



BSI Standards Publication

Metallic materials — Method of constraint loss correction of CTOD fracture toughness for fracture assessment of steel components

National foreword

This British Standard is the UK implementation of ISO 27306:2016. It supersedes BS ISO 27306:2009 which is withdrawn.

This International Standard describes methods for adjusting for differences in crack-tip constraint: between fracture toughness values, generated from standard, deeply-notched, single-edge notched bend (SENB), and tension (CT) fracture toughness specimens where fracture is by cleavage and other structural geometries loaded in tension. The effect is referred to as a constraint loss, which elevates the fracture toughness value for use in Engineering Critical Assessments (ECAs). However, no recommendations are given on which ECA procedure to use. Currently there is no International Standard that describes ECA methods. However, it is the opinion of the UK Committee that BS 7910 describes ECA methods in a comprehensive manner which includes a procedure for constraint correction, discussed below. Although ISO 27306 defines fracture toughness primarily in terms of Crack-tip opening displacement (CTOD), K and J parameters can be used as well. However, some of the procedures (for example, choice of the Weibull parameter for a Level 2 assessment) would be difficult to implement if CTOD data were not available.

In steels, fracture toughness values are usually subject to significant scatter, especially when fracture is by cleavage (brittle fracture). However, no guidance is given in ISO 27306 on the statistical analysis that should be carried out to choose the fracture toughness value to which the constraint correction is applied. In the opinion of the UK Committee, BS 7910 provides a complete and comprehensive assessment procedure which includes guidance on the choice of fracture toughness value, the assessment procedure and, in Annex N, an alternative constraint correction procedure. This is different from that described in ISO 27306 and, in addition, Annex N can be applied to materials in which crack extension is by ductile crack growth (tearing) as well as brittle fracture. Therefore, there is the potential danger that an ECA based on BS 7910 but using the ISO 27306 correction procedure could give different results to an ECA completely based on BS 7910 and the constraint procedure in Annex N. This could lead to differences in the risk assessment, with respect to failure by fracture, of a structural component. In structurally critical components this could have significant economic and safety consequences.

The title and scope of ISO 27306 suggest that the method can be used to assess constraint loss in structural steel components. However, it is the opinion of the UK Committee that the geometries allowed are four types of cracks in tension-loaded flat panels (or wide plate specimens), which do not directly relate to common engineering structures. The range of crack sizes and geometries permitted is limited. Furthermore, the method can only be applied to structural loading conditions where tension is the primary loading mode; bending stresses, stress concentrations and non-uniform residual stresses cannot be accounted for. This is important as the benefits of constraint loss are mitigated by bending stresses. Therefore the method may have limited application to the assessment of actual structural components. BS 7910, on the other hand provides a general assessment procedure that can be applied to a wide range of crack geometries representative of structural components and loading conditions. ISO 27306 is restricted to assessment of cracks in steel plate, but BS 7910 can be applied to assess cracks in a wide range of product forms, metallic materials (not just steel) and also welded structures.