BRITISH STANDARD

BS EN 1411 : 1996 BS 2782 : Part 11 : Method 1108B : 1996

Plastics piping and ducting systems — Thermoplastics pipes — Determination of resistance to external blows by the staircase method

The European Standard EN 1411 : 1996 has the status of a British Standard

ICS 23.040.20

Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee PRI/61, Plastics piping systems and components, upon which the following bodies were represented:

British Gas plc
British Plastics Federation
British Plumbing Fittings Manufacturers' Association
British Valve and Actuator Manufacturers' Association
Department of the Environment (British Board of Agrement)
Department of the Environment (Building Research Establishment)
Department of the Environment (Property and Buildings Directorate)
Department of Transport
Electricity Association
Federation of Civil Engineering Contractors
Health and Safety Executive
Institute of Building Control
Institute of Materials
Institution of Civil Engineers
Institution of Gas Engineers
Institution of Water and Environmental Management
National Association of Plumbing, Heating and Mechanical Services Contractors
Pipeline Industries Guild
Plastics Land Drainage Manufacturers' Association
Society of British Gas Industries
Society of British Water Industries
Water Companies Association
Water Services Association of England and Wales

The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

ERA Technology Ltd.
Engineering Equipment and Materials Users' Association
RAPRA Technology Ltd.

This British Standard, having been prepared under the direction of the Sector Board for Materials and Chemicals, was published under the authority of the Standards Board and comes into effect on
15 August 1996

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The following BSI references relate to the work on this standard:
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Contents

National foreword

This British Standard has been prepared by Technical Committee PRI/61 and is the English language version of EN 1411 : 1996 *Plastics piping and ducting systems — Thermoplastics pipes — Determination of resistance to external blows by the staircase method*, published by the European Committee for Standardization (CEN).

It is incorporated into BS 2782 *Methods of testing plastics : Part 11 : Thermoplastics pipes, fittings and valves*, as Method 1108B : 1996, for association with related test methods for plastics materials and plastics piping components.

This test method has been prepared for reference by other standards under preparation by CEN for specification of reinforced plastics piping systems and components. It has been implemented to enable experience of the method to be gained and for use for other fresh applications.

It is also for use for the revision or amendment of other national standards as practicable, but it should not be presumed to apply to any existing standard, which contains or makes reference to a different test method, until that standard has been amended or revised to make reference to this method and any requirements adjusted as appropriate.

Warning note. This British Standard, which is identical with EN 1411 : 1996, does not necessarily detail all the precautions necessary to meet the requirements of the Health and Safety at Work etc. Act 1974. Attention should be paid to any appropriate safety precautions and the method should be operated only by trained personnel.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 1411

January 1996

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Descriptors: pipelines, sheathing, plastic tubes, thermoplastic resins, tests, determination, shock resistance

English version

Plastics piping and ducting systems — Thermoplastics pipes — Determination of resistance to external blows by the staircase method

Systémes de canalisations et de gaines en plastiques — Tubes thermoplastiques — Détermination de la résistance aus chocs externes par la méthode en escalier

Kunststoff-Rohrleitungs- und Schutzrohrsysteme — Rohre aus Thermoplasten — Bestimmung der Widerstandsfähigkeit gegen äußere Schlagbeanspruchung im Stufenverfahren

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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

Central Secretariat: rue de Stassart 36, B-1050 Brussels

Ref. No. EN 1411 : 1996 E

Foreword

This European Standard has been prepared by the Technical Committee CEN/TC155, Plastics piping systems and ducting systems, of which the secretariat is held by NNI.

This standard is based on ISO/CD 11173 : 1991 *Thermoplastics pipes — Determination of resistance to external blows — Staircase method*, prepared by the International Organization for Standardization (ISO). It is a modification of ISO/CD 11173 for reasons of applicability to other test conditions and alignment with texts of other standards on test methods. The modifications are:

– the procedure has been extended to enable use without prior knowledge of a relevant drop height, striker mass or H_{50} value;

– editorial changes have been introduced.

The material-dependent parameters and/or performance requirements are incorporated in the system standard(s) concerned.

Annex A, which is informative, gives a bibliography.

This standard is one of a series of standards on test methods which support system standards for plastics piping systems and ducting systems.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by July 1996, and conflicting national standards shall be withdrawn at the latest by July 1996.

