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Method for Predicting CTOD Fracture Toughness Transition Temperature from Charpy Impact Test Based on Fracture Mechanics Analysis

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Summary: This paper presents a method for predicting the CTOD fracture toughness transition temperature T_i^{CTOD} for structural steels from Charpy impact toughness T_i^{Charpy} . T_i^{CTOD} and T_i^{Charpy} are defined as the temperature at which brittle fracture coincides with ductile cracking in both Charpy and CTOD testing. This method is proposed based on "local plastic strain criterion" for ductile crack initiation and "Weibull stress criterion" for brittle fracture initiation. The validity of this method is investigated for 490 MPa class strength steel; T_i^{CTOD} predicted in accordance with proposed method is almost consistent with that measured in experiment. For industrial applications, an engineering formula is established for predicting the transition temperature difference $\Delta T_i = T_i^{Charpy} - T_i^{CTOD}$ from Charpy impact test for structural steels with yield strength from 300 MPa to 900 MPa. In this formula, ΔT_i is dependent on the material properties that are the ductility level (ϵ_p^{tip}) and Charpy impact toughness level T_i^{Charpy} and flow properties (yield stress σ_Y and 2% Mises stress). The applicability of this formula is verified for 490 MPa, 590 MPa, and 780 MPa strength class structural steels.

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