INVESTIGATE ON MILD STEEL SPOT WELDING STRENGTH EFFECT BY USING DESIGN OF EXPERIMENT (DOE)

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SUPERVISOR DECLARATION

"I hereby declare that I have read this thesis and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Design and Innovation)"

Signature : ....

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DECLARATION

"I declare that this report entitled "Investigate on Mild Steel Spot Welding Strength Effect by using Design of Experiment (DOE)" is the result of my own research except as cited in the references"

Signature	: ………………………………….
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DEDICATION

Highest Special Thankful Wishes to Both My Lovely Father and Mother

Syed Hassan Bin Syed Mohamaad

&

Zaliha Bt. Anang

Also

Lovely Brothers and Sister

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ABSTRAK

Proses kimpalan rintangan titik adalah salah satu proses penyambungan logam yang penting terutamanya di industri automotif. Proses kimpalan rintangan titik memerlukan parameter yang telah ditentukan oleh pengguna kimpalan titik seperti arus elektrik atau kuasa elektrik, kitaran masa dan tekanan. Dalam kajian ini, parameter-parameter kimpalan rintangan titik akan dianggarkan menggunakan perisian statistik Minitab melalui kaedah rekabentuk eksperimen (DOE). Parameter-parameter tersebut perlu ditetapkan nilai atas dan bawahnya. Dengan menggunakan kaedah rekabentuk eksperimen (DOE), parameter-parameter tersebut dapat dioptimasikan dan mempunyai gabungan parameter yang mencapai kualiti sasaran. Analisis dari rekabentuk eksperimen (DOE) boleh menunjukkan kepentingan parameter-parameter yang digunakan sama ada ia memberi kesan ataupun tidak dalam perubahan kualiti dan kekuatan pada produk tertentu.

ABSTRACT

Spot welding is one of the metal joining processes that mainly use in the automotive industries. Spot welding process needed parameters that been define by the user such as power or current, time cycle, and pressure. In this study, parameters of the welding will be estimated using Minitab Statistical Software by Design of Experiment (DOE) method. The parameters will be set to high and lower value. By using DOE method, the parameters can be optimize and having the best parameters combination for target quality. The analysis from DOE method can give the significance of the parameters as it give effect to change of the quality and strength of product or does not.

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LIST OF ABBREVIATIONS

DOE	-	Design of Experiment
JIS	-	Japanese Industrial Standard
BS	-	British Standard
twd	-	Top Spot Welding Diameter
bwd	-	Bottom Spot Welding Diameter
lt	-	Overlapped Thickness
ML	-	Max Load
YL	-	Yield Load
Seq SS	-	Sequence Sum of Square
Adj SS	-	Adjusted Sum of Square
Adj MS	-	Adjusted Mean of Square

CHAPTER 1

INTRODUCTION

1.1 Background of The Project

Nowadays, development of technologies provides us an extra change and awareness in technology which lead to specific changes in economic and socio-cultural values. Along with the change in values, the society becomes more focus from production to information and creativity. As the result, the consumer of this era has started to access creativity and innovation.

Welding technology is one of the joining processes that are widely used in the modern manufacturing technology such as shipbuilding, automotive industry, bridges and more. It is also well-known that the welding distortions defects are always occur during the welding process due to the non-uniform expansion and contraction of the weld and the surrounding base material. The welding distortion and defects not only degraded the welding quality but also increasing the production cost. Therefore, the prediction and control of welding distortion and defects have become of critical importance in industries producing welded structures.

Spot welding process required two or three overlapped or stacked stamped components that are weld together due to heat created by electrical resistance. This process may be performed manually, robotic or by dedicated spot welding machine. The spot welding process take the shortest time comparing to the other type of welding process.

Weld that was done by spot welding process is discrete wed locations that look like small circles on the assembled components. This weld process is not continuous. In spot welding there are several variables involve in the process such as current, pressure, human element, type of material, material thickness, welders condition, material surface and electrode tip surface. Some of the spot welding machines were use power instead current. To achieve to good quality of spot welding start with a good process design that minimize the variables during the process.

Up to now, there a lot of study on the statistical method of getting the best parameters for welders, such as (Casalino, Curcio et al.) were investigates laser welding by using statistical and Taguchi approaches.

Design of Experiment (DOE) can be defined as a systematic problem-solving approach to engineering that applies principles and technique at the data collection stage to ensure the generation of valid defensible and supportable engineering conclusions. All of this carried out can reduce expenditure of engineering runs, time and money.

