PENGESAHAN PENYELIA

"Saya akui bahawa saya telah membaca
karya ini dan pada pandangan saya karya ini
adalah memadai dari skop dan kualiti untuk tujuan penganugerahan
Ijazah Sarjana Muda Kejuruteraan Mekanikal (Rekabentuk & Inovasi)"

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THE EFFECT OF PROBE TYPE IN ULTRASONIC TESTING

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Laporan ini dikemukakan sebagai
memenuhi syarat sebahagian daripada syarat penganugerahan
Ijazah Sarjana Muda Kejuruteraan Mekanikal (Design & Innovation)

Fakulti Kejuruteraan Mekanikal
Universiti Teknikal Malaysia Melaka

MEI 2009

"Saya akui laporan ini adalah hasil kerja saya sendiri kecuali ringkasan dan petikan yang tiap-tiap satunya saya telah jelaskan sumbernya."

Tandatangan : .....

Nama penulis : MUHAMAD FIRDAUZ BIN ABD. RASID

Tarikh : MEI 2009

ACKNOWLEDGEMENTS

First of all, I would like to give my utmost appreciation to Allah Almighty for His blessing, this project finally complete for submission to the Mechanical Engineering Faculty at Universiti Teknikal Malaysia Melaka (UTeM). Thanks to Allah Almighty to give me such a healthy body and clear mind to go through to finish this report.

I would like to express my highest gratitude to Mrs. Zakiah bt. Abd Halim as my supervisor, for her advice and guidance throughout this project. Not forgotten, to Mr. Saha, Mr. Shahrul, Mr. Syafiq and also Mr. Helmi from Advance Manufacturing Center (AMC) for their help to fabricate the test sample by using CNC 5-Axis Face Milling (DMG-DMU250) machine. I also would like to express my appreciation to Mr. Rizal from Non-Destructive Testing (NDT) laboratory for his help regarding to handle Krautkramer Ultrasonic Flaw Detector as a device to detect the defects.

Last but not least, to my beloved families and all of my friends for their unrestricted support and tolerance in completing this research. May this project will become a source of reference to other student soon.

ABSTRACT

Focus of this project is to investigate the effect of different probe type in Ultrasonic Testing. Although the studies of the effect of probe type in ultrasonic testing is not clearly investigate until now, but some investigations of previous research for probe type is discussed in literature review. Ultrasonic Testing is a part of Non-Destructive Testing (NDT) which is widely used to detect internal defects in the specimen. By using drawing software such as Catia V5R16 and AutoCAD 2007, the test sample for this experiment has been designed. This test sample has been fabricated using CNC 5-Axis Face Milling and EDM Wirecut Machine. Probe types that are used in the experiment are single probe (4MHz), dual probe (4MHz) and 45° angle probe (4MHz). This project observes the outcome between the different types of probes to be used, to the effectiveness of the echo detection to be recorded. Besides that, the test sample consists of two major parts which is to be the pockets and the notch. The result of experiment is the reflected of the sound energy from the probe to the defect. The result for each type of probes has been compared. As the final result, the dual probe (4MHz) has shows the effectiveness in detecting the pockets instead of the single probe (4MHz). For the notch part, the 45° angle probe (4MHz) has shows its capability in detecting the notch. Selection of the correct probe will lead to the found of the defect effectively.

