MATERIAL SELECTION IN MECHANICAL DESIGN OF CAR BUMPER

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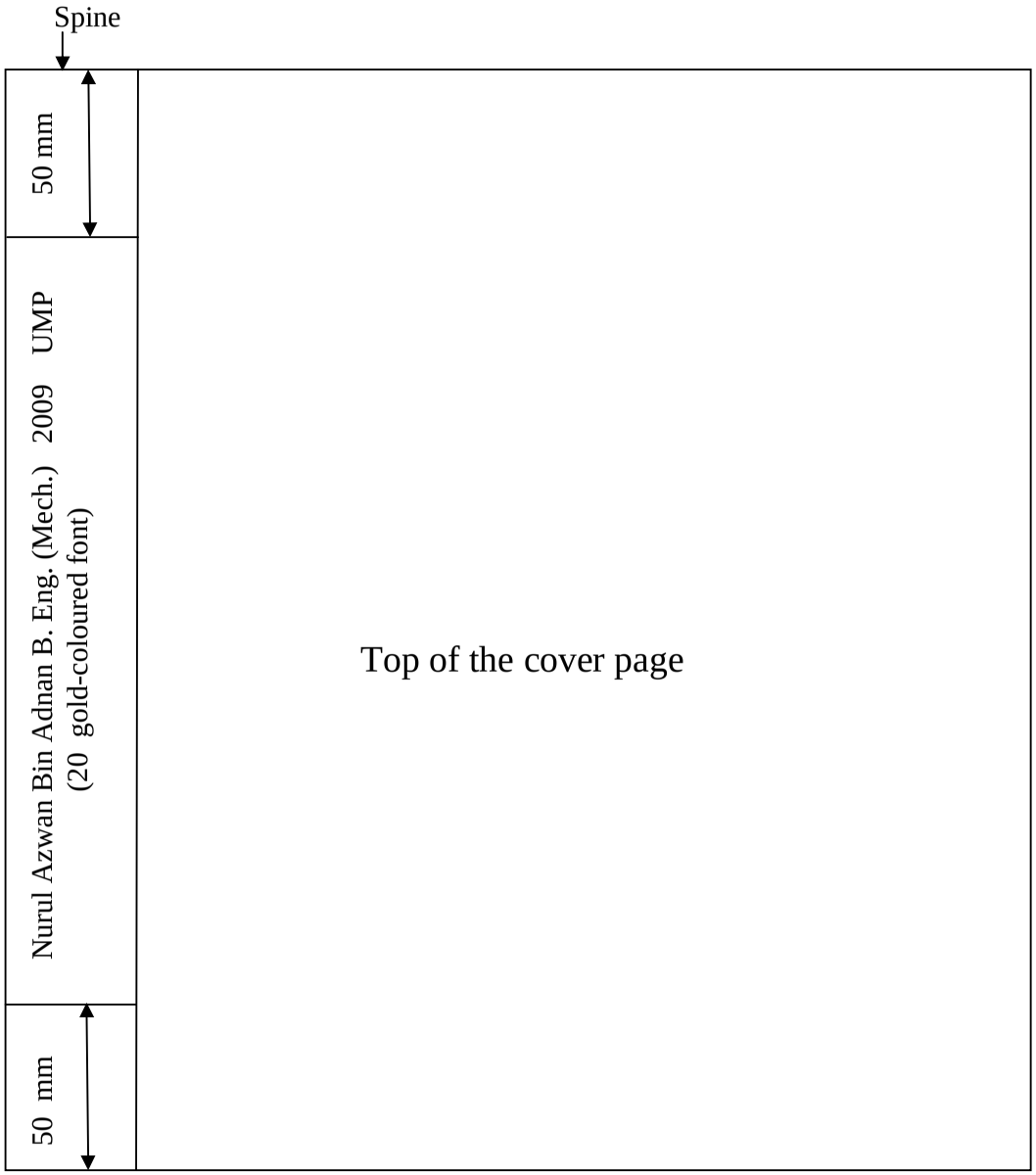
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MATERIAL SELECTION IN MECHANICAL DESIGN OF CAR BUMPER

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Report submitted in fulfilment of the requirements
for the award of the degree of
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LIST OF SYMBOLS

M	Material performance index
α	Weight factor
β	Scaling factor
γ	Performance index
E	Young's modulus
ρ	Density
m^3	Meter cube
Mg	Miligram
N	Newton
m	Meter (unit length)
s	Spring constant
r_0	Atom size
GPa	Giga Pascal
σ_f	Strength
C'	Cost
C	Cost per unit mass
F	Force
A	Area
L	Length
S	stiffness
MPa	Mega Pascal
σ_Y	Yield strength
δ	Deflection

b	Base length
h	Height
m	Mass
I	Inertia of moment
y_m	Perpendicular distance from the neutral axis to the outer surface of the beam
F_f	Force at failure

LIST OF ABBREVIATIONS

PU	Polyurethane
CFRP	Carbon fiber reinforced polymers
GFRP	Glass fiber reinforced polymers
Al Alloy	Aluminum Allloy
Mg Alloys	Magnesium Alloys
Ti Alloys	Titanium Alloys
FE	Finite Element

CHAPTER 1

INTRODUCTION

1.1 GENERAL INTRODUCTION

Most of the engineering product was through materials selected process before manufacturer start produces the product. The main purpose of materials selection process is to choose the suitable materials for produce high quality car bumper and make it suitable for do their job properly.

