PARAMETER-PROPERTIES RELATIONSHIP OF THIN PLATE WELDING BY COLDARC TECHNOLOGY

MUHAMMED SYAMEEL BIN AYOB
B051310331

UNIVERSITI TEKNIKAL MALAYSIA MELAKA
2017

PARAMETER-PROPERTIES RELATIONSHIP OF THIN PLATE WELDING BY COLDARC TECHNOLOGY

This report is submitted in accordance with requirement of the University Teknikal Malaysia Melaka (UTeM) for Bachelor Degree of Manufacturing Engineering (Manufacturing Process) (Hons.)

by

MUHAMMED SYAMEEL BIN AYOB

B051310331

941217-03-6413

FACULTY OF MANUFACTURING ENGINEERING

2017

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

Tajuk: **PARAMETER-PROPERTIES RELATIONSHIP OF THIN PLATE WELDING BY COLDARC TECHNOLOGY**

Sesi Pengajian: **2016/2017 Semester 2**

Saya **MUHAMMED SYAMEEL BIN AYOB (941217-03-6413)**

mengaku membenarkan Laporan Projek Sarjana Muda (PSM) ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Laporan PSM adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan laporan PSM ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. *Sila tandakan (√)

☐ SULIT (Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysiasebagaimana yang termaktub dalam AKTA RAHSIA RASMI 1972)

☐ TERHAD (Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/ badan di mana penyelidikan dijalankan)

☐ TIDAK TERHAD

Disahkan oleh:

MUHAMMED SYAMEEL BIN AYOB
Alamat Tetap:
PT 678 KG. KEDONDONG, JLN KOTA TERAS, KOTA JEMBAL 16150 KOTA BHARU KELANTAN.
Tarikh: _____

Cop Rasmi:

Tarikh: _____

*Jika Laporan PSM ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh laporan PSM ini perlu dikelaskan sebagai SULIT atau TERHAD.

DECLARATION

I hereby, declared this report entitled “Parameter-properties relationship of thin plate welding by coldarc technology” is the result of my own research except as cited in references.

Signature : ……

Author’s Name : MUHAMMED SYAMEEL BIN AYOB

Date : 14 June 2017

APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of Universiti Teknikal Malaysia Melaka as a partial fulfilment of the requirement for Degree of Manufacturing Engineering (Manufacturing Process) (Hons). The member of the supervisory committee are as follow:

…….....

(Profesor Madya Dr Nur Izan Syahriah Binti Hussein)

ABSTRAK

Tujuan kajian ini adalah untuk mengetahui sifat parameter kimpalan plat yang nipis dengan ketebalan yang berbeza oleh “ColdArc” teknologi. Kimpalan ini telah dijalankan oleh mesin robot automatik Kimpalan Arka Logam gas (GMAW). Proses kimpalan GMAW dilakukan dengan menggunakan wayar pengisi jenis ER70S-6. Perbezaan parameter kimpalan digunakan dan akan dikimpalkan pada spesimen. Set parameter telah direka oleh Minitab 16. Specimen pusingan bersama dengan ketebalan berbeza telah dikaji dengan menganalisis ujian tegangan, ciri-ciri micro-kekerasan dan analisis kumai kimpalan. Ujian tegangan, ujian micro-kekerasan Vickers dan ukuran kumai kimpalan telah dijalankan. Kombinasi voltan kimpalan, arus kimpalan, dan kelajuan kimpalan yang boleh membentuk input haba dengan menggunakan formula, yang mana hasilnya dapat bandingkan dengan ujian tegangan dan ciri-ciri micro-kekerasan. Tambahan pula, data akan dianalisis dengan menggunakan kaedah Taguchi untuk mencadangkan satu kimpalan parameter pengoptimuman untuk kimpalan plat jenis nipis oleh teknologi “ColdArc”. Hasil dari pengoptimuman menunjukkan bahawa kekuatan tertinggi yang diperolehi 241.7MPa adalah apabila arus kimpalan, voltan kimpalan dan kelajuan sekurang -70V, 17.6A dan 0.6 mm / min, masing-masing. Di samping itu, kekerasan yang tertinggi yang diperolehi 229.6HV apabila 75A arus kimpalan, 7.5V voltan kimpalan dan 0.8 mm / min kelajuan kimpalan digunakan.

