HÖGSKOLAN VÄST

Cold lap formation in Gas Metal Arc Welding of steel

An experimental study of micro-lack of fusion defects

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Abstract

Title: Cold lap formation in Gas Metal Arc Welding of steel — An experimental study of micro-lack of fusion defects
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Cold laps are defined as micro-lack of fusion defects at the weld toe more or less parallel to the surface of the parent plate. These defects are known to negatively influence the fatigue properties of weldments. Previous studies suggest that cold lap formation can not be avoided completely in Gas Metal Arc Welding (GMAW). Therefore, a better understanding of formation mechanisms is imperative to be able to minimize the number and size of these defects.

The main objective of this work has been to provide a more comprehensive understanding of cold laps, including categorising, characterisation and defining the most significant factors for formation. GMAW was used to produce welds that were investigated by metallographic methods using light optical microscopy, scanning electron microscopy and energy dispersive spectrometry.

A novel classification of cold laps was introduced and three types of cold laps were identified: spatter cold laps, overlap cold laps and spatter-overlap cold laps. It was shown that cold laps are partially or fully filled by oxides. The most common oxides are manganese silicon oxides which were concluded to be formed primarily by oxidation of droplets. The presence of oxides was found to significantly increase the tendency to form spatter cold laps as well as overlap cold laps. Particularly for overlap cold laps, it was found that the depth (in transverse direction of weld) is reduced when welding in a non-oxidising environment. Welding on blasted surfaces increased the cold lap formation by entrapment of gas. The droplet and base metal temperatures were also found to be significant factors in cold lap formation. For overlap cold laps the occurrence frequency decreased with increased preheating temperature of the base metal.

Mechanisms of overflowing resulting in overlap cold laps were discussed based on an extensive literature review. Several phenomena are believed to contribute to overflow including Rayleigh instability, the balance of forces, transfer of lateral momentum by droplets and an outward Marangoni fluid flow of the weld pool.

The present studies suggest that cold lap formation can be suppressed by ensuring that the welding process (arc) is as stable as possible and by welding on a preheated work piece in a non-oxidising environment.