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**Zkoušení svarových spojů polotovarů z termoplastů –  
Část 4: Odlupovací zkouška**





EUROPEAN STANDARD

**EN 12814-4**

NORME EUROPÉENNE

EUROPÄISCHE NORM

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Supersedes EN 12814-4:2001

English Version

## Testing of welded joints of thermoplastics semi-finished products - Part 4: Peel test

Essai des assemblages soudés sur produits semi-finis  
en thermoplastiques - Partie 4 : Essai de pelage

Prüfen von Schweißverbindungen aus  
thermoplastischen Kunststoffen - Teil 4: Schälversuch

This European Standard was approved by CEN on 10 December 2017.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

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This document consolidates EN 12814-4:2018 and the corrigendum EN 12814-4:2018/AC:2018.



EUROPEAN COMMITTEE FOR STANDARDIZATION  
COMITÉ EUROPÉEN DE NORMALISATION  
EUROPÄISCHES KOMITEE FÜR NORMUNG

**CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels**

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## European foreword

This document (EN 12814-4:2018) has been prepared by Technical Committee CEN/TC 249 “Plastics”, the secretariat of which is held by NBN.

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of an identical text or by endorsement, at the latest by October 2018, and conflicting national standards shall be withdrawn at the latest by October 2018.

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

This document supersedes EN 12814-4:2001.

This document includes the corrigendum EN 12814-4:2018/AC:2018 which corrects the symbol for the peel resistance in 5.5, 2<sup>nd</sup> paragraph, 1<sup>st</sup> line.

In comparison with the previous edition, the following technical modifications have been made:

- the procedures in the Clauses “T-peel test”, “Decohesion test”, “Crush test” have been detailed with specifications and consequently with the reference figures.

EN 12814, *Testing of welded joints of thermoplastics semi-finished products*, is composed with the following parts:

- *Part 1: Bend test;*
- *Part 2: Tensile test;*
- *Part 3: Tensile creep test;*
- *Part 4: Peel test;*
- *Part 5: Macroscopic examination;*
- *Part 6: Low temperature tensile test;*
- *Part 7: Tensile test with waisted test specimens;*
- *Part 8: Requirements.*

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

## 1 Scope

This document specifies the dimensions, the method of sampling and the preparation of the test specimens, and also the conditions for performing the peel test perpendicular to the weld in order to determine the peel resistance and the failure behaviour.

A peel test can be used in conjunction with other tests (e.g. tensile creep, macroscopic examination...) to assess the performance of welded assemblies, made from thermoplastics materials.

Peel tests are applicable to overlap welded assemblies made from thermoplastics materials.

The T-peel test as defined in Clause 5 will be used only for assessing welded sheet assemblies. This test is not applicable to welded test pieces containing sheets of different nominal thickness.

The decohesion test as defined in Clause 6 will be used only for assessing electrofusion joints with nominal thickness of pipe/fitting greater than 10 mm.

For socket fusion and for electrofusion socket joints with nominal outside diameter less than or equal to 90 mm, a crush test will be used, as defined in Clause 7.

The crush test can also be used for electrofusion joints with outside diameters greater than 90 mm.

The crush test for electrofusion saddle joints will be performed in accordance with ISO 13955 [1].

NOTE A decohesion test is also defined in ISO 13954 [2].

The tests defined in this standard are not intended to be used for assessment and/or qualification of thermoplastic fittings that already have their own requirements, e.g. polyethylene fittings according to EN 1555-3 [3] and EN 12201-3 [4].

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 5893, *Rubber and plastics test equipment — Tensile, flexural and compression types (constant rate of traverse) — Specification*

## 3 Terms and definitions

For the purposes of this document, the following term and definition apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

### 3.1

#### peel resistance

#### $P_1$

arithmetic mean of the force values divided by the width of the test specimen (only relevant for T-peel test)

## 4 Symbols and designations

For the purposes of this document, the symbols and designations given in Table 1 apply.

