



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

SIGNIFICANT EFFECT OF DIFFERENT BASE METAL IN METAL SHEET SPOT WELDING

This report is submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Mechanical Engineering Technology (Automotive Technology) with Honours

by

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910811-03-5921

FACULTY OF ENGINEERING TECHNOLOGY

2016

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **Significant Effect of Different Base Metal in Metal Sheet Spot Welding.**

SESI PENGAJIAN: **2016/17 Semester 1**

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I hereby, declared this report entitled “Significant Effect of Different Base Metal in Metal Sheet Spot Welding” is the results of my own research except as cited in references.

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Date : 13 December 2016

APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the Bachelor of Mechanical Engineering Technology (Automotive Technology) with Honours. The member of the supervisory is as follow:

.....
(Ms. Najiyah Safwa Binti Khashi'ie)

ABSTRAK

Proses kimpalan titik adalah salah satu proses pencantuman logam yang penting terutamanya di industri automotif. Rintangan kimpalan titik dengan lembaran logam berbeza asas umumnya lebih mencabar daripada lembaran logam sama asas disebabkan oleh beberapa gangguan. Kekuatan struktur kenderaan kebanyakannya bergantung kepada struktur kimpalan. Oleh itu, projek ini bertujuan untuk mengkaji sifat-sifat mekanikal yang berbeza asas di antara kepingan logam keluli kekuatan tinggi dan kepingan logam gulungan sejuk biasa. Parameter rintangan titik kimpalan seperti arus kimpalan, daya kimpalan dan masa kimpalan telah ditetapkan pada nilai yang tetap. Dalam projek ini, kekuatan pada ujian tegangan ricih dan ujian kekerasan pada sambungan kimpalan dengan ketebalan untuk 1.40 mm pada dua lapisan kimpalan telah dikaji. Proses ujian yang telah dilakukan adalah tegangan ricih ujian dengan menggunakan mesin ujian universal, ujian kekerasan dengan menggunakan mesin ujian kekerasan, dan permukaan mikro struktur menggunakan Scanning Electron Microscope. Dengan keputusan yang diperolehi dalam projek ini, SPCC BM mempunyai kekuatan tegangan yang tinggi dan kekerasan tahap rendah kerana kemuluran dalam SPCC BM adalah lebih tinggi berbanding dengan HSS BM. Keputusan telah menunjukkan bahawa kombinasi HSS asas logam adalah lebih baik daripada SPCC logam asas di dalam titik kimpalan rintangan. Hasil kajian ini mendapati, tempat kimpalan untuk SPCC asas logam perlu dikurangkan untuk meningkatkan kualiti di kereta kerangka badan.

ABSTRACT

Spot welding is one of the metal joining processes that mainly used in automotive industries. Resistance spot welding of different base metal sheet generally more challenging than same base metal sheet due to several interfaces. The strength of vehicle structure mostly depends on the weld structure. Thus, this project intended to study the mechanical properties of different base metal between high strength steel metal sheet and regular cold roll metal sheet. The parameter of resistance spot welding such as welding current, welding force, and welding time were fixed at a constant value. In this project, the tensile strength and hardness test of lap joint in spot welding for 1.40 mm thickness of two layer welded sheet was investigated. The testing process that had been done is tensile shear-test by using Universal Testing Machine, hardness test by using Hardness Testing machine, and surface microstructure by Scanning Electron Microscopy. By the results obtained in this project, SPCC BM have high tensile strength and low hardness because the level of ductility in SPCC BM is more higher compared to HSS BM. Results have shown that the combination of HSS base metal is better than from SPCC base metal in resistance spot welding. The results of this study found, spot welding for SPCC base metal should be reduced for improve quality at body frame car.

DEDICATION

Most Elevated Exceptional Grateful To Both My Beloved Father and Mother

Mat Zainu Zaman Bin Mat Deris

&

Esah Binti Ishak

Beloved My Wife

Noraini Binti Mat Yaakub

Also

Beloved Brothers and Sisters

Besides, I am very grateful to be given a Supervisor who was very helpful in this study

Ms. Najiyah Safwa Binti Khashi'ie

&

Mr. Mohd Harris Fadhilah Bin Zainudin

Lastly, to my panel for giving constructive comments

Mr. Muhamad Azwar Bin Azhari

Thank you a lot.

ACKNOWLEDGMENT

Firstly, millions of thankful wishes to ALLAH S.W.T because with His permissions, I am able to complete my Final Year Project report.

In setting up this paper, I have drawn in with many individuals helping me to finish this project. First, I wish to express my sincere appreciation to my main thesis supervisor Ms Najiyah Safwa Binti Khashi'ie and co-supervisor Mr Mohd Harris Fadhilah Bin Zainudin, for support, teachings, advices and inspiration.

