



BSI Standards Publication

# Testing of welded joints of thermoplastics semi-finished products

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Part 2: Tensile test

EUROPEAN STANDARD

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## Testing of welded joints of thermoplastics semi-finished products - Part 2: Tensile test

Essais des assemblages soudés sur produits semi-finis  
en thermoplastiques - Partie 2 : Essai de traction

Prüfen von Schweißverbindungen aus  
thermoplastischen Kunststoffen - Teil 2: Zugversuch

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## Contents

	Page
European foreword.....	3
1 Scope.....	4
2 Normative references.....	4
3 Terms, definitions, symbols and abbreviated terms .....	4
3.1 Terms and definitions.....	4
3.2 Symbols and abbreviated terms.....	4
4 Principle of the test.....	5
5 Sampling procedures.....	5
6 Dimensions of test specimens .....	6
7 Cutting of test specimens .....	8
8 Mechanical testing.....	8
9 Test equipment.....	8
10 Determination of the short-term tensile welding factor .....	8
11 Test report.....	9
Annex A (informative) Tensile test specimen for overlap joints .....	11
Annex B (informative) Recommended test speeds for some thermoplastics materials .....	12
Annex C (normative) Notched tensile test specimen.....	13
Bibliography .....	14

## European foreword

This document (EN 12814-2:2021) 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of an identical text or by endorsement, at the latest by July 2021, and conflicting national standards shall be withdrawn at the latest by July 2021.

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

This document supersedes EN 12814-2:2000.

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

- the reference standards ISO 5893 and ISO 13953 have been changed to undated;
- a new annex (Annex A), describing the tensile test specimen geometry for overlap joints, has been added.

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, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

## 1 Scope

This document specifies the dimensions, the method of sampling, the preparation of the test specimens and the conditions for performing the tensile test in order to determine the short-term tensile welding factor.

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

The test is applicable to welded semi-finished products made from thermoplastics materials filled or unfilled, but not reinforced, irrespective of the welding process used.

## 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.

EN 13100-1, *Non destructive testing of welded joints of thermoplastics semi-finished products - Part 1: Visual examination*

EN ISO 527-1, *Plastics - Determination of tensile properties - Part 1: General principles (ISO 527-1)*

ISO 5893, *Rubber and plastics test equipment - Tensile, flexural and compression types (constant rate of traverse) - Specification*

ISO 13953, *Polyethylene (PE) pipes and fittings - Determination of the tensile strength of test specimens from a butt-fused joint*

## 3 Terms, definitions, symbols and abbreviated terms

### 3.1 Terms and definitions

No terms and definitions are listed in this document.

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 <https://www.iso.org/obp>

### 3.2 Symbols and abbreviated terms

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

**Table 1 — Symbols and abbreviated terms**

<b>Symbols and abbreviated term</b>	<b>Designations</b>	<b>Units</b>
$a$	Minimum measured thickness of the test specimen within calibrated and parallel length	mm
$a_n$	Nominal thickness of the test piece	mm
$b$	Width of calibrated and parallel length of the test specimen	mm
$b_1$	Width of shoulder of the test specimen	mm
$D_n$	Nominal outside diameter of the tube	mm
$F_r$	The value of force of the unwelded test specimens taken from the same test piece, used in the calculation of $f_s$	N
$f_s$	The short-term tensile welding factor	None
$F_w$	The value of force of the welded test specimen used in the calculation of $f_s$	N
$L$	Total length of the test specimen	mm
$L_j$	Minimum distance between the clamping jaws	mm
$L_o$	Calibrated and parallel length of the test specimen	mm
$L_w$	Maximum width of the weld bead of the test specimen	mm
$r$	Radius of shoulder of the test specimen	mm
$a_r$	The value of stress of the unwelded test specimens taken from the same test piece, used in the calculation of $f_s$	N/mm <sup>2</sup>
$a_w$	The value of stress of the welded test specimens used in the calculation of $f_s$	N/mm <sup>2</sup>

#### 4 Principle of the test

The test specimen is extended along its major longitudinal axis at constant speed until the test specimen fractures or yields. During this procedure the load sustained by the test specimen is measured.

#### 5 Sampling procedures

The test specimens (welded and unwelded) shall be cut perpendicular to the welded joint at least eight hours after welding.

