UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF BUILDING APPLICATION NOISE BARRIER USING SANDWICH STRUCTURE

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor's Degree of Mechanical Engineering Technology (Maintenance Technology) with Honours

by

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor's Degree in Mechanical Engineering Technology (Maintenance Technology) with Honors. The member of the supervisory is as follow:

……

(Mr. Muhamad Azwar bin Azhari)

ABSTRAK

Salah satu isu yang dihadapi oleh manusia setiap hari di seluruh dunia adalah pencemaran bunyi. Pencemaran bunyi boleh dianggap sebagai bunyi yang tidak dingini dan memberi kesan kepada manusia dari segi fizikal dan fisiologi. Kajian ini akan merangkumi tentang cara untuk mengurangkan pencemaran bunyi dengan pengubahsuaian yang dilakukan pada laluan penghantaran bunyi dengan menggunakan penghadang pencemaran bunyi khusus untuk kegunaan bangunan. Oleh itu, kajian ini bertujuan mencari alternatif yang mampan dan mesra alam sebagai penghadang pencemaran bunyi dengan menggunakan sisa buangan tekstil dan gabus polyurethane yang boleh mengurangkan bunyi. Melalui keputusan yang diperolehi daripada ujian, bahan yang terbaik akan digunakan untuk pembuatan penghadang bunyi yang direka. Tambahan lagi, pengukuran In-Situ (In-Situ Method) akan memeriksa kecekapan halangan bunyi untuk mengurangkan pencemaran bunyi berdasarkan tahap tekanan bunyi dikurangkan yang dihantar dari sumber bunyi kepada penerima. Hasil yang sangat baik dimana kebisingan yang dihantar melalui penghadang pencemaran bunyi banyak berkurang malah dengan drastik selepas kehilangan kadar tekanan bunyi yang dihilangkan pada struktur sandwich dalam penghadang pencemaran bunyi.

ABSTRACT

One of the common problems that need to be faced by the people is noise pollution. Noise pollution can be describe as unwanted sound that effect human in physically and physiologically. The study will cover the way to reduce noise pollution by adjustment of the sound transmission through the transmission path from the development of the building application noise barrier. Therefore, this project found the alternative sustainable and environmentally friendly as noise barrier using textile waste and polyurethane foam which can reduce noise. From the result obtained, the best material are being be used in the noise barrier application. In addition, In-Situ measurement will check the efficiency of the noise barrier to reduce the noise pollution based on sound pressure level reduced that transmitted from the source of noise to the receiver. The result was excellence which the noise transmitted through the noise barrier reduced drastically and tremendously after sound pressure level is reduced due sandwich structure inside noise barrier.

DEDICATION

This thesis is dedicated to my parents for their love, endless support and encouragement.

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Assalamualaikum w.b.t

Very grateful to Allah S.W.T because of Allah S.W.T endowment, I can execute this Final Year Report at the right time. I would like to take this opportunity to express my deepest heartfelt and thank to all those who have guided and supported me during my Final Year Project either directly or indirectly.

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TABLE OF CONTENTS

Abstrak		i
Abstract		ii
Dedication		iii
Acknowledgment		iv
Table of Content		v
List of Tables		vii
List of Figures		viii
List of Abbreviations, Symbol and Nomenclatures		x
CHAPTER 1: INTRODUCTION		**1**
1.1	Vibration	1
1.2	Noise	2
	1.2.1 Machinery Noise	3
	1.2.2 Noise Acoustics	4
	1.2.3 Noise Reduction Method	4
1.3	Sound Absorption	4
1.4	Sound Transmission Loss	6
1.5	Problem Statements	7
1.6	Objectives	8
1.7	Scopes	8
CHAPTER 2: LITERATURE REVIEW		**9**
2.1	Building Noise	9
2.2	Noise Reduction Method	12
	2.2.1 Sound Absorption	14
	2.2.2 Sound Transmission Loss	16
2.3	Previous Research on Reducing Building Noise	18

