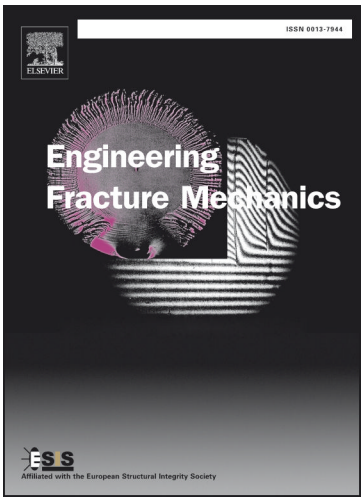

Through-thickness welding residual stress and its effect on stress intensity factors for semi-elliptical surface cracks in a butt-welded steel plate

Bin Qiang, Yadong Li, Changrong Yao, Xin Wang

PII: S0013-7944(17)31024-X
DOI: https://doi.org/10.1016/j.engfracmech.2018.02.016
Reference: EFM 5874

To appear in: *Engineering Fracture Mechanics*

Received Date: 4 October 2017
Revised Date: 25 January 2018
Accepted Date: 12 February 2018

Please cite this article as: Qiang, B., Li, Y., Yao, C., Wang, X., Through-thickness welding residual stress and its effect on stress intensity factors for semi-elliptical surface cracks in a butt-welded steel plate, *Engineering Fracture Mechanics* (2018), doi: https://doi.org/10.1016/j.engfracmech.2018.02.016

Through-thickness welding residual stress and its effect on stress intensity factors for semi-elliptical surface cracks in a butt-welded steel plate

Bin Qiang [a, b], Yadong Li [a], Changrong Yao[a*], Xin Wang [b]

a. Department of Bridge Engineering, Southwest Jiaotong University,

Chengdu, Sichuan, 610031, China

b. Department of Mechanical and Aerospace Engineering, Carleton University,

Ottawa, Ontario K1S 5B6, Canada

[*] Corresponding author: changrong_yao@hotmail.com (Changrong Yao)

Abstract: The through-thickness distribution of welding residual stress (RS) in a 30-mm-thick butt-welded Q345qD steel plate is investigated through experimental measurements and finite-element simulations. The simulated RS fields agree reasonably with the measured results for both surface and internal stresses. In addition, the weight function and finite-element methods are used to investigate the stress intensity factors (SIFs) at the surface and deepest points of semi-elliptical surface cracks subjected to a combination of external tensile load and through-thickness welding RS. Different crack aspect ratios and relative depths are analyzed. The results reveal that the longitudinal RS is always tensile through the plate thickness, making the SIFs of the surface and deepest points larger than those without considering the longitudinal RS. However, the transverse RS through the thickness presents tension–compression–tension, with the tensile transverse RS causing the SIFs to increase. When the crack tip enters the compressive stress region, the compressive stress offsets the external load and causes the SIFs to decrease.

Keywords: Through-thickness distribution; welding residual stress; stress intensity factor; surface crack; Q345qD steel butt-welded plate.