radius, when the hose or tubing is compressed, as between two plates. The test can be carried out at a specified internal pressure.

Method B is suitable for rubber and plastics hoses and tubing with inside diameter of up to and including 100 mm, and provides a means of assessing the behaviour of the hose and tubing when bent around a mandrel. The final mandrel diameter used can be taken as the minimum bend radius of the hose or tubing. As this value is determined by the reduction of the outside diameter which can be used as a measure of the flexibility of the hose or tubing. The hose or tubing being tested can be unpressurized, pressurized or under vacuum and, if required, with the curvature or against the curvature of the hose or tubing, if such curvature is present.

Methods C1 and C2 are suitable for rubber and plastics hoses and tubing with inside diameter of 100 mm and greater.

Method C1 provides a means of determining the flexibility of the hose and tubing at the minimum bend radius.

Method C2 provides a method of measuring the stiffness of the hose and tubing at the minimum bend radius.

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 4671, *Rubber and plastics hoses and hose assemblies — Methods of measurement of the dimensions of hoses and the lengths of hose assemblies*

ISO 8330, *Rubber and plastics hoses and hose assemblies — Vocabulary*

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 terms and definitions given in ISO 8330 and the following apply.

3.1
bending
shaping or forcing something straight into a curve or angle at a specified temperature

3.2
flexibility
ease of bending a hose without it being damaged by kinking, collapse, breaking or cracking

NOTE A hose can be bent around a mandrel, for example.

3.3
stiffness
resistance of a hose to bending

3.4
hose deformation
ovality obtained when a hose is compressed or bent around a mandrel

NOTE This may be measured by the reduction in the outside or inside diameter.

3.5
flexural stiffness
measure of the resistance of a hose to bending

3.6
dynamometer
force measuring device

4 Method A1

4.1 Apparatus

4.1.1 Apparatus, consisting of two guides A and B, guide A being fixed in a plane and guide B being movable in that plane, parallel to and in line with, guide A [see Figure 1a)].

If it is desired to measure the force to attain the specified radius of curvature, this may be done, for example, by means of pulleys and weights. Care shall be taken to minimize the effects of frictional resistance (see Figure 2).

4.2 Hose test pieces

4.2.1 Types and dimensions

The hose test pieces shall consist either of complete manufactured lengths of hose or suitable test lengths. If the manufactured length is shorter than the length required for the test, hose test pieces of adequate length shall be specially manufactured.

4.2.2 Number

Unless otherwise specified, two hose test pieces shall be tested.

4.3 Conditioning of hose test pieces

No test shall be carried out within 24 h of manufacture.

For evaluations which are intended to be comparable, the test shall, as far as possible, be carried out after the same time interval after manufacture. ISO 23529 shall be followed for time between sample manufacture and testing.

Before testing, hose test pieces shall be conditioned for at least 16 h at a standard laboratory temperature and humidity (see ISO 4671): this 16 h period may be part of the 24h interval after manufacture.

4.4 Test temperatures

The test shall be conducted at a standard laboratory temperature and humidity in accordance with ISO 23529.

4.5 Test procedure

4.5.1 If required, apply the specific test pressure or vacuum as given in the relevant product specification.

4.5.2 Measure and determine the average outside diameter, D, of the hose by means of a suitable measuring instrument as specified in ISO 4671.

4.5.3 Draw two parallel and diametrically opposed lines along the length of the hose. If the hose has natural curvature, one of the lines shall be on the outside of the curve. On each of these lines, mark a distance of 1,6 $C + 2\,D$ or 200 mm whichever is longer, where C is twice the minimum bend radius specified in the appropriate specification, so that the marked distances are exactly opposed. This ensures a sufficient length for the bend test and adequate support of the hose.

4.5.4 Separate guides A and B to a distance slightly less than 1,6 $C + 2\,D$. Place the hose between the guides so that the ends of the marked distances are parallel to the ends of the guides and remain in this position while the guides are closed to a distance of $C + 2\,D$ (see Figure 1).

