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DEVELOPMENT OF COST EFFECTIVE ULTRASONIC TESTING THICKNESS MEASUREMENT SPECIMENS AND BASIC LABORATORY GUIDELINES FOR UNIKL MIMET

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ABSTRACT

The aim of this research is to develop a cost effective ultrasonic testing thickness measurement specimens and basic laboratory guidelines for UniKL MIMET. Two specimens has been fabricated with 6 different profiles thickness on the first specimen and 3 different profiles thickness on the other specimen. These profile have been calibrated and tested using Krautkramer USM 35x machine. The thickness and shape of the profile has been determined from the measurement of return ultrasound waves from bottom to the top surface. Then the basic guidelines of the procedure on how to conduct the calibration and testing for thickness measurement has been developed. Finally the "Ultrasonic Testing Laboratory Report" which has been created can be used for the future students in UniKL MIMET to refer as an answer scheme for all 9 different profiles thickness.

Keywords: Non-destructive testing, wave, ultrasonic, calibration.

INTRODUCTION

Nondestructive testing (NDT) is a technique of analysis generally utilized for investigation as a part of science and industry. This analysis technique is used to calculate the material properties, system or component without causing any damage. There are many types of Nondestructive testing (NDT); one of the most common techniques is the Ultrasonic testing. Ultrasonic Testing (UT) is a technique which uses high frequency of sound waves (between the range of 0.5 to 15 MHz) in order to carry out measurements and experiments [1]. The Ultrasonic inspection is used to evaluate or detect flaw, lamination, and material properties and so on. As non-destructive testing types of examination, UT has high sensitivity in detecting the flaws in material.

Theoretical and practical knowledge are important in order to understand about UT inspection. It is easy to understand the theoretical part but for the practical part, high skills need in order to conduct UT inspection. There are several basic equipment need to be consider in UT inspection such as flaw detector, specimens, and calibration block [2].Nowadays UT inspection is very important in marine industry but not all individual in the industry are exposed to it especially marine students, so to overcome this situation, all engineering universities need to educate their students by developing training classes section. In UniKL MIMET, the UT machine and equipment for calibration are available in laboratory, but the specimens for testing are not available, because the costs to purchase the specimens are very expensive. In order to solve this issue, this project is about fabricating specimens with nominal price and at the same time developing basic laboratory guidelines on ultrasonic testing thickness measurement for UniKL MIMET.

ULTRASONIC TESTING (UT) MEASUREMENT

The thickness of materials and determination of the physicals properties of materials can be done by using ultrasonic testing. High frequency method is used widely in the way to control the quality of materials. The measurement of thickness can be done on a side of part easily and quickly by using ultrasonic techniques. The accuracies of the technique can reach until ±1 micron or ±0.0001 inch that area available in some places and applications. The basic materials that can be measured using ultrasonic are metal, plastic, ceramics, composite, and glass and biological specimens. Certain ultrasonic thickness gages normally works within the frequency between 500 KHz and 100 KHz by using piezoelectric transducers. The explosion of the sound waves when it reacts with the electrical pulses is generated using the piezoelectric transducer. In order to achieve the industrial applications the normal transducer that used is with different acoustics aspects. In measuring thick and high attenuating material normally they used low frequency method to get the accurate readings and at the same time for high frequency method normally the used in thinner and non - attenuating materials [15].

METHODOLOGY

Research activity flow is the plan for the research process from the beginning to the end in a timely and sequences flow. Each process comprises of important procedures that need to be followed in making the forecasting. It also states the loop that must be followed if the flow is not complete. This will ensure the result of the research is legitimate. Figure-1 showed the research methodology flowchart which consists of the procedure to be followed until obtaining the results for analysis and interpreting the results. The first process of methodology is start with identification of material.

