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Metallic materials — Sheet and strip — Erichsen cupping test

*Matériaux métalliques — Tôles et bandes — Essai d'emboutissage
Erichsen*



Reference number
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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

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 20482 was prepared by Technical Committee ISO/TC 164, *Mechanical testing of metals*, Subcommittee SC 2, *Ductility testing*.

This first edition of ISO 20482 cancels and replaces ISO 8490:1986 of which it constitutes a technical revision.

Metallic materials — Sheet and strip — Erichsen cupping test

1 Scope

This International Standard specifies a standard test method for determining the ability of metallic sheets and strips having a thickness from 0,1 mm up to 2 mm and a width of 90 mm or greater to undergo plastic deformation in stretch forming.

For materials that are thicker and when only narrower strips are available, tools of specified dimensions are provided, in which case subscripts are used, as shown in Table 1.

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 4287, *Geometrical Product Specifications (GPS) — Surface texture: Profile method — Terms, definitions and surface texture parameters*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1

through crack

crack that goes through the full thickness of the test piece and is just sufficiently wide to allow light to pass through part of its length

4 Symbols and designations

Symbols and designations used in this International Standard are illustrated by Figure 1 and given in Table 1.

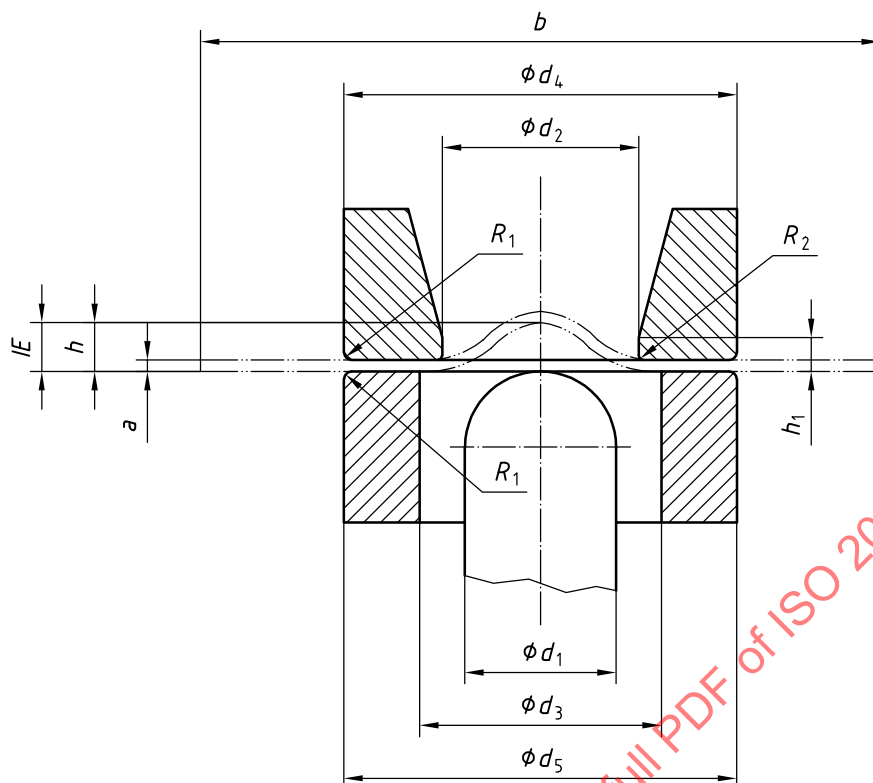


Figure 1 — Schematic representation — Erichsen cupping index

Table 1 — Symbols and designations

Dimensions in millimetres

Symbol	Designation	Test piece and tool dimensions, and Erichsen cupping indices			
		Standard test	Tests with thicker or more narrow sheets		
a	Thickness of the test piece	$0,1 \leq a \leq 2$	$2 < a \leq 3$	$0,1 \leq a \leq 2$	$0,1 \leq a \leq 1$
b	Width or diameter of the test piece	≥ 90	≥ 90	$55 \leq b < 90$	$30 \leq b < 55$
d_1	Diameter of the spherical end of the punch	$20 \pm 0,05$	$20 \pm 0,05$	$15 \pm 0,02$	$8 \pm 0,02$
d_2	Bore diameter of the die	$27 \pm 0,05$	$40 \pm 0,05$	$21 \pm 0,02$	$11 \pm 0,02$
d_3	Bore diameter of the blank holder	$33 \pm 0,1$	$33 \pm 0,1$	$18 \pm 0,1$	$10 \pm 0,1$
d_4	Outside diameter of the die	$55 \pm 0,1$	$70 \pm 0,1$	$55 \pm 0,1$	$55 \pm 0,1$
d_5	Outside diameter of the blank holder	$55 \pm 0,1$	$70 \pm 0,1$	$55 \pm 0,1$	$55 \pm 0,1$
R_1	Outside corner radius of the die, outside corner radius of the blank holder	$0,75 \pm 0,1$	$1,0 \pm 0,1$	$0,75 \pm 0,1$	$0,75 \pm 0,1$
R_2	Inside corner radius of the die	$0,75 \pm 0,05$	$2,0 \pm 0,05$	$0,75 \pm 0,05$	$0,75 \pm 0,05$
h_1	Height of the inside rounded part of the die	$3,0 \pm 0,1$	$6,0 \pm 0,1$	$3,0 \pm 0,1$	$3,0 \pm 0,1$
h	Depth of the indentation during the test	—	—	—	—
IE^a	Erichsen cupping index	IE	IE_{40}	IE_{21}	IE_{11}

^a The corresponding Erichsen cupping index is designated for the standard test. For thicker materials and narrower specimens of thinner materials, the d_2 dimension is added to the index.

