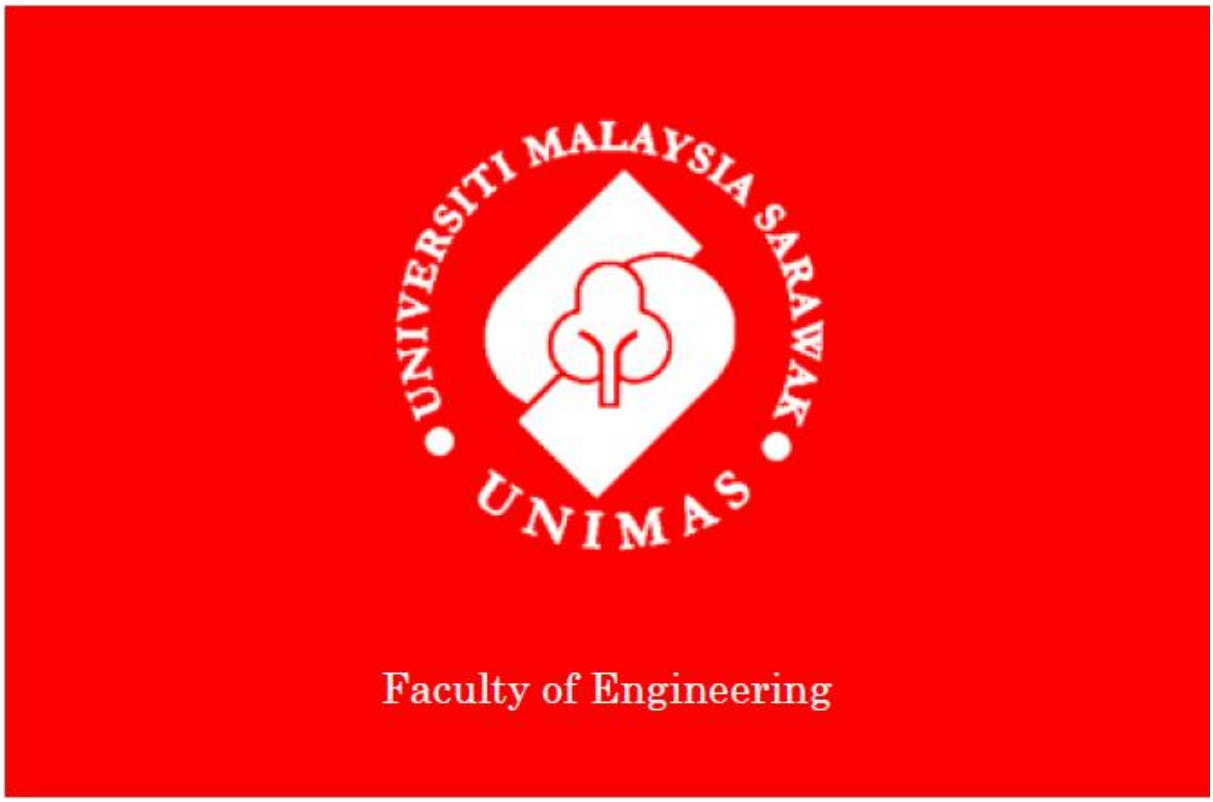

MECHANICAL TESTING ON WELDED PIPES

Yeo Cheng Chuan

Bachelor of Engineering with Honours

(Mechanical and Manufacturing Engineering)

2010

UNIVERSITI MALAYSIA SARAWAK

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Title : Mechanical Testing on Welded Pipes

Name : Yeo Cheng Chuan

Matric No. : 17579

is hereby read and approved by:

_____ _____

Ir. Dr. Mohammad Shahril Osman Date

Project Supervisor

MECHANICAL TESTING ON WELDED PIPES

YEO CHENG CHUAN

Thesis is submitted to

Faculty of Engineering, University Malaysia Sarawak

In Partial Fulfillment of the Requirements

For the Degree of Bachelor of Engineering

With Honours (Mechanical and Manufacturing Engineering) 2010

Dedicated to my beloved family and friends

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ABSTRAK

Pengelasan memainkan peranan yang penting dalam banyak industri terutamanya pengelasan paip dan sambungan las telah menjadi salah satu kaedah yang paling penting terkini. Oleh sebab itu, adalah penting untuk memahami sifat mekanik sambungan las untuk paip sehingga paip las dapat dilaksanakan secara berkesan dalam pelbagai jenis industri. Tujuan daripada projek ini adalah untuk menyiasat kekuatan paip telah dilas yang ditentukan oleh ujian mekanik berdasarkan Standard Kod ASME. Ketegangan ujian dan tiga titik uji lentur dilakukan untuk Karakterisasi sifat mekanik sambungan las paip. Keputusan paip dilas dan paip logam asas yang kemudian diinterpretasikan dan berbanding dalam hal kekuatan, strain, dan beban maksimum sebelum kegagalan contoh uji untuk membezakan dan menyiasat pengaruh paip logam asas selepas dilas. Keputusan dan analisis menunjukkan bahawa paip yang telah dilaskan memiliki kekuatan yang lebih tinggi sedikit daripada paip logam asas dalam kedua-dua ujian mekanik. Pipa logam asas menunjukkan sedikit peningkatan simpulan selepas dilaskan tetapi telah dikurangkan daktilitas. Secara keseluruhan, berdasarkan hasil kajian menunjukkan bahawa sambungan las adalah sebagai kuat, atau bahkan lebih kuat dari paip logam asas dan mempunyai perilaku mekanikal serupa dengan paip logam asas. Kajian juga menunjukkan bahawa persiapan sambungan las yang tidak tepat akan melemahkan kekuatan paip dilas dan gagal lulus ujian mekanik.

ABSTRACT

Welding plays an indispensable role in many industries especially the pipe welding and welded joint has become one of the most important joining methods available nowadays. Hence, it is essential to understand the mechanical properties of the welded joint for pipe so that the welding pipe can be applied effectively in various kinds of industries. The aim of this project is to investigate the strength of the welded pipe which is determined by mechanical testing based on ASME Standard Code. Tension test and three point bending test are conducted to characterize and gain greater understanding of welded joint mechanical properties and quality. The results of the welded pipe and base metal pipe are then interpreted and compared in terms of strength, strain, and maximum load before failure of test specimen to differentiate and investigate the effect of base metal pipe after being welded. Results and analysis indicate that the welded pipe has slightly higher strength than the base metal pipe in both of the mechanical tests. The base metal pipe shows a slightly increase of stiffness after being welded but has been reduced in ductility. Overall, based on the results, it shows that the welded joint is as strong as, or even stronger than the base metal pipe and has similar mechanical behavior with base metal pipe. The experiment also shows that the improper preparation of welded joint will weaken the strength of the welded pipe and will cause the failure for passing the mechanical testing.

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E	-	Young's Modulus
F	-	Load to failure
W	-	Weight
ε	-	Strain
σ	-	Tensile Strength
HAZ	-	Heat Affected Zone
L	-	Support span
m	-	Slope
mm	-	Millimeter
MPa	-	Mega Pascal

CHAPTER 1

INTRODUCTION

1.1 Background of Welding

Welding is the two pieces of metal which is fastened together to produce a coalescence of material by heating them with a high temperature to cause softening or melting during the process. It is a joining process that produces fusion of metal that requires the application of pressure or the filler metal but sometime does not depend on both of them. For welding with the use of pressure, the separate pieces of materials are forced to be combined to form one piece. While the welding that requires filler metal for joining process, the filler material is added to form a complete weld in the joint. The melting point of any filler metal used is either nearly same as the metals being joined or below these metals not above a minimum heating temperature. Nowadays, various types of energy sources are used for welding such as electric arc, gas flame, ultrasound, an electron beam and others (Larry, 2004).

