INFLUENCE OF CONSUMABLE AND CURRENT TOWARDS MECHANICAL PROPERTIES ON ARC WELDING

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SUPERVISOR DECLARATION

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering.

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DECLARATION

"I hereby declare that the work in this report is my own except for summaries and quotations which have been duly acknowledged."

Signature :

Author : Ngiow Shin Nian

Date : 20 / 12 / 2011

Special dedication to my beloved parents

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ABSTRACT

Welding is quite common in industry, and it is also very common that we heard of failure occur because of welding factor. Therefore, this research is going to obtain the optimum welding parameters of consumable and current flow that affect mechanical properties of a welding. Total of 3 different consumables and 3 different current range will involve. Butt joint and lap joint are used as joint sample for mechanical testing of weldment strength. The comparisons to verify the optimum parameter will be done by analysis of experimental result. Hardness test, tensile test, and shear test will be conducted and analized.

ABSTRAK

Kimpalan adalah teknologi yang agak biasa dalam industri, dan ia juga sangat umum bahawa kita mendenga kegagalan berlaku disebabkan faktor kimpalan. Oleh itu, kajian ini adalah untuk mendapatkan parameter kimpalan yang optimum untuk elektrod dan aliran arus yang memberi kesan kepada sifat-sifat mekanik kimpalan. Jumlah 3 jenis elektrod yang berbeza dan 3 aliran arus yang berbeza yerlibat dalan kajian tersebut. Butt sendi dan pusingan sendi digunakan sebagai sampel bersama untuk ujian mekanikal kekuatan hasil kimpal. Perbandingan untuk mengesahkan parameter optimum akan dilakukan oleh analisis keputusan eksperimen. Ujian-ujian kekerasan,ujian tegangan dan ricih akan dijalankan dan dianalisis.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

SYMBOL	TITLE	PAGE
AISI	AMERICA IRON AND STEEL INSTITUTE	4
ASTM	AMERICA STANDARD TEST METHOD	6
DC	DIRECT CURRENT	8
AC	ALTERNATING CURRENT	8
SMAW	SHIELDED METAL ARC WELDING	9
GMAW	GAS METAL ARC WELDING	9
FCAW	FLUX CORE ARC WELDING	9
GTAW	GAS TUNGSTEN ARC WELDING	9
SAW	SUBMERGED ARC WELDING	9
MIG	METAL INERT GAS	11
MMAW	MANUAL METAL ARC WELDING	11

LIST OF APPENDICES

CHAPTER 1

GENERAL INTRODUCTION

1.1 Introduction

Welding technology education is widely used on industrial ground. Basically, welding is a process of joining two metal or thermoplastic. It is normally done by melting of two workpieces with additional of filler matter to form a pool of molten metal and cool down become a good joint. There are many types of welding, for example, electric arc welding, gas welding, resistance welding, energy beam welding, and solid-state welding. Among those welding method, arc welding and gas welding are two conventional welding that is widely used in engineering field. The motivation of arc welding study is due to the low cost. Welding is a process lead to hazard such as burning, electric shock, vision damage, and poisonous gases. A few safety precaution need to be done before welding process.

This research was focused on arc welding. Although arc welding is a conventional welding method, there are still less research done on changes of welding parameter to determine optimum state of welding. Most of the researchers focused on the welding method to overcome the failure such as porosity and minor crack during welding. Basically, there are a few parameters that can affect weldment of an arc welding, which are current flow, type of consumable, preheat of workpieces, voltage, baking of consumable, and heat input. This research was focused on the influenced of current flow and type of consumable to mechanical properties of arc welding joint.

1.2 Research objectives

The objectives of this research are:

- To obtain the best consumable towards low carbon steel workpiece.
- To determine optimum current flow for better result of arc welding joint.
- To evaluate the strength of arc welding joint of different welding parameter.

1.3 Problem statement

Human and welding parameter error may cause failure of welding joints. From previous study, a lot of researchers study on the failure analysis of spot welding and stir welding. Lack of research done on the failure analysis or the optimum parameter for the welding joint. Therefore, failure analysis on arc welding will be done in this study. The optimum parameter for the welding joints will also be identified. The parameters to be identified are current flow and type of consumable rod as these two parameters influences the strength of the joints. Mild steel is chosen in this research because it is widely used in structure concrete and automotive industry.

1.4 Scope

Literature review on the related research;

- Analysis will focus on arc welding.
- 3 types of filler material involved in order to study the influence to the mechanical properties.
- 3 different current flow involved in order to study the influence to the mechanical properties.

