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RESEARCH ARTICLE

DESIGN OF WELDED CRACK DETECTION ROBOTIN CAR MANUFACTURING PRODUCTION INDUSTRY

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ABSTRACT

Now day car manufacturing industries are ruined by a robot. Robots are participating different types of tasks, such a tasks welding is one of the major operation, most of the industries are spending more time for inspecting the welding state. For this purpose, we propos welded crack detecting robot. This robot is holding. The magnetic flux system (MFS), MFS has been developed for the detection of the welding cracks on the plate. The MFS signal response from the welding sample which the Cracks varies and not the proper joining sample surface. A data acquisition program was developed to continuously display the Cracks variation of the tested sample. The signal analysis technique such as the power spectrum density of the fourier transform is applied to obtain an optimum parameter to describe the wall thinning of the plate. This technique can be used as a potential tool to detect the local wall thinning of a plate.

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INTRODUCTION

In recent years, the consolidation of automotive suppliers and facilities has resulted in welding operations made up of multiple styles and brands of welding equipment, including power sources, robotic controllers, robotic manipulators. The outcome is often a wide breadth of products to manage and, with fewer resources, an increased potential for costly errors and unscheduled downtime. Also manufacturing industries are facing one more problem, that is uneven welding, such as welding joints are some air gaps, over filling metal and low filling metals. For this problem we are invented magnetic flux system (MFS), this method for detecting welding problem. MFS has reduced the time and cost. To ensure this a continuous periodic monitoring of the structures is required without causing damage to their properties and performance. Laser welding has a high processor speed compared to conventional spot welding and arc welding, and it has a design freedom with unidirectional machining, so that it can be flexibly approached to the manufacture of body parts. In order to apply laser welding to actual industrial sites, it is essential to improve welding quality and productivity, and research has been conducted to measure and analyze physical phenomena occurring at this time. In order to improve the quality of laser welding, there are two methods to monitor the process.

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One is real time monitoring of various phenomena occurring during welding. The other is to measure parameters using sensors, It is a method to detect by the appearance and nondestructive inspection such as the shape of the site, pore, crack, etc. However, laser welding is a process in which the bead width of the welded part is relatively narrow and the non-visible light wavelength band is accompanied by rapid heat release and reflection for a short time. This is not easy. In addition, most of the laser-welding monitoring systems in some markets rely on overseas high end equipment detection of defects requires parameter setting based on expert knowledge (1). Therefore, in this study, we use the defect detection technique based on parameters using the reproducible preceding good data by minimizing the parameter setting required for defect detection. In addition, vision type hardware system for monitoring was developed and related software was developed and aimed at industrial application on the basis of laser welding monitoring technology. In contrast to the conventional, the pulse MFS employs repetitive pulses having a short duration in time (having broadband), which yields a signal having frequency contents from dc to several kHz or higher (Junand and Hwang, 2007). Because the eddy current diffusiondepth depends on the excitation frequency the Magnetic Field Technique (MFT) has the potential for bringing up deeper information about the tested sample. In MFT, a response, pulse always comes after an excitation pulse is over, so this method is less susceptible to interference (Ichinose *et al.*, 2006), moreover the pulse excitation can minimize the power consumption, which is more capable in the development of portable instruments. Because of the potential advantages of the PEC, prevalent investigations on this technique have beenmade, such as for detection of wall thinning and corrosion in aircraft multi-layer structures. In this study, a PEC system was developed for the evaluation of wall thinning in a welding plate of NPPs. For this purpose a PEC probe having a driving coil with a Mgnetic-sensor, pulse amplifier and a real time data acquisition program were developed for the continuous monitoring of Cracks variation in the tested sample, and is observed on the computer screen. Various signal analysis techniques are applied to obtain optimum parameters

Welding Methods

Experimental Material

As the experimental material, the surface of cold rolled steel sheet for automobile was galvanized steel sheet SGAFC 780DP 1.4t. The chemical composition ratio of base metal is shown in Table 1.