By understanding this scenario of the current needed. This project were pointed on investigating on spot welding strength effect in getting the optimize parameters as the one part to improve the parameters selection to get the best strength by using Design of Experiment (DOE) method.

1.2 Objective of the Project

This study aims to explore the role of the statistical modeling methods such as ANOVA, Taguchi approaches and Design of Experiment (DOE) on analyzing the parameters as the parameters that will affect spot welding quality. The primary interest is the parameters that give main effect to the welding quality and strength. The objectives of this project are:

i. To study the spot welding and the factors affecting the good spot welding quality.
ii. To analyze the spot welding parameters as the main effect of the welding strength by using statistical modeling.
iii. Using Design on Experiment to estimate good parameter of the spot welding variables.

1.3 Problem Statement

Spot welding is the major bonding technique that were widely use in automotive industry. 30% of the total amount of the joining part of the car was use spot welding as the joining technique due to difficulties to estimate welding parameters. The advantages of the resistance spot welding are high speed and suitability for automation and inclusion in high production assembly lines with other fabricating operations. Spot welding is a fast process that does not need any welding skill. Spot welding also have less probability on human error affect to the welding quality.

Several variables to control resistance spot welding in order to produce good quality welding are weld current, welding pressure and time. Current, timing and electrode force were control automatically. This type of control can produces a very fast process with high quality of welding and strength at high production rates and low unit labor cost as it can be operate by unskilled operators.

1.4 Scope of The Project

This study is base on the statistical experiment modeling by combining various welding parameters. Scope of this project will be covering the case study through the literature review, journal finding and experimental for new combination of welding parameters.

By study the literature review and journal, the effect to the strength and quality of the welding in understood. These can give some information during develop a new combination of spot welding parameters. The output data is collected by a method as the mathematical model is produce during the end of this study. The method going to be use is Design of Experimental (DOE). Scopes of this project are:

1. Study will base on the best combination of parameters on mild steel by using spot welding machine as tool for welding.
2. By using Design of Experiment (DOE) method to get the combination of parameters and the number of experiment.
3. Study on power usage for spot welding, time cycle needed, and pressure use to get the best quality ant toughest strength.
4. Observe welding quality that occurs from the experiment as the reference to comparing with the welding strength to get the best quality
5. Using mild steel with 2mm thickness as the welding material.

CHAPTER 2

LITERATURE REVIEW

2.1 Welding

Today, it is clearly shows that the status of welding has now changed from skill to science. A scientific understanding of the material and service requirement of the joints is necessary produce successful welds which will meet the challenge of hostile service requirements.

Welding is a process of permanent joining between two materials through localized coalescence resulting from a suitable combination of temperature, pressure and metallurgical. It also depending on the combination of temperature and pressure, a wide range processes has been developed. American Welding Society has classified the welding process as shown in **Figure 1**.

