

DESIGN OF A COMFORTABLE BUS PASSENGER SEAT

LIEW KEAN FEI

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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:

Date:

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**This report is submitted in partial
fulfillment of the requirements for the award of a
Bachelor of Mechanical Engineering (Automotive)**

**Faculty of Mechanical Engineering
Universiti Teknikal Malaysia Melaka**

JUNE 2013

DECLARATION

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

Signature:

Author:

Date:

Special thanks

My Parents

My Family

My FYP Supervisor

My Seminar Panels

My Course Mates

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ABSTRAK

Dalam projek ini adalah merekabentuk kerusi penumpang bas yang selesa dengan mengintegrasikan bahan berasaskan udara dan berasaskan gel. Ini adalah disebabkan kebanyakan bus ekspres menggunakan poliuretana berasaskan kusyen dalam padding kerusi. Jenis padding kerusi ini akan menyebabkan penumpang bas yang duduk dalam perjalanan yang panjang akan berasa tidak selesa dan dalam keletihan. Terdapat dua punca utama yang membawa kepada tidak selesa dan letih iaitu getaran kenderaan memandu dan taburan tekanan di kerusi. Satu soal selidik berkenaan kerusi penumpang bas dijalankan untuk mengenal pasti bahagian badan yang paling tidak selesa semasa perjalanan bas. Dalam kajian ini akan memberi penekanan kepada reka bentuk bersepadu tempat duduk penumpang bas untuk memastikan keselesaan yang maksimum kepada penumpang bus. Reka bentuk kerusi bas penumpang yang baru menggunakan berasaskan udara dan kusyen berasaskan gel untuk meningkatkan parameter selesa di dalam bus. Selepas sesi 'brainstorm', ia menyumbang idea-idea baru dan keluar dengan konsep yang terbaik daripada penilaian objektif berwajaran. Konsep dipilih akan dikesahkan dengan menggunakan perisian MatLab SimuLINK. Dalam pengesahan model telah menentukan beberapa parameter yang memberi kesan terhadap kadar perubahan tekanan model kusyen udara. Tahap selesa kusyen udara boleh penambahbaikan dengan mengurangkan kadar perubahan tekanan. Semua parameter yang berubah akan dibandingkan dan dibincangkan dalam bahagian perbincangan yang menunjukkan peningkatan yang dibawa oleh reka bentuk duduk penumpang bas yang baru ini. Dalam keputusan akhir menunjukkan bahawa ketinggian sel udara dan kekukuhan sel udara memberi kesan keselesaan tempat duduk bus penumpang.

ABSTRACT

In this project is to design a comfortable bus passenger seat by integrating air-based and gel-based material. This is due to most of the express coaches are using polyurethane foam based cushion in the seat padding. This type of the seat padding will cause a bus passenger who sit for long journey will feel uncomfortable and fatigue. There are two main causes which lead to uncomfortable and fatigue which is vibration of drive vehicle and pressure distribution on the seat. There was a bus passenger seat survey conducted to identify the most uncomfortable body part during the bus travelling. In this research will emphasize the integrated design of a bus passenger seat to ensure maximum comfort to the bus passenger. The new design a bus passenger seat is using air-based and gel-based cushion to increase the comfortable parameters in the bus. After the brainstorm session, it contributed new ideas and come out with the best concept from the weighted objective evaluation. The selected concept was validated by using MatLab SimuLINK software. In the model validation had determine some of the parameters gave effect on the pressure change rate of air cushion model. The comfortable level of the air cushion could be improvement by reduce the pressure change rate. All the changing parameters were compared and discussed in this discussion section to show the improvement brought by this new design of bus passenger seat. In the final results shown that the height of air cell and the stiffness of air cell gave an impact of the comfortable bus passenger seat.

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LIST OF SYMBOLS

A_1	=	Seated area of air cell, m^2
A_2	=	Connected area of air cell, m^2
D	=	Diameter of orifice, m
g	=	Acceleration due to gravity, ms^{-2}
h	=	Air cell height, m
K	=	Air cell stiffness, N/m
L	=	Length of orifice, m
P_1	=	Pressure in seated air cell, Pa
P_2	=	Pressure in connected air cell, Pa
$P_{initial}$	=	Initial pressure for air cushion model, KPa
ρ_{air}	=	Density of air, kg/m^3
μ	=	Dynamic viscosity, kg/ms
t	=	Time, s
V_1	=	Volume of seated air cell, m^3
V_2	=	Volume of connected air cell, m^3
x_1	=	Vertical displacement of seated air cell, m
x_2	=	Vertical displacement of connected air cell, m
W	=	Weight of the seated person, kg
ΔP	=	Pressure change, Pa
dP/dt	=	Pressure change rate, Pa/s
\dot{V}	=	Volume flow rate, m^3/s

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CHAPTER 1

INTRODUCTION

1.1 OVERVIEW

In this research is design a comfortable bus passenger seat by integrating air based cushion and gel based cushion. The air cushion as shown in Figure 1.1 is designed with a recessed area to take the pressure off the tailbone and help eliminate back pain to provide hours of soft comfortable seating.



