INTERNATIONAL STANDARD

ISO 13260

First edition
2010-06-15

Thermoplastics piping systems for non-pressure underground drainage and sewerage — Test method for resistance to combined temperature cycling and external loading

Systèmes de canalisations thermoplastiques pour branchements et collecteurs d'assainissement enterrés sans pression — Méthode d'essai de la résistance à un cycle de température et de charge externe combinés

Reference number
ISO 13260:2010(E)

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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 13260 was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 1, *Plastics pipes and fittings for soil, waste and drainage (including land drainage)*.

Thermoplastics piping systems for non-pressure underground drainage and sewerage — Test method for resistance to combined temperature cycling and external loading

1 Scope

This International Standard specifies two methods for testing pipes and fittings or joints for plastics piping systems intended for use in underground drainage and sewerage systems for their resistance to deformation and leakage, when subjected to sustained external loading in conjunction with the passage of hot water.

Method A involves temperature cycling, by passing hot water and cold water alternately, and is applicable to pipes and associated fittings having a mean outside diameter $d_{em} \leqslant 190$ mm.

Method B involves passing hot water only, except at intervals specified for measurement of internal deflection, and is applicable to pipes and associated fittings having a mean outside diameter 190 mm $< d_{em} \leqslant 510$ mm.

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

3 Principle

A test piece comprising a pipe or an assembly of pipe(s) and fitting(s) is placed on a 100 mm gravel bed and covered with gravel to 600 mm above the crown of the pipe confined by a box of specified dimensions. Depending on the nominal size of the largest pipe or joint under test, a constant vertical load is applied via the gravel and either a specified number of cycles of hot and cold water or just hot water is passed through the test piece. The deformation of the test piece, as indicated by vertical deflection or internal diametric compression, is measured.

For sizes having a mean outside diameter $d_{em} \leqslant 190$ mm, hot and cold water is passed through the test piece and air may be blown through the test piece during the intervals between stages (Method A).

For pipes with a mean outside diameter $190 < d_{em} \leqslant 510$ mm a constant flow of hot water is passed through the test piece (Method B).

Vertical deflection of the test piece is measured. The test piece is checked at the end of the test for cracking, for local deflection in the bottom of the main channel and for leakage at the joints.

It is assumed that the following parameters are set by the referring standard:

a) if appropriate, the limits of the temperature of the water flowing out (see 7.2.2);

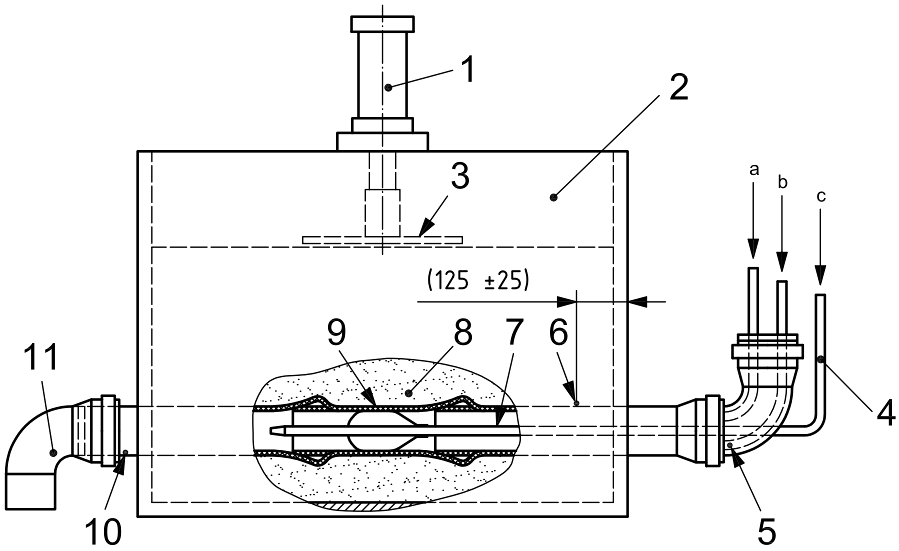
b) if appropriate, the duration of the flow (see 7.2.2);

c) the percentage, x, of d_i for the calculation of the diameter of the hard ball, in accordance with 7.3.3.

4 Apparatus

4.1 Gravel-filled box, to accommodate a test piece as shown in Figures 1, 2 and 3, with dimensions depending on the size of the test piece as given in Table 1 and with a horizontal base.

