EFFECT OF PARAMETERS ON PROPERTIES OF SHEET METAL WELDED BY ROCKER ARM SPOT WELDING MACHINE

NADIA SYAHIDA BINTI MOHD AMIR
B051310310

UNIVERSITI TEKNIKAL MALAYSIA MELAKA
2017

B051310310 BACHELOR OF MANUFACTURING ENGINEERING (MANUFACTURING PROCESS) (HONS.) 2017 UTeM

UNIVERSITI TEKNIKAL MALAYSIA MELAKA
2017

EFFECT OF PARAMETERS ON PROPERTIES OF SHEET METAL WELDED BY ROCKER ARM SPOT WELDING MACHINE

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

by

NADIA SYAHIDA BINTI MOHD AMIR

B051310310

941031-06-5240

FACULTY OF MANUFACTURING ENGINEERING

2017

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

Tajuk: **EFFECT OF PARAMETERS ON PROPERTIES OF SHEET METAL WELDED BY ROCKER ARM SPOT WELDING MACHINE**

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

Saya **NADIA SYAHIDA BINTI MOHD AMIR (941031-06-5240)**

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:

_____ _____

Alamat Tetap: Cop Rasmi:

_____

_____

_____

Tarikh: _____ 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 "Effect of Parameters on Properties of Sheet Metal Welded by Rocker Arm Spot Welding Machine" is the result of my own research except as cited in references.

Signature : ……

Author's Name : NADIA SYAHIDA BINTI MOHD AMIR

Date : 14th 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

Kajian ini bertujuan untuk menyiasat kesan parameter terhadap ciri-ciri tegangan, kekuatan dan diameter titik kimpalan dan mencadangkan parameter optimum untuk mengimpal kepingan keluli dengan menggunakan mesin kimpalan spot "rocker arm". Pada masa kini, industri boleh menggunakan 30% sahaja dari jumlah titik kimpalan kerana kesukaran dalam menentukan parameter kimpalan. Terdapat banyak faktor yang boleh menjejaskan kualiti kimpalan kerana ia adalah satu proses yang sangat cepat. Kegagalan juga boleh berlaku atas sebab tempat kimpalan mempunyai kekuatan ditolak dan boleh membawa kepada kemusnahan pada bahagian badan kereta. Spesimen yang perlu dikimpal perlu menetapkan julat parameter pada mesin kimpalan spot. Parameter kimpalan yang berbeza telah dihasilkan dengan menggunakan kaedah Taguchi Minitab 17. Terdapat dua dimensi yang digunakan dalam kajian ini. Sifat-sifat mekanik yang spot weld telah diuji dengan menggunakan ujian tegangan dan kekuatan mikro. Diameter titik kimpalan diperhatikan dengan menggunakan mikroskop stereo untuk menentukan kualiti dan kekuatan kimpalan. Ujian tegangan digunakan untuk menentukan kekuatan tegangan terhadap arus elektrik dan masa kimpalan. Kemudian, ia telah terbukti tegangan kekuatan dan kekerasan itu meningkat selari dengan peningkatan arus elektrik dan masa kimpalan. Titik kimpalan juga diperluaskan apabila haba tinggi digunakan. Berdasarkan analisis ANOVA, masa kimpalan sangat mempengaruhi kekuatan tegangan dan pengesahan ujian telah dijalankan untuk membuktikan bahawa masa kimpalan ialah parameter paling optimum dalam kajian ini.Oleh yang demikian, dapatlah disimpulkan bahawa apabila arus elektrik dan masak kimpalan meningkat, kekuatan tegangan, kekerasan dan titik kimpalan juga meningkat. Parameter optimum untuk mengimpal keluli yang ringan adalah masa kimpalan.