Exceptional appreciation to my father Mat Zainu Zaman Bin Mat Deris, my mother Esah Binti Ishak and my wife Noraini Binti Mat Yaakub for their prayer and steady backing. It is also a pleasure to thank all my siblings for encouragement from the day I start this project.

Lastly, thankful wish also to my panel Mr Muhamad Azwar Bin Azhari, all my lecturers, all my friends for giving spirit and support. Their undivided love and support during tough times will never be forgotten. Thank you all.

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LIST OF ABBREVIATION, SYMBOLS AND NOMENCLATURE

AC	-	Alternate Current
AF	-	Acicular Ferrite
BM	-	Base metal
DC	-	Direct Current
GF	-	Grain Ferrite
HAZ	-	Heat Affected Zone
HSS	-	High Strength Steel
HRB	-	Hardness Rockwell Ball
KV	-	Kilo Volt
M	-	Martenside
MPa	-	Mega Pascal
mm	-	Milimeter
mm/mm	-	Milimeter/Milimeter
N	-	Newton
PF	-	Polygonal Ferrite
RSW	-	Resistance Spot Welding
SPCC	-	Regular Cold Roll
SEM	-	Scanning Electron Microscope
ST	-	Squeeze Time
UTM	-	Universal Testing Machine
WT	-	Weld Time
ΔSN	-	Differential Size Nugget
ΔSH	-	Differential Size Heat Affected Zone
ΔST	-	Differential Shear Tensile Maximum Load
ΔHA	-	Differential Hardness Test

CHAPTER 1

INTRODUCTION

1.0 Introduction

This chapter is the framework of the project that including brief introduction about Resistance Spot Welding (RSW), the importance of RSW for automobile industry, objective and scope of the project.

1.1 Background of Project

Resistance spot welding is a process in which, it is been established that widely two or more sheet metals are joined by the heat obtained from resistance to electric current and it is an important the process that has used in vehicle assembly industry. It is the main technology used in the production of automotive assembly because it is the fastest and low cost. It also has the advantage of using weld if different combinations of materials that are difficult or impossible to join other welding techniques (Nielsen et al., 2011).

Proton and Perodua are examples of the local automotive companies using resistance spot welding in their manufacturing process. Almost the entire joining to the manufacturing car is the resistance spot welding. Usually, there are 3000-6000 spot resistance welding points in a vehicle (Yi et al., 2009). RSW is very important for the automotive industry for more than 90% of spot welding is used to form the frame of the car (Xinmin et al., 2007).

RSW process, is a where two or more metal work pieces will be joined by the heat generated by the current through the metal work piece and pressure electrodes. Figure 1.1 below, show an illustration of RSW circuit. The workpiece are held together under pressure between upper and lower electrode. This machine can automatic operation by robotic and manually depend on process and situation. The effect of heat welding mainly depends on three factors; welding time, welding current and contact resistance. For the quality of spot welding depends on the parameters used in accordance with the work piece. Good quality of spot welding depends on these three factor; welding time, welding current and electrode force.

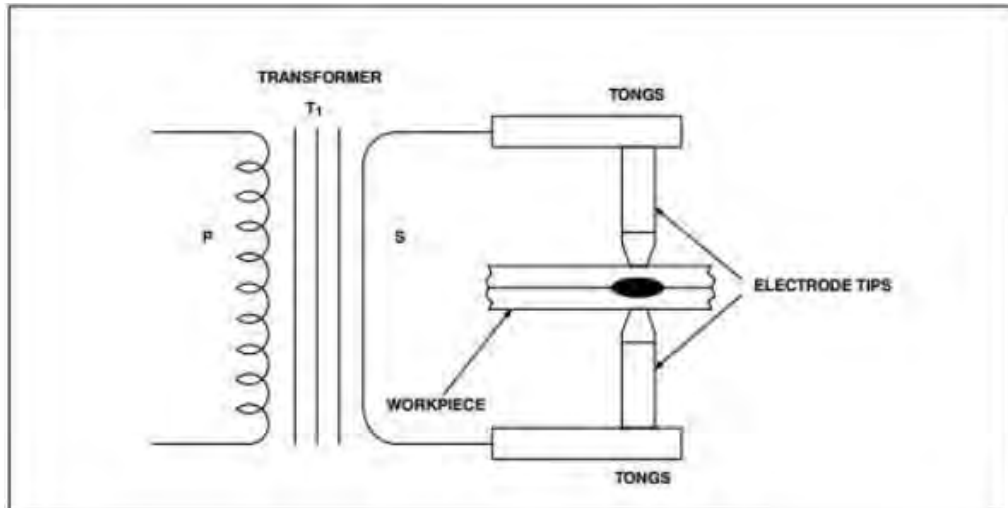


Figure 1.1 : Simple Drawing RSW with Work piece (Luo Yi et al., 2009)