4.5.5 Check that the hose on each side is supported to a length of not less than D.

4.5.6 Measure and determine the minimum outside dimension, T, in the curved position of the hose [see Figure 1b)].

4.6 Expression of results

Calculate the value of T/D using the mean values obtained. Compare the result with the permitted deformation given in the appropriate hose specification.

4.7 Test report

The test report shall include the following information:

a) a reference to this part of ISO 10619, i.e. ISO 10619-1:2011;

b) the method used;

c) a full description of the hose or tubing tested and a reference to the hose specification in accordance with which the hose was tested;

d) the test temperature;

e) the internal pressure or vacuum at which the test was carried out (if applicable);

f) observation on any abrupt change(s) in the hose section or irregularity in curvature caused by kinking;

g) the value of D,T and T/D;

h) whether T/D was within the permitted deformation;

i) the date of the test.

5 Method A2

5.1 Apparatus

5.1.1 Apparatus, consisting of two guides A and B, guide A being fixed in a plane and guide B being movable in that plane, parallel to and in line with, guide A, and attached to a series of pulleys and weights, as shown in Figure 2. Care shall be taken to minimize the effects of frictional resistance.

5.2 Hose test pieces

5.2.1 Types and dimensions

The hose test pieces shall consist either of complete manufactured lengths of hose or suitable test lengths. If the manufactured length is shorter than the length required for the test, test pieces of adequate length shall be specially manufactured.

5.2.2 Number

Unless otherwise specified, two hose test pieces shall be tested.

5.3 Conditioning of hose test pieces

No test shall be carried out within 24 h of manufacture.

For evaluations which are intended to be comparable, the test shall, as far as possible, be carried out after the same time interval after manufacture. ISO 23529 shall be followed for the time between sample manufacture and testing.

Before testing, hose test pieces shall be conditioned for at least 16 h at a standard laboratory temperature and humidity (see ISO 4671): this 16 h period may be part of the 24 h interval after manufacture.

5.4 Test temperatures

The test shall be conducted at a standard laboratory temperature and humidity in accordance with ISO 23529.

5.5 Test procedure

5.5.1 If required, apply the specific test pressure or vacuum as given in the relevant product specification.

5.5.2 Draw two parallel and diametrically opposed lines along the length of the hose test piece. If the hose has natural curvature, one of the lines shall be on the outside of the curve. On each of these lines, mark a distance of 1,6 $C + 2\ D$ or 200 mm whichever is longer, where C is twice the minimum bend radius specified in the appropriate specification, so that the marked distances are exactly opposed. This ensures a sufficient length for the bend test and adequate support of the hose.

5.5.3 Separate guides A and B to a distance slightly less than 1,6 $C + 2\ D$. Place the hose between the guides so that the ends of the marked distances are parallel to the ends of the guides and remain in this position while the guides are closed to a distance of $C + 2\ D$ by adding weights until the minimum outside dimension, T, in the curved position of the hose, has been achieved (see Figure 1).

5.5.4 Check that the hose on each side is supported to a length of not less than D.

5.5.5 Measure and determine the minimum outside dimension, T, in the curved position of the hose and note the total weight added, in kilograms, to reach this position [see Figure 1a)].

5.6 Test report

The test report shall include the following information:

a) a reference to this part of ISO 10619, i.e. ISO 10619-1:2011;

b) the method used;

c) a full description of the hose or tubing tested and a reference to the hose specification in accordance with which the hose was tested;

d) the test temperature;

e) the internal pressure or vacuum at which the test was carried out, if applicable;

f) the value of T and the force (i.e. the total mass added, in kilograms) required to reach the specific bend radius;

g) the date of the test.

6 Method B

6.1 Apparatus

6.1.1 **Mandrel**, having an outside diameter equal to twice the minimum bend radius specified for the hose, or a former, with an arc of at least 180°, as shown in Figure 3. If the minimum bend radius is not specified, the mandrel or former shall have an outside diameter of equal to 12 times the nominal bore of the hose. Additional mandrels whose outside diameter are less that the diameter of the original mandrel chosen should be available.