**Table 1 — Test specimen designations**

Symbols and abbreviations	Designations	Units
$a_n$	Nominal thickness of test piece	mm
$b$	Width of the test specimen	mm
$c$	Maximum width of the air channel (if applicable)	mm
$C_c$	Percentage of brittle failure	%
$d_2$	Maximum brittle-fracture length measure	mm
$d_n$	Nominal outside diameter of pipe	mm
$F_w$	Maximum force measured during the test	N
$L_c$	Clamped length of test specimen ligament	mm
$L_d$	Length of fracture in the fusion plane	mm
$L_i$	Free length of test specimen	mm
$L_w^a$	Maximum width of the weld of the test specimen	mm
$P_l$	Peel resistance	N/mm
$y$	Fusion zone length of electrofusion socket	mm
<sup>a</sup> For welds containing an air channel, $L_w$ shall be taken as the width of the whole weld minus the width of the channel ( $c$ ).		

## 5 T-peel test

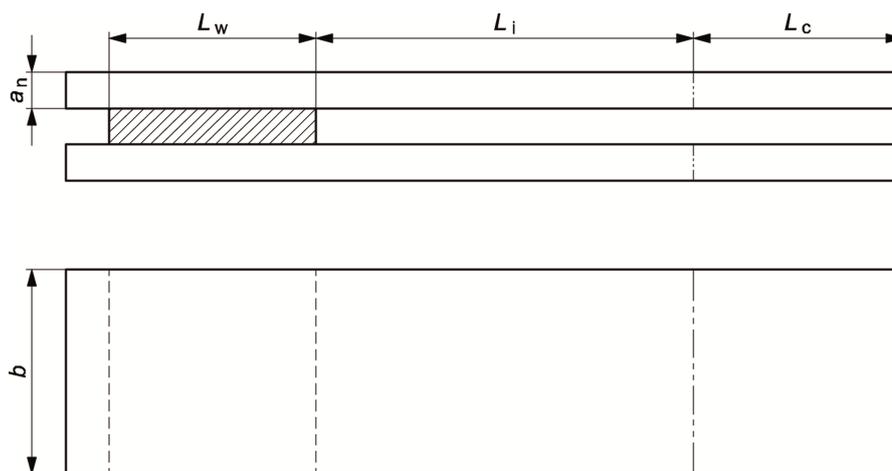
### 5.1 Principle of the test

The test consists of peeling a test specimen at a constant rate of displacement until it fractures, peels or yields.

### 5.2 Test specimens

#### 5.2.1 Dimensions of test specimens

The test specimen is shown in Figure 1 and the dimensions are given in Table 2.



**Figure 1 — T-peel test specimen**

The value of  $L_c$  shall be greater than, or equal to,  $b$ .

**Table 2 — Dimensions of test specimen**

Dimensions in millimetres

$a_n$	$b^a$	$L_i$
$a_n \leq 1,5$	15	$\geq 15$
$1,5 < a_n \leq 3$	15	$\geq 10 \times a_n$
$3 < a_n \leq 5$	25	$\geq 10 \times a_n$
$a_n > 5$	$5 \times a_n$	$\geq 10 \times a_n$

<sup>a</sup> For reinforced materials,  $b$  shall be 50 mm.

The tolerance for  $b$  shall be  $\pm 0,5$  mm.

### 5.2.2 Preparation of test specimens

The time between the end of the welding operations and the start of machining operations, shall be at least 8 h.

The welded test specimens shall be cut perpendicular to the welded joint.

The test specimens shall be cut with parallel sides as shown in Figure 1.

During cutting, heating of the test specimen should be avoided.

Cutting of the test specimen shall not produce notches.

After cutting, a visual examination of the weld should be carried out and any imperfections, as defined in EN 14728 [5], recorded.

Each test specimen shall be marked so that its original position in the test piece can be identified.

### 5.2.3 Number of test specimens

At least 5 specimens shall be tested for each welded test piece unless otherwise specified in the relevant application standard.

### 5.2.4 Conditioning of test specimens

No heat treatment or mechanical straightening operations shall be carried out on the test specimen. After machining, the test specimens shall be conditioned at least 2 h at the testing temperature.

### 5.3 Apparatus

The test equipment shall conform to the requirements given in ISO 5893.

The crosshead displacement shall be continuous, uniform and in accordance with Table 3.

After setting, the rate shall not vary during the course of any test or series of tests by more than  $\pm 5\%$  of the mean rate and shall remain within the limits imposed in Table 3.

The force shall be measured and recorded with an accuracy of  $\pm 2\%$ .

The test equipment shall be provided with a suitable self-aligning grip to hold the specimen.

