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 Degree of Mechanical Engineering Technology (Maintenance Technology) with Honours.

by

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I hereby, declared this report entitled "**Development of Building Application Noise Barrier Using Sandwich Structure**" is the results of my own research except as cited in references.

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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

Pencemaran bunyi merupakan salah satu isu yang dihadapi oleh manusia di seluruh dunia setiap hari. Kebisingan boleh memberi kesan kepada kesihatan manusia, ini disebabkan bunyi membawa perasaan tidak senang kepada manusia yang menerima pencemaran bunyi. Secara umumnya di dalam sistem pencemaran bunyi, kebisingan berpunca dari sumber bunyi dan bergerak melalui sebuah laluan dan seterusnya tiba kepada penerima. Kajian ini akan merangkumi cara tentang mengurangkan pencemaran bunyi melalui pengubahsuaian yang dilakukan pada laluan penghantaran bunyi dengan menggunakan penghadang pencemaran bunyi khusus untuk kegunaan bangunan. Tahap kebekersanan penghadang pencemaran bunyi untuk mengurangkan kebisingan diuji menggunakan kaedah pengukuran In-situ untuk mengukur kadar tekanan bunyi yang dikurangkan daripada sumber kepada penerima bunyi. Kajian ini memberi fokus untuk mengurangkan bunyi menggunakan penghadang bunyi berstruktur sandwich yang diperbuat daripada gabus Polyurethane dan sisa tekstil. Tahap prestasi penghadang pencemaran bunyi diuji menggunakan kaedah pengukuran In-situ di BK 37 dan BK 38 di Kampus Industri, UTeM. Penghantaran bunyi yang dikurangkan menunjukkan hasil antara 1 dB hingga 3 dB daripada penghantaran bunyi. Daripada keputusan ujian, kadar kebisingan dari BK 37 ke BK 38 telah berjaya dikurangkan.

ABSTRACT

Noise pollution is one of the issues that faced by the people over the world every day. Noise can effect to the human health as noise brings annoyance to the people. In general noise system, noise can be transmitted from source of noise through the transmission path to the receiver. The study will cover the way to reduce noise pollution by modification of the sound transmission trough the transmission path from the development of the building application noise barrier. The efficiency of the noise barrier to reduce the noise pollution is investigated by using In-Situ measurement of sound pressure level reduced that transmitted from the source of noise to the receiver. The study focused on reducing noise using sandwich structure noise barrier, composed from polyurethane foam and textile waste. The performances of the sandwich structure were tested using In-situ measurement method at BK 37 to BK 38 FTK Factory 3 Industrial Campus, UTeM. The transmission loss after using noise barrier resulted in reduction of 1 dB to 3 dB of transmission loss. From the testing result, noise level from BK 37 to Bk 38 is succefully reduced.

DEDICATIONS

To my beloved family,

My supervisor,

My lecturers,

And to all my friends,

Thanks for all support and ideas.

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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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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

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 Introduction Of Vibration

Mechanical vibrations and shock is the example of dynamic phenomena, and it can be desirable and undesirable (Broch, 1984). Vibrations can be defined as mechanical oscillations from a position where it is in equilibrium position, however vibration in mechanical systems is not desirable as this type of vibration contribute in loss of energy, decrease the efficiency and it might be harmful to the mechanical system (Takács et. al, 2012). Figure 1.1 shows the illustration of single degree of freedom with damping system. There are some situations that desire the existence of vibration such as in conveyor and screening machine, mechanical hammers, ultrasonic cleaning bath, and riveting hammers whereby the vibrations are produced on purpose (Broch, 1984).

According to Taylor (1994), Vibration frequency is not capable measured by sight or touch, thus a means should be taken to be convert into usable product that can be measured and analyzed. In mechanical equipment, energy radiated from the vibrating solid surfaces in the machinery is one of the major sources of noise. 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).

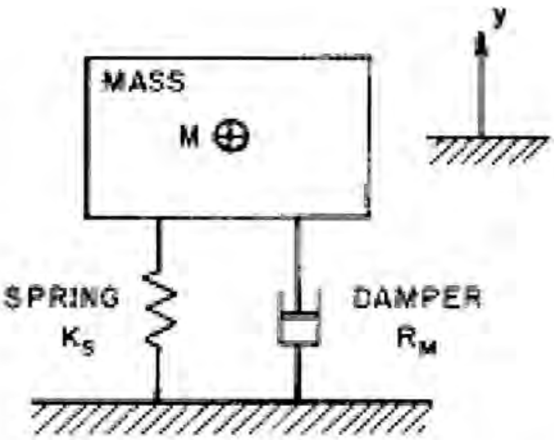

Figure 1.1 Illustration of single degree of freedom with damping system (Barron, 2003)

The motion of vibration can be the classified into three types, which are Harmonic Motion, Periodic Motion, and Random Motion. Harmonic motion is one form of periodic motion and it is repeatable periodically. Harmonic motion usually gives a sign of sinusoid or some other distorted version depending on the harmonic content, such as imbalance of rotating equipment in a linear system that produce the harmonic motion. Periodic Motion also is a motion that repeats periodically, and harmonic motion is one of the examples of the periodic motion.