Table 1. sgafc 780dp chemical composition of specimen(wt.%)

	C	Mn	Si	N	Fe
(wt.%)	0.20	1.5	1.5	0.01	Bal

Experimental apparatus

The laser welding system used in this study, and the system for laser welding consists of optical head, laser oscillator, industrial 6-axis robot and optical cable. The magnetic flux detector is attached to the rolling robot this robot is moving on the plate and scanning the welding crack, and at time output is shown on the screen. Roller robot is shown in Figure. 1, the crack detecting robot mainly consider of hall sensor, microcontroller, magnet and wireless communication system.

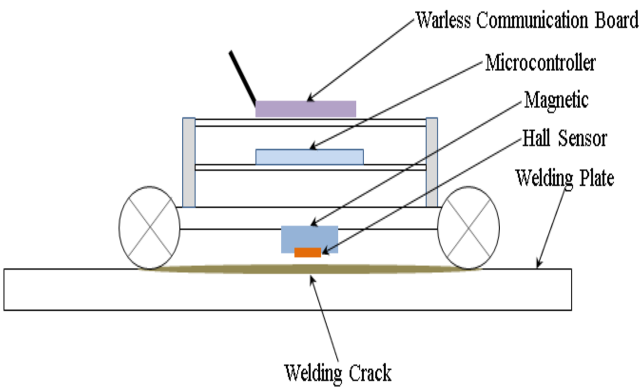

Fig. 1. Magnetic flux Detector with Robot

Experimental Method

The baseline of the laser beam is located about 500 mm away from the protective glass of the scanner. It is the same focal length as the diameter of the beam transmitted from the fiber optic cable. The welding method was SGAFC 780DP 1.4t overlapped welding and the laser power were set in the range of 1.0 ~ 6.0 kW to induce incomplete penetration from full penetration. The lap welding specimen of the galvanized steel sheet is shown in Fig. As shown in Figure. 2, the experiment was carried out with a zero gap and a forced gap of 0.2 mm (4).

Fig. 2. Laser welding preparation

Types of Welding Defects

The defect types of laser welding can be roughly divided into three types. Fig. As shown in Figure. 3, the undercut is a phenomenon in which the upper plate is melted and welded to the lower plate during laser welding, but the molten pool sinks downward due to an excessive gap to the lower plate. Solution refers to the phenomenon when the laser output is excessively high or the upper and lower plates are not melted due to the gap. When a dragon leak occurs, it can be seen that there is no melting in the form of a hole or a laser welding shape, and a phenomenon that the upper plate and the lower plate are separated may occur (Tian and Sopian, 2004).

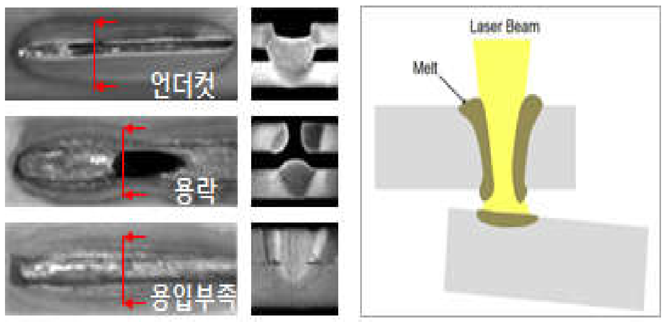

Fig. 3. Welding fault type

The laser beam is shown in Figure. 4, it causes multiple reflections and forms a keyhole and melts to proceed in the direction in which welding should proceed. When the laser output, that is, the amount of heat input is low, the laser beam cannot reach the bottom plate, Or incomplete penetration. In order to avoid such a bad case, it is necessary to raise the output or lower the irradiation speed of the laser beam to induce full penetration (4).