According to the CEN/CENELEC Internal Regulations, the following countries are bound to implement this European Standard: Austria, Belgium, Denmark, Finland, France, Germany,Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom.

1 Scope

This standard specifies a method for determining the resistance to external blows of thermoplastics pipes by using the staircase method. This method is not applicable to perforated pipes.

The method is intended to be applied for pipe testing at 0 °C. When necessary the method can be applied at −20 °C or +23 °C.

2 Definitions

For the purposes of this standard, the following definitions apply.

2.1 H_{50} **value:** The height of fall (drop height) of a striker of specified mass which provokes failure of 50 % of test pieces from samples of pipe taken to represent a batch.

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

2.2 production batch: a clearly identifiable collection of units, manufactured consecutively or continuously under the same conditions, using material or compound conforming to the same specification.

3 Principle

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

If a test piece fails (see d) of **7.1**), 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 blow on the subsequent test piece 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.

A preliminary test procedure (see **7.2**) is carried out to obtain a rough indication of the H_{50} value and to identify the first test piece from which the result will be used in a main test procedure (see **7.3**).

The severity of this test method can be adjusted to suit different specification needs by changing the mass of the striker and/or the test temperature.

NOTE. It is assumed that the following test parameters are set by the standard making reference to this standard:

a) the type of striker and striker mass (see b) of **4.1** and a) of **7.1**);

b) the test and conditioning temperatures and the conditioning medium (see **4.2** and clause 6);

c) the method of sampling (see **5.1**);

d) if appropriate, the number of test pieces to be used (see **5.2** and clause 7);

e) if applicable, the position of impact on the test piece and/or any alternative or additional criteria (see b), c) and d) of **7.1**);

f) if applicable, the initial drop height to be used in place of the preliminary test procedure (see e) of **7.1**);

g) the required H_{50} value for the pipe (see a) of **7.2.1**).

4 Apparatus

4.1 A falling weight impact testing machine incorporating the following basic components (see figure 1):

a) **main frame**, with guide rails or a guiding tube rigidly fixed in the vertical position, to accommodate a striker (see b)) and release it to fall vertically and freely such that the speed of the striker at the moment of hitting the pipe is not less than 95 % of the theoretical speed;

b) **striker**, having a nose comprising all or part of a hemispherical form combined with a cylindrical stem at least 10 mm long and having dimensions conforming to table 1 and figure 2, depending upon the mass of the striker. The mass of the striker, including any associated weights, shall be selected from 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 imperfections that could influence the results.

Table 1. Dimensions for the nose of the striker (see figure 2)

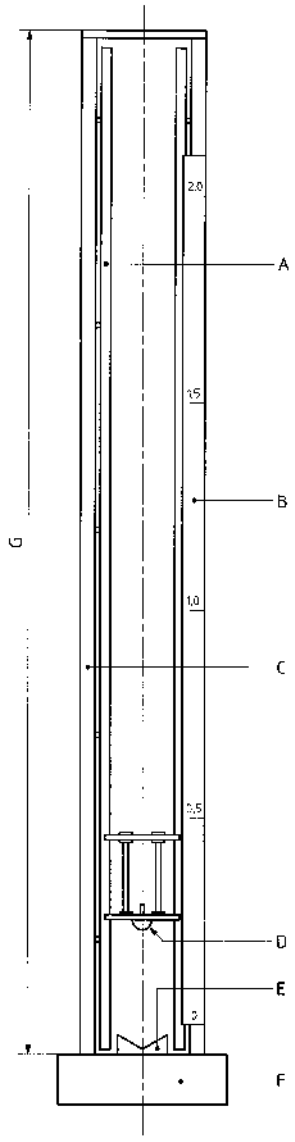
Type	R_s mm	D mm	D_s mm	α
d25	50	25 ± 1	*)	*)
d90	50	90 ± 1	*)	*)

*) Not specified

Table 2. Masses of strikers

Masses in kilograms

Mass of striker ± 0,005 kg					
Type d25			**Type d90**		
0,25	1,0	2,0	4,0	8,0	15,0
0,5	1,25	2,5	5,0	10,0	
0,8	1,6	3,2	6,3	12,5	



Key

A	Guide
B	Graduated scale, vertically adjustable for different sizes of pipe
C	Main frame
D	Striker
E	Steel block 120°, V-shaped or flat (see c) of **4.1**)
F	Solid base
G	Sufficient to give a clear height from striker to pipe of at least 2 m

Figure 1. Typical impact testing machine

c) **rigid test piece support**, having one of the following forms as applicable.

