ANALYSIS OF SOUND INSULATION OF TRIM MATERIALS IN CAR USING KENAF FIBRES WITH SEA

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DECLARATION

I declare that this project report entitled “Analysis of Sound Insulation of Trim Materials In Car Using Kenaf Fibres With SEA” is the result of my own work except as cited in the references

Signature : .....

Name : .....

Date : .....

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.

Signature : .....

Supervisor's Name : .....

Date : .....

DEDICATION

بسم الله الرحمن الرحيم

To my beloved mother and father

ABSTRACT

Customers require a suitable car and a comfortable atmosphere of disturbing noise generated from outside the vehicle. Therefore, the automotive industry has supplied sound insulation materials using synthetic materials such as felt fibres. Materials used are substances that affect chemicals and are not environmentally friendly. The purpose of project study as the alternative to conventional synthetic materials as sound insulation. Kenaf is a fibre made up of natural fibre has been selected to replace existing materials. To prevent noise from outside the vehicle, with the advantages of kenaf fibres capable of replacing the existing fibres as a sound insulation material. Simulation tests and experiments have been made to prove kenaf fibres capable of replacing existing materials.

ABSTRAK

Pelanggan mahukan kereta yang sesuai dan suasana yang selesa daripada terganggu bunyi bising yang terhasil daripada luar kenderaan. Oleh itu, industri automotif telah membekalkan bahan penebat suara dengan menggunakan bahan sintetik iaitu serat felt. Bahan yang digunakan adalah bahan yang mempengaruhi bahan kimia dan tidak mesra alam. Tujuan tesis ini dibuat adalah untuk menggantikan serat yang sedia ada dengan serat semulajadi. Kenaf adalah serat yang terdiri daripada bahan semulajadi telah dipilih untuk menggantikan serat yang sedia ada. Bagi menghalang bunyi bising daripada luar kenderaan, dengan kelebihan yang ada pada serat kenaf mampu untuk menggantikan serat yang sedia ada sebagai bahan penebat suara. Ujian simulasi dan uji kaji telah dibuat bagi membuktikan serat kenaf mampu untuk menggantikan bahan yang sedia ada

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LIST OF ABBREVIATIONS

SEA	Statistical Energy Analysis
TPNR	Thermoplastic Natural Rubber
EPDM	Ethylene Propylene Diene Terpolymer
PLA	Poly (Lactic Acid)
PLLA	poly-L-lactic acid
CFC	Chlorofluorocarbons
CLF	Coupling loss factor
VA	Vibro-acoustic
DLF	Damping loss factor

LIST OF SYMBOL

i	=	Ability balance for a system
j	=	Subsystem
$Pinj,i$	=	The input power to the subsystem
$Pdiss,i$	=	The power dissipated through internal damping
Pi,j	=	The power transmitted from subsystem
Ei	=	Vibrational energy
Ni	=	Number of modes
ηij	=	Damping loss factor (DLF)
I	=	Intensity
Si	=	Total surface
αSi	=	Absorption area
Co	=	Speed of sound
Vi	=	Volume of cathe vity
Sp	=	Panel of surace
τd	=	Transmission coefficient
$pexc$	=	Power in cavithe ty
ρo	=	Air density
ηi	=	Modal density
S'	=	Total surface area
L'	=	Total length of all edges
V	=	Volume
w	=	Width
h	=	Height
d	=	Depth of the cubic volume
f	=	Frequency
$\Delta\omega$	=	Number of frequencies
Ei	=	Total sound energy

Er	=	Sound energy reflection
Et	=	Sound energy transmission
α	=	Ratio of absorbed sound energy

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CHAPTER 1

INTRODUCTION

1.1 Background

Nowadays, the customer requires suitable vehicle systems with optimization intensity on vehicle noise and vibrations characteristics. Noise and vibrations of motor vehicles are progressively imperative for the automotive industry, especially for vehicle producers and component suppliers. The exterior sounds are usually controlled by sound pollution constitution, while internal noise and vibration feel highly valued by customers themselves (Dejan and Vladimir, 2016).

Noise is characterized as any repulsive or startling sound created by a vibrating object and has increasing importance to vehicle users and situations. Vibration is characterized as any frightful repetitive motion of an object, back-and-forth or up-and-down and represents an imperative issue closely related to reliability and quality of the vehicle (Dejan and Vladimir, 2016).

For existing materials inside the car's cabin is called felt which is the material that composed of wool that is mixed with synthetic. The combinations of the fibre for felt include wool and polyester or wool and nylon. Synthetics cannot be turned into felt by themselves but can be felted if they combine with wool (Giollo and Ann, 1981; McDowell and Colin, 1993). Felt material is represented as a synthetic fibre and becomes excellent sound insulator

because of having a superb vibration damping. It is made of chemical resistant and cannot be recycled.

The objective of this project is to study the feasibility of kenaf fibres as sound insulation materials in the car, an alternative to the conventional trim materials which is felt. In another word, kenaf is called 'Hibiscus Cannabinus'. Hassan et al. (2017) mention that the plant of the kenaf fibre native to East-central Africa. It is existence for nearly 4000 years ago. The potential of kenaf is easy to grow and high photosynthesis rate. Moreover, kenaf has been used as a building material for board production. In the year 2000, kenaf was first introduced to Malaysia with the name 'National Kenaf and Tobacco Board (NKTB)'. The current policy is to plant kenaf to replace tobacco at tobacco farms. The purpose of the replacement is to control and regulate tobacco. Kenaf has a very high potential to grow where it can reach 3.7 – 4.7 meters in 4 weeks. Basri et al. (2014) mention that tangkai kenaf plant consists of two types of fibres that are very useful. For outer part is called kenaf bast fibre and the inner part is called kenaf core fibre. Besides that, Mansor et al. (2013) mention that kenaf represents as one of the natural fibre and have good potential in several advantages and also known as environmentally friendly.