2.3.1 Materials 20
2.3.2 Design 24

CHAPTER 3: METHODOLOGY 27
3.1 Research Design 27
3.2 Material Selection 30
3.2.1 Textile Waste 30
3.2.2 Polyurethane Foam 31
3.3 Conceptual Design 32
3.4 Measurement Procedure 35
3.4.1 In-Situ Measurement 35

CHAPTER 4: RESULT AND DISCUSSION 37
4.1 Result and Discussion 37
4.2 Sound Pressure Level of Noise Sources 38
4.2.1 Sound Pressure Level with Panel and Without Panel at 0° 48
4.2.2 Sound Pressure Level with Panel and Without Panel at 22.5° 49
4.2.3 Sound Pressure Level with Panel and Without Panel at 45° 40
4.2.4 Sound Pressure Level with Panel and Without Panel at 67.5° 41
4.2.5 Sound Pressure Level with Panel and Without Panel at 90° 42
4.3 Comparison Sound Pressure Level without Panel 43
4.4 Comparison Sound Pressure Level with Panel 44
4.5 Sound Transmission Loss 46

CHAPTER 5: CONCLUSION AND FUTURE WORKS 48
5.1 Conclusion 48
5.2 Future Works 49

REFERENCES 51

LIST OF TABLES

2.1	Sound absorption coefficient values of natural fibers as studied by Berardi & Iannace (2015).	23
4.1	The results of transmission loss of noise barrier with panel and without panel at 3100 Hz frequency.	46

LIST OF FIGURES

1.1	Single degree of freedom with damping system (Barron, 2003)	1
1.2	Sound waves in material (Barron, 2003)	3
1.3	Sound absorption through a wall (Fallis, 2013)	5
1.4	Transmission loss in sound wave (Barron, 2003)	6
1.5	Illustration of noise pollution from BK37 to BK38, Factory 3, Industrial Campus UTeM	7
2.1	Diagram shows wave propagation from piling source to building (Deckner, 2012)	10
2.2	Illustration of airtight structure installation for windows in Horizontal, Vertical, and Gap – Sealing Position (Ku and Kim, 2015)	13
2.3	Rooms with and without sound absorptive treatment (Egan, 1988)	14
2.4	Typical absorbing boundaries in room and absorption properties of a curtain (Bruel and Kjaer, 1986)	15
2.5	Schematic of test rooms used for transmission loss evaluations (Robin R. Wareing et al., 2015)	17
2.6	Room Dimension (Sousa and Gibbs, 2014)	18
2.7	Building greenery as acoustic insulation. Almeida Theatre. London (Perez et al., 2016)	19
2.8	Acoustic performance using Sonic Crystal scatterers (Castiñeira-Ibañez et al., 2015)	20
2.9	Classification of sound absorbing materials (Sikora and Turkiewic, 2007)	22
2.10	Sound insulation panel design by (Wareing et al., 2015)	24

2.11	Schematic of the low – height barrier prototype (Jolibois et al., 2015)	25
2.12	Image of different types of corrugated board, from left to right: single, double and triple wave corrugated board patented by (Thompson, 1875)	26
3.1	Flow chart of the research	28
3.2	Textile waste as absorption material (Gabor, 2016)	30
3.3	Polyurethane Foam (Tiuc et al., 2016)	31
3.4	Conceptual design of noise barrier	32
3.5	Sort of different material for sound absorption material arrangement	33
3.6	Different thickness of absorption materials	34
3.7	Image of speaker placed in front of noise barrier	35
4.1	Sound Pressure Level with Panel and Without Panel at 0°	38
4.2	Sound Pressure Level with Panel and Without Panel at 22.5°	39
4.3	Sound Pressure Level with Panel and Without Panel at 45°	40
4.4	Sound Pressure Level with Panel and Without Panel at 67.5°	41
4.5	Sound Pressure Level with Panel and Without Panel at 90°	42
4.6	Comparison of Sound Pressure Level without Panel at 0°, 22.5°, 45°, 67.5° and 90°	43
4.7	Comparison of Sound Pressure Level with Panel at 0°, 22.5°, 45°, 67.5° and 90°	44

