SUPERVISOR DECLARATION

"I hereby declare that I have read this thesis 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 (Automotive)."

Signature: ....

Supervisor: ....

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INVESTIGATION OF PARAMETER THAT AFFECTING AIR FLOW AROUND VEHICLE FRONTAL AREA

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DECLARATION

"I hereby declare that the works in this report is my own except for summaries and quotations which have been duly acknowledged."

Signature: ....

Author: ....

Date: ....

To my beloved parents,

Mr. Mohd Akhir Bin Abdul Malek and Mrs. Hasimah Binti Tajuddin...

My family...

My Supervisor,

Mr. Fudhail Bin Abdul Munir...

My friends...

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ABSTRACT

In this project, simulation of air flow around vehicles frontal area which includes vehicle front hood and windscreen will be carrying out. The models that will be chosen for this research are the national car models. ANSYS Fluent software will be use to run the simulation. k-ε turbulent model is used to calculate air flow around the vehicle model and make a comparison between all models at vehicle speed 25m/s (90km/h). The main objective of the study is to study air flow around a vehicle frontal area and to obtain the air flow pattern around a vehicle frontal area. Several factors that influence the air flow pattern such as flow separation, the effect of pressure coefficient (Cp) and types of turbulent will be study. Detail velocity variation and pressure distribution plots around the vehicle envelopes will be present. At the end of the research, it is expected that the air flow pattern around a vehicle frontal area which includes vehicle front hood and windscreen can be obtained.

ABSTRAK

Dalam projek ini, simulasi aliran udara di sekitar bahagian hadapan kenderaan yang merangkumi hud hadapan kenderaan dan cermin hadapan kenderaan akan dilakukan. Model yang akan dipilih untuk kajian ini adalah model kereta nasional. Perisian ANSYS Fluent akan digunakan untuk mensimulasi model turbulen k-ε bagi mengira aliran di sekitar model kenderaan dan membuat perbandingan antara model kenderaan yang dipilih pada kelajuan 25m/s (90km/j). Tujuan utama kajian ini adalah untuk belajar mengenai aliran udara di sekitar bahagian hadapan kenderaan dan mendapatkan corak aliran udara di sekitar bahagian hadapan kenderaan. Beberapa faktor yang mempengaruhi pola aliran seperti pemisahan aliran, pengaruh pekali tekanan (Cp) dan jenis-jenis turbulen akan dikaji. Penelitian kelajuan dan penyebaran tekanan sekitar permukaan kenderaan akan dilakukan. Pada akhir kajian ini, corak aliran udara di sekitar bahagian hadapan kenderaan yang merangkumi hud hadapan kenderaan dan cermin hadapan kenderaan dijangka akan dikenalpasti.

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C_D	Drag Coefficient
C_L	Lift Coefficient
A	Surface Area
ρ	Density of air at 300K
V	Free stream velocity
μ	Dynamics fluid viscosity
Re	Reynolds number
L	Characteristic length
Cp	Pressure coefficient
P	Pressure at the car
P_∞	Static pressure of the free wind
T	Temperature

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CHAPTER 1

INTRODUCTION

1.1 OVERVIEW

This research was conducted to study air flow around a vehicle frontal area which includes vehicle front hood and windscreen. The windscreen is a sandwich structure whose stacking sequence contains five layers. The two external thick layers are made of glass, while the three thin intermediate layers are made of appropriate polymers. Front hood can be defined as the hinged cover over the engine of motor vehicles that allows access to the engine compartment for maintenance and repair.

Windscreen and front hood play an important role in the overall design of a vehicle. Windscreen is used to protect the vehicle's occupants from external variables such as wind, extreme temperature and flying object. It also is provide an aerodynamically formed window. While the function of front hood is allows access to the engine compartment for maintenance and repair.

Most of the vehicles were designed to take the attractiveness of the buyer and to adapt to changing of times. In previous years, most vehicle manufacturers only make the design as a gimmick to popularize their models without think about the effects of the aerodynamic characteristics. In this millennium era, knowledge and awareness of the consumers about the technical aspects of the vehicle are better because the development and advancement of information technology. This phenomena cause the consumers getting desperate in order to have a high-performance vehicles. Good aerodynamic characteristics give an effect on vehicle performance in terms of maximum speed, acceleration and fuel consumption of vehicles.

