APPLICATION OF ACOUSTIC EMISSION (AE) TECHNIQUE IN VARIOUS TYPES OF WOODS

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APPLICATION OF ACOUSTIC EMISSION (AE) TECHNIQUE IN VARIOUS TYPES OF WOODS

by

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This report is submitted in partial fulfillment of the requirement for the degree of

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Dedicated to my father (Andrew Abak Jawi),

my mother (Irene Enchi Ribut), my brothers (Nicholas, Jerry and Gerald) ,

and all my friends

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ABSTRAK

Kerja ini adalah untuk mengesan aktiviti pengeluaran akustik di dalam pelbagai jenis species kayu . Pengeluaran akustik adalah tenaga yang dikeluarkan apabila beban dikenakan ke atas bahan yang diuji. Secara amnya, pengeluaran akustik juga bertindak sebagai stetoskop.

Kayu yang dipilih di dalam kajian ini adalah Jelutong, Meranti merah, Meranti Kuning, Selangan Batu, Kruin, dan Kapur. Penggunaan teknik pengeluaran akustik kini dapat mengesan setiap aktiviti mikro dalam bahan yang diuji.

Dalam kajian ini, beban yang konstan dikenakan ke atas kayu yang diuji. Daripada hasil ujian ini perbezaan sifat-sifat akustik di dalam kayu yang berbeza. Selain itu, kita hendaklah memastikan tiada sumber yang tidak diingini iaitu "Noise (kebisingan)" di kawasan kajian tidak terlalu bising sehingga mempengaruhi keputusan ujian.

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CHAPTER 1

INTRODUCTION

1.1 General Information of AE technique

Acoustic emission (AE) is a wave that travels through a material as the result of some sudden release of strain energy. Acoustic emission is a rapidly maturing nondestructive testing method for monitoring structural integrity, detecting leaks and failures in mechanical equipment, and for characterizing materials behavior.

There are different types of Acoustic Emission (AE) system such as standard, powerful, integral PC computer with to 56 AE channels. Several different chassis are available, including sizes for 8, 16, 24, and 56 channels.

The DiSP-56, large capacity 56-channel chassis includes hardware for both AE feature extraction and complete hit waveform. The DiSP-24 is a portable AE system, equipped with a handle for carrying and integral keyboard built within the hinged front protective cover. Built-in AE features include a digitally controlled audio monitor, 8 parametric and

AE Hit indicator LED's. The DiSP-16L AE system is geared for laboratory use, holding up to 4 PCI-DSP4 cards for up to 16 AE channels of operation. The DiSP-16L has added features for reliable day to day operation, including extra cooling, ventilation and powerful PC computer motherboard.

1.2 Typical Acoustic Emission Application

Acoustic Emission can be apply for many thing such as:

- Tube trailers and High Pressure Gas Cylinders.
- Advanced Materials.
- Stress Corrosion Cracking.
- Petrochemical Pipelines.
- Nuclear Components.
- Composites.
- Above Ground Storage Tanks.
- Weld Monitoring.
- Other applications.

1.3 OBJECTIVES

The objectives of this final year project, firstly is to compare the different Graphs and result for different material. There are six types of woods, which are Jelutong, Red Meranti, Yellow Meranti, Selangan Batu, Kruin, and Kapur are used in the test. Three samples of each materials will be tested.

Each material have a different graphs and different results. All information about the materials will be explain briefly. This is important to identify the characteristic of the material and the characteristic wave inside the material.

Secondly is to introduce an Acoustic emission (AE) as a method to detect every micro activities within the materials.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

An acoustic emission (AE) is a sound wave, or stress wave that travels through a material as the result of some sudden release of strain energy, within a material due to the occurrence of microstructure changes. If enough energy are released, audible sounds are produced.

