UNIVERSITI PUTRA MALAYSIA

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By

NORWAZAN BINTI ABDUL RAHIM

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To my lovely hubby,
mummy and daddy
To my lovely baby

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

EFFECT OF BULGE GEOMETRY ON IMPACT BEHAVIOUR OF FRONT PLATFORM OF COMPRESSED NATURAL GAS VEHICLES

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NORWAZAN BINTI ABDUL RAHIM

June 2007

Chairman: Prof. Ir. Barkawi bin Sahari, PhD

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The effects of structural geometry and reinforcement part on the crash behaviour have been investigated throughout this study. The crash analysis under lateral (side) impact has been investigated on crash behaviour in term of crash distance and energy absorption on front platform also the deformation shape of model.

The crash behaviour studies for the geometry were analyzed in two different conditions which is the different bulge height and length attached on the front platform. In this case, the front platform was modified from the base front platform (without bulge) and joined the bulge plate together on the top of platform. This all the platform has been studies to compare their characteristic independently.

The next section of analyses, the front platform are attached with all other parts was studied between different pattern and thickness of the side member and center member assembly front floor. The mounting parts for the CNG tank underneath front platform consisted of the mounting bracket, mounting strap and bottom reinforcement are also attached to this assembly. All the parts are known as a reinforcement parts. Firstly, the entire model are being studies on different pattern and continuing with the different thickness of the side member and center member assembly front floor.

In the analytical work, finite element analyses were generated by using the HYPERMESH software and it has been analyzed using the LS DYNA software. In early stage, before the finite element models were created, the design stage of model is using the CATIA V5, 3D design software.

From the results obtained, the final stage of analyses have been achieved that the front platform with the new the side member and center member assembly front floor is the best front platform to use as the fabrication work. The exactly thickness of the side member and center member assembly front floor is 1.2 mm.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk ijazah Master Sains

KESAN TERHADAP GEOMETRI BONJOL PADA KELAKUAN HENTAMAN UNTUK LANTAI HADAPAN KENDERAAN YANG MENGGUNAKAN GAS NEUTRAL MAMPATAN

Oleh

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Kesan ke atas struktur geometri dan bahagian peneguhan kepada sifat-sifat rempuhan telah dikaji melalui pengajian ini. Sifat-sifat rempuhan yang dikaji ialah hentaman sisi khususnya jarak hentaman dan tenaga yang diserap ke atas lantai hadapan serta bentuk pencacatan model tersebut.

Pengajian sifat-sifat rempuhan bagi geometri telah dianalisis di dalam dua keadaan yang berbeza iaitu ketinggian bonjolan yang berbeza dan kepanjangan bonjolan yang berbeza yang diletakkan ke atas lantai hadapan. Di dalam kes ini, lantai hadapan telah diubah daripada lantai hadapan asas (tanpa bonjolan) dan disambungkan dengan bonjolan logam pada atas lantai hadapan tersebut. Keseluruhan lantai hadapan ini telah dikaji untuk membezakan sifat-sifatnya dengan terperinci.

Bahagian seterusnya, lantai hadapan disambungkan dengan ke semua bahagian yang lain juga dikaji di antara perbezaan bentuk dan ketebalan bagi komponen sisi dan tengah lantai hadapan. Bahagian penggantungan tangki GNM di bawah lantai hadapan pula termasuklah kekuda penggantung, pengikat penggantung dan penahan bawah telah disambungkan dalam proses pemasangan ini. Kesemua bahagian ini dikenali sebagai bahagian penahanan. Pada awalnya, keseluruhan model dikaji ke atas perbezaan bentuk terlebih dahulu dan diikuti dengan perbezaan ketebalan bagi komponen sisi dan tengah lantai hadapan tersebut.

Di dalam kerja analisis ini, analisis unsur terhad telah dihasilkan dengan menggunakan perisian HYPERMESH dan kemudian ia dianalisis menggunakan perisian LS DYNA. Pada peringkat awal, sebelum unsure terhad ini dihasilkan, peringkat rekabentuk pula telah dihasilkan dengan menggunakan perisian 3D iaitu CATIA V5.