LIST OF ABBREVIATIONS, SYMBOL AND NOMENCLATURES

A	-	Absorption Value after Treatment with Sound-absorbtive Materials
A0	-	Absorption Value Before Treatment with Sound-absorptive Materials
BK	-	Bilik Kuliah (Lecture Class)
d	-	Distance
dB	-	decibels
FTK	-	Fakulti Teknologi Kejuruteraan
Hz	-	Hertz
h	-	Height
Ks	-	Spring Constant
Kg/m^3	-	Kilogram per meter cube
LPF	-	Light Poly-urethane foam
M	-	Mass
m	-	Meter
NR	-	Noise Reduction
NRC	-	Noise Reduction Coefficient
R_M	-	Damper Constant
R_w	-	Rating of Sound Insulation Performance
SPL	-	Sound Pressure Level
S	-	Surface Area
TL	-	Transmission Loss
t	-	Thickness
UTeM	-	Universiti Teknikal Malaysia Melaka
WHO	-	World Health Organization

w	-	Width
α	-	Absorption Coefficient
α_w	-	Rating of Sound Absorption Coefficient
δ	-	Density
μm	-	Micro Meter
%	-	Percent
Ø	-	Diameter
Θ_i	-	Incident Wave Angle
Θ_R	-	Reflected Wave Angle
Θ_T	-	Transmitted Wave Angle

CHAPTER 1

INTRODUCTION

1.1 Vibration

Vibration occurs when something oscillates about a static position. The altering transfer of energy between its potential and kinetic forms involves in the vibration of a system. Besides that, vibration is also being known as the physical movement or motion of a rotating machine. A study by Taylor (2003), he state that since the vibration cannot be measured by sight or touch, employed should change the vibration into a usable product that can be measured or analyzed (Taylor, 2003). In our daily life routine, people were always exposed to the vibration which enviable or non-enviable. For example the reed in a woodwind instrument or harmonica, noise vibration from vehicles on the streets and mostly vibration comes from industrials.

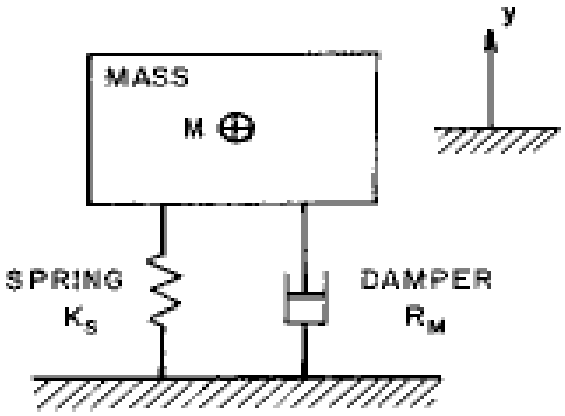

Figure 1.1: Single degree of freedom with damping system (Barron, 2003).

By referring to the figure above, in order to reducing the noise level, damping materials are used to dissipate the mechanical energy from being radiated into noise that transmitted into the air (Barron, 2003). According by Taylor (2003), he state that vibration can be divided into three types which are harmonic motion, periodic motion and random motion. Harmonic motion is the simplest periodic motion that shows displacement as a harmonic function of angular velocity and time. It is periodic, meaning it repeats at some point in time.

Vibration can also be seen as a periodic motion that moving repeatedly after a certain interval time. Random motion occurs in an erratic manner and contains all frequencies in a particular frequency band. It is a motion that not repeatable (Taylor, 2003).

Besides that's, vibration also will contribute to the deterioration of working environment. Workers exposed to occupational vibration are also often exposed to excessive noise. Worker will get hearing problem especially in cochlea. Cochlea will damage when exposed to excessive noise and worker become deaf (Futatsuka et al., 1991).

1.2 Noise

Nowadays, one of the environmental problems that will affect human health is noise. Noise can be describe as unwanted sound that effect human in physically and physiologically and destroying environmental properties will develop environmental pollution (Atmaca et al., 2005). Moreover, noise can cause heartbeat acceleration, increase of blood pressure and ringing or other noises in the ear or head known as tinnitus. The psychological effects of noise are more common compared to the psychological ones and they can be seen in the forms of annoyance, stress, anger and concentration disorders as well as difficulties in resting and perception (Cheung, 2004). Hearing loss will occur when there is continuous exposed to excessive noise at a level higher than 85 dB (Atmaca et al., 2005).