### 5.4 Test procedure

The two unwelded ends of the test specimen shall be bent in opposite directions until each end is perpendicular to the weld, to form a T-shaped specimen (see Figure 2) for clamping in the jaws of the test equipment. Inserting the test specimen into the test equipment shall not cause cracking at the weld. If it does, the test is invalid.

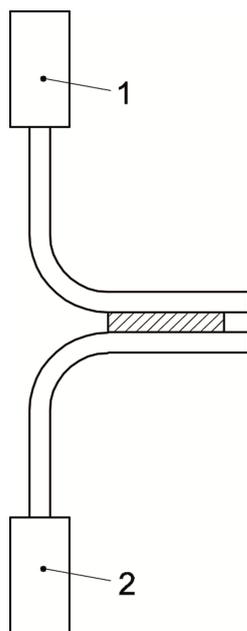
Unless otherwise specified, the test shall be carried out at a room temperature of  $(23 \pm 2)^\circ\text{C}$ .

The test speeds for some relevant thermoplastic materials are listed in Table 3.

**Table 3 — T-peel test speeds for some thermoplastics**

Material	Speed mm/min
PVC	$10 \pm 2$
PVDF, PP-H, PP-B	$20 \pm 2,5$
PE, PP-R	$50 \pm 5$

For other materials, the test speed shall be agreed between the contracting parties.



**Key**  
1,2 jaw

**Figure 2 — Peel test arrangement**

In order to provide additional information, a graph of force versus crosshead displacement may be recorded for each specimen.

### 5.5 Calculation of the peel resistance

At least five test specimens shall be used in the evaluation of the peel resistance. No test specimen shall be disregarded unless failure occurs in the clamps.

The peel resistance,  $\overline{P}_1$ , is calculated using the following formula:

$$P_1 = \frac{\overline{F}_w}{b}$$

where

$\overline{F}_w$  is the arithmetic mean of the maximum force values

$b$  is the width of the test specimens

## 6 Decohesion test

### 6.1 Principle of the test

A fused socket joint is sectioned at four equidistant positions around the circumference of the fitting and subjected to a longitudinal peel test, such that the resultant peel should be along the length of the fusion interface. Separation of the joint components is taken to completion and the parted surfaces shall be inspected for evidence of ductile and/or brittle failure along the joint interface.

## 6.2 Test specimens

### 6.2.1 Dimensions of test specimens

The dimensions of the test specimens are given in Figures 3, 4 and 5.

### 6.2.2 Preparation of test specimens

#### 6.2.2.1 General

The test specimens shall be cut with parallel sides as shown in Figures 3, 4 and 5.

During cutting, heating of the test specimen should be avoided.

Cutting of the test specimen shall not produce notches.

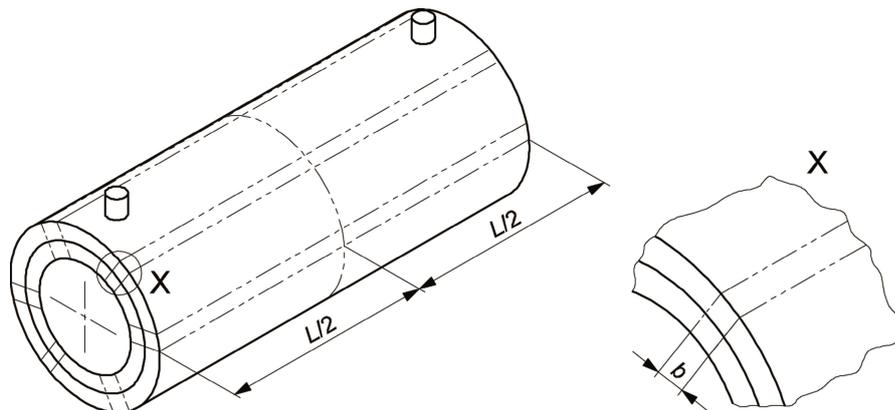
After cutting, a visual examination of the weld should be carried out and any imperfections, as defined in EN 14728 [5], recorded.

Initially, standard test specimens shall be used for the decohesion test. If the joint cannot be broken, using this test specimen, a side grooved test specimen shall be used (see 6.2.2.3).

Each test specimen shall be cut from an assembly between a socket and a spigot end of a fitting or a pipe.

