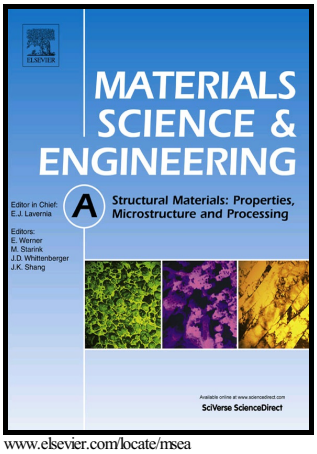
A method for establishing a continuous constitutive model of welded metals

L. Xing, M. Zhan, P.F. Gao, F. Ma



www.elsevier.com/locate/msea

PII: S0921-5093(18)30080-7
DOI: https://doi.org/10.1016/j.msea.2018.01.062
Reference: MSA36016

To appear in: *Materials Science & Engineering A*

Received date: 13 November 2017
Revised date: 15 January 2018
Accepted date: 16 January 2018

Cite this article as: L. Xing, M. Zhan, P.F. Gao and F. Ma, A method for establishing a continuous constitutive model of welded metals, *Materials Science & Engineering A,* https://doi.org/10.1016/j.msea.2018.01.062

A method for establishing a continuous constitutive model of welded metals

L. Xing [a], M. Zhan [a, *], P. F. Gao [a], F. Ma [b]

[a] State Key Laboratory of Solidification Processing, School of Materials Science and Engineering, Northwestern Polytechnical University, Xi'an 710072, China

[b] Long March Machinery Factory, China Aerospace Science and Technology Corporation, Chengdu, 610100, China

[*] Corresponding Author. Tel.: +86-29-88460212-801; Fax: +86-029-88495632; Email: zhanmei@nwpu.edu.cn (M. Zhan)

Abstract

Developing an accurate and continuous constitutive model across the weld bead and heat affected zone (HAZ) is an urgent challenge to address the inhomogeneous property distribution and its effects on plastic deformation of welded metals. In this study, such a universal method was proposed, in which the continuous variation in flow stress across these zones was characterized via the relationship among the flow stress, microhardness and weld shape. Through the method, the continuous constitutive model of welded metals can be expressed as a function of weld shape. Essentially, this continuous constitutive model eliminates the dependence of the accuracy on the partition of HAZ in the discrete constitutive model. Using the method, continuous constitutive models of a 2219 aluminum alloy welded plate (AAWP) and a QSTE340 welded tube (WT) were set up. These constitutive models were applied to the finite element (FE) modelings of longitudinal and transverse tensions of the 2219 AAWP and bending of the QSTE340 WT, respectively. The comparisons from simulation and experiment of both of the tensions show that the continuous constitutive model can accurately describe the deformation responses of the welded metals in simple loading processes. Comparison in prediction results of welded tube bending based on the continuous and discrete constitutive models shows that the continuous one presents higher prediction precision in complicated plastic deformation processes. Finally, the transverse tensile deformation behavior of the 2219 AAWP was obtained using the continuous constitutive model.

Keywords: Weld bead; HAZ; Continuous constitutive model; Microhardness; Application.