APPROVAL

This report is submitted to the Faculty of Mechanical Engineering of UTeM as a partial fulfilment of the requirement for the degree of Bachelor of Mechanical Engineering (Design and Innovation) with Honours. The member of the supervisory committee is as follow:

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Date : 23 May 2011

DECLARATION

"I hereby, declare this thesis is result of my own research except as cited in the references"

Signature : ……..

Author`s Name : Rodzman Rozimi Bin Radzi

Date : 23 May 2011

ACKNOWLEDGEMENT

First of all, I am grateful to Allah s.w.t for giving me strength to fulfil this case study. I also want to give my special thanks to my supervisor, Dr. Abd. Rahman Bin Dullah for his guide during completing this analysis. Not forgotten my colleagues for their helps taught me on how to do the analysis by using this ANSIS-Fluent Software. Thanks to my family for their long lasting support me in engineering field, and always pray for my success in completing this case study. Their hope and bless give me enough strength to fulfil the requirements of this study.

ABSTRAK

Helmet motosikal adalah alat keselamatan yang digunakan untuk melindungi kepala dari kecederaan kepala penting jika berlaku sebarang kemalangan jalan raya, selain menjadi factor utama kepada berlakunya kemalangan jalan raya disebabkan system pengudaraan dalam helmet. System pengudaraan yang baik mampu menyediakan suasana penunggangan yang baik . dalam kajian ilmiah ini, satu analisis akan dijalankan bagi menentukan kadar haba yang dihasilkan oleh kepala penunggang dan haba yang diserap oleh helmet motosikal dari persekitaran. Dinamik Bendalir Perkomputeran (CFD) diaplikasikan dalam konteks menyelesaikan permasalahan ini, yang melibatkan beberapa fasa iaitu fasa pra-pemprosesan, fasa penyelesaian, dan fasa pengolahan keputusan analisis. dalam fasa pra-pemprosesan, model kepala penunggang, model helmet motosikal dan udara persekitaran dibangunkan dengan menggunakan softwer CATIA. Data-data dari sini kemudian dipindah masuk ke sofwer ANSYS-Fluent untuk tujuan penyelesaian dan pengolahan keputusan analisis yang akan diterjemahkan dalam bentuk graf dan kontor. Berdasarkan analisis yang dijalankan, beberapa cadangan akan diusulkan bagi memastikan sistem pengudaraan lebih baik bagi helmet motosikal pada masa hadapan.

ABSTRACT

Motorcycle helmet is one of the important road equipment while riding, not only protect rider`s head from road accident impact, but it also be a major factor to cause the accident by determining the rider focus on the road, in term of inner space condition of the helmet. A good motorcycle helmet ventilation system helmet will always ensure the rider in an optimum riding condition. In this case study, an analytical study will be carried out in order to identify the heat released by rider head and the heat absorbed by the helmet outermost surface from surrounding. Computational Fluid Dynamics (CFD) method is chosen to solve this problem. This research conducted based on Physiological and Cognitive Effects of Wearing a Full-Face Motorcycle Helmet Journal by Cornelis Peter Bogerd .The process phases begin with pre-processing, followed by solution and ended by post-processing phase. A human head model, motorcycle helmet model and air box model constructed by using Computer Aided Design Software(CATIA), which are then exported into ANSYS-Fluent Software to solve and interpret the result data in form of graphs and contours. From the tabulated data, the maximum temperature and the minimum temperature will be determined. Due to the result obtained, several recommendations also proposed in order to ensure better ventilation system in future.

