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Metallic materials — Sheet and strip — Method for springback evaluation in stretch bending

Matériaux métalliques — Tôles et bandes — Méthodes d'évaluation du retour élastique lors d'un cintrage sous traction

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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 24213 was prepared by Technical Committee ISO/TC 164, *Mechanical testing of metals*, Subcommittee SC 2, *Ductility testing*.

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Introduction

This International Standard has been established to evaluate the amount of springback occurring in metallic sheets deformed by stretch-bending. It may be used for specifying a material, directly controlling a forming operation, designing dies, or calibrating finite element programs.

In metallic sheet forming processes, the geometry of the formed parts may deviate from the design geometry after the parts are removed from the dies due to elastic recovery. This phenomenon is referred to as springback.

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Metallic materials — Sheet and strip — Method for springback evaluation in stretch bending

1 Scope

This International Standard specifies a method for evaluating the amount of springback of sheets of metallic materials known to exhibit large amounts of springback subjected to plane-strain stretch bending, which is a typical deformation mode generated in press-formed panels. By using this method, the amount of springback under stretch bending is evaluated accurately and quantitatively.

2 Normative references

The following referenced documents relate to 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.

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ISO 31-0, *Quantities and units — Part 0: General principles*

3 Terms and definitions

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

3.1
curvature
κ
reciprocal of the radius of curvature r determined at the centre of a stretch-bent specimen on the inner surface in the longitudinal direction

$$\kappa = \frac{1}{r} \quad (1)$$

3.2
amount of springback
η
relative change in curvature of a test piece under force and after removal of the force shown in Figure 1

$$\eta = \frac{|\kappa' - \kappa|}{\kappa} = \frac{r' - r}{r'} \quad (2)$$

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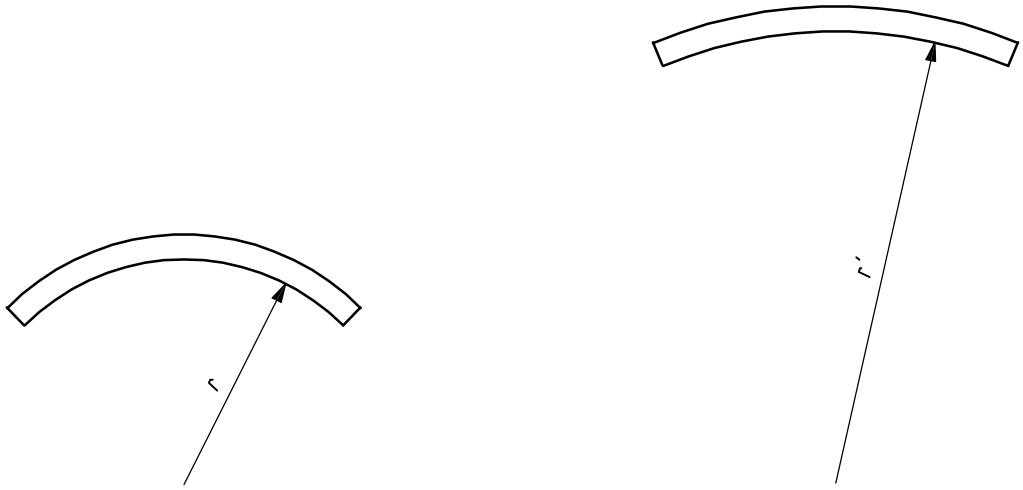

a) Under force

b) After removal of the force

Figure 1 — Radius of curvature of test piece under force and after removal of the force

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3.3
stretch bending
method of bending a test piece under tension

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3.4
blank holding pressure
force applied on the test piece in the direction of its thickness, divided by the surface area of the test piece contacting the die

NOTE The method for calculating the blank holding pressure is shown in Annex A.

3.5
nominal tensile stress
tensile force per unit cross-sectional area of the test piece

NOTE The method for calculating the nominal tensile stress is shown in Annex B.

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4 Symbols and designations

The symbols used in this International Standard and the corresponding designations are given in Table 1.

Table 1 — Symbols and corresponding designations

Symbol	Designation	Unit
a	Thickness of test piece	mm
b	Width of test piece	mm
F_h	Blank holding force	N
h	Amount of punch penetration	mm
F_p	Punch force	N
p	Blank holding pressure	MPa
R_p	Punch radius	mm
r	Radius of curvature of the inner surface of the test piece under force	mm
r'	Radius of curvature of the inner surface of the test piece after removal of the force	mm
r_d	Die profile radius	mm
S	Total surface area of test piece in contact with dies	mm^2
T	Nominal tensile stress applied to test piece	MPa
W	Distance between dies	mm
w	Width of the base of a dial gauge for measuring the curvature of the test piece after removal of the force, see Annex C	mm
x	Measured value by a dial gauge for measuring the curvature of the test piece after removal of the force (length of AD in Figure C.1)	mm
κ	Curvature of the inner surface of the test piece under force ($= r^{-1}$)	mm^{-1}
κ'	Curvature of the inner surface of the test piece after removal of the force [$= (r')^{-1}$]	mm^{-1}
η	Amount of springback	
2θ	Spread angle of test piece around punch	rad

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5 Principle

This test is a method for evaluating the springback of a metal sheet using a stretch-bending method. The amount of springback is determined as the change in curvatures of a test piece under force and after removal of the force (see Equations in 3.1 and 3.2). The nominal tensile stress applied to the test piece is determined using the measured value of punch penetration and punch force (see Annex B).

6 Test apparatus

The test apparatus is described below.

6.1 Stretch-bending testing device for springback evaluation.

An example of the stretch-bending device used in the test is shown in Figure 2. The radius of the semi-cylindrical punch shall be (100 ± 1) mm. However, the radius of the punch tip and its tolerance may be determined by agreement between the parties involved.

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