UNIVERSITI TEKNIKAL MALAYSIA MELAKA

IMPLEMENTATION AND IMPROVEMENT OF AIR HOLE AND FIN SHAPE TECHNOLOGY TOWARDS BICYCLE HELMET DESIGN

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

by

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I hereby, declared this report entitled “Implementation And Improvement Of Air Hole And Fin Shape Technologhy Towards Bicycle Helmet Design” 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 of Engineering Technology (Maintenance Technologhy) (Hons.). The member of the supervisory is as follow:

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MOHD AFDHAL BIN SHAMSUDIN

ABSTRACT

Aerodynamic drag contributes to resistance experienced by a cyclist when riding bicycle. The lower aerodynamic drag was required for helmet to obtained the high performance. The helmet surface was designed without air hole and fin shape which could not reduce attached airflow. Then, that helmet can‟t help to maintain airflow behaviour and improved performance. SolidWorks simulation was used to analyse the air flow behaviour via existing helmet by using method of Computational Fluid Dynamics, CFD. The best result of CFD was achieved and can reduce about 7.93% compare the drag force of existing design was 1.210 N. The result drag force of improved design bicycle helmet was 1.114 N. In conclusion, all analyse get the characteristic of aerodynamic and the effect of air hole and fin shape towards bicycle helmet are positive for airflow behaviour via bicycle helmet by addition of air holes and fin shape.

ABSTRAK

Seretan aerodinamik menyumbang kepada rintangan yang dialami oleh pelumba ketika menunggang basikal. Seretan aerodinamik yang rendah yang dikehendaki untuk topi keledar mempunyai prestasi yang tinggi. Untuk permukaan topi keledar yang direka tanpa lubang udara dan bentuk sirip tidak dapat mengurangkan aliran udara yang dilampirkan. Kemudian, topi keledar tersebut tidak membantu mengekalkan aliran udara yang melalui permukaan topi dan prestasi yang lebih baik. SolidWorks simulasi digunakan untuk membangunkan model yang sedia ada dalam topi keledar dan untuk menganalisis kelakuan aliran udara melalui topi keledar yang sedia ada dengan menggunakan kaedah pengiraan dinamik bendalir, CFD. Keputusan CFD terbaik dapat dicapai dan boleh mengurangkan kira-kira 7.93% berbanding daya seretan daripada reka bentuk sedia ada iaitu 1.210 N. Oleh itu, keputusan daya seretan untuk reka bentuk tambah baik topi keledar basikal ialah 1.114 N. Kesimpulannya, semua analisis mendapatkan ciri-ciri aerodinamik dan kesan lubang udara dan bentuk sirip arah topi keledar basikal adalah positif untuk aliran udara tingkah laku melalui topi keledar basikal dengan tambahan lubang aliran udara dan bentuk sirip pada permukaan topi keledar basikal.

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Dedicated to:

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Maznah Binti Ismail

Mohammad Juraidie Bin Jumahat

Noor Masyitah Binti Jumahat

Noor Maziah Binti Jumahat

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LIST OF SYMBOLS AND ABBREVIATIONS

A	-	Area of the Object
CFD	-	Computational Fluid Dynamics
C_D	-	Drag Coeficient
CAD	-	Computer Aided Design
ρ	-	Density of Air
V	-	Velocity
m/s	-	meter per second
km/h	-	kilometer per hour
mm	-	Milimeter
cm	-	Centimetre
%	-	Percentage
g	-	Gram
°	-	Degree
N	-	Newton

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Bicycle helmets are available for recreational bicycle or professional bicycle riders in many states. Blair and Sidelko (2008) claim that there are two further parameters such as aerodynamic efficiency and thermal comfort are correspondingly significant for several bike helmet design. These bike helmets will be for professional or recreational used. Other than that, Alam et al., (2008) state that the main purpose of a helmet is to give the head protection during a failure or accident, thermal comfort as well as aerodynamic efficiency are taking on a key role in the design criteria. The aerodynamic performances of these workable ultimate helmets are unspecified, simply inadequate evidence is accessible in the community domain.

Moreover, other manufactures demand their helmets have thermal comfort and ideal aerodynamic efficiency, no orderly facts are accessible to provision their demand. Meanwhile, no proportional research of the aerodynamic performance of numerous time trial and racing helmets had been conducted based on the previous study or in open literature. Alam et al. (2008) found that aerodynamic drag significantly can reduce the velocity of cyling by the cyclist. Thus, the helmet position can be put into appropriate phases of the race with the conserved energy obtained. Each second during bicycle cycling are generally essential in determining the champions by using an appropriately designed helmet and conserving precise body position (Kyle & Bassett, 2003).

