Principles for Open-Arc Weld Deposition of High-Chromium White Iron Surface Layers

John Anthony Francis

Department of Mechanical Engineering
The University of Adelaide

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ABSTRACT

This study examines the mechanisms controlling the dilution, geometry and wear performance of weld-deposited high-chromium white iron surface layers. These layers are often deposited on steel components when resistance to abrasion is required. Manual-metal-arc welding (MMA) and flux-cored-arc welding (FCAW) are the processes most frequently employed to deposit such overlays. This work focuses on layers deposited by mechanised FCAW, as this process achieves higher deposition rates than MMA welding and affords a greater degree of control over individual welding variables.

Attention is first given to the factors affecting the dilution and geometry of single-bead deposits. The work presented in previous studies is reviewed and the findings are explained with reference to the welding literature. The findings of previous studies are also compared with results obtained in the current work. Expressions for the single-bead width and height are presented.

The wear performance of high-chromium white iron weld deposits is addressed. Wear testing was conducted both under laboratory conditions and in a series of field trials. The results of both sets of experiments are presented. The observed trends are then discussed and compared with the results of previous studies.

The mechanisms controlling dilution in multi-pass overlays were found to be different to those controlling the dilution of a single-bead deposit. Consequently, two distinct approaches were developed for predicting dilution in multi-pass overlays deposited in the

down-hand position. The first approach is semi-empirical and the second is based on first principles and geometry. The trends in the output data from each model were in close agreement. This agreement and the accuracy of the predictions provided a level of confidence in the output and, as such, the models could be used to draw conclusions and identify trends over a broader range of welding conditions.

This work culminates in what is believed to be the first set of working principles for the deposition of high-chromium white iron multi-pass overlays. Until now, the two most important features of a multi-pass overlay, namely the composition and geometry, had been determined by a trial-and-error process or retrospectively. It is believed that these principles will substantially improve the production and performance of weld overlays.