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LIST OF ABBREVIATIONS

CAD	=	Computer Aided Engineering
CFD	=	Computational Fluid Dynamics
A1	=	Inlet air flow area
A2	=	Exit air flow area
h	=	Air convection coefficient
PSM	=	Projek Sarjana Muda
%	=	Percentage
h	=	Convective heat coefficient [W/^{o}C]
K	=	Conductive heat transfer [W]
RH	=	Relative Humidity

CHAPTER I

INTRODUCTION

1.1 Background Study

All motorcycle helmets consist of three main parts, an impact absorber layer which is made of impact reducing foam, a comfort liner that situated between head and the impact absorber layer and an outer most shell which is made to absorb the initial impact and protect rider`s head as well as take all of the damage that the road or other hard object would have done to the head.[1]

By wearing a helmet is a reflection of your attitude toward riding and shows that they are responsible riders who take motorcycle riding seriously.[2]

A helmet will not only protect rider`s head from a potential injury, but also cut down on wind noise, windblast on their face and eyes, and deflect bugs and other debris that flies through the air. It will also protect them from changing weather conditions and reduce rider fatigue.[3]

1.2 Problem Statement

UTeM students mostly are from states out of Melaka. Most of them are using motorcycle. Usually it takes from three to four hours riding from their hometown to Melaka. The long journey may affect their concentration of driving, because of the thermal condition in their helmets. The longer journey they take, the more CO2 and heat released by the riders during their ride.[4] This situation contributes the uncomfortable journey for them, unfortunately this situation may lead to road accident, because of the lack of focus during their riding.

1.3 Project Objectives

The objective of this research is to study the heat distribution inside the motorcycle helmet at different conditions (speeds and ambient temperature) and compare it with experimental result. Besides, the suitable method also will be proposed to improve this heat distribution.

1.4 Project Scope

At the end of this research, the result will be presented in journal format. The course provides me two simulation methods; FEA/CFD model simulation. Since this research involves fluid dynamics case, CFD (Computational Fluid Dynamics) ia preferred as the best method to be applied through my research. At the end of the analysis, the result obtained by the simulation will be the theoretical values. This result is then will be compared with the experiment results.

CHAPTER II

LITERATURE REVIEW

2.1 Introduction

We use helmet mostly every day in our life. It is a compulsory if we are on the riding. Motorcycle helmet, according to Longman Dictionary of Contemporary English, 2003, is a strong hard hat that soldiers, motorcycle riders, the police etc. wear to protect their heads. Nowadays, this head protector is used mostly by students, workers and anyone who use motorcycle as their transport

But it is not too comfort for the motorcyclists since there aren't exist any good ventilation system in the helmet. According to COST 357 Final Report(2005): CO2 and O2 Concentrations in Integral Motorcycle Helmets. Applied Ergonomics, most of road accidents contribute to the critical injuries are factorized by the bad ventilation condition in the helmet. During the riding, the motorcyclist exhaled too much carbon dioxide gas (CO_2) and discharge heat from their bodies during respiration process. After about 2 to 3 hours, the concentration of the carbon dioxide gaseous increased in the helmet. The CO_2 gaseous is then inhaled by the motorcyclist during their riding. This situation caused them to be less focus on their riding and led to the road accident.

Brühwiler(2003) in his experiment found that the heat released by our head also contribute to the road accident. From the technical report, the heat loss from the

scalp trapped between the human head scalp and the helmet (impact absorbing liner) surface. By the way, the finding of his experiment is state that the heat released from the face area is greater than the scalp. So he recommended some improvement for the air to flow around that area.

Zhang (2003; Arens et al., 2006a; b) state that the thermal condition in the helmet also contributes to the road accident to be occurred. Motorcyclist expected that the discomfort thermal condition in the helmet will affect their riding concentration so that they adopt that situation as their reason why they refused to wear that motorcycle helmet while they are on the road. Table 1 shows the types of motorcycle helmets and their related helmet sensation properties.

Table 1 Selected subjective parameters as a function of helmet type, expressed as percentage of subjects of both control and accident cases agreeing with the given statements.

Type Of Helmet	Helmet Sensation					
	Helmet Not Comfortable	Problems With Hearing	Narrow Field Of Vision	Helmet Too Noisy	Headaches After A Long Trip	Chin-Stap Not Comfortable
Integral (N=264)	8,3%	16,2%	22,1%	39,5%	12,3%	13,0%
Jet (N=215)	7,0%	8,9%	7,6%	21,0%	9,9%	15,9%
Motocross (N=12)	0,0%	0,0%	16,7%	41,7%	8,3%	8,3%
With Retractable Chin-Bar(N=86)	9,3%	12,8%	29,1%	47,7%	20,0%	16,3%
Total (N=577)	7,8%	12,6%	17,7%	33,9%	12,5%	14,5%

(source : http://www.cost357.org)

By referring to the above table that produced by Cost357 team, we can conclude that the thermal condition in the helmet also is one of the major factors why the road accident frequently occurred. This phenomena can be observed through the title `Headaches After a Long Trip` under `Helmet Sensation` in Table 1.