Each test specimen shall be marked in order to identify its original position within the test piece.

No heat treatment or mechanical straightening operations shall be carried out on the test specimen.

## 6 Dimensions of test specimens

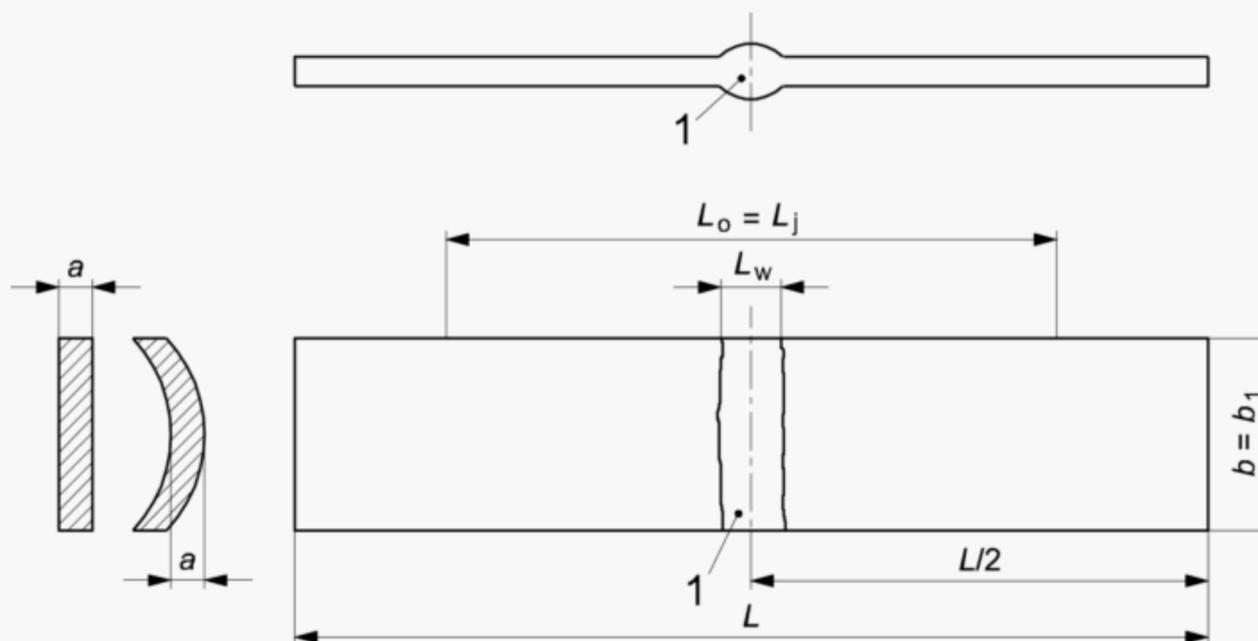
For tubes of nominal outside diameter  $D_n$  less than 20 mm, the whole tube shall be tested and the minimum distance between the clamps shall be 200 mm.

The dimensions of test specimens are given in Table 2 and Table 3.

**Table 2 — Dimension of type 1 test specimens**

Dimension in millimetres

$D_n$ or $a_n$	$b$	$L_o$	$L$
$20 \leq D_n < 50$	$a_n + \frac{D_n}{10}$	80	$\geq 120$
$50 \leq D_n < 100$	$a_n + \frac{D_n}{10}$	120	$\geq 170$
$D_n \geq 100$  or flat assemblies: $a_n \leq 10$ $10 < a_n \leq 20$ $a_n > 20$	15 30 $1,5 a_n$	120 120 200	$\geq 170$ $\geq 300$ $\geq 400$



