



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**SIGNIFICANT EFFECT OF GALVANNEAL METAL SHEET TO
THE QUALITY OF SPOT WELDING**

This report 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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ABSTRAK

Dalam industri automotif, penilaian pelanggaran merujuk kepada keupayaan struktur sesebuah kereta menyediakan perlindungan yang mencukupi untuk penumpang daripada kecederaan ketika kemalangan berlaku. Kebanyakannya, struktur kereta bergantung kepada kualiti kimpalan dan sifat-sifat mekanikal itu sendiri. Oleh itu, hasil daripada kimpalan pada bahagian yang ketara memberi kesan kepada keselamatan kenderaan dan sehubungan itu, kesan logam Galvanneal kepada kualiti kimpalan telah dikaji. Proses eksperimen yang telah dilakukan adalah ujian kekerasan (Rockwell) dan ujian tegangan (Shimadzu Universal Testing Machine). Sampel untuk diuji dibahagikan kepada dua kelas parameter. Perbezaan dapat dilihat dengan jelas apabila semua keputusan ujikaji selesai terhadap kedua dua kelas parameter. Dari eksperimen, saiz nugget untuk kepingan logam Galvaneal adalah 4.9mm. Sementara itu bagi sampel yang telah di buang lapisan cat adalah 4.6mm. Hasil kekerasan menunjukkan sampel Galvanneal adalah lebih keras berbanding sampel yang tiada lapisan cat. Keputusan ujian ketegangan juga sama menunjukkan sample Galvanneal mempunyai nilai yang tinggi berbanding sampel yang satu lagi. Hasilnya telah dianalisis dan ia menunjukkan kelas parameter B memberi kekuatan tegangan yang tinggi dan saiz nugget sampel adalah dalam julat yang dikira berdasarkan rumus $\sqrt[4]{t}$. Sifat-sifat nugget juga telah dibuktikan dengan mengkaji mikrostruktur pada bahagian berkenaan. Dari hasil SEM, mikrostruktur nugget dalam Parameter B menunjukkan bahawa seluruh kawasan nugget dipenuhi dengan martensit.

ABSTRACT

In automotive industry, crashworthiness refers to the capability of a car structure to provide adequate protection to passengers against injuries when crash happen. Mostly, car structure depends on the spot weld quality and mechanical characteristic behaviour. Therefore, the result of spot welds significantly affects the safety of the vehicles and effect of Galvaneal metal sheet has been studied. The experimental processes that has been done is Hardness test (Rockwell) and Tensile test (Shimadzu Universal Testing Machine). The samples were divided into two class parameters. The result for two class parameter is absolutely different. From the experiment, the size of nugget for Galvaneal metal sheet is 4.9mm meanwhile for rework sample is 4.6mm. The result of hardness show that the Galvaneal sample is hard than rework sample. The result was analysed and it show the parameter class B give the highest strength tensile, nugget size and optimum parameter compare to parameter A . The properties that have been produced at the fusion zone after process spot welding is also proved by studying the microstructure of the division. From the study, microstructure at fusion zone for Parameter B shows that the entire area is filled with martensite and austenite. This microstructure has elastic properties and high hard, parallel to the mechanical tests that have been carried out.

DEDICATION

Most Elevated Exceptional Grateful To Both My Loving Father and Mother

Ab Rahim Bin Yahya

&

Noraini Binti Othman

Also

To My Beloved Brothers and Sisters

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

RSW	-	Resistance Spot Welding
FZ	-	Fusion Zone
HAZ	-	Heat Affected Zone
M	-	Martensite
LB	-	Lath Bainite
A	-	Austenite
B	-	Bainite

CHAPTER 1

INTRODUCTION

1.0 Background of Project

Resistance spot welding (RSW) one type of resistance welding, characterized by its discrete areas of joining known as spot weld. RSW easily to identify because it's different with other welding which is use electrical resistance to joining materials. Today spot welding is one of metal joining process that mainly use in automotive industry (Anon 2013). The main focus of the automotive industry is to reduce the weight of car, enhance safety and crashworthiness while the cost is low. Galvanized steel sheet are now widely used to be the substrate for body in white. This study focuses on significant effect of galvanized metal sheet to the quality of spot welding. Two layer spot welding will be done by using galvanized metal sheet and HSS steel sheet as a base metal.

