INTERNATIONAL STANDARD

ISO 14323

Second edition
2015-03-01

Resistance welding — Destructive testing of welds — Specimen dimensions and procedure for impact tensile shear test and cross-tension testing of resistance spot and embossed projection welds

Soudage par résistance — Essais destructifs des soudures — Dimensions des éprouvettes et mode opératoire pour les essais de cisaillement par choc et les essais de traction par choc sur éprouvettes en croix des soudures par résistance par points et par bossage

Reference number
ISO 14323:2015(E)

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/IIW, *International Institute of Welding*, Commission III.

This second edition cancels and replaces the first edition (ISO 14323:2006), which has been technically revised.

Requests for official interpretations of any aspect of this International Standard should be directed to the ISO Central Secretariat, who will forward them to the IIW Secretariat for an official response.

Introduction

This edition of ISO 14323 no longer includes figures showing failure types and modes for tensile shear and cross tension testing in accordance with ISO 14329:2003.

ISO 14323 was revised to align it with ISO 17677-1.

Resistance welding — Destructive testing of welds — Specimen dimensions and procedure for impact tensile shear test and cross-tension testing of resistance spot and embossed projection welds

1 Scope

This International Standard specifies specimen dimensions and testing procedures for impact tensile shear and cross-tension testing of resistance spot and embossed projection welds in overlapping sheets, in any metallic material of thickness 0,5 mm to 4 mm.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 14272, *Specimen dimensions and procedure for cross tension testing resistance spot and embossed projection welds*

ISO 17677-1, *Resistance welding — Vocabulary — Part 1: Spot, projection and seam welding*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 17677-1 and the following apply.

3.1
impact cross-tension failure energy
failure energy obtained from the impact cross-tension testing

3.2
impact cross-tension strength
maximum impact force obtained in the impact cross-tension testing

3.3
impact tensile shear failure energy
failure energy obtained from the impact tensile shear testing

3.4
impact tensile shear strength
maximum impact force obtained in the impact tensile shear testing

4 Test specimen

The dimensions and form of the impact tensile shear test specimen are shown in Figure 1 and Table 1.

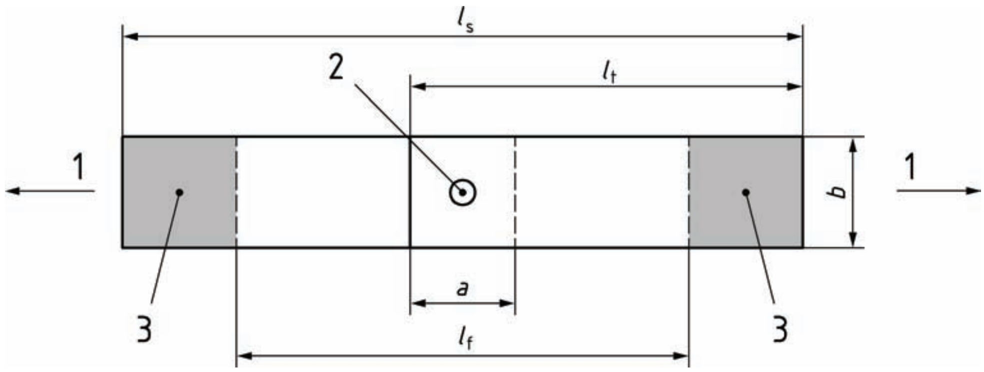
The positional accuracy of the weld on the test specimen shall be ±1 mm or less in every direction.

The dimensions and form of the impact cross-tension specimen are shown in Figure 2 (see ISO 14272).

An example of a jig for welding the impact cross-tension specimen is shown in Figure 3. Two punched strips are placed at right angles to each other, held in the jig, and welded together.

Table 1 — Dimensions of impact tensile shear test specimens

Thickness t mm	Overlap a mm	Specimen width [a] b mm	Specimen length l_s mm	Free length between clamps l_f mm	Length of individual test coupons l_t mm
$0,5 \leq t \leq 1,5$	35	45	175	95	105
$1,5 < t \leq 3$	45	60	230	105	138
$3 < t \leq 4$	60	90	260	120	160



