INTERNATIONAL STANDARD

ISO 11173

First edition
1994-12-01

Thermoplastics pipes — Determination of resistance to external blows — Staircase method

Tubes en matières thermoplastiques — Détermination de la résistance aux chocs extérieurs — Méthode en escalier

Reference number
ISO 11173:1994(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 11173 was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 5, *General properties of pipes, fittings and valves of plastic materials and their accessories — Test methods and basic specifications.*

International Organization for Standardization
Case postale 56 • CH-1211 Genève 20 • Switzerland

Printed in Switzerland

Thermoplastics pipes — Determination of resistance to external blows — Staircase method

1 Scope

This International Standard specifies a method for determining the resistance to external blows of thermoplastic pipes of circular cross-section; it is called the staircase method.

This method is applicable to isolated batches of pipe to be tested at 0 °C.

NOTE 1 If testing below 0 °C is necessary, the temperature of – 20 °C is recommended.

2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the edition indicated was 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 edition of the standard indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 6603-1:1985, *Plastics — Determination of multi-axial impact behaviour of rigid plastics — Part 1: Falling dart method.*

3 Definitions

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

3.1 drop height for 50 % failure, H_{50}: Height of fall of a striker of specified mass, which provokes failure of 50 % of test pieces from samples of pipe taken to represent a batch.

NOTE 2 In practice, test pieces are drawn at random from the batch and the result is only an estimate of the H_{50} for that batch.

3.2 failure: Unless otherwise specified in the product standard, shattering or any crack or split on the inside of the pipe that was caused by the impact and that can be seen by the naked eye (lighting devices may be used to assist in examining the specimens).

Indentation of the test piece or a crease on the surface shall not be considered a failure.

4 Principle

Test pieces, comprising cut lengths of pipe, are each subjected to a single blow by a falling striker of specified mass and shape dropped from one of a sequence of different heights onto a random position around the circumference of the pipe.

If a test piece fails, the drop height for the next blow is decreased by a predetermined amount. If a test piece does not fail, the drop height for the next blow is increased accordingly. If sufficient test pieces are used, the H_{50} value of a batch, or a production run from an extruder, can be calculated.

The severity of this test method can be adjusted by changing the mass of the striker and/or the test temperature.

5 Apparatus

5.1 Falling-weight testing machine, incorporating the following basic components (see figure 1).

5.1.1 Main frame, with guide rails or a guiding tube rigidly fixed in the vertical position, to accommodate a striker (5.1.2) and release it to fall vertically and freely. When calibrated, the speed of the striker at the moment of impact shall be not less than 95 % of the theoretical speed.

5.1.2 Striker, having a nose comprising all or part of a hemisphere, combined with a cylindrical stem at least 10 mm long, and having dimensions conforming to figure 2 and table 1, depending upon the mass of the striker. The mass of the striker, including any associated weights, shall be selected from the values given in table 2. Below the stem, the nose shall be of steel with a minimum wall thickness of 5 mm and the striking surface shall be free from visible imperfections such as scratches or dents which may influence the results.

