REDESIGN OF BOMBARDIER PUTRA LRT SEAT

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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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DECLARATION

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

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Date	:	20 JUNE 2013

DEDICATION

This project is dedicated to my Parents who have never failed to give us financial and moral support, for giving all our need during the time we developed our system and for teaching us that even the largest task can be accomplished if it is done one step at a time.

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Most especially to my family and friends

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ABSTRACT

The objective of this project is to redesign the PUTRA LRT's seat. The purpose to redesign is due to current PUTRA LRT seat had been use for more than 10 years, colour of seats are not attractive and there is some wear and tear. This new design is based on the Bombardier requirement. The new design of LRT seat was used Fibre Reinforce Polymer (FRP) as material. By using CAE software which is Generative Shape Design in CATIA, few designs were drafted as conceptual design. The best design of LRT seat was selected by using engineering design selection method. This new design of seat had been analysed by using Generative Structure Analysis (FEA) in CATIA to identify the critical part. Besides, D 6110 ASTM Standard Test Method for Determining the Charpy Impact Resistance of Notched Specimens of Plastics used to ensure the seat is safe to use. FEA and Charpy test result shown the new design of seat was pass the requirement of rail transportation industry.

ABSTRAK

Objektif projek ini adalah untuk merekabentuk semula kerusi LRT PUTRA. Tujuan untuk merekabentuk semula adalah disebabkan kerusi PUTRA LRT telah digunakan selama lebih daripada 10 tahun, warna kerusi tidak menarik dan ada kerosakan dan lusuh. Rekabentuk baru ini adalah berdasarkan permintaan Bombardier. Rekabentuk baru kerusi LRT telah digunakan Gentian Memperkukuh Polymer (FRP) sebagai bahan. Dengan menggunakan perisian CAE iaitu Generative Shape Design dalam CATIA, beberapa rekabentuk telah digubal sebagai rekabentuk konsep. Reka bentuk kerusi LRT yang terbaik telah dipilih dengan menggunakan kaedah pemilihan rekabentuk kejuruteraan. Rekabentuk baru kerusi ini telah dianalisasi dengan menggunakan Generative Structure Analysis (FEA) dalam CATIA untuk mengenalpasti bahagian kritikal. Selain itu, ASTM D 6110 Kaedah Ujian Standard untuk Menentukan Rintangan Impak Charpy Spesimen Notched Plastik digunakan untuk memastikan kerusi itu adalah selamat untuk digunakan. Hasil ujian FEA dan Charpy menunjukkan bahawa reka bentuk baru kerusi adalah lulus keperluan industri pengangkutan rel.

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D, d	=	Diameter
F	=	Force
g	=	Gravity = 9.81 m/s
I	=	Moment of inertia
1	=	Length
m	=	Mass
N	=	Rotational velocity
P	=	Pressure
Q	=	Volumetric flow-rate
r	=	Radius
T	=	Torque
Re	=	Reynolds number
V	=	Velocity
w	=	Angular velocity
x	=	Displacement
z	=	Height
q	=	Angle

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CHAPTER 1

INTRODUCTION

1.1 Overview

Travel by Light Rail Train becomes a common activity in Kuala Lumpur, Malaysia. With the increasing in age of LRT facilities, it is important to improve LRT facilities. Besides, increasing in numbers of passengers of PUTRA LRT result to wear and tear of the seat. Beside than PUTRA LRT, other Light Rail Train service company in Klang Valley was undergoing improvement of its LRT service. An industry project between TKH manufacturing Sdn Bhd and Bombardier is to redesign and develop new PUTRA LRT seat. The specific name of current PUTRA LRT seat is “818”. TKH responsible to redesign a Putra LRT seat based on Bombardier requirement. Since the current PUTRA LRT seats (818) ergonomic had been accepted by Bombardier, the new design must follow the major dimension of the 818 seat. However, the new design still needs to be testing its impact strength before produce a sample of material. Once the design have been confirm, a sample of material will be produce by using FRP. This sample of material is undergoing a standard test which require by rail transportation industry.