The testing sample will do in same thickness which is 0.7mm. Meanwhile one side/surface of Galvanized steel sheet has been rework for another sample to get the comparison result. Parameters such as welding time, welding force and welding current is constant. The strength of the joining metal will be test by using Universal Testing Machine (UTM) and Scanning Electron Microscopy (SEM) will uses to analyse the characteristic of the nugget microstructure.

Resistance spot welding (RSW) process were widely used in automotive industry and commonly used method for joining steels sheet For Automatic Production Line and the issuing of Massively, Resistance welding is a very effective

method. Resistance welding to very easy, flexible for an operation. In addition, this process also can be used to specify the coated metal sheets

Basically spot welding operate by applying an electric current through two contact point, two or more layer of metal sheet will welded together. The interfaces of the parts create current resistance and produces heat. The welds will be of the approximate size of the contact points and the filler metal of the base materials only. This process may be performed by robotic, manually or by dedicated spot welding machine. Spot welding process take only a few second. The illustrate diagram of resistance spot welding can be seen in Figure 1.1 below.

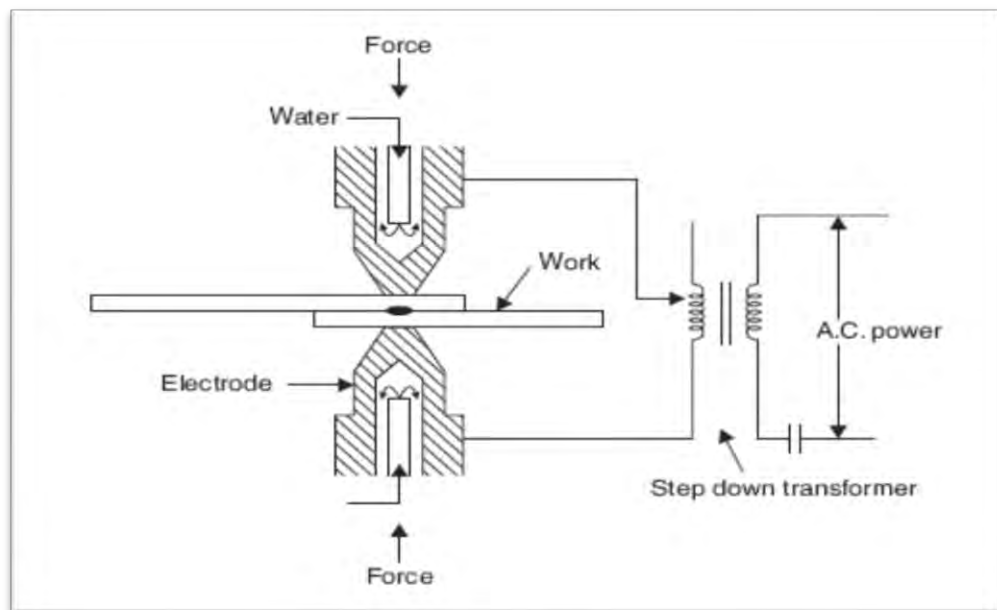


Figure 1.1 : Resistance Spot Welding with work piece.(Hwang et al. 2010)

In automotive industry, RSW is important process which to form the automobile's body structure or normally known as the body- in-white (BIW) in various thicknesses and type. Due to its robustness, speed, flexibility and low cost operation, RSW is a good choice applied to the automotive industry. Spot welding is a key technology in automotive assembly production due to fast process. Besides that, RSW also easily can weld many type of material combinations which are hard to do or even impossible to join by other welding technique. Referring to the

Arumugam, there are about 4000 – 6000 spot welds in an automobile (Arumugam & Nor 2015).

When the process of RSW is applying, the quality of spot weld is very important concern in relation to auto body durability, safety design and corrosion resistance of the automobile body. Therefore, the quality of the welding more concern to the strength, hardness and weldability of spot weld. A great result or quality of spot welding can determine by the study characteristic of nugget formation. Commonly spot welds can fail in two different modes, nugget pull out failure and interfacial failure (Chao 2003).

Due to the quality of welding, Galvanized steel sheet one of the material choose that commonly used based to their great corrosion resistance and durability (Hwang et al. 2010). To investigate the quality of spot welding, this study will focused on result of tensile, hardness and the microstructure of nugget formation between galvanized and ungalvanized metal sheet are used.