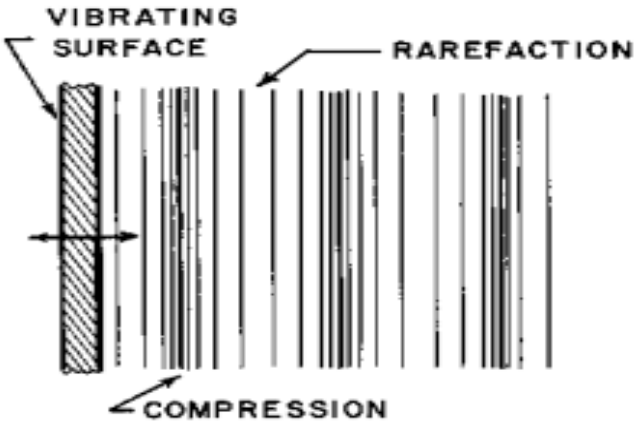

Figure 1.2: Sound waves in material (Barron, 2003).

Noise also can be defined as any perceived sound that is objectionable or damaging for a human. Noise is somewhat subjective, because one person's ''music'' may be another person's ''noise.'' Some sounds that could be classified as noise, such as the warning whistle on a train, are actually beneficial by warning people of potential dangerous situations (Barron, 2003). The sound wave in various materials is given in Figure 1.2.

1.2.1 Machinery Noise

The most unwanted hazard in the industry is noise. A lot of machinery in industry produces a lot of sound. Machines such as motor, pump, turbine and generator will produce noise while operating. Continuous exposure to the noise level above 85 dB is considered hazardous because the standard limit of daily noise exposure at the workplace for most countries is 85 dB for an 8 –hour (Amedofu, 2007). Machinery noise should be reduce to protect worker from continues hearing excessive noise. Noise can be controlled by noise control at the source and modification along the sound transmission path (Fard et al., 2013).

1.2.2 Building Acoustics

It's a noisy world. Twenty-four hours a day, seven days a week, we are exposed to sounds we do not want, need, or benefit from. When the surrounding noise level is same as speech level, the intelligibility rates would be decrease to 95% due to redundancy of speech that lead to unpleasant conversation because of sound interference (Lazarus, 1986, 1987). The study of sound propagation is not only focusing only at acoustical design of large performance halls but it is also concern about acoustical comfort surroundings where people spend lot of times either in the workplace, homes, hotels and restaurants (Bennet, 1975).

1.2.3 Noise Reduction Method

It is compulsory to eliminate or at least reduce the source of noise in order to protect humans from continually exposed to the noise. Manipulating the source of the noise or by modifying the receiver of the sound can secured the sound easily. (Barron, 2003). Occupational Safety and Health Administration (OSHA) sets the admissible noise exposure limit in the room 85 dB for an eight hour period. In order to create an acoustically pleasing environment for the human, noise control and its principles play a very important role to bring down the intensity of sound to a safer level for human ears.

1.3 Sound Absorption

Materials that have low absorption ability have a chance to reflect most of the acoustical energy. Sound absorption is a capability of a material to convert sound energy into other energy. This energy is usually converted to heat energy (Kuttruff, 1995).

