BRITISH STANDARD

BS EN
10274:1999

Metallic materials — Drop weight tear test

The European Standard EN 10274:1999 has the status of a British Standard

ICS 77.040.10

National foreword

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Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 8, an inside back cover and a back cover.

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English version

Metallic materials — Drop weight tear test

Matériaux métalliques — Essai de chute de masse

Metallische Werkstoffe — Fallgewichtsversuch

This European Standard was approved by CEN on 16 April 1999.

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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 10274:1999 E

Foreword

This European Standard has been prepared by Technical Committee ECISS/TC 29, Steel tubes and fittings for steel tubes, the Secretariat of which is held by UNI.

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of an identical text or by endorsement, at the latest by November 1999, and conflicting national standards shall be withdrawn at the latest by November 1999.

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association. This European Standard is considered to be a supporting standard to those application and product standards which in themselves support an essential safety requirement of a New Approach Directive and which make reference to this European Standard.

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Contents

1 Scope

This European Standard specifies the drop weight tear test for metallic materials and includes a method for assessing the fracture appearance of ferritic steels. Assessment can also be based on the energy absorbed in fracturing the test piece, particularly for materials other than ferritic steels.

NOTE 1 This test method is based on the use of a falling weight or pendulum, however other types of machine, e.g. with hydraulic actuators, may be used provided that the requirements of this European Standard are satisfied.

NOTE 2 The test is most commonly applied to ferritic steel tubes and to ferritic steel plate for the manufacture of tubes.

2 Definitions

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

2.1

shear area

the area of the fractured surface of the test piece that has broken in a ductile manner

NOTE It is normally identified by a grey silk-like appearance.

2.2

cleavage area

the area of the fractured surface of the test piece that has broken in a brittle manner

NOTE It is normally identified by a shiny crystalline appearance.

2.3

anvil

that part of the testing machine used to support the test piece during impact

2.4

striker

part of the hammer which is in contact with the test piece

NOTE This definition is identical to that given in EN 10045-2:1992, **3.5**.

2.5

hammer

the part of the test machine which impacts the test piece

2.6

fracture appearance transition temperature (FATT)

the temperature required to cause a specified percentage of the fracture to occur by shear. Expressed as follows e.g. for 85 % specified percentage of shear fracture at −30 °C, FATT (85) = −30 °C.

2.7

ferritic steel

steel in which the ferritic state is stable at all service temperatures

3 Symbols and abbreviations

3.1 Symbols and designations

a	depth of pressed notch
L	length of test piece
L_c	minimum length of unflattened central portion of test piece
R_h	radius of curvature of hammer
R_n	root radius of pressed notch
R_s	radius of curvature of anvil support
S	span between anvils
T	thickness of test piece
W	width of test piece
θ	angle of pressed notch

3.2 Abbreviations

DWTT	drop weight tear test
FATT	fracture appearance transition temperature (see **2.6**)
KV	Charpy V-notch energy

4 Principle

The test is generally carried out on test pieces taken from plate for the manufacture of tubes or from tube with an outside diameter greater than 300 mm and a thickness greater than 6 mm.

The test involves fracturing a test piece containing a pressed notch by supporting it near its ends, and impacting it behind the notch (see Figure 1).

The test is carried out at a specified test piece temperature.

The test is as follows:

a) to measure the relative proportions of shear and cleavage fracture, which are generally assessed visually, and to derive from these either:

1) the temperature at which a specified percentage of shear fracture has occurred (FATT); or

2) the amount of shear area produced by testing at a specified temperature;

and/or

b) to measure absorbed energy at the specified temperature.

