UNIVERSITI TEKNIKAL MALAYSIA MELAKA

OPTIMIZATION PARAMETER AND MECHANICAL PROPERTIES FOR ALUMINIUM 5052 – H32 BY MULTI - PASSES BUTT JOINT USING FRICTION STIR WELDING

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

by

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DECLARATION

I hereby, declared this report entitled Optimization Parameter and Mechanical Properties for Aluminium 5052 – H32 By Multi – Passes Butt Joint Using Friction Stir Welding is the results of my own research except as cited in references.

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APPROVAL

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

……………………………….

(EN MOHD HAIRIZAL BIN OSMAN)

ABSTRACT

This report is the result of an experiment to investigate the tensile strength of the welding joint. By using Fiction Stir Welding Machine to optimize the setting of welding parameter spindle speed (rpm) and weld rate (mm/s) on tensile strength of welding joint of Aluminium 5052 – H32 as a workpiece material. In the main, welding parameter will be influenced the result of tensile strength of welding joint. The design of experiment (DOE) by using Taguchi and ANOVA Method was created, the signal to noise ratio (S/N) was used to study the welding parameter effect to tensile strength of the welding joint (welding bead).

ABSTRAK

Laporan ini adalah hasil daripada eksperimen untuk mengenal pasti kekuatan tegangan pada sambungan kimpalan. Dengan menggunakan mesin kimpalan geseran untuk mengoptimumkan penetapan pada parameter kelajuan pengumbar (rpm) dan pergerakan kimpalan (mm/s) pada bahan aluminium 5052 – H32 untuk menganalisis kekuatan tegangan pada sambungan kimpalan ini sebagai bahan kerja ujikaji. Kebiasaanya, parameter kimpalan ini akan mempengaruhi keputusan kekuatan tengangan pada sambungan kimpalan. Oleh itu, dengan pengunaan Kaedah Taguchi dan ANOVA dapat mencorak rekabentuk eksperimen (DOE) untuk menilai nisbah isyarat – hingar (S/N) digunakan untuk mengkaji atau analisis kesan parameter kimpalan terhadap kekuatan tengangan pada kawasan sambungan bahan yang dikimpal.

DEDICATIONS

I dedicate my dissertation work to my family and all my friends, A special feeling of gratitude to my loving parents, Asmahniar Binti Sarrah and Hairus Saleh Bin Omar whose word of encouragement and always give positive vibes whenever me in depress. I also dedicate my dissertation to all my friends that support and contributed some of the ideas for this research. Thank you for everything.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

ANOVA	-	Analysis of variance
Al	-	Aluminium
FSW	-	Friction Stir Welding
FOW	-	Forge welding
CW	-	Cold welding
EXW	-	Explosive welding
DFW	-	Diffusion welding
rpm	-	Rotation per minute
OA	-	Orthogonal Arrays
DoE	-	Design of experiment
S/N	-	Signal-to-Noise ratios
AISI	-	America Iron and Steel Institute
ASTM	-	American Standard Testing and Material
UTS	-	Ultimate Tensile Strength
HAZ	-	Heat affected zone
TMAZ	-	Thermo mechanical affected

F	-	F test (ANOVA)
P	-	P test (ANOVA)
Adj SS	-	Adjusted Sum of sequences (ANOVA)
Adj MS	-	Adjusted Mean of sequences (ANOVA)

CHAPTER 1

INTRODUCTION

This chapter will be explaining the overview of the experiment study of friction stir welding similar join for multi - passes. This chapter includes the background, objective, scope, and problem statement to achieve study is going to be conducted.

1.1 Background of the study

In industry now a day, material use for fabrication of automotive part, aerospace, ship building and fabrication is aluminum 3, 5, 6 and 7 series of materials. These materials basically use fabrication of oil tank, rim wheel, marine building body and bracket aerospace and etc. This application of material normally use because this type of material have good mechanical properties, good for fabrication, light weight and anti-corrosion.

However, Minitab 15 software has many type of method for research application. In this experiment study, use two methods at Minitab 15 software is Taguchi and ANOVA to analyze and determine the optimization of parameter at friction stir welding process the output. The Orthogonal Array (OA), Signal to Noise (SN) ratio, predicted value and analysis of Variance applied for the data analysis respectively.

In this experiment, used the flamefast friction stir welding to analysis the process of experiment for multi – passes joining process, the material use in this experiment is material aluminum 5052-H3 for multi-passes joining. From this research and development for multi-passes joining to measure or identify the strength of mechanical properties, to analyze the significant value of parameter using the Taguchi Method and ANOVA to measure the significant parameter of multi – passes based on two type of parameter friction stir welding is Spindle Speed (rpm) and Weld Rate (mm/s). In this experiment for analysis the tensile strength of joining using the Universal Tensile Test Machine INSTRON 5669 to measure the strength of multi-passes joining. Tensile test it also known as tension test is probably the most fundamental type of mechanical test that can be performing on welding part to see the strength of welding area. Tensile test are simple, relatively, inexpensive, and fully standardized. By pulling on something, you will very quickly determine how the material will react to forces being applied in tension.

