

This is a preview of "BS 7448-3:2005". [Click here to purchase the full version from the ANSI store.](#)

# Fracture mechanics toughness tests —

**Part 3: Method for determination of  
fracture toughness of metallic materials  
at rates of increase in stress intensity  
factor greater than  $3.0 \text{ MPa} \cdot \text{m}^{0.5} \text{ s}^{-1}$**

ICS 77.040.10

This is a preview of "BS 7448-3:2005". [Click here to purchase the full version from the ANSI store.](#)

## British Standard

This British Standard was entrusted by Technical Committee ISE/NFE/4, Mechanical testing of materials, to Subcommittee ISE/NFE/4/4, Toughness testing, upon which the following bodies were represented:

British Non-Ferrous Metals Federation  
GAMBICA Limited  
HSE — Health and Safety Executive  
Lloyd's Register  
National Physical Laboratory  
Network Rail  
QinetiQ  
Society of British Aerospace Companies Ltd.  
UK Steel Association  
United Kingdom Accreditation Service  
Welding Institute

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 23 March 2005

© BSI 2007

First published March 2005

### Amendments issued since publication

Amd. No.	Date	Comments
17334 Corrigendum No. 1	31 August 2007	In Foreword, added supersession detail.

The following BSI references relate to the work on this British Standard:

Committee reference  
ISE/NFE/4/4  
Draft for comment 03/303157 DC

ISBN 978 0 580 59480 9

This is a preview of "BS 7448-3:2005". [Click here to purchase the full version from the ANSI store.](#)

	Page
Committees responsible	Inside front cover
Foreword	iii
<hr/>	
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Symbols and designations	3
5 Principle	5
6 Test specimens	7
7 Specimen preparation and fatigue precracking	15
8 Test equipment	17
9 Test procedure	21
10 Analysis of test data	24
11 Check lists for qualification of data	38
12 Test report	38
<hr/>	
Figure 1 — Flow chart for the choice of fracture toughness parameter, specimen design and displacement measurement	6
Figure 2 — Proportional dimensions and tolerances for the rectangular section bend specimen	7
Figure 3 — Proportional dimensions and tolerances for the square section bend specimen	8
Figure 4 — Proportional dimensions and tolerances for the straight notch compact specimen	9
Figure 5 — Proportional dimensions and tolerances for the stepped notch compact specimen	10
Figure 6 — Acceptable fatigue crack starter notches and fatigue crack configurations	12
Figure 7 — Chevron notch	12
Figure 8 — Outward pointing knife edges and corresponding notch geometrics	13
Figure 9 — Outward pointing knife edges and corresponding notch geometrics	14
Figure 10 — Fixture for three point bend tests	19
Figure 11 — Typical design of clevis for applying a tensile force to a compact specimen using a circular hole in the clevis and a pin having a diameter of $(0.24 \pm_{0.015}^{0.005}) W$	20
Figure 12 — Typical design of clevis for applying a tensile force to a compact specimen using a hole with a flat in the clevis, and a pin having a diameter of $(0.24 \pm_{0.005}^{0.000}) W$	21
Figure 13 — Characteristic types of force versus displacement records in fracture tests	23
Figure 14 — Assessment of pop-in behaviour	25
Figure 15 — Principal types of force versus crack mouth opening gauge displacement records showing the limits of allowable force and displacement variation for $K_{Ic}$ determination	27
Figure 16 — Force variation limits for fracture toughness determination	28
Figure 17 — Limits of crack mouth opening gauge displacement variations for plane strain fracture toughness determination	29
Figure 18 — Definition of $V_p$ (for determination of CTOD)	30
Figure 19 — Limits of force and displacement for CTOD and J determination	31
Figure 20 — Force and load point displacement variation for fracture toughness determination	33

This is a preview of "BS 7448-3:2005". [Click here to purchase the full version from the ANSI store.](#)

Figure 21 — Displacement variation limits for CTOD and $J$ determination	34
Figure 22 — Definition of $U_p$ (for determination of $J$ )	35
Figure A.1 — Resistance strain gauge positions for load measurements from rectangular section bend specimen	41
Figure A.2 — Limits of loading point displacement variations for CTOD and $J$ determination	42
Figure B.1 — Schematic representation of the comparator bar	44
Figure B.2 — Displacements associated with three-point bend specimens	44
Figure B.3 — Simultaneous determination of extraneous displacements ( $z_2 - z_1$ )	45
Figure B.4 — Location of two notch opening displacement measurements ( $V_1$ and $V_2$ ) for the determination of load-line displacement	45
Figure C.1 — Basic fracture plane identification — Rectangular section	46
Figure C.2 — Basic fracture plane identification — Cylindrical sections	46
Figure C.3 — Non-basic fracture plane identification	47
Figure D.1 — Examples of good and unacceptable force records	48
Figure D.2 — Examples of good and unacceptable notch opening displacement records	48
Figure D.3 — Test system for d.c. signal conditioners and amplifiers	49
Figure D.4 — Example of the amplitude output of an instrument as a function of frequency	49
Figure D.5 — Test system for a.c. transducers	50
Figure E.1 — Force versus time record from dynamic tensile test showing no distinct yield point	52
Figure E.2 — Force versus time record from dynamic tensile test showing distinct yield point	53
Figure E.3 — Limits to ram displacement versus time record from dynamic tensile test	53
Table 1 — Dimensions of specimens that can lead to valid $K_{Ic}$ values	11
Table 2 — Values of for $f\left(\frac{a}{W}\right)$ three point bend specimens	16
Table 3 — Values of for $f'\left(\frac{a}{W}\right)$ three point bend specimens	17

This is a preview of "BS 7448-3:2005". [Click here to purchase the full version from the ANSI store.](#)

## Foreword

This part of BS 7448 has been prepared by Technical Committee ISE/NFE/4. It is required because the instrumentation and procedures in BS 7448-1 may not be adequate for high rate tests.

