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ONLINE ISSN : 1881-1760

PRINT ISSN : 1880-3717

Journal of the Japan Society of Naval Architects and Ocean Engineers

Vol. 8 (2008) pp.291-300

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Constraint Loss Correction for Assessment of Brittle Fracture Initiation in Residual Stress Field Based on the Weibull Stress Criterion

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(Accepted August 26, 2008)

Summary: This paper studies the method for estimating the welding residual stress effect on brittle fracture of structural steel based on the Weibull stress criterion. Using wide plate (WP) specimens with and without welding residual stress, the brittle fracture tests have been conducted at -75°C . The material used is a high strength steel of 780MPa class. Welding residual stress significantly decreases the fracture force and the critical CTOD of the wide plate with welding residual stress at the onset of brittle fracture initiation. And it has been shown that the critical CTOD of the WP specimens can be predicted from fracture test results of the 3-point bend specimens without residual stress based on the Weibull stress criterion. The present paper proposes the assessment method of constraint loss effects on CTOD of wide plate with residual stress based on the equivalent CTOD ratio, β_r under residual stress field. The equivalent CTOD ratio, β_r is defined as the ratio, δ/δ_{WP}^r , where δ and δ_{WP}^r are CTODs of the standard fracture toughness specimen and wide plate with welding residual stress, respectively, at the same level of the Weibull stress. Fracture assessment results using β_r are shown within the framework of failure assessment diagram (FAD). An excessive conservatism observed in the conventional procedure is reasonably reduced by applying the equivalent CTOD ratio, β_r .

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Yoichi Yamashita and Fumiyoshi Minami: Constraint Loss Correction for Assessment of Brittle Fracture Initiation in Residual Stress Field Based on the Weibull Stress Criterion , Journal of the Japan Society of Naval Architects and Ocean Engineers, (2008), Vol. 8, pp.291-300 .

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