The periodic motion can be recognized from a misalignment of motor coupling that is not properly tightened or loose and having bump once in every revolution of the shaft could be a good example of periodic motion. Even the motion of the bump is not in harmonic pattern, yet it is happened in periodically in specific interval time. For random motion, it is in random and not in specific pattern that contain all frequencies with some frequency band. Random motion usually happened as a result of severe looseness in machine (Taylor, 1994).

1.2 Noise

Rise in noise level will creating an uncomfortable feeling to the people. Noise in generally can be refer as unneeded or discomfort sound that are generated by human activities, and one of the main environmental problems that faced by the people all over the world is noise pollution. There are some conflict that is exist due to noise pollution such as, high noise levels that are generated by human activities, this is unwanted situation whereby when some other hand does want noise at low level to assure that the people could allow them to rest (Ibanez et. al, 2015). From the previous study, people are being exposed to the effects of noise where effects the people in term of, working efficiency, loss of hearing ability, unpleasant, sleep disruption, and speech interference (Zaheerudin et. al, 2008).

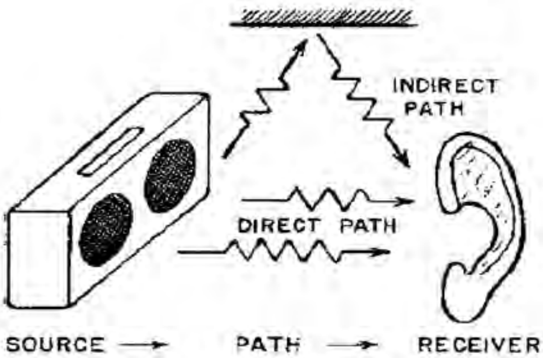

Figure 1.2 Components in noise system (Barron, 2003).

1.2.1 Noise In Machinery

Noise is one of the hazards that occur in the industrial sector. Machinery in industrial often generates high number amount of sound intensity. Motor, pump, turbine and generator usually produce this unwanted sound while the machines are under operating condition. Exposure to the noise level that are more than 85 dB can be considered as hazardous noise pollution as normal limit of daily exposure at the workplace for most of countries is at 8 hours (Amedofu et. al, 2007).

According to the World Organization (WHO) and the US Environmental Protection Agency mentioned that, the continuous sound level that are safe to human health is 70 dB (WHO, 2000). As stated by (Fard et. al, 2013) machinery noise must be reduce to keep worker from being exposed to excessive noise pollution, this can be done by control the noise pollution at the source and doing some changing to modify the sound transmission path (Fard et. al, 2013) .

1.2.2 Noise In building

Noise pollution in building closely associated with human. 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, 1987). The study of sound propagation in closed room related because of a few reason, it 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

Noise can be controlled by manipulating the source of the noise, the transmission path of the noise or by modifying the receiver of the sound (Barron, 2003). Due to World Organization of Health (WHO, 2016) preference to the selection and design of control measures, source of unwanted sound should be identified and the noise generated must tidily observe.

The noise produced from a source can be deter from transmitted to worker by placing sound barrier in between the transmission path from source of noise to the receiver. In isolated condition, noise usually can passes and transmitted through the hindrance material in practice and the noise reduction can be measured in dB (decibel) are closely related to the properties of the materials (WHO, 2016).

1.3 Sound Absorption

According to Fallis (2013), Figure 1.3 shows 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. In the air, it's usually neglected as the effect to the sound frequency is not very noticeable.

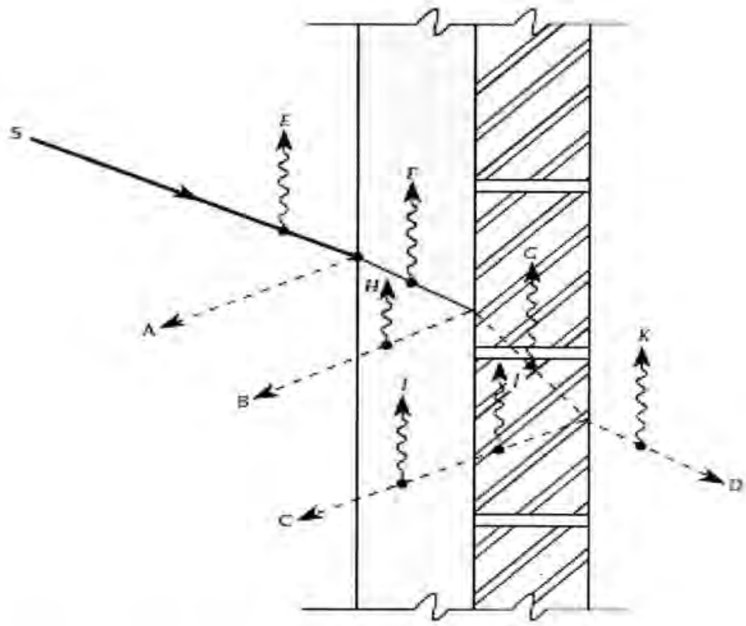

Figure 1.3 Sound absorption through a wall (Fallis, 2013).