ABSTRACT

The aim of this study is to investigate the effect of parameters on tensile properties, hardness, and weld nugget diameter and to suggest optimum parameter to weld steel sheets by using rocker arm spot welding machine. Nowadays, industries can only use 30% of the total amount of spot weld due to difficulty in determine the welding parameter. There are many factors that can affect the quality of spot welds as it is a very fast process. Failure also could happen on spot welds cause the spot welds to have less strength and can lead into destruction of joining parts of car bodies. The specimens were welded by setting range of parameters on spot welding machine. The weld parameters were generated by using Taguchi method from Minitab 17. There were two dimensions used in the study. The mechanical properties of the spot weld were tested by using tensile shear test and micro hardness test. The nugget diameter of spot weld was observed by using stereo microscope to determine the quality and strength of a spot weld. Tensile test was used to determine the tensile shear strength of a spot weld against weld current and weld time. Then, it was proved that tensile shear strength and hardness value increase parallel with the increase of weld current and weld time. Weld nugget diameter also extended when high heat input was applied. Based on ANOVA analysis, weld time highly influenced tensile shear strength as it came out in first rank. Confirmation test had been conducted to prove that weld time is the optimum parameter in this research. Therefore, it can be concluded that when weld current and weld time increase, tensile shear strength, hardness value and nugget diameter also increase. The optimum parameter to weld mild steel was weld time.

DEDICATION

Only

my beloved father, Mohd Amir

my appreciated mother, Siti Zuraini

my adored sisters and brothers, Nabila, Nazira, Nabil, Najmi and Najwan

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.

Primarily, I would like to thank my supervisor, Associate Professor Dr. Nur Izan Syahriah Binti Hussin who had taken a lot of efforts meticulously to give advices, constant guidances and came out with helpful suggestions.

I also want to thank my family for giving me endless love, understanding and support. Lastly, I would like to express thanks and gratitude to those who have helped me to make this project success.

TABLE OF CONTENT

LIST OF TABLE

LIST OF FIGURES

LIST OF ABBREVIATIONS

RSW	-	Resistance Spot Welding
C	-	Carbon
Si	-	Silicon
P		Phosphorus
Fe	-	Iron
Cu	-	Copper
Mn	-	Manganese
Cr	-	Chromium
Al	-	Aluminum
Q	-	Amount of Heat Generated
I	-	Current
R	-	Resistance
t	-	time
DOE	-	Design of Experiment
S/N		Signal noise
ANOVA		Analysis of Variance

LIST OF SYMBOLS

mm	-	Mili Metre
s		Second
kA	-	Kilo Ampere
MPa	-	Mega Pascal
kN	-	Kilo Newton
HVN		Hardness Vickers

CHAPTER 1
INTRODUCTION

This chapter introduces the subject matter and the problems that are being studied. It states the general idea on what is the study is all about. It should consist of background of study, problem statement, objectives, and scope of project.

1.1 Background of Study

Resistance spot welding (RSW) is of the oldest welding processes. It is one type of welding that weld at least two metal sheets together without utilizing any filler material. This is because it can be applied pressure and heat to the area that is going to be welded by using electrode. Spot welding is widely used as joining process for fabrication in automotive, home appliances and many more because of the effectiveness and adaptability of the high-speed automation. RSW joins the material by applied the pressure and pass on the welding current through the workpieces. The material between the electrode will be pressed together. When the current is turned off, the nugget will be formed. Figure 1.1 illustrates the complete spot welding circuit (Ali *et al*., 2015).