ABSTRAK

Fokus utama kajian ini ialah untuk mengkaji kesan penggunaan jenis alat pengesan yang berbeza dalam Kajian Ultrabunyi. Kesan penggunaan jenis alat pengesan yang berbeza ini masih belum dijalankan sepenuhnya tetapi terdapat kajian terdahulu yang dibincangkan dalam kajian ilmiah. Kajian Ultrabunyi merupakan salah satu cabang Kajian Tanpa Musnah (NDT) dan telah digunakan secara meluas untuk mengesan kecacatan dalam spesimen. Lukisan telah dilakukan dengan menggunakan perisian seperti AutoCAD 2007 dan Catia V5R16. Spesimen ini akan difabrikasi menggunakan Mesin Kisar Permukaan 5-Paksi CNC dan Mesin Pemotongan Dawai EDM. Jenis alat pengesan yang akan digunakan dalam eksperimen adalah alat pengesan tunggal (4MHz), alat pengesan berkembar (4MHz) dan dan alat pengesan bersudut 45° (4MHz). Kajian ini ialah untuk mengkaji keupayaan penggunaan alat pengesan yang berlainan jenis, dengan hasil yang akan diperolehi. Kesemua data yang diperoleh akan direkodkan. Selain itu, sampel ujian yang difabrikasi terdiri dari dua ciri utama iaitu rongga tidak tembus dan juga takik di sepanjang permukaan sampel ujian. Hasil eksperimen ini ialah pantulan tenaga bunyi dari alat pengesan yang berlainan jenis, dan kemudiannya keputusan setiap jenis alat pengesan yang digunakan ini akan dibandingkan. Sebagai keputusan di penghujung projek ini mendapati bahawa alat pengesan berkembar (4MHz) lebih baik penggunaannya untuk mengesan kecacatan daripada alat pengesan tunggal (4MHz). Untuk bahagian takik, alat pengesan bersudut 45° (4MHz) telah menunjukkan kemampuannya untuk mengesan jenis kecacatan yang bersudut seperti takik. Pemilihan alat pengesan yang sesuai akan mempengaruhi hasil keberkesanan dalam mengesan kecacatan yang ada pada sampel ujian.

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CHAPTER 1

INTRODUCTION

Non-Destructive Testing (NDT) is a versatile method of testing to detect the defect on the test sample without destroying it. There are so many types of defects can be detecting using NDT method. Defect or crack can be detected by using Ultrasonic Testing (UT) and it is required the correct selection of probe and the frequency. There are lots of Non-Destructive Testing (NDT) technique are applied in industries, such as Dye Penetrate Inspection, Magnetic Particle Inspection, Eddy Currents and Radiography. Most of those methods can only define several types of defect such as structural deformities, wall thinning and planar defects.

1.1 Background of the Project

Ultrasonic Testing is a proven method for the evaluation of raw materials, semi finished and finished products. Ultrasonic inspection can be used for flaw detection / evaluation, dimensional measurements, material characterization, and more. Ultrasonic Testing made of the basic physical property that sound waves travel at known constants velocities through any medium. By measuring the time for a sound wave to travel through a material it can be determine how far that wave has travelled. In this way, sound waves can be used to measure distances. Besides that,

sound waves are reflected at an interface between two materials such as steel and air to detect defects. A typical Ultrasonic Testing inspection system consists of several functional units, such as the pulser / receiver, probe, and display devices. A pulser / receiver are an electronic device that can produce high voltage electrical pulses. Driven by the pulser, the probe generates high frequency ultrasonic energy. The sound energy is introduced and propagates through the materials in the form of waves. When there is a discontinuity such as a crack in the wave path, part of the energy will be reflected back from the flaw surface [1]. The reflected wave signal is transformed into an electrical signal by the transducer and is displayed on a screen. The reflected signal strength is displayed versus the time from signal generation to when an echo was received. Signal travel time can be directly related to the distance that the signal traveled. From the signal, information about the reflector location, size, orientation and other features can be gained. Ultrasonic Testing results are greatly affected by probe type and probe frequency. There are three types of probe. Which are single crystal, dual crystal and angle beam probe. While frequency, the higher the probe frequency, the shorter the dead zone. By increasing the frequency, the solid angle of the beam will decrease.

1.2 Problem Statement

Transducer or probe is one of the basic components for an Ultrasonic Testing System. It is manufactured in a variety of forms, shapes and sized to suit for varying applications. Selection of correct Probe Type is one of the critical parameter to optimize the Ultrasonic Testing Capabilities. Proper selection is important to ensure accurate inspection data as desired for specific applications. Therefore, an investigation is required to specify the suitability of different type of probe.

