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Fatigue strength assessment of butt-welded joints with undercuts

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ABSTRACT

Undercuts are geometrical discontinuities that affect fatigue strength of welded joints, since they constitute a notch at the weld toe. Detrimental effects of these flaws are governed by stress concentration, which is characterised by notch depth and root radius. Variety of undercut shapes and extensions demands accurate prediction of fatigue lifetime for each particular case, or the most conservative situation. Furthermore, lack of agreement in codes and standards about undercut tolerances evinces the need of a theory-based methodology, which can provide understandings of the involved damaging process. From this standpoint, numerical simulations of transversely stressed butt joints were performed. Relationship between undercut geometry and fatigue strength of weldments was studied by means of a fracture mechanics approach. Recommendations for the acceptance of weld undercuts and comparison with current standard tolerances were discussed.

Keywords: Fatigue limit; Notches; Undercut; Fracture mechanic approach

List of Symbols

a_i	initial crack length
a_{np}	non-propagating crack length
c	half crack length measured at the surface
C, C^*, m and m^*	environmental sensitive material constants
d	location of the strongest microstructural barrier (e.g. grain size)
D	undercut depth
da/dN	crack propagation rate
F, f	geometrical constants
k	material constant that takes into account development of ΔK_C
k_f	fatigue strength reduction factor
k_t	stress concentration factor (SCF)
N	cycles in fatigue life
P	applied load in the four point bending test
p_i, q_i	fitting constants
R	stress ratio (minimum stress/maximum stress)
s, L	half the minor and major span in four point bending scheme

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