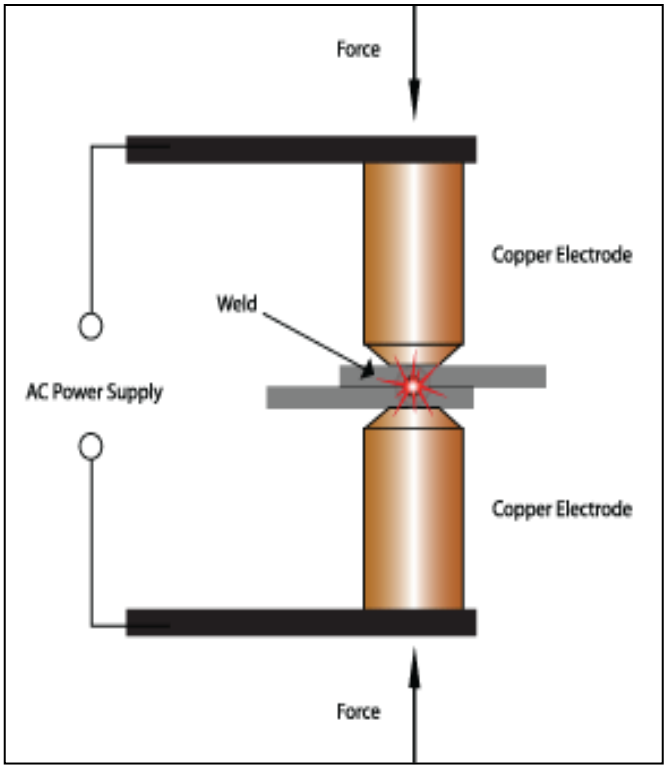

Figure 1.1: Complete Circuit of Resistance Spot Welding (Ali *et al*., 2015)

Pandey *et al*. (2013) stated that RSW is a major metal sheet joining process in many industries. It is so important especially in automobile industries. For example, there are 3000 to 6000 spot welds in any car, which shows the importance of spot welding. The advantages of the RSW are low cost, high production rate and adaptability of the high-speed automation.

Aslanlar *et al.* (2007) also stated that RSW is a critical process in industry. In RSW, the overlapped workpiece is situated between the water-cooled electrodes. Then the heat input will be passed by a large electrical current for a brief timeframe. RSW also has been used widely as a joining process to fabricate sheet metal assemblies because of its advantages in welding efficiency and appropriateness for automation. For example, 7000 to 12 000 spots of welding are needed for assembly according to the size of a car. That is why the spot welding process in very important.

1.2 Problem Statement

Spot welding is a major joining process in automotive industries. Today, only 30% of the total amount of spot weld to join a part of a car can be used. This is because there is difficulty in determine the welding parameter. Even though RSW has advantages for high speed and suitability for automation and other fabricating operations, it also has the limitation. There are many factors that can affect the quality of spot welds as it is a very fast process (Lukman, 2007).

Pouranvari *et al*., (2013) stated that the failure that happen on spot welds cause the spot welds to have less strength and can lead into destruction of joining parts of car bodies. So, the failure characteristics and performance of the spot weld will affect the durability and safety of the vehicles.

In today technology, resistance spot welding is an important form in manufacture especially automotive. Automotive industries must meet the customers' requirements to face the global competition that are high strength values of used sheet, the stiffness of weld joint and ability to absorb impacts. Several parameters influenced the quality of the weld joint (Aslanlar *et al*., 2007) .

Resistance spot welding is a cheap and effective method to join the metal sheets. It has good benefits in economy such as low cost, high speed, and suitability for automotive industries. The order of sheets and the surface condition are the causes why each spot welding cannot be implement in the same condition (Akkas *et al*., 2016).

Normally, 3000-6000 spot weld are weld in any car. That is how important the resistance spot welding as it need low cost and can produce high production rate in automation assemblies. The diameter of nugget determines the quality of weld joint (Pandey *et al*., 2013). The weld is produce by heat, electrode force and time. It uses the resistance of the materials to flow the current that will localized heating between the part to be joined. So, it is important to understand the mechanisms that are needed to control the weld quality.

1.3 Objectives

Ojectives of the study are: -

i. To investigate the effect of parameters to the tensile properties, hardness, and nugget diameter of spot weld.
ii. To suggest optimum parameter to weld steel sheets by using Rocker Arm spot welding machine.

1.4 Scopes of Project

In this research, the mild steel will be used as a material. It will be cut by using shear cutting machine into plate. There will be two dimensions which are for tensile shear test and micro hardness test that are 100 mm x 40 mm and 60 mm x 30 mm respectively. The thickness of the steel plate is 1 mm. The mild steel will be grinded first by using sand paper to remove any contaminants on the surface of the mild steel. The mild steel plate then will be welded by using rocker arm spot welding machine. The parameters that will be focus on is weld current and weld time. The joining type for the spot welding process is lap joint as shown in Figure 1.2. Taguchi method approach is used to create L9 orthogonal array design with two factors and three levels. Then, the spot welds are tested by using tensile shear test, Vickers hardness test, and nugget diameter measurement.