Dimensions in millimetres



Key

1 loading device
2 box
3 loading plate
4 cold water sensor
5 inlet hot water sensor
6 upper surface sensor
7 cold water spray (sparge pipe)
8 filling material
9 test sample
10 outlet hot water sensor (for Method B only)
11 water outlet (sealable)

[a] Air inlet.
[b] Hot water inlet.
[c] Cold water inlet.

Figure 1 — Typical box loading test (BLT) apparatus

Table 1 — Box dimensions

Dimensions in millimetres

	Mean outside diameter pipe/fitting d_{em}	**Inside box width**[a] l_1	**Minimum length of box** l_2
Method A	$\leqslant$ 190	600 < l_1 $\leqslant$ 990	1 200
Method B	190 < d_{em} $\leqslant$ 205	790 < l_1 $\leqslant$ 1 005	1 300
	205 < d_{em} $\leqslant$ 255	805 < l_1 $\leqslant$ 1 055	1 500
	255 < d_{em} $\leqslant$ 320	855 < l_1 $\leqslant$ 1 120	1 500
	320 < d_{em} $\leqslant$ 410	920 < l_1 $\leqslant$ 1 210	1 500
	410 < d_{em} $\leqslant$ 510	1 010 < l_1 $\leqslant$ 1 310	1 500

[a] The inside box width shall be determined on the basis of a clearance of (350 ± 100) mm between the side of the pipe/fitting and the side of the box. The inside box width should be adjustable by closing the gap using plywood sheeting or brickwork as a spacer.

The inside walls of the box shall be vertical ±3 mm and shall have an inside smooth surface, e.g. plywood or flat sheet.

The box shall be constructed and reinforced such that, when under load, it shall not deflect more than 3,0 mm at any point.

The pipe line shall pass through the walls of the box via holes sealed in such a way as to impose minimal restraint on the assembly (see Clause 5), e.g. by flexible closed cell sponge collars. The test assembly of pipes or pipes and fittings shall be placed with a fall of between 1:100 and 1:75 to the horizontal base, such that in the case of Method A, conditions alternate between discharges of hot and cold water or in the case of Method B, water at a constant temperature can be passed through the assembly while it is subjected to a constant force acting through the gravel.

The box shall be constructed such that it can accommodate a total height of gravel of 600 mm above the crown of the pipe.

Dimensions in millimetres and prior to load being applied

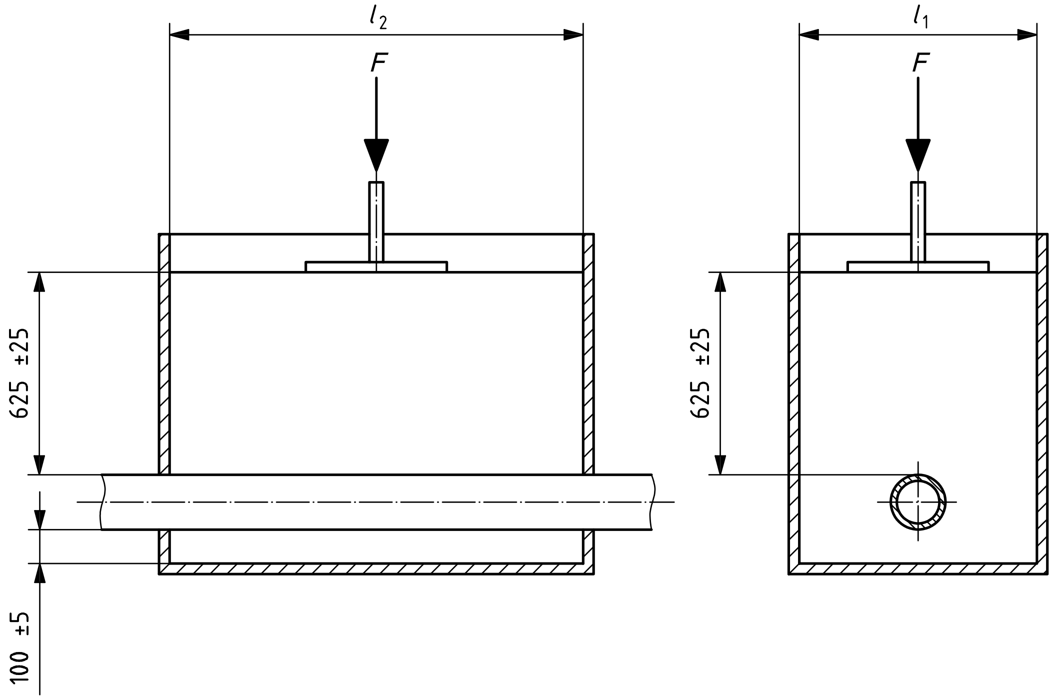
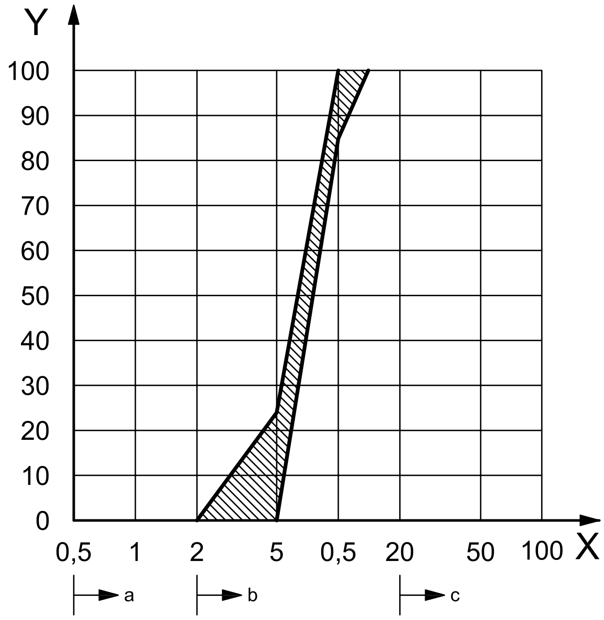