ABSTRACT

The purpose of this study was to understand the parameter-properties relationship of thin plate welding with dissimilar thickness by “ColdArc” welding. This welding was conducted by automated gas metal arc welding (GMAW). The GMAW welding process performed by using ER70S-6 filler wire. The specimen was welded by using different parameters of welding. The set of parameters was designed by Minitab 16. Specimen of lap joint with dissimilar thickness were studied by analyzing the tensile properties, microhardness properties and weld bead dimension. Tensile test, Vickers microhardness test and weld bead dimension were conducted. The combinations of welding voltage, welding current, and welding speed in which can form the heat input of the process were employed in this study. Tensile testing and microhardness properties were then compared. Furthermore, data was analyzed by using Taguchi method to suggest an optimization of welding parameter for thin plate welding by “ColdArc” technology. The result showed that the highest strength that was 241.7MPa was obtained when welding current, welding voltage and speed were at 70V, 17.6A and 0.6mm/min, respectively. In addition, the highest hardness was obtained at 229.6HV when 75A welding current, 7.5V welding voltage and 0.8mm/min welding speed were used.

DEDICATION

Only

my beloved father, Ayob bin Ahmad

my appreciated mother, Che Dzaleha bt Saad

my adored sister and brother, Syuhada and Syahidan

for giving me moral support, money, cooperation, encouragement and also understandings

Thank You So Much & Love You All Forever

ACKNOWLEDGEMENT

In the name of ALLAH, the most gracious, the most merciful, with the highest praise to Allah that I manage to complete this final year project successfully without difficulty.

My respected supervisor, Profesor Madya Dr Nur Izan Syahriah Binti Hussein. Her kindness, unwavering patience and mentorship guided me through the process, her easily understood explanations and open mind allowed me to grow and learn in such a way that I am now a better researcher.

Last but not least, I would like to give a special thanks to my best friends who gave me much motivation and cooperation mentally in completing this report. They had given their critical suggestion and comments throughout my research. Thanks for the great friendship.

Finally, I would like to thank everybody who was important to this FYP report, as well as expressing my apology that I could not mention personally each one of you.

TABLE OF CONTENTS

LIST OF TABLE

LIST OF FIGURES

LIST OF ABBREVIATIONS

ASTM	-	American society for testing and materials
AWS	-	American Welding Society
CMT	-	Cold Metal Transfer
DOE	-	Design of Experiments
EDM	-	Electrical discharge machine
GMAW	-	Gas Metal Arc Welding
HAZ	-	Heat affected zone
STT	-	Surface Tension Transfer
TIME	-	Transfer Ionized Molten Energy
UTM	-	Universal testing machine

LIST OF SYMBOLS

%	-	Percent
^{o}	-	Degree
x	-	Multiply
A	-	Ampere
mm	-	Millimetre
kg	-	Kilograms
mm/min.	-	Millimetre per minute
kN	-	Kilo newton
V	-	Voltage
kJ/mm	-	Kilo joule per milimetre

CHAPTER 1
INTRODUCTION

1.1 Background

Recently, the technology of arc welding was improved to get a perfect joining. These technologies are intended to solve problem during the welding process. One of that, ColdArc technology. Thin plate parts are normally used in automotive sector where in assembly part the ColdArc technology is introduced to save the mass production without lose the quality (Miranda *et al.* ,2011)

ColdArc technology is one of the techniques that used by Gas Metal Arc Welding (GMAW) process but the modification in parameter sector where can produce the particularly low level of heat during welding process with specific filler rod. With this advantage, the thin plate can be welded with strong bond thus produce a lightweight of the automotive part with the high-strength thin plate. Therefore, it can save costs and protect the environment (Goecke, 2005)

In joining, the suitable level of parameters are needed to get a strong joint of parts. Even, the joint is complete there is might be a defect and the joint is not tough especially in different thickness. Therefore, the best parameter is required in this study to avoid the failure. Besides, the distortion during welding is different when the welding technique is different.

