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Fatigue assessment of welded joints under variable amplitude loading using a novel notch stress approach

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ABSTRACT

Experimental fatigue data for ASW, HFMI and LTT treated joints under VA tensile loading were analyzed using the 3R-method that takes the local stress ratio into account. The main focus of the work was study of how the new approach predicts the fatigue strength of welded joint under VA loading. Equivalent CA notch stress ranges at failure were calculated using a mean master *S-N*-curve and Miner's linear cumulative damage rule. All calculated equivalent stress ranges at failure were above the characteristic master *S-N*-curve, which corresponds to a damage sum of 0.174 at failure, in a case-independent reference notch stress system.

Keywords: Welded joints; fatigue; variable amplitude; effective notch stress; local stress ratio

NOMENCLATURE

ASW	as-welded condition
CA	constant amplitude
CAFL	constant amplitude fatigue limit
ENS	effective notch stress approach
FAT	IIW fatigue class, fatigue strength corresponding to two million cycles
HAZ	heat affected zone
HFMI, HFP	high frequency mechanical impact treatment (generic term)
HSS	high strength steel
IIW	International Institute of Welding
LTT	low transformation temperature filler material
LTT C	Cr-Mn-Fe based LTT consumable
MC	quenched and cold-formable
MSSPD	minimization of the sum of squared perpendicular distances from a line
QC	direct quenched and cold-formable
QL	conventional quenched and tempered
3R	novel notch stress approach: R - R_m - σ_{res}
SWT	Smith-Watson-Topper approach
UP/UIT	ultrasonic peening/ ultrasonic impact treatment
UPT	ultrasonic peening treatment
VA	variable amplitude
C	fatigue capacity
f_u	ultimate strength, nominal
f_y	yield strength
H	cyclic strain hardening coefficient
K_f	fatigue notch factor
K_m	structural stress concentration factor
K_t	elastic stress concentration factor
k	number of stress range levels
l	half distance between clamps
m	slope of the stress-life curve in a log-log graph
N_f	cycles to failure

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