Figure 2 — Main dimensions of the box

The gravel shall be classified in accordance with Table 2, shall have a surface texture in accordance with Table 3, with granular composition within the range shown in Figure 3 and shall conform to the requirements of Table 4.



Key

X particle size, in millimetres

Y cumulative percentage passing

a Sand.

b Gravel.

c Stone.

Figure 3 — Gradation range of the gravel for box loading test

The gravel shall be washed natural material comprising hard, durable and clean particles.

It shall be dry during the preparation and completion of the test.

Table 2 — Particle shape

Classification	Description
Rounded	Fully water-worn or completely shaped by attrition
Irregular	Naturally irregular or partly shaped by attrition and having rounded edges
Angular	Possessing well-defined edges formed at the intersection of roughly planar faces
Flaky	Material of which the thickness is small relative to the other two dimensions
Elongated	Material, usually angular, in which the length is considerably larger than the other two dimensions
Flaky and elongated	Material having the length considerably larger than the width and the width considerably larger than the thickness

Table 3 — Surface texture of particles

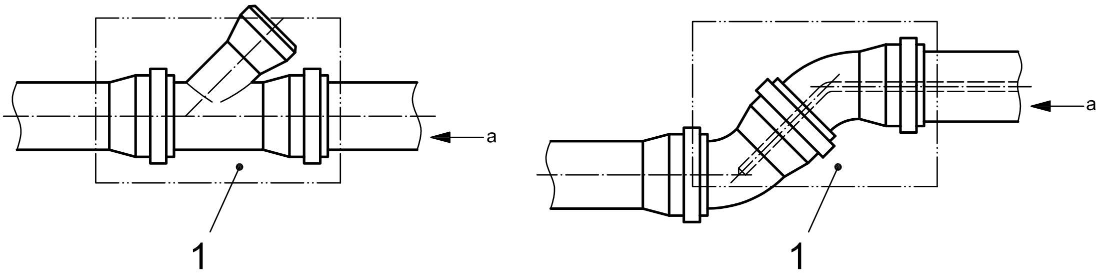
Surface texture	Characteristics
Glassy	Conchoidal fracture
Smooth	Water-worn, or smooth due to fracture of laminated or fine-grained rock
Granular	Fracture showing more or less uniform rounded grains
Rough	Rough fracture of fine or medium-grained rock containing no easily visible crystalline constituents
Crystalline	Easily visible crystalline constituents

Table 4 — Shape of particles

Shape	Surface	Content
Rounded or irregular	Glassy or smooth	At least 85 %
Up to 15 % may fall within the other classes / textures given in Tables 2 and 3 as applicable. The particle size distribution for all particles shall conform to Figure 3.		