Recently, the study of the kenaf fibres as sound insulation remains lacking. This research is about to replace the conventional trim material inside the car cabin with the natural fibre which is kenaf.

1.2 Problem Statement

The research is made to reduce the sound from the outside of the car to get into the interior compartment. To block the noise from entering the interior of the car, barriers and other treatments have been used. For the interior of the vehicle, kenaf fibre and conventional trim materials have applied to dissipate sound and thus reduce the overall sound pressure level. The thickness of the material is directly related to the effectiveness of sound insulation (Zent and Long, 2007).

More recently, issues related to global warming caused by the emission of greenhouse gases into the atmosphere by the industrial manufacture of materials may change the acoustical materials market. The production of conventional trim materials contributes to the release of carbon dioxide mostly from power plants and transport, methane, nitrous oxide and others Therefore, the amount of greenhouse gas emissions set directly and indirectly by the production of materials affects its carbon footprint, which may become increasingly important in the consideration of future world trade (Arenas and Crocker, 2010). Consumers are more in favour of eco-friendly materials, less contaminating processes, and recycling of products as they have been aware of and concern about the negative effects of pollution.

Natural fibres can be vegetables such as cotton, kenaf, hemp, flax, wood, and etc. For the animal, such as wool, fur felt or mineral such as asbestos. Conventional trim material which is synthetic fibres can be cellulose such as bamboo fibre. For mineral is fibreglass, mineral wool, glass wool, graphite, ceramic, and etc. For the polymers, such as polyester, polypropylene, Kevlar, and etc.

Obviously, sound absorbers made from natural fibres such as kenaf can be easily recycled, and their production involves low carbon footprint and no CFC release so they can be classified as ecological green building materials.

There is no research about using kenaf fibre as sound insulation in the car prior to my research. The main purpose of using kenaf fibre is to make kenaf fibre as sound insulation inside the car cabin.

1.3 Objective

1. To develop statistical energy analysis (SEA) model of 'rough' body-in-white car structure.
2. To study the feasibility of kenaf fibres as insulation materials in the car, as an alternative to the conventional trim materials.
3. To perform an experiment to take a measurement of transmission loss using impedance tube.

1.4 Scope

The scopes in this project are:

1. Only plate panel is considered.
2. In this work structural vibration and noise transmission, the interior part of the vehicle is studied.
3. The main focus is on the computation of absorption and transmission loss of the SEA panels, the approximations used and the way pass-through are included in the model.
4. The kenaf fibre is only tested on a sedan car.

CHAPTER 2

LITERATURE REVIEW

2.1 Building The SEA

Elliot et al. (1988) reported SEA can be a great tool for acoustic designs to predict the reactions and power flows between model elements.

Pinnington and White, (1981) mention that generally configured between the noise and vibration source and the rest of the complex structure, the project of the vibration isolation system is to reduce the flow of noise and vibration. Calculation of vibration transmission structures is performed as part of the calculation of sound and vibration transmission through complex structures. The vibration isolation system is a mechanism for transferring noise and vibration.

Most studied in Souli et al. (2015) said that in the SEA system method is considered to be divided into linear outlines subsystems and convert energy through resonant vibration mode. The subsystem may be a dash, floor, doors, firewall and etc. In the automotive industry with similar modes, and wherever the main variable is energy.

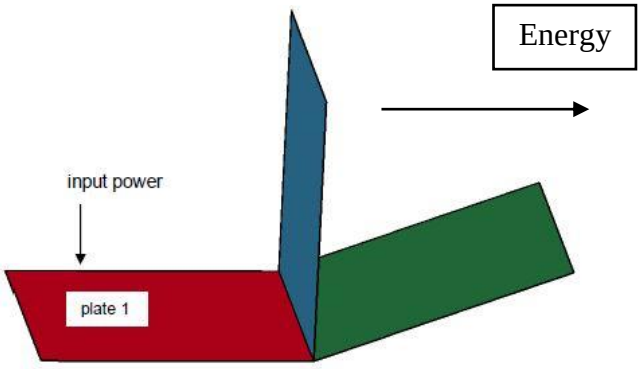

Figure 2.1: SEA subsystem (Souli et al., 2015)

Figure 2.1 shows the SEA subsystem may be a dash, floor, doors, firewall and etc. In the automotive industry with similar modes, and wherever the main variable is energy.

2.2 Model Development

The development of the Statistical Energy Analysis (SEA) model depends on energy storage in the structure and also the coupling type between the substructures. According to Lafont et al. (2016), there is no general definition of SEA subsystem. A subsystem is just outlined as a group of modes wherever the energy is equally distributed. A subsystem dissipates energy exchanges energy with the other subsystems. The equation governing the ability balance for a system i *is*

$$P_{inj,i} = P_{diss,i} + \sum_j P_{i,j} \tag{2.0}$$

Where $P_{inj,i}$ the input power to the subsystem from external sources is, $P_{diss,i}$ is the power dissipated through internal damping, $P_{i,j}$ is the power transmitted from subsystem i to a neighbouring subsystem j through the mechanical coupling. All powers are time averaged.