1) For pipes having a circular external cross section, consisting of a 120 ° V-block of steel at least 200 mm long, positioned so that the axis of the line of fall of the nose of the striker shall intersect the axes of the V to within ± 2,5 mm (see figure 1).

2) For pipes with a flat bottom, a horizontal support of flat steel together with guides to ensure that the line of fall of the striker shall intercept to within ± 2,5 mm the striking point specified on the test piece by the referring standard.

The support construction shall be sufficiently rigid not to cushion the effect of the impact.

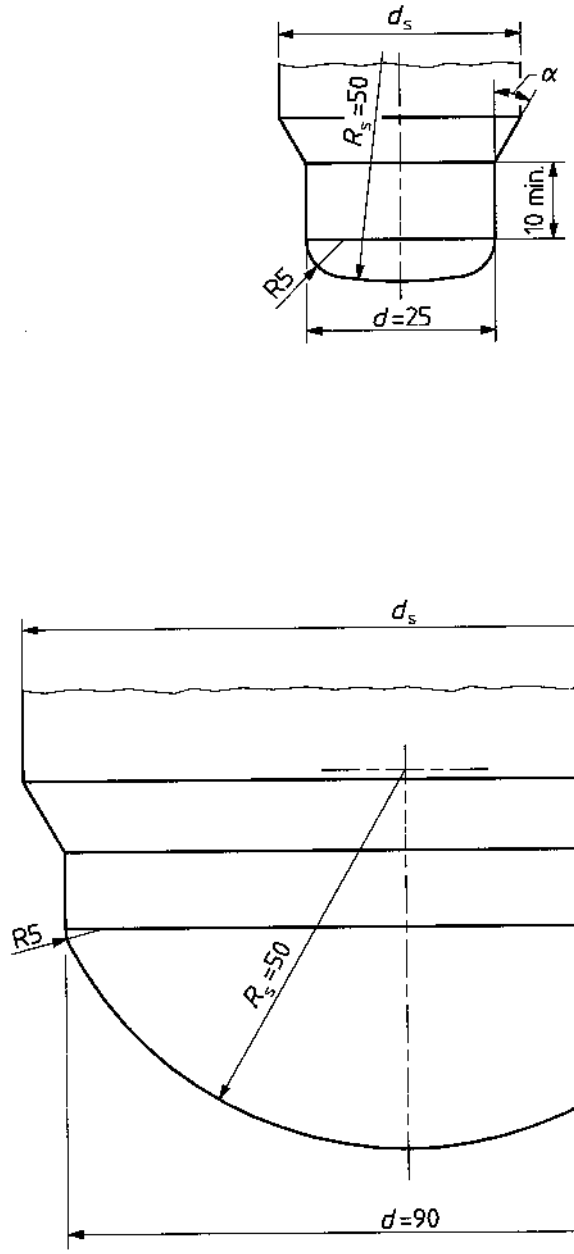
d) **release mechanism**, such that the striker can fall from a variable height which can be adjusted up to 2 m, as measured from the top surface of the test piece with an accuracy of 10 mm. The drop height shall be a multiple of 100 mm.

4.2 A liquid bath or air cabinet, capable of maintaining one of the following conditioning temperatures for testing at the temperature as specified in the referring standard.

For testing at 0 °C, the conditioning temperature shall be (0 ± 1) °C.

For testing at −20 °C, the conditioning temperature shall be (−20 ± 2) °C

For testing at +23 °C, the conditioning temperature shall be (+ 23 ± 2) °C.



Dimensions in millimetres

Figure 2. Dimensions of strikers

5 Test pieces

5.1 Preparation

The test pieces shall be cut from pipes selected at random.

In the case of pipes having longitudinal seam lines, the seam lines (see note) shall be marked, e.g. with different colours, before the pipe is cut as follows.

NOTE. When pipes are continuously moulded between two running moulds, lines are formed in the longitudinal direction of the pipe which are called seam lines.

For each test piece, the length shall be (200 ± 10) mm.