Figure 1.1: Air cushion seat
(Source: Roho, 2012)

On the other hand, gel seat is contains layer of viscos elastic gel and conforms to the shape of the body. It also provides support while allowing body to take a natural sitting shape as shown in the Figure 1.2. Besides, the new design of the

seat will consider about the ergonomically shape to improve the Fit parameter levels of a bus passenger seat.



Figure 1.2: Gel cushion seat
(Source: Geltec, 2012)

1.2 PROBLEM STATEMENT

Nowadays, most of the express coaches are using polyurethane foam based cushion in the seat padding. This type of the seat padding will cause a bus passenger who sit for long journey will feel uncomfortable and fatigue. There are two main causes which lead to uncomfortable and fatigue which is vibration of drive vehicle and pressure distribution on the seat. In this research will emphasize the integrated design of a bus passenger seat to ensure maximum comfort to the passenger.

1.3 OBJECTIVE

To design a comfortable bus passenger seat by integrating air-based and gel-based material.

1.4 SCOPE

1. Study the current bus passenger seat and identify the product requirement on new design of bus passenger seat.
2. Design a bus passenger seat by using air-based and gel-based cushion to increase the comfortable level in the bus.
3. Simulate the new design of bus passenger seat by using MatLab SimuLINK.

CHAPTER 2

LITERATURE REVIEW

2.1 DEFINING THE COMFORTABLE

The term of “seat comfort” is mean that the short-term effect of feeling of a seat on a human body. This will be the sensation usually appear during sitting on a seat for a short interval of time. The feel of “Comfort” is a vague or ambiguous concept and generally defined as lack of discomfort (Shen et. al., 1997).

In contrast, “driver fatigue” defines the physical impairments due to experience the seat dynamics for a long time. These uncomfortable condition are known in nature and include reducing in attention during driving, decision-making not correctly, reaction time slow down and vigilance (Seigler, 2002). For example, a tractor driver may exposure a lot of tension in physical and mental. The operator work performance will be very poor if the seat is not comfortable and there is also a possibility of accidents (Mehta et. al., 2007).

From this case shown that a comfortable seat is very important for a tractor operator but other consumer also very concern about this issue. The consumer expectations for a comfortable automobile seat keep increasing and the evident is the current automobile seat comfort development process. The automobile seat comfort is designed and came out with an ergonomics background which is developed in the field of applied science (Fazlollahtabar, 2010).

In the automotive seating industry, seat system design teams focus on objective and measurable laboratory standards that can relate with the performance

measures. The performance measures of seat comfort for automobile based on human physiology and biomechanics. The mechanisms of the seat comfort are including pressure distribution, thermal comfort, vibration transmissibility and other (Fazlollahtabar, 2010).

Firstly, some of the researchers recommend that the pressure distribution will affects the perceptions of seat comfort. Pressure distribution at human-seat interface as shown in the Figure 2.1 is one of the important cause affecting the seating comfort and work efficiency of various worker (X. Wu, 1996). The appearance of the high pressure at the human-seat interface affect the soft tissue deformation leading to restricted blood and nutrient flows in the part of the body and bring discomfort to the human (Kumar et al., 1994). So, a seat with a good pressure distribution brings a suitable and balanced support to body areas during the contact on the seat.

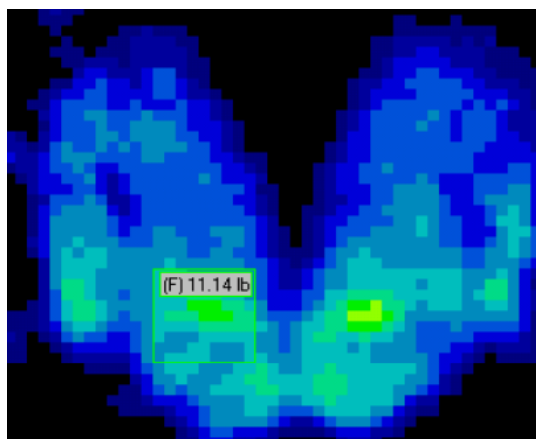


Figure 2.1: Pressure distribution of a seated person
(Source: Seigler, 2002)