6.2 Hose test piece

The hose test piece shall be cut from the hose under test and shall have a length adequate to provide a grip at each end in addition to a section which can be bent around the periphery of the mandrel. In addition, if the hose is being tested under pressure or vacuum the sample should be long enough to allow the attachment of suitable end fittings.

6.3 Test temperatures

The test shall be conducted at a standard laboratory temperature and humidity (see ISO 23529).

6.4 Procedure

6.4.1 Measure the outside diameter of the hose or hose assembly (if the sample is being tested under pressure or vacuum) using a suitable procedure conforming with ISO 4671.

6.4.2 The hose or hose assembly should be bent around a circular support mandrel (chosen as specified in 6.1) in order of decreasing diameter until a 20 % reduction in the outside diameter is achieved. If the hose assembly has any natural curvature the test should be done with the natural curvature of the hose. Record the dimension of the mandrel where this reduction in outside diameter occurred. Note other percentage reductions in outside diameter may be used.

6.4.3 Repeat the procedure in 6.4.2 except against the natural curvature of the hose, if applicable.

6.5 Test report

The test report shall include the following:

a) a reference to this part of ISO 10619, i.e. ISO 10619-1:2011;

b) a full description of the hose and its origin;

c) the dimensions of the hose test piece;

d) the pressure under which the test was performed, if applicable;

e) the diameter of the mandrel at which the 20 % reduction (or other specified percentage reduction) of outside diameter occurred;

f) the minimum bend radius of the hose under which the test was performed;

g) the date of the test.

7 Method C1

7.1 Apparatus

7.1.1 Apparatus, as shown in Figure 4. The hose test piece is placed on three support trolleys placed underneath the hose at either end and at the middle of the hose sample. The trolleys should be of a suitable design so as to move freely when the hose is being bent.

The ends of the hose test piece are connected to suitable tensioning device capable of bending the hose to its minimum bend radius.

7.2 Hose test piece

The testing shall be carried out on a finished hose.

7.3 Test temperature

The test shall be conducted at a standard laboratory temperature and humidity (see ISO 23529).

7.4 Procedure

The bending test shall be performed as indicated in Figure 4 with either the hose empty or pressurized, if applicable. The hose shall be bent until the minimum bend radius has been achieved. The test shall be repeated five times. After completion of the bend test, there shall be no permanent deformation, such as kinking or ovality, when returned to the straight position.

7.5 Test report

The test report shall include the following:

a) a reference to this part of ISO 10619, i.e. ISO 10619-1:2011;

b) a full description of the hose and its origin;

c) the dimensions of the test specimen;

d) the pressure under which the test was done, if applicable;

e) the curvature of the hose under which the test was performed;

f) minimum bend radius of the hose, if required;

g) visual examination, such as kinking or ovality when retuned to the straight position;

h) the date of the test.

8 Method C2

8.1 Apparatus

See 7.1.

8.2 Hose test piece

The testing shall be carried out on a finished hose.

8.3 Test temperature

Each hose test piece (with ends unblocked) shall be thermally conditioned for 48 h in an environment maintained at a temperature of 15 ˚C to 25 ˚C.

For testing at temperatures of 5 ˚C to 14 ˚C and 26 ˚C to 35 ˚C the ends of the hose shall be blocked before the hose is thermally conditioned.

8.4 Procedure

With the hose test piece empty and straight, a 1m reference length shall be marked on the centre line of the hose at the hose centre as shown in Figure 4. The ends of the hose shall be blocked before the hose is thermally conditioned.

The hose test piece (which is empty) shall be bent until the hose has reached its minimum bend radius and then allowed to relax to its unloaded condition. Each cycle time (the act of bending the hose) shall be a minimum of 10 min and the relaxing time between each cycle shall be 5 min maximum. The roller system on the hose support trolleys shall be sufficiently friction free so that the induced error is negligible. This procedure is repeated at least four times but not more than seven times ensuring that the bending arc is as close as possible to the original bending arc used.