By doing market survey on the motorcycle helmet company, the improvement had been done a lot for their product with various specifications. The improvement including the motorcycle helmet shapes, sizing and comfort. There are 5 shapes are provided by the company; round, earth, egg, and reverse egg shape, as we can see in the Figure 4. They also provide an excellent facilities for the customers by designed several sizes of the helmet, in order to fulfil the good riding condition for the customers. The sample taken from current market is shown below.

Figure 1 Various human head shapes

(source : http://www.webBikeWorld.com)

2.2 Motorcycle Helmet Layer

Basically, a motorcycle helmet contains three main layers. They are:

1. Rigid outer shell layer (outer most layer)
2. Impact absorbing layer (middle layer)
3. Comfort/ fit padding layer (inner layer)

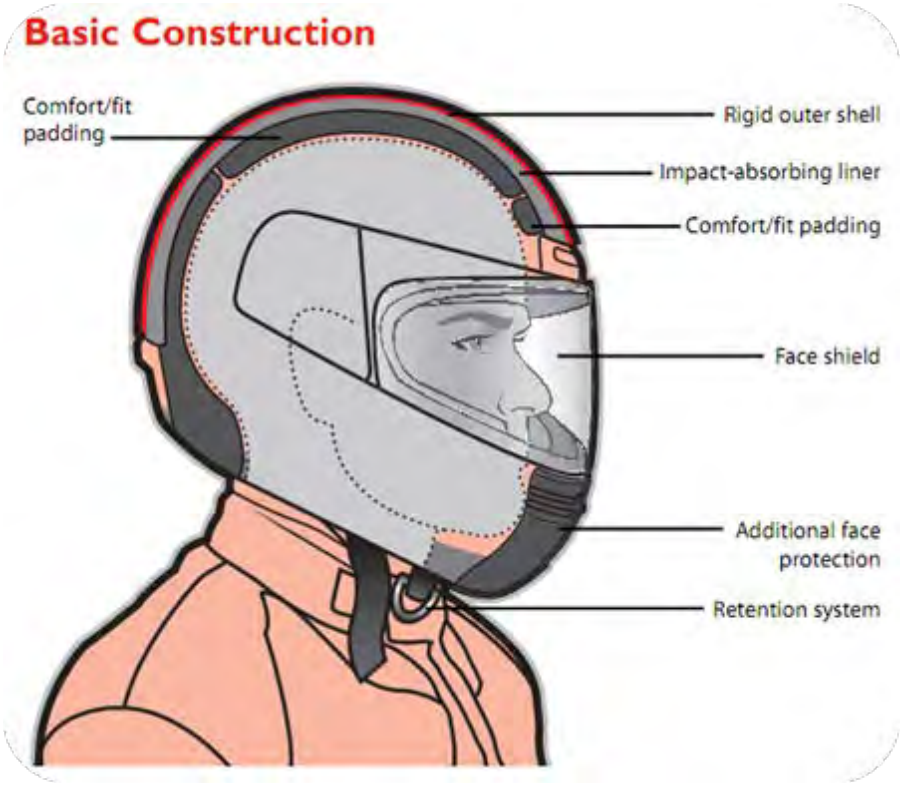

Figure 2 Basic motorcycle helmet layers

(source : http//:www.msf-usa.org)

2.2.1 Rigid outer shell layer (outer most layer)

Rigid outer shell layer is the hardest layer. This layer will deflects small objects like sticks, dirt and bugs. And can be hit by the road surface of other object on the road as the rider undergoes road crash, which is usually made of flexible

material like fibreglass, polycarbonate, or carbon fibre. The shell flexes during a major impact to help disperse the force to a larger area which then transferred to the impact-absorbing liner.[5]