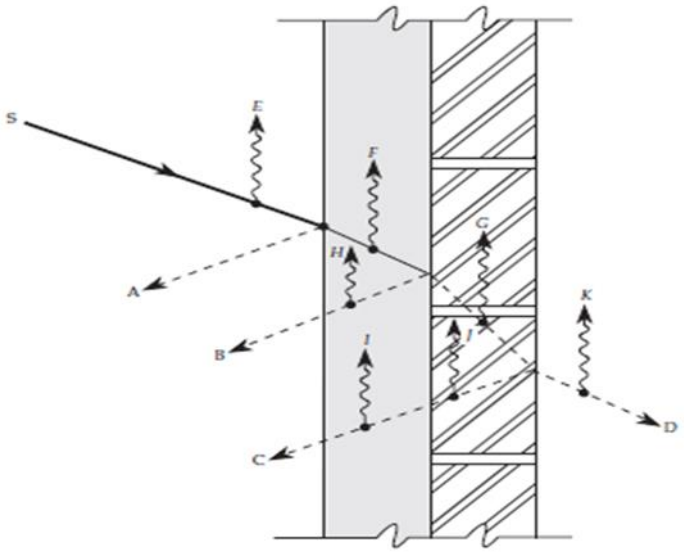

Figure 1.3: Sound absorption through a wall (Fallis, 2013).

Fallis (2013) stated that, a sound ray reflecting away from its original path into different directional as the sound ray impinging on the surface with different reflection angles and sound absorptions into the air and through the absorption material. All sound waves naturally fading by the medium along the transmission path (Fallis, 2013). Different conditions such as in large area hall and at increasing frequencies condition this would be different as it is significantly become noticeable (Bennet, 1975). The fraction of incident sound energy introduced from the absorption coefficient of a boundary that is not reflected by incident of sound energy, and the quantity are rely on the frequency value and the sound incidence. There are three types of sound absorber as stated by (Bennet, 1975), they are Absorption by Yielding Walls, Absorption by Porous Materials, and Resonance Absorbers.

1.4 Sound Transmission Loss

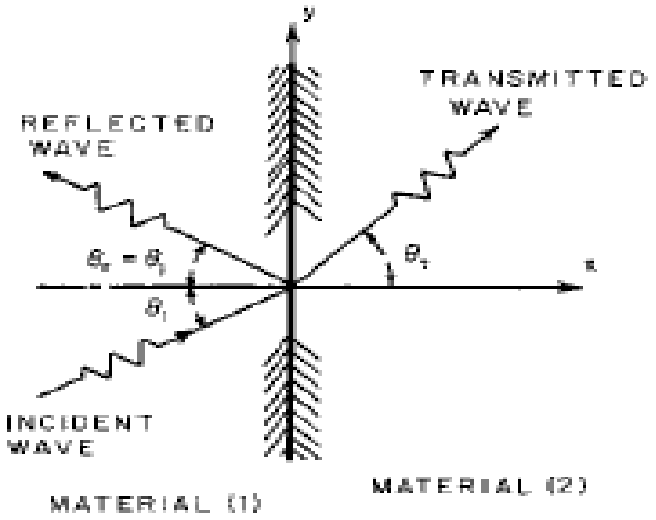

Figure 1.4: Transmission loss in sound wave (Barron, 2003).

Noise can be control by changing at the beginning stage of its transmission starting from source of sound, the transmission path or controlling the noise by modify the receiver of the sound (Barron, 2003). There are two methods that can be applied in reducing noise, they can be done by using sound absorption technique and the other one is by applying the transmission loss control. One of the main factors in controlling noise pollution to be considered is determination the sound energy transmitted through a wall (Barron, 2003). Acoustic barrier or acoustic wall is one of the procedures for noise control in order to reduce noise pollution from being transmitted through a medium. In purpose for designing noise barrier, the designer should be know and have sense to predict the transmission loss through the wall over a broad range of frequencies (Barron, 2003).

1.5 Problem Statement

Human especially students need to focused when studying. Persistent expose to noise can give negative effect to the student such as disturbance noise from another class. Now, this situation has been face by students and lecturer in FTK, UTeM Industrial Campus. They have feeling annoying due to noise interference from another class while learning section is being conducted. A study by Zaheerudin (2008), normal acceptable distance for good interaction in ambient environment should be not more than 65 dB for young and teenagers while 55 dB for old people. The students are having resistance on their focusing on learning process due to noise interference from another class. Interaction between people in speech is ascendant method, noise interference significantly effect on the communication (Zaheerudin, 2008). Noise barrier control the unwanted noise by reducing direct contact of sound pressure to human. There are two types of method to reduce noise which are sound absorption and sound time loss or reflection of sound. Materials that have tendency to reduce noise in large scale become priority for development of noise barrier.