The pull load, (as indicated by the dynamometer after a period of 5 min from the end of the load application) shall not vary by more than 23 kg force between the last two consecutive pulls; if not, continue until the 7th cycle is reached and register the load, P.

Record the dimensions L, C and H shown in Figure 4 after the last pull; these shall be used to calculate the flexural stiffness. The chord, C, measured between the reference marks should be less than 1,0 m.

8.5 Expression of results

The flexural stiffness, EI, is calculated using the following equation:

$$EI = MR$$

where

$$M = PL$$

and

$$R = \frac{C^2 + 4H^2}{8H}$$

where

M is the bending moment at the hose centre, expressed in kilograms per metre (kg/m)

P is the dynamometer load (cable tension), expressed in kilograms (kg)

L is the moment arm, expressed in metres (m)

R is the minimum bend radius at hose centre, expressed in metres (m)

C is the chord of the bending arc, expressed in metres (m)

H is the offset, expressed in metres (m)

8.6 Test report

The test report shall include the following:

a) a reference to this part of ISO 10619, i.e. ISO 10619-1:2011;

b) a full description of the hose and its origin;

c) the dimensions of the hose test piece;

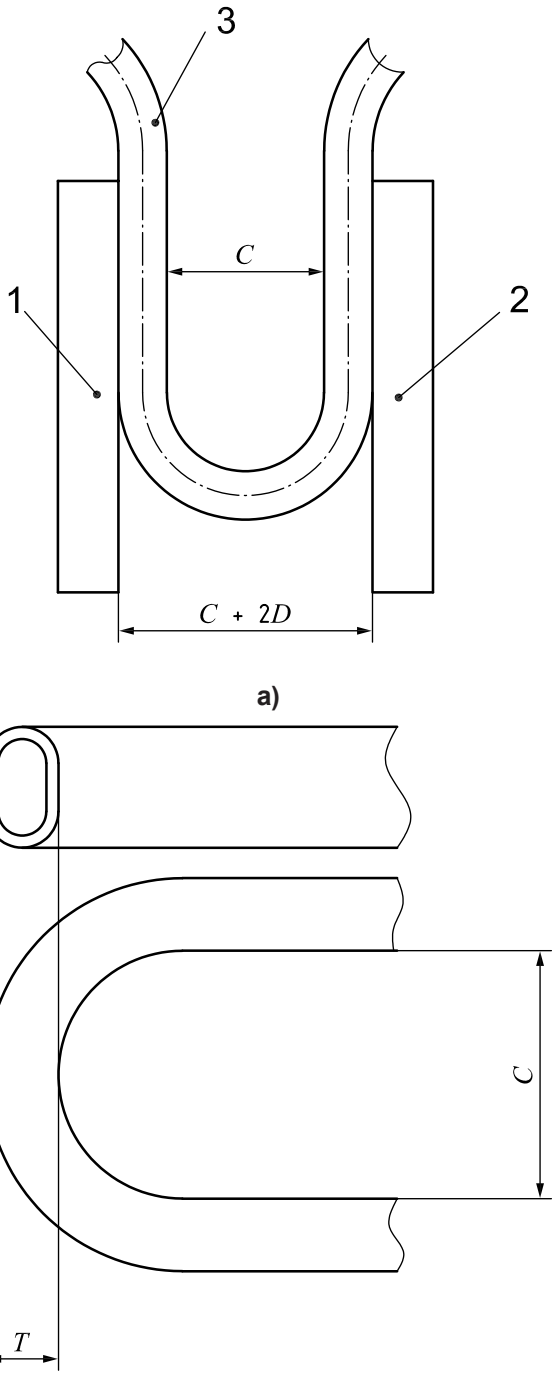
d) the pressure under which the test was done, if applicable;

e) the curvature of the hose under which the test was performed;

f) minimum bend radius of the hose, if required;

g) the result of the flexural stiffness, EI;

h) the date of the test.