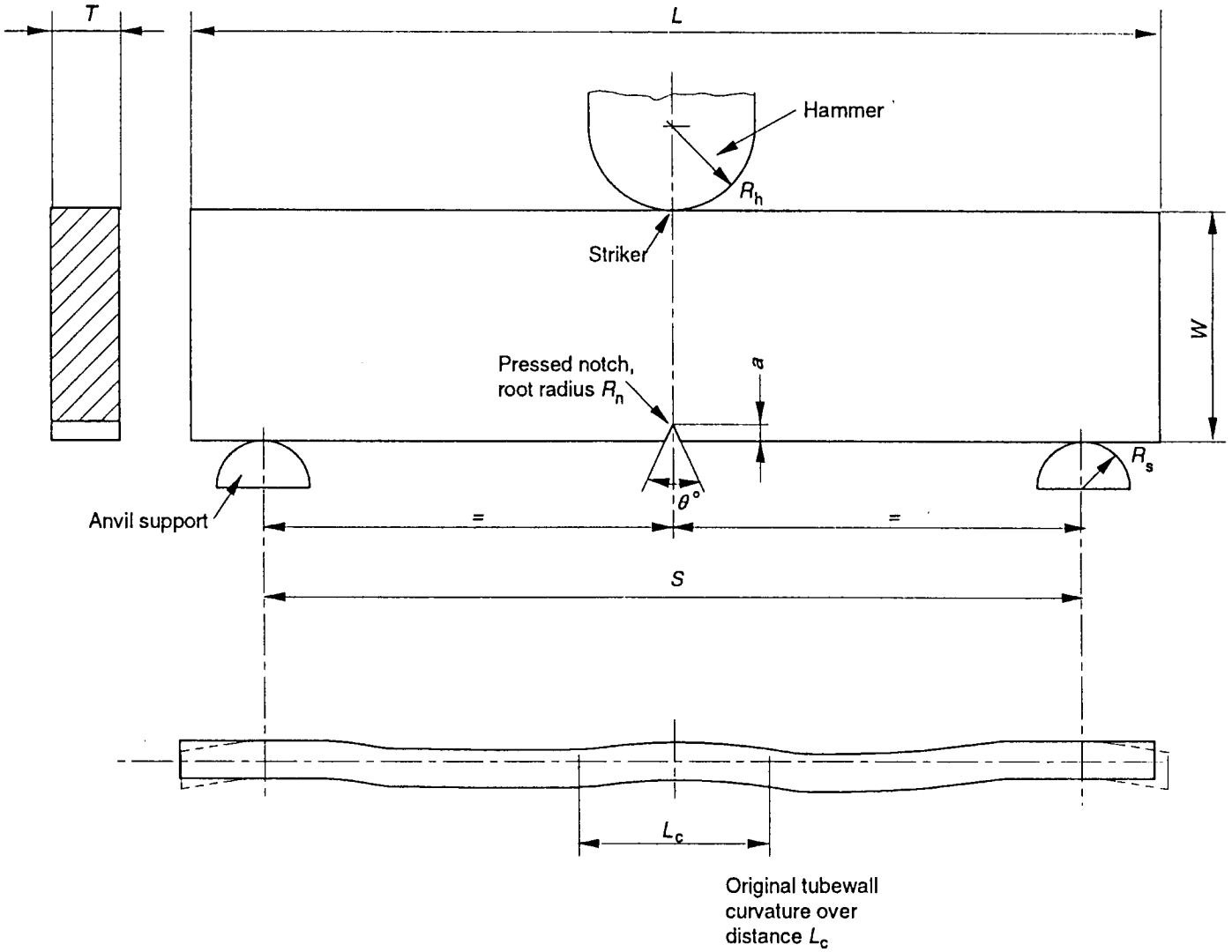


Figure 1 — Test piece geometry and recommended flattened tube profile

5 Apparatus

5.1 The testing machine may be a falling weight type or a pendulum type. Other types of testing machine, e.g. with hydraulic actuators, may be used providing it can be demonstrated that their impact velocity and dynamic performance conform to the requirements of **5.2**.

5.2 The energy available at impact to be used in the test shall be greater than the anticipated fracture absorption energy of the test piece (see note).