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

5.2 Number

Unless otherwise specified by the referring standard, up to 50 test pieces shall be used as follows:

a) for a given striker mass, up to 10 test pieces may be used for the preliminary test procedure (see **7.2**) to determine the drop height which provokes the first failure;

b) at least 20 test pieces are used for the main test procedure (see **7.3**).

NOTE. Only one blow is made per test piece.

6 Conditioning

Condition the test pieces in a liquid bath or air for not less than the applicable period given in table 3 where that period shall commence when the temperature of the conditioning medium has returned to the specified temperature if disturbed by the introduction of the test piece. The wall thickness e_t shall be determined as follows:

a) for pipes with smooth inside and outside surfaces the wall thickness e_t of the pipe shall be the total wall thickness through the pipe section;

b) for pipes which are corrugated or ribbed externally the wall thickness e_t shall be the minimum wall thickness between inside and outside surfaces both in contact with the conditioning fluid.

Table 3. Conditioning periods

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

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

7 Procedure

7.1 General

Conduct the procedures given in **7.2** and **7.3** in accordance with the following criteria, as applicable.

a) The striker shall have a mass selected from table 2, either as specified in the referring standard or, if not thus 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, either at random or on a generatrix, as specified by the referring standard (see clause **3**). Unless the ambient temperature is in the same range as the specified conditioning temperature, the impact shall occur within 10 s of the removal of the test piece from the conditioning environment.

If that 10 s interval is exceeded, the test piece shall be returned to the conditioning environment within a further 10 s for a minimum period of 5 min or shall otherwise be discarded or fully reconditioned.

c) Unless otherwise specified by the referring standard, the circumferential orientation of the test piece in the V-shaped support 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 (see figure 2), the test piece shall be positioned so that the impact of the striker will be on the top of a corrugation or a rib.

NOTE. The referring standard may specify testing along one or more generatrices.

d) Unless otherwise specified by the referring standard, failure of a test piece shall comprise shattering or any crack or split on the inside of the pipe that was caused by the impact and that can be seen without magnification.

Lighting devices may be used to assist in examining the test pieces. Indentation of the test piece or a crease on the surface shall not be taken as a failure.

e) For routine testing (e.g. batch release 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 (see **7.2**) may be omitted. The drop height for the first impact in the main test procedure shall be that corresponding to the H_{50} value obtained from a preceding batch from the same production run, rounded down to the next smaller 0,1 m.

NOTE. A convenient format for summarizing the procedure followed and results obtained is given in figure 3.

7.2 Preliminary test procedure

NOTE. 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 from which the result will be used in the main test procedure (see **7.3**).

7.2.1 Set a drop height for the striker (see clause **4**) in accordance with one of the following criteria:

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

b) 0,5 m.

7.2.2 Remove a test piece from the conditioning environment and within 10 s position it on the appropriate support and subject the test piece to one impact by the striker.

Determine and record whether the test piece failed (see d) of **7.1**). If it did not fail, proceed in accordance with **7.2.5**. Otherwise, record the type of failure and proceed in accordance with **7.2.3** or **7.2.4**, as applicable.

7.2.3 If testing in accordance with a) of **7.2.1** and the first result is a failure, repeat **7.2.2** using the same drop height and another test piece.

If the second result is a pass proceed in accordance with **7.2.5**.

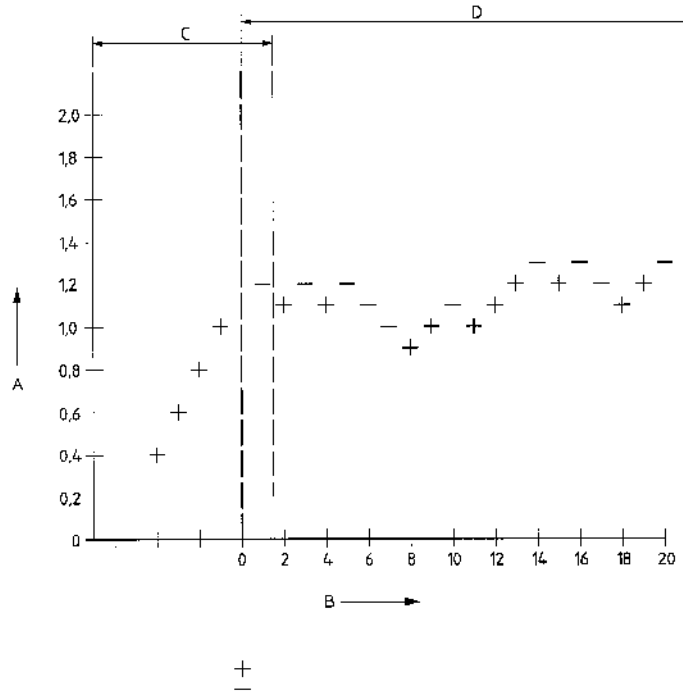
If the second result is a failure record the sample as not conforming to the specified value and proceed to clause **9**.