Key

1 guide A
2 guide B
3 hose test piece

Figure 1 — Bending test apparatus

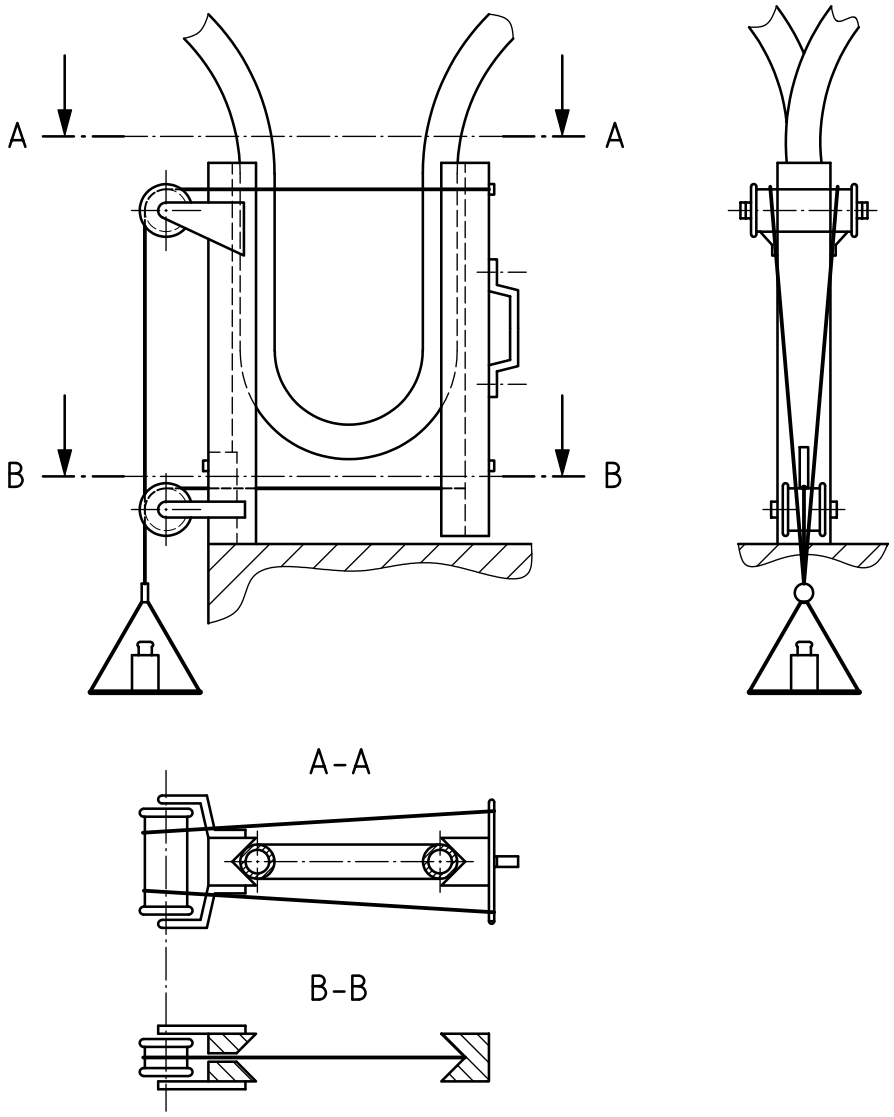
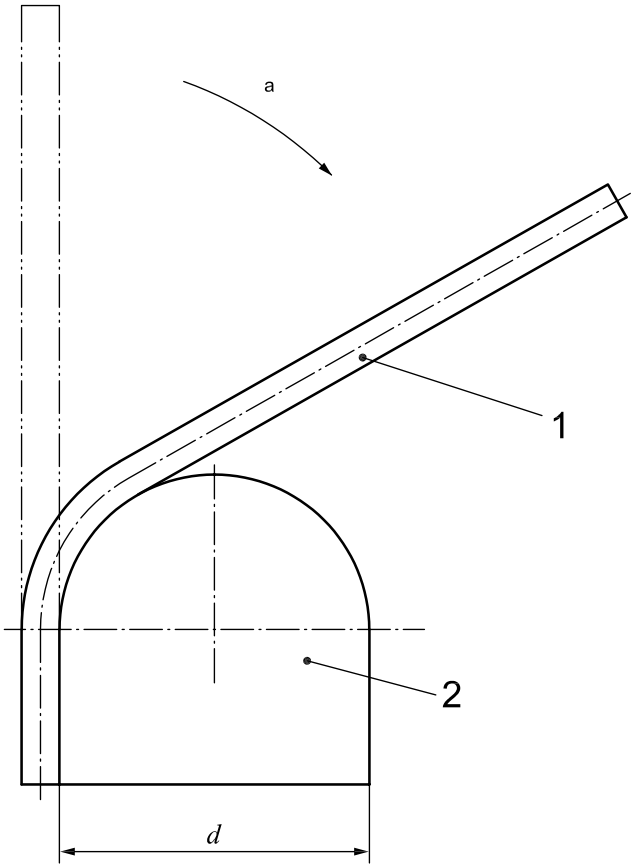