### Key

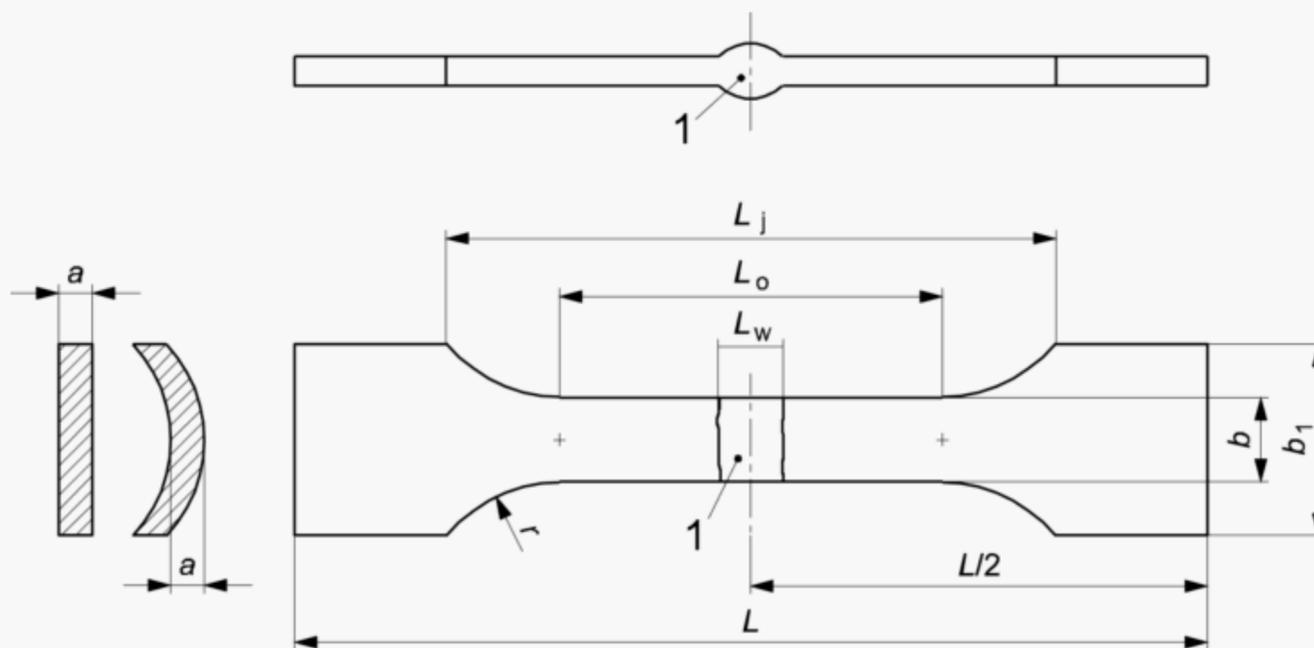
1 weld

**Figure 1 — Type 1 test specimen for flat and tubular assemblies**

**Table 3 — Dimension of type 2 test specimens**

Dimensions in millimetres

$D_n$ or $a_n$	$b$	min. $b_1$	$L_0$	$L$	$r$
$20 \leq D_n < 50$	$a_n + \frac{D_n}{10}$	$b + 10$	80	$\geq 120$	60
$50 \leq D_n < 100$	$a_n + \frac{D_n}{10}$	$b + 10$	120	$\geq 170$	60
$D_n \geq 100$ or flat assemblies: $a_n \leq 10$ $10 < a_n \leq 20$ $a_n > 20$	15 30 $1,5 a_n$	20 40 80	120 120 200	$\geq 170$ $\geq 300$ $\geq 400$	60 60 60

**Key**

1 weld

**Figure 2 — Type 2 test specimen for flat and tubular assemblies**

Where the beads are left intact in service, they shall be left intact for the test. Where the beads are removed in service, they shall be removed prior to testing.

The tolerance for  $b$  shall be  $\pm 1$  mm and the minimum value shall be 6 mm. The tolerance for  $L_0$  shall be  $\pm 2$  mm.

The variation of  $b$  over the length  $L_0$  shall not exceed  $\pm 2\%$  of the average value of  $b$ .

The forms of the test specimens are given in Figure 1 and Figure 2.

For overlap joints, the dimensions and form of the test specimens are given in Annex A.

## 7 Cutting of test specimens

The tensile test specimens shall be cut with parallel sides as shown in Figures 1 and 2. During cutting, heating of the test specimen shall be minimized.

Cutting of the test specimen shall not produce notches.

After cutting, a visual examination of the weld according to EN 13100-1 shall be carried out and recorded.

## 8 Mechanical testing

Test specimen shall be conditioned to a temperature of  $(23 \pm 2)$  °C and unless otherwise specified, the test shall be carried out at a room temperature of  $(23^{+2}_{-5})$  °C.

