NSAI Standards

Irish Standard
I.S. EN ISO 7539-9:2021

Corrosion of metals and alloys - Stress corrosion testing - Part 9: Preparation and use of pre-cracked specimens for tests under rising load or rising displacement (ISO 7539-9:2021)

I.S. EN ISO 7539-9:2021

Incorporating amendments/corrigenda/National Annexes issued since publication:

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National Foreword

I.S. EN ISO 7539-9:2021 is the adopted Irish version of the European Document EN ISO 7539-9:2021, Corrosion of metals and alloys - Stress corrosion testing - Part 9: Preparation and use of pre-cracked specimens for tests under rising load or rising displacement (ISO 7539-9:2021)

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN ISO 7539-9

August 2021

ICS 77.060

Supersedes EN ISO 7539-9:2008

English Version

Corrosion of metals and alloys - Stress corrosion testing - Part 9: Preparation and use of pre-cracked specimens for tests under rising load or rising displacement (ISO 7539-9:2021)

Corrosion des métaux et alliages - Essais de corrosion sous contrainte - Partie 9: Préparation et utilisation des éprouvettes préfissurées pour essais sous charge croissante ou sous déplacement croissant (ISO 7539-9:2021)

Korrosion von Metallen und Legierungen - Prüfung der Spannungsrisskorrosion - Teil 9: Vorbereitung und Anwendung von angerissenen Proben für die Prüfung mit zunehmender Kraft oder zunehmender Verformung (ISO 7539-9:2021)

This European Standard was approved by CEN on 24 July 2021.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
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European foreword

This document (EN ISO 7539-9:2021) has been prepared by Technical Committee ISO/TC 156 "Corrosion of metals and alloys" in collaboration with Technical Committee CEN/TC 262 “Metallic and other inorganic coatings, including for corrosion protection and corrosion testing of metals and alloys” the secretariat of which is held by BSI.

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of an identical text or by endorsement, at the latest by February 2022, and conflicting national standards shall be withdrawn at the latest by February 2022.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN ISO 7539-9:2008.

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According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Endorsement notice

The text of ISO 7539-9:2021 has been approved by CEN as EN ISO 7539-9:2021 without any modification.

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INTERNATIONAL STANDARD

ISO 7539-9

Second edition
2021-08

Corrosion of metals and alloys — Stress corrosion testing —

Part 9:
Preparation and use of pre-cracked specimens for tests under rising load or rising displacement

Corrosion des métaux et alliages — Essais de corrosion sous contrainte —

Partie 9: Préparation et utilisation des éprouvettes préfissurées pour essais sous charge croissante ou sous déplacement croissant

Reference number
ISO 7539-9:2021(E)

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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).

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).

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

For an explanation of 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 www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 156, *Corrosion of metals and alloys*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 262, *Metallic and other inorganic coatings,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 7539-9:2003), which has been technically revised.

The main change compared to the previous edition is as follows: the formula for K in Figure 9 has been corrected.

A list of all parts in the ISO 7539 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Corrosion of metals and alloys — Stress corrosion testing —

Part 9:
Preparation and use of pre-cracked specimens for tests under rising load or rising displacement

1 Scope

1.1 This document specifies procedures for designing, preparing and using pre-cracked specimens for investigating the susceptibility of metal to stress corrosion cracking (SCC) by means of tests conducted under rising load or rising displacement. Tests conducted under constant load or constant displacement are dealt with in ISO 7539-6.

The term “metal” as used in this document includes alloys.

1.2 Because of the need to confine plasticity at the crack tip, pre-cracked specimens are not suitable for the evaluation of thin products such as sheet or wire and are generally used for thicker products including plate, bar, and forgings. They can also be used for parts joined by welding.

1.3 Pre-cracked specimens can be stressed quantitatively with equipment for application of a monotonically increasing load or displacement at the loading points.

1.4 A particular advantage of pre-cracked specimens is that they allow data to be acquired from which critical defect sizes, above which stress corrosion cracking can occur, can be estimated for components of known geometry subjected to known stresses. They also enable rates of stress corrosion crack propagation to be determined.

1.5 A principal advantage of the test is that it takes account of the potential impact of dynamic straining on the threshold for stress corrosion cracking.

1.6 At sufficiently low loading rates, the threshold stress intensity factor for susceptibility to stress corrosion cracking, K_{ISCC}, determined by this method can be less than or equal to that obtained by constant load or displacement methods and can be determined more rapidly.

