APPLICATION OF CONVERTED MODE FOR DEFECT DEFECTION IN PLATE

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In fulfillment of the requirement for the degree of
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DECLARATION

I declare that this report entitled *"Application of Converted Mode for Defect Defection in Plate"* is the result of my own research except summaries and quotations which have been acknowledged. The report has not been accepted for any other degree and is not concurrently submitted in candidature of any other degree.

Signature : .....

Name : Mohamad Izreen Bin Abd Razak

Date : 14 June 2017

APPROVAL

I hereby declare that I have read this project report and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Plant and Maintenance).

Signature	:	.....
Name of Supervisor	:	Dr Nor Salim bin Muhammad
Date	:	14 June 2017

DEDICATION

I would like to dedicate to

My father,

ABD RAZAK BIN ABAS

My mother,

RAHIMAH BT NAWAWI

My supervisor,

DR. NOR SALIM BIN MUHAMMAD

and

All my friend,

for their assistances & supportive efforts.

ABSTRACT

Non-Destructive Testing (NDT) is mainly use to testing, inspecting, and evaluating materials or components without destroying the any part of the structures. This study investigate the propagation of guided wave through experimental on Lamb wave propagation on plates. It was aimed study the behavior of wave interaction around defects by studying the behavior of mode conversion from defects. A composite PZT transducer was used to generate S0 mode whereas an angle beam transducer was used to measure the reflected wave from defect in plates. Two types of transducer shoes used to form the angle transducers that made of acrylic and aqualane materials. The acrylic and aqualene shoes were designed to be predominantly sensitive to S0 and A0 modes, respectively. Investigations on the mode conversion were carried out on plate with groove defects at different depths. Effect of the frequency shift from the central frequency of the PZT transducer which is designed at 100 kHz also been observed through the excitation at 80 kHz and 120 kHz, respectively. The mode conversion is predicted to be appeared after the reflected wave of S0 mode from defects which is not at the arrival time of the reflected wave of A0 mode from defects.

ABSTRAK

Ujian Tanpa-Musnah (NDT) terutama digunakan untuk menguji, memeriksa, dan menilai bahan atau komponen tanpa memusnahkan mana-mana bahagian struktur. Kajian ini mengkaji penyebaran gelombang berpandu melalui percubaan pada penyebaran gelombang Lamb di atas plat. Ia bertujuan mengkaji kelakuan interaksi gelombang sekitar kecacatan dengan mengkaji tingkah laku penukaran mod dari kecacatan. Satu transduser PZT komposit digunakan untuk menghasilkan mod S0 sedangkan sebuah sudut sinar transduser digunakan untuk mengukur gelombang yang dipantulkan daripada kecacatan dalam plat. Dua jenis kasut transducer digunakan untuk membentuk sudut transduser yang terbuat dari bahan akrilik dan aqualane. Kasut akrilik dan aqualena direka bentuk untuk menjadi lebih sensitif kepada mod S0 dan A0, masing-masing. Siasatan pada penukaran mod dilakukan pada plat dengan kecacatan alur pada kedalaman yang berbeza. Kesan peralihan kekerapan dari kekerapan pusat transduser PZT yang direka pada 100 kHz juga diperhatikan melalui pengujaan pada 80 kHz dan 120 kHz. Penukaran mod diramalkan akan muncul selepas mod gelombang S0 yang terpantul daripada kecacatan yang tidak pada masa ketibaan gelombang gelombang A0 dari kecacatan.

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LIST OF ABBEREVATIONS

UT	Ultrasonic Testing
NDT	Non-Destructive Testing
PZT	Piezoelectric Ultrasonic Transducer
S0	Symmetric Mode
A0	Anti-symmetric Mode
SH	Shear Horizontal Mode

LIST OF SYMBOL

A0	=	Anti-symmetric mode
S0	=	Symmetric mode
θ_i	=	Incidence Angle
θ_R	=	Refracted angle
V_1	=	Sound Velocity in Shoes
V_2	=	Sound Velocity in aluminum plate
v_g	=	Group Velocity
T_X	=	Transmitter
Rx	=	Receiver
KHz	=	Kilohertz
ms	=	Milliseconds

CHAPTER 1

INTRODUCTION

1.1 Background Study

Non-Destructive Testing (NDT) is mainly use to testing, inspecting, and evaluating materials or components without destroying the any part or the systems. It is often use for the physical properties on resistance, fracture toughness, fatigue and ductility. One of the Non-Destructive Test use is to inspecting pressure vessel in the industry. NDT methods use to inspect the failure of the pressure vessels internal structure damage. The surface of imperfection is invisible to be seen by eye. It does only can be detect by using NDT method. It can detect if any corrosion, crack, and thickness of the wall pressure vessels happen. Nowadays, many improvements on advanced technologies such as liquid penetrant testing, magnetic particle testing, eddy-current testing and ultrasonic testing. It provides more accurate assessments, reducing maintenance cost and seeding up turnaround times which can detect smaller defects in more location. Guided-wave testing (GWT) can shoots on guided low frequencies ultrasonic waves on pipes, section of tubes, pipes or other thick wall on the pressure vessels. It's can go through screening on detection of changes on the materials properties because of corrosion or cracking around the circumference and the changes on cross sectional area in its path. When it is place in a pipe, a wave collar emits waves that inspect 100% of the volume within its reach. More than a decade the energy industry has use guided

wave testing and others industries also are now beginning to take advantage on the ability of the inspection on the inaccessible thick walled components and piping.