1.2 Problem Statement

In automotive industry, the assembly part is one of the most parts that needs high consideration because it involves in combining with dissimilar thickness. As to produce high-

strength joint, proper selection of parameters is crucial. According to Nuraini *et al.* (2014), the study states that by getting the correct parameter the robotic welding will become precision and the quality of the product will increase. Next, according to Yan *et al.* (2015) it states that the energy ingestion is condensed and the thermal efficient is enhanced when the parameter of welding is improved. The welding current and welding speed give a huge impact on a parameter in order to decrease the energy ingestion and improved thermal efficient. In Dean and Hidekazu (2007) studies thin plate structure are easy to buckling when high heat input give on it. It has a significant influence in order to make welding distortion. Therefore, the ColdArc technology is one of the most inexpensive methods of joining process especially tailored blanks at automotive parts. The combination of dissimilar thickness is needed nowadays in automotive manufacturing. So, in this experiment will investigate about the current, voltage and welding speed parameter with its properties to a dissimilar thickness of thin plate operate by ColdArc Technology.

1.3 Objective

The objectives of this study are:-

a) To study the effect of welding parameters to the properties of cold rolled mild steel sheet with dissimilar thickness, welded with GMAW ColdArc technology.
b) To suggest the optimum set of parameters.

1.4 Scope of Project

In this study, the material used was cold rolled steel sheet with dissimilar thickness (1 mm and 0.8mm). The experiment concentrated on the parameter of ColdArc welding and its properties of thin plate joints fabricated by robotic gas metal arc welding (GMAW). Type of

joining was lap joint and the weld joining with different thickness. This experiment started with literature review. Determined the GMAW parameter by using the design of the experiment, the Taguchi method type with 3 level and 3 factor, testing for this experiment were tensile testing and micro-hardness.

1.5 Significance of Study

This study will benefit to the car manufacturer where applied the welding on the dissimilar thickness metal plates. This study also gives advantage to the car manufacturer to save the cost on welding process because consist one replication to joining dissimilar thickness plate. Besides that, the low current usage also can gain from this study thus, can save the cost.

1.6 Activity Planning

Activity planning of this study is outlined in a Gantt Chart as in Appendix A.

CHAPTER 2

LITERATURE REVIEW

This chapter reviews on the development of welding, cold arc technology, type of weld material and its properties. The descriptions are based on the collected data and information from some reference through the article, books and internet searching.

2.1 Welding Process

Welding is one of the techniques that makes metal joint together through amalgamation to become unified whole where amalgamation is defined as joining two materials to become as one piece. This technique happens either heat or pressure or both (Liu, 2010). According to American Welding Society (AWS) welding is existed in variation which including arc welding, gas welding, brazing, also the soldering. This variation can be categories into three such as Fusion Welding, Solid-state Welding and Soldering (Figure 2.1).