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 7539-6, *Corrosion of metals and alloys — Stress corrosion testing — Part 6: Preparation and use of precracked specimens for tests under constant load or constant displacement*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 7539-6 as well as 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
rate of change of crack opening displacement at loading plane
$\dot{V}_{LL}$
deflection at the loading point access measured over a fixed period

3.2
stress intensity factor at crack initiation
$K_{\text{I-init}}$
stress intensity applied at the commencement of measurable crack growth

3.3
displacement rate
$\mathrm{d}q/\mathrm{d}t$
rate of increase of the deflection either measured at the loading point axis or away from the loading line

4 Principle

4.1 The use of pre-cracked specimens acknowledges the difficulty of ensuring that crack-like defects introduced during either manufacture or subsequent service are totally absent from structures. Furthermore, the presence of such defects can cause a susceptibility to stress corrosion cracking which in some materials (e.g. titanium) may not be evident from tests under constant load on smooth specimens. The principles of linear elastic fracture mechanics can be used to quantify the stress situation existing at the crack tip in a pre-cracked specimen or structure in terms of the plane strain-stress intensity.

4.2 The test involves subjecting a specimen in which a crack has been developed from a machined notch by fatigue to an increasing load or displacement during exposure to a chemically agressive environment. The objective is to quantify the conditions under which environmentally-assisted crack extension can occur in terms of the threshold stress intensity for stress corrosion cracking, K_{ISCC}, and the kinetics of crack propagation.

4.3 Tests may be conducted in tension or in bending. The most important characteristic of the test is the low loading/displacement rate which is applied.

4.4 Because of the dynamic straining which is associated with this method the data obtained may differ from those obtained for pre-cracked specimens with the same combination of environment and material when the specimens are subjected to static loading only.

4.5 The empirical data can be used for design or life prediction purposes in order to ensure either that the stresses within large structures are insufficient to promote the initiation of environmentally-assisted cracking at whatever pre-existing defects may be present or that the amount of crack growth which would occur within the design life or inspection periods can be tolerated without the risk of unstable failure.

4.6 Stress corrosion cracking is influenced by both mechanical and electrochemical driving forces. The latter can vary with crack depth, opening or shape because of variations in crack-tip chemistry and electrode potential and may not be uniquely described by the fracture mechanics stress intensity factor.

4.7 The mechanical driving force includes both applied and residual stresses. The possible influence of the latter should be considered in both laboratory testing and the application to more complex geometries. Gradients in residual stress in a specimen may result in non-uniform crack growth along the crack front.

4.8 K_{ISCC} is a function of the environment, which should simulate that in service, and of the conditions of loading.

5 Specimens

5.1 General

5.1.1 A wide range of standard specimen geometries of the type employed in fracture toughness tests may be used, those most commonly employed are described in ISO 7539-6. The particular type of specimen used will be dependent upon the form, the strength and the susceptibility to stress corrosion cracking of the material to be tested and also on the objective of the test.

5.1.2 A basic requirement is that the dimensions shall be sufficient to maintain predominantly triaxial (plane strain) conditions in which plastic deformation is limited in the vicinity of the crack tip. Experience with fracture toughness testing has shown that for a valid K_{Ic} measurement, both the crack length, *a,* and the thickness, *B*, should be not less than

$$2,5\left(\frac{K_{Ic}}{R_{p0,2}}\right)^2$$

and that, where possible, larger specimens where both *a* and *B* are at least

$$4\left(\frac{K_{Ic}}{R_{p0,2}}\right)^2$$

should be used to ensure adequate constraint.

From the view of fracture mechanics, a minimum thickness from which an invariant value of K_{ISCC} is obtained cannot currently be specified. The presence of an aggressive environment during stress corrosion may reduce the extent of plasticity associated with fracture and hence the specimen dimensions needed to limit plastic deformation. However, in order to minimize the risk of inadequate constraint, it is recommended that similar criteria to those employed during fracture toughness testing should be employed regarding specimen dimensions, i.e. both *a* and *B* should be not less than

$$2,5\left(\frac{K_I}{R_{p0,2}}\right)^2$$

and preferably should be not less than

$$4\left(\frac{K_I}{R_{p0,2}}\right)^2$$

where K_I is the stress intensity to be applied during testing.

As a test for its validity, the threshold stress intensity value eventually determined shall be substituted for K_I in the first of these formulae.

5.1.3 If the specimens are to be used for the determination of K_{ISCC}, the initial specimen size should be based on an estimate of the K_{ISCC} of the material. In the first instance, it is better to over-estimate the K_{ISCC} value and therefore use a larger specimen than that which may eventually be found necessary. Where the service application involves the use of material of insufficient thickness to satisfy the conditions for