Figure 1.2: Lap joint of a mild steel (side view)

CHAPTER 2
LITERATURE REVIEW

This chapter reviews the important and extensive review of literature related to the topic of this research. It is a base for the experimental and analytical sections of this study. It also an important summary and synthesis of current study of the topic.

2.1 Resistance Spot Welding

Resistance spot welding (RSW) is often used for producing a vehicle body-in-white (BIW). It is normally made of thin metal sheets. The sheets are connected by clamping with two pincers and the force and current are applied to it. The nugget will develop and the interface will disappear. The quality factor of resistance spot welding usually consists of fusion zone size, weld mechanical performance and failure modes. During the spot weld process, the changes will occur in mechanical and metallurgical properties of the spot weld area (Ghazali *et al*., 2015).

In the spot welding process, an electric current is passed through the parts that will be welded together. Normally, high conductive electrode is used in this process. A pressure is exerted during the process to hold the parts that will be welded. Sufficient heat must be applied to the metal surface that will be welded together to obtain a good welding joint. Weld current weld time must be properly related to produce a good weld (Aslanlar *et al*., 2008). Spot welding may be performed manually, robotically or by a dedicated spot welding machine but this project emphasizes on the in-house fabricated spot welding machine.

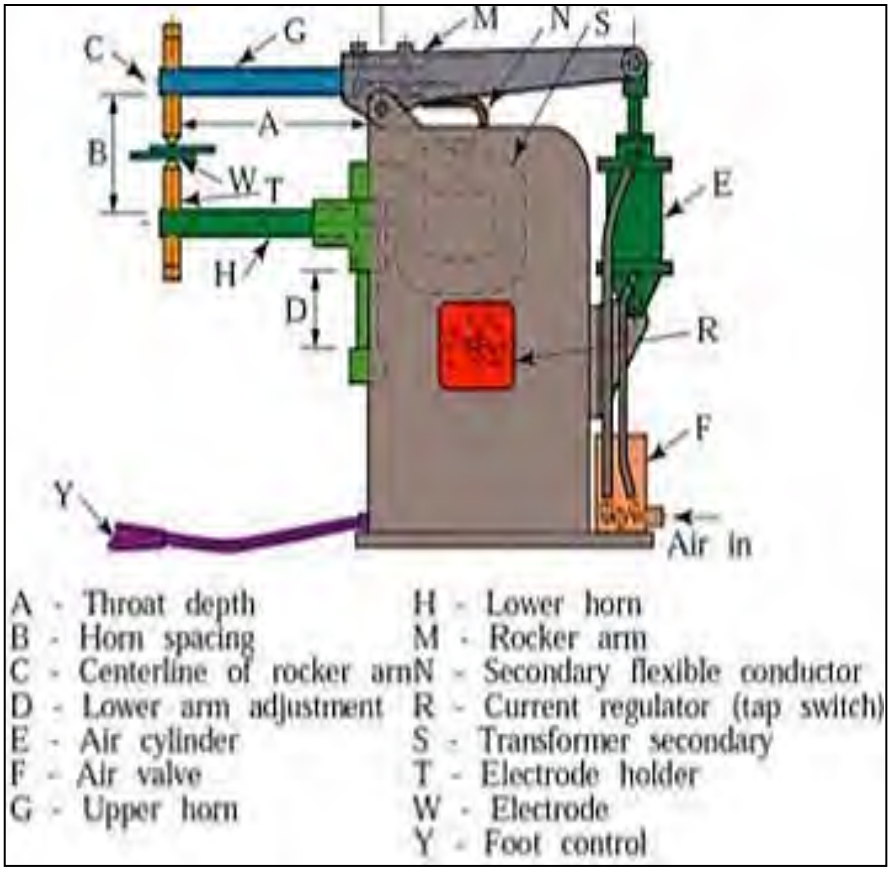

Figure 2.1: Illustration of Rocker Arm Spot Welding Machine (Kalpakjian and Shmid, 2006).

Figure 2.1 shows a schematic diagram for a spot welding machine. It is a rocker-arm type spot welding machine that commonly used for small parts. In RSW, the spot weld is produced from a resistance heating after electrodes touch the surface of two sheet metals as shown in Figure 2.2.