#### 6.2.2.2 Cutting of test specimens

The conditioned welded assembly shall be cut into parallel-sided sections (see Figure 3).



#### Key

$b = 20$  ( $90 < d_n \leq 180$ )

$b = 30$  ( $d_n > 180$ )

**Figure 3 — Cutting test specimens**

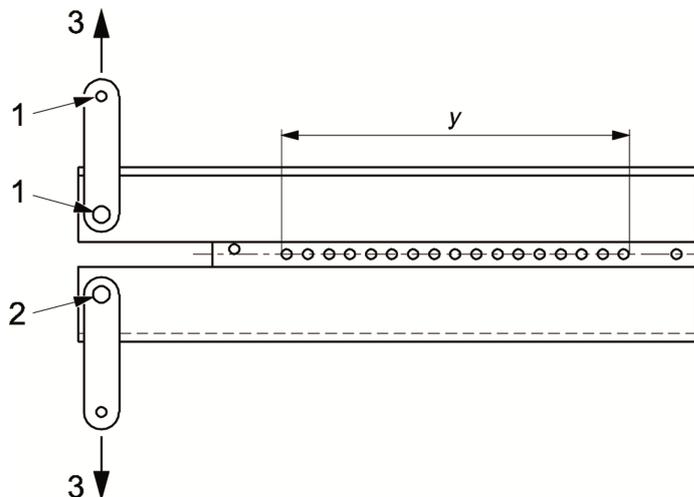
Test specimens shall be spaced at equidistant intervals around the joint circumference. The specimen length shall include the fusion zone and both cold zones of the electrofusion joint.

Test specimen shall not include terminals.

For electrofusion joints with nominal outside diameter greater than 90 mm and up to and including 180 mm, the width  $b$  of the test specimen shall be 20 mm.

For pipes of nominal outside diameter greater than 180 mm, the width  $b$  of the test specimen shall be 30 mm.

One hole of at least 5 mm diameter shall be drilled through the pipe and one hole of equal size through the fitting at the ends containing the “cold zones” see Figure 4.



**Key**

- 1 loading pins
- 2 5 mm diameter holes in specimen
- 3 direction of the load
- y fusion zone length

