UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DESIGN AND ANALYSIS EFFECT OF FRONT AREA OF LAND ROVER DEFENDER ON AERODYNAMIC

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

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 of Engineering Technology (Automotive Technology) (Hons.). The member of the supervisory is as follow:

……

(DR. ABDUL MUNIR HIDAYAT SYAH LUBIS)

ABSTRACT

The Land Rover Defender was developed from the original Land Rover Series that in 1983 for the first outcome. There are already 68 years in producing of Land Rover Defender by the company. The old design for the Land Rover Defender is considered has no aerodynamic features because related to fuel consumptions. The design was simple design and not futuristic design to the customers. The aerodynamics air drag and lift is the main focus for this project report. Thus, the objective of this study is to do basic study on concept design and analysis of Land Rover Defender's front area (front bumper and front hood). This done by sketching the 1990's Land Rover Defender and redrawn it on CATIA software before imported to the HyperMesh for further analysis. Three designs were proposed by modify the blunt edge of the front bumper and the angle of the front hood. The designs then imported to the Virtual Wind Tunnel (VWT) software for the Computational Fluid Dynamics (CFD) analysis to determine the effect of the design on the drag (C_D) and lift (C_L) coefficient for the stability for the car. The value of the drag coefficient, C_D, results in this analysis is 0.639 (Original Design), 0.598 (Custom Design 1), 0.566 (Custom Design 2) and 0.612 (Custom Design 3) while for the lift coefficient, C_L results is -0.234 (Original Design), -0.126 (Custom Design 1), -0.216 (Custom Design 2) and -0.137 (Custom Design 3). Increasing the angle of front bumper and front hood affected the result of C_D which provide more air flow area, thus the air flow will disperse to reduce C_D. For the lift coefficient, by increasing the angle of front bumper and front hood affected the result of C_L is negative, which means to keep the vehicle nearer to the ground and makes the vehicle more stable.

ABSTRAK

Land Rover Defender telah dibangunkan dari asal Land Rover Siri yang pada tahun 1983 untuk hasil yang pertama. Sudah 68 tahun dalam menghasilkan Land Rover Defender oleh syarikat. Reka bentuk lama bagi Land Rover Defender dianggap tidak mempunyai ciri-ciri aerodinamik kerana ia sangat berkaitan dengan penggunaan bahan api. Reka bentuk ini adalah reka bentuk mudah dan reka bentuk tidak futuristik kepada pelanggan. Seretan aerodinamik udara dan lif merupakan fokus utama untuk laporan projek ini. Oleh itu, objektif kajian ini adalah untuk melakukan kajian asas kepada reka bentuk konsep dan analisis kawasan hadapan Land Rover Defender (bumper depan dan hud hadapan). Ini dilakukan dengan melakarkan tahun 1990-an Land Rover Defender dan dilukis semula pada perisian CATIA sebelum diimport ke HyperMesh untuk analisis selanjutnya. Tiga reka bentuk telah dicadangkan kemudian diimport ke perisian Virtual Wind Tunnel (VWT) bagi pengiraan dinamik bendalir (CFD) analisis untuk menentukan kesan reka bentuk pada seretan (C_D) dan lif pekali (C_L) untuk kestabilan untuk kereta. Nilai pekali seretan, C_D, keputusan dalam analisis ini adalah 0,639 (Design Original), 0,598 (Custom Design 1), 0,566 (Custom Design 2) dan 0,612 (Custom Design 3) manakala bagi pekali daya angkat, keputusan C_L adalah - 0,234 (Design Original), -0,126 (Custom Design 1), -0,216 (Custom Design 2) dan -0,137 (Custom Design 3). Meningkatkan sudut bumper depan dan hud hadapan membuat hasil daripada CD yang lebih pendedahan kepada udara yang masuk, dengan itu aliran udara akan mendapatkan rintangan lebih pekali seretan. Untuk pekali daya angkat, dengan meningkatkan sudut bumper depan dan hud hadapan menjadikan hasil daripada CL adalah negatif, yang bermakna ia menolak kenderaan lebih dekat ke tanah dan membuat kenderaan menjadi lebih stabil.