7.2.4 If testing in accordance with b) of **7.2.1** and the first result obtained is a failure, repeat **7.2.2** using a drop height of 0,30 m and another test piece.

If the second result is a pass proceed in accordance with **7.2.5**.

If the second result is a failure, if possible select a striker having the next lighter mass in accordance with table 2 and recommence testing in accordance with **7.2.1**.

Otherwise, if already using a striker mass of 0,25 kg record the result and proceed to clause **9**.



Key

A	Height in metre
B	Number of blows
C	Preliminary test procedure
D	Main test procedure
+	indicates a pass
−	indicates a failure

Figure 3. Typical record for impact test data, obtained using the staircase method (in this example, the H_{50} value = 1,14 m)

7.2.5 Reset the striker drop height 0,2 m higher and test another test piece in accordance with **7.2.2**. If necessary, 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 test procedure (see **7.3**).

If the drop height has reached 2 m without failure, select the striker having the next greater mass in accordance with table 2 and recommence testing in accordance with **7.2.1** (see a) of **5.2**).

7.3 Main test procedure

7.3.1 Record as the striker drop height for the first result that height obtained in accordance with e) of **7.1** or with **7.2**, as applicable.

Set the striker drop height 0,1 m lower than that thus recorded.

7.3.2 Remove a test piece from the conditioning environment and within 10 s position it on the appropriate support and subject the test piece to one impact by the striker.

Determine and record whether and how the test piece failed (see d) of **7.1**) and proceed to **7.3.3**.

7.3.3 If the result obtained in accordance with **7.3.2** was a failure, reset the striker drop height 0,1 m lower, otherwise reset it 0,1 m higher, and test another test piece in accordance with **7.3.2**.

7.3.4 Repeat the procedure given in **7.3.3** until one of the following conditions is satisfied, as applicable.

a) For routine testing of a product in accordance with e) of **7.1**, proceed until ten test pieces have been tested. If six or more failures have been found, test a further ten test pieces and proceed in accordance with c) as follows. Otherwise stop testing and proceed to clause **8**.

b) If following preliminary testing in accordance with **7.2**, proceed until 20 test pieces have been tested, including the first failure in accordance with **7.2.5** and proceed in accordance with c) as follows.

c) If less than eight failures or less than eight passes are found, extend the test to a total of 40 test pieces by striking a further 20 test pieces in accordance with **7.3.2**. Otherwise stop testing. Proceed to clause **8**.

8 Calculations

Calculate to the nearest 0,01 m the arithmetic mean of the drop heights recorded during the main test procedure.

NOTE. The confidence limits of the calculated mean value H_{50} may be obtained by calculation in accordance with **7.3.3** of ISO 6603-1 : 1985.

If more than three passes are obtained using the maximum height and striker mass of the testing apparatus, the H_{50} value is greater than the average so calculated.

9 Test report

The test report shall include the following information:

a) a reference to this standard and to the referring standard;

b) the full identification of the pipe under test, including application, material, dimensions;

c) the method of sampling;

d) the numbers of test pieces used for the preliminary and main test procedures, respectively;

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

f) the type of striker and its mass, in kilograms;

g) if applicable, details of other failure criteria (see e) of **7.1**);

h) the minimum and the maximum drop heights found during the main test procedure or the drop height used if testing was stopped in accordance with **7.2.3** and **7.2.4**;

i) the H_{50} value;

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

k) the date of test.

Annex A (informative)
Bibliography

ISO 6603-1 : 1985 *Plastics — Determination of multiaxial impact behaviour of rigid plastics — Part 1: Falling dart method*

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List of references

See national foreword.

BSI — British Standards Institution

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