UNIVERSITI TEKNOLOGI MARA

INVESTIGATE ON WELDING DISTORTION, RESIDUAL STRESS AND METALLURGICAL BEHAVIOR USING FEM AND EXPERIMENTAL STUDY

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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ABSTRACT

This study sets out to investigate the distortion, residual stress and metallurgical behavior of low carbon steel due to single-pass and multipass GMAW process using finite element method (FEM). There are various cases studies were conducted started with the basic welding structure of butt joint which is divided into four (4) major case studies, which are (1) distortion analysis compared with analytical calculation FEM and experimental study on butt joint, (2) metallurgical behavior analysis on butt joint, (3) residual stress estimation analysis of butt joint using analytical method.A welding simulation was created using FE commercial software package SYSWELD 2010 and Weld Planner 2010 with the capabilities to geometry welding processes. However, in the simulation study, the FEA commercial software was employed to predict welding distortion, residual stress and metallurgical behavior in butt joint weld of low carbon steel with thicknesses of 4 mm, 6 mm and 9 mm. It was found out that, the 2D multipass analysis could be employed to obtain the fast average result of angular distortion while 3D multipass analysis to produce more accurate and complete results. For verification purpose, a series of experiments were performed to measure the weld. Therefore, the experimental works were conducted by using GMAW fully automated robotic welding process. By comparing the results, It can be summarized that the 3D analysis, simulation shows reasonable agreement and good correlation with experiments, except in 2D analysis on geometry. This result of the study indicates that the simulation study is a reliable tool in predicting the welding induced on the particular geometry and welding joint in this study. The effects of the clamping and welding sequence on distortion were also investigated in this study, and it was found out that the clamping condition and the welding sequences play a considerable factor in distortion, residual stress and metallurgical behavior.

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CHAPTER ONE
INTRODUCTION

1.1 BACKGROUND OF STUDY

Welding is the fundamental process in manufacturing, fabrication structures. It is also a common fact that distortion and residual stress are an inevitable occurrence in any type of welding process. Hence, it is important to predict the distortion and residual stress during the design stage. In this study, distortion, residual stress and metallurgical effects will be analyzed and predicted due to welding process using simulation, experimental investigation and analytical method. This chapter sequentially explains the background, problem statement, objectives, scope of work and significance of this study.

Welding is a joining process that produces coalescence of materials by heating them to the welding temperature with or without the application of pressure or by the application of pressure alone, and with or without filler metal usage. This process is an extremely important technology because many modern industries would never have developed without this technology. Welding can be considered as an economical and efficient way to permanently join metals which can act as a single piece so called monolithic structure. One of the common techniques applied for welding process is multipass welding which is normally employed for surfacing, build up, hard facing and cladding weldment. Multipass welding is a reliable and efficient joining process for a thick metal sections which is widely used in most engineering fields, shipbuilding, power plant and oil industries. This technique is also applied for repair welding such as turbine tip, railway rail and hardfacing of oilfield drill collars [1] [2] [3]

Distortion and residual stress are known as a major concern for welded structure.Theoretically,distortion is defined as the outcome of deviation or twist out of the original shape permanently and temporarily while residual stress is the remaining stress in a body if all external loads and restraints are removed.

Unlike distortion, residual stress will not show immediate effect but can cause catastrophic failures during the service of the welded part so that it can be reduced the