4.2 Compressive loading equipment, capable of applying the force, F, (see 7.1.7) by means of hydraulic or pneumatic equipment acting through a (450 ± 5) mm × (300 ± 5) mm steel plate at least 25 mm thick, or of another material of an equivalent stiffness, which shall be positioned horizontally. The 450 mm side of the plate shall be positioned parallel to the long wall of the box as shown in Figures 1, 2 and 4. Force shall be applied such that the initial applicable load is applied for a 1 min to 2 min time period and maintained to within ±1 kN.

Fixed points shall be established above each of the four corners of the loading plate to act as datum points to measure the sinking of the plate into the gravel after application of the final load (see 7.1.7).



Key

1 loading plate 300 mm × 450 mm

a Flow.

Figure 4 — Example of positioning of a test piece under the loading plate

4.3 Hot and cold water and air delivery systems, capable of providing the following:

a) hot water at the specified flow and temperature, T_1, see 7.2.1 or 7.2.2, along the invert of the test assembly for the applicable periods (see 7.2.1 or 7.2.2);

b) cold water at the specified flow and temperature [see item c) of 7.2.1.2], which shall be sprayed on to the upper part of the inside surface of the test assembly throughout its entire length for the applicable periods (see 7.2.1). The internal spray arrangement shall be designed to spray the upper 120 °C sector of the test assembly. The sparge pipe shall be held off the surface of the test assembly;

c) if required, additional cold air may be passed through the test piece before, during or after circulation of cold water [see item c) of 7.2.1.2].

4.4 Temperature measuring device, having temperature sensors linked to an automatic continuous recording device and capable of measuring, to an accuracy of ±1 °C, external surface temperatures or water temperature(s), as necessary, in accordance with 7.2 and positioned as shown in Figure 1.

4.5 Bore micrometer or equivalent, capable of measuring changes in the vertical inside diameter of the test piece to within ±0,1 mm.

4.6 Gauge, capable of checking the bottom radius of the test piece for the purposes of item b) of 7.3.2.

4.7 Hard ball, conforming to 7.3.3, if applicable.

4.8 Straight edge, of length ⩾ (1,5 × actual outside diameter ± 10) mm.

4.9 Tamping tool, of overall mass (10 ± 0,5) kg and having a (300 ± 10) mm^2 foot face with rubber at least 5 mm thick and nominally 60 IRHD, when measured in accordance with ISO 48.

5 Test piece

The test piece shall comprise an assembly of two pipes connected together or fitting(s) assembled with two or more pieces of pipe, of the size(s) and type(s) for which the fitting is designed or a length of pipe having no joints.

Any jointing shall be carried out in accordance with the manufacturer's instructions.

6 Conditioning

Pipes and fittings shall not be tested within a period of 24 h after their production.

7 Procedure

7.1 Test piece embedment and loading

7.1.1 Wherever this method calls for compaction, the following method shall be used.

Apply 75 blows with the tamping tool evenly spaced over the surface of the gravel. For each blow, raise the tamping tool (450 ± 50) mm above the surface of the gravel and allow it to fall under gravity.

7.1.2 Using gravel conforming to Table 4, lay and level a compacted gravel bed (100 ± 5) mm thick, such that a fall of between 1:100 and 1:75 is achieved in the direction of flow.

7.1.3 Check that the test piece conforms to the dimensional requirements of the applicable standard and determine the minimum inside diameter, d_0, of the test piece. Place the test piece flat on the gravel bed under the loading plate as indicated in Figure 4 and such that the weld line of fittings, if any, will be subjected to the flow of water, where this is possible.

For pipes jointed directly, position the joint under the centre of the loading plate. In the case of a single branch fitting, install the side inlet of the fitting at a gradient of approximately 1:40.

When testing a branch, locate the side limb in the horizontal position and seal any socket not being used with a short length of pipe having a sealed end or by means of a socket plug.

If necessary, add gravel such that the test piece rests on an even base or remove gravel such that a close fit is achieved for any socket.

7.1.4 Attach a temperature (upper surface) sensor to the crown of the test piece, where applicable, inside the box adjacent to the water inlet, within 100 mm to 150 mm from the inside of the box (see Figure 1).

For Method A, place a temperature sensor in the inlet of the hot water stream.

For Method B, place a temperature sensor in the outlet side of the hot water flow outside of the box structure.

7.1.5 Fill the box in the following stages:

a) using gravel conforming to Table 4, fill the box to within 100 mm to 150 mm above the crown of the pipe, minimizing voids below the pipe ensuring that it is fully supported and compacted;

b) thereafter fill the box with two approximately equal layers, each compacted in turn, to achieve a total depth of gravel cover of between 600 mm and 650 mm over the crown of the assembly.