Key

1 direction of test load

2 weld

3 clamping zone

Figure 1 — Impact tensile shear test specimen

5 Test equipment and testing procedure

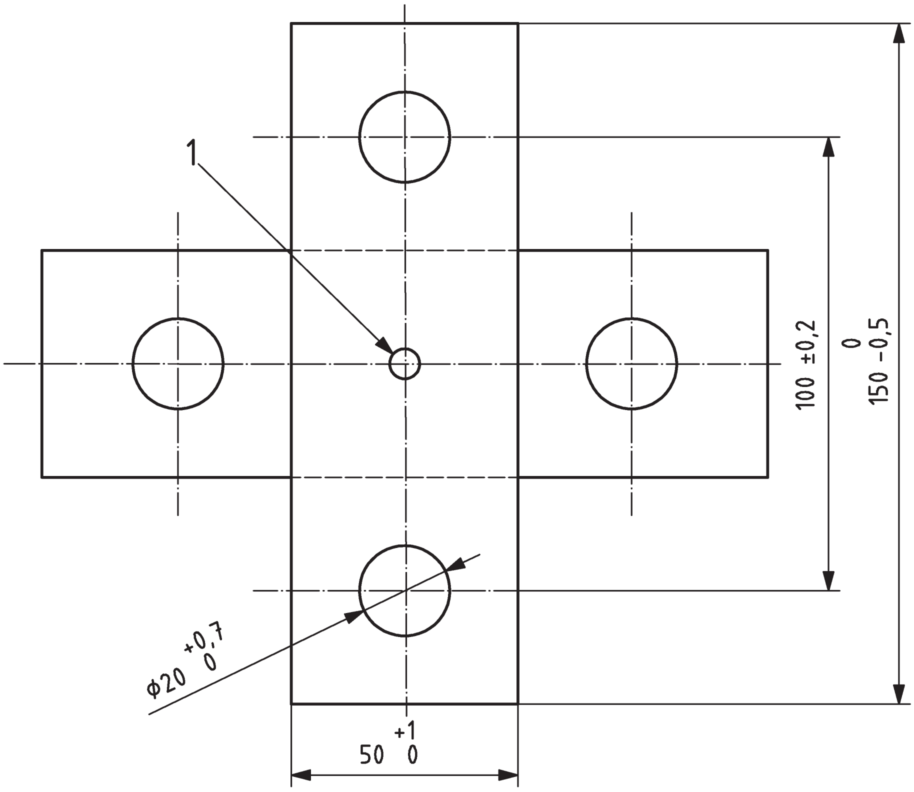
5.1 General

Testing can be accomplished with an appropriate impact-testing machine. If needed, the load can be obtained using hydraulic test equipment.

The pendulum-type machine is generally used for a sheet thickness range of 0,5 mm to 3 mm, and the drop-weight machine for a sheet thickness range of 1 mm to 4 mm.

The minimum number of specimens tested shall be five.

Dimensions in millimetres



Key

1 weld

NOTE Weld is centred.

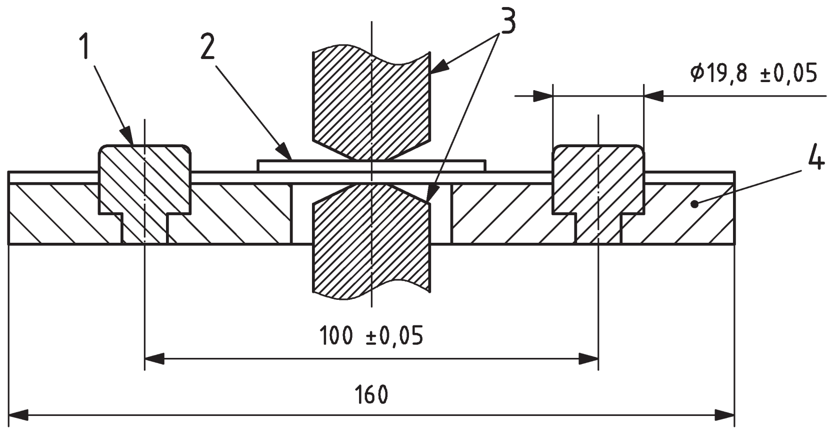
Figure 2 — Impact cross-tension test specimen

5.2 Modified pendulum machine

The test specimen is fixed between the clamping device and the crosshead as shown in Figure 4 and Figure 5. A U-shaped hammer shall be used for testing and is attached to the pendulum.

At the bottom of the pendulum swing, the hammer strikes the crosshead. The energy to failure is indicated by the extent of the upward swing of the pendulum. The velocity of the pendulum at the time of impact is 5,5 m/s. To measure impact force, strain gauges attached to the clamping device or an appropriate load cell shall be used (see Figure 4 and Figure 5). The failure energy is determined as a function of time (see Annex A).