In the past few years, new applications, methods and systems have been developed immensely as the contribution of welding. Moreover, the civilization of human beings is also developed tremendously and the industries have grown rapidly as well. The continuing research causes welding become a premier leader in industrial processes. Meanwhile, the prevailing of welding also possible to develop new industries like space industries and the nuclear power industries as well as

increasing the world's supply of good if the industrial processes are simplified and progressed rapidly (R.Bohnart, 2005).

Welding is always the preferable method to fasten the metal and can be applied in many different environments like in the open air, under water and even in outer space. This is because it is the strongest and most common method of permanently joining steel components together. However, the suitable type of welding process should be chosen from the many types of prevailing welding processes so that the product can be fabricated with a high quality, long lasting, attractive and safe. In the present day, there are over 90 welding process used in all industries. The uses of the welding in industries have been expanded and redesigned to meet the current special needs in various industries.

As the civilization developed, the improvement of many tools, materials and machinery has resulted in development of welding technology. As industry expands and improves its technology, new modern welding techniques will advance quickly and play a vital part in progress (R.Bohnart, 2005).

At the present time, there are five welding associations that provide standards and guidance related to the welding industry as shown below (R.Bohnart, 2005):

1) American National standards Institute (ANSI)
2) American Petroleum Institute (API)
3) American Society of Mechanical Engineers (ASME)
4) American Welding Society (AWS)
5) American Bureau of Shipping (ABS)

1.2 Problem Statement

Nowadays, steel pipe plays a vital role and is widely used in various industries as it has numerous functions in structure, piping system and others. There are many methods for joining the pipes such as threaded joints, flanges with bolts and gaskets, welded joints, lead and hemp joints and other types of joints. Hence, it is essential for design engineers and material engineers to select the most suitable way to join the pipe together in any kinds of application so that the joint is adequate and economical.

However, it becomes a major problem for selecting the most suitable joint among of these joints when joining of steel pipes. Design and material engineers need to investigate the mechanical behavior of any types of joint to suit the pipe joining so that the design requirement can be achieved especially for the structural design. Failure in selection of appropriate pipe joint for design will result in loss of material, money, time or even life.

Therefore, in this project, the mechanical behavior of the pipes after being welded and the strength of the welded pipe is determined whether or not it is same as its base metal pipe or even better than it. Besides that, the welded joint is also identified whether it is stronger than the parent metal pipe or vice versa.

1.3 Objectives of the Final Year Project

In this project, there are several objectives on studying mechanical testing on welded pipes. Two main objectives that are needed to be achieved at the end of this study are:

- To study the strength of the welded pipe by using mechanical testing based on ASME codes
- To study the testing of welds to investigate and identify that the welded joint strength equals or even better than the design base metal pipe strength

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1.4 Project Strategy

In this project, the understanding of the welding and fabrication procedure, welded piping system and mechanical testing is important. The analysis of the various mechanical testing will help to test the welded pipes to achieve the qualification. The study conducted will be a great help in testing the welded pipes to meet the requirement of piping system in various industries. Testing concept is generated base on the analysis, research and study done on the literature review. The project carried out on is expected to bring benefit and deliverable to the UNIMAS.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The literature review will describe about the welding and mechanical testing on the welded pipes and the weld. This chapter will analyze of the mechanical testing and the purposes of them on the welded specimens. Furthermore, this chapter also includes the discussion on the pipe welding as well as the description of weld.

2.2 Analysis of Mechanical Testing

Mechanical testing or destructive test is where an assessment of the material strength that apply to a controlled stress. Its main function is to evaluate mechanical properties of materials and measurement of the material's ability to carry or resist mechanical forces such as tension, shear, compression, torsion and impact. Specification is needed to some form of mechanical test as a matter of course with high quality components or where any failure in the design load applied would bring problem that can cause any injuries and increase the costs (Ross, 1995). A mechanical testing is normally considered as a destructive examination process as the testing usually results in damage permanently to the testing specimen. A part or

sometime whole sample specimen is consumed, broken, or damaged to the degree that it is no longer can be used for its other intended purpose (O.Fellers, 1990).

