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50. Internationales Wissenschaftliches Kolloquium
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Chia-Lung Chang and Yen-Hung Chen

Application of Reverse Engineering Technique in Butt Weld Profile Measurement

Abstract

The weld of a butt weld should have a certain desired profile for maximum strength. The weld must be made to the specifications for which it is fabricated. Unacceptable profile is a weld defect which produces stress concentration that reduces the weld strength. In this study, the reverse engineering technique, which a laser scanning system integrated with CAD software, was used to provide a more accurate measurement of a butt weld. The sectional profiles of the external weld geometry along the weld length were generated from the measured points by CAD software. The weld specimens were made of low-carbon steel plates with groove joint using CO_2 welding. The weld geometry and weld deposit volume were accurately determined from CAD model.

Introduction

The weld profile of butt weld affects not only the quality, but also the safety of the structure. The weld must be made to the drawings and specifications for which it is designed and constructed. The external weld geometry plays an important role in the acceptability of a butt weld, since the weld geometry is directly related to the load resistance. The weld profile has to be inspected to confirm the specifications of the welding code. Visual examination is the most widely used and the least expensive inspection method. The weld profile varies with the welding process parameters in the weld operations. In this study, the reverse engineering technique is used to measure the weld profile of a butt groove weld. A laser scanner is used as the measuring device to measure the weld specimen, then the weld surface is re-constructed by the CAD software from the measured points. The weld profile can be efficiently and accurately inspected from the generated CAD model of the weld.

Weld profile measurement

The measurement system comprised a laser scanner, machine center, and personal computer, as shown in Fig.1. The laser scanner was mounted on the spindle of a machine center, and the weld specimen was fixed by a fixture placed on the work table of the machine center. The movement of the machine center was controlled by instruction codes from the computer through RS232 card, and the position of the work table was acquired by encoder signals through multi-function control card connected to computer. The laser scanner was consisted of two CCD cameras and laser light sources. The CCD transformed the scanning data of the weld specimen into image signals transferred to the image card. Following the digitization procedures, the CAD surface of a weld was constructed by surface fitting of the measured 3D points of weld surface. In order to save the computation time of large data, the B-Spline fitting integrated with sub-surface connecting technique was used to construct the weld surface. The CAD surface was generated with 4×4 control points, and a sub-surface or patch that was the middle portion of the generated surface was chosen as a basis element to form the CAD surface. The surface was generated sequentially passing through the measured points, and the whole CAD surface was constructed by connecting sub-surface by sub-surface.

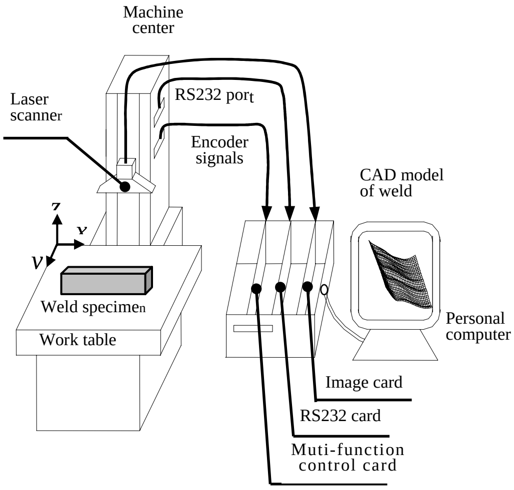

Fig.1. Schematic illustration and set-up of measurement system.

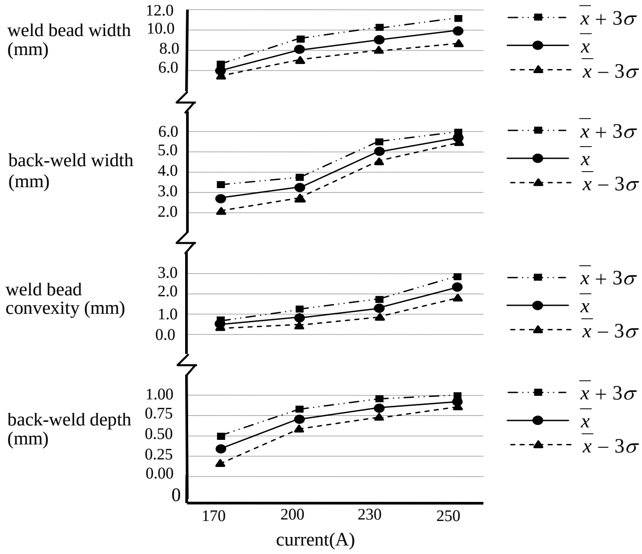

Fig.2. The effect of welding current on the butt weld geometry.

The size of the specimen used in the experiment was 65mm (width)× 120mm (length)×6mm (thickness), and butt welding was performed with two parts of low carbon steel. The CO_2 arc welding machine was used with 100 percent CO_2 as the shielding gas and gas flowrate 15 L/min. The effect of welding current with the welding voltage 24V and the welding speeding 280mm/min on the weld geometry and weld volume is shown in Fig.2. Fig.2 shows that the weld bead width, back-weld width, weld bead convexity, and back-weld depth are increased as the welding current increased, and the standard deviations of the measured weld width and convexity are also increased as the welding current increased. Fig.2 also shows both the weld bead volume and back weld volume are increased as the welding current increased.

Conclusions

The weld profile of a butt groove weld has considerable effect on its performance to the load resistance. The weld profile must be made to conform the specifications of the welding code. Failure to conform the specifications constitutes a weld defect. In this study, a reverse engineering technique, which a laser scanning system is in conjunction with CAD software, is used to measure the weld geometry and evaluate the weld profile acceptability. It can be concluded that the proposed method is a feasible inspection method, which provides an efficient, non-destructive, full-field, and accurate way to evaluate the geometry quality of a butt weld.

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