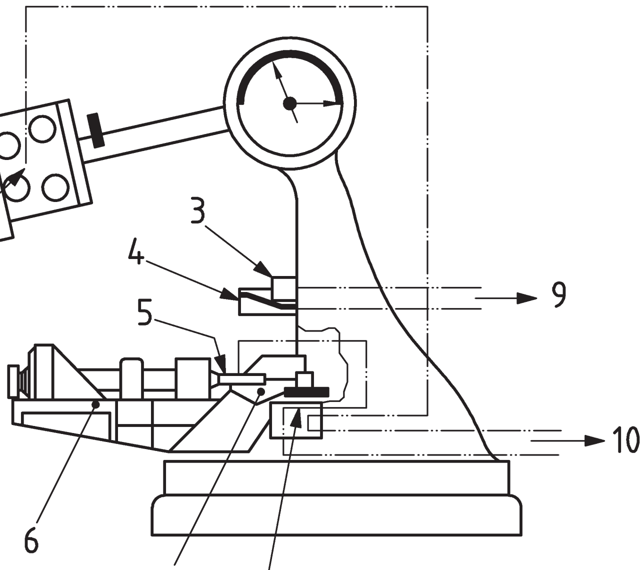
Dimensions in millimetres



Key

1 location pins
2 specimen
3 welding electrodes
4 insulating materials

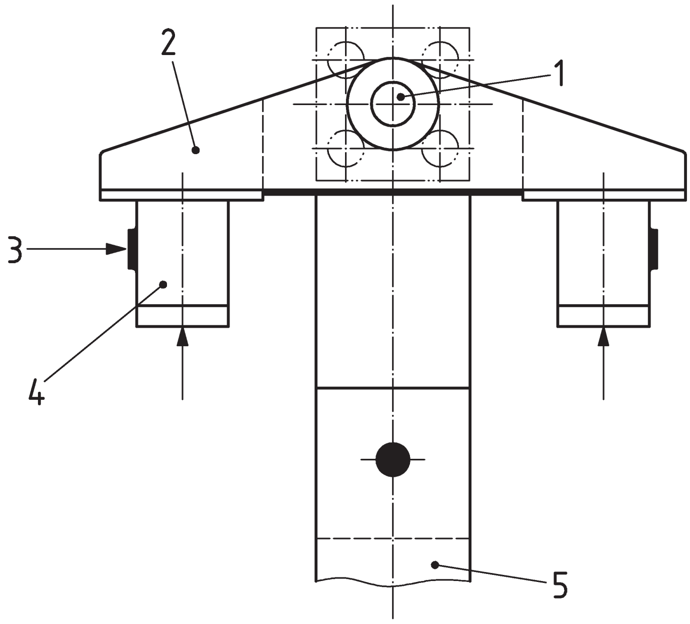
Figure 3 — Example of cross-tension test specimen in welding jig



Key

1 hammer
2 strain gauge/load cell
3 lamp
4 photodiode
5 strain gauge
6 clamping device
7 test specimen
8 cross head
9 power supply
10 amplifier

Figure 4 — Pendulum machine with U-shaped hammer, equipped for testing spot-welded impact tensile shear specimens



Key

1 pivot (maximum rotation 2°)

2 cross head (introduce load into test piece)