At impact the hammer velocity shall be not less than 5 m/s and not more than 10 m/s.

NOTE To ensure regular crack propagation an available energy of 1,5 times the absorbed energy is generally sufficient [1]. If the absorbed energy is not measured, the minimum required impact energy (E_{REQ}) can be estimated from the Charpy V-notch energy (KV) adjusted for test piece cross-sectional fracture area using the following expression

$$E_{REQ} = 5.6\ (KV)\ \times \frac{A_{DWTT}}{A_{KV}}$$

where

A_{DWTT} is the drop weight tear test fracture area;

A_{KV} is the Charpy test fracture area.

5.3 The striking edge of the hammer shall be radiused and shall be centred on the anvil with the supports at a span of 254 mm as shown in Figure 1. Provision shall be made to prevent out of plane rotation of the test piece on or after impact. The tolerances on the machine and set up dimensions shall be in accordance with Table 1.

Table 1 — Test machine dimensions and tolerances

Measurement	Dimension mm	Tolerance mm
S	254,0	±1,5
R_s	15,0	±1,0
R_h	25,0	±1,0
Centre line hammer with respect to mid-point between anvil supports	0	±1,5

5.4 A temperature controlled environment shall be provided in which the test piece can be soaked in a suitable medium for temperature conditioning before testing. Provision shall be made for circulation of the medium to ensure a uniform soaking temperature.

NOTE A procedure should be developed for test temperatures above or below room temperature to ensure that the temperature variation between the exit from the temperature conditioning medium and the execution of the test are within specified limits.

6 Test piece preparation

6.1 Test piece location

Test piece location and orientation within the tube or plate shall be as specified in the product standard.

6.2 Test piece

6.2.1 Unless otherwise specified in the product standard the test piece may be flattened completely for testing purposes or the central 50 mm may be left with the original pipe curvature. In the latter case the mid thickness at the centre of the test piece shall be in the same plane as the mid thickness at the anvil supports (see Figure 1).

In the case of dispute the results of tests on test pieces with the central area unflattened shall apply.

NOTE Flattening the fracture area of the test piece may give more conservative results than those obtained from an unflattened test piece.

6.2.2 The test piece thickness shall be the full tube or plate thickness up to and including 19 mm. For thicknesses greater than 19 mm the test piece thickness may be either the full tube or plate thickness or it may be reduced to 19 mm. An alternative procedure for testing thicker materials, reduced in thickness to 19 mm, is given in annex A.

If the test piece thickness is reduced to 19 mm it shall be agreed and documented at the time of enquiry and order.

6.2.3 Test pieces may be prepared from an oversize flame-cut sample, however, final preparation shall be by a cold machining process (e.g. planing, sawing, or milling) to remove any heat affected zones. Test piece dimensions and tolerances shall be in accordance with Table 2.

Table 2 — Test piece dimensions and tolerances

Measurement	Dimension mm	Tolerance mm
L	305,0	±20,0
W	76,0	±1,5
a	5,0	±0,5
θ	45°	±2°
R_n	0,01 to 0,04	—
Centre line notch with respect to centre line of hammer	0	±1,5
L_c	50,0	

6.2.4 The notch shall be pressed to the depth given in Table 2 with a chisel of minimum hardness 45 HRC, and shall have a radius of 0,02 mm ± 0,01 mm.

Machined notches are prohibited.

7 Test procedure

7.1 The test piece shall be soaked in a suitable medium which is at a temperature within the following limits:

a) for test temperatures below room temperature: +1,0 °C and −10,0 °C of the specified test temperature;

b) for test temperatures above room temperature: −1,0 °C and +10,0 °C of the specified test temperature.

Test pieces shall be separated from each other and from the sides and bottom of the bath by a distance of at least the test piece thickness.

When the surface of the test piece has reached the required temperature it shall remain in the medium at that temperature for the greater of the following times (see note).

1) For liquid medium: 15 min or 30 s per mm thickness.