5 Principle

Forming an indentation by pressing a punch with a spherical end against a clamped test piece between a blank holder and a die until a through crack appears. The measured depth of the indentation is the result of the test based on the movement of the punch.

6 Testing equipment

6.1 The test shall be carried out on a machine equipped with a die, punch and blank holder with dimensions and tolerances as given Table 1.

6.2 The construction of the machine shall be such that it is possible to observe the outside of the test piece during the test in order to be able to determine the instant when a through crack appears.

NOTE In general, the commencement of rupture is accompanied by a drop in the force sustained by the test piece and sometimes by perceptible noise.

6.3 The machine shall be equipped with a gauge for measuring the movement of the punch with a scale division of 0,1 mm.

6.4 The die, the blank holder and the punch shall be sufficiently rigid not to deform during the test. The Vickers hardness of working surfaces of the die, the blank holder and the punch shall be at least 750 HV 30.

6.4.1 The punch shall not turn during the test.

6.4.2 The working surface of the punch shall be spherical and polished. The mean value of roughness R_a as defined in ISO 4287 shall be $\leq 0,4 \mu\text{m}$.

6.5 The distance from the axis of the die to the centre of the spherical part of the punch shall be less than 0,1 mm throughout its range of movement in use.

6.6 The surfaces of the blank holder and of the die in contact with the test piece shall be plane and perpendicular to the axis of movement of the punch. The forming die shall be self-aligning to the (fixed) blank holder.

6.7 The machine shall ensure that the test piece is held with a constant holding force of approximately 10 kN.

6.8 Measurement of the movement of the punch takes place from the point where it initially touches the surface of the test piece.

6.9 Instead of the punch defined in Figure 1, Table 1 and in 6.1, 6.4, 6.5, hardened steel balls may be used.

7 Test piece

7.1 The test piece shall be flat and of such dimensions that for $b > 90 \text{ mm}$ the centre of any indentation is not less than 45 mm from any edge of the test piece, and not less than 90 mm from the centre of the adjacent indentation. For narrow test pieces the centres of the indentations shall be in the centre of the test piece width and at least one strip width from the centre of an adjacent indentation.

7.2 The preparation of the test piece shall not produce on the edges any burr or distortion which would prevent it being placed in the machine and which could interfere with the performance of the test.

7.3 Before testing, the test piece shall not be submitted to any hammering or hot or cold working.

8 Test conditions

In general, the test shall be carried out at a temperature between 10 °C and 35 °C. The test carried out under controlled conditions, where required, shall be made at a temperature of $(23 \pm 5)^\circ\text{C}$.

9 Procedure

9.1 Determine the thickness of the test piece to the nearest 0,01 mm.

9.2 Before operating the machine, lightly grease the surfaces of the test piece which will be in contact with punch and die using graphite grease. For the recommended composition of the graphite grease, see Annex A.

By agreement, another type of lubricant may be used.

9.3 Clamp the test piece between the blank holder and the die. The blank holder force shall be approximately 10 kN.

9.4 Bring the punch, without causing shock, into contact with the test piece. Take the measurement of penetration from this point.

NOTE Before the test starts, the top of the punch should be on the same level as the upper surface of the blank holder (test point of the calibration).

9.5 Proceed with forming the indentation smoothly, at a rate between 5 mm/min and 20 mm/min for the standard test. For the test pieces with $b < 90$ mm the rate shall be between 5 mm/min and 10 mm/min.

NOTE 1 For manually operated machines, toward the end of the operation, reduce the rate to near the lower limit in order to determine accurately the moment when a through crack appears.

NOTE 2 When using computer controlled testing machines, the reduction of the rate at the end of the test is not necessary, because the test result is directly given by the force/punch displacement diagram.

9.6 Stop the movement of the punch the instant a crack appears through the full thickness of the test piece.

9.7 Measure the depth of penetration to the nearest 0,1 mm.

9.8 A minimum of three tests shall be carried out unless otherwise specified in product standards. The value of Erichsen cupping index IE shall be the average of a minimum of three individual values, expressed in millimetres.

10 Test report

The test report shall include at least the following information:

- a) reference to this International Standard, i.e., ISO 20482;
- b) identity of the test piece (test piece orientation);
- c) thickness of the test piece;
- d) type of lubricant used;
- e) appearance of test piece after rupture, if required;
- f) value of the Erichsen cupping index, IE , single values if required.

Annex A (informative)

Recommended composition of the graphite grease

It is known that the test results depend on the type of grease used. One representative grease that is known to be suitable has the following characteristics as determined by the relevant material specifications.

The grease consists of calcium soap, refined mineral oil and flake graphite.

It should be free from corrosive matter, grit resin, wax and fillers.

The grease and its components should conform to the requirements shown in Table A.1.

Table A.1 — Recommended characteristics of the graphite grease

Component	Characteristic	Recommended value
Grease	Worked penetration of cone of 150 g at a temperature of 25 °C	250 to 280
	Free acidity	0,2 % max. ^a oleic acid
	Free alkalinity	0,3 % max. ^a Ca(OH) ₂
	Water content	0,5 % to 1,2 %
	Graphite content	23 % to 28 % ^a
Flake graphite	Maximum particle size	0,3 mm
	Ash	4,5 % max. ^a
Mineral oil	Viscosity at 37,8 °C	100 cS to 120 cS
	Closed flash point	177 °C min.
	Ash	0,01 % max. ^a
	Neutralization value	0,1 mg of KOH/g max.
^a Mass fraction.		