3 strain gauge

4 impact part of the hammer

5 fixed part of the specimen

Figure 5 — Impact tensile shear test specimen and details of crosshead

5.3 Drop-weight machine

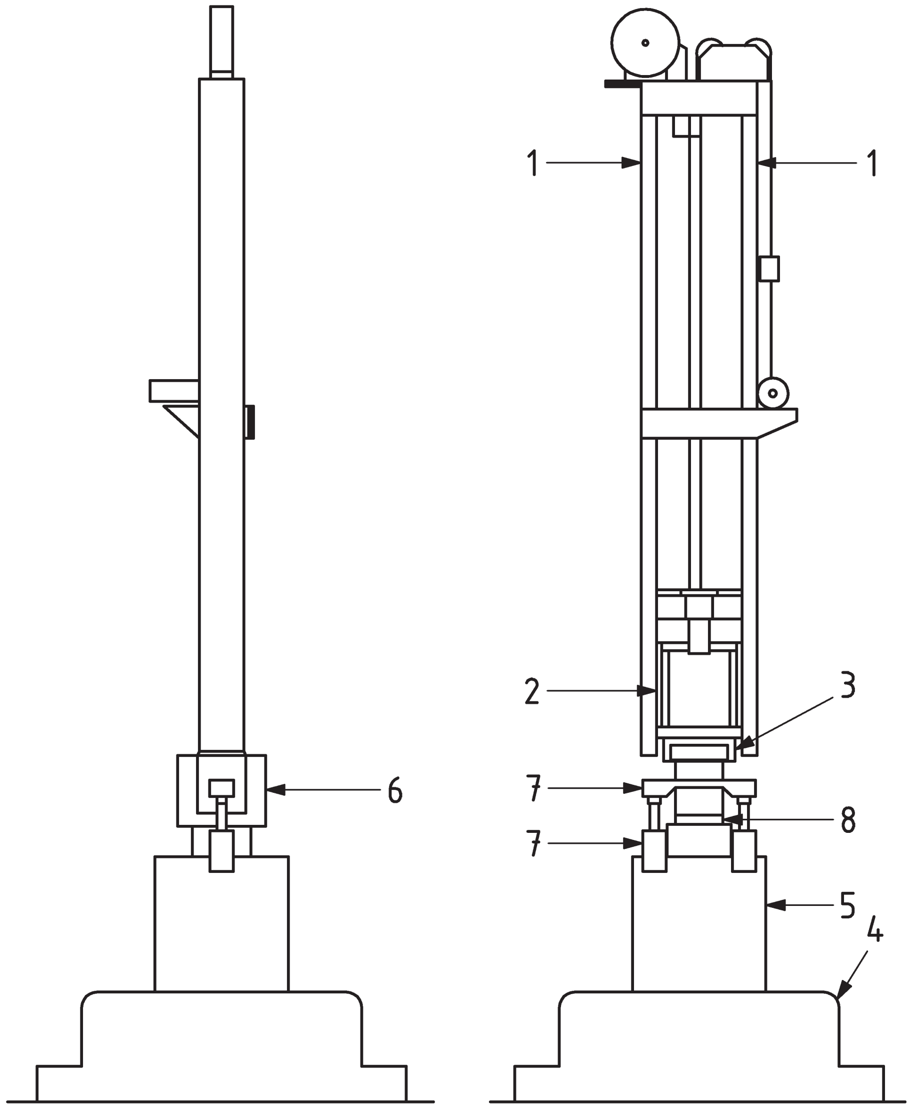
The drop-weight machine has a variable mass that can be dropped onto the specimen from different heights. There are two types of equipment as shown in Figure 6 and Figure 7. Figure 6 is known as a double striking type and Figure 7 is known as a single striking type.

The impact tensile shear test specimen and the impact cross-tension test specimen are held in clamps as shown in Figures 8 and Figure 9. The drop-weight machine shall be equipped with instrumentation to monitor displacement or velocity before and after impact, as well as force variation during impact. The difference in velocity can be used to calculate the total energy absorbed by the sample. To ensure complete fracture of the welded specimens, the impact energy shall be greater than 10 times the failure energy. The velocity of the drop-weight striker at the time of impact shall be in the range 5 m/s to 15 m/s.

The force variation during failure shall be monitored by load cells mounted beneath the four corners of the anvil, as shown in Figure 8 and Figure 9. Alternatively, a load cell can be mounted in the specimen clamp device to provide the force signal. Examples of results using a drop-weight machine are shown in Figure 10.

To avoid excessive attenuation of the force/time signal through the electronic filtering system, the time to fracture of the specimen shall be at least 1,5 times, and ideally greater than 10 times, the response time of the filter. The optimum filtering system depends on the equipment and should be determined.