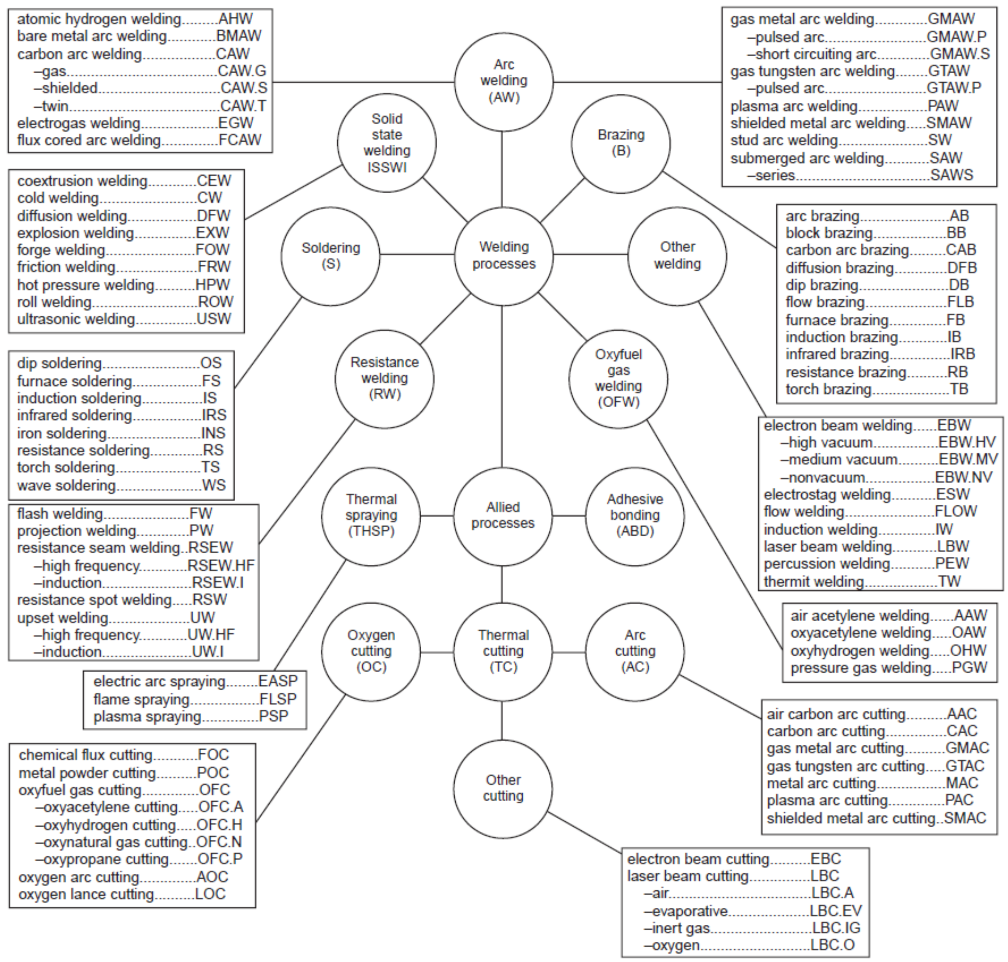

Figure 1: Master Chart of Welding and Applied Processes

(http://www.newagepublishers.com/samplechapter/001469.pdf)

Type of welding processes:

i. Gas Welding
- Oxyacetylene
- Oxy hydrogen

ii. Arc Welding
- Carbon arc
- Metal arc
- Submerged arc
- Inert gas welding (MIG and TIG)
- Plasma arc
- Electro-slag

iii. Resistance Welding
- Spot welding
- Seam welding
- Projection welding
- Butt welding
- Induction welding

iv. Solid State Welding
- Friction welding
- Ultrasonic welding
- Explosive welding
- Forge and diffusion welding

v. Thermo-chemical Welding
- Thermit welding
- Atomic H_2 welding

vi. Radiant Energy Welding
- Electron beam welding
- Laser beam welding

To obtain coalescence between two materials there must be a combination of proximity and activity between the molecules of the pieces being joined, sufficient to cause the formation of common metallic crystals. Proximity and activity can be increase by plastic deformation or by the melting the two surfaces so that the fusion occurs.

Solid state welding, surfaces are joined by mechanically or chemically cleaned to welding. Fusion welding, the contaminants are removed from the molten pool by the use of fluxes and in vacuum or in outer space the removal of contaminant layer is quite easy and welds are formed under light pressure.

Surfaces contaminants may be organic film, absorbed gases and chemical compounds of the base metal. Heat when used as a source of energy, effectively removes organic films and adsorbed gases and only oxide film remains to be cleaned. Fluxes are used to clean the oxide film and other contaminants to form slag which floats and solidifies above the weld bead protecting the weld from further oxidation.

To protect the molten weld pool and filler metal from atmospheric contaminants such as oxygen and nitrogen, shielding gas need to be used. This shielding gas would be argon, helium, carbon dioxide or combination of argon and helium with carbon dioxide supplied externally. Carbon dioxide can also be produced by the burning of flux coating on the consumable electrode which supplies the molten filler metal to the weld pool.

When the molten metal solidified, the microstructures formed in the weld and the heat affected zone (HAZ) region determines the mechanical properties of the joint produced. The cooling rate in the weld and HAZ regions can be control by post welding heat-treatment and pre-heating and thus control the microstructure and properties of the welds produced. Deoxidants and alloying elements are added as in foundry to control the weld-metal properties.

2.1.1 Selection of Welding Process

A weld should achieve a complete continuity between the parts being joined such that the joint is indistinguishable from the metal in which the joint is made. An ideal situation is unachievable but welds giving satisfactory service can be made in several ways. The choice of the particular welding will depends on several factors, that is:

i. Type of metal and its metallurgical characteristics
ii. Type of joint, its location and welding position
iii. End use of the joint
iv. Cost production
v. Structural size
vi. Desired performance
vii. Experience and abilities of man power
viii. Joint accessibility
ix. Joint design
x. Accuracy of assemblies required
xi. Welding equipment available
xii. Work sequence
xiii. Welder skill
xiv. Robotic welding skill