Computational Fluid Dynamics is now being applied by researchers and engineers to preserve a number of select level teams, and creates the most technically innovative equipment (Lukes et al., 2006). Stories of CFD in elite sports range of the subject areas of cycling, to rowing, to swimming (Debraux et al., 2011). This has partially caused the performance become more interested in the role of technology to help find the all important more faster. Beside that, it is also from the increases in computational capabilities at near desktop (Kyle, 2003). Mathematical simulations are also developed, nevertheless, they are suffering from the inadequate aerodynamic input over and over again. Oggiano et al. (2006) reported it is relatively problematic to predict a full combination of all the above publications, particularly, when models of helmet relations may be introduced in the grommet.

Nevertheless, the difficulty to represent realistic air flow conditions were defined through experimental, although the numerical studies offer further flexibility in testing situations, they suffer from the lack of accuracy of characteristic low order methods or from the large computational times when innovative modelling is applied (Brownlie et al., 2010). Thus, bicycle helmets design improvement can be done and recognize in the future by improving or adding air flow conditions to Computational Fluid Dynamic (CFD) simulations together with helmet simulations followed by an evaluation the on-road responses (Debraux et al., 2011).

1.2 Problem Statement of Study

Nowadays, cycling is becoming more popular as it is a common game and sports organized as a Sukma Game, Sea Game, Olympic, Asia Game and Le Tour De Langkawi. Therefore, cyclist required aerodynamic criteria in the slipstream (Lukes et al., 2005). According to the publication, it refers the cyclist to the body position, wearing apparel, motorcycle frames, altitude and air density, shoes and pedals, and helmet (Oggiano et al., 2008). Consequently, the motivation has been initiated to examine the function of the helmet to help the cyclists perform faster in the raceway (Blair & Sidelko, 2008).

This can be identified that, the trouble is relatively through the sensitivity of air flow involves via aerodynamic helmets for cyclist. The existing rate of air stream should be analysed. From different sources such as weather, traffic of the environment surrounding the direction or track can affect the air flow (Brownlie et al., 2010).

Meanwhile, the boundary layer also plays a significant role because the wind speed increase via the top drop. The variety of issues make it difficult to model the air flow rate ideal conditions. Aerodynamic research, focuses on interface of design with aerodynamic performance of the helmet (Alam et al., 2008). In the past two decades, experimental and several trials had been made to address design changes in which to diminish the evaluation of the helmet in the air flow steady and unsteady conditions (Blair & Sidelko, 2008). Subsequent alternative helmet modifications that could improve the helmet‟s performance for a range of head positions were investigated. However, the main motivation for carrying out this research was to try to answer the question „How can we maximise the speed of cyclists based on helmet used, and which method results in the biggest gain?‟ into the improvement of design air holes and fin shape used for providing inspiration for adding to the existing helmet design.

1.3 Objective of Study

The purpose of this research is to implement and improve the design of air hole and fin shape technology towards bicycle helmet. Thus, this research objective is as follows:

1. To develop a 3D CAD model of existing bicycle helmet.
2. To analyse air flow behaviour via existing bicycle helmet.
3. To analyse the effect of the additional design of air holes and fin shape towards existing bicycle helmet in air flow behaviour.

1.4 Scope of Study

For this research, several scopes had been identified as follows:

1. Developing a 3D CAD model of existing bicycle helmet by using SolidWorks Software.
2. Analysing air flow behaviour via existing bicycle helmet by using Computational Fluid Dynamics, CFD simulation in SolidWorks Flow Software.
3. Analysing the effect of the additional air holes and fin shape towards existing bicycle helmet based on CFD simulation.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction of Helmet

The helmet is a type of equipment worn for safety head. In general, the helmet is used when cycling, driving, on sports (cricket, American football, skates, racing car and etc.) Type of helmet that used by the bike riders are motorcycle helmet (Bicycle Helmet Safety Institute, 2009). Motorcycle safety is the main purpose of using a motorcycle helmet (Blair & Sidelko, 2008). This is due to protect the rider‟s head during impact, consequently avoiding or decreasing head injury and protection exposed the rider‟s life.