Figure 2 — Test apparatus with pulleys and weights



Key

1 hose sample

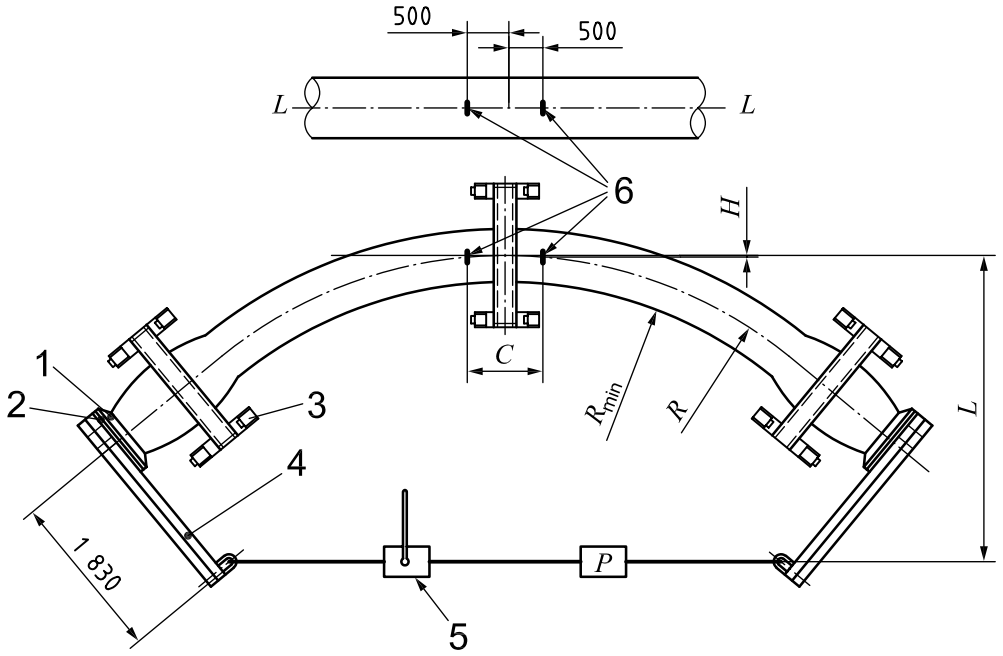
2 mandrel or former

d diameter of mandrel or former

a Direction of bending.

Figure 3 — Test apparatus using a mandrel or former

Dimensions in millimetres



Key

1	hose flange
2	test plate
3	trolley to allow for movement of hose
4	hose bending beam
5	tension device
6	test marks
C	chord of bending arc
H	offset
L	moment arm
P	cable tension/dynamometer load
R	bend radius at hose centre line
R_{min}	minimum bend radius

Figure 4 — Method for flexural stiffness testing

ICS 23.040.70

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