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Metallic materials — Sheet and strip — Determination of forming-limit curves —

Part 2: Determination of forming-limit curves in the laboratory

Matériaux métalliques — Tôles et bandes — Détermination des courbes limites de formage —

Partie 2: Détermination des courbes limites de formage en laboratoire

Reference number
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Contents

Page

Foreword ... iv
Introduction ... v
1 Scope ... 1
2 Symbols and abbreviated terms ... 1
3 Principle ... 2
4 Test pieces and equipment ... 3
5 Analysis of strain profile and measurement of ε_1 - ε_2 pairs ... 10
6 Documentation ... 15
7 Test report ... 16
Annex A (normative) **Second derivative and "filtered" second derivative** ... 17
Annex B (normative) **Calculation of the width of the fit window** ... 18
Annex C (normative) **Evaluation of the inverse best-fit parabola on the "bell-shaped curve"** ... 19
Annex D (normative) **Application/Measurement of grid — Evaluation with magnifying glass or microscope** ... 21
Annex E (informative) **Tables of experimental data for validation of calculation programme** ... 22
Annex F (normative) **Representation and mathematical description of FLC** ... 23
Annex G (informative) **Examples of critical cross-sectional data** ... 24
Annex H (normative) **Flowchart from measured strain distributions to FLC values** ... 25
Bibliography ... 27

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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 12004-2 was prepared by Technical Committee ISO/TC 164, *Mechanical testing of metals*, Subcommittee SC 2, *Ductility testing*.

This first edition of ISO 12004-2, together with ISO 12004-1, cancels and replaces ISO 12004:1997 which has been technically revised.

ISO 12004 consists of the following parts, under the general title *Metallic materials — Sheet and strip — Determination of forming-limit curves*:

— *Part 1: Measurement and application of forming-limit diagrams in the press shop*

— *Part 2: Determination of forming-limit curves in the laboratory*

Introduction

A forming-limit diagram (FLD) is a diagram containing major/minor strain points.

An FLD can distinguish between safe points and necked or failed points. The transition from safe to failed points is defined by the forming-limit curve (FLC).

To determine the forming limit of materials, two different methods are possible.

1) Strain analysis on failed press shop components to determine component and process dependent FLCs:

   In the press shop, the strain paths followed to reach these points are generally not known. Such an FLC depends on the material, the component and the chosen forming conditions. This method is described in ISO 12004-1.

2) Determination of FLCs under well-defined laboratory conditions:

   For evaluating formability, one unique FLC for each material in several strain states is necessary. The determination of the FLC has to be specific and it is necessary to use different linear strain paths. This method should be used for material characterization as described in ISO 12004-2.

For this part of ISO 12004 (concerning determination of forming-limit curves in laboratory), the following conditions are also valid.

— Forming-limit curves (FLCs) are determined for specific materials to define the extent to which they can be deformed by drawing, stretching or any combination of drawing and stretching. This capability is limited by the occurrence of fracture, localized necking. Many methods exist to determine the forming limit of a material; however, it should be noted that results obtained using different methods cannot be used for comparison purposes.

— The FLC characterizes the deformation limit of a material in the condition after a defined thermo-mechanical treatment and in the analysed thickness. For a judgement of formability, the additional knowledge of mechanical properties and the material's history prior to the FLC-test are important.

To compare the formability of different materials, it is important not only to judge the FLC but also the following parameters:

a) mechanical properties at least in the main direction;

b) percentage plastic extension at maximum force, according to ISO 6892-1;

c) r-value with given deformation range, according to ISO 10113;

d) n-value with given deformation range, according to ISO 10275.