This British Standard supersedes BS 6729:1987 which is withdrawn.

This part of BS 7448 is one of a series dealing with fracture mechanics toughness tests, the other parts being:

— *Part 1: Fracture mechanics toughness tests — Method for determination of  $K_{Ic}$  critical CTOD and critical  $J$  values of metallic materials.*

— *Part 2: Fracture mechanics toughness tests — Method for determination of  $K_{Ic}$ , critical CTOD and critical  $J$  values of welds in metallic materials.*

— *Part 4: Fracture mechanics toughness tests — Method for determination of fracture resistance curves and initiation values for stable crack extension in metallic materials.*

It is assumed in the drafting of this standard that the execution of its provisions is entrusted to appropriately qualified and competent people.

This British Standard describes methods of test only, and should not be used or quoted as a specification. References to this standard should indicate that the methods of test used are in accordance with BS 7448-3:2005.

**CAUTION** It is important to note that tests of the type described involve the use of large forces, and may involve the rapid movement of machine parts and fractured test specimens. Therefore it is important to consider the safety of machine operators.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

**Compliance with a British Standard cannot confer immunity from legal obligations.**

## Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, a blank page, pages 1 to 55 and a back cover.

The BSI copyright notice displayed in this document indicates when the document was last issued.

This is a preview of "BS 7448-3:2005". [Click here to purchase the full version from the ANSI store.](#)

This is a preview of "BS 7448-3:2005". Click here to purchase the full version from the ANSI store.

## 1 Scope

This part of BS 7448 describes a method for determining the opening mode plane strain fracture toughness  $K_{Ic}$ , the critical crack tip opening displacement (CTOD) fracture toughness and the critical  $J$  fracture toughness of metallic materials. The method uses fatigue precracked specimens tested in displacement control at rates of increase in stress intensity factor greater than  $3.0 \text{ MPa} \cdot \text{m}^{0.5} \text{ s}^{-1}$  but less than  $3\,000 \text{ MPa} \cdot \text{m}^{0.5} \text{ s}^{-1}$ <sup>1)</sup> during the initial elastic deformation. Stress intensity factors greater than  $3\,000 \text{ MPa} \cdot \text{m}^{0.5} \text{ s}^{-1}$  are covered in Annex A. These rates are greater than those permitted in BS 7448-1.

The definition of fracture toughness values relevant to particular structural integrity assessments is outside the scope of this British Standard.

NOTE This standard does not cover integrity assessments. Such assessments are covered in BS 7910.

## 2 Normative references

The following referenced documents are indispensable for the application 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.

BS 7448-4:1997, *Fracture mechanics toughness tests — Part 4: Method for determination of fracture resistance curves and initiation values for stable crack extension in metallic materials.*

BS 7935-1, *Constant amplitude dynamic force calibration — Part 1: Calibration and verification of non-resonant uniaxial dynamic testing systems — Method.*

BS 7935-2, *Constant amplitude dynamic force calibration — Part 2: Calibration of the calibration device instrumentation to be used for the dynamic calibration of non-resonant uniaxial dynamic testing systems — Method.*

BS EN ISO 7500-1:1999, *Metallic materials — Verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Verification and calibration of the force-measuring system.*

BS EN ISO 12737, *Metallic materials — Determination of plane-strain fracture toughness.*

## 3 Terms and definitions

For the purposes of this part of BS 7448 the following terms and definitions apply.

### 3.1

#### stress intensity factor

#### $K$

magnitude of the stress field near the crack tip (a stress-field singularity) (see 3.2) in a homogeneous, ideally linear-elastic body

NOTE This is a function of applied force, crack length and specimen geometry, and is expressed in units of  $\text{MPa} \cdot \text{m}^{0.5}$ .

### 3.2

#### opening mode

opening displacement of the crack surfaces in a direction normal to the original (undeformed) crack plane near the crack tip

### 3.3

#### plane strain fracture toughness

#### $K_{Ic}$

measure of a material's resistance to crack extension when the stress state near the crack tip is predominantly plane strain, plastic deformation is limited, and opening mode monotonic loading is applied

### 3.4

#### maximum fatigue stress intensity factor

#### $K_f$

maximum value of opening mode stress intensity factor which is applied during the final stages of fatigue crack extension

<sup>1)</sup>  $1 \text{ N} \cdot \text{mm}^{-1.5} = 0.0316 \text{ MPa} \cdot \text{m}^{0.5} = 0.0316 \text{ MN} \cdot \text{m}^{1.5}$ .