COMPUTATIONAL FLUID DYNAMICS ANALYSIS OF PERODUA AXIA BODY WITH SEVERAL TYPES OF SPOILER

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BACHELOR OF MECHANICAL ENGINEERING TECHNOLOGY (AUTOMOTIVE TECHNOLOGY) WITH HONOURS

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in fulfillment of the requirements for the degree of
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DECLARATION

I declare that this Choose an item. entitled " Computational Fluid Dynamics Analysis of Perodua Axia Body with several types of spoiler." is the result of my own research except as cited in the references. The Choose an item. has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature :

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Date : 17/1/2022

APPROVAL

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor of Mechanical Engineering Technology (Automotive Technology) with Honours.

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Signature :

Supervisor Name : *DR. SETYAMARTANA PARMAN*

Date : 18/1/2022

DEDICATION

I dedicate my dissertation work to my family and many friends. A special feeling of gratitude to my loving parents, Wan Azir and Hamidah. My siblings Wan Adib, Wan Adibah, Wan Afiq, Wan Atiq and Wan Atif.

I also dedicate this dissertation to many friends who have supported me throughout the process. I will always appreciate all they have done.

ABSTRACT

This thesis presents the computational fluid dynamics analysis of the Perodua Axia body with several types of spoiler. The design of the Perodua Axia body is was created with several types of spoiler to analyze the drag force at the rear back. A spoiler's design purpose is to minimize drag and improve fuel economy. From the rear border of the roof to the trunk or tail of the automobile, many automobiles have a rather steep downward inclination. Flow separation occurs when air moving across the roof tumbles over this edge at a higher velocity. The airflow becomes turbulent, resulting in the formation of a low-pressure zone, which increases drag. Adding a spoiler to the vehicle's very back reduces flow separation by making the air slice longer and softer from the roof to the spoiler. Reduced flow separation reduces drag, which improves fuel efficiency; it also aids in keeping the back window clear by allowing air to flow easily through it. Due to the constraints of traditional wind tunnel experiments and quick advances in computer power, much effort has been devoted to studying vehicle aerodynamics computationally during the last decade. A 3D computer model of the Perodua Axia car will be designed with the software Catia Autocad and be used as the base model. The other model will be designed with another spoiler design. The simulation will be run to determine the aerodynamic effects of the spoiler.

ABSTRAK

Tesis ini membentangkan analisis dinamik bendalir pengiraan badan Perodua Axia dengan beberapa jenis spoiler. Reka bentuk badan Perodua Axia dicipta dengan beberapa jenis spoiler untuk menganalisis daya seret di bahagian belakang belakang.Reka bentuk badan perodua axia dibuat dengan dan tanpa spoiler untuk menganalisis daya tarik di bahagian belakang. Tujuan reka bentuk spoiler adalah untuk meminimumkan daya seret dan meningkatkan ekonomi bahan bakar. Dari sempadan belakang bumbung ke batang atau ekor kenderaan, banyak kereta mempunyai kecenderungan ke bawah yang agak curam. Pemisahan aliran berlaku apabila udara yang bergerak melintasi bumbung jatuh di tepi ini pada halaju yang lebih tinggi. Aliran udara menjadi bergelora, menghasilkan pembentukan zon tekanan rendah, yang meningkatkan daya tarik. Menambah spoiler di bahagian belakang kenderaan akan mengurangkan pemisahan aliran dengan menjadikan hirisan udara lebih panjang dan lebih lembut dari bumbung ke spoiler. Pemisahan aliran yang dikurangkan mengurangkan seretan, yang meningkatkan kecekapan bahan bakar; ia juga membantu menjaga tingkap belakang tetap bersih dengan membiarkan udara mengalir dengan mudah melaluinya. Oleh kerana kekangan eksperimen terowong angin tradisional dan kemajuan cepat dalam daya komputer, banyak usaha telah dikhaskan untuk mempelajari aerodinamik kenderaan secara komputasi selama dekad yang lalu. Model komputer 3D kereta perodua axia akan dirancang dengan perisian Catia Autocad dan digunakan sebagai model asas. Model lain akan direka dengan reka bentuk spoiler lain.. Simulasi akan dijalankan untuk menentukan kesan aerodinamik spoiler.

