UNIVERSITI TEKNIKAL MALAYSIA MELAKA

INVESTIGATION VEHICLE CABIN NOISE USING ARDUINO DATA LOGGER

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

By

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B071410670

930825-12-6005

FACULTY OF ENGINEERING TECHNOLOGY

2017

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TAJUK: **Investigation Vehicle Cabin Noise Using Arduino Data Logger**

SESI PENGAJIAN: **2017/2018**

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DECLARATION

I hereby, declared this report entitled "Investigation Vehicle Cabin Noise Using Arduino Data Logger" 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 fulfilment of the requirements for the Degree of Bachelor's in Mechanical Engineering Technology (Automotive Technology) (Hons). The member of the supervisory is as follow:

……

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(Project supervisor)

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ABSTRAK

Bunyi yang dihasilkan oleh getaran memberi kesan kepada pemandu dan penumpang di dalam kenderaan. Dalam sistem kenderaan, setiap komponen- komponen mekanikal akan bergetar dan menyumbang kepada kewujudan hingar di dalam kenderaan ketika sedang beroperasi dengan keadaan bergerak atau statik. Objektif kajian ini adalah untuk menguji tahap bunyi bising di kabin Perodua Viva Elite 1.0cc. Matlamat utama kajian ini adalah untuk membandingkan kebisingan dalam keadaan kenderaan yang berbeza dengan menggunakan Arduino Data Logger dan Sound Level Meter 3M Pro serta perbezaan peratusan data. Untuk keputusan, menunjukkan bahawa perbezaan enjin (RPM) dan Speed (km / h), keadaan kenderaan memberi perbezaan pada tahap bunyi. Di samping itu, ia mempunyai peratusan perbezaan antara Sound Level Meter dan Arduino Data Logger. Keputusan keseluruhan bahawa kewujudan bunyi yang ada di dalam kabin kenderaan Perodua Viva Elite 1.0cc adalah tidak selesa dan arduino dapat menjadi alat untuk pengukuran. Menunjukkan bahawa selepas mendapatkan hasilnya adalah bunyi bising meningkat dengan peningkatan kelajuan enjin dan rpm.

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ABSTRACT

Noise generated due to the vibrations and affects the driver and passenger inside the vehicle. In a vehicle system, each of parts and components will vibrate and contributed to the noise existence inside vehicle when it is running at condition of moving or static. The objective of this study is to test the noise level in Perodua Viva Elite 1.0cc cabin. The main goal of this study is to compare the noise in different condition of vehicle by using an arduino data logger and sound level meter. The noise is recorded using an arduino data logger and sound level meter at the driver seat. The experimental study is performed at different engine speeds (RPM) for static condition and different of speed(km/h) for dynamic condition of vehicle stationary, moving without air conditioner and varying type of road namely highway road. The data is analyzed and discussed for comparison. For the results, indicated that difference of engine (RPM) and Speed(km/h), conditions vehicle gives different on noise level. In addition, it has percentage of differences between sound level meter and arduino output data. The overall results that noise existence inside vehicle cabin Perodua Viva Elite 1.0cc is non-comfort and arduino can be capable as an instrument for measurement. Indicated that after gain the results is noise increase with the increasing of engine speed and rpm.

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DEDICATION

I dedicate my work to my family and others friends. Realize that every of challenging work is needed self-efforts as well as helps and guidance from elders and friends. Also, special feeling of gratitude to my beloved parents, Ayub bin Sugaba and Pujiah binti Narusin whose words of encouragement and pushed, prayers of the day and night. I also dedicate my work to my supervisor and co-supervisor who have guided me to do the real of work-self until finish. From this supporter, i can handle the work even the challenger that very hard to faced. Encouragement and advice from them I am able to get such a success.

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ACKNOWLEDGEMENTS

In the name of Allah, the Most Gracious, the Most Merciful. First and foremost, I should to praises to the Almighty God for giving me the opportunity and strength to complete implement this project. I am also gives thankful to my parents for their encourage and support to doing this project. Besides that, I am also thankful to my friends for their knowledge to share knowledge and gives supporting and motivating to me.

