Determination of Stress-Strain Curve of Duplex Stainless Steel Welds

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Abstract : Dual-phase duplex stainless steel comprised of ferrite and austenite has shown high strength and corrosion resistance in many aggressive environments. Joining duplex alloys is challenging due to several embrittling precipitates and metallurgical changes during the welding process. The welding parameters strongly influence the quality of a weld joint. Therefore, it is necessary to quantify the weld bead's integral properties as a function of welding parameters, especially when part of the weld bead is removed through a machining process due to aesthetic reasons or to couple the elements in the in-service structure. The present study uses the existing stress-strain model to predict the stress-strain curves for duplex stainless-steel welds under different welding conditions. Having mathematical expressions that predict the shape of the stress-strain curve is advantageous since it reduces the experimental work in obtaining the tensile test. In analysis and design, such stress-strain modeling simplifies the time of operations by being integrated into calculation tools, such as the finite element program codes. The elastic zone and the plastic zone of the curve can be defined by specific parameters, generating expressions that simulate the curve with great precision. There are empirical equations that describe the stress-strain curves. However, they only refer to the stress-strain curve for the stainless steel, but not when the material is under the welding process. It is a significant contribution to the applications of duplex stainless steel welds. For this study, a 3x3 matrix with a low, medium, and high level for each of the welding parameters were applied, giving a total of 27 weld bead plates. Two tensile specimens were manufactured from each welded plate, resulting in 54 tensile specimens for testing. When evaluating the four models used to predict the stress-strain curve in the welded specimens, only one model (Rasmussen) presented a good correlation in predicting the strain stress curve.