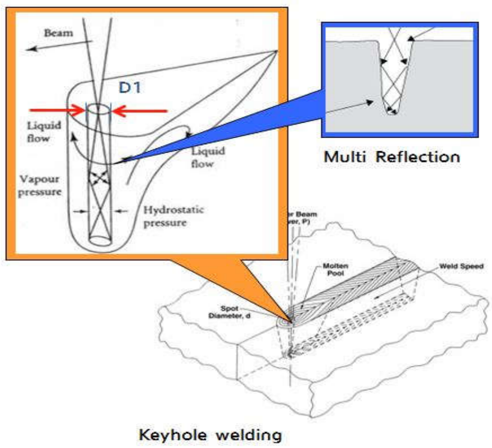

Fig. 4. Laser welding principle

Reheating methods of welding defects type

In case of laser welding failure, MIG welding is used for rework in the general automotive industry. However, in this study, the laser pattern, shape and redundant laser welding method were used to control the rework for welding failure. First, the welding failure type using the two-times welding with the laser pattern, shape is an undercut or a crater defect. The rework method is the laser pattern that is subjected to rework in comparison with the width of the laser pattern to be welded is 1.5 times larger than the laser pattern. This can dissolve the surrounding base material by the volume of defects generated in the present welding, and can be absorbed by the holes and undercuts of the welded portion to mitigate defective portions. In addition, the weld failure pattern in which incomplete penetration occurs leads to complete penetration by again investigating the same pattern.

Magnetic Flux System

System Design

The PEC system consists of a pulse amplifier, the probe having a driving coil with a magnetic field detecting sensor (Hall-sensor), a sensitive differential amplifier with variable gain to amplify the output voltage from the Hall-sensor, A/D converter, X-Y scanner and a computer with signal processing software. The rectangular signal from the waveform generator is fed to a pulse amplifier which excites the excitation coil in the probe. The exciting signal frequency and duty cycle can be adjusted by the waveform generator depending on the necessity (Tian and Sopian, 2004).

Fabrication of Magnetic Probe

Magnetic shape ferrite core as shown in Figure.6. The magnet has a 5 mm height and 10 mm diameter. The cylindrical type ferrite core not only reduces the magnetic leakage, but also improves the detection sensitivity by sustaining adequate excitation intensity. There are several types of magnetic sensors are available for sensing the magnetic field strength, comparable to cost and accuracy the Hall sensor is good, anisotropic magneto resistance (AMR) and giant magneto resistive (GMR) devices. These sensors perform better than pickup coils for sub-surface.

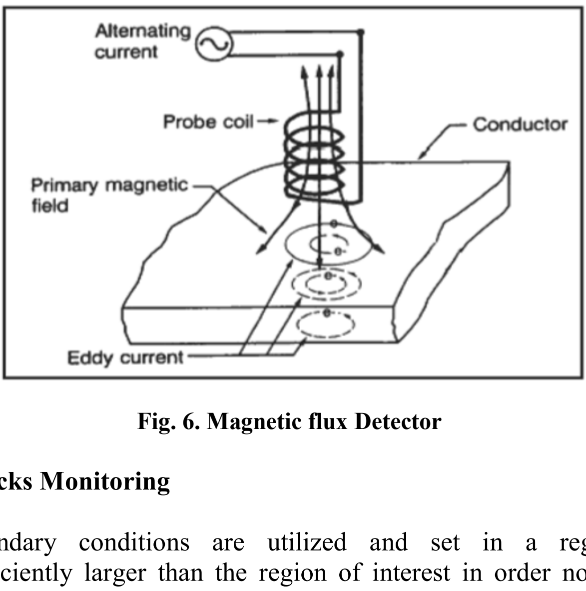

Fig. 6. Magnetic flux Detector

Cracks Monitoring

Boundary conditions are utilized and set in a region sufficiently larger than the region of interest in order not to affect the result. A smaller mesh size of 0.02 mm is used at the inside and outside regions of the crack in order to achieve accurate results. The crack is made at the 0 mm mark and positioned perpendicular to the applied magnetizatic field. All the cracks used in this investigation have a constant width and length of 0.2 mm and 10 mm respectively. The depth of the surface cracks refers to the distance from the top surface of the sample to the bottom tip of the crack, while the depth of the far-surface cracks refers to the distance from the bottom surface of the sample to the top tip of the crack to an opening at the bottom. The far-surface cracks are located. This setup is used to predict the axial (Bx) component of the leakage field for both the surface and far-surface cracks. The transient responses are obtained when the field probe is directly above a crack with a sensor lift-off of 0.5 mm.

