ANALYSIS AND SIMULATION ON IMPACT COLLISION OF MULTI-PURPOSE VEHICLE (MPV) AS NGV

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A thesis submitted in fulfillment of the requirements for the award of the degree of bachelors of mechanical engineering (automotive)

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MAY 2009

"I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of the degree of Bachelors of Mechanical Engineering (Automotive)."

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To my beloved father and mother

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ABSTRAK

Projek ini sebenarnya mengusulkan tentang pembelajaran, analisis dan membuat simulasi tentang impak perlanggaran pada kenderaan pelbagai guna (MPV) yang dilengkapi sistem gas asli untuk kenderaan (NGV). Simulasi ini bertujuan untuk menunjukkan perbezaan kerosakkan struktur kenderaan di antara kenderaan pelbagai guna yang dilengkapi sistem NGV dan tanpa di lengkapi sistem NGV apabila perlanggaran berlaku. Untuk simulasi ini, kedua – dua model kenderaan ini di uji dengan melanggar tembok pegun secara perlanggaran depan sepenuhnya pada kelajuan 80 kilometer per jam mengikut spesifikasi yang di tetapkan. Dengan menggunakan perisian ABAQUS, struktur kerangka kenderaan telah dirangkakan. Kemudian, simulasi kenderaan tersebut di lakukan menggunakan perisian ABAQUS bagi menunjukkan kestabilan atau analisis beban dan juga impak tenaga yang terhasil apabila perlanggaran tersebut berlaku. Keputusan yang di perolehi menunjukkan bahawa kenderaan yang di aplikasikan dengan menggunakan sistem NGV akan mempunyai momentum yang lebih besar disebabkan penambahan berat kenderaan dan menghasilkan impak dan kerosakkan struktur yang lebih besar berbanding dengan kenderaan tanpa menggunakan sistem NGV ini ketika perlanggaran.

ABSTRACT

This project actually to study, analyze and show the simulation about the impact of collision on multi-purpose vehicle (MPV) as NGV (Natural Gas Vehicle). The simulation will shows the comparison about the vehicle's structure damage between the MPV that was applied with the NGV system and MPV without the NGV system when the collision occurred. For this simulation, both vehicle models were tested to crash the static barrier from the front side with full-width crash at 80 kilometer per hour with the standard specification. By using ABAQUS software, the vehicle frame was designed. Then, the simulation was created by using ABAQUS software to show the load analysis and energy absorb that was produced when the vehicle in the collision situation. The result show the vehicle that was applied by the NGV system will produce a big momentum due to the increasing of vehicle's weight and give a big effect on structure damaging compare to the vehicle without applying the NGV system during collision.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

mph	=	mile per hour
psi	=	pound per square inch
kg	=	kilogram
L	=	liter
F	=	force
m	=	mass
V	=	velocity
t	=	time
Δ V	=	velocity change
Δ t	=	time change
Δ P	=	momentum
I	=	impulse
mm	=	millimeter
M	=	meter
I_X	=	moment inertia of X axis
I_y	=	moment inertia of Y axis
b	=	base
h	=	height

LIST OF ABBREVIATIONS

MPV	Multi-Purpose Vehicle
NGV	Natural Gas for Vehicle
IIHS	Insurance Institute for Highway Safety
FEA	Finite Element Analysis
NHTSA	National Highway Test Safety Association
FHWA	Federal Highway Association
IEA	Impact Energy Absorbed

LIST OF APPENDICES

CHAPTER I

INTRODUCTION

1.1 General Overview

In the automotive manufacturing, the vehicle that was produced should be fulfill all the aspect and specific criteria including their design, performance and the most important is safety of the vehicle. In order to ensure the vehicle are suitable or 100% safe to drive, some test was applied to all model of vehicle including the mechanical test which is to ensure all the system involved in the vehicle can work properly or suitable to the vehicle. Besides that, the other important test will be discussed is crash test.

The crash test usually applied to the vehicle divided into 2 types which are frontal crash test and the side crash test. Besides, other test which has been considered to analyzed is oblique crash test and back crash test. There are 2 conditions that involve in the frontal crash such as full-width test and offset test. The purpose of these tests is to determine the condition of structure/safety cage of the vehicle, measure the injury of occupant and analyze restrains/dummy kinematics. The result of all these tests are different based on some factor such as acceleration and the weight of the vehicle tested.

The previous test on the previous model of vehicle shows that the vehicle passes or fulfills the entire standard that was needed in crash test with their standard

parameter of manufacturing. However, recently the new technology to reduce the usage of fuel was applied to the standard vehicle called NGV. The application of this system totally changes the standard manufacturing of the vehicle especially its maximum weight.

As we know, the different weight of vehicle will produce the different impact to the vehicle's structure during crash. So, this project will show the frontal crash with full-width test on the vehicle from MPV model to overview their structure condition during crash.