2) For a gaseous medium: 30 min or 1 min per mm thickness.

NOTE If evidence can be produced to show that the test piece equilibrium temperature can be developed in a shorter time then these holding times can be reduced.

7.2 The test piece shall be removed from the medium and broken on the test machine, by a single blow. The surface temperature of the test piece at the time of testing shall be within ±1,0 °C of the specified test temperature.

This condition is considered to be met if the test is undertaken within 10 s of its removal from the soaking medium which is itself at a temperature within ±1 °C of the specified test temperature. If the test piece is out of the medium for longer than 10 s, it shall be returned to the bath until the requirements of **7.1** are again fulfilled.

7.3 The test piece shall be placed in the test machine such that the centre line of the notch is aligned with the centre line of the hammer. The test piece shall be suitably restrained to prevent out of plane rotation on or after impact.

7.4 When appropriate the fracture absorption energy shall be recorded. The elements of the energy absorption shall be subject to calibration.

NOTE It has been found that the most consistent results are obtained when using test machines with anvil support radii of 15 mm ± 1 mm and hammer radius of 25 mm ± 1 mm as jamming and friction are minimized under these conditions.

8 Test evaluation

8.1 Ferritic steels

8.1.1 The result of the test is usually expressed as a Fracture Appearance Transition Temperature (FATT), or as a percentage shear value at the specified temperature defined in the product standard.

8.1.2 For test piece thicknesses of 19 mm or less, the percentage shear area of the fracture surface shall be evaluated, neglecting the fracture surface for a distance of one test piece thickness (T) from the root of the notch and for a distance of one test piece thickness from the side opposite the notch. For test piece thicknesses greater than 19 mm, the neglected regions shall be 19 mm. The shaded area in Figure 2 illustrates that portion of the fracture surface to be considered in the evaluation of the percentage shear area.

Methods for calculating the percentage shear area for ferritic steels are given in annex B.

Excessive plastic deformation at the impact point may occur in very tough materials over 19 mm thick which leads to conservative results. An alternative method for assessing the FATT of ferritic steels having thicknesses greater than 19 mm is given in annex A which can also be used when the impact energy of the test machine is limited.

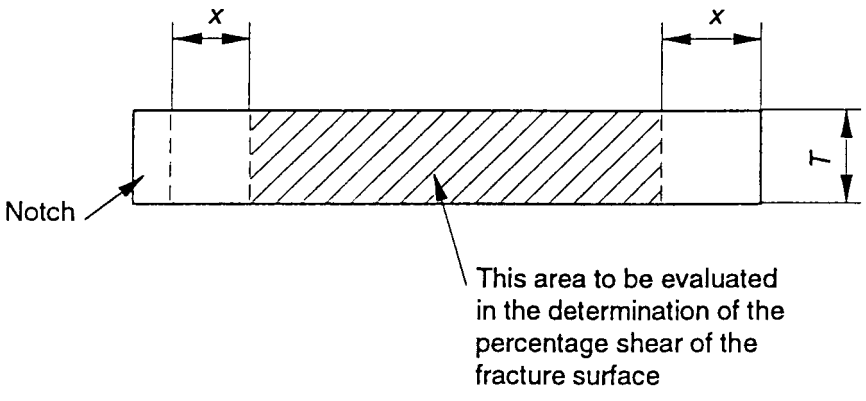


Figure 2 — Fracture surface included in percentage shear area determination

8.1.3 The fracture shall be assessed when viewed perpendicularly to the surface. If a fracture surface exhibits areas having an arrowhead form, these areas shall be classed as cleavage (see Figure 3).

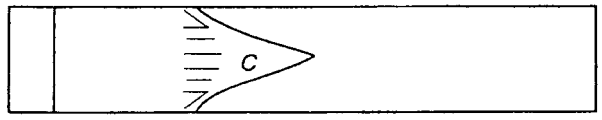
Occasionally test pieces exhibiting the fracture appearance shown in Figure 4 will be encountered. These fractures have intermittent regions of shear and cleavage fracture. The individual areas of cleavage fracture shall be summed.