I would like to express my appreciation to my supervisors, Mr Muhammad Nur Bin Othman and Mr Mohd Sulhan bin Mokhtar for their guidance, knowledges, advices and enthusiasm for my project. I am thankful to them for their helpful, advice and suggestion when i do my project, "Investigation Vehicle Cabin Noise Using Arduino Data Logger" which is a one part of the final year project required for Bachelor's Degree in Mechanical Engineering Technology (Automotive Technology) with Honors. It is impossible to be done the project successfully without their supports and guidance.

Besides that, I would like to acknowledge and give a special thanks to my friends, Mohd Akhmal Syafi bin Md Yazid for giving me a some share of knowledge an arduino and gives some help. Lastly, I would like to thanks to all my lecturers who has taught me throughout in my study at Universiti Teknikal Malaysia Melaka.

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CHAPTER 1

INTRODUCTION

1.0 Introduction

This chapter will cover subtopic of background, problem statements, objectives and scope of the study. While the background will states the briefing of the vehicle noise in cabin.

1.1 Background of study

Noise, vibration, and harshness can be refer as a noise and vibration (N&V) that is the study of the noise and vibration appearances of vehicles, mostly cars and trucks. But, noise and vibration can be measured, while harshness is a subjective quality, and is measured either via "jury" evaluations. Interior (NVH) agreements with noise and vibration experienced by the passenger and driver in the cabin, while exterior NVH is largely troubled with the noise radiated by the vehicle, and includes drive-by noise. According to Nopiah et al. (2012), driving focus can be decrease further disturb driver's emotions level and generally noise which is generated by the vehicle system vibration. This undesirable noise may affect with dialogue between both of driver and passenger or passenger with passengers, driving attentiveness and also can cause sleep disturbance during the night and may also described as one of a source of annoyance for humans. An audible sound, undesirable and harmful sound which either disturbs the silence or an intentional sound listening or leads to annoyance is defined as a noise(Genuit 2003); Skrúcaný et al. 2015).

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This study is more focus on the investigation the noise level in vehicle cabin. By choosing the Perodua Viva cabin and varying two type of condition (stationary and moving) only and the noise level will recorded by using arduino noise data logger and sound level meter. It is also concentrate the term of investigate the noise in cabin by the knowledge and explain, analysis to get the right information. Repeated, two conditions of vehicle to investigate the noise in Perodua's cabin by stationary and moving condition vehicle. This investigation will be as a literature based and this information will be as a reference to anyone that to know the noise level and data logger of arduino after report will be done.

1.2 Problem statement

Not feeling well and deal to annoying in vehicle cabin indications of discomfort of noise in vehicle cabin. This amount of discomfort may come from the particular factors such as vibration of structure borne, airborne, tire road interaction, source of engine, exhaust system and etc that will be contribute to vibration and produce the noise (undesired sound). This sound vibration and the background deafening in vehicle interior (cabin) will also difficult to hear speeches because of undesirable noise come. Depending on the value of noise produced usually measured in dB or Hz, the effects of noise will go through to not feeling well and annoy to driver and passenger also if produced to high. Range between 20 Hz and 20 000 Hz the ear is capable of hearing sounds(Malchaire 2001). 140 dB will pain threshold and 150 dB above permanent damage to hearing. According to (Junoh, A.K., et al., 2011), noise generated by the vehicle system vibration will disturb the driver's feelings and reduction the level of driving concentration. Noise must be investigate because the potentially of the noise that may affect the driver's emotion and contribute to decreases the driving focus which is from generated due to the car cabin system. From this situation, it is also contribute to blurred views which is from the exposure of the vibration and contribute relative movement between the eye retina and object that seen. By affecting the driving concentration of driving, this condition will influence the visual performance and will also affect the driving comfort and further becomes the reason behind road accidents(Mohd et al. 2015). Realize that, an audible sound which either bothers the

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silence or an intentional sound listening or leads to annoyance is defined as a noise(Genuit 2003). Based on related studies automotive, investigating the noise with (minimal of noise level) are encouraged. Therefore, this study is carried out to measure the noise inside the vehicle cabin where the data is analysed at different conditions of vehicle.