Hall Sensors

Hall Effect Sensors are devices which are activated by an external magnetic field. We know that a magnetic field has two important characteristic flux density, and polarity (North and South Poles). The output signal from a Hall effect sensor is the function of magnetic field density around the device. When the magnetic flux density around the sensor exceeds a certain pre-set threshold, the sensor detects it and generates an output voltage called the Hall Voltage, VH. Consider the Equation below.

$$V_H = R_H\left[\frac{I}{t} \times B\right](1)$$

Where,

V_H : Hall Voltage in volts
R_H : Hall Effect co-efficient
I : current flow through the sensor in amps
t :Cracks of the sensor in mm
B: Magnetic Flux density in Teslas

Experimental for Data Aquatation

The basic con of the sensor is shown in Figure.7. The sensing element consists of the soft magnetic amorphous ferromagnetic core and pick-up coil. Amorphous wire was annealed at 460 ◦C for 90 min. The presented hall sensor is orthogonal type. The magnet wire is excited by wire was magnetically saturated in the circumferential direction. The magnets produced by sine wave should be large enough to saturate the core. The second harmonic of induced voltage in the pickup coil was measured using a lock in amplifier. The sensor was placed in a shielded solenoid and external magnetic.

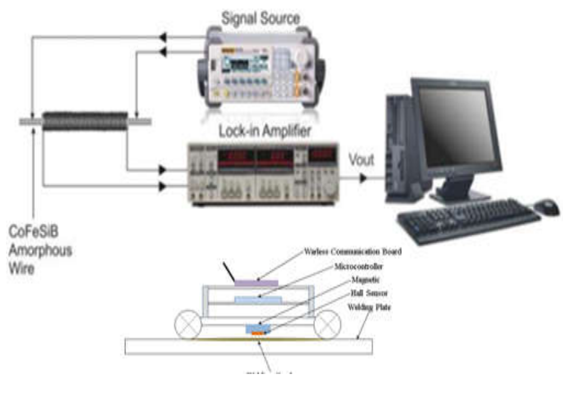

Fig. 7. Data Aquatation System

Tested Sample and Cracks Monitoring

A calibration sample is utilized to convert the PEC signal to the wall Cracks. The calibration tubes have five segments with Cracks of 100%, 80%, 60%, 40% and 20% as a ratio of original Cracks. The plastic plate of 6 mm is mounted on the flat side of the sample to simulate the welding on the plate. The PEC probe is placed on the plastic insulator during the measurement. The tested sample as shown in the Figure. 8. The probe is fixed to the robot to perform the scanning on the flat side of the tested sample including the plastic insulation. A data acquisition program was developed to continuously monitor the variation in the Cracks of the sample and is observed on the computer screen in a specified Cracks monitoring window during the scanning. After the completion of each scan, the data from the program can be stored in the computer, one can reproduce the graph which is displayed in the Cracks monitoring window, by plotting the stored data (Robers and Scottini, 2002).

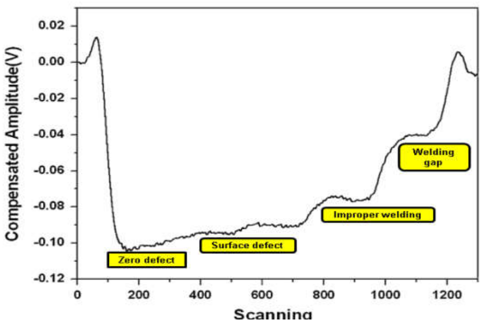

Fig. 8. Scanning result of welding the air signal and shows the variations in Cracks