Over the years, vehicle manufacturers only focus on the rear area vehicle design. They produced various forms that change rear area such as sedan, estate and fastback. Due to certain limits, vehicle manufacturers began to focus on the design of the vehicle frontal area. Various changes and adjustments can be made to the geometry of the vehicle frontal area. All these changes will affect the air flow of the vehicles.

In this study, Computational Fluid Dynamics (CFD) is used to determine the air flow pattern around a vehicle frontal area. CFD software is used to calculate the pressure distribution, drag and lift coefficient in order to define the air flow pattern around a vehicle frontal area.

The aim of this study is to obtain the air flow pattern around a vehicle frontal area which includes vehicle front hood and windscreen and to see the effect of the air flow to the driving and comfort characteristic. Comparison between three national car model which are Proton Saga BLM, Perodua Myvi and Perodua Kenari to investigate the effect of the air flow pattern. All car model are chosen based on the average car been used by Malaysian. The result of this study hopefully can be used as a reference and guideline by other researcher.

1.2 PROBLEM STATEMENT

At average speed (90km/h) and above, as driving speed increased, aerodynamic factors on ground vehicle affect the comfort of the occupants and also the performance of the vehicle. Hence, it is vital for the researchers and engineers to study these phenomena in order to make improvement on future models.

1.3 OBJECTIVES

The objectives of this study are:

1. To study air flow around a vehicle frontal area which includes vehicle front hood and windscreen.
2. To obtain the air flow pattern around a vehicle frontal area which includes vehicle front hood and windscreen.

1.4 SCOPES

The scopes of this proposed project are:

1. Simulate air flow around a vehicle frontal area which includes vehicle front hood and windscreen for differents national car's model which are Proton Saga BLM, Perodua Myvi and Perodua Kenari.
2. To investigate parameters that affecting air flow around a vehicle frontal area which includes vehicle front hood and windscreen.

1.5 EXPECTED RESULT

At the end of the research, it is expected that the air flow pattern around a vehicle frontal area which includes vehicle front hood and windscreen can be obtained. The air flow pattern then will show which national car model is more aerodynamic.

CHAPTER 2

LITERATURE REVIEW

2.1 OVERVIEW

This chapter will define and discuss the information related to the background knowledge of vehicle frontal area which includes vehicle front hood and windscreen, the aerodynamic theory and the used of Computational Fluid Dynamics (CFD) in determining the air flow around frontal area of a vehicle. Reviews on previous studies concerning the flow on frontal area of vehicle are included as well.

2.2 VEHICLE FRONTAL AREA

Frontal area of vehicle is including many parts such as hood, windscreen, bumper, headlight and others. In this study, front hood and windscreen are selected to study air flow pattern around them.

2.2.1 Windscreen

The windscreen is a sandwich structure whose stacking sequence contains five layers. The two external thick layers are made of glass, while the three thin intermediate layers are made of appropriate polymers [1]. An appropriate polymers layer laminated between it for safety purpose. The vehicle windscreen is a very important part of any vehicle and the unfortunate thing is that they are prone to damage. The windscreen is usually made of glass which is a fragile material by nature, this means when driving extra care should be taken to ensure that the windscreen is in perfect condition each time when turn on the engine to prevent further problems.

The main function of windscreen is to protect the vehicle's occupants from wind, temperature extremes, and flying debris such as dust and stone. It also is provide an aerodynamically formed window towards the front. Modern windscreens are made and designed to be dual layered. It also aids in the rigidity of the structure of the car. As with many modern products it goes through intense quality checking to reduce the chance of it being easily damaged. The windscreen though, takes a lot of wear and tear in part due to the wiper blades.

Figure 2.1: Windscreen of a vehicle

There are some problems that occur in some country as the cold weather. That means we need to scrape the frost off the windscreen. It will increase the chances of it becoming scratched. There also tends to be more grit and stones on the road than usual and these can easily flick up from the road and chip the windscreen, particularly when driving at high speed. It is really important that you drive with a clear screen. This is because if have chips on it or it is dirty, driver vision will be disturbed. It will increase the probability of accident.