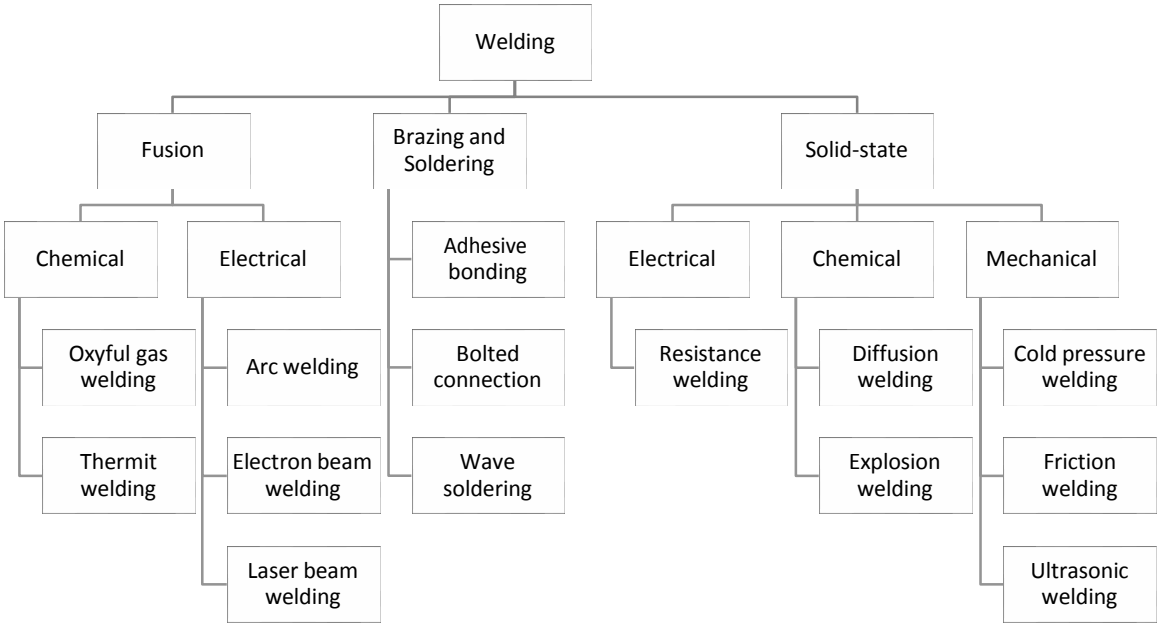

Figure 2.1: Classification of Welding (Liu, 2010).

Figure 2.1 shows the classification of welding which in basic. From that, the advantages of welding can be described based on the cost effectiveness. The metal that has been joint is strong and tight, also its process can be automated and mechanised. The application of these process widely used in making motor car chassis, boilers tanks and steel structures. On the other hand, it also has the weakness where the structures of welded place can be changed by distortion and internal stresses. Besides, heat affected zone (HAZ) is formed and it creates a permanent joint (Kah *et al.*, 2013).

2.1.1 Arc Welding

In Arc welding, its principle commonly called “stick electrode” where the arc welding is based on the electric circuit. When the electrode and workpiece are nearest to connected the electric arc is formed. Its purposed is to melt the edge of the joint forming for workpiece joint

together and to melt the tip of the coated electrode. The electrode performed as a filler material which mixed with the melted base material to seal the joint (Vural, 2014).

