MEASUREMENT AND EVALUATION OF THE SOUND ABSORPTION COEFFICIENT FOR VARIOUS ASIAN WOODS

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ABSTRACT

The research is carried out to determine the sound absorption coefficient of various wood samples. Acoustic surface impedance of sound absorbing materials can be measured by several techniques such as the impedance tube for normal impedance or with using the vibration chamber. All these techniques are based on the determination of the sound absorption. In this report, the impedance tube will be used as a method. The description of the measurement technique and a detailed analysis of the acoustic theory as well as the sample materials are included. The paper presents a measurement technique of the sound absorption properties of materials, based on the measurements on random incidence technique. It allows one to measure the absorption coefficient with using different frequency value. The sound absorption coefficient (α) are number in range 0.00 – 1.00, the higher the number, the greatest the sound absorption coefficient (α).

ABSTRAK

Kajian ini dijalankan untuk menentukan pekali penyerapan bunyi di kalangan pelbagai jenis kayu-kayu di Asia. Permukaan impedans akustik bagi bahan penyerap bunyi boleh diukur dengan beberapa teknik seperti menggunakan tiub impedans ataupun dengan menggunakan teknik 'vibration chamber'. Teknik-teknik ini semua digunakan untuk mencari pekali penyerapan bunyi. Dalam laporan ini, kaedah dengan menggunakan tiub impedans dipilih dengan berdasarkan sampel yg sesuai. Huraian mengenai kaedah pengukuran ini dan juga data analisis mengenai teori akustik di samping bahan-bahan sampel dipenuhu dalam laporan ini. Laporan ini menyediakan teknik pengukuran pekali penyerapan bunyi bagi bahan, berpandukan atas pengukuran 'random incidence technique'. Kaedah ini membenarkan frekuensi yang berlainan yang akan dikenakan bagi mencari pekali penyerapan bunyi. Keputusan yang dijangkakan bagi nilai pekali penyerapan bunyi diantara 0.7-0.9

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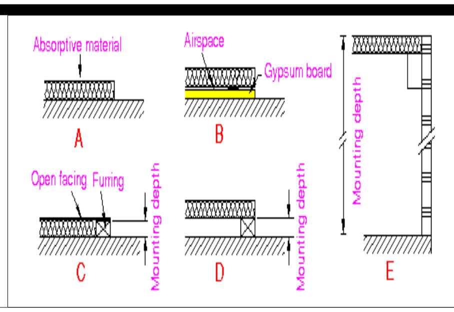
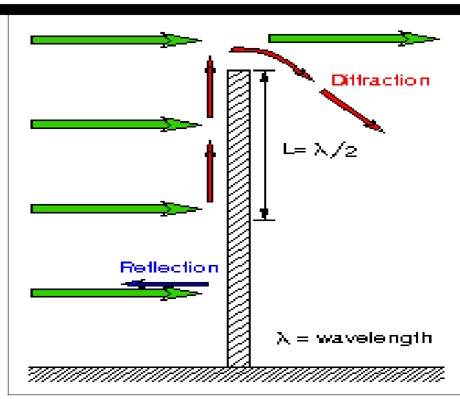
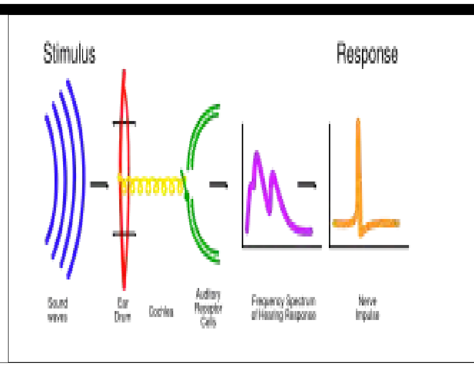
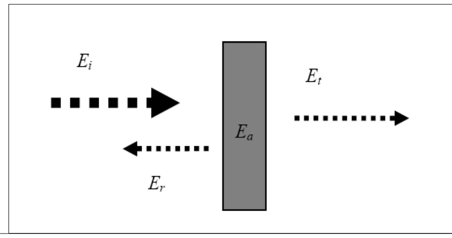
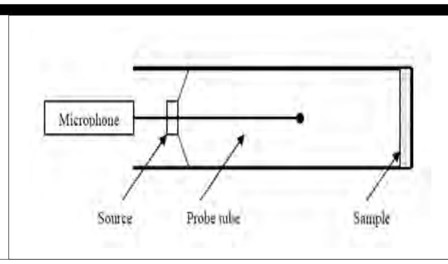
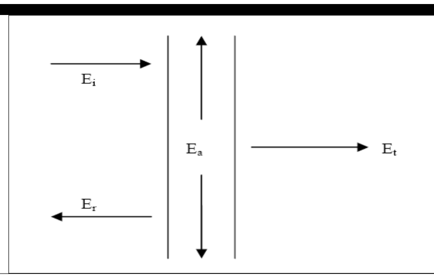
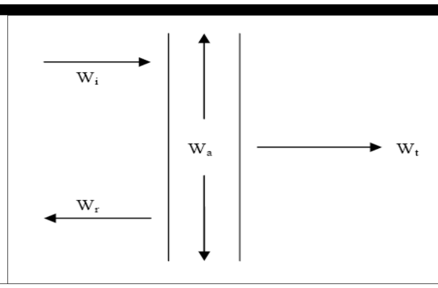
1		Noise reduction coefficient NRC is the arithmetic average of the sound absorption coefficients at 250, 500, 1000, and 2000 Hz, then this average is rounded to the multiples of 0.05	12
2		Diffraction phenomenon depends significantly on the ratio of the wavelength of the sound to the size of the obstacle. The longer the wavelength is, the stronger the sound diffraction. Diffraction effect happens to the sound transmitted through openings as well.	12
3		Figure 3: A schematic representation of hearing. (Blue: sound waves. Red: eardrum. Yellow: cochlea. Green: auditory receptor cells. Purple: frequency spectrum of hearing response. Orange: nerve impulse)	16