In manufacturing sector, material selection process is one importance step before they start produce the car bumpers. The material selection process is important because it will guarantee the product produce is success in market or not. Material selection also will affect the quality and cost of car bumpers. The high quality will give satisfaction to the user.

The performance of the product produce is depending on the properties of the material used and the design of the component. Under some circumstances material can be selected satisfactorily by specifying ranges for individual properties. To start making the material selection process, people must know the characteristic of the things or component they want to produce. After that performance index must be finding before select the suitable material. But it's not a final step of the material selection. In this stage, the several type of material must be chosen depend on the character of the component want to produce. **Fig. 1(a)** is shows the example of car bumper produce by polyethylene (PU) materials and **Fig. 1(b)** car bumpers using carbon-fiber reinforced

polymers (CFRP) materials. PU usually used for universal car and CFRP used for sports car and racing car because CFRP are light.

Figure 1.1 Car bumpers (a) using polyurethane (PU) material (b) using carbon-fiber reinforced polymers (CFRP) material

1.2 PROBLEM STATEMENT

The best selected materials are needed for produce a high quality car bumper. The quality of bumper is not only depending on the design but materials used also important. This study is important to compare the alternative method and conventional method for recognize which one from this two method are the best method to select the best materials for car bumpers. In this study also use CES software to find the best processes for selected materials. The problem is how to make the processes selection for selected materials using CES software.

1.3 OBJECTIVES

The objectives of this study are:

i. To perform material selection process for find the best material that can be use as car bumpers material.
ii. To compare the alternative method with conventional method.
iii. To use Computer-aided selection software to find the best process for car bumper manufacturing.

1.4 SCOPES OF THE STUDY

This study is about analysis of materials performance requirement for car bumpers based on functional requirement, process ability requirement, cost and availability of the material. Scopes of this study are:

i. Perform materials selection process using alternative method.
    a) Determine material performance index, M
    b) Determine weight factor, α
    c) Determine scaling factor, β
    d) Determine performance index, γ
    e) Select the best materials
ii. Perform materials selection process using conventional method.
    a) Determine cost per unit property
    b) Select the best material
iii. Compare the material selected from alternative method and conventional method.
iv. Using Computer-aided process selection software to find the processes suitable for selected materials.

ABSTRACT

This study was carried out to study Material selection in mechanical design of car bumper. The objectives of this study are to perform material selection process to find the best material that can be use as car bumpers material, compare the alternative method with conventional method and use Computer-aided selection software (CES) to find the best process for car bumper manufacturing. Weight property method as alternative method and cost per unit property method as conventional method were performed to find the suitable material for car bumper. After finish selection using weight property method, cost per unit property method was performed. The material selected from these two methods was compared to find the best selected material. The materials performance index, M, were derive basic formula like stiffness and force at fracture. Material performance index M, for car bumper was found to be $M_1 = \frac{E}{\rho}$, and $M_2 = \frac{\sigma_f}{\rho}$. Function of materials performance index, was plotted on the Young's modulus – density chart and strength – density chart. In weight property method, the material selection was made by referring to the performance index. It was found that Carbon fibre-reinforced polymer (CFRP) was the best material as it has high performance index. The best selected material in cost per unit property method was Magnesium alloys (Mg Alloys) based on the smallest value of cost per unit property. However, due to limitation of cost per unit property method, result is more accurate value to several of attributes. Lastly, Computer Aided selection processes were used to find the suitable manufacturing processes for selected material.

ABSTRAK

Kajian ini dijalankan sebagai satu kajian untuk memilih bahan dalam rekabentuk mekanikal bagi bumper kereta. Objektif tesis ini adalah menjalankan proses pemilihan untuk memilih bahan terbaik bagi kegunaan bumper kereta, membandingkan kaedah alternatif dan konvensional dan menggunakan perisian komputer penolong pemilihan (CES) untuk mencari proses pembuatn terbaik untuk bumper kereta. Kaedah sifat pemberat adalah kaedah alternatif dan kos per unit sifat pula adalah kaedah konvensional telah dijalankan untuk mencari bahan yang sesuai untuk bumper kereta. Bahan terpilih daripada kedua-dua kaedah akan dibandingkan semula untuk memilih satu bahan yang terbaik. Sebelum menjalankan kaedah pemberat sifat, indek perlaksanaan bahan, M, dicari terlebih dahulu. Bagi mendapatkan indek perlaksanaan bahan, M, asalan rumus asal seperti kekakuan dan daya pada retak mestilah dicari terlebih dahulu. Indeks tindak balas bahan M, untuk bumper kereta didapati sebagai $M_1 = \frac{E}{\rho}$, dan $M_2 = \frac{\sigma_f}{\rho}$. Fungsi indek perlaksanaan bahan, M, telah diplotkan pada carta modulus Young's – ketumpatan dan carta kekuatan – ketumpatan. Dalam kaedah sifat pemberat, pemilihan bahan dibuat dengan merujuk nilai indek perlaksanaan. Bahan yang mempunyai nilai indek terbesar, adalah bahan yang terbaik. Selepas selesai pemilihan menggunakan kaedah pemberat sifat, kaedah kos per unit sifat pula dijalankan. Dalam kaedah kos per unit sifat, bahan terbaik dipilih berdasarkan nilai terkecil indek perlaksanaan bahan. Nilai yang terkecil dipilih sebagai bahan terbaik. Akhir sekali, perisian komputer telah digunakan dalam proses pemilihan untuk mencari proses pembuatan sesuai bagi bahan pilihan.

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