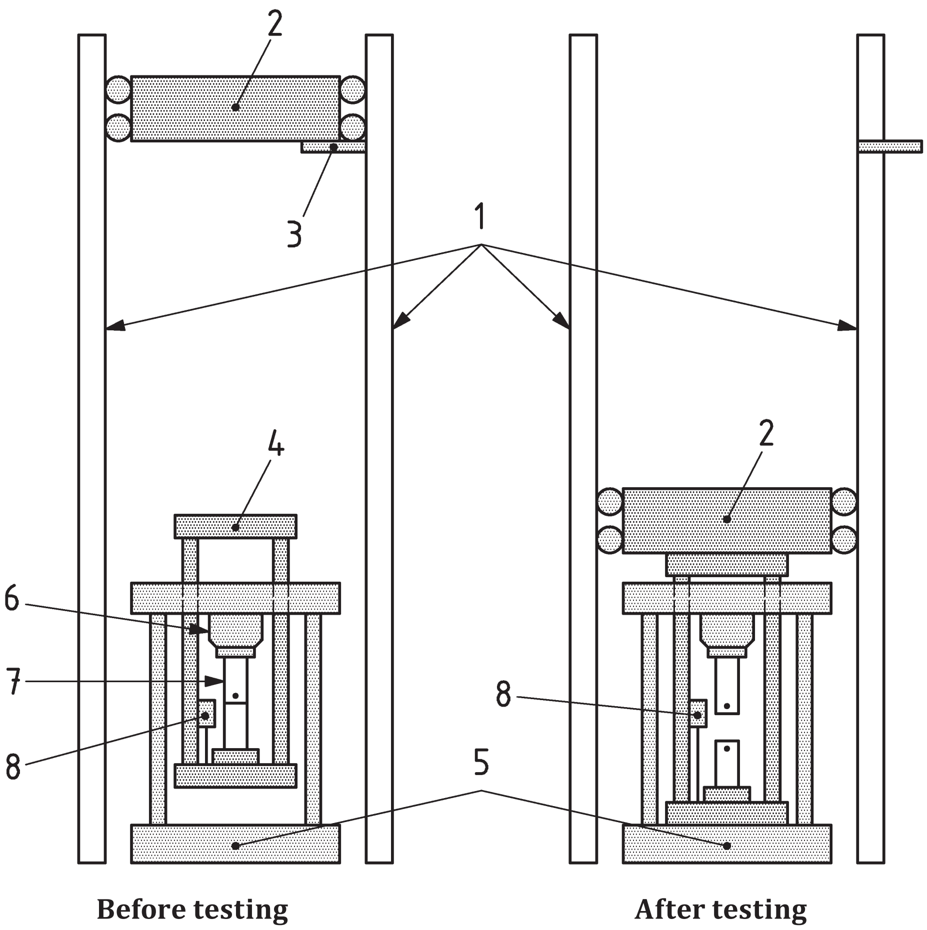
The results can be analysed by the method given in Annex A.



Key

1 guide columns
2 carriage weight
3 striker
4 inertia block
5 working table
6 specimen holder
7 shock absorber system
8 load cells

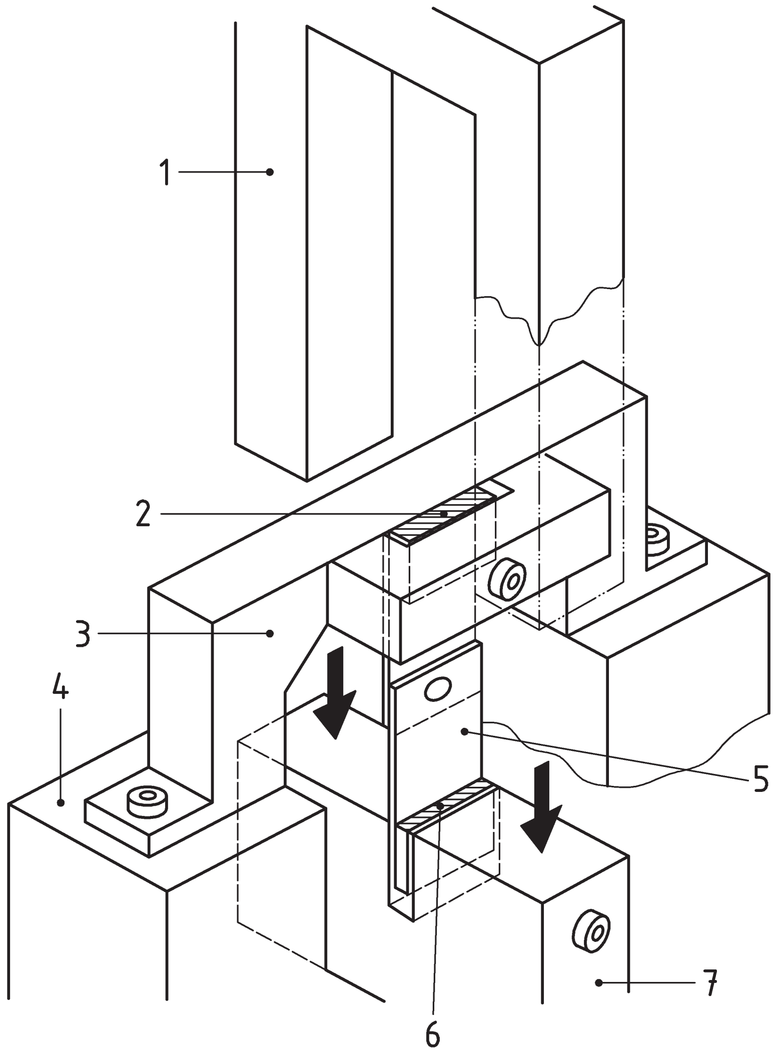
Figure 6 — Example of drop-weight impact testing equipment of double striking type



Key

1 guide columns
2 carriage weight
3 stopper
4 working frame
5 inertia block
6 load cell
7 test specimen
8 displacement sensor

Figure 7 — Example of drop-weight impact testing equipment of single striking type