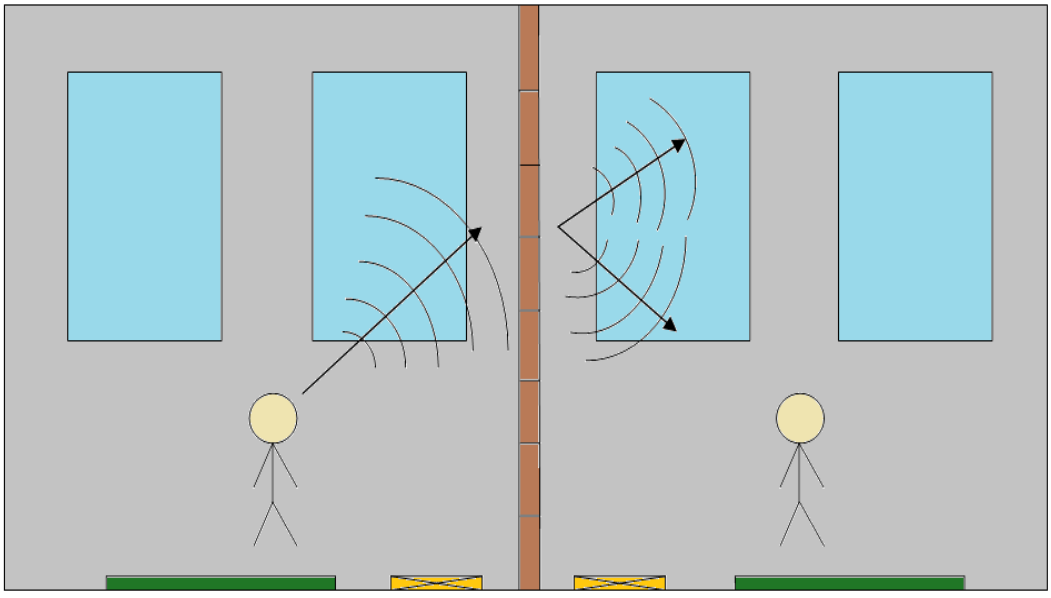

Figure 1.5: Illustration of noise pollution from BK37 to BK38, Factory 3, and Industrial Campus UTeM.

Figure 1.5 shows noise pollution disturb the lectures session are being conducted between these two classes at the same time. The students and lecturers in FTK, UTeM Industrial Campus having experienced on feeling annoyance due to noise interference while the learning session are being conducted. Voice coming out from human voice projection in BK38 possibly leaks into BK37 at some of times during lectures session that being conducted surely will bring an annoyance condition to the students and the lecturer that affected by the noise pollution.

1.6 Objectives

The objectives of the project are:

- To develop noise barrier for building application using sandwich structure design.
- To test the effects of noise barrier in the class by using In-situ measurement method with different angles.

1.7 Scopes

The scopes of the project are:

- Developing noise barrier using sandwich structure as the design of the barrier.
- Testing noise barrier based on sound transmission loss and sound absorption rate by using In-situ measurement method with different angles.

CHAPTER 2

LITERATURE REVIEW

2.1 Building Noise

The acoustical environment on the whole buildings is affected by numerous interrelated and interdependent factors associated with the building planning, design and construction process. The architect, the engineer, the building technologist, and the constructor all play a part in the control of the acoustical environment. With some prepared knowledge of basic acoustical principles on how materials and structures control the sound, many problems can be avoided altogether or, at least, solved in the early stages of the project at greatly reduced cost. ‘‘Corrective” measures are inevitably more costly after the building is finished and occupied (Cavanaugh and Wilkes, 1998). Sometimes, unwanted sound from railroads, road traffic, construction area and recreation will cause annoying sound to the people inside the buildings (Barron, 2003). Some cases occur when people are complaining about piling works that annoying them to change in normal condition either in temporary and short time due to intense and sudden noise that received by the people (Head and Jardine, 1992).