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Metallic materials — Method of test for the determination of quasistatic fracture toughness of welds

Matériaux métalliques — Méthode d'essai pour la détermination de la ténacité quasi statique à la rupture des soudures

Reference number
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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.

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 voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 164, *Mechanical testing of metals*, Subcommittee SC 4, *Toughness testing — Fracture (F), Pendulum (P), Tear (T).*

This second edition of ISO 15653 cancels and replaces the first edition (ISO 15653:2010), which has been technically revised.

The main changes compared to the previous edition are as follows:

— new formulae for the calculation of single-point determination of CTOD (12.2.2) have been added;

— introduction for reverse bending in C.3 has been added;

— assessment of pop-in in D.1 has been clarified;

— new formula for the calculation for single-point determination of CTOD in shallow notched specimens in E.4 has been added.

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Metallic materials — Method of test for the determination of quasistatic fracture toughness of welds

1 Scope

This document specifies methods for determining fracture toughness in terms of stress intensity factor (K), crack tip opening displacement or CTOD (δ) and experimental equivalent of the J-integral for welds in metallic materials (J).

This document complements ISO 12135, which covers all aspects of fracture toughness testing of parent metal and which needs to be used in conjunction with this document. This document describes methods for determining point values of fracture toughness. It should not be considered a way of obtaining a valid R-curve (resistance-to-crack-extension curve). However, the specimen preparation methods described in this document could be usefully employed when determining R-curves for welds. The methods use fatigue precracked specimens which have been notched, after welding, in a specific target area in the weld. Methods are described to evaluate the suitability of a weld for notch placement within the target area, which is either within the weld metal or within the weld heat-affected zone (HAZ), and then, where appropriate, to evaluate the effectiveness of the fatigue crack in sampling these areas.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 12135:2016, *Metallic materials — Unified method of test for the determination of quasistatic fracture toughness*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12135 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at https://www.iso.org/obp

3.1
stretch zone width
SZW
increase in crack length associated with crack tip blunting, i.e. prior to the onset of unstable crack extension, *pop-in* (3.3) or slow stable crack extension, and occurring in the same plane as the fatigue precrack

3.2
target area
intended fatigue crack tip position within the *weld metal* (3.7) or *HAZ* (3.9)

3.3
pop-in
abrupt discontinuity in the force versus displacement record, featured as a sudden increase in displacement and, generally, a sudden decrease in force, subsequent to which displacement and force increase to above their values at the initiation of the discontinuity

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3.4
local compression
controlled compression applied to specimens in the thickness direction on the unnotched ligament prior to fatigue cracking using hardened steel platens

Note 1 to entry: See Annex C.

3.5
welding
operation in which two or more parts are united by means of heat, friction, pressure or all three of these, in such a way that there is continuity in the nature of the metal between these parts

Note 1 to entry: Filler metal, the melting temperature of which is of the same order as that of the parent metal, may or may not be used.

3.6
weld
union of pieces of metal made by *welding* (3.5)

3.7
weld metal
all metal melted during the making of a *weld* (3.6) and retained in the weld

3.8
parent metal
metal to be joined by *welding* (3.5)

3.9
heat-affected zone
HAZ
zone in the parent metal that is metallurgically affected by the heat of *welding* (3.5)

3.10
fusion line
FL
junction between the *weld metal* (3.7) and the *parent metal* (3.8) heat-affected zone

3.11
weld positional
WP
target position for the fatigue crack tip, defined with respect to a reference line

Note 1 to entry: See Figure A.1 for examples.

3.12
specific microstructure
SM
target microstructure for the fatigue crack tip

Note 1 to entry: See Figure A.2 for examples.

3.13
specimen blank
specimen prepared from *weld metal* (3.7) plus *parent metal* (3.8) prior to notching

3.14
post-weld heat treatment
heat treatment applied after *welding* (3.5) for the purpose of reducing residual stresses or modifying *weld* (3.6) properties

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