Chapter 2

LITERATURE REVIEW

2.1 Introduction Of Steel

Steel was known in antiquity. The earliest known production of steel is of ironware. Steel is the world most important engineering material. Iron and steel are used broadly in the field of construction like roads, railways, and other infrastructure.

Steel is a kind of allow that contents mostly iron and has some carbon content in a range of 0.2% and 2.1% by its weight. Carbon content is depending on grade of steel that we required. Among the content of steel, carbon is the most common alloying element for iron. However, there are more alloying material such as manganese, chromium, vanadium, and tungsten. Elements other than iron are acting as hardening agent to prevent dislocations of iron atom crystal lattice from sliding. Changing the amount of alloying contents can actually controls quality of steel in term of hardness, ductility, and tensile strength of steel. Steel made of high carbon content is much harder and higher strength than iron but lower ductility.

Alloys with a carbon content higher than 2.1% we called it as cast iron as it has lower melting point and high castability. Steel that contain small amount of carbon but included in form of slag inclusion is distinguish from wrought iron. It has increased rust resistance and better weldability.

However, there is no material called steel as steel is a general name given to the huge family of alloys of iron with carbon content and various different elements in it. A small differences in the composition of steel can have a big effect on its characteristic and other properties. In addition, properties of steel can be changed or improved by various mechanical process and heat threatments.

Therefore, steel is a very versatile material as we can adjust its composition of elements, internal and external structure to meet specific requirement. This is how engineering produce different kind of steel for different usage like paperclips, steel for bridges, thin strips of steel for razor blades, and huge beams for columns.

2.2 Type Of Steel

Steel is never a single product. There are more than 3500 different grades of steel with various chemical, physical and environment properties currently. It is approximate 75% of modern steels have been improved in the past 20years. With current steel technology, to rebuild Fiffel Tower would just need one-third of the amount of steel. In other words,current steel technolody is more eco friendly and consume less steel ore. Modern cars can be built with new steel that is stronger and lighter than in the past.

The American Iron and Steel Institute have standardized AISI steel grades as below:

2.2.1 Carbon Steel and Low Alloy Steel;

Carbon steel is steel where main interstitial alloying content is carbon. The America Iron and Steel Institute(AISI) has defined steel as:" Steel is considered as carbon steel when there is no minimum content is required for chromium, cobalt, molybdenum, nikel, niobium, titanium, tungsten, vanadium, or any other element to be added for alloying process. Carbon steel is to be used when steel which is not stainless steel. When carbon element increases, steel can become harder and stronger by heat treatment process, but it will decreases in ductility. High carbon content steel reduces its weldability.

Carbon steel is devided into 3 different categories;

Low carbon steel - carbon content is less than 0.1%
Medium-carbon steel - carbon content is in the range of 0.4% - 0.6 %
Ultrahigh-carbon steel - carbon content is in the range of 1.25% - 2.0%

Low Alloy Steel;
Low Alloy Steel is a category of ferrous materials that show mechanical properties that superior to plain carbon steels by adding alloying elements like nickel, chromium, and molybdenum. Sum of alloy content can be from 2.07% until a level just below that of stainless steel. Primary performance of alloying elements is to improve hardness in order to maximize mechanical properties and toughness after heat treatment.

Both the steels are designated by a four digit number. First two digit representing alloying elements while the last two digits representing the amount of carbon, in hundreths of a percent by weight.

Example : Carbon Steels,Mn steel,Mo steel,Ni steel,Cr steel,Ni- Cr steel,Chromium-Molybdenum (Chromoly) Steels,Nickel-Chromium-Molybdenum Steels,Nickel-Molybdenum Steels,Cr steel,Chromium-Vanadium Steels,Tungsten-Chromium Steels,Silicon-Manganese Steels and more.

2.2.2 Stainless steel;

200 Series—austenitic chromium-nickel-manganese alloys
300 Series—austenitic chromium-nickel alloys
Type 301—highly ductile, for formed products. Also hardens rapidly during mechanical working.
Type 303—Free machining version of 304 via addition of sulfur
Type 304—the most common; the classic 18/8 stainless steel.
Type 316—the next most common; for food and surgical stainless steel uses; Alloy addition of molybdenum prevents specific forms of corrosion. 316 steel

is more resistant to corrosion than 18-8 stainless steels. 316 steel is used in the handling of certain food and pharmaceutical products where it is often required in order to minimize metallic contamination. 316 steel is also known as "marine grade" stainless steel due to its increased ability to resist saltwater corrosion compared to type 304. SS316 is often used for building nuclear reprocessing plants.