1.3 Objectives

An objective is defined as the purposes or target that will be obtain after finishing the project :

1. To test the noise level in Perodua Viva elite 1.0cc cabin.
2. To compare the noise in different condition of vehicle.

1.4 Work scope

This investigation project will focus on the testing the noise level and comparing noise level in perodua viva 1.0cc cabin by varying the two type of condition vehicle (stationary and moving). The noise in vehicle cabin data will be recorded by arduino and sound level meter for static condition while for dynamic only arduino data logger only used as an measurement instrument. Other aspects such as investigation of harshness, development of arduino product and reliability and calibration of product, vibrations of graph does not covered.

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CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

To complete the literature review, should be done the important thing is the relevant written documents should be search first. It can be originate in any of project papers and any others of sources. This research information is based on some major topics and sub-topics that related to this project. From this, every theory and information will be compared among it and summarize it with critically analysed for these documents. Most suitable information's will be selected to be done in this project.

2.1 Type of Vehicle

2.1.1 Hybrid Vehicle

Hybrid vehicles generally use a combination of gasoline engine and electric motors to produce power. The gasoline engine in these systems are often smaller and more efficient than their gas-only counterparts. The electric motor provides additional power to assist the engine in accelerating, passing or hill climbing. Besides that, the braking energy will be stored and utilized through regenerative braking. The electric motor applies resistance to the drivetrain which resulting the wheels to slow down. In return, the energy from the wheels turns the motor which then acts like a generator. Then, the power will giving back to the battery. The hybrid vehicles automatically shuts off

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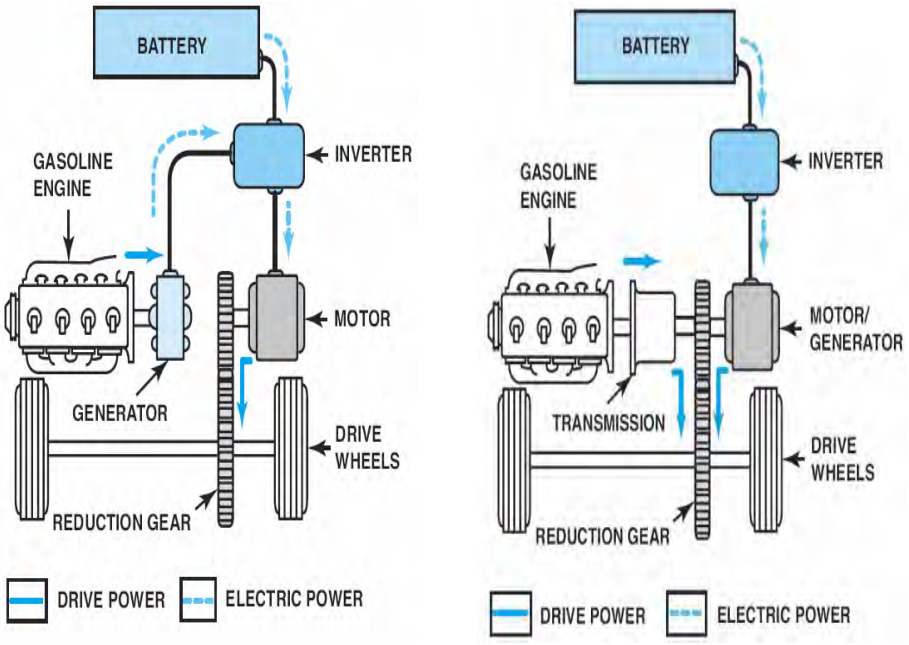
when the vehicle stop and restarts it when the accelerator is pressed. This is to prevent wasted energy from idling. (Masias n.d.)



Series HV Parallel HV

Figure 2. 1 : Schematic diagram for series and parallel hybrid(Harun 2016).

2.1.2 Electric Vehicle

All electric vehicles (EV) run on electricity only. There is no engine like in the conventional and hybrid car. They were propelled by one or more electric motors powered by rechargeable battery packs. According to (Chen & Shih 2015), the internal combustion engine vehicles have a motor that is same as the electric vehicles. However, instead of mechanical power derived from burning gasoline, the electric vehicle's power supply derived from battery-stored electricity.