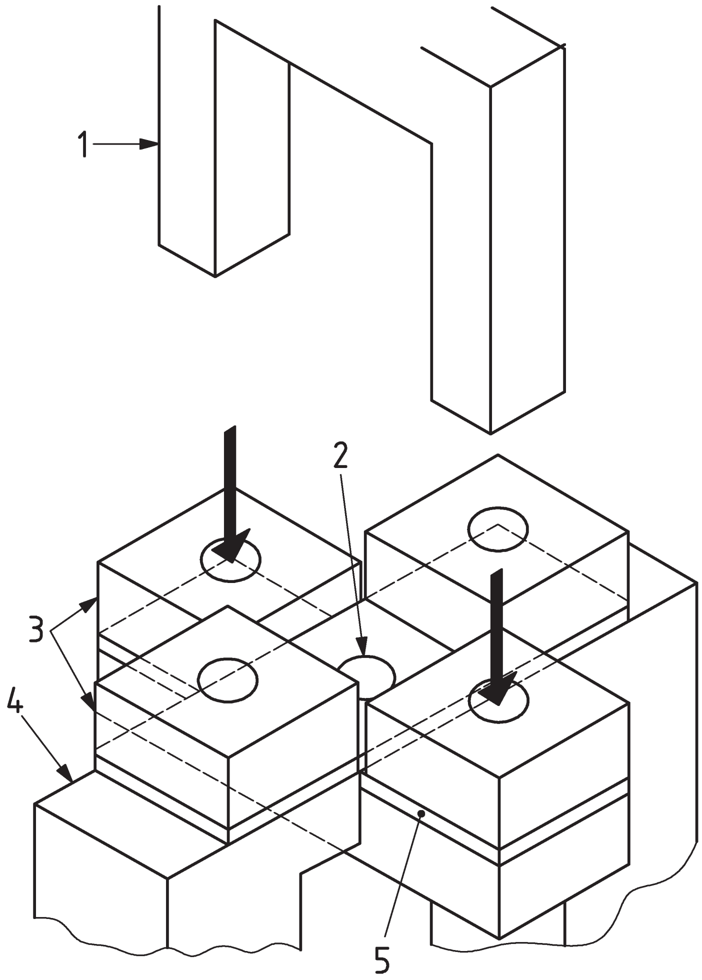


Key

1 striker mounted on drop-weight carriage
2 clamping plate
3 static sample holder
4 test jig support mounted on load measuring system
5 sample
6 clamping plate
7 struck sample holder

NOTE Not to scale.

Figure 8 — Sketch of drop-weight impact test set-up of double striking type for impact tensile shear testing