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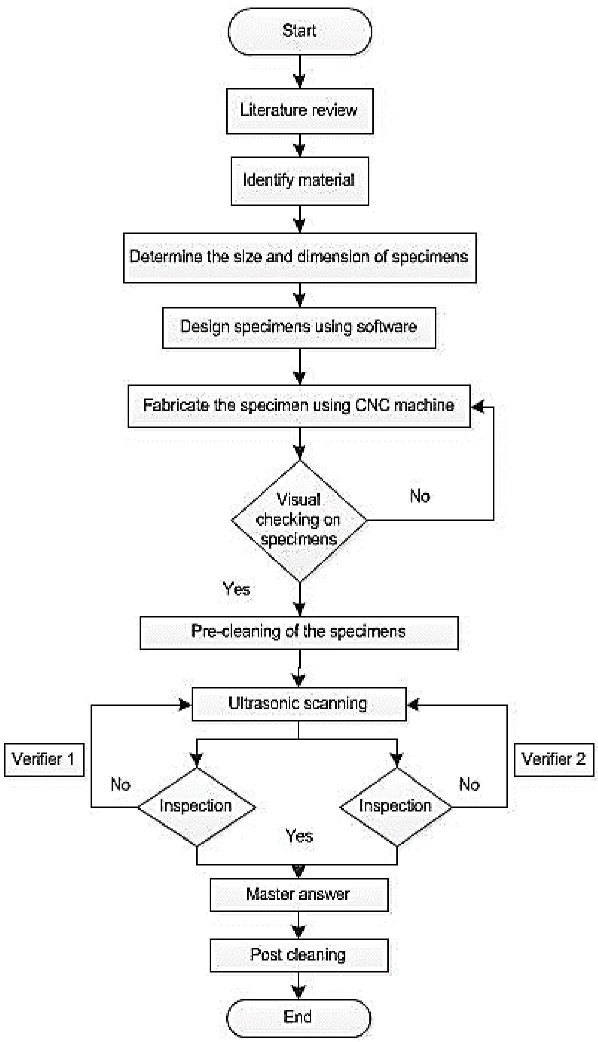

Figure-1. Research process.

Specimens development process

Once the material specification has been chosen, the next step is to make a design for the specimen. The design for the specimen has been design and drawn by using software. Figure-2 showed the development process for specimen. Firstly, by using Solidworks, the specimen has been designed according to the dimension and measurements that was decided for this survey. The completed drawing from Solidworks will be transferred to Alpha Cam V7 software. This software will be integrated with Alpha Cam V7 Graduate Mill software. This software will convert the design into coding that will be used to fabricate the specimen by using Computer Aided Manufacturing machine. The same steps have been used to design both plates 25mm and 20 mm thickness plate.

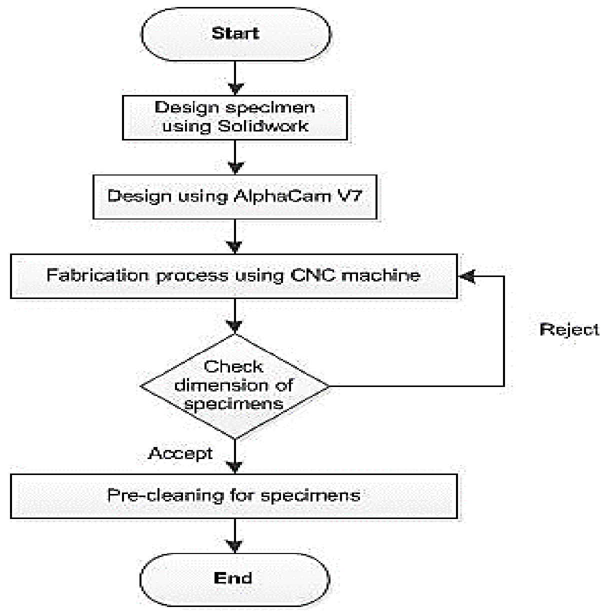

Figure-2. Specimen development process.

Calibration process

In order to start ultrasonic testing, there are some procedures that need to be considered and followed to get the accurate results. Figure-3 showed the flowchart of the steps on how to run the testing with the correct procedure. If one step is missed, the accurate results cannot be obtained.