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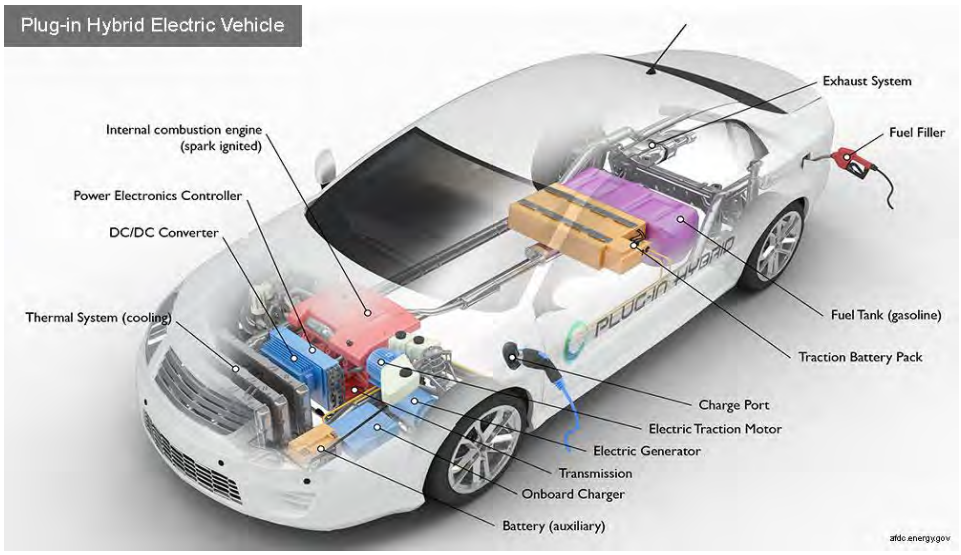

Figure 2. 2 : Electric Vehicle

2.1.3 Conventional Vehicle

In generally, to power or propel an IC engine is conventional vehicles that use gasoline or diesel. In addition, IC engine also use in Hybrid system and normally fuel like conventional vehicles. But, actually it is combine between it.

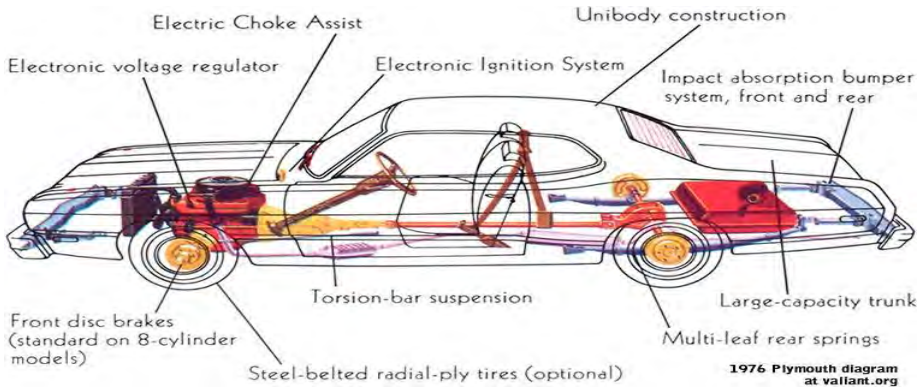

Figure 2. 3 : Conventional Vehicle

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2.2 Fundamental of Noise Interior Cabin Vehicle

The main attributes in a passenger car are Noise, Vibration and Harshness (NVH)(Shangguan et al. 2016). Leads to annoyance is noise defined as an audible sound(Genuit 2003). According to (Junoh, A.K., et al., 2011) driving focus decrese further more can disturb driver's emotions level generally noise which is generated by thevibrated vehicle system. This undesirable noise may have an affect with dialogue between both of driver and passengers or passenger with passenger, driving attentiveness and also can cause disturb sleep during the night are also source of frustration for humans. The physical characteristics of the sound occurrence depends on the evaluation of noise, the human ear is on the psychological aspects of man on the psycho-acoustical features. Significantly, improved differentiates statements than the simple reflection is consider of the psycho-acous(Abdullah et al. 2015)tical features of the human ear.(Genuit 2003). According to (Skrúcaný et al. 2015), used to measure the sound intensity level is the unit bel (B), for examples intensity of sound which are 20dB for whisper, 50dB for normal conversation, 60dB is rush street, 90dB for motorcycle, 110dB for rock concert and 120dB for jet aeroplane. For vehicle, according to (Putra et al. 2012), Even at the idle engine was operation, the engine in the powertrain system will creates noise because of vibration of the components and parts in the system related. From (Putra et al. 2011), Aerodynamic surface, speed and sometimes by the side mirror and windows' visors will affecting to generate noise because of from wind. While for interior cabin, at around 40 to 50 dB and at the frequency range from 2.5k to 3k Hz of the passenger comfort level for noise (Abdullah et al. 2015).