DEDICATION

This project and research work is dedicated to my beloved parents for their enthusiastic caring throughout my life, my loving siblings, my supervisor/co. supervisor and also my friends for their encouragement and love

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

FEA	-	Finite Element Analysis
CFD	-	Computational Fluid Dynamics
CAD	-	Computer Aided Design
C_D	-	Drag Coefficient
C_L	-	Lift Coefficient
CATIA	-	Computer Aided Three Dimensional Interactive Application

CHAPTER 1
INTRODUCTION

1.0 Introduction

Land rover was created for heavy road style and specialist in four wheel drive vehicles. The first owner of the company is British multinational car manufacturer Jaguar Land Rover. Since 2008, the company turn owned by India's Tata Motors. The name of Land Rover was originally used by the Rover Company for the Land Rover series that launch in 1948. The first prototype was built by the company was designed for the army. This iconic car was improved over the years and it has been known for generations as a national treasure. All models is based on four wheel drive models, including Defender, Range Rover, Discovery, Freelander, Range Rover Sport and Range Rover Evouge.

Production of the model Defender began in 1983 as the Land Rover One Ten, 1983, a name which reflected the 110-inch (2,800 mm) length of the wheelbase. The Land Rover Ninety, 1984, with 93-inch (2,362 mm) wheelbase, and Land Rover 127, with 127-inch (3,226 mm) wheelbase, soon followed as now (liquisearch, 2016).

Aerodynamics plays an important thing in the development process nowadays. Aerodynamics loads is influenced for the vehicle performance, its stability and the vehicle cooling system. Its also for the drivers comfortable and visibility. From that side, the automotive industries nowadays applied wind tunnel experiments and Computational Fluid Dynamic (CFD) simulations to study the aerodynamic loads on their vehicles.

Aerodynamic drag is the force that acts on a body moving through air that opposite to the direction of motion of the vehicle. It may cause and affects the performance and fuel efficiency. Total fuel energy is lost around 50% to 60% to overcome the drag force, 10% to 20% for operating electrical appliance and 30% to 40% to overcome road resistance (P Ramaya, 2015). For nowadays, the aerodynamics drag is one of the prime concerns in vehicle aerodynamics and great effort in research for better fuel economy and performance road vehicles due to market competition for consumers. It's also happened in research and development of the Land Rover Defender.

1.1 Problem statement

With the increasing of automobile industries, people begin to pay attention to dynamic performance of automobile including the Land Rover industry. Front area in all cars, including the front bonnet, front grill, both sides of front eyebrows, is the most important to the aerodynamics features to reduce the air drag. The old Land Rover Defender design is just a simple design that the shape is consider did not possess aerodynamics design features.

Aerodynamics are affected the driving safety, operations, characteristics, stability and oil consumption of the vehicle. Therefore, redesigning the front area of the Land Rover Defender as to look more aerodynamically and look more futuristic, light in their weight and also reduce number of components or panels for the aerodynamics design features are required.

Since lack of information on 1990's Land Rover Defender aerodynamic air drag was not much found, study about this is considered important. This factor because of the company made the information of the design as Private and Confidential. That's why; this project subjected to the aerodynamic drag for the 1990's Land Rover Defender with the design provided in this research.

1.2 Objective

The objectives of this project are:

1. To do basic study on concept design front bumper and front hood of 1990's Land Rover Defender.
2. To determine effect of designed front part to drag coefficient (C_D) of the 1990's Land Rover Defender.
3. To determine effect of designed front part to lift coefficient (C_L) of the 1990's Land Rover Defender.

1.3 Scope of study

The scopes of study of this project are:

1. Sketching and feature modelling of 1990's Land Rover Defender by using CATIA.
2. Focusing on the effect drag and lift coefficient on the shape of Land Rover Defender 1990's based on aerodynamic features.
3. Computational fluid dynamics analysis by using HyperMesh processor software.

CHAPTER 2
LITERATURE REVIEW

2.0 Introduction

This chapter will be focused on the information of the research and the results of the study about the design and analysis front area (both sides and front hood) of Land Rover Defender in terms of the shapes and materials. This knowledge then will be used as the guideline to find the most suitable design based on the factor and the supported theory to finalize the design based on the scopes of the project.

