



BSI Standards Publication

Metallic materials — Unified method of test for the determination of quasistatic fracture toughness

National foreword

This British Standard is the UK implementation of ISO 12135:2021. It supersedes BS 7448-1:1991 and BS 7448-4:1997, which are withdrawn.

The UK participation in its preparation was entrusted to Technical Committee ISE/101/4, Toughness testing.

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

[BS 7448-1:1991](#), *Fracture mechanics toughness tests — Part 1: Method for determination of K_{Ic} , critical CTOD and critical J values of metallic materials*, and [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*, have not undergone revision since their publication. BSI Technical Committee ISE/101/04, which is responsible for those standards, decided to work with ISO to revise and update ISO 12135:2016 rather than update those British Standards. This approach is consistent with the decision, taken some years previously, to work with ISO to publish [BS EN ISO 15653:2018](#), *Metallic materials — Method of test for the determination of quasistatic fracture toughness of welds*, which was based on [BS 7448-2:1997](#), *Fracture mechanics toughness tests — Part 2: Method for determination of K_{Ic} , critical CTOD and critical J values of welds in metallic materials* (now withdrawn). BS ISO 12135:2021 now provides a unified standard, bringing together both single point and resistance curve fracture toughness testing of homogeneous metallic materials. This makes sense technically because, without prior knowledge, it is not possible to know how the test material will behave. In addition, BS ISO 12135:2021 now complements BS EN ISO 15653:2018 on weldment testing (which BS 7448-1:1991 and BS 7448-4:1997 did not).

The 2021 edition of ISO 12135, in addition to updating the 2016 edition, now incorporates many of the revisions requested by BSI Technical Committee ISE/101/04 and includes conclusions from research into fracture toughness testing since the 1990s. In general, the methods of specimen preparation and testing remain the same as in BS 7448-1:1991 and BS 7448-4:1997, with the possible exception of the fatigue precracking requirements. However, the lower limit of the initial fracture toughness testing rate has been reduced from $0,5 \text{ MPam}^{0,5} \text{ s}^{-1}$ to $0,3 \text{ MPam}^{0,5} \text{ s}^{-1}$.

The main changes relate largely to the methods used to analyse the test results. These include better-defined fatigue precracking requirements, which are intended to minimize the risk of overestimating fracture toughness. When the fatigue crack front straightness requirement cannot be achieved, the application of modification techniques, described in BS EN ISO 15653:2018, is now permitted. There is a slight relaxation in the way that crack front straightness is calculated. Now, the difference between the central seven- and nine-point weighted average should not exceed 10 % a_0 . In addition, the formulae for calculating crack tip opening displacement (CTOD) have been revised based on research carried out in the UK and Japan. The new formulae are still based on the concept that the specimen rotates around a hinge point located ahead of the crack tip but recognize that CTOD depends on the material yield to tensile strength ratio. The formulae in BS 7448-1:1991 and BS 7448-4:1997 tend to overestimate CTOD for materials that exhibit high strain hardening (i.e. a low yield to tensile strength ratio). This means that CTOD values for these materials calculated according to the

new formulae will be lower than when calculated according to the old formulae. However, CTOD values for low strain-hardening materials will remain largely unchanged. The formulae for calculating J -integral are unchanged but have been supplemented to include using crack-mouth opening displacement in addition to load-line displacement.

Furthermore, BS ISO 12135:2021 now incorporates five informative annexes that supplement or are additional to those in either BS 7448-1:1991 or BS 7448-4:1997.

[Annex A](#) describes the determination of δ_i and J_i using scanning electron microscopy.

[Annex C](#) provides detailed examples of what can be included in the test report.

[Annex D](#) contains stress intensity factor and compliance formulae.

[Annex F](#) describes the derivation of pop-in formulae.

[Annex H](#) describes in detail single-specimen methods for determining CTOD and J -integral R -curves using partial unloading compliance and electrical resistance methods.

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Amendments/corrigenda issued since publication

Date	Text affected
30 November 2022	Implementation of ISO corrected text August 2022: Details in ISO foreword