Figure 1.1: Damaged vessel wall due to damaged sealing mechanism.

Ultrasonic Testing (UT) performs high frequency energy to organize examinations and make measurements. Ultrasonic inspection can be used for dimensional measurements, material characteristic, flaw detection and others. A typical pulse/echo inspection can be illustrated by the general inspection. The pulser, transducer and display devices act as the functional units on Ultrasonic Test inspection. Function of the pulser is to produce high voltage electrical pulses. Sound energy penetrates through the wall or materials in form of waves. If there is defect at the wave path, part of the energy will be reflected back from the flaw surface. Electric signal will transform from the transducer by the reflected wave and will display on the display devices 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 sometimes be gained.

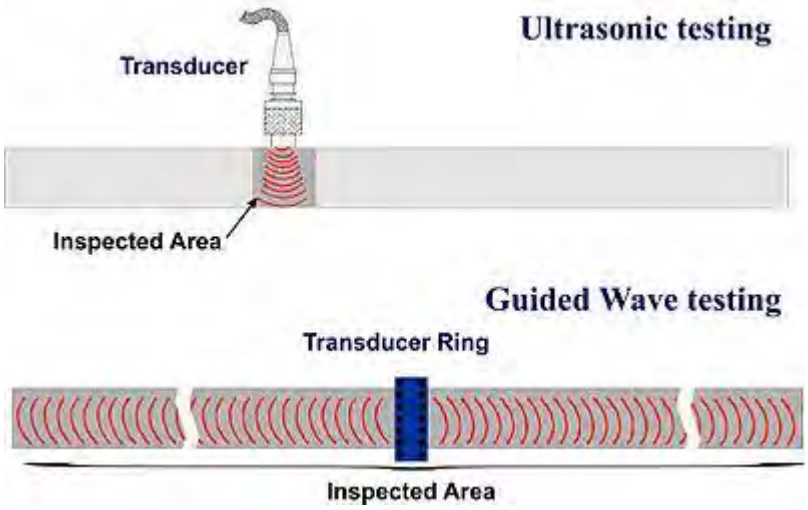

Figure 1.2: Ultrasonic testing and Guided Wave testing.

Guided waves is a wave the energy of which is concentrated near a boundary or between parallel boundaries separating different materials and that has a direction of propagation parallel to these boundaries. When the guided in plates, it is known as Lamb waves which have high attention for larger area in Non Destructive Testing inspection. Similar types of wave can also have in rods, cylinders and elongated structures which are not axially symmetric such as railroad rails and I-beams. The examined or study on the public infrastructure is to confirm that infrastructure does not suffer from aging early, cracking especially on critical components and changes in the form of concrete buildings. By using the

guided wave as inspection is one of good ways because these waves can propagate over longer distances and can be used at low frequencies. Shoe or shoess is one of the guided wave equipment. The position of shoess were located between transducer and specimen which it is to improve the sensitivity for line contact with specimen. The shoess also used to stimulate the symmetrical mode (S0-mode) and asymmetrical mode (A0-mode). By using different material of shoess, it will transmit the different type of wave. In this experiment, the material of shoess is acrylic for determine the S0-mode and elastomer material for the shoess to determine A0-mode.

1.2 Problem Statement

S0 mode indicated the fastest wave velocity in Lamb wave propagation at low frequency bandwidth, however the speed decrease rapidly when the frequency increase at the vicinity of the A1 cutoff frequency. At the same time, A0 mode shows lower wave velocity at low frequency bandwidth but has small wave dispersion characteristic as the S0 start having large dispersion characteristic in Lamb wave propagation.

The use of S0 mode in low frequency bandwidth might simplify the complicated wave structure due to its shortest travel time compared to A0 mode. However, low frequency bandwidth has longer wavelength that will reduce the sensitivity of the defect inspection. The use of A0 mode that has half of S0 mode wavelength is predicted to have higher sensitivity to defects in structures.

Therefore, a combination of A0 and S0 mode is proposed to utilize the mode conversion occurs around defect in structures for defect location in pulse echo technique.

1.3 Objectives

To study the behavior of wave interaction around defect by investigating the mode conversion caused around defects in plates.

1.4 Scope of Works

1) To investigate the defect of plate with different depth by using conversion mode.
2) To analyze the lamb wave by using symmetrical mode (S0-mode) and asymmetrical mode (A0-mode).
3) To design shoes by using plexiglass for S0 mode and aqualene for A0-mode
4) To develop casing for the transducer.
5) To make five locations for the defect detection to construct one signal.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview

This chapter will discuss the literature review regarding on the application of converted mode in detection in plate. This review will based on the past of journals, report, articles, and references books that have been studied in order to understand the related topics for these study. Besides that, this chapter will explain regarding on the topic of guided waves, snail law, and dispersion curve.

2.2 Ultrasonic Guided Waves

Ultrasonic guided wave is a type of ultrasonic signal that propagates through the boundaries. Guided waves can propagate in many type of boundaries such as thin plates, rods, and multilayer structure. The Ultrasonic waves will reflect back and forth inside the waveguide that will lead to the interference phenomena. Exciting an ultrasonic energy into a plate with an angle and specific frequency, the waves reflect back and forth, mode of conversion will occur.(Joseph L. Rose 2014). The setup of the experiment in determining in guided waves is as in the figure 2.1.