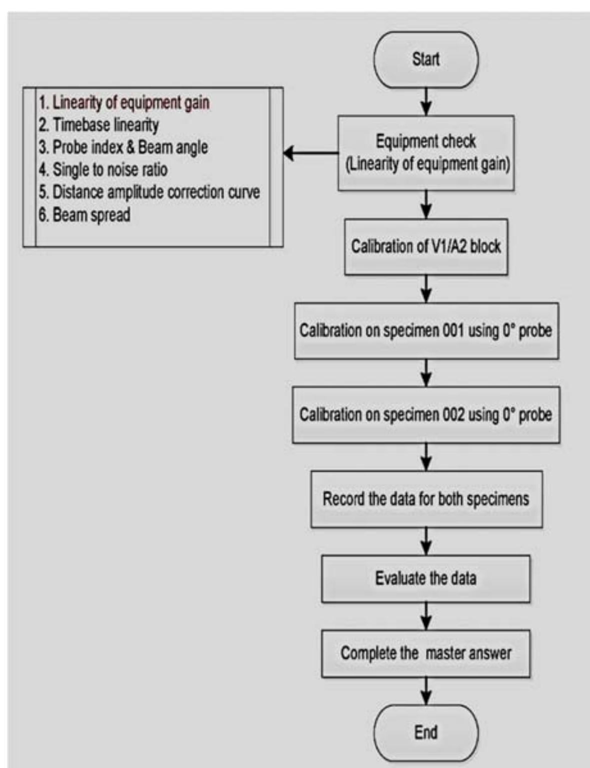

Figure-3. Calibration process.

Sizing methods 0˚ probe (Equalization technique)

The equalization is very familiar in operating to the 6dB drop except that the probe is moved off the edge of the reflector until its signal is equal in amplitude to the rising. At this position the center of the probe is marked onto the surface, again continuing along the edge of the reflector to map out the shape and size.

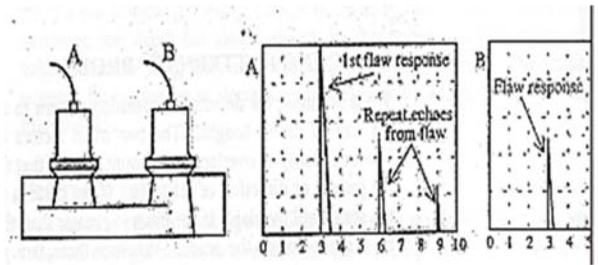

Figure-4. Equalization technique.

RESULT AND DISCUSSIONS

Design of the specimens

The design for the specimen has been drawn using Solidworks software. In this design phase, the dimension of the specimen has been set to 200mm length, 100mm width with two different thickness which were 20mm and 25mm.

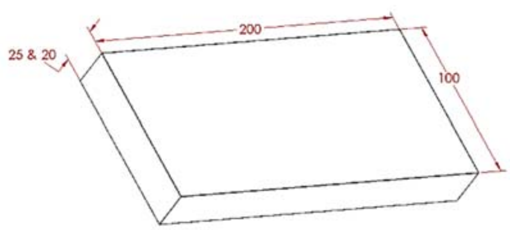

Figure-5. The size of the specimens with different thickness.

Each of the specimens has different profiles with different thickness and all are designed in range. Specimen 001 contained 4 different profiles while specimen 002 contained 3 different profiles and all the profiles have different thickness.

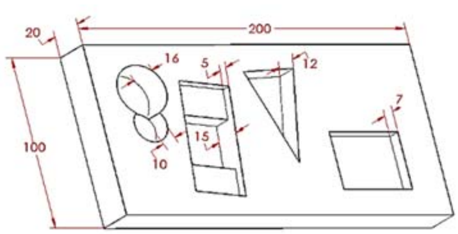

Figure-6. Design specimen 001 using Solidworks software.

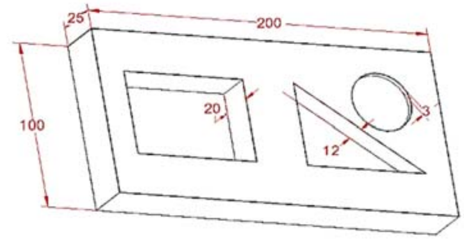

Figure-7. Design specimen 002 using Solidworks software.