1.2 Problem Statement

In the modern era, the main cause of death was involved in a fatal crash (Teng et al., 2008). Statistics shown in 2003, 6286 was recorded people and increased to 6917 in year 2012 in Figure 1.2 shows below the statistics road accidents. Thus, the cars produced by the vehicle industry, many accidents involving vehicles were damaged in the accident.

Based on the investigation conducted by a vehicle involved in an accident at least one passenger suffered a severe injury or death to be hospitalized. Information submitted by the investigation allow vehicle manufacturers to change the shape of their vehicle by changing the materials used in their vehicles to improve the safety of passengers. To reduce the severity of injuries sustained by passengers in the event of an accident involving vehicle design and safety features that enhance the design, materials and safety features that correspond to the metal used (Teng et al., 2008).

TAHUN Year	JUMLAH KEMALANGAN Total Number of Accidents	KECEDERAAN DAN KEMATIAN Casualties			JUMLAH Total
		MATI Death	PARAH Serious	RINGAN Minor	
2003	298,653	6,286	9,040	37,415	52,741
2004	326,817	6,228	9,229	38,631	54,088
2005	328,264	6,200	9,397	31,429	47,026
2006	339,252	6,287	9,254	19,884	35,425
2007	363,319	6,282	9,273	18,444	33,999
2008	372,990	6,527	8,866	16,901	32,294
2009	397,330	6,745	8,849	15,823	31,417
2010	414,421	6,872	7,781	13,616	28,269
2011	449,040	6,877	6,328	12,365	25,570
2012	462,423	6,917	5,868	11,654	24,439

SUMBER : POLIS DIRAJA MALAYSIA
Source : Royal Malaysian Police

Figure 1.2: Statistic total casualties and injuries caused by road, accidents in Malaysia, 2003 -2012.

The latest government law to reduce greenhouse gas emissions and fuel consumption for environmental preservation in this situation of cold roll (SPCC) is seen more suitable for lower cost and higher form ductility (Long et al., 2016). Furthermore, In Sung Hwang in his research found that the use of high strength steel (HSS) at automotive sector is on the rise to improve fuel efficiency as well as weight reduction of a vehicle. Resistance spot welding machine is normally used in automotive industry to

assembly and it can be used for welding metal sheet such as cold roll steel and high strength steel. (Shamsul et al., 2007).

In recent years, a number of analysis and other methods already exist to modernize the welding process to produce quality welds with different process parameters. The study, to see the effect of the three parameters such as welding power, welding time and welding current to a tensile shear strength. In this study, involving two metal combinations of HSS and SPCC and most important is a consideration of welding parameters (Hamidinejad et al., 2012). To produce some quality welding automatic welding machines running on the same metal and to show the quality of resistance spot welding is controlled with different parameters to compare the quality of the weld as parameters corresponding to the metal (Tsai et al., 1991).

From the point of view of the reliability of automotive structures, many investigations have been conducted to assess and predict the fatigue strength of spot welded joints. When spot welding two layers of HSS with SPCC electrode usually experience significant depression due to high costs, which in many cases is unacceptable for aesthetic reasons (Nielsen et al., 2011).

The main study is to evaluate the weldability of different base metal in RSW. The base metal consists of two different types, which are SPCC and HSS. A fixed value of welding parameters, such as welding time, welding current and welding force are applied during RSW process. Weldability assessment to be performed on each work piece is destroyed test, hardness test, and the surface structure to see the corresponding parameters in the two different types.

1.4 Objective

The main objective of this research is investigate the effect of different base metal in RSW by using 2 layer of different base metal in metal sheet spot welding.

- I. To prepare the testing workpiece in different base metal.
- II. To compare the quality and weldability of welded metal sheet in different base metal.
- III. To analyse the microstructure weldability of welded metal sheet in different base metal.

1.5 Project Scope

The research is subjected to the following scope:

- I. Preparing the testing workpiece using cutter machine and resistance spot welding machine.
- II. Investigate the strength of 2 layer welded sheet by using Universal Testing Machine (UTM), Hardness Testing Machine. In this study, the test is making the hardness test and shear tensile test.
- III. Scanning Electron Microscope (SEM) for investigate the microstructure of different base between high strength steel (HSS) and cold roll (SPCC).
- IV. Investigate the parameter suitable in RSW to high strength steel (HSS) and cold roll (SPCC).