The acoustic emission technique (AE) involves listening to the sounds (which are usually inaudible to the human ear) made by a material, structure or machine in use or under load and drawing conclusions about it's "state of health" from what is heard, just as a Doctor would listen to our heart and lungs. It is allows us to extend our hearing to detect sound of higher frequencies and lower intensities. With AE equipment we can "listen" to the sounds of crack growth, fibred breaking, martensites transformations and other modes of active damage in the stressed material.

The weak acoustic signal is captured by an AE sensor and preamplifier . After the preamplifier the signal can be filtered or go directly to the AD-converter which digitizes the signal. This AD-converter can be inside the PC as a plug-in card or outside the PC as a separate system.

2.2 The history of Acoustic Emission Technique

Acoustic Emission (AE) is a physical process that is one of many reflections of the materials failure. That is why AE has been used for developing of a wide class of nondestructive testing (NDT) techniques for practical applications. The great AE happened between 70's and 80's due to efforts of an enthusiastic group of researchers from industry and universities.

The principal of listening for warning of structural problems goes back into prehistory. The connection between fissures and the sounds that they make is so strong, that the word "crack" itself has acquired a double meaning, it refer to both fissure and sound. The phase "crack the whip" shows that the sound is short and sharp not a rumble or a vibration but a discrete shock. This is called the sound of crack growth.

Intensive scientific investigation about the sound of crack growth during 1960's, when it was realized that they could be made the basic of a "new" nondestructive testing method

(NDT). Instruments and technique were developed for measuring "acoustic emission" and displaying the result in numerical and graphical forms.

In the 70's, many practical application of the emerging technology, including the first bridge monitoring studies funded by the Federal Highways Administration. These projects had the nature of feasibility demonstration as the AE pioneers tried to show that they could successfully detect and locate the growth of flaws in the presence of interfering background noise in challenging environment.

In the 80's, the infrastructure of Acoustic Emission testing took shape. Written test procedures were developed and standardized for metal, fiberglass pressure vessels, storage tank, aerial man lift devices and railroad tank cars and for weld monitoring.

For a technology to be widely used, it is not enough for it to be technically feasible. Beyond feasibility, it must compete cost-effectively with the other possible solution to the problem and it must be readily accessible to those who would use it.

2.3 Introduction of Acoustic Emission Technique

Acoustic Emission, according to ASTM, refers to the generation of transient elastic waves during the rapid release of energy from localized sources within a material. Source of these acoustic emission include many different mechanisms of deformation and fracture. The Acoustic Emission Nondestructive Testing (NDT) technique is based on the detection and conversion of these high frequency elastic waves to electrical signals.

Sudden movement at the source produces a stress wave, which radiates out into the structure and excites a sensitive piezoelectric transducer. Sensors are coupled to the structure by means of a fluid couplant and are secured with tape, adhesive bonds or magnetic hold downs. As the stress in the material is raised, many of these emissions are generated. The signals from one or more sensors are amplified and measured to produce data for display and interpretation. The source of the acoustic emission energy is the elastic stress field in the material. When the structure is not loaded the acoustic emission cannot detect any discontinuity-the acoustic emission does not exist. Consequently, it does not detect geometrical inaccuracy. Acoustic emission sensor is collecting the burst type of signal (hits). There are two basic ways of hit descriptions. Hit description by parameter is easier and does not need so many recorded values. Time recording of hit amplitude contains more information about acoustic emission phenomenon, but the number of recorder values is higher then by the parameter's description. Transformation from time to frequency domain is very useful for stationary signal but for non-stationary one it is not much suitable. Time-frequency analysis appears as powerful tool to determination non-stationary signals. This specifies frequency components in particular time moment.