Secondly, the thermal comfort also one of the important performance measures for seat comfort. The thermal comfort is a combination of temperature and humidity of the skin surface than can bring to discomfort. Most of reason is because of the increasing in the coefficient of friction when the skin is moist (Fazlollahtabar, 2010). There is a ready-made seats with different materials are studied by the physiological laboratory test methods skin model and seat comfort tester. In the climatic chamber shown the results that the fabric cover produces more sweat compare than leather which mean fabric cover bring more discomfort than leather seat (Bartels, 2003).

Next, the vibration transmissibility in vertical direction is one of the most investigated objective measures of seat comfort. Human will experience the vibration to some degree in any transportation or moving vehicle which is car, truck, bus, train, airplane or boat. The frequency range of 2-6 Hz will bring the hazard to the human operator because the resonance occurs within this frequency range. Then, the design parameters improvement for tractor seats is needed to increase the reductions in the level of ride vibrations exposure by tractor operators (Prasad, 1995).

From the thesis related the term of “seat comfort” had shown that to design a comfortable seat must reduce the several performance measures based on physiology and biomechanics. The performance measures are more important and need to be studied will be pressure distribution, thermal comfort and vibration transmissibility.

2.2 HISTORY OF SEAT

First of all, the seating unit is referring to a base and a seat support supported by the base. Usually, the structure for a seat is the back upright is function to support on the base for adjustment between an upright position and a reclined position (Peterson, 2007). On this seating unit, the cushion is position on the surface of the back support and the seat support. The cushions conduct a cushioning effect so that seated user’s body experienced the comfort when sit on the seating unit and the example of the seating unit as shown in the Figure 2.2 (Peterson, 2007).

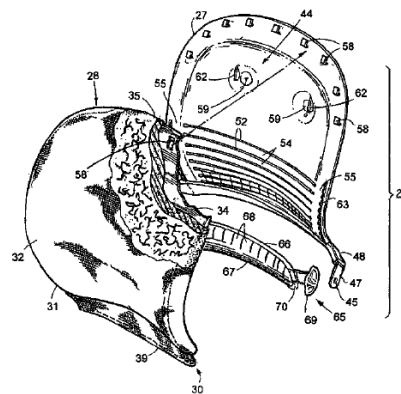


Figure 2.2: Basic of seating unit

(Source: Peterson, 2007)

After look into the basic of the seating unit, there is a Canadian magazine for antique and collectible cars, Old Autos was recently described the earliest reference to an automotive seating type (Ontario, 2007). One of the article with title “The Benz patent motor car, No 1” is about the world’s first petroleum-based fuel vehicle in 1885. The bench seat of this Karl Benz Car as shown in Figure 2.3 is described as “horseless carriage” and “The padded, leather bench seat sat on springs mounted directly to the frame” (Ontario, 2007). After that moment, the construction of the automotive seat and the cushioning material employed to build up a more comfortable place for operators and the improvement on automotive seat have continued to evolve (Blair, 2008).

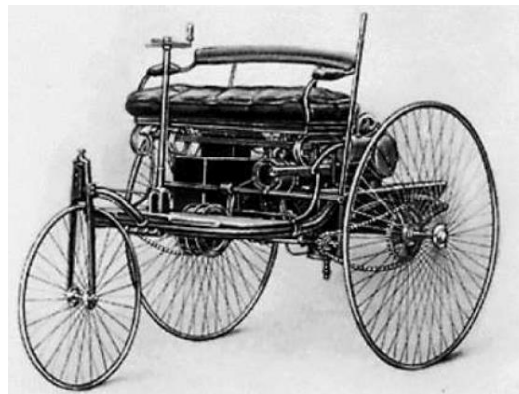


Figure 2.3: Karl benz car
(Source: Blair, 2008)

Next, the seating cushion is very important for human who travelling because it can provide a comfortable seat in the vehicle. The ergonomic seating cushion has a central cavity and the interior boundaries form an oscillating waveform can provide a comfortable seat. It is because the feature had reduced the pressure gradient on skin pressing again the cushion, promoting blood flow to the region (Loomos, 2003).

In additionally, the cushioning material in seating unit plays a main role to support operator posture, reduce the vibration and improve the ride quality. By using the different characteristic of the seat cushion will affect the damping characterization and select the proper seat cushion will improve operator’s comfort. There is one of the results showing that the high density polyurethane foam based