UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Design and Validate Passive Automotive Engine Mount System

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Engineering Technology (Automotive Technology) (Hons.)

by

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DECLARATION

I hereby, declared this report entitled "Design and Validate Automotive Passive Engine Mount Engine" is the results of my own research except as cited in references.

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Date	:	09th DECEMBER 2014

APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Engineering Technology (Automotive Technology) (Hons.). The member of the supervisory is as follow:

………………………………

(Project Supervisor)

ABSTRAK

Pada zaman pasca kini, kebanyakkan kenderaan baru mempunyai penyerap gegaran pada bahagian enjin sesebuah kenderaan berbanding dengan kenderaan terdahulu. Sistem penyerap gegaran kini lebih peka terhadap setiap gegaran yang terhasil dan akan lebih menjamin keselesaan pemandu dan penumpang. Satu kaedah telah diketengahkan untuk menyerap gegaran dengan menghasilkan isolator gegaran yang berkos rendah yang boleh digunakan pada sistem penyerap gegaran untuk mengurangkan kadar gegaran. Berdasarkan pengajian ini, pendekatan yang positif dengan cara mengurang kadar penglibatan kos rendah adalah dengan menambah sistem penyerap gegaran daripada satu kepada empat sistem penyerap gegaran enjin. Aplikasi akan digunakan pada “test rig” bersertakan dengan enjin yang mempunyai beban yang tidak seimbang akan dikenakan pada enjin tersebut. Hasil kajian yang berterusan akan dilaksanakan bagi menyediakan asas dinamik kebebasan yang juga dikenali sebagai “degree of freedom” pada sistem penyerap gegaran enjin, model pasif simulasi sistem penyerap gegaran hidraulik, dan reka bentuk terperinci pada model kenderaan, dan pebinaan “test rig” untuk menjalankan eksperimen.

ABSTRACT

Now-a-days the demand for low cost, quiet operation, and increased operator comfort in automobiles and other applications is requiring that new techniques be developed for noise and vibration isolation. One approach to reduce noise and vibration harshness is to develop low cost vibration isolator that can be used to mount components that generate vibration. To develop this isolator, the passive engine mounting were studied. Based on this study, the most promising approach is by adding four mounts of the engine mounting instead of one engine mounted on the test rig to decrease the vibrations, noise and harshness. This application will be applied on test rig and with unbalanced load engine. The progress results that this study provides are; a fundamental dynamic Degree of Freedom (DOF) equation of the passive engine mount system, a simulation model of a passive hydraulic engine mount, a detail design of a model the passive engine mounts, and fabricate a test rig to run experiments.

DEDICATION

To my beloved parents and the whole Haji Ariffin’s family members.

ACKNOWLEDGEMENT

First and Foremost, I would like to express my greatest appreciation and thanks to Universiti Teknikal Malaysia Melaka for giving me the opportunity to undergo my final year "Projek Sarjana Muda" under the supervision of ENGR. Mr. Muhamad Hafiz Bin Harun. A special thank you also goes to my supervisor ENGR. Mr. Muhamad Hafiz Bin Harun and my co-supervisor Mr. Fauzi Bin Ahmad for his dedication and guidance during the period of undergoing my project and also to master student Mohamad Zaharudin Bin Sariman for his guidance.

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LIST OF SYMBOLS

Symbol		Description
P(t)	-	Excitation Force
Me	-	Engine Mass
Mu	-	Unbalance Mass
Fs	-	Spring Force
Ks	-	Spring Constant
Cs	-	Damping Constant
Zs	-	Engine Unit Displacement
Zu	-	Chassis Unit Displacement
$\dot{Z}s$	-	Engine Unit Velocity
$\dot{Z}u$	-	Chassis Unit Velocity
$\ddot{Z}_s$	-	Engine Unit Acceleration
Fsf	-	Front Spring Force
Fsrr	-	Rear Spring Force
Fsr	-	Right Spring Force
Fsl	-	Left Spring Force
Fdf	-	Front Damper force
Fdrr	-	Rear Damper Force
Fdr	-	Right Damper Force
Fdl	-	Left Damper Force
P	-	Track Width
L	-	Wheelbase Length
Ksf	-	Front Spring Constant
Ksrr	-	Rear Spring Constant

Ksr	-	Right Spring Constant
Ksl	-	Left Spring Constant
Csf	-	Front Damping Constant
Csrr	-	Rear Damping Constant
Csr	-	Right Damping Constant
Csl	-	Left Damping Constant
Zsf	-	Front Engine Unit Displacement
Zsrr	-	Rear Engine Unit Displacement
Zsr	-	Right Engine Unit Displacement
Zsl	-	Left Engine Unit Displacement
Zuf	-	Front Chassis Unit Displacement
Zurr	-	Rear Chassis Unit Displacement
Zur	-	Right Chassis Unit Displacement
Zul	-	Left Chassis Unit Displacement
Żsf	-	Front engine unit velocity
Żsrr	-	Rear engine unit velocity
Żsr	-	Right engine unit velocity
Żsl	-	Left engine unit velocity
Żuf	-	Front chassis unit velocity
Żurr	-	Rear chassis unit velocity
Żur	-	Right chassis unit velocity
Żul	-	Left chassis unit velocity
Mp	-	Pitching Moment
Mr	-	Rolling Moment
Ip	-	Inertia in Pitching
Ir	-	Inertia in Rolling
Θ	-	Pitching angle
$\dot{\theta}$	-	Pitch rate

$\ddot{\theta}$	-	Pitch acceleration
A	-	Roll angle
$\dot{\alpha}$	-	Roll rate
$\ddot{\alpha}$	-	Roll acceleration

CHAPTER 1

INTRODUCTION

1.1 Background

A car engine is connected with an engine mount on the car frame. An engine mount are usually made of rubber and metal. The metal portions are connected to the engine on the one side and to the frame on the other. The rubber is between an apparatus for controlling relative movement and engine mount housing to provide some flexibility. Now-a-days, most of the newer cars are used slightly different mounts. However, there purpose is still the same.