4		Reflection, absorption, and transmission	24
5		Standing wave method	31
6		The phenomena of the principle of conservation energy	34
7		The phenomenon of reflection, absorption and transmission of sound power in an acoustic material	35
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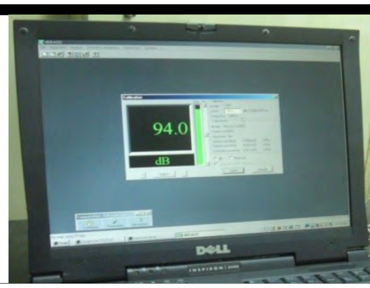
13		01dB Building Acoustics Software type dBBati32 32-Bit Version	43
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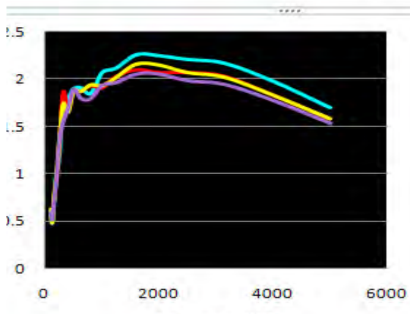
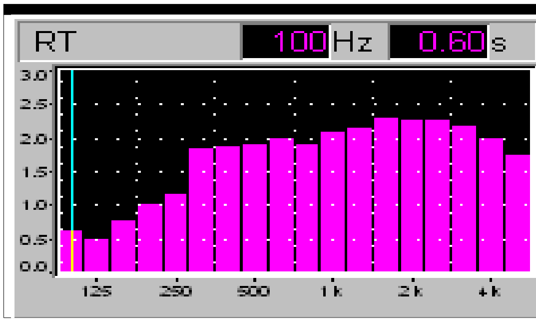
15		Graph of Reverberation Time vs. Frequency	49
26		Reverberation Time Graph	53

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CHAPTER 1

INTRODUCTION

1.1. Background

Acoustics is the science that concerned with the production, control, transmission, reception, and effects of sound. Their origin began with the study of mechanical vibrations and the radiation of these vibrations through mechanical waves. This research will do to look into many aspects of the fundamental physical processes involved in waves and sound and into possible applications of these processes to determine the sound absorption coefficient that apply on this theory.

Although people must have been aware of the acoustic peculiarities of rooms since the first buildings were built, the first systematic studies of room acoustics were those begun by W. C. Sabine around 1895. Sabine discovered the relation between reverberation in a room and its sound absorption. He found that, to an adequate approximation, he could calculate the room absorption by adding up the areas of the various room surfaces multiplied by appropriate sound absorption coefficients for the respective materials involved. Thus the way was open for the design and prediction of the reverberation properties of rooms. Sabine's instrumentation consisted of a stopwatch, a set of organ pipes, and his two ears, and although this sufficed to solve his immediate problems, it was recognized as a pretty primitive approach. Both the theoretical bases and the measuring technology have been evolving ever since. The paper traces these processes from the viewpoint of their effects on acoustical design.

1.2 Objective

The objectives of this project are to determine the sound absorption coefficient among various Asian woods like Damar Hitam, Meranti and Resak. This research is important in order to learn more about the sound absorption coefficient measurement techniques using different methodology and the measurement will walk in with suitable methodology depend on the sample. At the end of the project, a table that shows the sound absorption coefficient among these Asian woods is anticipated.

1.3 Scope

The field of this project approximately will cover the knowledge in application of consumer service in general and will cover the learning of acoustic theory that applies in this project to determine the sound absorption coefficient value. This research will also help to specify what are the various Asian woods are and how to get the sample for each example. The research methodology will help to determine the sound absorption coefficient among various Asian woods by using suitable method in acoustic theoretical and also how to prepare the procedures for measuring the absorption among various

Asian wood. After all procedure and the experiment will be done, the next step is to collect data and make it into a table.