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This chapter will explain the theory about spot welding machine, parameters spot welding, types and features material, types of testing machine and theory testing.

2.1 Resistance welding Machine

The welding have many types which usually using in joining two or more steel sheet. Resistance spot welding (RSW) is the predominant welding technique used for joining steel in automotive applications (Khan et al., 2008). An electric current will flow on section are welded with using electrodes highly conductive during the welding process. The force needed to hold metal sheets during process welding. The nugget weld shaped through three parameters is time, heat and pressure. In to making a good quality welding joint, heat is required in sufficient quantities on the surface of metal sheets. Parameters must be in the correct value parameter as force, current and time to get a good weld. The resistance welding process can be classified:-

- I. Projection welding machine
- II. Spot welding machine
- III. Seam welding machine
- IV. Flash butt welding machine

2.1.1 Projection Welding Machine

Figure 2.1 shown the types of RSW process specially designed of projections in one section. The projection welding process is similar to spot welding except that the welding pressure, and welding current. Hence the welding heat are localized by making projection or embossments on one or both of the work pieces to be joined. Common use of projection welding is the use of special nuts that have projections on the portion of the part to be welded to the assembly. The advantage of the resistance projection welding is more than one spot weld can be made in a single operation, so the operation is very fast and welding current and pressure required is less (Saleem, 2012).

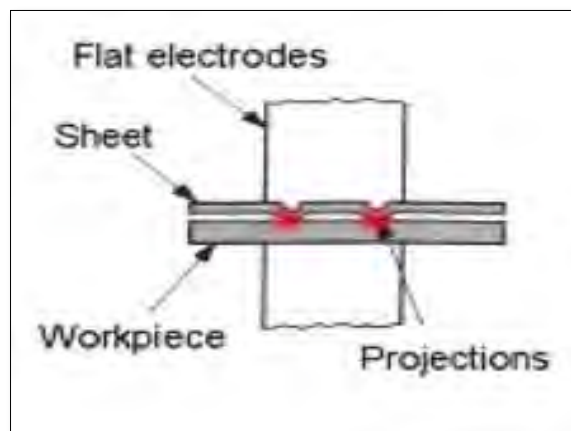


Figure 2.1: Projection Welding.

2.1.2 Spot welding Machine

The RSW is the most popular method joining metal sheet. The electric welding process which used in automotive industry is RSW which oldest. The connection arises by flowing the current and action of welding force. RSW was shown on Figure 2.2. The combination of pressure, heat and time welding will produce welds. The name resistance

welding because the resistance of the metal which need welded and produce heat for joints metal sheets. The required amount of time current flows in the joint is determined by material thickness and type, the amount of current flowing and the cross-sectional area of the welding tip contact surfaces. Heat produced between surfaces normally at surface metal sheets.

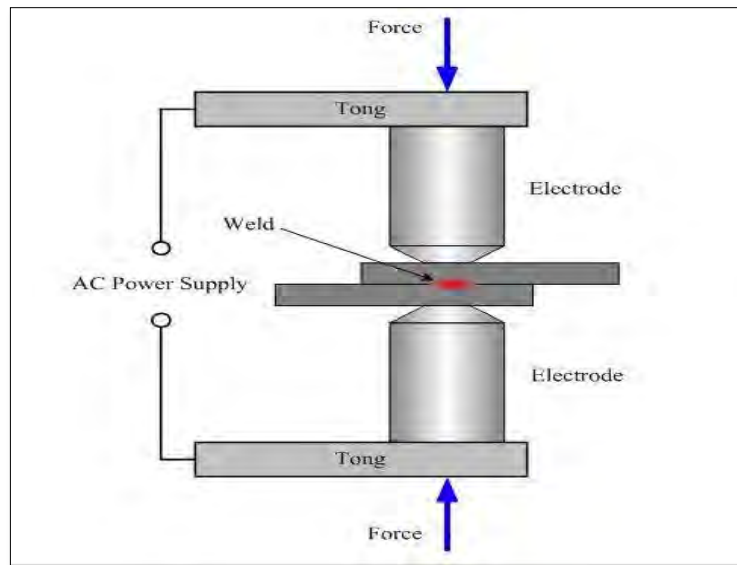


Figure 2.2: Spot Welding.

2.1.3 Seam welding Machine

Figure 2.3 shown the seam welding electrodes which use for welding. The electrical current will through cylinder electrode and produce heat at metal sheet to shape nugget and welded metal sheet. Welding process which called seam welding process will shape a series on the surface of the workpiece.