Dimensions in metres

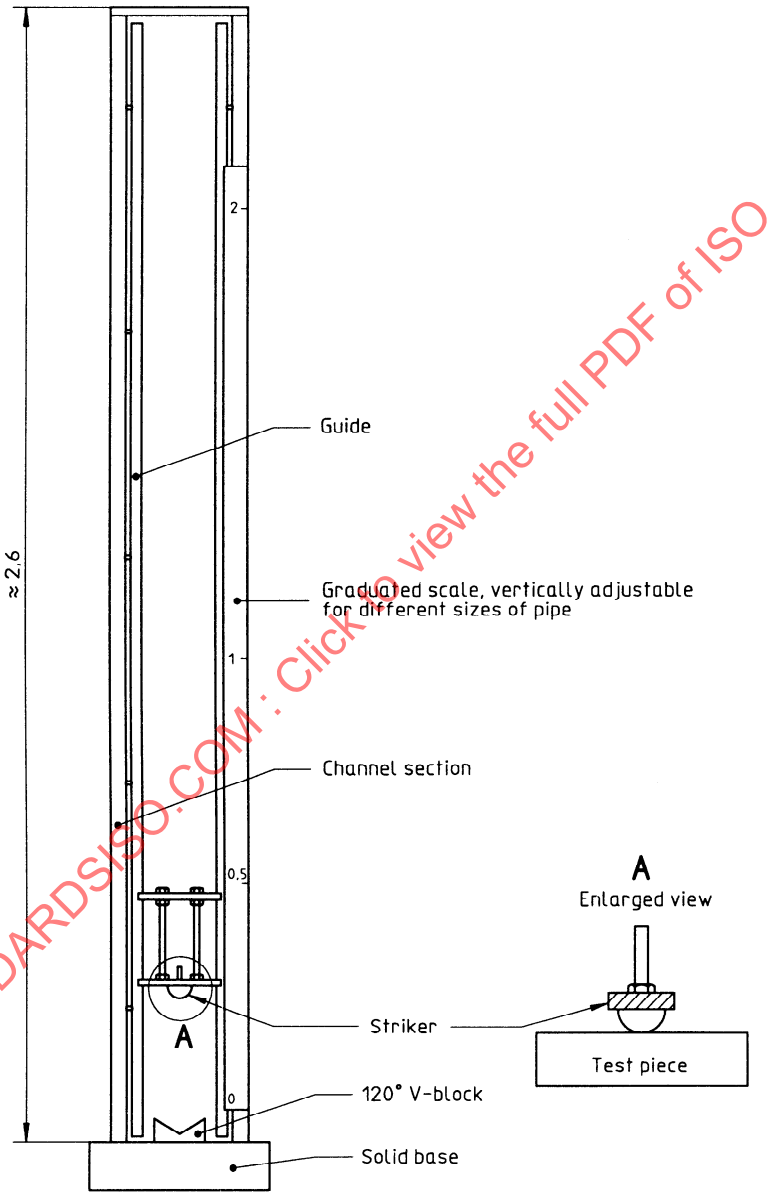
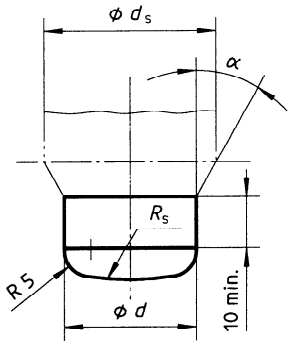
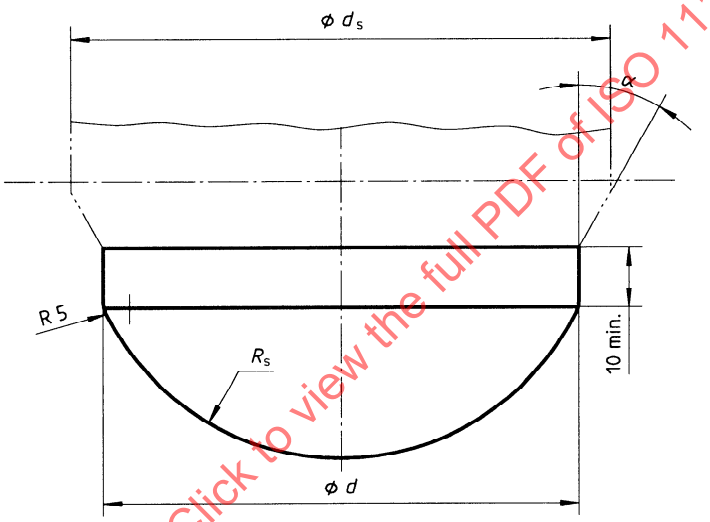


Figure 1 — Diagrammatic representation of an impact-testing machine

Dimensions in millimetres



a) Type d25 (for strikers of mass 0,5 kg and 0,8 kg)



b) Type d90 (for strikers of mass equal to or greater than 1kg)

Figure 2 — Noses of the strikers (see table 1)

Strikers with 0,5 kg and 0,8 kg mass shall have a type d25 nose. Strikers with greater masses shall have a type d90 nose.

Table 1 — Dimensions for the nose of the striker

Dimensions in millimetres

Type	R_s	d ± 1	d_s	$\alpha°$
d25	50	25	free	free
d90	50	90	free	free

Table 2 — Recommended masses of strikers

Masses in kilograms

0,5	1,6	4,0	10,0
0,8	2,0	5,0	12,5
1,0	2,5	6,3	16,0
1,25	3,2	8,0	

NOTE — The permissible tolerance on the mass of a striker shall be ± 0,5 %.