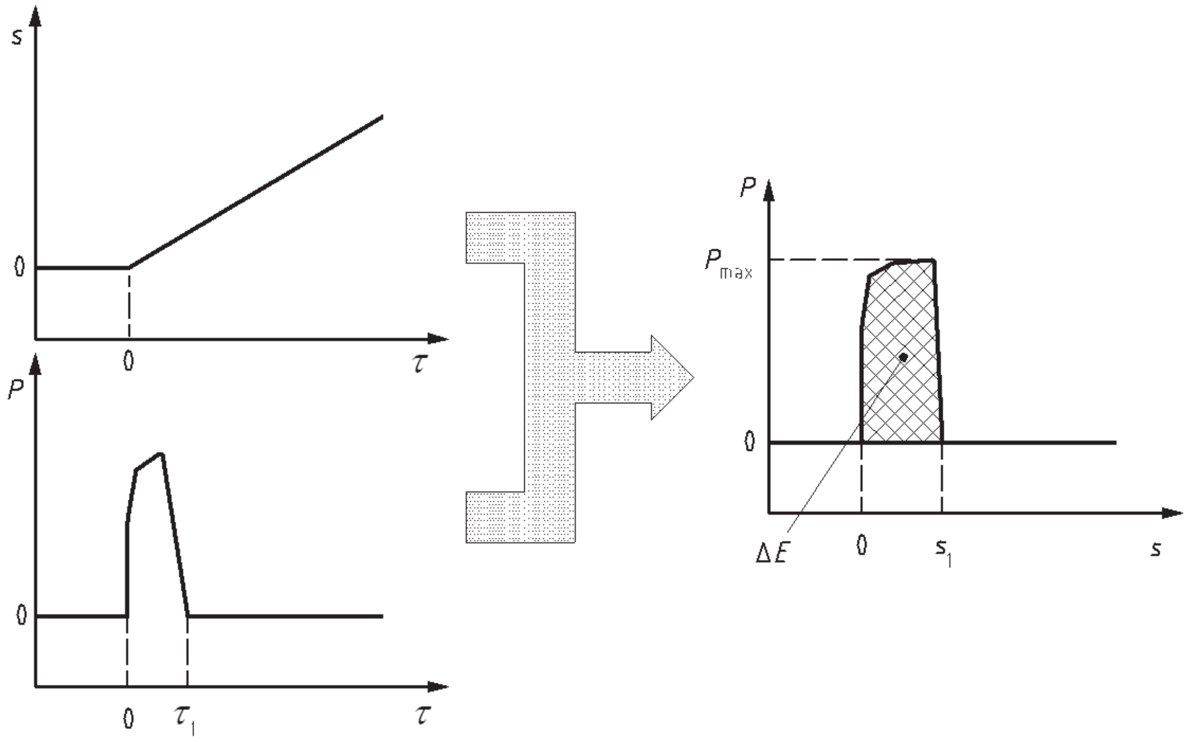


Key

1 striker mounted on drop-weight carriage
2 weld
3 clamping blocks
4 test jig support mounted on load measuring system
5 cross-tension test piece

NOTE Not to scale.

Figure 9 — Sketch of drop-weight impact test set-up of double striking type for cross-tension testing



Key

P impact force

s displacement

τ time

P_{max} impact cross tension strength or impact tensile shear strength

Δ*E* failure energy

Figure 10 — Typical traces showing displacement/time, force/time, and force/displacement

6 Test records

The test results shall be recorded with values of the tensile shear strength, type of failure mode, and weld diameter of each weld in accordance with ISO 17677-1.

7 Test report

The test report shall include the following:

a) reference to this International Standard (i.e. ISO 14323);

b) date and place of test;

c) testing equipment used;

d) setting parameters of testing equipment;

e) welding process;

f) welding conditions and equipment;

g) material and its condition;

h) dimensions of the test specimens;

i) individual values, mean value, and standard deviation of the impact cross tension strength, impact tensile shear strength, and the failure energy;

j) failure description (symmetrical plug failure, asymmetrical plug failure, partial plug failure, interfacial failure, etc.);

k) individual values, mean value, and standard deviation of the weld diameter;

l) other relevant comments;

m) names of individuals conducting the test.

Annex A
(informative)

Determination of failure energy

A.1 Determination of energy absorbed during testing as a function of time for pendulum equipment

The failure energy (so-called absorbed energy) is shown on the pendulum equipment dial. In addition, the force, P, can be measured using strain gauges attached to the specimen-clamping device. The failure energy can be derived from the area beneath the force/time curve (see Figure A.1).

A.2 Determination of failure energy for drop-weight equipment

A.2.1 General

In the case of the drop-weight test, the failure energy is calculated as a function of the displacement or time depending on the aim of the test. The failure energy is calculated by a single integration with no displacement measurement. The requirements for the calculations are

— mass of the striker,

— drop height, and

— the force/time record.

A.2.2 Symbols and formulae

See Table A.1.

Table A.1 — Symbols and definitions

Symbol	Description	Unit
E_a	V_0 × integral of force/time	J
ΔE_0	failure energy (absorbed energy)	J
E_0	impact energy	J
P	impact force	N
m	mass of the striker	kg
g	acceleration due to gravity	m/s^2
V_0	impact velocity	m/s
h	drop height	m
τ	time during test	s
$\int_0^{\tau_1} P \mathrm{d}\tau$	integrated force/time	N·s

$$V_0 = \sqrt{2gh} \tag{A.1}$$

$$E_a = V_0 \int_0^{\tau_1} P \, d\tau \tag{A.2}$$

$$E_0 = \frac{mV_0^2}{2} \tag{A.3}$$

$$\Delta E_0 = E_a \left(\frac{1 - E_a}{4E_0} \right) \tag{A.4}$$

EXAMPLE

m, mass of striker = 10 kg

h, drop-height = 10 m

$$V_0 = \sqrt{2gh} = \sqrt{2 \times 9{,}81 \times 10} = 14 \text{ m/s} \tag{A.5}$$