2.2.2 Impact absorbing layer (middle layer)

Inside the outer shell is the impact-absorbing liner, usually made of styrofoam. The function of this layer is not to deflect the force but to absorb it. The foam compresses during impact, absorbing much of the impact. This system is designed to work one time. That's why a motorcycle helmet should be thrown away after being involved in a crash or significant blow.[6]

2.2.3 Comfort/ fit padding layer (inner layer)

This is the soft layer inside the impact-absorbing liner. This helps the helmet fit more snugly and keeps you comfortable. It absorbs sweat, so some comfort liners can be removed.[7]

2.3 Microclimate heat distribution

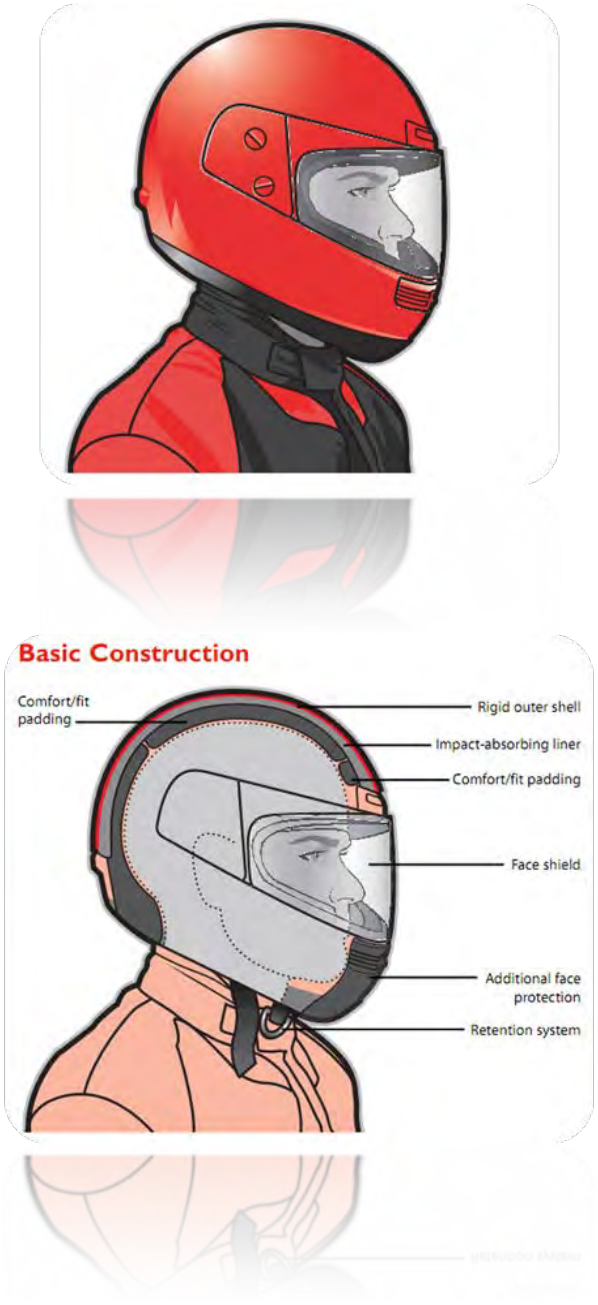

Figure 3 Cross section between head and the motorcycle helmet

(source : http//:www.msf-usa.org)