1.3 Objective

The main objective of this project is to investigate the effect of selection of Probe Type in Ultrasonic Testing. The suitability of different type of probe type in Ultrasonic Testing is specified. Hence it will lead to the effectiveness of using the correct selection of probes. Another objective is to fulfill the requirement final year student of Universiti Teknikal Malaysia Melaka (UTeM) to complete 'Projek Sarjana Muda' (PSM).

1.4 Scope

The main scope for this research is to design and fabricate the Ultrasonic Testing test sample and to make correct selection of Probe Type. The experimental procedure is developed to investigate the effect of different type of probe. Then, the experiment is conducted based on the procedure developed. The main objective of the experiment is to specify the suitability of probe type for three applications which is for the single probe (4MHz), dual probe (4MHz), and 45° angle probe (4MHz). Overall parameter in this project are consist of done the research about the probes, designed the test sample, fabrication of the test sample, and analyzed the fabricated test sample.

1.5 Planning and Execution

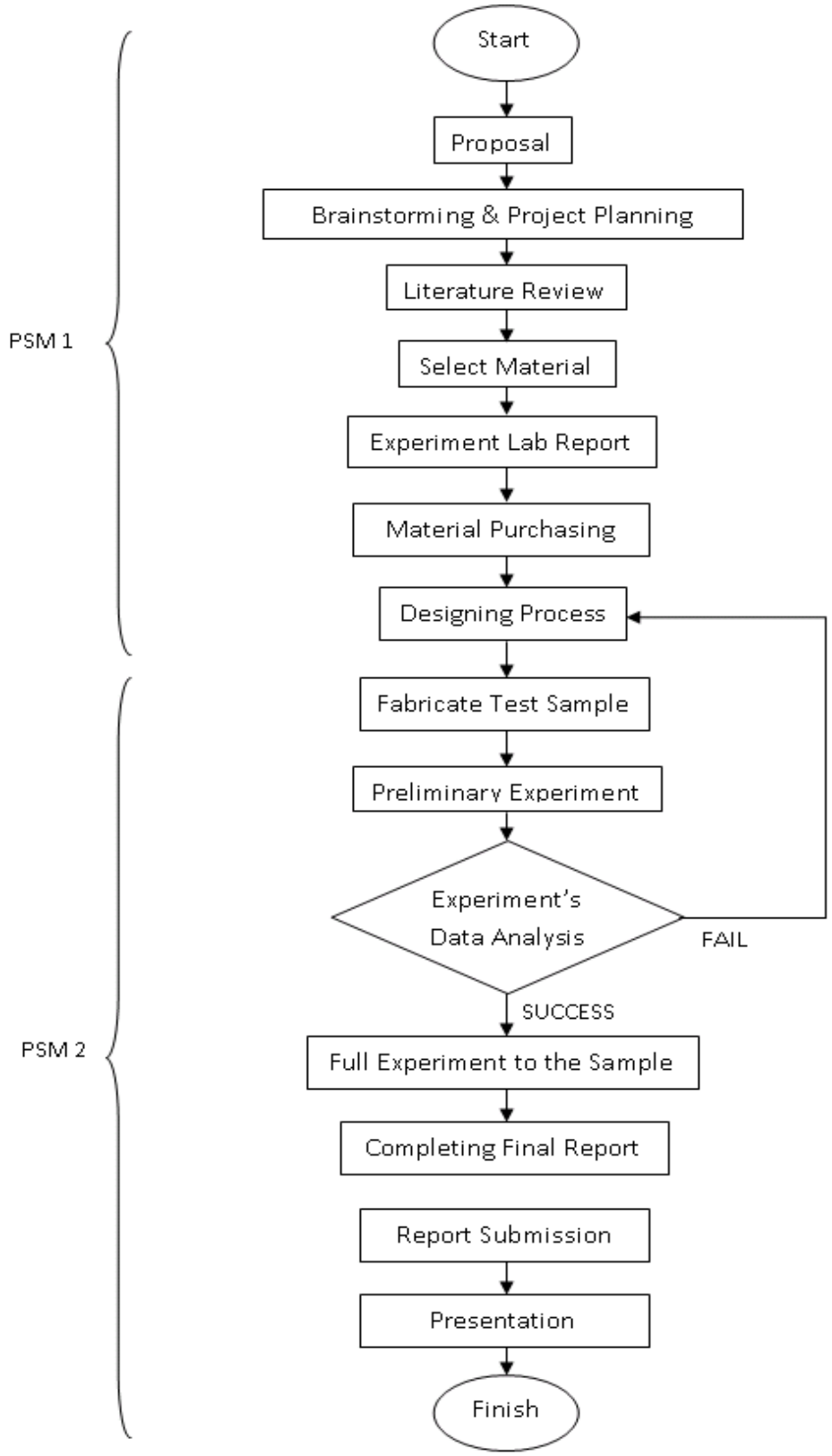

Figure 1.1: Planning and execution for PSM

Figure 1.1 at the previous page shows the flow this project. For PSM 1, start with selection of the topic from the lecturer. The topic is The Effect of Probe Type in Ultrasonic Testing, and then the proposal is made and handed within the first two week. After that do a lot of brainstorming and project planning which is consist of problem statement, scope, objectives and literature review need to be analyze. Hence, the material used chosen and the design started. In PSM 2, the test sample will be fabricated and then the experiment begins. The result will be observe and record, if fail, the test sample will be redesign but if success, the defects of test sample will be characterize. The full report will be completed and preparation for presentation will be done in each semesters.

CHAPTER 2

LITERATURE REVIEW

2.1 Basic Principle of Ultrasonic Testing