2.1 History of Land Rover Defender

The Land Rover Defender was created from the first Land Rover Series that in 1983 for the main production. There are also called as Land Rover Ninety and Land Rover One Ten. Until now, the Land Rover Defender has many sorts and models that distinctive design and usefulness. There are as of now 68 years in delivering of Land Rover Defender by the organization. Creating of the Land Rover One Ten at 1983 and Land Rover Ninety at 1984 is the base of the organization for the generation and that is the reason the Land Rover Defender was called as the name of Land Rover Ninety and Land Rover One Ten.

Indeed, there is little to recognize the post-1983 vehicles from the Series III Land Rover. A full-length cap, reconsidered grille, in addition to the fitting of

wheel curve expansions to cover more extensive track axles are the most perceptible changes. At first the Land Rover was likewise accessible with low maintenance 4WD system well known to all subsidiaries created since 1949, showing Land Rover's anxiety for innovative advancement. The low maintenance framework neglected to offer and was immediately dropped from the choices list by 1984. While the motor and other body boards extended from the Series III, mechanically the Ninety and One Ten was modernized, including on the curl springs, offering a more agreeable ride and enhanced pivot enunciation. A changeless four-wheel-drive framework got from the Range Rover, including a two-speed exchange gearbox with a lockable focus differential. Likewise changes of the inside for look present day, a taller one-piece windscreen and another arrangement of logically more effective and more cutting edge motors (historics.co.uk, 2015).

After 68 years of the Land Rover Defender creation, October 2013 Land Rover reported that the generation would be end in December 2015 lastly finished on 29 January 2016 with the model Land Rover Defender H166 HUE.

2.1.1 Front design

The Land Rover Defender car's first body design is was in 1983 and 1984 is the base of the company for the production and that's why the Land Rover Defender was called as the name of Land Rover Ninety and Land Rover One Ten. However, there are revolutions on their design every series outcomes based the years of the productions. The design is for the military used for the army. All design is for the off road and tough job. Therefore, the all materials used are hard and tough based on metals and aluminium.

Figure 2.1: The first Land Rover Defender, 1983 (beachautobrokers, 2016)

In a 1983, 'Birmabright' is the materials that used by the designer of the Land Rover Defender for the production of the car. However, in their manufactured, there is some difficulty facing especially for the parts used in and for the spare parts while change the materials. The parts are assembling by riveting to other parts. The design also not too aerodynamics features.

Figure 2.2: Land Rover Defender, 1990 (landrover, 2016)

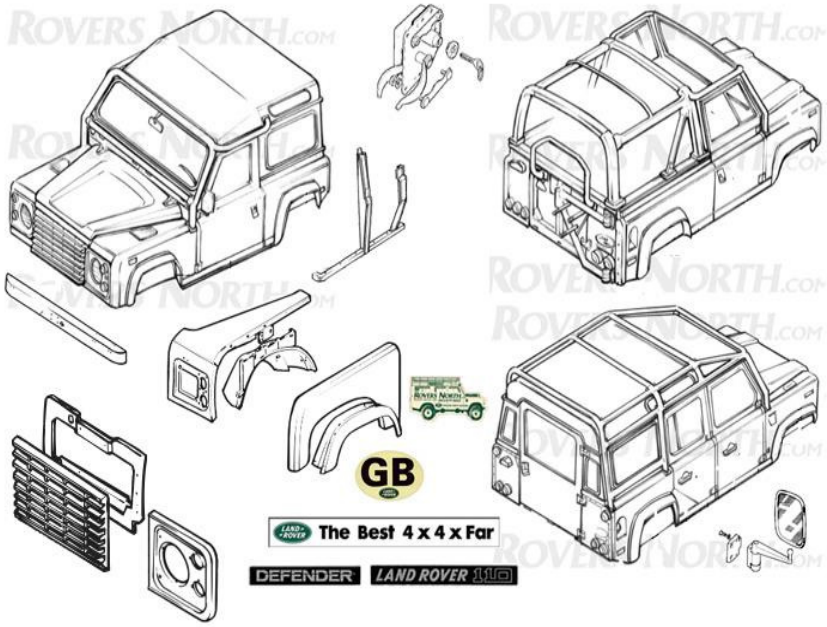

Figure 2.3: Land Rover Defender body parts, 1990 (globallandrovers, 2016)

At 1990 the Land Rover Defender changed their front design from the previous to look more advance in aerodynamics. The materials used in the production of the Land Rover Defender in that year are aluminium plate as the main materials for the body.