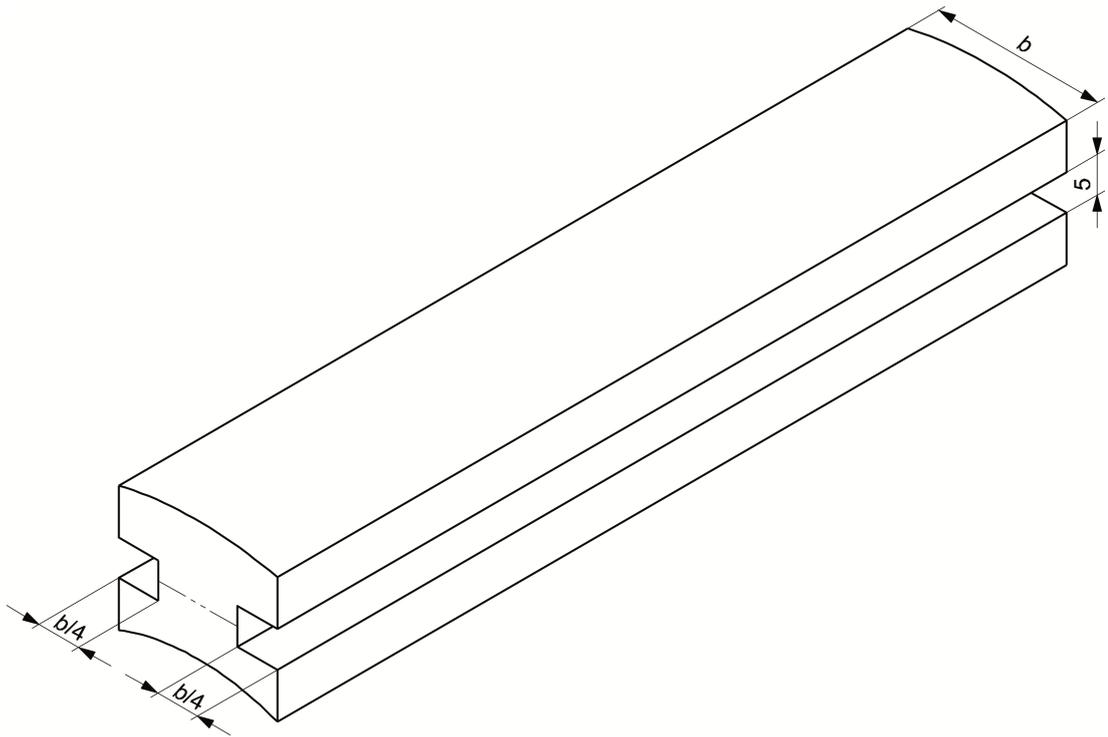
**Figure 4 — Loading arrangement**

The holes shall be located as close to each other as possible.

NOTE Standard dimensions are not specified as the individual manufacturer's dimensions vary.

**6.2.2.3 Cutting of side grooved test specimens**

A 5 mm wide side groove shall be machined in the test specimen, using a milling machine with a flat-bottomed cutter (or similar apparatus) see Figure 5.



**Figure 5 — Side grooved test specimen**

Grooves shall be machined into both faces of the test specimen, penetrating to a quarter of the specimen width.

The joint interface shall lie within the groove.

### **6.2.3 Number of test specimens**

The number of test specimens tested shall be as specified in the relevant application standard.

### **6.2.4 Conditioning of test specimens**

Between the welding and machining operations, the test piece shall be conditioned for at least 8 h at an ambient temperature of  $(23 \pm 2)$  °C.

After machining, the test specimen shall be continuously conditioned at the test temperature.

### **6.3 Apparatus**

All tests shall be conducted on a tensile testing machine conforming to the requirements given in ISO 5893.

After setting the cross head speed, the rate shall not vary during the course of any test or series of tests by more than  $\pm 5$  % of the mean rate and shall remain within the limits imposed in 6.4

The tensile testing machine shall incorporate a means of providing a permanent record of the force/displacement history during the test.

### **6.4 Test procedure**

The test temperature shall be  $(23 \pm 2)$  °C.

Push fit metal pins shall be placed in the holes drilled in the test specimen and drilled side plates attached which allow free movement during alignment see Figure 4.

For polyethylene joints, the tensile force shall be applied using a cross-head rate of displacement of  $(25 \pm 2,5)$  mm/min.

For other thermoplastic materials the cross-head rate of displacement shall be agreed between the contracting parties.

The test shall be continued until there is complete separation of the test specimen.

A force/displacement graph shall be obtained for each test.

The mode of failure shall be recorded by noting the location and length of either brittle crack growth (with no signs of macro-ductility) or ductile yielding as marked by intense white colouring and/or extensive cold-flow of the plastic material.

## 6.5 Calculation of the percentage of the brittle fracture

The percentage of the brittle failure  $C_C$  shall be calculated using the following formula:

$$C_C = (d_2/y) \times 100$$

## 7 Crush test

### 7.1 Principle of the test

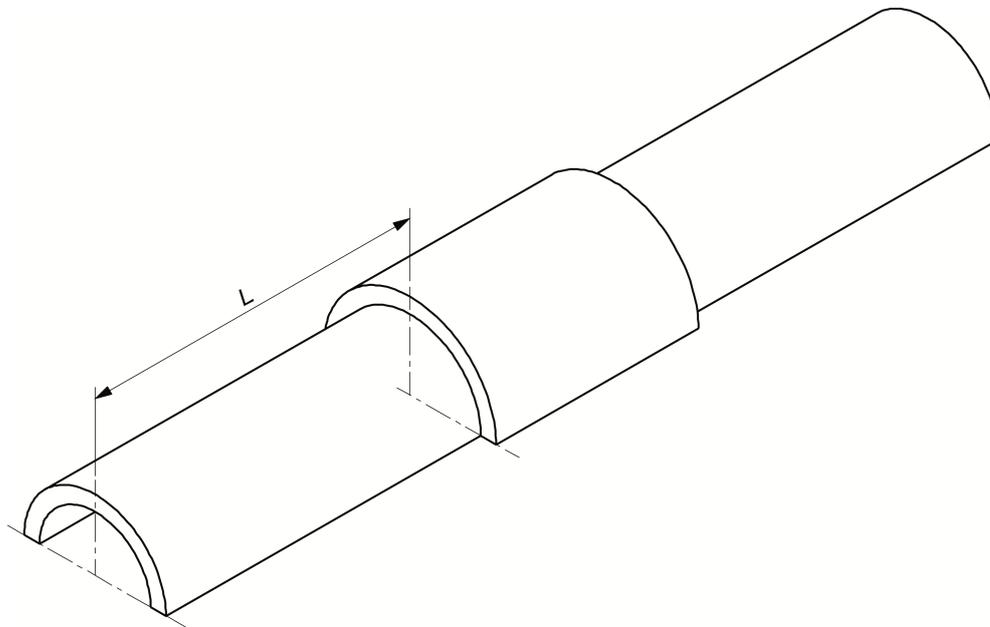
A welded socket joint is sectioned in the axial direction in two equal parts.