The design specification of the specimens already shown above which has been execute from the starting point that is decide the material until the end which is the design of profile with different thickness. The material has been fabricate according to size that has been designed. Squaring process will be done in order to get a surface smooth and straight alignment. Once squaring process has been done, the program from Alphacam will be transfer to the CNC machine for fabrication.

Figure-8. Image of specimen 001 after fabricated.

Figure-9. Image of specimen 002 after fabricated.

Calibration on specimen 001

The complete method and procedures for the calibration on Specimen 001 were listed below:

I. Before start the testing process, the surface of the specimen should be clean. Then, the presetting for 0˚ probe is recalled by selecting memory button and then select 'SET 7', and then press enter. Once done, press unfreeze (do not forget to roll on the knob on the right).

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Figure-10. Recall ‘SET 7’.

II. Then, by referring to the 0˚ probe calibration, set the sensitivity of the 2nd back wall echo to full screen height.

Figure-11. Adjust the 2nd BWE to full height screen (FSH).

III. Then, start to move the transducer on the specimen until get the 1st indication in front of the 1st back wall echo.

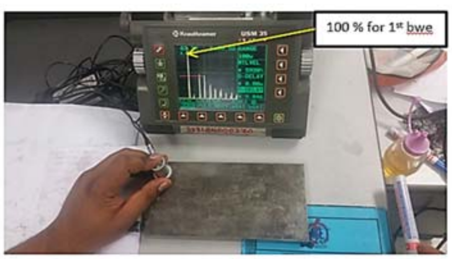

Figure-12. Finding the first indication on specimen 001.

Figure-13. The thickness of specimen 001.

IV. After finding the 1st indication on the screen display, move the probe until the amplitude of the 1st indication is equal to the 1st back wall echo (using equalization method). This method is used to find the edge of the profile.

Figure-14. The equalization technique.

V. Once get the indication, mark ‘x’ on the specimens. The movement of the transducer should do as shown in figure below.

Figure-15. The marking of profiles on specimen.

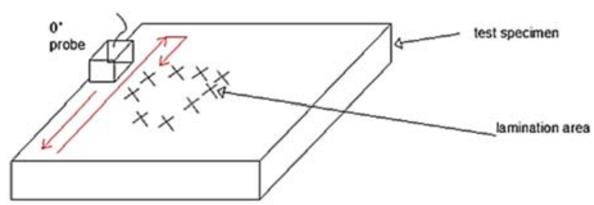

Figure-16. The standard movement of transducer for calibration.

VI. Then, find all the profile thickness and lastly, mark all until get the full area of lamination.

Figure-17. The thickness of the profile no.1 on specimen 001.

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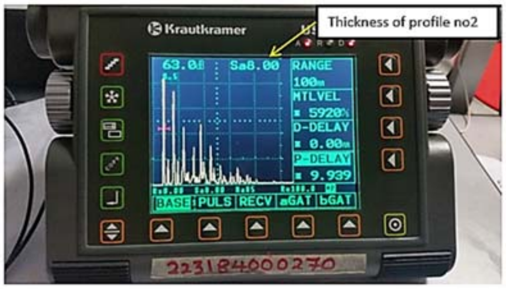

Figure-18. The thickness of the profile no.2 on specimen 001.

Figure-19. The thickness of the profile no.3 on specimen 001.

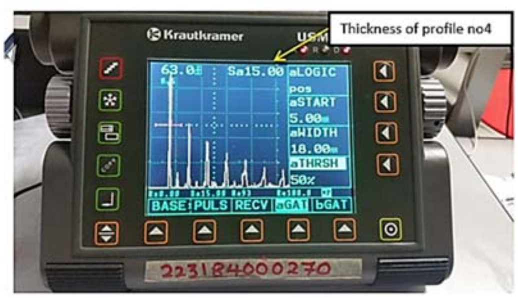

Figure-20. The thickness of the profile no.4 on specimen 001.