1.1 Problem Statement

According to the Bois, vehicle crashworthiness and occupant safety remain among the most important and challenging design considerations in the automotive industry (Bois et al. 2004). In other word it is refer to the edge or structure that will secure the passenger during crash. Crashworthiness is very important because it related to safety. Pouranvi said that the quality of RSW significantly affect durability and crashworthiness of vehicle (M. Pouranvari, P. Marashi 2008).

Teng said that, traffic accidents are one of the leading causes of mortality in modern society (Teng et al. 2008). Therefore, while it is desirable to retain the convenience and social functions afforded by automobiles, it is essential to reduce the number of deaths on the road. Vehicle crashworthiness provide adequate protection to its passengers against injuries in the event of a crash (Pouranvari & Marashi 2012).

The amount of car on the road has increased by the time and the probability to have traffic accidents also increase. One of the solution to reduce the severity of the injuries of occupant during accident is by improving the design of automobile an their protective features. According to the (Teng et al. 2008), there have a few features and safety device was created by manufactures such as airbags, energy-absorbing steering columns, side door beams and so on. Manufacture also have to work hard to fulfil the criteria that required by customers and from the company.

In automotive market they have to compete to produce multi-material structure of auto body in order to satisfy request at the same time improving car strength. But in the same time, the spot welds also have failure such as less strength and can lead into total destruction of manufacturing parts of car bodies. Usually, durability and safety design of the vehicle is significant affect due to characteristic failure and performance of the spot welds (Pouranvari & Marashi 2012).

In automotive industry, spot welding is an important welding technique that has been long established and extensively used. Weight of car also increased when safety item was added to automobiles. For example impact resistant bumpers and door impact beams (Pollard 1974). But it is still can avoided from the main focus of the automotive industry is to reduce the weight of car, enhance safety and crashworthiness while the low cost (Ramazani et al. 2015).

Besides that, the strength of weld joined can reduce the impact during accident. Clearly it can been seen that the spot welds and quality of weldability is one of the ways which can reduce..the impact from accident especially at the front and side of car. The combination of materials used padding structure on vehicle are important to upgrade damage lessening. Alluding to the (Fildes and Lane 1994) expansive extent of all genuine and lethal wounds was delivered from sidelong effects - as much as 27% to 30% and side effects represent 12% of aggregate "damage". The percentage direction of impact..in two-car side collision as shown in Figure 1.2.

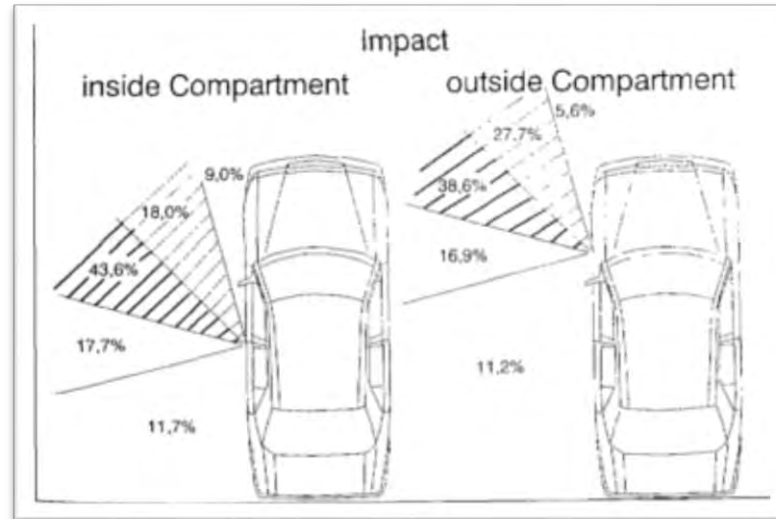


Figure 1.2: Percentage of Impact (Fildes and Lane 1994).

As a limitation of requirement..such as low cost and reduction weight, there are a few commonly type of material used in automotive. In order to fulfil the limitation, found that the Nielsen was study on Advance High Strength Steel (AHSS) combined with low carbon sheet material. Based on his study, Nielsen said there have problem when the formation of hard martensite phase during the rapid cooling is increase..the risk joint having brittle fracture (Nielsen et al. 2011).