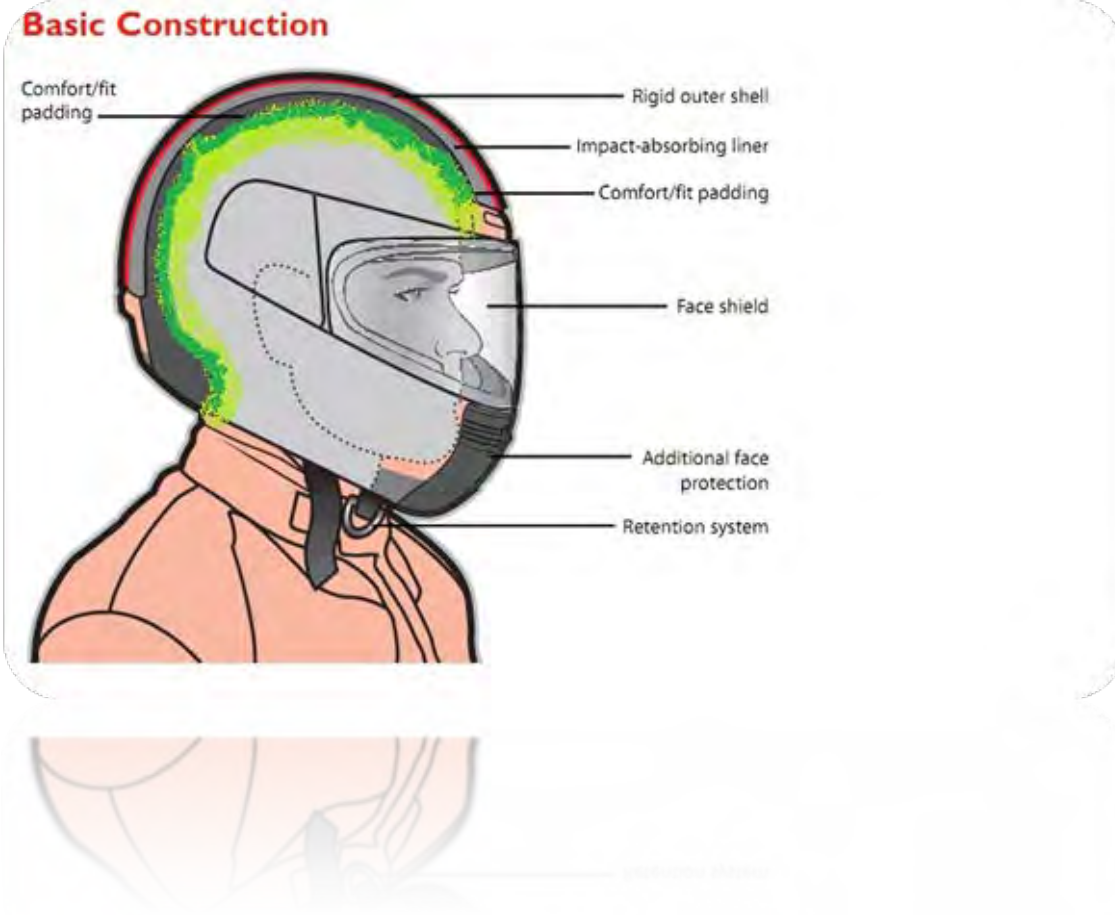

Figure 4 Heat trapped between head and motorcycle helmet

(source : http//:www.msf-usa.org)

Heat absorbed from surrounding and released by scalp is trapped between scalp and comfort padding. Dark green noting the heat absorbed from surrounding. Light green noting the heat discharge from scalp

2.4 Heat transfer theory

In mathematics, a finite difference is like a differential quotient. The derivative of a function *f* at a point *x* is defined by the limit

$$\lim_{h \to 0} \frac{f(x+h) - f(x)}{h}.$$

If *h* has a fixed (non-zero) value, instead of approaching zero, this quotient is called a finite difference.

2.4.1 Calculus of finite differences

One important aspect of finite differences is that it is analogous to the derivative. This means that difference operators, mapping the function f to a finite difference, can be used to construct a calculus of finite differences, which is similar to the differential calculus constructed from differential operators.

2.4.2 Numerical analysis

Another important aspect is that finite differences approach differential quotients as *h* goes to zero. Thus, we can use finite differences to approximate derivatives. This is often used in numerical analysis, especially in numerical ordinary differential equations and numerical partial differential equations, which aim at the numerical solution of ordinary and partial differential equations respectively. The resulting methods are called finite-difference methods.

Consider the ordinary differential equation

$$u'(x) = 3u(x) + 2.$$