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LIST OF SYMBOLS AND ABBREVIATIONS

P	-	Pressure
P	-	Density
v	-	Velocity
F_d	-	Force Drag
C_d	-	Drag Coefficient
A	-	Area
F_L	-	Force Lift
C_L	-	Lift Coefficient
Re	-	Reynolds number
L	-	Length
μ	-	Viscosity of the fluid
m	-	Mass
V	-	Volume
F	-	Force
u/y	-	Rate of shear deformation
Q	-	Heat energy
c	-	Specific heat capacity
ΔT	-	Change in temperature
h	-	Heat transfer coefficient
q	-	Heat flux
ΔT	-	Difference in temperature between a solid surface and surrounding fluid

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background

Aerodynamics is the study of how things flow through the air. Aerodynamics is a field of fluid dynamics that examines the motion of air (thomas,2016). The laws of aerodynamics describe how an object interacts with air in motion. Aerodynamics effect anything that moves freely, from a jet to a banner. Because they are accompanied by air, even automobiles are impacted by aerodynamics.

The body and chassis of the vehicle can be built to reduce total weight and enhance overall aerodynamic characteristics for better riding circumstances, higher navigational accuracy, and reduced energy usage. More power under the hood means higher rotational speeds can be produced, for which become loses its aerodynamic properties are insufficient to provide the necessary downforce and handling. The aerodynamic properties of an automobile have a major impact on its performance, handling, protection, and comfort. Additional body components, such as rear spoilers, lowered front and rear skirts, airflow dams, and other aerodynamic assists, are installed to guide airflow in a new direction and reduce drag while improving stability.

Owners of daily vehicles nowadays tend to change their vehicles to make them look more sporty (Katz, 2016). A rear spoiler is a part that aids in the generation of downforce in a car. It's an aerodynamic device that "ruins" adverse airflow across a vehicle's body. As an air barrier, a spoiler could be installed on the front or back bumper. Spoilers can be attached to any part of a car, although the most common location is in the back.

This is also determined by the form of the car's rear end, which might be rectangular, notchback, or sportys sedan. Lift and drag are two main aerodynamics factors that the rear spoiler contributed to. The spoiler can also be utilised to control cornering balance and conserve power by reducing drag force. A rear spoiler can reduce drag and back wheel boost while somehow decreasing dust on the back floor.

1.2 Problem Statement

The automobile has a strong tendency to lift over when driven at a fast speed, particularly on a road with a speed of traffic of 110 km/h. The pressure decreases as the higher amount of air in front of the glass accelerates as it passes over the glass. This decreased pressure elevates the roof as the air travels over the car. When the air is expelled, the notch created by the window falling to the body creates a vacuum or low pressure area that the air cannot adequately cover.

The wind is stated to split, and the consequent lower pressure creates lift, which affects the body's surface area. To reduce lift and increase high pressure, a rear spoiler can be added to the vehicle's body. Spoilers are most commonly found on sedans. They act as airflow barriers, allowing for increased air pressure at the front of the spoiler. This is beneficial because, as stated earlier, the low-pressure zone above the trunk lifts the car's back end, making it look "Light." At high velocities, its key goal is to decrease drag and air noise, lower noise emissions, and eliminate undesired lift forces and other causes of aerodynamic instability. The air is likewise considered a fluid in this circumstance..

The chief purpose of a spoilerare to make the car looking awesome. It is also to improve the downforce for a car that traels at high speed. Aerodynamic drag increases as a vehicle speeds up, making the engine work harder to maintain speed. Additionally, more air gets beneath it, causing "lift," which weakens grip and makes the car less stable. The quantity of air that passes beneath the car is reduced by front spoilers. Spoilers produce greater downforce towards the back, where airflow is more turbulent and generates more lift, keeping the car firmly planted on the road. So when the drivers are interested on installing the spoiler, the drivers cannot decide which are the best option for the car. Perodua Axia car was choosed to be analyzed with several types of spoiler. It is because Perodua Axia is well-known for being the entry-level car. Its also comes with affordable price and small dimensions, which is the best option as the perfect starter car for a new driver. So the whole body of Axia will be selected to be analyzed using CATIA and Ansys, it will be tested with several types of spoiler.

