

Empirical Formulae to Predict Hardness, Hydrogen Diffusion Coefficient and Tensile Properties of Steel HAZ

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Abstract: Weld cold cracking is categorized as hydrogen cracking. To assess cold cracking susceptibility of steel HAZ (heat affected zone), it is necessary to estimate local hydrogen content and residual stress at a weld root that are in general numerically calculated by FEM and/or FDM. To conduct numerical calculations, physical and mechanical properties such as diffusion coefficient of hydrogen in steel are necessary. In this work, we have developed empirical formulae to calculate HAZ hardness, hydrogen diffusion coefficient and tensile properties. The present empirical formula of HAZ hardness is expressed using chemical compositions of a welded steel and weld thermal history. The thermal history may be calculated by FEM and/or FDM. The tensile properties such as 0.2% proof strength and strain-stress curve are calculated using the predicted value of HAZ hardness. These predicted properties can be used to calculate residual stress and strain in a weld by FEM. The hydrogen diffusion coefficient is expressed as a function of hardness, temperature and plastic strain. The hardness and the plastic strain are considered to represent the hydrogen trapping sites such as dislocations. The temperature and the plastic strain are expected to be calculated by FEM and/or FDM. Since the effect of the prior austenite grain size is considered in the prediction of HAZ hardness, the present formulae of hardness, hydrogen diffusion coefficient and tensile properties can be applied to each point of the HAZ. These predicted values can be used to calculate the residual stress and hydrogen diffusion in a welded joint, which is necessary to assess cold cracking susceptibility of steel HAZ.