The test speeds and tolerances shall be in accordance with EN ISO 527-1.

For all materials the test speed shall be chosen to ensure that the test is terminated in about one minute. Examples of test speeds for some relevant thermoplastics materials are listed in Annex B.

At least five test specimens shall be tested for each welded and unwelded test piece.

Welded and unwelded test specimens shall be of the same geometry and shall be tested at the same speed with the same distance between the clamps.

If all welded test specimens fracture or yield within the calibrated length, but outside of the weld ( $L_w$ ), the unwelded test specimen do not need to be tested, and the short-term tensile welding factor shall be taken as 1.

In order to achieve a failure in the weld, the test specimens shall be as described in ISO 13953 (Type A only, for thickness less than 25 mm) or in Annex C.

## 9 Test equipment

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

The crosshead displacement shall be continuous, uniform and in accordance with Clause 8.

## 10 Determination of the short-term tensile welding factor

In order to determine the short-term tensile welding factor, welded and unwelded test specimens shall be tested.

The short-term tensile welding factor is determined from the arithmetic mean values of the fracture stresses of the welded test specimens,  $\sigma_w$ , and the unwelded test specimens  $\sigma_r$ , where:

$$\sigma_w = \frac{F_w}{ab}$$

$$\sigma_r = \frac{F_r}{ab}$$

If the test specimens yield prior to fracture, the yield stress shall be used instead of fracture stress.

Short term tensile welding factor  $f_s = \frac{\bar{a}_w}{\bar{a}_r}$

if  $\bar{a}_w > \bar{a}_r$ , then  $f_s = 1$ .

At least ten test specimens (five welded and five unwelded) shall be used in the evaluation of the short-term tensile welding factor. No test specimen shall be disregarded unless failure occurs in the clamps.

In the case of the type 1 test specimens, failure within a distance of 1 times specimen width  $b$ , from the clamps shall be regarded as failure in the clamp.

If type 1 test specimens consistently fail in the clamps then type 2 test specimens shall be used.

In the case of type 2 test specimens, failure outside of the calibrated length ( $L_0$ ) shall be regarded as failure in the clamp.

In the case of the whole tube tensile test, failure within a distance of  $1,5 D_n$  from the clamps shall be regarded as failure in the clamp.

## 11 Test report

The test report shall include at least the following information:

- 1) description and identification of the test piece and test specimens;
- 2) appearance of the test pieces before the test:
  - a) visual examination of weld;
  - b) beads removed or not;
- 3) weld type;
- 4) maximum width of the weld bead, if applicable ( $L_w$ );
- 5) nominal outside diameter of the tube, if applicable ( $D_n$ );
- 6) number of test specimens;
- 7) appearance of all surfaces of the test specimens, (e.g. flaws, scratches, visual imperfections);
- 8) thickness of test specimen ( $a$ );
- 9) type of test specimen;
- 10) appearance of all surfaces of the test specimens, (e.g. flaws, scratches, visual imperfections);
- 11) thickness of test specimen ( $a$ );
- 12) width of calibrated and parallel length ( $b$ );
- 13) calibrated and parallel length ( $L_0$ );
- 14) total length of the test specimen ( $L$ );
- 15) width of the test specimen shoulder, if applicable ( $b_1$ );
- 16) radius of shoulder ( $r$ );
- 17) distance between the clamping jaws;
- 18) temperature of the test specimen ( $^{\circ}\text{C}$ );