Besides that, in the sport of cricket, cricket player frequently wears a helmet for protection purposes. Alam et al. (2008) found that it can protect them from trauma or brain injury with the cricket ball, which is indeed strong and can be speeded to them at rates above 140 km/h. Cricket helmets cover the whole of the head, and throw a vent or visor to protect the face mask (Alam et al., 2008). Frequently made with a carbon fibre and Kevlar shell, the helmet is considered to bound cricket balls as well as shield the wearer from impact, and its liner involves of an expandable element to inflexibly adapt to the helmet to its wearer's head. In addition, in American football and Canadian football, the football helmet is a part of shielding gear used frequently. It comprises of a solid artificial plate with heavy softening of the confidential, a face mask made of only or more layered metal bars, and a courage strap (Daneshvar et al.,2011).

To mention that all sideways grips are a diverse kind of face mask to equilibrate safety and brightness, and polycarbonate visors were added by some players to their helmets, which are functional to guard their eyes from frown and influences. Other than that, a bicycle helmet is considered to decrease effects to the foremost of a cyclist in falls, whereas reducing side effects such as interfering by low visualization.

In same location in which an arranged straight exactly reviewed into the level of safety, provided by bicycle helmets in the effect of an accident, and on the belongings of helmet wearing on cyclist and racing car driver behaviour (Brownlie et al., 2010). In that location is active argument over what can be resolved from available studies, and on whether the use of helmets by cyclists should be encouraged or authorized, either just for children, or for cyclists of all ages (Alam et al., 2008). In certain the argument over bicycle helmet laws is increasing and sharply, often constructed not only on different clarifications of the exact and other educational writings, but also on different conventions and comforts of numerous events (Oggiano et al., 2009).

2.2 Existing Bicycle Helmet

2.2.1 Mountain Bicycle Helmet

The most worldwide mountain bike helmet is related to any extra bike helmet that may need to use on the road or as a kid. It straps against the crest of the head and usually accepts an artificial courage slide that hits it. Several helmets have some category of the contraction knob on the cover so that can create an inviting, convention adequate (Blair & Sidelko, 2008). Helmets offer various designs and ventilation constructions, with the aim to provide protection, which is cool, comfortable and aerodynamic as potential (Alam et al, 2008). This character of mountain bike helmet is appropriate for outdoor and track riding.

2.2.2 Racing Bicycle Helmet

A helmet made for air motion facilitating proficiency at racing speeds in the time trials and track interest events (Alam et al., 2008). It is basically a round ball, yet most are stretched teardrop shapes. Some experience truly long tails that sit on the rider's back and mix the shape into a streamlined structure. At the point when riders sit up or look down the tail is lifted up into the slipstream (Burke & Pruitt, 2003). No less than one is intended to bell if the base is strange. The most aerodynamic optimized models have no vents to run the quiet stream of flying about the case (Brownlie et al, 2010). This, combined with the absence of air impact at typical road velocities confines this sort of head protector to track or time trail utilization. In a disaster area, the long tail would be similar to a lever to snap the head. Race coordinators now require these protective helmets to have power shield, so they are made with EPS froth and a light plastic shell (Oggiano et al., 2009).

2.3 Design of Racing Bicycle Helmet

2.3.1 Aero Helmet

Aero helmets have a lower drag than no helmet at all. The drag of even the smallest human shock is higher. An aero helmet smoothes the flow over the brain and lowers the drag by about 100g at 45 km/h (Alam et al., 2008). Some recent aero helmets, such as the one used by Graeme Obree and Lance Armstrong, have streamlined tail specially contoured to conform to the rider‟s back, the helmet curves over the ears and below the chin (Lukes et al., 2005). These potentially have lower drag force as presented in Figure 2.1.

Figure 2.1: Types of existing Aero Bicycle Helmet, (BHSI,2015)

2.3.2 Ventilation of Helmet

Air holes and fin shape which is a part of ventilation (Oggiano et al., 2006). Look at Aero helmets, have less ventilation holes and teardrop shape produce the lowest drag. For examples, included the aero helmets that were employed by the U.S Olympic cycling team from 1984 to 1996, the helmet used by Greg Lemond to win the Tour De France in 1988, and the helmets used in virtually all world record time trial effort (Alam et al., 2008). Unstreamlined, blunt, blocky helmets, usually employed in racing today, weightless and deliver good cooling, but their air resistance is from 100 to 180 g higher than that good aero model (Daneshvar et al. 2011). Standard helmets will lose more than 1 s per 1.5 km to an aero helmet. Therefore, aero helmets should be employed in all important time trials up to one hour, where chilling is not normally a problem. Helmets with smooth, rounded edges and a polished surface are superior to those a rough finish and sharp edges or ridges Debrauex et al., 2011). The concept of air holes and fin shape of standard helmet is shown in Figure 2.2.

