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A comparison in a back-bead prediction of gas metal arc welding using multiple regression analysis and artificial neural network

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Abstract

This research was done on the basis of prediction that there is a relationship between welding parameters and geometry of the back-bead in arc welding which is a gap. Multiple regression analysis and artificial neural network were used as methods for predicting the geometry of the back-bead. The multiple regression analysis and the artificial neural network were formed, and the analysis data or verification data which were used in the formation process of the multiple regression, and the training data or test data which were used in the formation process of the artificial neural network, were used to perform the prediction of the back-bead. Through this research, it was found that the error rate predicted by the artificial neural network was smaller than that predicted by the multiple regression analysis, in terms of the width and depth of the back-bead. It was also found that between the two predictions, the prediction of the width of the back-bead was superior to the prediction of the depth in both methods. © 2001 Published by Elsevier Science Ltd.

Keywords: Artificial neural network; Multiple regression analysis; The geometry of back-bead

1. Introduction

In gas metal arc welding, the weld quality is greatly affected by the welding parameters. Especially, the welding parameters are closely related to the geometry of

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the back-bead, a relationship which is thought to be very complicated. Repeated experiments are needed in order to determine the optimal welding conditions among welding parameters. Also, the optimal welding conditions are determined by combined factors such as the type of base metal, the welding process, and the geometry of the welded parts. Therefore, an immense amount of data is needed in order to obtain optimal welding conditions. In reality, as this amount of experimentation is impossible, a research method which can predict the geometry of the back-bead is necessary.

Investigation into the relationship between the welding parameters and bead geometry began in the mid-1900s, and regression analysis was applied to welding geometry research in 1987 by Raveendra and Parmar [1]. Chandel [2] suggested the correlation between the welding process parameters and bead geometry in bead-on-plate of gas metal arc welding. He confirmed that the arc current was a major parameter in determining the bead geometry. Yang et al. [3] used the linear, and curvilinear models to calculate the bead height from the welding process parameters in the regression equation. Also, Il-Soo Kim et al. [4] empirically confirmed Yang's linear, curvilinear methodology. However, there has not been any research in real welding where a gap in butt welding has been considered.

Therefore, the objective of this study is to obtain the desired weld bead in real welding by predicting the geometry of the back-bead using welding parameters in gas metal arc welding. The regression analysis and the artificial neural network were used in the research. First, a system configuration was done which would predict the bead geometry, and the two prediction methods were compared and analyzed.

2. Experiment

2.1. System configuration

The system configuration consists of the 3-axis table system, welding machine and measuring system. The CO_2 arc welding machine was used as a welding power source, and CO_2 was used as a shielding gas. A laser vision sensor was used to measure the geometry of the back-bead. The flow rate of the shielding gas was 15 l/min, and the contact tip to workpiece distance (CTWD) was determined at 15 mm. The feed wire which was used had a diameter of 1.2 mm. The system configuration of the experiment is shown in Fig. 1.

2.2. Image processing to obtain experimental data

It is necessary to measure data quickly and accurately in order to produce the quantitative width and depth of the back-bead. The laser stripe, which is the shape of the welding bead, is obtained through the laser vision sensor. This stripe is composed of 256 points. In order to measure the width and depth of the back-bead, these points were expressed in lines or curves. Generally, a parametric form is often used as a plain curve. The image processing method was performed as follows. The segment splitting method was used to calculate the straight line which is most approximated to the laser