1.3 Research Objective

a) To study aerodynamic performance of city car that is Perodua Axia by Computational Fluid Dynamics method.

b) To investigate the impact of the several type of spoiler on the aerodynamic performance of Perodua Axia by the Computational Fluid Dynamics method.

1.4 Scope of Studies

The following are the parameters of the this study:

- Design of Perodua Axia body performed by using CATIA.
- Perodua Axia's design is used as a comparison for the aerodynamics performance.
- Ansys system is use to perform Computational Fluid Dynamics analysis which is shows which spoiler are better when it comes to aerodyanmics.
- Simulation of pressure and airflow through a car and the impact of the rear spoiler are the main focus of this project.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Automobiles can travel at such a high velocity rate that they can lose balance and cause accidental injuries as a result of their accelerated speed. This demonstrates the need for a controlling element such as aerodynamic wing with a spoiler that produces a carefully balanced body to stall over the wing section behind the spoiler, minimizing the lift of that wing section (Remer,2019). Spoilers are engineered to minimize lift while also raising drag significantly.

As an air dam, a spoiler may be added to the front or rear bumper. The rear spoiler contributed to two major aerodynamic factors: lift and drag. The spoiler can also be utilized to control cornering stability and conserve power by reducing drag force. A rear spoiler can help minimize drag and back wheel boost, as well as dust on the rear ground.

2.2 Automotive Aerodynamics Technology's History

The merging of aerodynamics with automotive technology has taken a long time. Only after numerous efforts has a synthesis of the two proved effective (Thomas,2016). This is unexpected, because collaboration with fluid mechanics has proven to be quite beneficial in the surrounding fields of traffic technology, naval design, and aeronautics. Of course, ship and airplane designers had a leg up. They got their inspiration from fish and birds in nature. Many fundamental characteristics were taken from these natural forms. In the automobile, there were no such originals. As a result, its architects attempted to mimic the forms of ships and airplanes, which must have seemed sophisticated to them at the time. This rapidly proved to be the incorrect technique. Aerodynamics made a breakthrough in the car only when it broke free from these faulty originals.

Some other reason for early and repeated vehicle aerodynamic problems is that they began much too early. The early vehicles were sluggish and inefficient. Streamlined bodies would have looked absurd on the poor roads of the day. The original design of horse-drawn carriages protected the people in the car from wind, mud, and rain. Eventually, the stereotype that aerodynamic bodies are just for peculiar individuals won over the need to gain from aerodynamics for economic reasons.

Figure 2.1 depicts a brief history of vehicle aerodynamics. People, the majority of whom were not from the motor business, worked on aerodynamic development throughout the first two of the four eras. They attempted to apply fundamental ideas from aviation aerodynamics to automobiles. Later, throughout the last two periods, automobile firms took up the discipline of vehicle aerodynamics and integrated it into product development. Aerodynamics has been (and continues to be) the responsibility of teams rather than individual inventors since then.

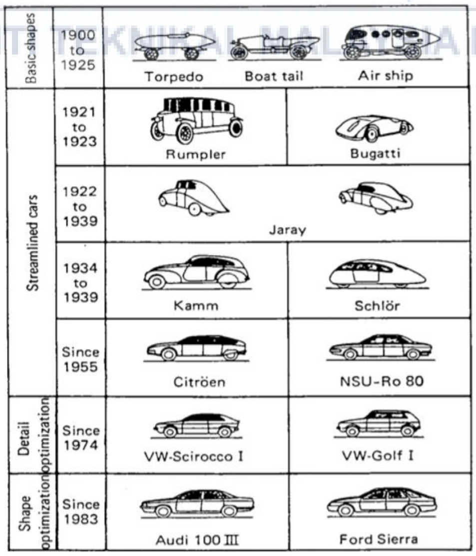

Figure 2.1: Vehicle dynamics in commercial vehicles throughout time. (Thomas, 2016)