UNIVERSITI PUTRA MALAYSIA

EFFECT OF VIBRATION FREQUENCIES ON THE WELDING PROPERTIES OF RECTANGULAR MILD STEEL PLATE

ALAA RAAD HUSSEIN

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By

ALAA RAAD HUSSEIN

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

November 2010

DEDICATION

This work is dedicated to:

My mother,

Your encouragement and comforting words are a tonic for my soul.

My father,

Your dynamic and generous spirit continues to enrich my life.

My brother & sisters,

Your friendship is a treasure beyond compare.

My fiancée Zuhor,

Your love is inspired me during this long journey.

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

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Chairman : Nawal Aswan Abd Jalil, PhD

Faculty : Engineering

The welding process induces potential deflection, which significantly affects the ultimate strength behaviour of the welded structure. The deflection can result in many problems that can have an adverse effect on the accuracy of the assemblage part, external appearance or strength characteristics of the welded metal. The main aim of this study is to identify a relationship between the induced vibration and welding temperature including the properties of welding in order to obtain the deflection that occurs on the plate's surface. In addition, the effect of frequency during welding on the mechanical properties of the welding fusion metal was also investigated. Four different values of frequencies were investigated (3, 5, 10 and 100) Hz and applied on a rectangular plate with dimension (400 x 200 x 6) mm. The strain was measured at the area close to the middle surface and on the transverse direction (at the edge, 20, 40, 60 and 90) mm from the edge. The theoretical results showed that the maximum value of the deflection occurs at the middle surface and it decreases on the transverse direction downward to the edge. Further more the effect

of varying temperature and frequency on the measured strain provides the same behaviour of deflection at the middle surface and it decreases on the transverse direction downward to the edge, which started at 3.9 micro strain at the edge when both of welding and 100 Hz are applied and kept increasing to reach the maximum value at the middle 7.8 micro strain when the 100Hz are applied. The applied vibration during welding resulted in an improvement of about 50% for tensile strength and maximum load of 29076.68 N for the ductility of the filler metal due to the fine distribution of the filler metal by the effect of vibration. The increase in the frequency value during welding process led to reduce the micro crack that generated inside the fusion filler metal which generated because of high welding temperature.

In conclusion, the applied frequency and thermal load at the centre of the plate surface generate plate deflection and resulted in less value of deflection on the transverse direction than the centre. In addition, these forces led to increase in the strain value at the centre of the plate. The applied vibration during welding results in a fine distribution of the filler metal and increased the ductility and the tensile strength of the filler metal. This increasing in the mechanical properties provides a good indicator of the positive effect of induced vibration on welds.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

PENGARUH GETARAN FREKUENSI TENTANG PENGELASAN PROPERTI Dari PERSEGI MILD STEEL PLAT

Oleh

ALAA RAAD HUSSEIN

November 2010

Pengerusi : Nawal Aswan Abd Jalil, PhD

Fakulti : Kejuruteraan

Proses pengimpalan berpotensi mendorong defleksi yang mana memberi kesan secara signifikan kepada perilaku kekuatan struktur logam yang telah diimpal. Defleksi ini boleh menyebabkan banyak masalah yang mempunyai kesan negatif pada ketepatan bahagian himpunan, penampilan luaran atau kekuatan sifat logam yang diimpalkan. Tujuan utama kajian ini adalah untuk mengenalpasti hubungan antara getaran induksi dan suhu pengimpalan termasuk ciri-ciri pengimpalan yang menyebabkan defleksi terjadi pada permukaan logam. Selain itu, kesan frekuensi semasa proses pengimpalan terhadap sifat mekanik dari pengimpalan logam yang dicantum juga diselidik. Empat nilai frekuensi yang berbeza yang diselidik iaitu (3, 5, 10 dan 100) Hz. Untuk kesemua empat frekuensi itu, defleksi plat logam dikira secara teori di tengah permukaan dan pada arah melintang. Regangan diukur pada kawsasan berhampiran dengan permukaan tengah dan pada arah melintang (di tepi, 20, 40, 60 dan 90) mm dari sisi. Keputusan secara teori menunjukkan bahawa nilai maksimum defleksi berlaku pada permukaan tengah dan berkurangan pada arah melintang ke bawah menuju ke tepi. Dikenalpasti bahawa suhu yang berbagai

mempunyai kesan lebih mendalam kepada defleksi plat berbanding daripada frekuensi yang berbagai, selain itu pengaruh variasi suhu dan frekuensi pada regangan yang diukur memberikan defleksi yang sama perilaku pada tengah permukaan dan menurun pada arah melintang ke bawah menuju ke tepi. Getaran yang digunakan semasa pengimpalan menghasilkan peningkatan sekitar 50% untuk kelenturan dan kekuatan ketegangan oleh filet logam. Peningkatan nilai frekuensi semasa proses pengimpalan membantu untuk mengurangkan retakkan mikro yang terhasil di dalam cantuman filet logam disebabkan oleh ketinggian suhu pengimpalan. Penyelesaian bentuk matematik disimpulkan untuk getaran induksi dan beban termal telah diterbitkan untuk menunjukkan secara teori perilaku defleksi pada tengah dan pada arah melintang.

Kesimpulannya, penggunaan frekuensi dan beban termal di tengah permukaan plat meningkatkan defleksi plat dan mengakibatkan nilai kecil defleksi pada arah melintang, juga daya-daya ini membantu meningkatkan nilai regangan di tengah permukaan. Getaran diterapkan semasa pengimpalan menghasilkan pembahagian yang halus kepada filet logam dan meningkatkan kelenturan dan kekuatan ketegangan filet logam. Hal ini meningkatkan sifat mekanik dalam memberikan penunjuk yang baik dari kesan positif oleh getaran yand diinduksi dari pengimpalan.

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Last but not least, I would like to express my gratitude to my beloved parents, with their guidance, supports, love and encouragement.

I certify that a Thesis Examination Committee has met on 24 of Nov. 2010 to conduct the final examination of Alaa Raad Hussein on his thesis entitled "The effect of vibration frequencies on the welding properties of rectangular mild steel plate" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the University Putra Malaysia [P.U.(A)] 15 March 1998. The Committee recommends that the Student be awarded the relevant Master of Science.

Members of the Thesis Examination Committee were as follows:

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

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DECLARATION

I declare that the thesis is my original work except for quotations and citation which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or other institutions.

ALAA RAAD HUSSEIN

Date: 24 November 2010

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