1.2 Problem Statement

In the friction stir welding is one of the important factors the effect the welding strength. These frictions stir parameter consists such as spindle speed (rpm) weld rate (mm/s) and plunge depth. The microstructure can be analysis such as the defect into the zone of friction stir welding is stir zone (welding bead), flow arm zone, thermo – mechanical affected zone (TMAZ) and heat- affected zone (HAZ). The analysis of the mechanical testing all specimens tested, using Universal Tensile Test Machine. By using the Taguchi and ANOVA Method, we are going to achieve the optimize parameter friction stir welding for aluminum 5052 using two variables of parameter at three level. The result from the tensile test will be determined the best parameter or significant value parameter will be presented using Taguchi and ANOVA Method.

1.3 Objectives

The general objective of this project is to:-

I. To optimize parameter of multi passes for friction stir welding.

II. To identify the welding strength factor of mechanical properties for multi – passes friction stir welding.

III. To determine the most significant level of parameter using the Taguchi and ANOVA method

1.4 Scope

In this research, things included and limitation of parameter for Multi – Passes for Friction Stir Welding will discussed. The area of study is optimal parameter and mechanical properties for tensile strength. The machine that will be used is Flamefast Friction Stir Welding. This is due to easy preparation of the machine. This machine also can do different parameter for spindle speed (rpm) and weld rate (mm/s) kind of process that we will use when running the experiment. The process that will involve in this experiment is parameter of Multi - Passes. These processes will use the same friction stir tool, the same parameter and same material. At the end of the process, the result of the Multi – Passes Friction Stir Welding Butt Joint that are being used in this research.

After finish the Multi – Passes process welding, the part will be examined on the tensile test of the specimen. The tensile tester will be used to determine the value of the strength of joining. Then the part will be compared the data using the Taguchi and ANOVA to determine the best parameter and Rank of parameter Multi – Passes Friction Stir Welding using the Minitab software.

The material that will be used in the experiment is aluminium 5052 – H32. These materials will undergo the machining process under parameter that has been set. This research will only focus the two main things that are tensile strength and significant parameter.

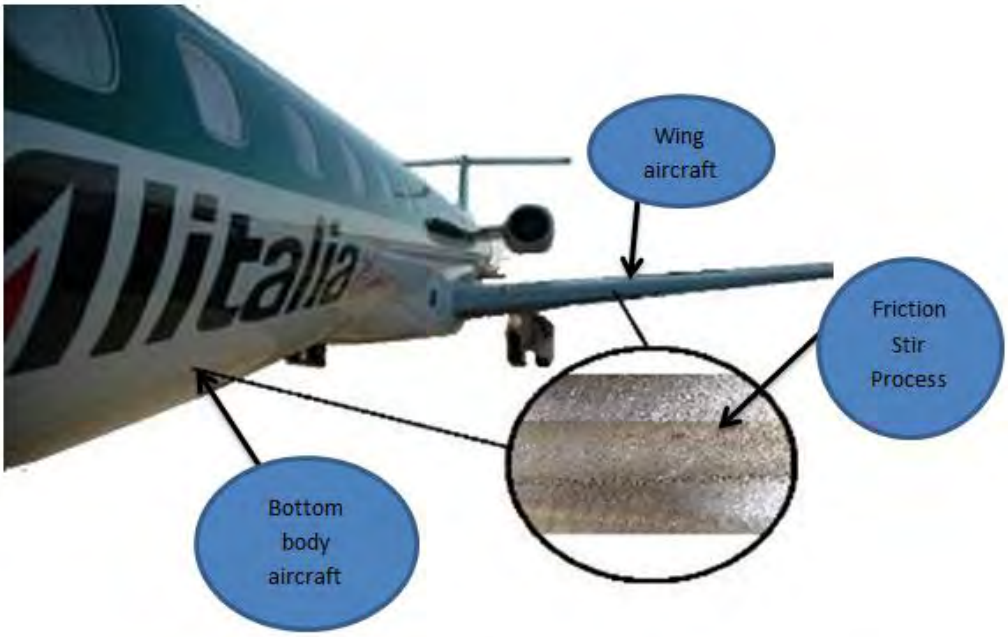

Figure 1.1(a): Application Friction Stir Welding (Aerospace)

Figure 1.1(b): Application Friction Stir Welding (Automotive)

Table 1.1(a): Type of parameter

PARAMETER	LEVEL			OBSERVED VALUE (Mpa)
Spindle speed (rpm)	800	900	1200	Tensile Strength
Weld Rate (mm/s)	5.0	7.0	9.0	

Table 1.1(b): Experimental layout using Taguchi Method

No	Spindle speed (rpm)	Weld rate (mm/s)	Tensile specimen				
			T1	T2	T3	T4	T5
1	800	5.0					
2	900	7.0					
3	1200	9.0					
4	800	5.0					
5	900	7.0					
6	1200	9.0					
7	800	5.0					
8	900	7.0					
9	1200	9.0					

CHAPTER 2

LITERATURE REVIEW

In this chapter, we will discuss literature review of this project. A literature review is based on searching, collecting, analyze, studying and write the conclusion from all debates and issues raised in the relevant body of the literature. In this project literature review will be focusing on the research of various theory and basic knowledge that are related to the friction stir welding joining. The relevant case study will be providing on this chapter as previous research are to be determined and compared with the similar.