2.4 Acoustic Emission and Application

Some typical applications of the Acoustic Emission principle in testing material are as follow:

i. **Behavior of materials – metals, ceramics, composites, rocks, concrete.**

- Crack propagation
- Yielding
- Fatigue
- Corrosion, stress corrosion
- Creep
- Fiber fracture, delamination

ii. **Nondestructive testing during mannfacturing processes**

- Material processing
- Phase transformation in metals and alloys (martensitic transformation).
- Detection of detects such as pores, quenching cracks, inclusions.
- Fabrication.
- Deforming processes such as rolling, forging and extruding.
- Welding and brazing –defects detection (inclusions, cracks, lack of penetration).
- Weld monitoring for process control.

iii. **Monitoring structure**

- Continuous monitoring (metallic, structure, mines).
- Periodic testing (pressure vessel, pipelines, bridges, cable).

- Loose Part Detection.
- Leak Detection.

iv. **Special application**

- Petrochemical and chemical: storage tanks, reactor vessel, offshore platform, drill pipe, pipelines, valves, hydro-treaters.
- Electric utilizes : nuclear reactor vessels, piping, steam generators, ceramic insulators, transformers, aerial devices.
- Aircraft and aerospace : fatigue cracks, corrosion, composite structure.
- Electronics: loose particles in electronic components, bonding, substrate cracking.

2.5 Principles of Acoustic Emission Technology

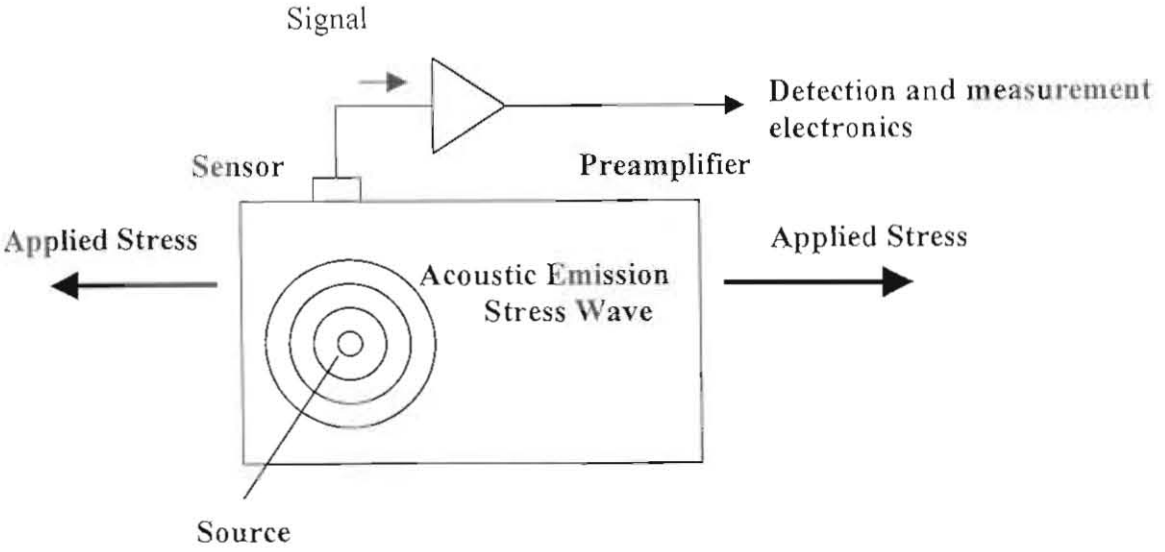

Figure 2.1: Principle of the acoustic emission method

Acoustic emissions are stress waves produced by sudden movement in stressed materials. Figure 2.1 shows the process of generation and detection of acoustic emission. This inspection technique detects elastic waves generated within a test specimen by such mechanisms as plastic deformation, fatigue, and fracture. Sudden movement at the source produces a stress wave, which radiates out into the structure and excites a sensitive piezoelectric transducer. As the stress in the materials is raised, many of these emissions are generated. The signals from one or more sensors are amplified and measured to produce data for display and interpretation. The source of the acoustic emission energy is the elastic stress field in the material. Without stress, there is no emission. An acoustic emission inspection is usually carried out during a controlled loading of the structure.