Daripada penemuan keputusan, peringkat terakhir bagi analisis juga telah tercapai di mana lantai hadapan dengan komponen sisi dan tengah lantai hadapan adalah merupakan lantai hadapan yang terbaik untuk digunakan pada peringkat pembuatan. Ketebalan sebenar bagi komponen sisi dan tengah lantai hadapan ialah 1.2 mm.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

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DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citation which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

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NORWAZAN BINTI ABDUL RAHIM

Date: 20 October 2007

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LIST OF ABBREVIATIONS

BIW	Body in white
C, P	Strain rate parameter
CAD	Computer aided design
CAE	Computer aided engineering
CNG	Compressed natural gas
E	Young's modulus
ECE R94	ECE Regulation 94
ECE R95	ECE Regulation 95
EEVC	European Enhanced Vehicle-Safety Committee
EU	European Union
Euro NCAP	European New Car Assessment Programme
FMVSS	Federal Motor Vehicle Safety Standards
FRB	Fixed rigid barrier
h	Bulge height
HSS	High-strength steels
l	Bulge length
m	Mass
MDB	Moving deformable barrier
NGV	Natural gas vehicle
NHTSA	National Highway Traffic Safety Administration

ODB	Offset deformable barrier
R-Point	Seating references point
SAE	Society of Automotive Engineers
UHSS	Ultra high-strength steels
UNECE	United Nations Economics Commission for European
US NCAP	New Car Assessment Program
v	Velocity
w	Bulge width
ρ	Mass density
σy	Yield stress
υ	Poisson's ratio

CHAPTER 1

Introduction

The platform is the one of main structure of vehicle. It is use as a plate to support all the compartments and the human who use the vehicle. The term of platform used is referred to basic floor of vehicle that can be divided into the front platform and rear platform. The front platform in automotive design is one of platform that is basic shape of vehicle while the front platform refers to the structural from the firewall (excluding firewall) up to the rear passenger seat (Halderman & Mitchell, 2000). In the design of automotive platform, the main characteristics to be determined included static strength, torsion stiffness, first mode vibration natural frequency and crashworthiness analysis (Jin Yi-Min, 1999).

The importance of improved safety and crashworthiness in automotive vehicles is evident through increased design requirement. When it comes to reducing the impact deformation on vehicle body and improving design in transportation, crash impact analysis may represent the right choice. In this research, the crash analyses were studies

to get the crash characteristics such as crash distance and energy absorption for each front platform.

The studies focused on the simulation work in term of crash analysis of front platform remodelling. This front platform was chosen from initial concept design which it has two concepts design in early stage. But, only one concept study will be selected and analysed in this research. The selected of front platform has a two compressed natural gas (CNG) tank will be mount under platform which locate under front passenger seat. This front platform have been remodeling from existing model based on the CNG tank shape.

Regarding to get the crash behaviour or characteristics of front platform, the simulation work on finite element analysis has been used. The finite element analysis is very important before the fabrication of the vehicle platform. The computer aided engineering (CAE) model has been used widely in automobile industry to assess different design concept and prediction vehicle's performance in crashes before proceed to fabrication stage. Another advantage, this method also can reduce the cost and time consuming instead to do the testing method on the design model.

The study presented in this thesis represented the crash behaviour of front platform in term of crash distance, energy absorption and energy dissipated by rigidwall. In early

stage, the studies have been carried out for different bulge height and length on front platform. Then, the studied was continued with the different pattern and thickness of reinforcement parts which attached to front platform on crash analysis. This all characteristics are important to compare with the existing front platform behaviour before it used as a natural gas vehicle (NGV).

According to all characteristic of crash analysis in term all different geometry of front platform, the best platform was chosen to developed front platform on NGV. Thus, the front platform and tank mounting structures were designed depends on the right behaviour front platform and also CNG cylinder sizes and volumes available on market.

The NGV of front platform was studies because NGV is one of the popular technologies in all country include Malaysia. Natural gas also is the cleanest burning alternative transportation fuel available today. According to IANGV (2004), the NGV has been used widely in Argentina which it have more than 120 thousand NGV in their country. In Malaysia, the majority users as NGV is a city taxis especially in Klang Valley. Nowadays, the NGV are being expanded to other vehicle such as a salon or sedan car according to increasing the global petrol market. Since 1991, the Petroleum Nasional Berhad (Petronas) has been launched the NGV program to promote the natural gas in the transportation sector.

1.1 Problem Statement

Nowadays, the government invites to company in Malaysia to design and build up the NGV to replace the gasoline vehicle in order to have the cleanest burning and cheaper fuel. Currently, in Malaysia the NGV has been used on the taxi only but it was used as other alternative fuel to replace the gasoline function. The taxi has been used the CNG with the CNG cylinder tank are located at the luggage compartment without modification on the platform either front platform or rear platform of vehicle.

But, the current quantity of CNG in taxi vehicle is also not enough for the high travel range. The space available also is not suitable with the shape of cylindrical to mount under platform. According to the situation above, this studies have been completed to support and get the CNG platform while the front platform are created with the remodeling from the existing front platform on the petrol vehicles. This remodeling front platform design should be modified to support more than one of CNG tank and to locate in the vehicle.

The design of modified front platform was produced with the limitation because the ground clearance and the booth space cannot be bothered. Then, the front platform has been modified according to size of CNG cylindrical tank and will be locate underneath of driver and front passenger seat only with small modification. But the design of