7.1.6 Measure and record the vertical inside diameter, or a convenient vertical diameter reference, d_1, of the test piece at the centre of the test piece, which should coincide as closely as practicable with the vertical axis of the centre of the loading plate.

Depending on the size of the test assembly, apply the appropriate test force (see Table 5) to the surface of the gravel and maintain the force within the specified limits throughout the test.

7.1.7 Apply the load in the following manner.

a) Lower the rigid plate to the surface of the gravel and within 2 min apply an initial load of (5 ± 0,5) kN. Note the level of the face of the load plate by measurement using the four corners as datum points (see 4.2).

b) Depending on the size of the test assembly, apply the test load (see Table 5).

Table 5 — Test loads

Mean outside diameter d_{em} mm	Load F kN
$\leqslant 255$	50 ± 2
$255 < d_{em} \leqslant 410$	55 ± 2
$410 < d_{em} \leqslant 510$	60 ± 2

c) If the plate sinks more than 20 mm at any datum point, remove the load plate. In case of dispute, empty the box and refill it in accordance with 7.1.5, otherwise add to, level and re-compact the top layer of gravel to re-establish a total depth of gravel cover of between 600 mm and 650 mm over the crown of the pipe. Restart the test by commencing at the procedure given in 7.1.6.

7.2 Exposure to hot water

7.2.1 Method A: Temperature cycling — for pipes/fittings with a mean outside diameter $d_{em} \leqslant 190$ mm

7.2.1.1 Procedure

Subject the assembly to a minimum of 2 500 cycles in accordance with 7.2.1.2, provided that within the first 20 cycles and for all subsequent cycles, the temperature of the crown of the pipe recorded by the (upper surface) sensor is above 30 °C on the hot cycle and is below 30 °C on the cold cycle. If necessary, this may be achieved by controlling the outlet ventilation.

If, during the test, the water temperature drops below 83 °C or the load drops below the minimum required for a number of cycles, an equal number of cycles shall be added to the test.

If, during the test, the water temperature increases above 87 °C or the load rises above that specified, the test may be discontinued at the discretion of the manufacturer.

The hot and cold water temperatures may be recorded at the inlet hot water sensor and cold water sensor, respectively, continuously during the test.

7.2.1.2 Cycle procedure

Use the following cycle schedule, where cooling may be supplemented by an air flow or air blast at any time during the cycle so as to achieve the requirements of 7.2.1 for the temperatures measured by the (upper surface) sensor:

a) pass (35 ± 3) l of water at (85 ± 2) °C measured at the point of inlet to the assembly by the inlet hot water sensor, over a period of 90 s to 95 s;

b) rest and drain period of 60 s to 90 s;

c) pass at least 30 l of water of between 5 °C and 22 °C via a sparge pipe positioned within the bore of the assembly and having holes on its upper part to direct the flow over the pipe crown. The flow, together if necessary with an optional air flow or air blast through the test assembly, shall be sufficient to reduce the crown temperature to below 30 °C as recorded by the (upper surface) sensor. The cooling discharge shall be introduced through a pipe of suitably small diameter positioned in the bore within the assembly and having perforations along its upper part such that the water is directly over the upper 120° sector;

d) drain the assembly for a period sufficient to allow the assembly to be emptied;

e) return to a).

7.2.2 Method B: Constant hot water — for pipes/fittings with a mean outside diameter d_{em} > 190 mm

Pass water at a temperature, T_1, of (50 ± 2) °C constantly through the test piece. The temperature of the water, T_2, measured at the outlet hot water sensor, shall be (50 ± 2) °C, unless otherwise specified in the referring standard.

NOTE Surface temperatures are not measured.

Unless otherwise specified in the referring standard, maintain the flow for 192 h.

The hot water temperature may be recorded at the outlet hot water sensor, continuously during the test.

7.3 Assessment

7.3.1 Assessment of initial deflection and leaktightness

Before removing the force on the loading plate, and unless 7.3.3 applies, proceed as follows.

a) Locate, measure and record the vertical inside diameter, d_2, or the reference dimension at the position at which d_1 was measured.

b) Seal the pipe ends, fill the assembly with water at a temperature of (17 ± 5) °C and, after a conditioning period of 15 min, apply a hydrostatic pressure of 0,35 bar, for a period of 15 min whilst monitoring the pressure and during which the pressure shall not fall below 0,3 bar.