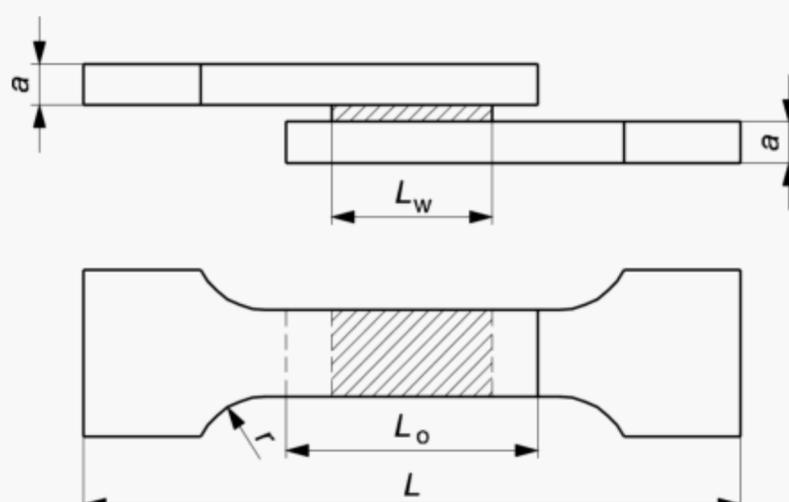
- 19) room temperature during the test ( $^{\circ}\text{C}$ );
- 20) the crosshead speed (mm/min);
- 21) visual examination of the ruptured surface, if applicable;
- 22) individual values of measured forces ( $F_w$  and  $F_r$ );
- 23) individual values of calculated stresses ( $a_w$  and  $a_r$ );
- 24) values of calculated average stresses ( $\bar{a}_w$  and  $\bar{a}_r$ );
- 25) calculated value of the short-term tensile welding factor ( $f_s$ );
- 26) identification of the laboratory;
- 27) date of the test;
- 28) name and signature of the responsible person for the test report.

## Annex A (informative)

### Tensile test specimen for overlap joints

In order to determine a short-term tensile welding factor for overlap joints, the test specimen geometry used is described in Figure A.1 and Table A.1.

The values of  $f_s$  determined using this specimen geometry should not be correlated with the values of  $f_s$  determined using the type 1 or type 2 test specimens described in Clause 6.



**Figure A.1 — Test specimen for overlap joints**

**Table A.1 — Dimensions of test specimens for overlap joints**

Dimensions in millimetres

$a$	$b$	Min. $b_1$	$L_0$	$L$	$R$
$a_n \leq 5$	15	20	120	$\geq 170$	60

## **Annex B**

(informative)

### **Recommended test speeds for some thermoplastics materials**

The recommended test speeds used for some thermoplastics materials are given in Table B.1.

**Table B.1 — Recommended test speeds for some thermoplastics materials**

<b>Material</b>	<b>Speed</b> mm/min
PVC	10
PVDF, PP-H, PP-B	20
PE, PP-R	50

## Annex C (normative)

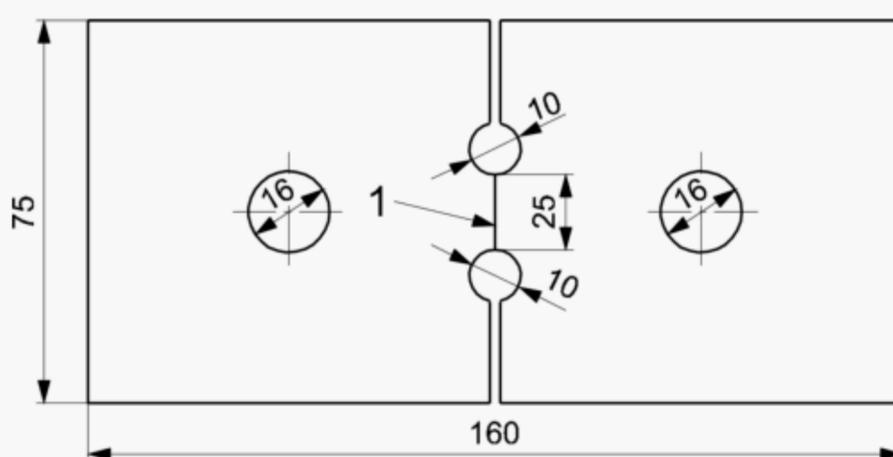
### Notched tensile test specimen

A notched tensile test forces failure to occur in the weld and can be used in order to optimize welding parameters or to qualify welding personnel (e.g. EN 13067 [1]).

The values of  $f_s$  determined using the notched tensile test do not correlated with the values of  $f_s$  determined using type 1 or type 2 test specimens.

The test specimen used for the notched tensile test shall be as described in Figure C.1.

Dimension in millimetres



#### Key

1 weld line

Figure C.1 — Notched tensile test specimen

## Bibliography

- [1] EN 13067, *Plastics welding personnel - Qualification of welders - Thermoplastics welded assemblies*



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