A stone chip is the most usual form of damage on the windscreens. There are many road maintenance carried out throughout the country and this means there will be stone or other grit on the road. When driving around the area with poor road surfaces, particularly in the road that in maintenance process, take extra care and drive slowly. So, the stones are less probability to get flicked up on to the windscreen and potentially chipping or cracking it.

A stone chip in a windscreen can be consider as a minor problem but it can quickly turn into a bigger problem as the chip cracks the glass surface. This is very important to get the chip repaired as soon as driver notice it. This is because a cost to get a chip repaired is relatively cheap and some companies will do it for free if you have the right insurance cover. Buying a new windscreen can cost lots of money. It is depending on the model of the car. It is also more environmentally friendly to get a chip fixed because the original windscreen will not have to be disposed of.

2.2.2 Front Hood

Front hood can be defined as the hinged cover over the engine of motor vehicles that allows access to the engine compartment for maintenance and repair [2]. Front hood can be considered as another type of door in a vehicle as it consists of an outer panel and inner panel.

Figure 2.2: Front hood of a vehicle

The front hood consists of a one-piece frame of crisscrossing braces, the inner panel. Their function is serves as the underbelly that supports the outer panel so it won't easily flex and get dented. The outer panel is a metal sheet moulded to fit. The outer panel is functioning to shield the under hood systems from the external elements such as rain that should not be in the engine compartment.

In British term, the front hood refers to a fabric cover over the passenger compartment of the vehicle. In many vehicles that built in the 1930s and 1940s, the similarity to an actual hood is clear when open and viewed head-on and in modern vehicles it continues to serve the same purpose but no longer similar a head covering.

On modern vehicle, a front hood may be held down by a concealed latch. But, on race cars or cars with aftermarket hoods that do not use the factory latch system, the hood may be held down by hood pins. A front hood also may contain a hood ornament, power bulge, and wiper jets. The main material for front hood is steel. But, in some auto companies, aluminium is gaining popularity. Aftermarket manufacturers may construct front hoods out of fibreglass, carbon fibre, or dry carbon.

There are many designs and styles for the front hood. One of the design is the inner panel are covered with a sound-absorbing material to minimize the roar or noise that escapes the engine bay. Besides, there also surface that specially moulded to add special accessories, such as scoops. These accessories are always found on SUVs, trucks, or sports cars. The functions of the scoops are similar to air ducts. It allows the engine bay to "inhale" and "exhale." If scoop installed on the front end of the vehicle, they are able to 'inhale' air directly to the air filter. It will improve the performance of the engine. But there are also scoops that have their openings facing backwards. Instead of taking in air, they are designed to vent hot under hood air. It also helps engine performance.

Nowadays, new regulations set. The rule set that places a limit on the severity of pedestrian head injury when struck by a vehicle. This rule lead the manufacturer designs an advanced design of front hood. For example, the multi-cone hood inner panel designs as found on the Mazda RX-8 and other vehicles. Other changes are being made to use the front hood as an active structure and push its surface several centimetres away from the hard motor components during a pedestrian crash. This may be achieved by spring force or pyrotechnic devices.

2.2.3 Air Flow around Vehicle Frontal Area

To understand the effect of air flow around vehicle frontal area, characteristic of air flow must be observed first. Refer to Figure 2.3; by consider air flow on 2D model, air flow will divided to two components. One part will flow to under and one more part flow on upper area of vehicle. This is happen because fluid characteristic that flow past the solid.