1.2 Problem Statement

TKH manufacturing SDN BHD is assigned by Bombardier to redesign a brand new outlook Putra LRT seat. 818 PUTRA LRT seat had been use for more than 10 years. In other word, 818 PUTRA LRT seat has been classified as out of trend (Bombardier, 2012). Hence, Bombardier plans to change those seats due to the colour of seats are not attractive. In additional, there is some wear and tear on 818 LRT seat. Those design required to follow the major dimension of current PUTRA LRT's seat. These major dimensions include height, length, width and thickness of the seat. Besides, the material of seat required was FRP (Fibre Reinforce Polymer). In order to fulfil the demand, LRT seat must redesign based on Bombardier's requirement.

1.3 Objective

To redesign current PUTRA LRT's seat based on Bombardier's requirement.

1.4 Scope

This project involves the study of 818 PUTRA LRT seat dimension, contour and shape outlook. By using CAE software, based on 818 PUTRA LRT seat, come out with few brand new and fresh designs. One of these designs is select to be final design by collect response from a survey. Total of 50 respondents were involve in this survey session. This survey data was analyzed by using a statistical method. SPSS® version 15.0 for Windows® was use as tool to complete this analysis. This final design was analysis by using finite element analysis (FEA) to determine it critical part of the LRT seat. Next, the final design is proceed to the sample of material develop. Sample of material (FRP) will develop and supply by TKH manufacturing Sdn Bhd. Lastly, the sample of material is tested by ASTM Standard Test Method for Determining the Charpy Impact Resistance of Notched Specimens of Plastics to ensure the seat is safe to use. This sample testing was conducted at laboratory of material structure, Industry Campus, University Teknikal Malaysia Melaka.

CHAPTER 2

LITERATURE REVIEW

2.1 History of Seat

The history of automotive seating was refer to the world's first petroleum-based fuel vehicle in 1885. This bench seat was described as "The padded, leather bench seat sat on springs mounted directly to the frame" (Blair et al., 2008).

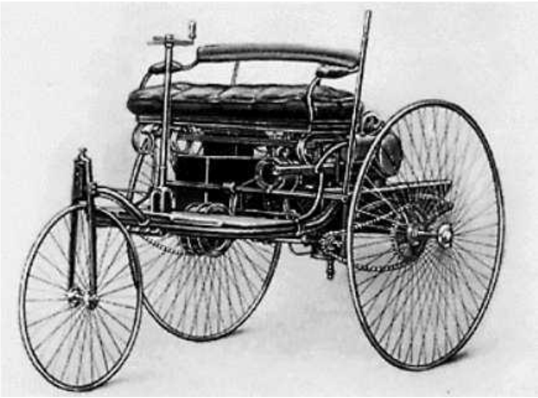

Figure 2.1: Karl Benz car
(Blair et al., 2008)

Since that time the development of the automotive seat and the cushioning material used to give the passenger a comfortable place to sit while operating a motor vehicle have continued to evolve (Blair et al., 2008). These developments have been considered on ease of manufacture, cost, safety legislation, durability, and the consumer requirement for increased comfort (Blair et al., 2008). The evolution of automotive seat as illustrated in timeline in Figure 2.2

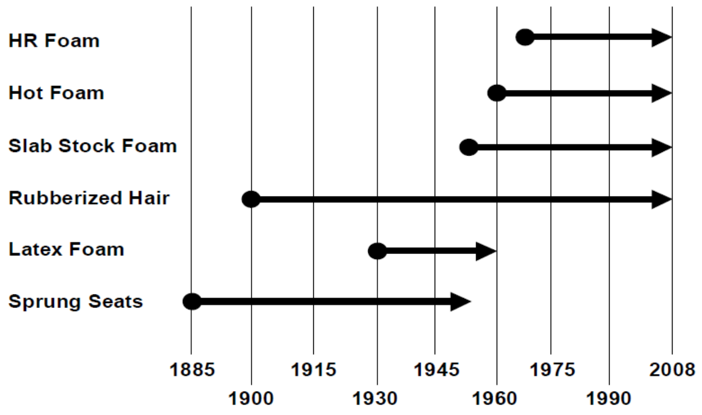

Figure 2.2: Timeline of automotive seat evolution
(Blair et al., 2008)

Nowadays, FRP had been used as material to make seat for train and rail, buses and various chairs. The aircraft industry during the 1940s was the first use of glass fibre reinforced polyester composites (PlasticsEurope, 2006). Figure 2.3 show the application of FRP on rail seat.