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2.3 Elements Sound Vibration/Noise Major Sources Interior Cabin

2.3.1 Engine

Noise in a vehicle is mainly to the engine.(Priede 1971). Component motion and rotation due to the vibration that noise was generated due to the reciprocating mechanism working by vehicle. Changing the speed also affect the noise and vibration production(Aldhahebi et al. 2016). A machine that converts heat energy into mechanical energy is an engine. It will produces power which move the vehicle the process is from heat that burning a fuel to create heat which then creates power which process is burning a fuel internal combustion (IC) engines there are in automotive system because burned internally or inside the engines. According to (Aldhahebi et al. 2016), such of valves, piston knocking, tranasmission and oil supply system further more the combustion noises are cause the mechanical noises. Besides that, (Cerrato 2009), the engine is the essential element to defining the character of the car, in a vehicle powered by an IC engine. Over the years, the isolation of the passenger cabin from the engine has improved significantly in generally and more to the issue about the quality of the sound of the engine than its noisiness. At high-speed cruise conditions diesel engine noise is acceptable in most passenger vehicles. At low speed and idle the majority of the adverse reaction to diesel noise (“it sounds like a tractor”) occurs(Cerrato 2009).

2.3.1.1 Engine petrol

In high compression of engines that cause of knocking or rumbling have been alarmed in petrol engine noise caused by pressure rise at high rates and abnormal combustion. The combustion examination that slope about for 50 dB per decade (tenfold) increasing frequency for large petrol engines(Raff & Perry 1973).

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2.3.1.2 Engine diesel

Caused by the process of combustion and its associated high rates of pressure rise, characteristic of diesel noise, the characteristics of diesel engine noise have been so methodically covered in other I.S.V.R. papers that no added mention will be made of them except by comparison(Raff & Perry 1973). According to (Priede 1971), higher peak pressures and rates of pressure rise considerably for diesel engines work and thus result in greater noise and vibration.

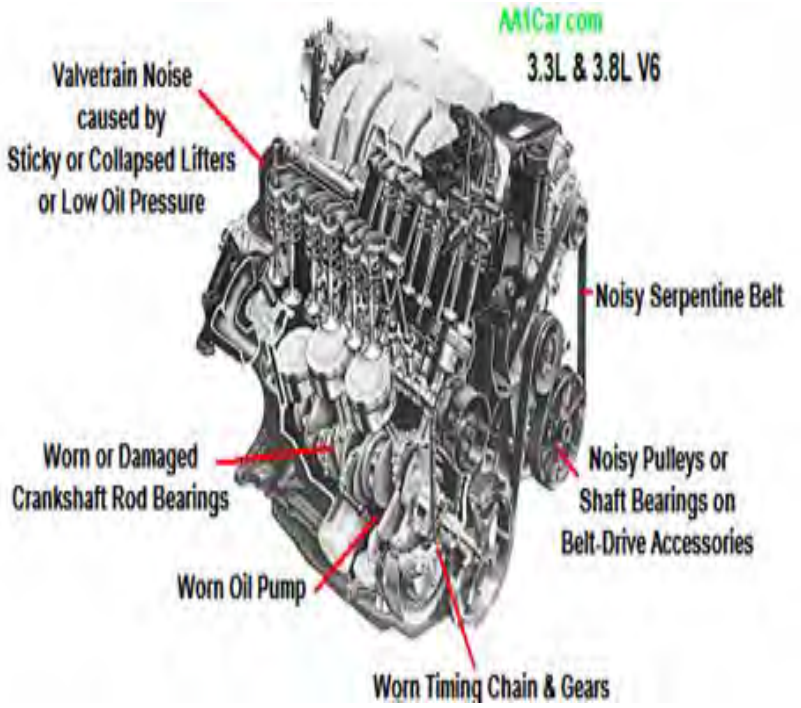

Figure 2.4: Engine noise sources

2.3.2 Tire road interaction

One of the factor vibration noise inside the cabin of car which is the tire road contact, also one of important thing and considerable. While the vehicle in motion will caused this vibration or noise source and it is produced by tire-

