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Özler Karakaş

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Application of Neuber's Effective Stress Method for the Evaluation of the Fatigue Behaviour of Magnesium Welds

Özler Karakaş[1,*]

[1]Mechanical Engineering Department, Engineering Faculty, Pamukkale University, 20070

Kinikli – Denizli / Turkey

*Corresponding author: Tel.: 0090 258 2963228; Fax: 0090 258 2963262

E-mail address: okarakas@pau.edu.tr

Abstract

In this study, the microstructural length of magnesium welded joints was determined by using experimental data acquired from three different weld geometries and Neuber's stress averaging method. The aim was to determine microstructural length, which is assumed to be a material constant that is identical for all Mg-materials, so that it can be employed for effective stress and fictitious notch radius r_f calculations. By considering the worst case scenario, $r_{real} = 0$, this fictitious notch radius can be used as a new reference radius r_{ref} for magnesium welded joints.

Using the reference radii from two different hypotheses $r_{ref} = 1$ mm and $r_{ref} = 0.05$ mm, calculations were performed for notches and data were employed in the calculations. Also FE-analyses were utilised in order to identify the stress gradients for weld geometries. Effective stresses were calculated using experimental data along with the stress gradients in Neuber's stress averaging method.

Finally, S-N lines were derived by correlating effective stresses with fatigue life for the worst case with R=0.5 to account for possible high tensile residual stresses. The scatters of these S-N lines were calculated and compared for every ρ^* iteration. The length value that resulted in the minimum scatter corresponded to the microstructural length. The identified microstructural length was $\rho^* = 0.12$ mm. Until now, there were no published results for microstructural length of magnesium welded joints and the findings in this paper can be used to replace the current recommendations regarding magnesium welded joints.

Keywords: magnesium welds; fatigue; effective stress; notch stress; reference radius

Nomenclature

FEA	Finite Element Analysis
IIW	International Institute of Welding
r_{ref}	Reference radius
R	Stress ratio
$\sigma(x, y, z)$	Stress field
σ_{nl}	Nominal stress
σ_s	Structural stress
σ_{eff}	Effective stress
$\sigma_{1,max}$	Maximum stress