



# SLOVENSKI STANDARD SIST EN ISO 15653:2018

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**Kovinski materiali - Preskusna metoda za ugotavljanje kvazistatične lomne žilavosti zvarnih spojev (ISO 15653:2018)**

Metallic materials - Method of test for the determination of quasistatic fracture toughness of welds (ISO 15653:2018)

Metallische Werkstoffe - Prüfverfahren zur Bestimmung der quasistatischen Bruchzähigkeit von Schweißnähten (ISO 15653:2018)

Matériaux métalliques - Méthode d'essai pour la détermination de la ténacité quasi statique à la rupture des soudures (ISO 15653:2018)

**Ta slovenski standard je istoveten z: EN ISO 15653:2018**

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**ICS:**

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EN ISO 15653

NORME EUROPÉENNE

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English Version

## Metallic materials - Method of test for the determination of quasistatic fracture toughness of welds (ISO 15653:2018)

Matériaux métalliques - Méthode d'essai pour la détermination de la ténacité quasi statique à la rupture des soudures (ISO 15653:2018)

Metallische Werkstoffe - Prüfverfahren zur Bestimmung der quasistatischen Bruchzähigkeit von Schweißverbindungen (ISO 15653:2018)

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## European foreword

This document (EN ISO 15653:2018) has been prepared by Technical Committee ISO/TC 164 "Mechanical testing of metals" in collaboration with Technical Committee CEN/TC 121 "Welding and allied processes" the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by July 2018, and conflicting national standards shall be withdrawn at the latest by July 2018.

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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*

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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](http://www.iso.org/directives)).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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](http://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 ( $\delta$ ) 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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## 4 Symbols and units

For the purposes of this document, the symbols and units given in [Table 1](#) apply in addition to those in ISO 12135.

**Table 1 — Symbols and units**

Symbol	Unit	Designation
$d_1, d_2$	mm	Lengths of microstructural features associated with pop-in.
$h$	mm	Effective weld width, defined as shortest distance between fatigue crack tip and weld fusion line within the central 75 % of the thickness (see <a href="#">Figures 13</a> and <a href="#">14</a> ).
HV10		Vickers hardness using 10 kg force.
N		Normal to welding direction.
P		Parallel to welding direction.
Q		Weld thickness direction.
$R_{p0,2b}$	MPa	0,2 % offset yield strength of parent metal at the temperature of the fracture test.
$R_{p0,2w}$	MPa	0,2 % offset yield strength of weld metal at the temperature of the fracture test.
$R_{mb}$	MPa	Tensile strength of parent metal at the temperature of the fracture test.
$R_{mw}$	MPa	Tensile strength of weld metal at the temperature of the fracture test.
$s_1$	mm	Distance between crack tip and target area measured in the crack plane (see <a href="#">Figure 12</a> ).
$s_2$	mm	Distance between crack tip and target area measured perpendicular to the crack plane (see <a href="#">Figure 12</a> ).
$V$	mm	Crack mouth opening displacement at notch edge in bend specimen and that at load line in compact specimen.
$V_g$	mm	Displacement measured by clip gauge mounted on knife edges.
$V_{g1}$	mm	Displacement measured with the double clip gauge arrangement described in <a href="#">E.3</a> and illustrated in <a href="#">Figure E.1</a> .
$V_{g2}$	mm	Displacement measured with the double clip gauge arrangement described in <a href="#">E.3</a> and illustrated in <a href="#">Figure E.1</a> .
X		Direction parallel to primary grain flow of parent metal.
Y		Direction transverse to primary grain flow and to thickness of parent metal.
Z		Direction through thickness of parent metal.
$\Delta a_{pop}$	mm	Maximum length of brittle crack extension (beyond SZW; see <a href="#">3.1</a> ) associated with pop-in.
$\lambda$	mm	Length of specific microstructure measured in pre-test or post-test metallography (see <a href="#">Figure B.2</a> ).

## 5 Principle

This document specifies procedures for the determination of fracture toughness on notched-plus-fatigue-cracked specimens taken from welds. It pertains to situations where the fatigue crack tip is

- located in relation to a weld feature of interest, referred to as “weld positional” (WP), and
- specifically located within a microstructure of interest, referred to as “specific microstructure” (SM).

Metallographic examination of the weld is used to confirm that the target weld feature and/or microstructure is indeed present at the crack tip and in sufficient quantity for testing.

Specimen geometry and notch orientation are chosen, and a fatigue crack then extended from the specimen's notch tip into the target weld feature or microstructure by applying a controlled alternating force to the specimen. The purpose of the test is to determine weld fracture toughness in the absence of significant residual welding stresses. To achieve this and to produce a straight-fronted fatigue crack,