Figure-21. The thickness of the profile no.5 on specimen 001.

Figure-22. The thickness of the profile no.6 on specimen 001.

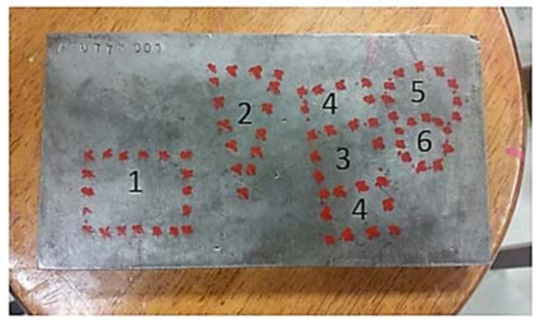

Figure-23. The profiles that are found and marked on specimen 001.

VII. The result has been obtained by using the basic guideline of laboratory and there are 6 profiles with different thickness have been found. Finally, measure all the dimension of the lamination on the specimen and draw or sketch it on the UT laboratory report for justification.

Calibration on specimen 002

The same steps and method have been used to calibrate the specimen 002. The setting that has been changed is the thickness of the plate.

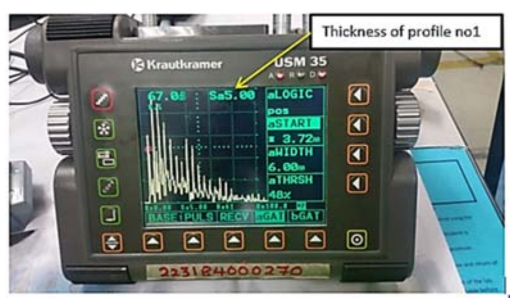

Figure-24. The thickness of the profile no.1 on specimen 002.

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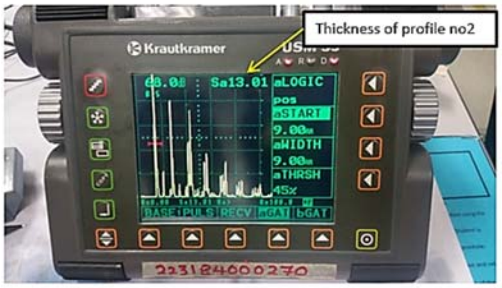

Figure-25. The thickness of the profile no.2 on specimen 002.

Figure-26. The thickness of the profile no.3 on specimen 002.

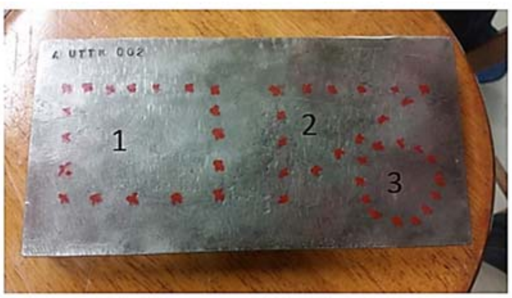

Figure-27. The profiles that are found and marked on specimen 002.

The result has been obtained by using the basic guideline of laboratory and there are 3 profiles with different thickness have been found. Finally, all the dimension of the lamination on the specimen will be measured and the answer will be drawn ar sketched on the UT laboratory report for justification.

CONCLUSIONS

In this research, two specimens has been fabricated. In total 9 different thickness profiles has been developed on the specimens. The material used for the specimens was a mild steel grade A36. These specimens can help UniKL MIMET students to expose and familiar with real specimens of the thickness measurement. Although the fabricated specimens were not perfectly and exactly followed the international specimens that is used in every ultrasonic training center but it is still can be used as an application for students to understand Ultrasonic Testing method that normally used in the industry. The basic laboratory guidelines on ultrasonic testing thickness measurement for UniKL MIMET has been developed in order the student can refer as a guide on how to use the machine. The students also can refer to the "UT Laboratory Report", an answer scheme for all 9 different thickness profiles

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