400 Series—ferritic and martensitic chromium alloys

Type 408—heat-resistant; poor corrosion resistance; 11% chromium, 8% nickel.

Type 409—cheapest type; used for automobile exhausts; ferritic (iron/chromium only).

Type 410—martensitic (high-strength iron/chromium).

Type 416

Type 420—"Cutlery Grade" martensitic; similar to the Brearley's original "rustless steel". Also known as "surgical steel".

Type 430—decorative, e.g., for automotive trim; ferritic.

Type 440—a higher grade of cutlery steel, with more carbon in it, which allows for much better edge retention when the steel is heat treated properly.

500 Series—heat resisting chromium alloys

600 Series—martensitic precipitation hardening alloys

Type 630—most common PH stainless, better known as 17-4; 17% chromium, 4% nickel .

2.2.3 Other steels;

The standards organization ASTM International produces standards for structural steel used in the construction industry. Those steel alloys have designations which start with A, for example A36, A588, or A514.

2.3 Mild steel

Mild steel is one of the carbon steel members. Carbon steel which is also called plain carbon steel is a metal alloy. It is a combination of at least two elements, iron and carbon are the major element whereas other elements are present at a minor quantities which is too small to affect its properties. The only allowable alloying elements in plain carbon steel are manganese, silicon, and copper at a range of 0.6% to 1.65%. steel with low carbon content has same properties as iron which is soft but easily formed. The increase of carbon content consequences metal to become harder and stronger but drop in ductility and more difficult to weld. High carbon content lowers melting point of steel and its temperature resistance.

2.4 Arc Welding

Arc welding is a joining process that involve fusion of two pieces of metal by an electric arc between the pieces being joined, the work pieces, and an electrode that is guided along the joint between the work pieces. Electrode is simply a rod that carries current between the tip of electrode and the work piece. It is a process that a rod that melts and provides filler metal to a joint.

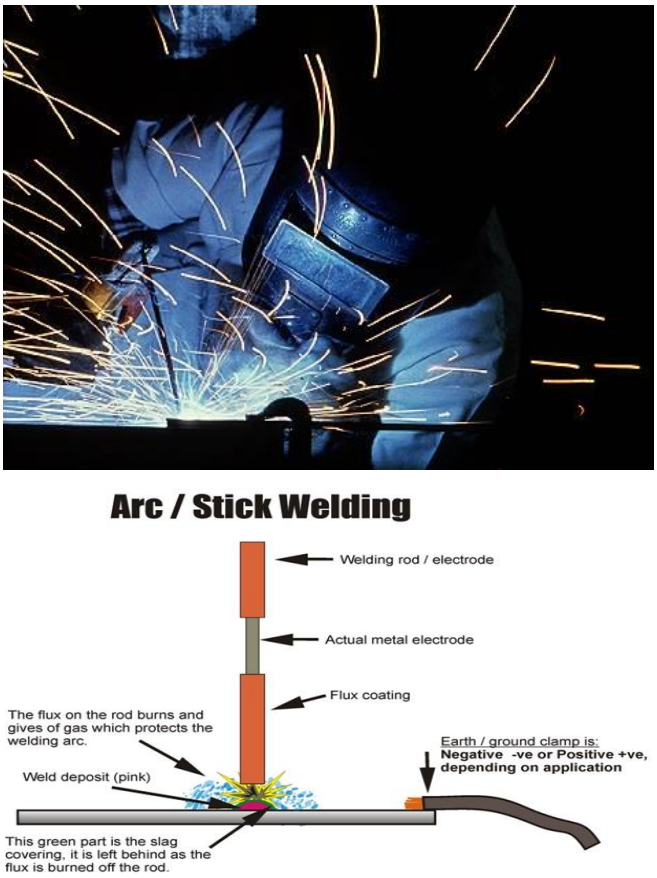

Figure 2.1: Arc welding

An electric arc is created between an electrode and the base metal. It can use either direct current (DC) or alternating current(AC) and consumable or non-consumable electrodes. Weldment is normally covered by some type of shielding gas, vapor or slag as protection.

When electrode is positioned close to a work piece, arc will be created across the gap between metal and hot cable electrode. An ionized column of gas is developed to complete the circuit. A temperature of 3600 degree celcius will be produces at the tip of electrode and melts part of metal being welded and part of electrode. A pool of molten metal that cools and solidified behind the electrode will be produced as it is moved along the joint.

In most arc welding processes,contact between molten metal and air with shield of gas , vapour or slag will be minimized. A decreases in strength of weld when metal at high temperature react with oxygen and nitrogen in the air to form oxides and