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THE THICKNESS EFFECT OF WELDED DETAILS IMPROVED BY HIGH-FREQUENCY MECHANICAL IMPACT TREATMENT

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Abstract

High-frequency mechanical impact (HFMI) treatment can enable resource-efficient structural design by improving the fatigue strength of welded joints. While the thickness effect with reference to the fatigue of welded details is well known and covered in design codes, this effect has not been investigated systematically when the welds are improved by HFMI. In this study, experimental data of 582 small-scale fatigue tests on welded details with HFMI treatment has been collected from the literature and evaluated with respect to the thickness effect. In order to separate the effects of yield strength and thickness on the fatigue strength, a new approach was developed to adjust the data to a reference yield strength of 355 MPa prior to thickness evaluation. The test data covered transverse butt welds, details with non-load-carrying transverse attachments and details with non-load-carrying longitudinal attachments. The thickness effect of details with transverse attachments corresponds well with the IIW recommendation of n = 0.2, whereas transverse butt welds have a much weaker thickness effect. Details with longitudinal attachments show a "reverse" thickness effect.

Keywords: fatigue; size effect; thickness effect; HFMI; steel.

Nomenclature

a	the intercept of the *S-N* curve
f_y	material yield strength
$f_{y,0}$	reference yield strength
$f_{y,i}$	the material yield strength of data i
k	number of data points
K_n	stress concentration factor (effective notch stress)
L	weld toe distance
m	the slope of the *S-N* curve
n	thickness correction exponent
N_f	number of cycles to failure
N_i	fatigue life of data i
N_m	mean fatigue life, 50% survival probability
R	stress ratio
t	main plate thickness
t_{ref}	the thickness of a reference case corresponding to ΔS_{ref}
t_s	Student's T-quantile for 95%
β	regression coefficients
ΔS_c	characteristic fatigue strength at two million cycles, 95% survival probability
ΔS_i	stress range of data i
ΔS_m	mean fatigue strength at two million cycles, 50% survival probability
ΔS_{ref}	fatigue strength of a reference case on which the design *S-N* curve is based
$\Delta S_{\beta,i}$	adjusted stress range with respect to yield strength of data i, after performing the β-method