Sound waves are simply vibrations of the particles making up a solid, liquid, or gas. As an energy form they are therefore an example of mechanical energy, and it follows that, since there must be something to vibrate, sound waves cannot exist in a vacuum. The only human sense that can detect sound waves is hearing, and that sense is restricted to a relatively narrow range of vibration frequencies called "the audible range". It follows that there will be vibration frequencies that are so low or so high that they cannot be detected by the human ear [1].

The unit of frequency is hertz, abbreviated as Hz, defined as "one cycle of vibration per second." Sounds below approximately 16 Hz are below the limit of human hearing and are called "subsonic vibrations," and sounds above approximately 20,000 Hz are too high to be heard and are called "ultrasonic vibrations." Between those two values, in the audible range, it is more common to use the term "pitch" to refer to frequency; a high-pitched sound means high audible frequency, and low-pitched means low audible frequency [2].

Ultrasonic waves are mechanical vibrations having the same characteristics as sound waves, but having a frequency so high that they cannot be detected by the human ear that is greater than about 20 kHz. For weld examination in metals the ultrasonic waves usually have a frequency in the range 500 kHz to 10 MHz, most applications using a frequency between 2 MHz and 5 MHz [3].

It is important to realize that ultrasonic waves are not electromagnetic radiation passing through the specimen, but are the result of induced particle vibration in the specimen, and are possible because of the elastic properties of the material of the specimen. For this reason, the wave velocity is different in different materials [3]. From the basic velocity law:

Velocity of waves = wavelength x frequency ($V = \lambda \times n$)

As the result, compressional waves the particles of the transmitting material move in the direction of waves can be transmitted in solid and liquids. The particle movement is very small, within the elastic limits of the material, so that there is no change in the specimen due to the ultrasonic energy.

Ultrasonic Processors consist of three major components that are an Ultrasonic Power Supply (generator), a Converter (transducer) and a Probe (horn). Additionally, a variety of accessories can be used to expand the capabilities of Ultrasonic Processors [4]. The ultrasonic processor can be observing in Figure 2.1 at the previous page.