Generally, hydraulic engine mounts are used in aerospace and automotive application for the purpose of cabin noise and vibration reduction. The dynamic stiffness will be smaller at certain frequency than the static stiffness, cabin vibration and noise reduction. All the hydraulic mount design parameters are selected very carefully. This frequency is referred as notch frequency and it is provided at that frequency.

In this paper, passive hydraulic engine mounts will be modelled. An improved decoupler control is introduced that the mechanism steady state behaviour does not noticeably affect, but start up and transient response improves. Hydraulic mount design more effective and it is tuneable and the mechanism of decoupler design will be smaller and lighter.

1.2 Project Problem Statement

1. The compatibility an engine mounts system to run on a test rig.
2. The proper method is needed to solve the dynamics vibration occurs on the test rig and the engine mounting.

1.3 Project Objective

1. To analyze engine mount system using a 3-DOF equation.
2. To model the engine mount system using MATLAB Simulink.
3. To validate the engine mount model with engine mount test rig.

1.4 Scope of Project

My research project will focus primarily on the functions of the passive engine mounting to be implemented on a test rig. An engine that attaches to unbalance load will be placed on a test rig. There will be four sensors that will be attached to the test rigs to detect the vibration, noise and harshness that is caused by motor or any mechanism of the engine parts. Then, the result obtained from MATLAB Simulink into the sensor will be applied.

1.5 Approach

My proposed report will begin with a brief review of the engine mounting. The report will then discuss how the passive engine mounting function or operate as a safety mechanism to be implemented on the vehicle's chassis.

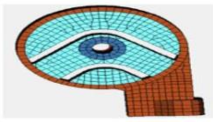
1.6 Result Expectation

1. Engine mount system using 3-DOF equation will be analyzed.
2. Manage to model passive engine mount system.
3. Validate the engine mount model with engine mount test rig.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction



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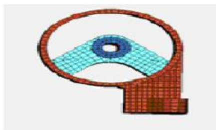

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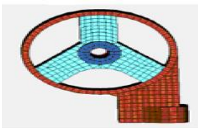

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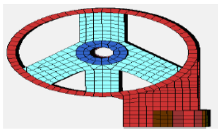

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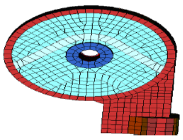

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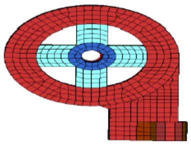

(f)

Figure 2.1: Different Engine Mount Designs. (a) Basic design (b) Two arm design (c) Three arm design (d) Four arm design (e) Filler arm design (f) Four arm symmetry design (Anynomous,ND)

Now-a-days, most of the cars are used slightly different types of design of the engine mounts as shown as in the Figure 2.1. However, the function and purpose is still the same. To give the driver and the passenger the comfort while experiencing the driving moment.

2.2 Types of Engine Mounts

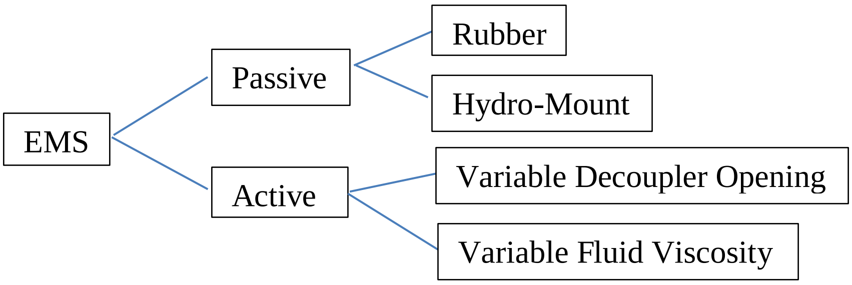

Figure 2.2: Engine mounting system technology road map (Anynomous,ND)

Figure 2.3: Rubber Mount (On the left) and Hydro Mount (On the right) (Anynomous,ND)

In Figure 2.2 shows that a system technology road map of engine mounting. Commonly an engine mounting looks like as shown in figure 2.3. Usually, a drivetrain car consists of the engine and transmission. The engine makes up a substantial bulk of a car's weight, and where and automobile manufacturer decides to mount the engine directly impacts the vehicle's performance. The position of the engine affects performance by setting the car's moment of inertia, which is a physical property that determines, among other things, how quickly a car can turn (ehow.com, 2010). Car engine mounting are divided into 3 parts;

i. Front Mounted: Car manufacturers can mount a car's engine in two ways. Front-mounted engines will be placed on in front or directly over the forward axle. A front-mid-mount is placed on the engine behind the front axle.

ii. Mid Mounted: The engine mount is placed on the rear axle, but behind the cab passenger seat. Cars with a mid-mounted engine use either RWD or AWD to transfer power to axles. The position of mid-mounted offers the lowest moment of inertia.

iii. Rear Mounted: Rear mounted engine is placed behind the back axle and behind the cab where the passengers sit. Cars with a rear-mounted engine transfer power to the axle with either RWD or AWD. This position of the engine mount will increase the moment of inertia and drivers must fight against over-steering during acceleration.