Figure 2.3: Application of FRP on rail seat

2.2 PUTRA LRT

Generally, the buses are divided into two types which are short distance bus and long distance bus. There difference between the long distance and short distance bus are short distance bus is consider about the city traffic, the time stay for passengers on the bus and easy for passengers movement in the bus (Alvio, 1986). However, the long distance bus is more concentrate on the comfortable of passengers.

This is due to passengers will spend a more time on the bus (Alvio, 1986). Short haul rail can define as movement less than 500 miles (RSTAC, 2011). Hence, Light Rail train can be classified as a short haul vehicle.

The definition light rail transit has been used to describe electric rail systems since the 1970s. There is no formal definition until 1989, when the transportation research board (TRB) developed a standard definition as: "*A lightweight metropolitan electric railway system characterized by its ability to operate single cars or short trains along exclusive right-of-way at street level. These vehicles are usually powered by overhead electrical wires, and offer a frequent, fast, reliable, comfortable and high quality service that is environmentally sustainable"* (Boorse, 2000).

The Kelana Jaya Line is one of rapid transit system in Malaysia. In Kuala Lumpur, there are two rail transit lines operated by RapidKL Rail (Geyer, 2006). The PUTRA LRT was start operated on 1998 while Ampang Line start operated on 1997 (Geyer, 2006). Kelana line was formerly known as PUTRA LRT (Projek Usahasama Transit Ringan Automatik Sdn Bhd). In July 2005, Putraline was officially changed to Kelana Jaya Line (Prasarana, 2011).

When PUTRA line launched, it is the world's longest 100% automated driverless transit system in the world which is 29km long. Currently it was known as the world's second longest 100% automated driverless metro system and the longest self-powered transit in Asia (Prasarana, 2011).

Syarikat Prasarana Negara Berhad (Prasarana) is a wholly-owned Government company is the owner of PUTRA line. In October 2006, Prasarana signed a contract with Bombardier and Hartasuma Consortium. In this contract, Prasarana purchase 22 new 4-car train sets, with an option for another 13, total amount is RM1.2 billion. In December 2009, the four-car trains started operate. (Prasarana, 2011).

Bombardier and Hartasuma Consortium responsible in produce the PUTRA LRT seat. Seats will be designed to emphasize human factors. Also, the seat assembly was modular seat shell of FRP (plastic moulding) structure without inserts (TKH, 2012). Figure 2.4 show the current FRP seat by Bombardier.

Figure 2.4: Bombardier FRP seat

The current PUTRA LRT seat design was followed the requirement of rail transportation industry. The requirements are Safety Standard No. 302, *Flammability of Interior Materials and* ADA Standards for Accessible Design (TKH, 2012).

Based on Safety Standard No. 302, the flammability is referring to requirements of fire retard for materials used in the occupant compartments of motor vehicles. Occupant compartment air space refers to the space contains refreshable air within the occupant compartment. The aim of this standard is to reduce the injuries and deaths to motor vehicle occupants caused by vehicle fires which include those come from in the interior of the vehicle from sources like matches or cigarettes (TSD, 2007).

ADA Standards for Accessible Design sets guidelines for accessibility to places of public accommodation and commercial facilities by individuals with disabilities. These are one of the requirements to design the PUTRA LRT seat by Bombardier and Hartasuma consortium. The design must fulfill the ADA Standards required by regulations issued by Federal agencies, including the Department of Justice, under the Americans with Disabilities Act of 1990 (ADA standard, 1994).

Based on the requirement, Bombardier had been produced a seat design. This seat design had been approved by SIRIM QAS International sdn. bhd. with seat qualification test report by similarity (TKH, 2012). Figure 2.5 show the major dimension of PUTRA LRT seat.

