

BS ISO 15850:2014



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Plastics — Determination of tension-tension fatigue crack propagation — Linear elastic fracture mechanics (LEFM) approach

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National foreword

This British Standard is the UK implementation of ISO 15850:2014. It supersedes BS ISO 15850:2002 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PRI/21, Testing of plastics.

A list of organizations represented on this committee can be obtained on request to its secretary.

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**Plastics — Determination of tension-
tension fatigue crack propagation
— Linear elastic fracture mechanics
(LEFM) approach**

*Plastiques — Détermination de la propagation de fissure par fatigue
en traction — Approche de la mécanique linéaire élastique de la
rupture (LEFM)*





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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
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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).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information.

The committee responsible for this document is ISO/TC 61, *Plastics*, Subcommittee SC 2, *Mechanical properties*.

This second edition cancels and replaces the first edition (ISO 15850:2002) of which it constitutes a minor revision.

Plastics — Determination of tension-tension fatigue crack propagation — Linear elastic fracture mechanics (LEFM) approach

1 Scope

This International Standard specifies a method for measuring the propagation of a crack in a notched specimen subjected to a cyclic tensile load varying between a constant positive minimum and a constant positive maximum value. The test results include the crack length as a function of the number of load cycles and the crack length increase rate as a function of the stress intensity factor and energy release rate at the crack tip. The possible occurrence of discontinuities in crack propagation is detected and reported.

The test can be also used for the purpose of determining the resistance to crack propagation failure. In this case, the results can be presented in the form of number of cycles to failure or total time taken to cause crack propagation failure versus the stress intensity factor (see [Annex A](#)).

The method is suitable for use with the following range of materials:

- rigid and semi-rigid thermoplastic moulding and extrusion materials (including filled and short-fibre-reinforced compounds) plus rigid and semi-rigid thermoplastic sheets;
- rigid and semi-rigid thermosetting materials (including filled and short-fibre-reinforced compounds) plus rigid and semi-rigid thermosetting sheets.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 291, *Plastics — Standard atmospheres for conditioning and testing*

ISO 527 (all parts), *Plastics — Determination of tensile properties*

ISO 2818, *Plastics — Preparation of test specimens by machining*

3 Terms and definitions

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

3.1 cycle

smallest segment of a load-time or stress-time function which is repeated periodically

Note 1 to entry: The terms fatigue cycle, load cycle, and stress cycle are also commonly used.

3.2 number of cycles completed

N

number of load cycles since the beginning of a test

3.3

waveform

shape of the load-time curve within a single cycle

3.4

maximum load

$P_{\max}$

highest value of the load during a cycle

Note 1 to entry: It is expressed in newtons.

Note 2 to entry: Only positive, i.e. tensile, loads are used in this test method.

3.5

minimum load

$P_{\min}$

lowest value of the load during a cycle

Note 1 to entry: It is expressed in newtons.

Note 2 to entry: Only positive, i.e. tensile, loads are used in this test method.

3.6

load range

ΔP

difference between the maximum and the minimum loads in one cycle, given by:

$$\Delta P = P_{\max} - P_{\min}$$

3.7

load ratio

stress ratio

R

ratio of the minimum to the maximum load in one cycle, i.e.:

$$R = \frac{P_{\min}}{P_{\max}}$$

3.8

stress intensity factor

K

limiting value of the product of the stress $\sigma(r)$ perpendicular to the crack area at a distance r from the crack tip and of the square root of $2\pi r$, as r tends to zero:

$$K = \lim_{r \rightarrow 0} \sigma(r) \sqrt{2\pi r}$$

[SOURCE: ISO 13586:2000, 3.3]

Note 1 to entry: It is expressed in pascal root metres ($\text{Pa} \cdot \text{m}^{1/2}$).

Note 2 to entry: The term factor is used here because it is in common usage, even though the quantity has dimensions.

3.9

maximum stress intensity factor

$K_{\max}$

highest value of the stress intensity factor in one cycle

3.10 minimum stress intensity factor

$K_{\min}$
lowest value of the stress intensity factor in one cycle

3.11 stress intensity factor range

ΔK
difference between the maximum and minimum stress intensity factors in one cycle, given by:

$$\Delta K = K_{\max} - K_{\min}$$

3.12 energy release rate

G
difference between the external work δU_{ext} done on a body to enlarge a cracked area by an amount δA and the corresponding change in strain energy δU_S :

$$G = \frac{\delta U_{\text{ext}}}{\delta A} - \frac{\delta U_S}{\delta A}$$

Note 1 to entry: It is expressed in joules per square metre.

Note 2 to entry: Assuming linear elastic behaviour, the following relationship between the stress intensity factor K and the energy release rate G holds:

$$G = \frac{K^2}{E'}$$

where

$$E' = E \quad \text{for plane stress;}$$

$$E' = \frac{E}{1 - \nu^2} \quad \text{for plane strain conditions;}$$

E and ν are the tensile modulus and Poisson's ratio, respectively.

3.13 maximum energy release rate

$G_{\max}$
highest value of the energy release rate in one cycle

3.14 minimum energy release rate

$G_{\min}$
lowest value of the energy release rate in one cycle

3.15 energy release rate range

ΔG
difference between the maximum and minimum energy release rates in one cycle, given by:

$$\Delta G = G_{\max} - G_{\min}$$

3.16

notch

sharp indentation made in the specimen, generally using a razor blade or a similar sharp tool, before a test and intended as the starting point of a fatigue-induced crack

3.17

initial crack length

a_0

length of the notch ([3.16](#))

Note 1 to entry: It is expressed in metres.

Note 2 to entry: For compact tensile (CT) specimens, it is measured from the line joining the load-application points (i.e. the line through the centres of the loading-pin holes) to the notch tip (see [Figure 2](#)). For single-edge-notched tensile (SENT) specimens, it is measured from the edge of the specimen to the notch tip. Details of the measurement procedure are given in [7.3](#).

3.18

crack length

a

total crack length at any time during a test, given by the initial crack length a_0 plus the crack length increment due to fatigue loading

Note 1 to entry: It is expressed in metres.

3.19

fatigue crack growth rate

da/dN

rate of crack extension caused by fatigue loading and expressed in terms of average crack extension per cycle

Note 1 to entry: It is expressed in metres per cycle.

3.20

stress intensity calibration

mathematical expression, based on empirical or analytical results, that relates the stress intensity factor to load and crack length for a specific specimen geometry

3.21

gauge length

L_0

<single-edge-notched tensile (SENT) specimen> free distance between the upper and lower grips after the specimen has been mounted in the test machine

Note 1 to entry: It is expressed in metres.

3.22

number of cycles to failure

N_f

total number of load cycles from the beginning of the test to fatigue crack propagation to sample failure

3.23

t_f

time to failure

total number of load cycles from the beginning of the test to fatigue crack propagation to sample failure, expressed in time

Note 1 to entry: It is expressed in hours.