Meanwhile, at 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. All of the three types sound absorber characteristics can be manipulated as a factor in selection the material and developing design of the Building Application Noise Barrier.

1.4 Sound Transmission Loss

As stated by (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.

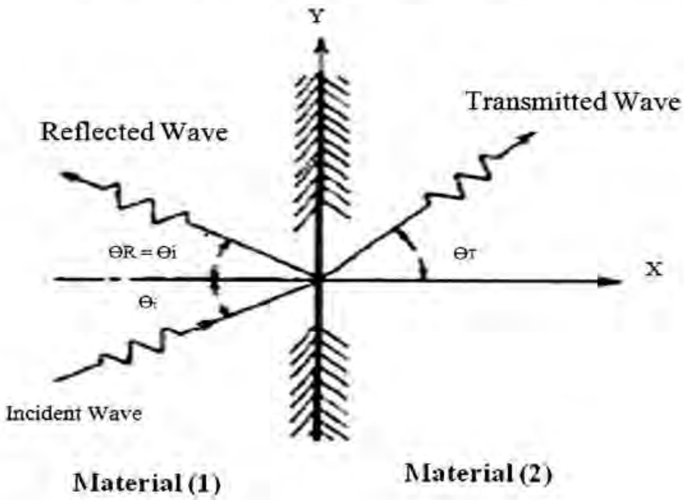

Figure 1.4 Transmission loss in sound wave (Barron, 2003).

From the Figure 1.4 , sound wave that strike on a surface of material comes in various angles and as the wave move in their path, the incidence of sound wave influenced by the angle where it is come from. This phenomenon could be manipulated to reflecting away the sound wave to reduce or eliminate the unwanted sound from being transmitted to the receiver which is the human or animals. 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

Environmental noise pollution problems show a rising trend to the people all over the world. Based on the noise level generated, the effects range to the people affects from the noise pollution can be seen to the people from mild annoyance to sleep disturbance (Fahy and Walker, 2004). To have a good quality of sleep, people need to let their mind in rest and peaceful. People that are most likely to having sleep disturbances due to noise are the people that are living in highly populated urban area (Delton et. al, 2007). This is the evidence that noise cause a problem to the people. As shown in the Figure 1.5 the students and lecturers in FTK, UTeM Industrial Campus also experienced the same thing of feeling annoyance due to noise interference while the learning session are being conducted.

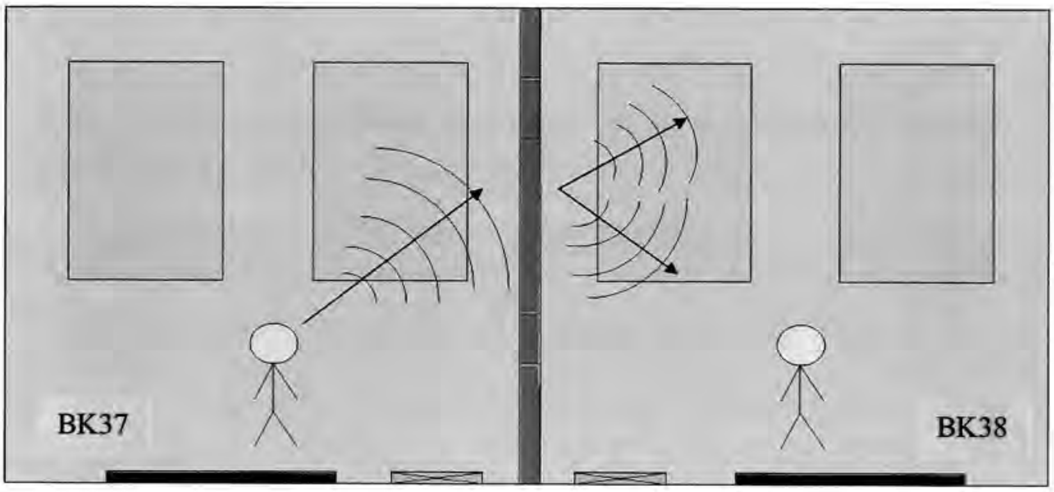

Figure 1.5 Illustration of noise pollution from BK37 to BK38, Factory 3, Industrial Campus UTeM.

As shown in the Figure 1.5, noise pollution can be happened during the lectures session are being conducted between these two classes at the same time. At the time lectures session are being conducted in the class, voice that coming out from human voice projection in BK 37 possibly leaks into BK 38 at some of times that surely will bring an annoyance condition to the students and the lecturer that affected by the noise pollution.

Thus, the learning process would be affected due some of the students are not capable to understand on what the lecturer trying to explain to the students as the noise pollution will interrupt the learning session. According to Zaheerudin (2008), normal distance for good communication in ambient environment the noise level reading should be not more than 65 dB for young and middle aged while 55 dB for old people. The students are having difficulties due to noise interference that would effects the learning process. As the predominant method of communication between people is speech, noise interference significantly effects on the communication (Zaheerudin, 2008).