The similar material joining part is yet to be determined after several studies on other related researches. The purpose of this chapter is, review the best type of the similar material joint for friction stir for the aluminum 5052.

2.1 Literature Review

2.1.1 Solid State Welding

In solid state welding have many type of the joining processes, type in the solid state welding is brazing, soldering, adhesive and mechanical fastening. These solid states welding commonly apply in industry aerospace, automotive, shipping build and rail.

For solid state welding three types is chemical, electrical and mechanical. For mechanical has type of welding is forge, cold, roll, hot pressure, diffusion, friction,

friction stir, and ultrasonic, this all type for solid state is joint takes place without fusion welding at the interface of the two parts to be welding, this process no liquid or molten phase is present in the joint. The processes are automated by suing robotics, vision systems, sensors, and adaptive computer controls for the cost reduction, consistency, reliability of weld quality, and higher productivity. This solid state welding involves one or more phenomena are diffusion, pressure and relative interfacial movements.

Diffusion is the transfer of atoms across an interface causing diffusion bonding will be apply external heat improves strength of the bond between the two surfaces being joined, this heat may be generated internally by friction, electrical resistance heating and externally by induction heating. Solid state welding is a welding process in which two work pieces are joined under pressure providing an intimate contact between them and intimate contact between them and at a temperature essentially below the melting point of the parent material.

The advantages of solid state welding:

- Weld bonding is free from microstructure defect.
- Mechanical properties of the weld are similar to those of the parent metal.
- No consumable materials are required.
- Dissimilar metal may be joined.

The disadvantages of solid state welding

- Expensive equipment.

This solid state welding have 6 type of solid state welding is:

- Forge welding (FOW)
- Cold welding (CW)
- Friction Stir welding (FSW)
- Explosive welding (EXW)
- Diffusion welding (DFW)
- Ultrasonic welding (USW)

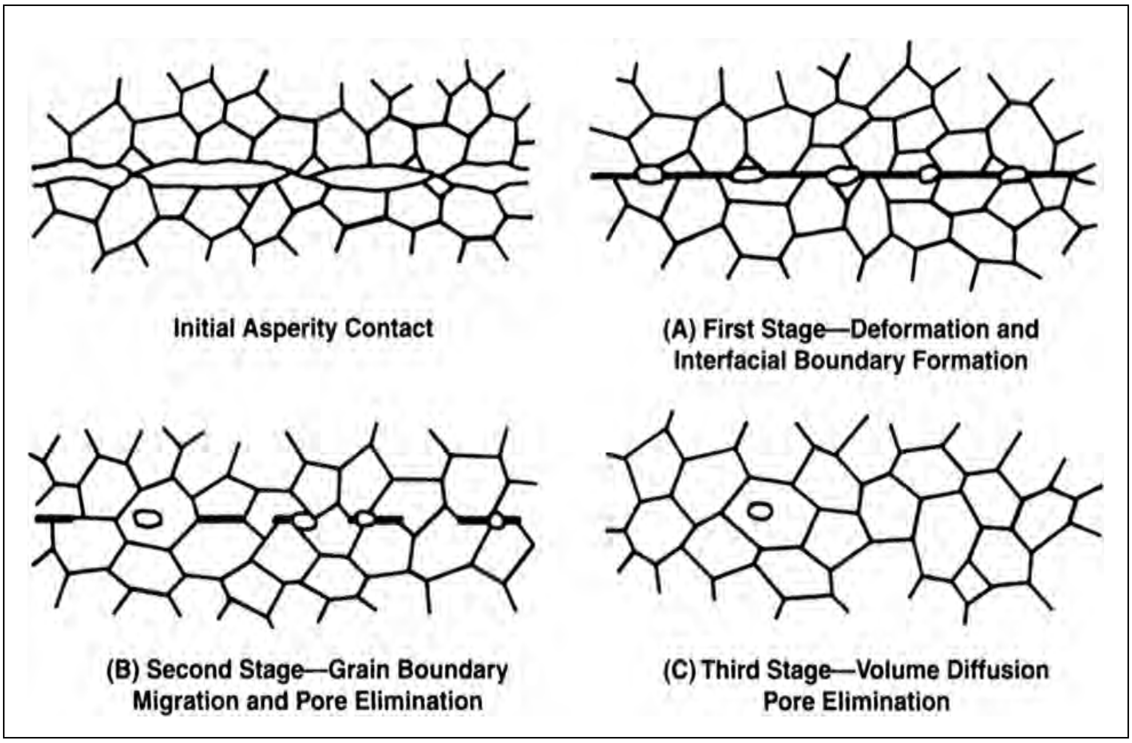

Figure 2.1(a): Three – stage mechanistic model of diffusion welding

Adapted from: thermalscieneapplication.com