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COMBINED APPROACH FOR INTEGRITY ASSESSMENT OF WELDED JOINTS WITH MULTIPLE DEFECTS

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Abstract

Presence of various types of defects is an unavoidable issue when it comes to welded joints. Typical approach to dealing with this problem includes the effects of individual defects, without considering the combined influence of several different defect types on the integrity of a welded joint. Research which will be presented here includes the initial steps and the development of a method for analysing the effects of multiple types of welded joint defects, using a number of different approaches - with the main focus on experiments and numerical simulations based on the finite element method. This research, inspired by real problems encountered in engineering practice, initially focused on the geometry of welded joints with defects, as an important factor in terms of stress concentration, which could decrease the load-bearing capacity of a weld by a significant margin. As the methodology continued to develop, experimental tests were included, in order to provide input data for the numerical models, and to verify their accuracy. The experimental part of this research was further improved by combining it with stereometric monitoring methods - mainly Digital Image Correlation (DIC). In this way, a more detailed insight into the behaviour of welded joints with defects was obtained, providing an extensive and reliable base of information, which could be used by and compared to the numerical simulations.

In the more recent experimental and numerical analyses, the welded joint itself for considered in more detail, by observing each of its regions - the parent material (PM), the weld metal (WM) and the heat affected zone (HAZ) - in terms of mechanical properties. The goal was to include different values of yield stress, tensile strength and deformation for each individual zone, which would correspond to the experimentally determined values. For the HAZ, it was not possible to experimentally obtain these values, hence an iterative method was developed to determine them using the FEM models, by comparing the results with DIC images.

Metallurgical aspects were also an important factor which was included in these analyses, as knowledge about what kind of microstructures occurred in each region during welding was crucial in determining the expected mechanical properties of the HAZ. Due to specific conditions during welding (in order to obtain relevant defects), it was assumed that the microstructures would deviate from those obtained under regular conditions.

Taking all of the above into consideration resulted in a quick, effective and reliable method of determining the influence of multiple defects on the structural integrity of welded joints. Next step, which are currently underway, include the application of this methodology to a different combination of materials - namely a welded joint between a ferritic steel and an austenitic stainless steel.

Keywords: welding defects; structural integrity; digital image correlation; finite element method; welded joint region