5.1.3 Rigid test support, consisting of a 120° V-block at least 200 mm long, positioned so that the vertical projection of the point of impact of the falling striker is within 2,5 mm of the axis of the V-block (see figure 1).

For pipes with a flat bottom, a horizontal support of flat steel shall be used.

5.1.4 Release mechanism, such that the striker can fall from a variable height which can be adjusted up to at least 2 m, as measured from the top surface of the test piece, with an accuracy of ± 10 mm. The drop height shall be a multiple of 100 mm.

6 Test pieces

6.1 Preparation

Test pieces of length 200 mm ± 10 mm shall be cut from pipe selected at random from the batch, or a production run from an extruder.

The cut ends shall be square to the axis of the pipe, clean and free from damage. For spiral-rib pipes, the cut end of the spiral rib shall be rounded off in order to eliminate any sharp edges.

6.2 Number of test pieces

Unless otherwise specified in the product standard, up to 30 test pieces shall be used, as follows:

a) up to 10 test pieces might be used for the preliminary test (see 8.2) to determine the drop height which provokes the first failure;

b) at least 20 test pieces are used for the main test (see 8.3).

7 Conditioning

The test pieces shall be conditioned in a liquid bath or in air at a temperature of 0 °C ± 1 °C for at least the period given in table 3.

In case of dispute over the results, a liquid bath shall be used.

Table 3 — Conditioning periods

Wall thickness e mm	Conditioning period min	
	Liquid bath	Air
$e \leqslant 8{,}6$	15	60
$8{,}6 < e \leqslant 14{,}1$	30	120
$14{,}1 < e$	60	240

For pipes with smooth inside and outside surfaces, the wall thickness of the pipe to be tested shall be the total wall through the pipe section.

For pipes which are corrugated or ribbed externally, the wall thickness is the thickest wall of the pipe cross-section.

8 Procedure

8.1 General

Follow the procedures given in 8.2 and 8.3, with the following criteria:

a) the striker shall have a mass in accordance with the product standard or, if not specified, such that the H_{50} value is between 0,5 m and 2,0 m;

b) each test piece shall be struck only once and the impact shall occur at the mid-length of the test piece within 10 s of its removal from the conditioning environment;

c) unless otherwise specified in the product standard, the circumferential orientation of each circular test piece in the supporting vee shall be random; for corrugated or ribbed pipe, if the pitch of the corrugation or ribs is more than 0,25 times the diameter d of the stem of the striker nose, the test piece shall be positioned so that the impact of the striker will be on the top of a corrugation or a rib;

d) For regular testing of a product for which the H_{50} value is found to be at least 50 % higher than the required minimum level, the preliminary test procedure (8.2) may be omitted; the drop height for the first impact in the main test shall be that corresponding to the H_{50} value obtained for the preceding lot from the same production run, rounded down to the next 0,1 m.

8.2 Preliminary test procedure

The purpose of the preliminary test procedure is to obtain a rough indication of the H_{50} value and to identify the first test piece for which the result will be used in the main test.

8.2.1 Set a drop height for the striker in accordance with one of the following conditions:

a) 50 % of the specified H_{50} value for the pipe, if known; otherwise

b) 0,5 m.

8.2.2 Remove the test piece from the conditioning environment and test it within 10 s. Determine and record whether the test piece failed and, if so, how.

8.2.3 If the first result is a failure, repeat 8.2.2 using the same drop height and a fresh test piece. If the result for the second test piece is again negative, record the sample as not conforming to the specified value.

8.2.4 If the first result is a pass, reset the striker drop height 0,2 m higher and test a fresh test piece in accordance with 8.2.2. Repeat this step until the first failure occurs.

Record the drop height for the first test piece that fails for use as the first test piece result for the main staircase test.

8.3 Main test

8.3.1 Set the striker drop height at 0,1 m lower than that recorded in 8.2.4 or as defined in 8.1 d).

8.3.2 Remove a test piece from the conditioning environment and test it within 10 s. If the result obtained is a failure, reset the striker drop height 0,1 m lower. Otherwise, reset it 0,1 m higher and test another test piece.