1.4 Problem statement

Nowadays, there are most of the buildings have used materials that has it transpired sound absorption coefficient. The table below shows that the sound absorption coefficient among the selected materials with different frequency applied. From the table, there are many materials that had been measured their sound absorption coefficient but there is a lack of data for the sound absorption coefficient in terms of Asian woods. What will happens when the consumer need to build their house or their studio with different sound absorption by using the various Asian woods while there is no sound absorption coefficient value for the various Asian woods. Hence, this project can solve the problem by providing the table of sound absorption coefficient among various woods. The experiment would be carried out to give the perfect coefficient value among Asian woods. So, the purpose of this project is to measure the sound absorption coefficient among various Asian wood and make the data available for future use.

Table 1: Absorption coefficients of common building materials and finishes.

(Source: campanellaacoustics website)

Floor materials	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
carpet	0.01	0.02	0.06	0.15	0.25	0.45
Concrete (unpainted, rough finish)	0.01	0.02	0.04	0.06	0.08	0.1
Concrete (sealed or painted)	0.01	0.01	0.02	0.02	0.02	0.02
Marble or glazed tile	0.01	0.01	0.01	0.01	0.02	0.02
Vinyl tile or linoleum on concrete	0.02	0.03	0.03	0.03	0.03	0.02
Wood parquet on concrete	0.04	0.04	0.07	0.06	0.06	0.07
Wood flooring on joists	0.15	0.11	0.1	0.07	0.06	0.07

1.6 Report Structure

Chapter 1 presents the introduction of this project. It discuss about the background, objective of this project, the scope, the problem statement and the Gantt chart for this PSM1.

Chapter 2 explains the theory that applies on this project. Terms that are related to determine the sound absorption coefficient will be discuss in this chapter.

Chapter 3 covers the research methodology that has been used to determine the sound absorption coefficient. The raw materials that need to use also explained in this chapter.

Chapter 4 covers the experimental methodology that has been used to determine the sound absorption coefficient. The method is used in this project is explained in detail.

Chapter 5 discusses the result and show the calculation to determine the sound absorption coefficient (α).

Conclusion and recommendation for this whole report will discuss in Chapter 6.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

In this chapter, the term that related to the sound absorption coefficient will be discussed. The principle of acoustic theory is elaborated. This chapter will cover the theory of acoustic, the application of sound absorption, sound, and perception of sound, speed of sound, sound pressure, sound pressure level, sound power level, loudness, and sound intensity.

2.1 Terms definitions

Before doing this project thoroughly, the general concept apply in this acoustic theory must be understood. Basically the first thing need to know is, what the frequency.

2.1.1 Frequency

Frequency (f) is the number of cycles that the periodic signal completes in one second. The unit of the frequency is Hz (Hertz). The pure tone or the sine wave has a single frequency. Sound and noise usually are not pure tones. Depending on Fourier transform (the complex signal can be synthesized from sine signals - or pure tones - of different frequencies, different amplitudes and different time delays or phases) the sound signal represents pure tones with defined amplitudes (or intensities). The upper and the lower limits of the audible frequency range considered 16 Hz to 20,000 Hz; depend on many factors such as the setup of the measurements and the age of the listeners. The human hearing system is more sensitive to frequencies in the range of 1000 Hz-4000 Hz. [1]

2.1.2 Sound Levels and Decibel

Next, what the sound levels and decibel is. The definitions of sound levels and decibel are related to the amplitude of the signal. The absolute value of the sound intensity (I) can be described in Watts per square meter or W/m^2. As discussed above for frequency, the change in the sound intensity (or sound pressure level, SPL) must be more than certain value in order to be noticeable by the human hearing system. The full range of the audible sound intensity values can be divided into 100 ranges, the higher the sound intensity (louder the sound) the wider the intensity range. Hence the Bel unit is considerably large, one tenth of it is used (the same concept as discussed above for more frequency resolution), and the resulting unit is called decibel or (dB). In sound application the reference value is 20 μPa for sound pressure or 10E-12 W/m^2 for sound intensity. These values give 0 dB sound level, and represent the human threshold of hearing (the lowest level that can be perceived). [2]

2.1.3 Sound Absorption Coefficient

What the sound absorption coefficient is. Sound absorption coefficient describes the efficiency of the material or the surface to absorb the sound. The ratio of the absorbed sound energy to the incident energy is the sound absorption coefficient.

For architectural purposes, sound absorbing materials and constructions can be divided into four types of materials depending on the way the absorption is mainly performed:

1. Turning the sound energy into heat such as fiberglass and carpet.
2. Vibrating with a specific frequency when the sound hits the surface such as lightweight panels and 5/8" gypsum board. (These materials absorb the sound effectively on a narrow band of frequencies).
3. Turning the sound energy into heat in the neck of the cavities (Helmholtz resonator) such as sound blocks. (This construction has a good absorption on low frequencies).
4. Allowing the sound to go through such as some types of grid systems and lay-in ceiling with sound leakage above it.

The most common way to measure sound absorption coefficient is to lay a piece of the material in a reverberant room (a room which has very long Reverberation Time) then measure the RT so the coefficient can be derived from Sabin equation (the original version of RT calculation). There is a standard that details this procedure. The value of the coefficient for the same material varies with the type of the mounting in the test room. Mounting types that are frequently given in manufacturer's data sheets of the acoustical panels are illustrated in Figure 1. (http://home.tir.com/~ms/concepts/concepts.html).