The pipe is squeezed in order to assess the weld properties of the assembly.

### 7.2 Test specimens

#### 7.2.1 Dimensions of test specimens

The dimensions of the test specimens are given in Figure 6.



Key

$$L = 5 d_n$$

Figure 6 — Crush test specimen

### 7.2.2 Preparation of test specimens

Each test specimen shall be cut from an assembly between a socket and a spigot end of a fitting or a pipe.

The test specimens shall be cut as shown in Figure 6.

During cutting, heating of the test specimen should be avoided.

Cutting of the test specimen shall not produce notches.

After cutting, a visual examination of the weld should be carried out and any imperfections, as defined in EN 14728 [5], recorded.

### 7.2.3 Number of test specimens

Two test specimens shall be cut from each welded assembly.

The number of test specimens tested shall be as specified in the relevant application standard.

### 7.2.4 Conditioning of test specimens

Between the fusion and machining operations, the test piece shall be conditioned for at least 8 h at an ambient temperature of  $(23 \pm 2)$  °C.

After machining, the test specimen shall be continuously conditioned at the test temperature.

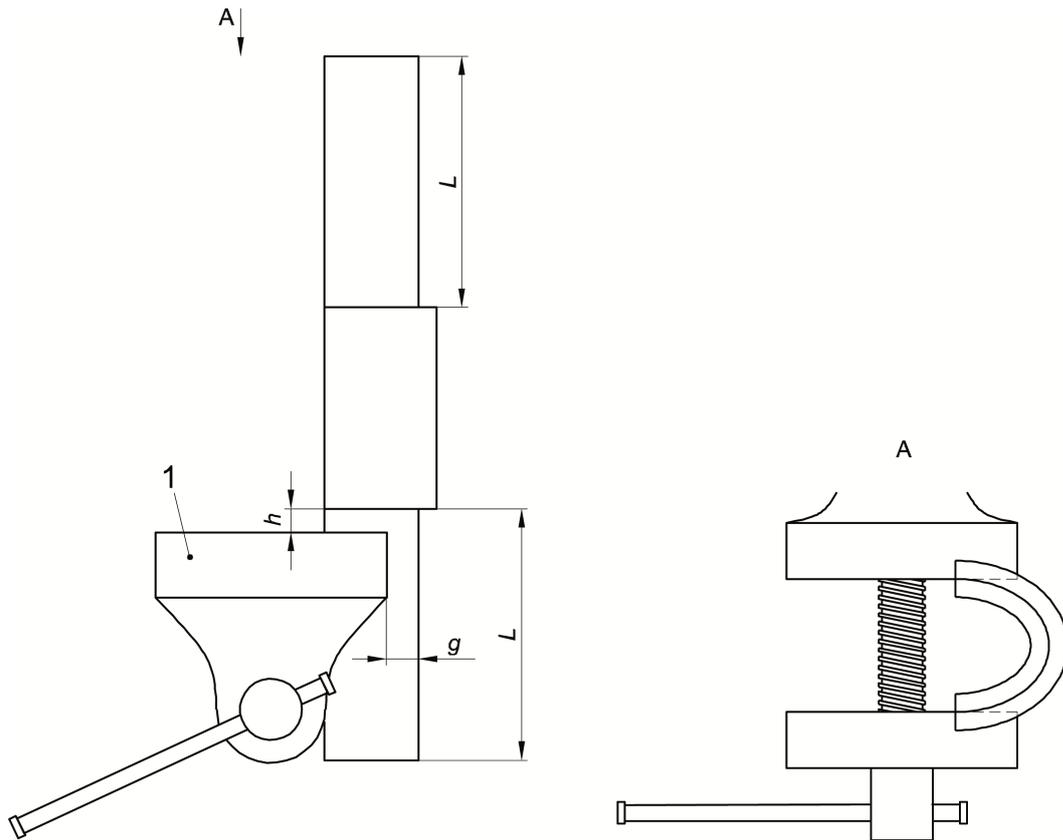
## 7.3 Apparatus

All tests shall be carried out on compression equipment, capable of applying the necessary compressive force.