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road contact. According to (Aldhahebi et al. 2016), the generation of vibration level in various degrees affected by different roads for example more vibration will contribute on rough roads. Both tire/road and power unit noise levels increase, when vehicles are under acceleration due to engine load and extra tire torque, the increases are normally the highest for power unit noise. The interaction between tire and road surface is noise to passenger cars. Investigation from D.J. O'Boy et al (2008) of effect tyre belt vibration (means by rubber tread) to the interior noise in passenger vehicle cabin show that level of sound can be produced differences by the characteristics of the tread rubber(Junoh, A.K et al., 2011).

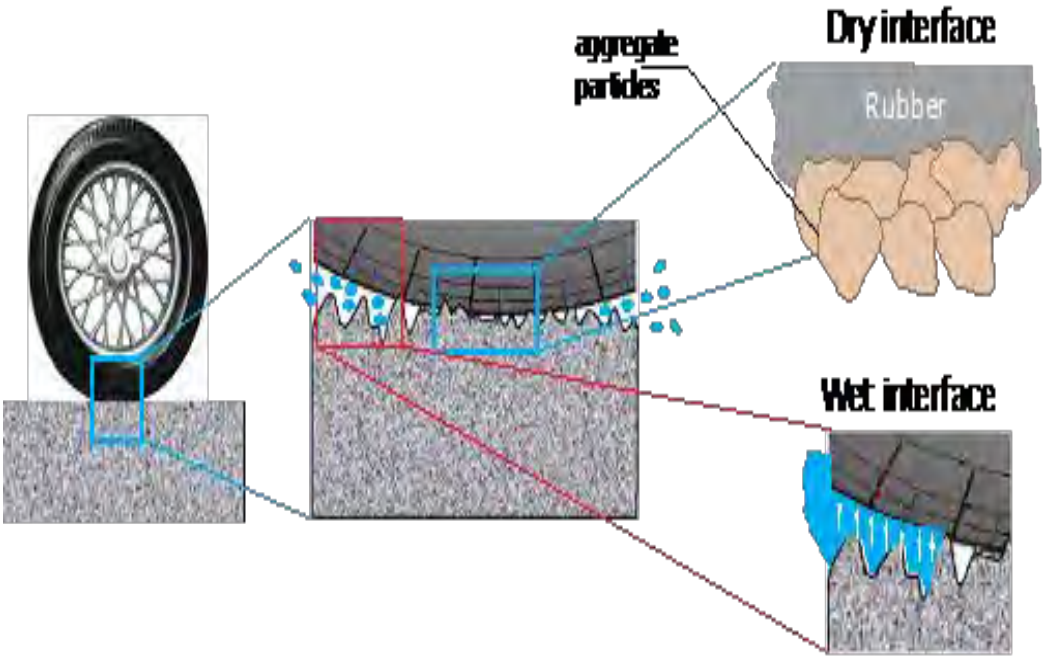

Figure 2.5: Tire-road interaction

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a) Highway road surface b) Pavement road surface

Figure 2.6 a) Highway road surface, b) Pavement road surface(Aldhahebi et al. 2016).

2.3.3 Structure Borne and Airborne Noise

2.3.3.1 Airborne Noise

It is radiates straight into the air which is the noise produced by a source in short term. Pressure variations in the open air or along continuous air passages such as corridors and duct systems simply as an airborne sound waves are transmitted. The action of the fluctuates of sound pressure versus one side of the wall, that the path of the airborne sound wave and causes it to vibrate. Transmitted way is another one example airborne sound waves that the other side of the wall from which it is re-radiated. Transmitted structurally to other parts of the building where it eventually emerges as airborne sound is same with the vibrational energy of the wall. It means a secondary a transmitter of structure-borne sound is the wall itself. (D n.d.). According to (Schevenels et al. 2007), directly radiated from the vibrating parts of the machine, this is the sound into the air. By the airborne sound power level it can be characterized.

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