Figure 2.4: New Land Rover Defender plans, 2018 (autoexpress, 2015)

The Land Rover Defender will come out with the new design and version in 2018 with SVR execution form on the cards to rival the Merc G63 AMG. This new design is more modern, futuristic, sports and more streamlined features highlights or aerodynamics. The front body parts are basic than past design and utilized more lightly, hard and suitable materials (autoexpress, 2015).

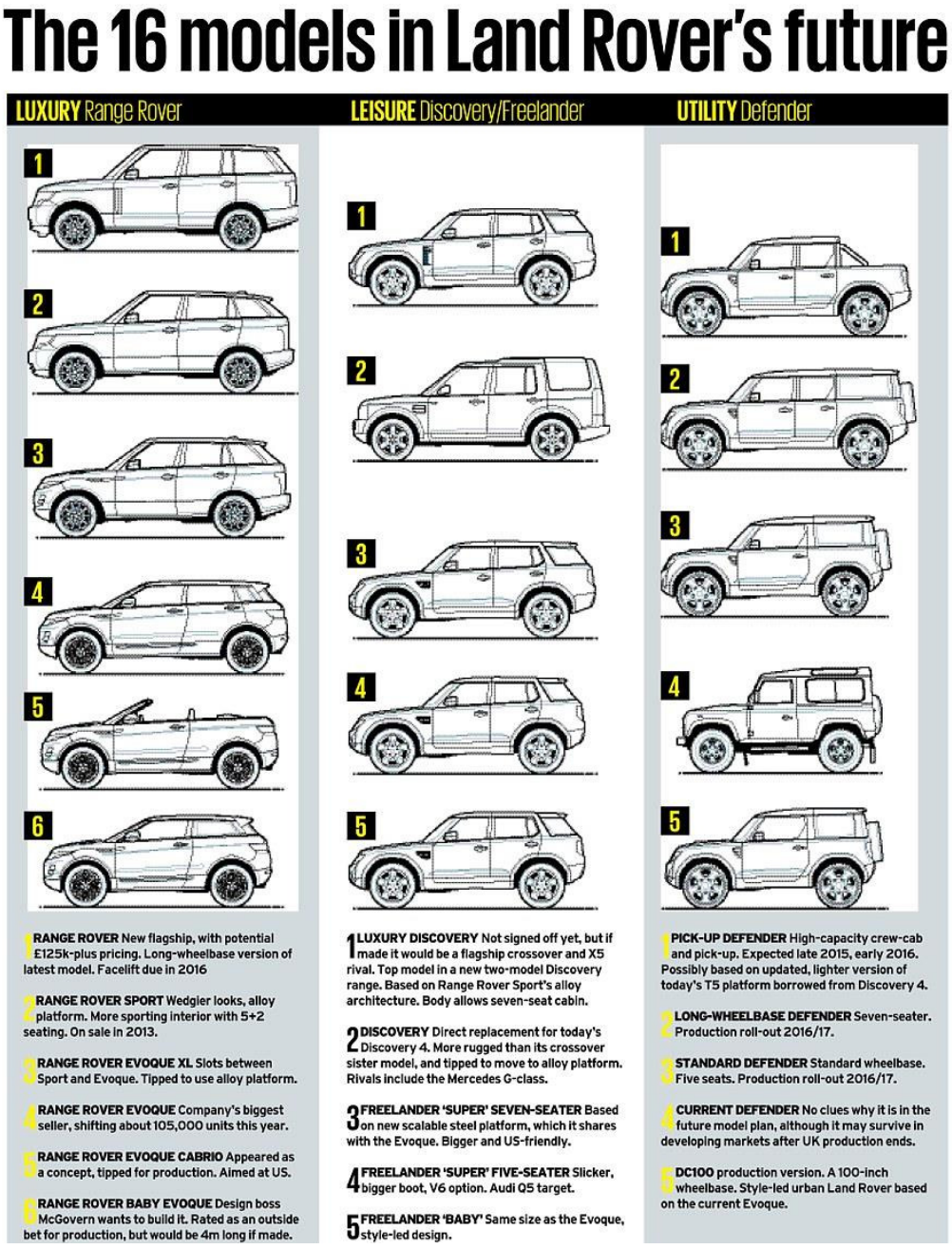

Figure 2.5: The 16 models in Land Rover's future (mailonline, 2012)