## 7.4 Test procedure

The pipe of each test specimen shall be squeezed  $5 \text{ mm} \pm 2 \text{ mm}$  from the mouth of the socket (see Figure 7) until the internal pipe surfaces touch, i.e. the distance between the jaws of the squeezing equipment becomes equal to twice the pipe wall thickness. The time to squeeze the pipe shall be recorded.

The assembly shall be held in this position for ten minutes, at the end of which, the fused interface shall be inspected and the length of fracture in the fusion plane, parallel to the axis of the pipe,  $L_d$ , shall be measured.



**Key**

1 apparatus (e.g. manual vice)

$L > 5 d_n$

$h = (5 \pm 2) \text{ mm}$

$g < 10 \text{ mm}$

**Figure 7 — Crush test arrangement**

For each test specimen, tests shall be performed on both ends of the socket.

Caution should be taken since the specimen may spring out of the clamps during the test.

## 8 Test report

The test report shall include the following general information:

- a) reference to this standard and to the relevant application standard;
- b) description and identification of the test piece and test specimen;
- c) weld type;
- d) the welding conditions for test pieces (if known, reference should be made to CEN/TS 16892 [6]);
- e) dimensions of the test specimen;
- f) test temperature;

- g) the number of test specimens used;
- h) the time for conditioning the test pieces and test specimens before testing;
- i) appearance of all surfaces of the test specimens before the test (e.g. flaws, scratches, visual imperfections);
- j) description of failure behaviour (e.g. photos, ...);
- k) identification of the laboratory;
- l) the date of the test and the name and the signature of the operator; completed by the following specific information:
  - 1) for the T-peel test:
    - i) distance between the clamping jaws;
    - ii) individual values of measured maximum force ( $F_W$ );
    - iii) maximum width of the weld of the test specimen ( $L_W$ );
    - iv) peel resistance ( $P$ );
    - v) test speed;
    - vi) the failure position;
    - vii) the maximum width of the air channel (if applicable);
  - 2) for the decohesion test:
    - i) the nominal size of the fitting;
    - ii) the dimensions of the pipes, including the mean outside diameter and thickness;
    - iii) the fusion conditions for the test pieces;
    - iv) the location of the holes for the loading pins (i.e. internal or external cold zone);
    - v) the calculated values of the percentage of brittle failure,  $C_C$  for each test specimen;
  - 3) for the crush test:
    - i) the nominal size of the fitting ;
    - ii) the dimensions of the pipes, including the mean outside diameter and thickness;
    - iii) the free length of pipes;
    - iv) the length of fracture in the fusion plane ( $L_d$ ) for each test specimen;
    - v) the time to squeeze the pipe.

## Bibliography

- [1] ISO 13955, *Plastics pipes and fittings — Crushing decohesion test for polyethylene (PE) electrofusion assemblies*
- [2] ISO 13954, *Plastics pipes and fittings — Peel decohesion test for polyethylene (PE) electrofusion assemblies of nominal outside diameter greater than or equal to 90 mm*
- [3] EN 1555-3, *Plastics piping systems for the supply of gaseous fuels — Polyethylene (PE) — Part 3: Fittings*
- [4] EN 12201-3, *Plastics piping systems for water supply, and for drainage and sewerage under pressure — Polyethylene (PE) — Part 3: Fittings*
- [5] EN 14728, *Imperfections in thermoplastic welds — Classification*
- [6] CEN/TS 16892, *Plastics — Welding of thermoplastics — Specification of welding procedures*



**U p o z o r n ě n í :** Oznámení o změnách, opravách a nově vydaných normách jsou uveřejňována ve Věstníku Úřadu pro technickou normalizaci, metrologii a státní zkušebnictví.

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