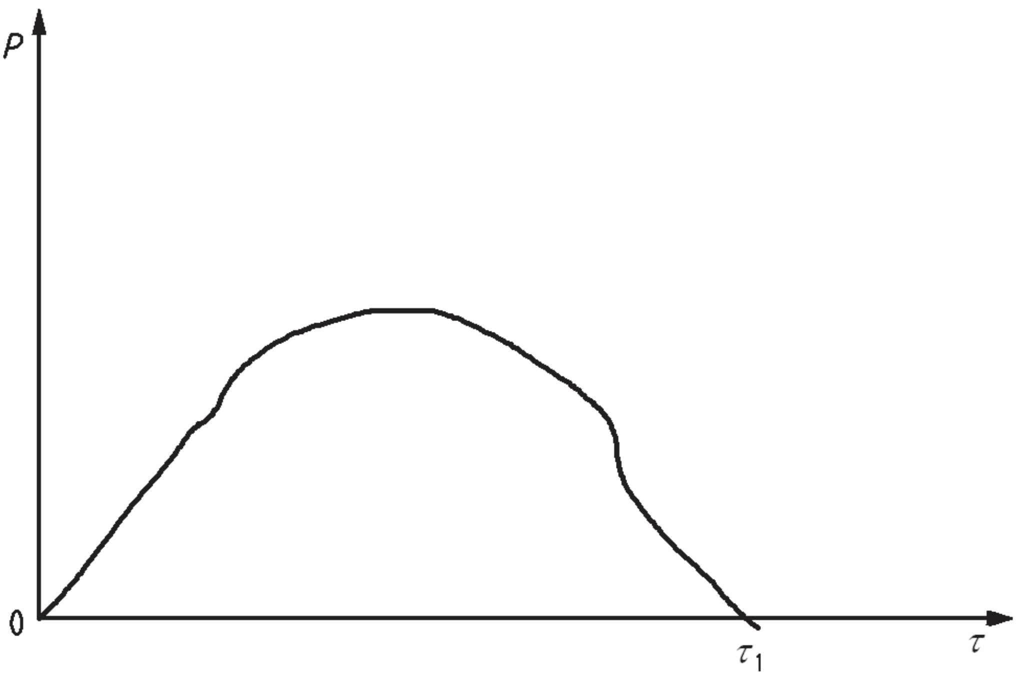


Figure A.1 — Typical impact force/time diagram

$$E_a = V_0 \int_0^{\tau_1} P \, d\tau = 14 \times 140 = 1\,960 \text{ J} \tag{A.6}$$

$$E_0 = \frac{1}{2} mV^2 = \frac{1}{2} \times 10 \times 14^2 = 980 \text{ J} \tag{A.7}$$

$$\Delta E_0 = E_a \left(\frac{1 - E_a}{4E_0} \right) = 1\,960 \left(\frac{1 - 1\,960}{4 \times 980} \right) = 980 \text{ J} \tag{A.8}$$

Failure energy = 980 J

A.3 Determination of the failure energy as a function of displacement for drop-weight equipment with the double-integration technique

The double-integration technique gives the force/displacement relationship from the force/time record by determination of force, acceleration, and displacement. This method does not require measurement of displacement or velocity and relies solely on measurement of load (see Figure 10).

Since the impact force, P, is equal to mass × acceleration of the striker, a, the P/τ relationship is equivalent to the a/τ relationship. Therefore, double integration of P/τ gives an s/τ relationship (where s is displacement). Combining this with the original P/τ relationship gives a P/s curve, the area under which is the equivalent to the energy absorbed.

The requirements for the calculations are impact force/time, the mass of the striker and the specimen holder, and the velocity of the striker prior to impact.

Symbols and formulae are in accordance with Table A.2.

Table A.2 — Symbols and formulae

Symbol	Description	Unit
P	impact force	N
m_1	mass of striker	kg
m_2	mass of specimen holder	kg
a	acceleration	m/s^2
V	velocity of striker during impact	m/s
V_1	velocity of striker before impact (specimen holder stationary)	m/s
V_0	velocity of striker plus specimen holder at onset of impact	m/s
V_2	velocity of striker plus specimen holder at failure	m/s
s	displacement of striker during impact	m
s_1	displacement at failure	m
C_1 and C_2	constants of integration	
E	initial energy of striker	J
ΔE	failure energy (absorbed energy)	J
τ	time during test	s

$$\text{force} = \text{mass} \times \text{acceleration} \tag{A.9}$$

$$\text{velocity} = \frac{1}{\text{mass}} \int \text{force d}\tau \tag{A.10}$$

$$\text{displacement} = \frac{1}{\text{mass}} \iint \text{force d}\tau\text{d}\tau \tag{A.11}$$

Plotting force against displacement during test allows the energy calculation:

$$\text{failure energy} = \int \text{force d}s \tag{A.12}$$

Bibliography

[1] ISO 148-2, *Metallic materials — Charpy pendulum impact test — Part 2: Verification of testing machines*

[2] ISO 14329:2003, *Resistance welding — Destructive tests of welds — Failure types and geometric measurements for resistance spot, seam and projection welds*

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