

Assessment of the Fatigue Threshold of Welded Details subjected to Post-Weld Ultrasonic Impact Treatment

by

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Abstract

Post-weld enhancement of the fatigue resistance of common attachment details such as transverse stiffeners, cover plates, gusset plates, bulkheads and other welded details that experience crack growth from a weld toe is essential for efficient use of modern high-performance steels. Ultrasonic Impact Treatment (UIT) was found to enhance the fatigue resistance of common welded attachment details that experience crack growth from a weld toe. Large scale treated welded joints in rolled and built-up ferrite-steel beam specimens having yield strength of 345 MPa to 690 MPa were evaluated with constant amplitude fatigue tests resulting in positive stress ratios up to 0.6, and the mechanisms of improvement were assessed. The geometric effect of UIT was analytically evaluated based on both notch stress and the fatigue crack growth threshold in order to assess the endurance limit and mean load effects. Spatial residual stress distributions due to welding and subsequent treatment were measured and simulated by finite element analysis. Elaborate metallographic and fractographic examinations were conducted to characterize the effects of treatment. Sharp crack-like discontinuities were found to remain at the weld toe that could not be completely eliminated by the treatment. These discontinuities were sensitive to the presence of high mean stress that offset the beneficial compressive residual stresses at the crack growth threshold. Fatigue design curves based on two parameters, minimum stress and stress ratio, has been proposed for the post-weld treated details as a modification to the current AASHTO specification for as-welded details.

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