Cleavage in separations not included in shear area rating are shown in Figure 5.

NOTE Shear areas may contain areas of apparent separation which can be ignored.

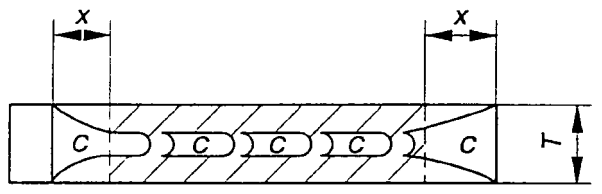
8.2 Other materials

The result of the test is generally expressed as the fracture absorption energy.



C denotes the cleavage regions

Figure 3 — Appearance of arrowhead cleavage fracture



C denotes the cleavage regions

Figure 4 — Alternate shear–cleavage fracture appearance

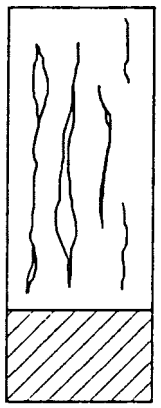


Figure 5 — Cleavage in separations not included in shear area rating

9 Test report

The test report shall include at least the following information:

a) reference to this European Standard i.e. EN 10274;

b) identification of the test piece; e.g. cast No./ tube No./identification No.;

c) material specification if known;

d) dimensions of the plate or tube;

e) test piece thickness;

f) impact energy used in the test or the mass and height of drop of the hammer;

g) whether the test piece has been flattened;

h) the percentage shear area and test temperature of each test piece when appropriate;

i) the fracture appearance transition temperature corresponding to a specified percentage shear area when appropriate;

j) fracture absorption energy when appropriate.

Annex A (informative)

Alternative procedure for testing thick material

When this procedure is adopted, it is necessary for test pieces with thicknesses greater than 19 mm to be reduced in thickness to 19 mm minimum by machining one or both surfaces. They should be tested and assessed as described in clauses **7** and **8**.

For ferritic steels ≤40 mm thick the test temperature should be reduced by the amount given in Table A.1.

NOTE For ferritic materials greater than 40 mm thick and for other materials the procedure to be used should be agreed between the purchaser and manufacturer at the time of enquiry and order.

Table A.1 — Reduction in test temperature

Plate or tube wall thickness mm	Temperature reduction °C
>19 ≤22	5,5
>22 ≤29	11,0
>29 ≤40	17,0

Annex B (informative)

Method for calculating the percentage shear area for ferritic materials

B.1 The percentage shear area of the fracture surface should be determined by one of the following methods.

— Measure the shear area of the fracture with a planimeter on photograph or optical projection of the fracture surface.

— Compare the fracture surface with a set of reference specimens. The percent shear area of the reference specimens should have been evaluated with a planimeter; the thickness of the reference specimen should be identical to that of the evaluated specimen ± 3 mm.

— Follow the procedure described in **B.2**.

— Use any other procedure that can be shown to produce results equivalent to those obtained from one of the three methods above.

B.2 For shear areas between 45 % and 100 % of the fracture surface on test piece thicknesses of 19 mm or less the percentage shear area may be calculated from the formula:

$$\%\ \text{shear area} = \frac{[(W - a - 2x)\ T - (3/4)\ AB] \times 100}{(W - a - 2x)T}$$

where

A is the width of the cleavage fracture at the "one T" line beneath the notch (mm);

B is the length of the cleavage fracture in between the "one T" lines (mm);

T is the test piece thickness (mm);

W is the width of the test piece (mm);

a is the depth of the pressed notch (mm);

x is the test piece thickness ≤19 mm (x = 19 for thicknesses > 19 mm).

Annex C (informative)

Bibliography

[1] Fallgewichtversuch nach Battelle, Stahl-Eisen-Prüfblatt 1326:1983.

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