In mechanical testing, the mechanical properties of material under different applied loads and the behavior and structural response of a specimen can be analyzed and investigated in spite of testing the failure of the specimen. The test can be either static or dynamic at where the stress is applied slowly during static test while for during the dynamic test, the stress is suddenly applied.

The mechanical testing is much easier to be conducted, more information and data can be obtained and convenient for the interpretation compared with the non-destructive testing. Mechanical testing is widely used for welder and procedure qualification because the methods used in various kind of testing are highly reliable and relatively inexpensive. In the mechanical testing, only a small number of specimens are destroyed and the cost of it can be considered negligible. Therefore, many material testing experiments prefer mechanical testing as it is most suitable, economic for the objects which will be mass produced. In the case of a building, mechanical testing is not preferable as only one or few items are to be produced and mostly not economical.

Various code-making bodies such as the American Society of Mechanical Engineers (ASME) have developed and provided certain general test procedure and standard for the industry as a guideline and instruction for any testing. The only differences are the tests may be differ in application and detail from industry to another industry, the basic procedures and types of the test specimens which are recommended by the various code-making bodies are still continuously applied in their material testing.

2.2.1 Overview of Mechanical Testing on Welded Pipes

Mechanical testing plays a vital aspect of weldability study. In the design work, mechanical testing is essential to be used to test the welded pipe so that the engineers can determine and do the research on the mechanical properties of welded joint before using it. Mechanical testing is conducted to determine the quality of the weld and the skill of the welder after a weld has been completed so that the quality assurance and quality control of the welded pipes can be ensured. Fracture, failure and engineering design analysis of the welded pipes can be investigated and interpreted by mechanical testing. Furthermore, mechanical testing is able to reveal the important weld behaviors such as weld button size as well as obtaining quantitative measures of a weld's strength (O.Fellers, 1990).

The main function of the mechanical test is to determine a quantitative measure instead of qualitative sense of weld quality. Mechanical testing of a weldment can be static or dynamic as a weld's strength commonly refers to its capability to withstand both static and dynamic loads. The dynamic strength of spot welds is an important quality index because of its implication on the performance of welded structures while the static tests are normally conducted to determine the weldability of metal. There are two types of static tests which are tension test and shear test while the dynamic tests are generally refer to fatigue and impact test. Static tests are preferable to be conducted to test the weldment as the dynamic testing is relatively low in reliability and repeatability as well as cost expensive high cost.

2.3 The Functions of Welding in Industry

Welding is a technological process that is widely practiced in modern engineering and industries nowadays. It is a very economical process and used in both manufacturing and repairing work. Many industries select welding in some particular jobs as preferable joining method because there are numerous great advantages from welding. For instance, industries such as oil and gas, automotive, military, industrial construction and others are more preferred welding as joining method. Generally, welding plays two important roles in industries such as a means of fabrication and a technique for maintenance and repair. (J.Sacks, 1984).

Welding fabrication is very useful as it can provide more flexible design and the design cost is saved because the patterns such as the pattern drawing, pattern making and repairing are not required in welded design. Some industries use welding method to replace riveting method in the purpose of saving weight. Welding fabrication can minimize the inventory and obsolescence charges as well as the worker-hours of production (J.Sacks, 1984).

Welding is also used for maintaining and repairing the broken parts immediately by welding and the cost interruptions in production and expensive replacement can be minimized. With the use of welding, some particular production requirements can be achieved by innovating the production equipment, shop fixtures and many types of structures to fulfil the requirement (J.Sacks, 1984). Figure 2.1 shows the schematic presentation of the most common welding methods (Weman, 2003).

