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<AT>A modeling study of welding stress induced by friction stir welding

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Abstract A model is developed to obtain the friction stir welding (FSW) induced stress in structures, which includes the welding process and the cooling process. The characteristics of the welding stress are presented in the analytical results. A detailed numerical simulation is also performed to verify the effectiveness of the proposed model. Numerical results of the welding stress agree well with the welding stress obtained from the analytical model. Then, the effects of process parameters of FSW on the welding stress are studied by using the analytical model. The process parameters involve the depression depth of the welding tool, the rotational speed, and the advancing speed. The calculated results show that the radial stress in the welded structure decreases with the increase of the depression depth. Larger tensile stress appears beneath the tool shoulder with the increase of the rotational speed. Higher advancing speed introduces lower tensile stress in the welded structure.
<KWD>Keywords: Welding stress; Friction stir welding; Depth of depression; Rotational speed; Advancing speed

<td:DefL>Nomenclature

<xps:span class=deft> b </xps:span> <xps:span class=defd> External radius of the thick-walled cylinder</xps:span>

c, c_1, μ_r Integral constant of axial stress, integral constant of radial displacement, and friction coefficient in radial direction, respectively

$\mathrm{d}\theta$ Central angle of the fan-shaped element

E, υ Elastic modulus and Poisson's ratio, respectively

h_p Height of the tool pin

L, W Length and width of the welded specimen

M, P Moment of the spindle and mechanical power of the tool, respectively

P_z, σ_z Axial force and axial stress, respectively

Q_{in} Total heat input

Q_P, Q_S Volume heat of the pin and surface heat of the shoulder, respectively

q_P, q_S Heat flux of the pin and heat flux of the shoulder, respectively