The vertical deflection may be measured continuously during the test.

7.3.2 Control of deflection, weld line and cracks

After the leak-tightness test and within 24 h after removal of the force, and unless 7.3.3 applies, measure the local deflections in the test piece as follows.

a) Measure the evenness of the bottom of the test piece from the outside in the direction of the longitudinal axis, by placing the straight edge against the bottom of the test piece, without contacting any raised structural features of the test piece, and measuring the greatest gap between the straight edge and the bottom of the test piece;

b) Measure deviations in the bending radius of the test piece by using a gauge not less than 2 mm thick in the shape of a cylinder with the axis of the gauge aligned with the longitudinal axis of the test piece and the convex part of the gauge turned in the direction of the perimeter along the test piece which was subjected to water flow;

c) Drain, recover and dismantle the test piece and inspect the test piece components for any damage visible without magnification. In weld line zones, if any opening is visible, break it open and measure the greatest depth of the crack in the fracture surface induced by the exposure to hot water. Record the observations and the crack depth(s), as applicable.

7.3.3 Alternative deflection measurement

Alternatively, 7.3.1 a), 7.3.2 a) and 7.3.2 b) may be replaced by the following procedure.

Determine whether the test piece assembly is capable of passing a hard ball having a diameter D_B in accordance with Equation (1):

$$D_B = (d_1 - \times) \quad (1)$$

where

x is a percentage of d_i, as specified by the referring standard;

d_1 is the measured vertical inside diameter prior to loading and exposure to hot water (see 7.1.4), in millimetres.

8 Calculation and expression of results

Calculate the deformation, λ, as the percentage change in inside diameter, using Equation (2):

$$\lambda = \frac{d_1 - d_2}{d_1} \times 100 \quad (2)$$

where

d_1 is the measured vertical inside diameter prior to loading and exposure to hot water (see 7.1.4);

d_2 is the measured vertical inside diameter after loading and exposure to hot water at the position at which d_1 was measured (see 7.3.1).

9 Test report

The test report shall include the following information:

a) a reference to this International Standard, i.e. ISO 13260:2010, and the referring standard;

b) the identity of the fitting or pipe under test, including its (their) nominal size(s);

c) the force, F, applied through the loading plate, in kilonewtons;

d) the test method used, i.e. Method A (see 7.2.1) or Method B (see 7.2.2);

e) the hot water temperature, T_1;

f) for Method A, the number of hot and cold water cycles applied, or for Method B, the total time during which hot water was passed through the test piece;

g) the initial inside diameter, d_1;

h) as applicable, one of the three items 1), 2) and 3) or item 4):

1) the inside diameter, d_2, of the test piece after water cycling (Method A) or hot water passage (Method B) [see item a) of 7.3.1] and;

2) the deviation of the evenness of the bottom [see item a) of 7.3.2] and;

3) the radius in the bottom [see item b) of 7.3.2]; or

4) the diameter of the ball, D_B, and whether or not the ball would pass through the test piece (see 7.3.3);

i) the deformation, λ, of the test piece after water cycling (Method A) or hot water passage (Method B);

j) any opening of the weld line [see item c) of 7.3.2];

k) if and at what stage(s) during the test any leakage from the test piece was observed;

l) a description of any visible effects of the test upon the test pieces;

m) any factors that could have affected the results, such as any incidents or any operating details not specified in this International Standard;

n) the date of test.

Annex A
(informative)

Recommended requirements

In the interest of rationalization of the setting of requirements by system standards, it is recommended that, if possible, the following requirements be set as applicable:

a) the maximum vertical deflection after the test is completed, but before the load is released (see 7.3.1) should be 8 % for products of PVC-U and ABS and 9 % for products of PE and PP [see item f)].

b) the tightness test as specified in item b) of 7.3.1 should allow no leakage.

c) when determined in accordance with item a) of 7.3.2 the deviation from evenness in the bottom caused by the test should be maximum 3 mm [see item f)].

d) when determined in accordance with item b) of 7.3.2 the radius in the bottom should be at least 80 % of the original [see item f)].

e) when determined in accordance with item c) of 7.3.2 any opening of a weld line should be $\leqslant$ 20 % of the wall thickness at that point.

f) items a), c) and d) may be replaced by passing a hard ball as specified in 7.3.3. In that case, the ball should easily pass the test assembly.

ICS 23.040.20; 23.040.45; 91.140.80; 93.030

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