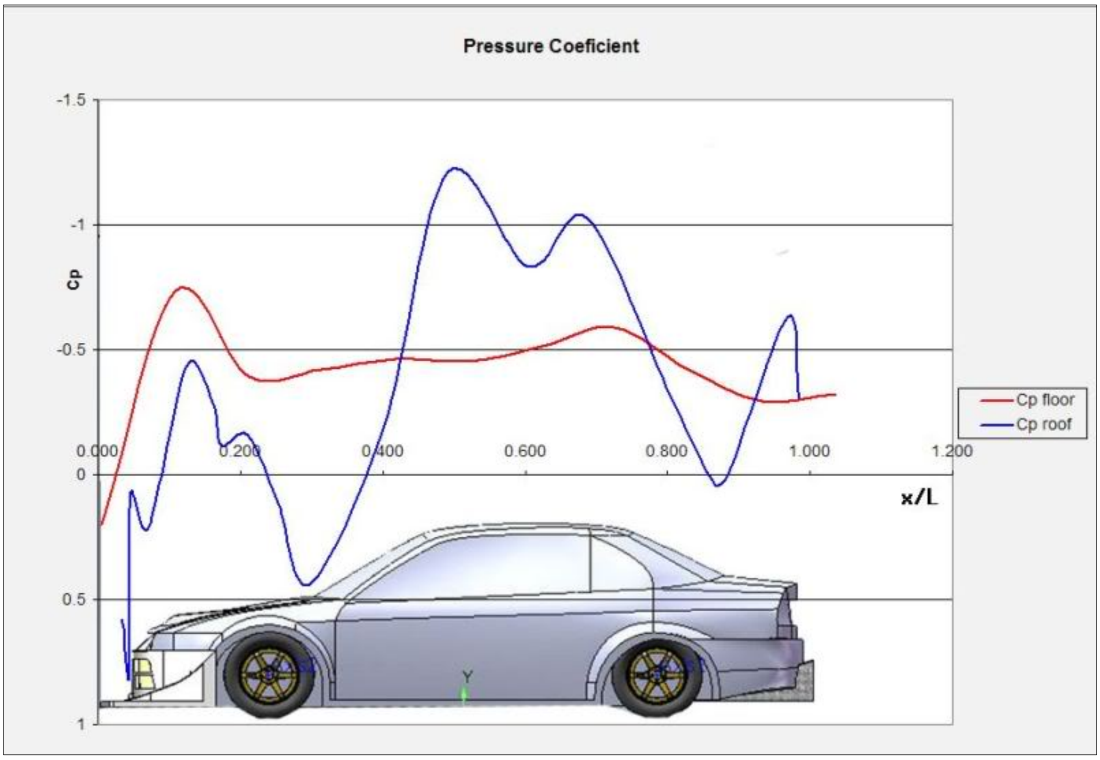

Figure 2.3: Pressure distribution on vehicle [3]

Positive and negative value of pressure coefficient because compare with the measured environmental pressure away from the car. From Figure 2.3, air flow will separate from car body when close to grill radiator upper area. This separation can be happen when air pressure increase on the air flow direction.

The flow separations that happened on vehicle frontal area can slow down boundary layer flow and produce a drag on that area.

On the windscreen start point, air flow forced to follow a shape of windscreen. It will cause the high pressure on this area because air velocity is decreasing. On the vehicle rear area, air pressure will increase because air velocity is slow.

2.2.4 Importance of Vehicle Frontal Area Design

Vehicle frontal area plays an important role in the overall design of a vehicle especially in aerodynamics. To get minimum drag force, several of design can be studied. The shape that used must practical and suitable with engine space, passenger and basic design of vehicle.

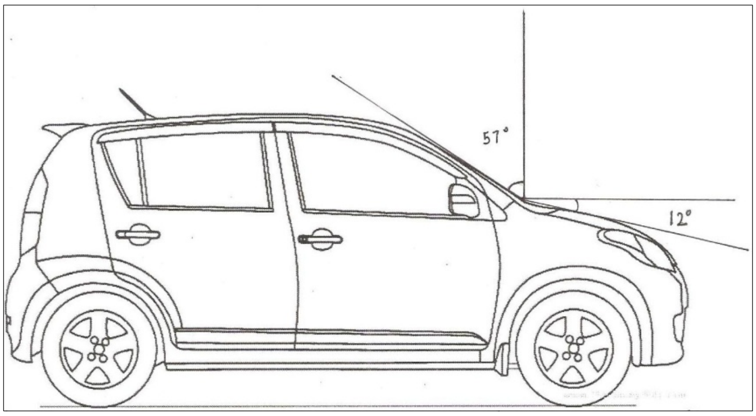

Figure 2.4: Position of angles that are studied

The designer must designs the vehicle frontal area in order that shape that been produced will cause pressure decreasing uniformly until top edge windscreen area [17]. Besides prevent air flow separate from vehicle surface, it will produce low drag area.