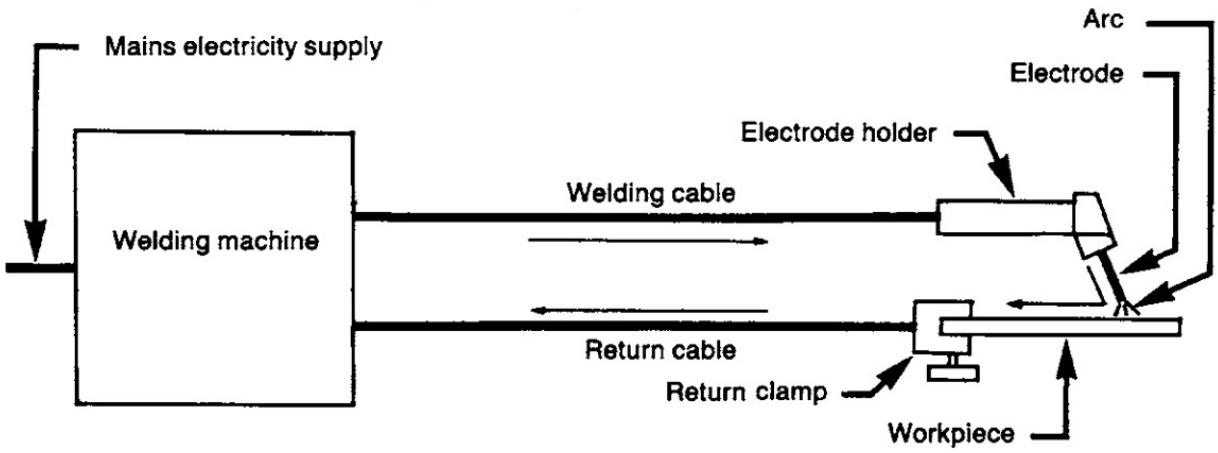

Figure 2.2: The Arc Welding Circuit (Vural, 2014).

Figure 2.2 illustrates the arc welding circuit. According to Vural (2014), the existing of a weld between metals is formed when the electrode connected nearest to the workpiece, then the arc struck between the workpiece by consuming the filler metal. The arc immediately melts a piece of the base metal while the heat created, resulting in the formation of a weld pool.

2.1.2 Gas Metal Arc Welding (GMAW)

Gas metal arc welding is a welding process that melts and joint metal through heating them to their melting point with the arc placed between a continuously fed filler wire electrode and the metals. Shielding of the arc and molten weld pool is usually by using an inert gas like argon and helium. This process is well established a semi-automatic process. It also gives less distortion and no slag removal, associated with accurate jigs and fixture. GMAW can give a good result on non-ferrous welding by applying a good control of heat input by Mandal (2009).

Wahab (2014) discussed that GMAW is operated by the automated feeding of a continuous, simple and expandable electrode that protected by an externally supplied shielding gas. It shows schematically in figure 2.3. During the welding process, all material went through in high temperature then, reacted with oxygen and nitrogen thus, the elimination of air from the weld zone occurred by shielding gas. In this process, the arc is struck by scratching the electrode on the workpiece during the welding process. Electrode wire diameters ranging from 0.8 mm to 6.5 mm are commonly used in GMAW, the size depending on the thickness of the parts being joined and the desired weld metal deposition rate. The gun guides the consumable electrode conducts the electrical current and directs shielding gas to the workpiece.

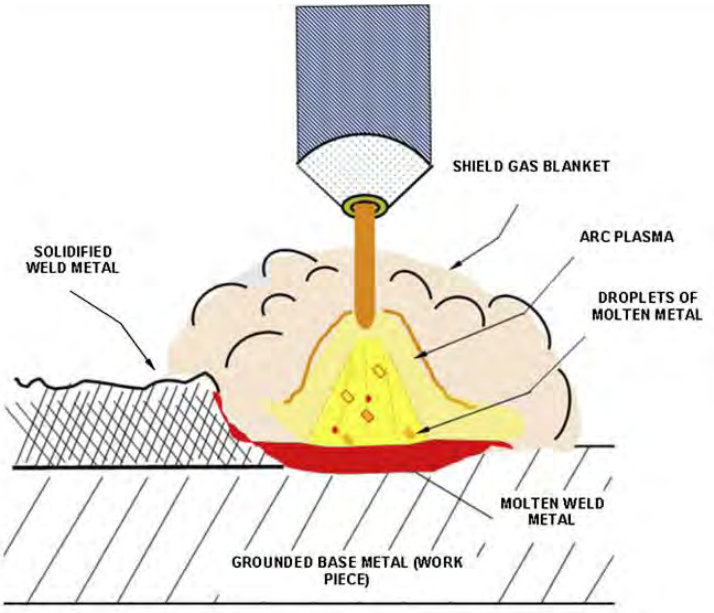

Figure 2.3: Illustrate of Gas Metal Arc Welding (AWS, 2001).

2.1.3 Thin Plate Welding

Welding innovation is generally utilized as a part of shipbuilding and cars industries. Lately, transport creators have been compelled to join lighter, thinner steel structures to lessen