Experimental Result

Fig. 9. Welding cracks detection Robot

In figure.9 the roller robot crack scanner is used to scan on the welding plate, result of graph is shown in fugure.10.A narrow pulse of 1A current having the pulse width of 20 s excites the PEC probe. The received signal shape is of interest for the purpose of interpretation, a fast rise to a peak followed by a slower decay. Figure. 10(a) shows the detected pulse responses from 1 mm to 5 mm Cracks change in stainless steel and Figure. 10(b) shows the variation of pulse amplitude with sample Cracks, which is obtained from Figure. 4(a). The amplitude is exponentially decreased with increasing sample Cracks, i.e., the thick part of the sample shows a lower peak height. When the probe is placed on the sample the detecting Hall-sensor measures the difference of the excitation coil filed and field due to induced eddy currents in the sample, as the Cracks of the sample increases since a large cross-sectional area leads to higher induced magnetic field results to decrease in the detected filed and hence the pulse amplitude. The slope of the detected pulse up to arrival of maximum value of peak is steeper at the thinnest part of the sample; this rising time to the peak value of the receiving pulse is delayed as the sample Cracks increases. The step function voltage applied to the coil induces transient eddy current in the sample which is the current that flow in the opposite direction to the current in the excitation coil. Since we are measuring the difference of two fields which are one is due to the excitation coil and another is due to induced field in the sample, the final signal is dependent on the effect of both conductivities and eddy currents. In the thickest part of the sample, initially applied magnetic field does not penetrate far into the sample due to the characteristics of the step-function voltage As time goes on, the magnetic field penetrates more deeply into the sample and the eddy current increases to a maximum value. At later times, the eddy current decays to zero due to the electrical resistance of the material under test. The measured signal is the change in the magnetic field due to the eddy current in the metal. Part of the sample; this rising time to the peak value of the receiving pulse is delayed as the sample Cracks increases. The step function voltage applied to the coil induces transient eddy current in the sample which is the current that flow in the opposite direction to the current in the excitation coil. Since we are measuring the difference of two fields which are one is due to the excitation coil and another is due to induced field in the sample, the final signal is dependent on the effect of both conductivities and eddy currents. As time goes on, the magnetic field penetrates more deeply into the sample and the eddy current increases to a maximum value. At later times, the eddy current decays to zero due to the electrical resistance of the material under test. The measured signal is the change in the magnetic field due to the eddy current in the metal. Pulsed eddy current techniques require a particular signal processing which differs from usual amplitude and phase analysis. In order to obtain reliable parameter for PEC signal, the pulse energy and power spectrum density were measured (7)(8).

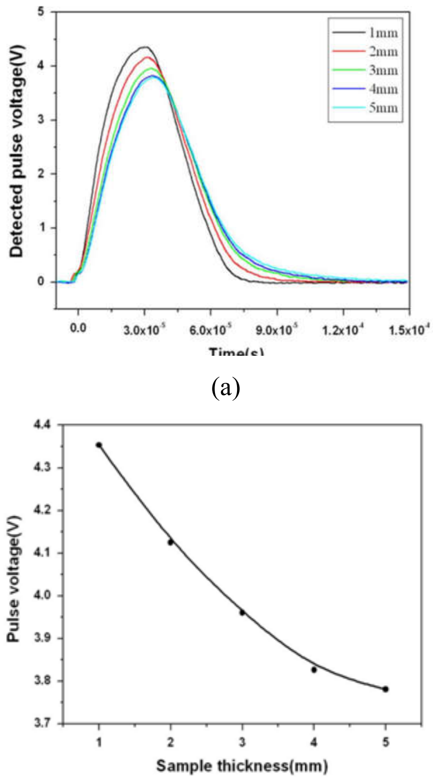

Fig. 10. (a) Magnetic flux responses at the cracks of the tested sample (b) Magnetic flux versus the sample cracks

Conclusion

A PEC system has been developed for the detection of the welding defects on a plate. The Hall-sensor probe can detect the Cracks variation. The RMS value, energy of the pulse and PSD of the pulse can be derived, and these parameters will describe the Cracks variation. The results show the PEC has the potential to detect the welding defects of the plate. A MF system has been developed for the detection of the welding defecate on welding cracks on a plate. The Detecting sensor probe can detect the Cracks variation and these parameters are well described the cracks and Cracks variation. The results show the MF has the potential to detect the welding defects of plate.

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