According to the (Hwang et al. 2010) galvanized steel sheets with great corrosion resistance and durability have been most commonly used. Since the characteristic of galvanized sheet metal is same with the automotive demand such lower cost and good corrosion resistance. Hence, the purpose of this project research is to study the significant effect of galvanized steel sheet to the quality of spot welding by two layer spot weld.

1.2 Objectives

The objective is:

1. To investigate the quality and weldability of two layer welding using galvanized and non-galvanized metal sheets.
2. To investigate the optimum welding parameters in different metal sheets.

1.3 Project Scope

The research is subjected to the following scope:

1. To check the weldability of different metal sheet by using UTM.
2. To investigate the optimum welding by selecting three different welding parameter for different metal sheet.
3. Using Scanning Electron Microscopy (SEM) to investigate the microstructure of nugget related to the quality of the spot weld.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This chapter will discuss mainly on the theory / literature review about spot welding, parameters spot welding, types and features material, type of testing machine and theory testing.

2.1 Resistance Welding

In 1877, Professor Elihu Thomson was invented the resistance spot welding. The has been widely used in manufacturing industry especially in the automobile and air craft industries (Nied 1984). Resistance spot..welding is a process use heat obtained from resistance to electric current for joined contacting surfaces. The metal will join together and occur when the resistance of the flow current through the weld piece at the pressure point creates heat. In other to make a good welding joint, sufficient heat must be produced at the surface of the metal plates. Parameters such as current, force and time must be properly related in order to obtain a good weld.

The resistance spot welding process can be classified into:

- Projection welding
- Spot welding
- Seam welding
- Flash butt welding

2.1.1 Projection Welding

Projection welding is a type of spot welding. In this procedure, the weld is restricted by method for raised segments, or projections, or both of the work pieces to be joined. Heat is concentrated at the projections, which allows the welding of heavier areas or the nearer dispersing of welds. Projection welding is commonly used to weld studs, nuts, and other screw machine parts to metal plate (Furlanetto et al. 2012). Besides that it is also used to join crossed wires and bars. The advantages of the resistance projection welding is can be used for making several welds simultaneously. In terms of energy used, the concentration of welding current makes projection welding more efficient than others welding method.

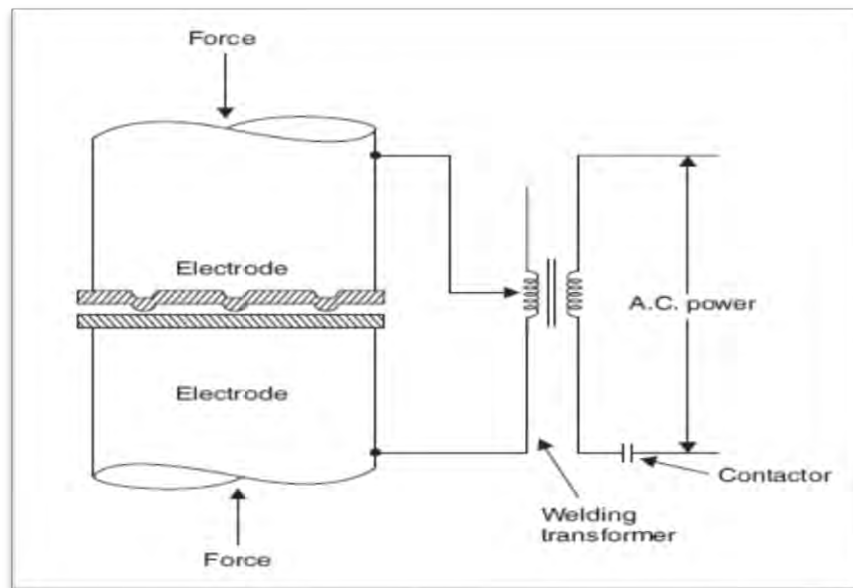


Figure 2.1 Diagram of projection welding (Furlanetto et al. 2012).

2.1.2 Resistance Spot Welding

Resistance spot welding process is a widely used process in industries especially in automotive industry. The process of spot welding are to join the metal by resistance to the flow of current electric through work pieces that are held together under force by electrodes. The fuse nugget of weld metal is formed when