1.2 Problem Statement

The application of NGV totally solves the problem of fuel price to the vehicle user. Unfortunately, the standard vehicle should make some modification to apply this NGV system. This application of the NGV to the vehicle will change the standard specification of the vehicle manufacturer's especially their maximum vehicle's weight. The previous analysis proved that the NGV system is safe to use in the normal and crash condition but did not mention about the impact of vehicle's structure due to that crash after applied the NGV system.

As we know, the changes of vehicle weight will change a lot other physic character of vehicle such as their force and momentum. All of this has relationships that give an impact to the structure of vehicle especially during the crash. The impact produced may lead to vehicle's structure damage and at the same time raised the high risk of injury or fatal death to the driver and passengers.

Hence, it is important to study the load analysis, energy absorption and its impact to the vehicle's structure during crash due to the vehicle's weight increase from the standard weight cause by application of the NGV system. This project will show the comparison of analysis and simulation on collision impact between the petrol and NGV as MPV that totally have a different weight.

1.3 Objective

The objective of this project is to study, analyze and simulate impact during collisions of the multi-purpose vehicle (MPV) as NGV.

1.4 Scope

1. To do finite element analysis using ABAQUS software.
2. To do simulations on full-frontal collision of MPV compare petrol and NGV.

1.5 Planning of Research

This thesis is divided into five chapters which is introduction of the thesis has been covered in chapter 1. Besides, term as general overview, problem statement, objective and scope are also described. Consequently in chapter 2, the literature reviews of previous analysis on impact of collision in the different case and some information about the frontal crash and NGV system was shown. Meanwhile, explaining about the methodology; defining the frame design, creating the MPV frame, barrier structure and modeling the simulation was done in chapter 3. This thesis was continued with the chapter 4 which covered on result and the discussion. The analysis of the result that produced from the simulation done was describing details and completely discussion was done base on the recorded result. The comparison result between the MPV without NGV system and MPV with NGV system was explaining in this chapter as an objective of this thesis. Last but not list, the chapter 5 is a conclusion of this thesis. Some recommendation for the future research was included in this chapter.

CHAPTER II

LITERATURE REVIEW

2.1 Vehicle Safety History

Over the past century, occupant safety has become an important design objective among all the performance criteria of ground transportation vehicles. Manufacturers realized early on the need to demonstrate occupant protection before the public accepted the automobile as a viable means of transportation. There are three distinct periods in the development history of automotive safety. An early period of safety from the turn of the century to 1935 was a period of genesis, growth, and developments to understanding the extremely complex process of vehicle collisions. The vehicle collision is a consequence of circumstances that produce abnormal operating conditions for the vehicle. Whether the collision occurs with another vehicle or with a stationary obstacle, it subjects the vehicle structure to forces and deformations. If the forces involved exceed the energy absorbing capability of the vehicle structure, occupants may be injured or killed.

This early period focused on basic improvements such as reduction of tire blowouts to avoid loss of vehicle control; introduction of the self-starter to eliminate injuries associated with engine cranking; incorporation of headlamps to provide for night visibility, installing laminated glass to reduce facial lacerations, and adopting an all-steel body structure for better occupant protection. In addition, the first full scales crash tests were conducted in the early 1930's. These tests involved rollover simulations and car-to-barrier impact.

The second period from 1936 to 1965 was an intermediate safety period. Early in this period, auto manufacturers introduced many crash avoidance devices including turn signals, dual windshield wipers, improved headlamps, a test to simulate head impact into the instrument panel, and high penetration-resistant windshield glass. In addition, General Motors conducted the first car-to-barrier frontal crash test, launching a vehicle into a retaining wall. These early tests were quite rudimentary by today standards. Neither dummies nor electronic instrumentation were sufficiently developed for use in crash testing. Evaluation of the vehicle structural performance was based on observations of the crushed vehicle. Perhaps the most significant safety device of that era was the introduction of seat belts as an option in 1956.

The third period starts in 1966, when President Lyndon Johnson signed into law the Highway Safety Act, and authorized the creation of the National Highway Traffic Safety Administration (NHTSA). During this post-regulation period, many mandatory safety standards, known as Federal Motor Vehicle Safety Standards (FMVSS), were introduced. These standards regulate several aspects of vehicle crashworthiness and crash avoidance performance.

Interestingly, long before 1966, occupant safety and security had been an integral part of the vehicle development process. Vehicle safety improvements over the past seven decades have focused on crash avoidance technology, structural crashworthiness, and occupant protection devices. The influence of the collective vehicle safety technologies, together with improvements to highways and better driver education has contributed to an impressive drop in the rate of traffic fatalities.

Today, transportation safety efforts focus on crashworthiness, crash avoidance, driver performance, and highway construction. Over the past decade automakers have added many features to help the driver avoid a crash, such as anti-lock braking systems, traction control devices and daytime running lamps. Vehicles also include many crashworthiness features such as rigid steel occupant-cells surrounded by strategically placed, energy absorbing components. In addition, vehicles are equipped with an impressive array of restraint systems such as energy-absorbing steering columns, three-point belts, front and side air bags and head