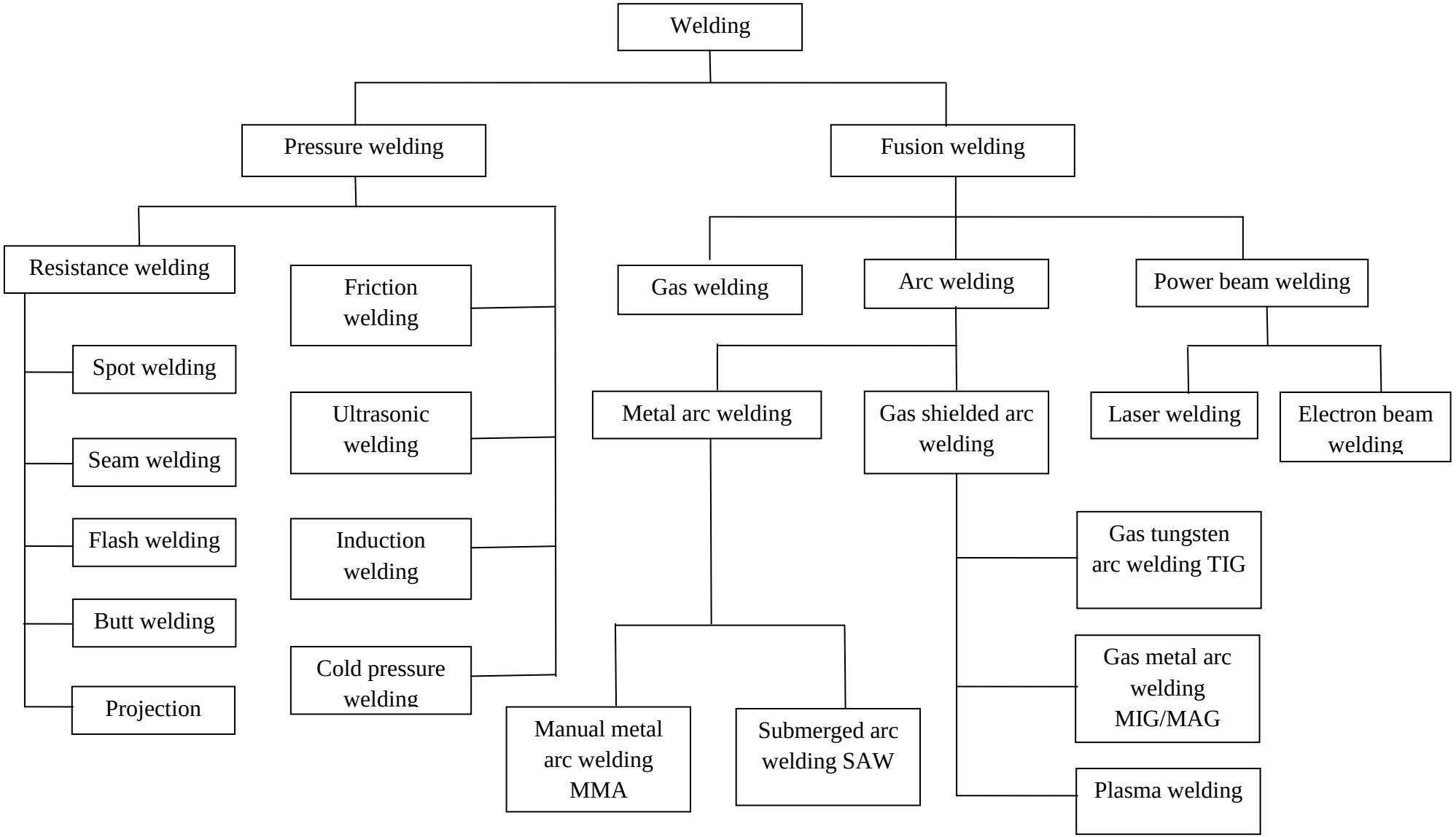

Figure 2.1: Schematic presentation of the most common welding methods (Weman, 2003)