8.3.3 Repeat the procedure of 8.3.2 until one of the following conditions is satisfied:

a) if testing in accordance with item d) of 8.1, 10 test pieces have been impact tested; however if less than 3 test pieces are found to be satisfactory, a further 10 test pieces shall be impact tested;

b) until a total of 20 test pieces have been impact tested, including the first failure in accordance with 8.2.4.

If less than 8 failures or less than 8 satisfactory test pieces are found, extend the main test to a total of 40 test pieces by impact testing a further 20 test pieces in accordance with 8.3.2.

9 Calculations

Calculate the H_{50} value as the average of the drop heights recorded during the main test.

If more than three satisfactory test pieces are found using the maximum height and mass of striker of the test apparatus, the H_{50} value is greater than the average thus calculated.

See 7.3.3 of ISO 6603-1:1985 for statistical calculation of the mean of H_{50} and the standard deviation.

The results can only be used to determine the reproducibility of the H_{50} value.

10 Test report

The test report shall include the following information:

a) full identification of the pipe under test;

b) a reference to this International Standard, i.e. ISO 11173;

c) the method of sampling;

d) the number of specimens used for the preliminary and main tests;

e) the test temperature, in degrees Celsius, and the conditioning medium;

f) the mass of the striker, in kilograms;

g) the diameter of the hemispherical surface of the striker;

h) the failure criteria, if different from those given in 3.2;

i) the minimum and the maximum drop heights, found during the main test;

j) the H_{50} value for the pipe; rounded to the nearest 0,01 m;

k) any factors which may have affected the results, such as any incidents or operating details not specified in this International Standard;

l) the date of the test, the laboratory and the operator.

11 Example of the use of the impact-resistance test

See figure 3.

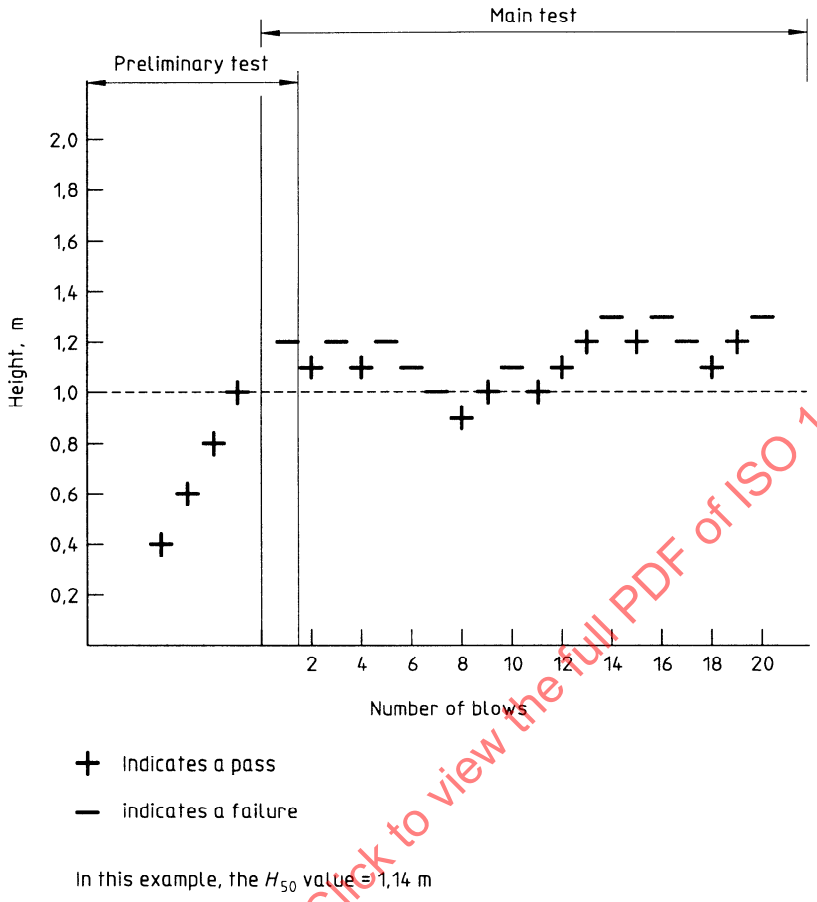


Figure 3 — Example of the use of the impact-resistance test, staircase method

This page intentionally left blank