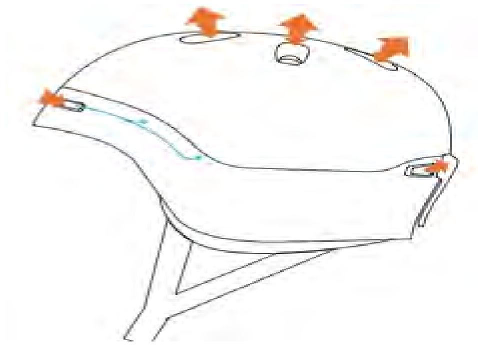

Figure 2.2: Air holes and Fin Shape Concept, (BHSI, 2015)

2.3.3 Visor Helmet

Among numerous typical protection maneuversis visor helmet (Alam et al., 2008). For instance, full face visor and half face visor. With that, a better cycling experience for bikers can be improved and gained. Furthermore, cycling is more than simply a sportsman for several individuals which is to them, it is a healthy living lifestyle (Ross et al., 2010). Other that that, in order to match every cycling condition, usage of visors is anticipated. Some of the cycling conditions are either cycling through the pavement, snow, water, trail, or the climb. Besides that, a helmet visor is commonly built with protected edges and lip (Chen & Jaw, 1998). This is for a well steadiness even at an extreme cycling speediness. It is still pliable besides being made with water-repellent materials.

A lot of goods have been inaugurated to the market place to create an contribution of further beneficial ultimate because of the greatness of this kind of physical bodily function. Meanwhile, a bike helmet bill is specifically thought to shield riders in the middle of the shifting climate surroundings (Burke & Pruitt, 2003). A bicycle helmet circular is meant to support relaxation or relief to the cyclists amongst other cycling devices (Alam et al., 2006).

Elevation of free air flow through the helmet vents consequently promotion of cooling eventually allowed the cyclist to be more relax and comfortable during cyling (Alam et al., 2008). The visor might look approximating broad in coverage though it might not, in any way, impede the cyclist's vision. Figure 2.3 shows examples of visor for racing bike helmet.

Figure 2. 3: Visor, (BHSI)

2.4 Aerodynamic

One of important characteristic in the racing helmet is aerodynamic (Basset et al. 1999). The aerodynamic shape is effect air flow to the helmet during cycling (Lukes et al. 2005). The main force is an aerodynamic force. Temperature will be an event of the breeze on a helmet at higher speed during cycling (Oggiano et al., 2008). The load of aerodynamic also affects the helmet performance. The aerodynamic concept includes aerodynamic drag, pressure drag, skin friction drag, drag coefficient, separation, boundary layer, significance of surface, and the direction to reducing drag (Oggiano, et al., 2009). Figure 2.4 shows Aerodynamic principles.

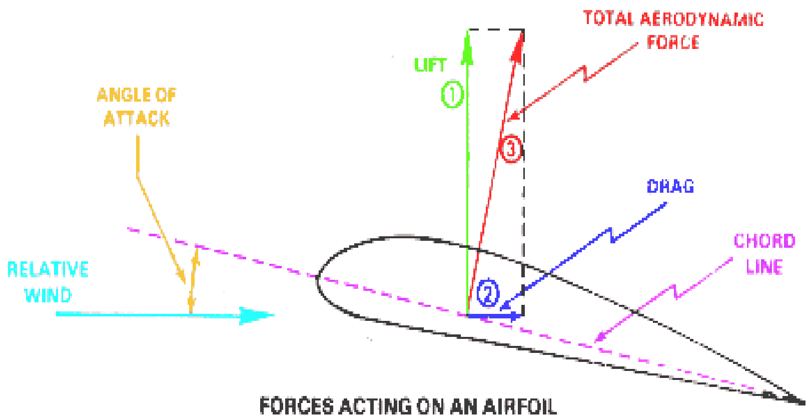

Figure 2.4: Aerodynamic Principles (Dynamic Flight, 2008)