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ANALYSIS AND SIMULATION ON IMPACT COLLISION OF COMPACT PASSENGER CAR AS NGV

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A project report submitted in partial

fulfillment of the requirement for the award of

the Degree of Bachelor Mechanical Engineering (Automotive)

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"I hereby declared that this is my own work except the ideas and summaries which I have clarified their sources "

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Special dedicate to my family, supervisor, my friends and all that help me to finish my thesis.

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ABSTRAK

Kemalangan kenderaan biasanya berlaku di mana jua terutamanya pada musim perayaan. Pada masa kini harga petroleum telah melonjak dengan mendadak dan mengakibatkan ramai pihak mencari sumber alternatif lain. Ramai pihak telah memilih NGV sebagai jalan penyelesaian. Objektif utama tesis ini adalah untuk menyelidik impak serapan tenaga dan kesan pelanggaran terhadap kenderaan yang menggunakan NGV dibandingkan dengan kenderaan yang tidak menggunakan NGV. Model chasis dibina menggunakan perisian Abaqus. Bagi bahagian simulasi penggunaan perisian Abaqus masih digunakan. Perisian ini menyumbang kepada data-data penting untuk pembelajaran ini seperti daya tindakbalas, jenis tenaga dan perubahan bentuk. Data-data ini akan digunakan untuk mendapatkan penyerapan tenaga selepas impak.

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ABSTRACT

Car crash happens especially during festival time. Besides that, nowadays fuel price is very high and this is a critical issue that makes people concern. For current condition, NGV is the right answer for this problem due to a lower price compared to petroleum and diesel. The main objective for this research is to study the energy absorption and its impact on the vehicle structure during a crash which used natural gas. The compact car chassis drawn by using Abaqus software follow the exactly parameter of compact car. Besides that Abaqus is use to conduct the simulation session. All data that from the software will be a guideline to make the discussion about impact energy and reaction force.

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LIST OF SYMBOL

F	=	Force , N
v	=	Velocity, m/s
t	=	Time, s
a	=	Acceleration, m/s^2
I	=	Impulse
W	=	Work, Nm
PE	=	Potential Energy, Joule
E_k	=	Kinetic Energy, Joule
m	=	Mass, Kg
b	=	Base, m
h	=	Height, m
r	=	Radius, m
J	=	Joule
CNG	=	Compressed Natural Gas
NGV	=	Natural Gas Vehicle
LNG	=	Liquefied Natural Gas

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CHAPTER 1

INTRODUCTION

1.1 Background

A Natural gas vehicle or NGV is an alternative fuel vehicle that uses compressed natural gas (CNG) or, less commonly, liquefied natural gas (LNG) as a clean alternative compare to other automobile fuels. Worldwide, there are roughly 5 million NGVs as of 2006, with the largest number of NGVs in Argentina, Brazil, Iran, Pakistan and Thailand. In Europe they are popular in Germany and Italy. The primary component of natural gas is methane (CH_4), the shortest and lightest hydrocarbon molecule. It may also contain heavier gaseous hydrocarbons such as ethane (C_2H_6), propane (C_3H_8) and butane (C_4H_{10}), as well as other gases, in varying amounts. Hydrogen sulfide (H_2S) is a common contaminant, which must be removed prior to most uses (*Internet reference*, 9/7/08).

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A crash simulation is a virtual activity of a destructive crash test of a car using a computer simulation in order to examine the level of safety of the car and its occupants. Crash simulations are used by automakers during Computer-Aided Engineering (CAE) analysis for crashworthiness in the Computer-Aided Design (CAD) process of modeling new cars. During a crash simulation, the kinetic energy, energy of motion, that a vehicle has before the impact is transformed into deformation energy, mostly by plastic deformation (plasticity) of the car body material (Body in White), at the end of the impact (*Internet reference*, 10/7/08).

1.2 Objective

In this research, there are four main objectives to be achieved. The objectives are listed as follow:

1. To study impact during collision of compact car as NGV.
2. To analyze the load and energy absorption in the compact car collision.
3. To simulate the impact during collision of compact car.

1.3 Scope

The scopes of this study include:

1. Finite element analysis using Abaqus software.
2. Simulation on collision of compact car that use petrol and NGV.
3. Compare of the result for impact collision between compact cars that uses natural gas with compact car without natural gas.

