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Method of Estimation for Tensile Residual Stress Effects on Brittle Fracture Initiation

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Summary: This paper studies the method for estimating the residual stress effect on brittle fracture of structural steel based on the Weibull stress criterion. Using 4-point bend specimens, tensile residual stresses have been introduced by compressive preloading at a room temperature and the subsequent fracture tests have been conducted at -75°C and -100°C . The material used is a high strength steel of 780MPa class. It has been shown that the compressive preloading apparently decreases the critical load and critical CTOD at the onset of brittle fracture initiation. And it has been shown that the critical Weibull stress at brittle fracture initiation is a material property independent of test conditions with and without preloading. On the basis of the Weibull stress fracture criterion, the critical CTODs of the compressive preloaded specimens can be predicted from fracture test results of the specimens without preloading. Discussion is followed on alternative fracture criterion, critical tensile plastic zone size (ω^+) criterion. It is indicated that the critical CTODs predicted by the ω^+ criterion are higher to a large extent than those based on the Weibull stress criterion. This means that the ω^+ criterion is not always appropriate for predicting the critical CTODs under compressive loading conditions.

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