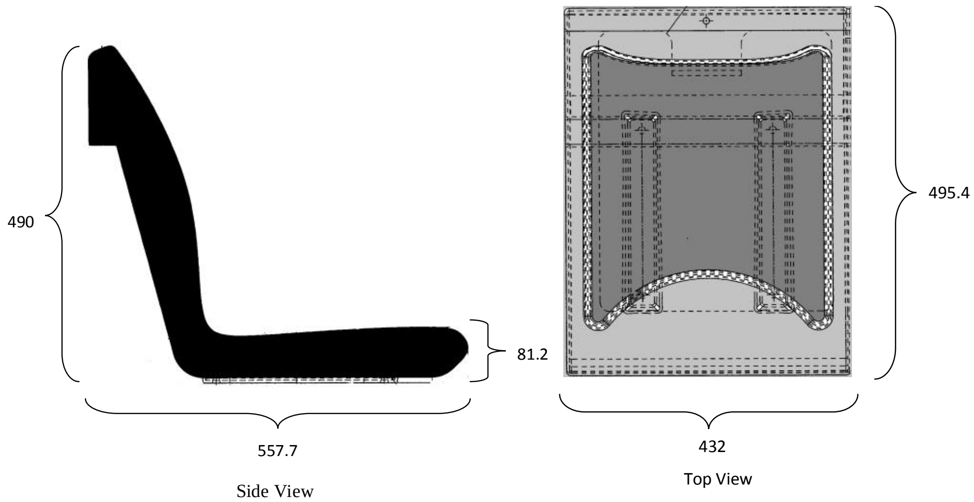

Figure 2.5: Dimension of 818 PUTRA LRT seat

2.3 Fibre Reinforced Polymer

Fiber Reinforced Polymer (FRP) synthetic with fibers bonded together with the assist of organic polymers is being related to as the materials of 21st century because of many intrinsic advantages (GangaRao et al., 2010). The advantages of FRPs compared to traditional materials are (PlasticsEurope, 2006):

- Light weight
- High strength-to-weight ratio
- Good electrical insulating properties
- High levels of stiffness
- Chemical resistance
- Design freedom
- Maintain of dimensional stability over a wide range of temperatures

Also, composites are aesthetically pleasing, dimensionally stable and cost effective with lower maintenance and better durability than the traditional materials (GangaRao et al., 2010). FRP composites applications to civil engineering started in the form of marine structures, tanks. Piers and pilings for military demand. After that, major field applications of FRP composites have taken place in roads, bridges, marine structures and construction of structures, with great success in retrofits (Mallick, 1993).

In the last decade, great efforts have been made to carry forward and develop design guidelines, maintenance and construction standards, and specifications for FRP including standardized test procedure.

Advantages and Disadvantages of FRP (GangaRao et al., 2010):

1. Light weight: Reduction in dead load results in an increased live load capacity with possible elimination of weight limitation.
2. Rapid installation: Due to its pre-fabricated, modular and light weight units that eliminate forming and solidification efforts needed for conventional materials, FRPs can be fast implemented.
3. Reduced interruption: low stop function of an in-service structure and use rapid installation procedures can guide to lower user costs, better safety, lower maintenance, and better public relations.
4. Good durability: Good resistance to chemicals results in eliminating corrosion and cracking together with steel reinforced concrete.
5. Long service life: Non-civil FRP structures have performed very well in bad environments for long time. For example, FRP bridge decks are expected to use for 75-100 years with low maintenance.
6. Fatigue and impact resistance: FRPs have high fatigue durability and collision resistance.
7. Quality control: shop manufacture of FRP results in good quality control with lower transportation cost.
8. Ease of installation: Installation time of FRP reduction of up to 80%.
9. Cost savings: structural recovery using FRP costs a fraction (1/15th to 1/10th) of the replacement cost.

Also, prolong the service life by additional 25-30 years. Recovery also gives less environmental effect and green house gas emissions (Ryszard, 2010). In additional, new FRP construction gives lower life-cycle costs and excellent FRP thermo-mechanical properties.