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1.2 Problem statement

Nowadays fuel price is very high and this is a global issue that makes everybody concern. For current condition, NGV is the right answer for this problem due to a lower price compared to petroleum and diesel. However, there are many people who have converted their cars into NGV without any research or scientific study. The installation of NGV might affect the car's condition especially during a crash or accident. This research will analyze and simulate the impact collision of compact car that is converted to NGV.

The important for this research is that a car crash happens in a very short time period, and the effect of the fast moving vehicle gives more impact as compared to slow moving. This is because the momentum changes due to the impact over a short period of time generate large force. Mass of the vehicle also contributes to the increasing of the momentum, if the vehicle mass is heavy so the momentum will be large and it may lead to injury or fatal death to people, damage to the surrounding environment and also structural damage of the vehicle itself. These problems will lead to great economic loss to the society.

Therefore it is really important to study the energy absorption and its impact on the vehicle structure during a crash. Information and result from the research will assist the manufacturer in vehicle manufacturing in order to development minimize the damage or injury to passenger and environment

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CHAPTER 2

LITERATURE REVIEW

Literature review has been done to gain some ideas before conducting this research. In this chapter the previous works done by other researchers are discussed. Journals about car crash and simulation are being referred as a guide line to understand the background of this research. Besides that this chapter also includes basic information about NGV and compact car.

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2.1 NGV

CNG is typically stored in steel or composite containers at high pressure (3000 to 4000 lbf/in², or 205 to 275 bar). These containers are not typically temperature controlled, but are allowed to stay at local ambient temperature.LNG (Liquefied Natural Gas) storage pressures are typically at or just above the local atmospheric pressure (0 to 30 lbf/in², or 0 to 2.1 bar). LNG is stored at temperatures as low as -260°F (-162°C). At these temperature and pressure conditions, natural gas is in a liquid state. Storage temperatures may vary due to varying composition and storage pressure. LNG is far denser than even the highly compressed state of CNG. As a consequence of the low temperatures, vacuum insulated storage tanks are used to store LNG (*Internet reference*, 9/7/08).

In this research, vehicle with NGV tank will be assumed to collide with static wall and the result will be compared with standard vehicle. There are four types of cylinder for compressed natural gas in use (*Internet reference*, 31/7/08):

- All metal cylinders made of steel or aluminum. There is no covering other than paint on the outside of the cylinder. This is the most common type of cylinder and has a marking instead of a label.
- A metallic cylinder with a partial wrapping that goes around the cylinder. The wrapping is usually made of glass fiber, aramid fiber or carbon fiber, embedded in an epoxy or polyester resin.
- Cylinder which is fully wrapped with the same kind of materials used for the partial wrapping of a Type 2 cylinder, but with a metallic liner.
- Cylinder is which fully wrapped with the same kind of materials used for the partial wrapping of a Type 2 cylinder, but with a plastic liner.

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2.2 Compact Car

A compact (North America), small family (European) or c-segment car is a classification of cars which are larger than a supermini but smaller than a sedan car. Current dimension of compact cars are between 4,100 mm (161 in) and 4,450 mm (175 in) long if they are hatchbacks, or between 4,400 mm (173 in) and 4,600 mm (181 in) if they are cabriolets, sedans or station wagons. Multi-purpose vehicles(MPV) and sport utility vehicles(SUV) based on small family cars, which are called compact MPVs and compact SUVs respectively, have become popular since the early 1990s (*Internet reference*, 4/8/08).

Common engines are 1.5 to 2.4-litre straight-4s, either petrol or Diesel, with a range between 100 bhp (75 kW) and 170 bhp (127 kW). Some models also have economical 1.3 or 1.4-litre units. High-performance versions, called hot hatches or sport compact sedans, may have turbocharged 2.0 or 2.5-litre engines, or even V6 3.2-litre units, ranging maximum outputs from 170 bhp (127 kW) to 300 bhp (224 kW). Small European family cars include the Ford Focus, Opel Astra, Peugeot 307, Renault Mégane, and Volkswagen Golf. Japanese branded examples include Honda Civic, Mazda 3, Subaru Impreza, and Toyota Corolla. The Chevrolet Cobalt and Dodge Caliber are an example of a compact made in the United States (*Internet reference*, 4/8/08).

2.3 Collision

A collision is an isolated event in which two or more bodies (colliding bodies) exert relatively strong forces on each other for a relatively short time. Collisions involve forces (there is a change in velocity). Collisions can be elastic (conservation energy and momentum conservation), Inelastic (momentum conservation but not energy) or totally plastic (momentum conservation where the two objects stick together). The magnitude

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