UNIVERSITI TEKNIKAL MALAYSIA MELAKA

CONVERSION OF GO-KART TO E-KART MOUNTING DESIGN AND FABRICATION

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

by

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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

Laporan ini berkaitan dengan kajian tentang rekabentuk dan fabrikasi pemegang enjin Go-Kart. Tujuan utama pemegang enjin adalah untuk menyerap gegaran yang terhasil daripada daya kilas yang dihasilkan oleh enjin atau motor. Gegaran yang terhasil akan memberi kesan terhadap rangka kenderaan dan pemanduan. Oleh itu, ianya perlu diubahsuai bagi meningkatkan kepada prestasi yang lebih baik dan pengendalian yang baik dalam perlumbaan. Objektif projek ini adalah untuk mereka bentuk dan fabrikasi pemegang enjin Go- Kart untuk prestasi dan pengendalian yang lebih baik. Fokus penyelidikan tertumpu kepada sudut yang sesuai untuk pemegang enjin Go- Kart bagi mencapai prestasi yang lebih baik. Reka bentuk pemegang enjin direka menggunakan perisian Computer Aided Design (CAD) berdasarkan kajian literatur dan menganalisis dengan pelbagai sudut menggunakan perisian Inspire Solid Thinking. Dari proses pengoptimuman, rekabentuk yang optimum telah diperolehi berdasarkan objektif. Kemudian reka bentuk ini telah dipertimbangkan dan difabrikasi. Daripada projek ini, ia boleh disimpulkan bahawa pemegang enjin dapat bertahan terhadap getaran dan daya yang dikenakan padanya.

ABSTRACT

This report deals with the study of conversion of Go-Kart to E-Kart mounting design and fabrication. Vibration is one of important issue. The design of mounting can contribute to the vibration. The challenge in designing a Powertrain Mounting System (PMS) is how to determine the stiffness and the damping of the mounts (Shangguan et al. 2016). The primary aim of this project is to achieve optimal vibration which contribute to better performance and handling in racing. In order to improve this project requirement. The objective of this project is to design and fabricate the motor mounting for E-Kart for better performance and driver comfort. This research focus on the suitable angle attack of the mounting for the E-Kart achieving optimal vibration. The motor mounting is design based on the literature research using the Computer Aided Design (CAD) software and analyse and simulate it with various angle of attack using the Inspire Solid Thinking software. From the optimization process, optimum design has been obtained based on the objective. Then the design has been considered and fabricated. From this project, it can be concluded that the motor mounting can withstand vibration and force exerted on it.

DEDICATION

I would like to dedicate this to my father, Mr. Abu Bakar bin Ismail and my mother, Mrs. Ainun binti Suparthy, my supervisor Mr. Mohd Faruq bin Abdul Latif, co-supervisor, Mr. Mohd Sulhan bin Mokhtar and my friends Shafiq Laili, Husaini Hashim, Hazim Mazlan, Adi Azri Ngahdiman, Khairul Anwar, Faidhillah Omar, Azmir Zainal, Tarmizi Bahari, Syed Naguib, Safwan Abd. Rahim and Faiz Razali for supporting me from the beginning until the end of this project.

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My sincere thanks to my co-supervisor Mr. Mohd Sulhan bin Moktar for his dedication and guidance in teaching me for the writing of this thesis and how to use the software. Without the help of my Supervisor and Co-Supervisor, it is possible for me to complete this project on time.

Thanks to my beloved parents, Mr. Abu Bakar bin Ismail and Mrs. Ainun binti Suparthy who always support me and give me courage since the beginning of this project. Their words have give me strength to complete this thesis project. My sincere thanks to my all my friends for their support and guidance during the project period.

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CHAPTER 1

1.0 INTRODUCTION

1.1 Background

The engine mounting is the component that holds the engine to the body of the car. Typically for a car, the engine and transmission also known as powertrain bolted together reinforced by several of mountings. The mounting that retaining the transmission is called the transmission mounting, others are referred as engine mounting. There are several types of engine mounting have been used to minimize the engine vibration, the engine mounts are filled with rubber so that there is no direct metal-to-metal contact between the engine and the car body. To further dampen the vibration, some engine mounts are filled with liquid. Some of car manufacturers use active vacuum controlled engine mounts. An advance technology nowadays uses electromagnetic mounting to reduce engine vibration transferred to the physical structure. An engine mounting does not need any maintenance or regular servicing. It only needs to be replaced when it fails or wears out.

This project is to study and investigate the load characteristic and its effect using Inspire Solid Thinking software. The load exerted need to be optimized in order to reduce the vibration effect towards the chassis.

1.2 Problem Statement

Vibration is one of important issues. The design of mounting can contribute to the vibration. The challenge in designing a mounting is to specify the stiffness and the damping of the mounting and to properly install them in a vehicle to control the motion of the powertrain, to depress the vibration of the powertrain under excitation of ground and to isolate the vibration of engine transmitted to car body structure (Shangguan et al. 2016).

The mount stiffness at linear section in three directions of the Mount Coordinate System, mount locations and orientations are obtained by optimization of the six natural frequencies of the powertrain rigid mode and mode energy (Shangguan et al. 2016).

To optimize a Powertrain Mounting System based on the limitation requirements of vibrations and noises at cabin using experimental, simulation and numerical analysis. One of the important tasks using this method is to determine vibration and noise transfer functions from mount forces to the vibration and noise at cabin present a method to extract transfer function without dissembling the vehicle structure to its subsystems. But in the developed model for calculating mount forces, the influence of rigid models of the car body and unsprung mass are not included (P.Diemer et al. 2003).

In order to overcome this problem, an improvement of the motor mounting construction need to be taken mostly when designing for an optimal E-kart motor mounting. The stronger of the mounting it will be more durable and less vibration.

1.3 Objective

Based on the problem statement discussed, the objectives of this study are:

1. To design and fabricate motor mounting of E-kart.
2. To investigate load characteristic and optimize it‟s effect by using Solid Thinking software.

1.4 Work Scope

This project is to study and investigate the load and vibration as well as its effect. The main idea about this project is to optimize the load effect to the drivers that also contribute to motorsports. Some factors which characterize the vibration will be considered when designing for optimal mounting. Firstly, measuring process of the actual Go-Kart chassis will be done before design the motor and battery mounting by using CATIA software. Besides that, other software such as Solid Thinking will be utilized in this project to optimize the load and vibration, reduce mass and displacement that occur. After all, process has been done, the best result will be the benchmark for fabricating process. The area that will be not covered is a vibration that occurs from the tire due to the road surface. Overall of this project is to reduce the vibration produce by the motor and it‟s effect towards the chassis.

CHAPTER 2

2.0 LITERATURE REVIEW

2.1 Background

This chapter focuses on all features of the engine or motor mounting. An engine mount is the part that holds the engine to the body frame or body structure of the car. In go-kart, the mounting will hold the motor and absorb the vibration produce from being transferred to the chassis. If the frequency of the vibration occur is too high, it will affect the chassis. There are several types of go-kart that use different kind of power source such as Hybrid, Internal Combustion Engine (ICE) and Electric.

Hybrid vehicles or kart is vehicles with two or more power sources in the drive train, from the mechanical architecture, Hybrid Electric Vehicle (HEV) can be categorized into three categories which is parallel hybrids, series hybrids, and power-split hybrids. Each of the power can drive the vehicle individually or collaboratively (Of & Warhead 2010).

ICE is common and widely used in vehicles and kart which is the power source is mechanical engine. Electric kart uses battery as the power source and a motor as the drive train.

2.1.1 K-chart

Figure 1 below shows the flow of K-Chart.

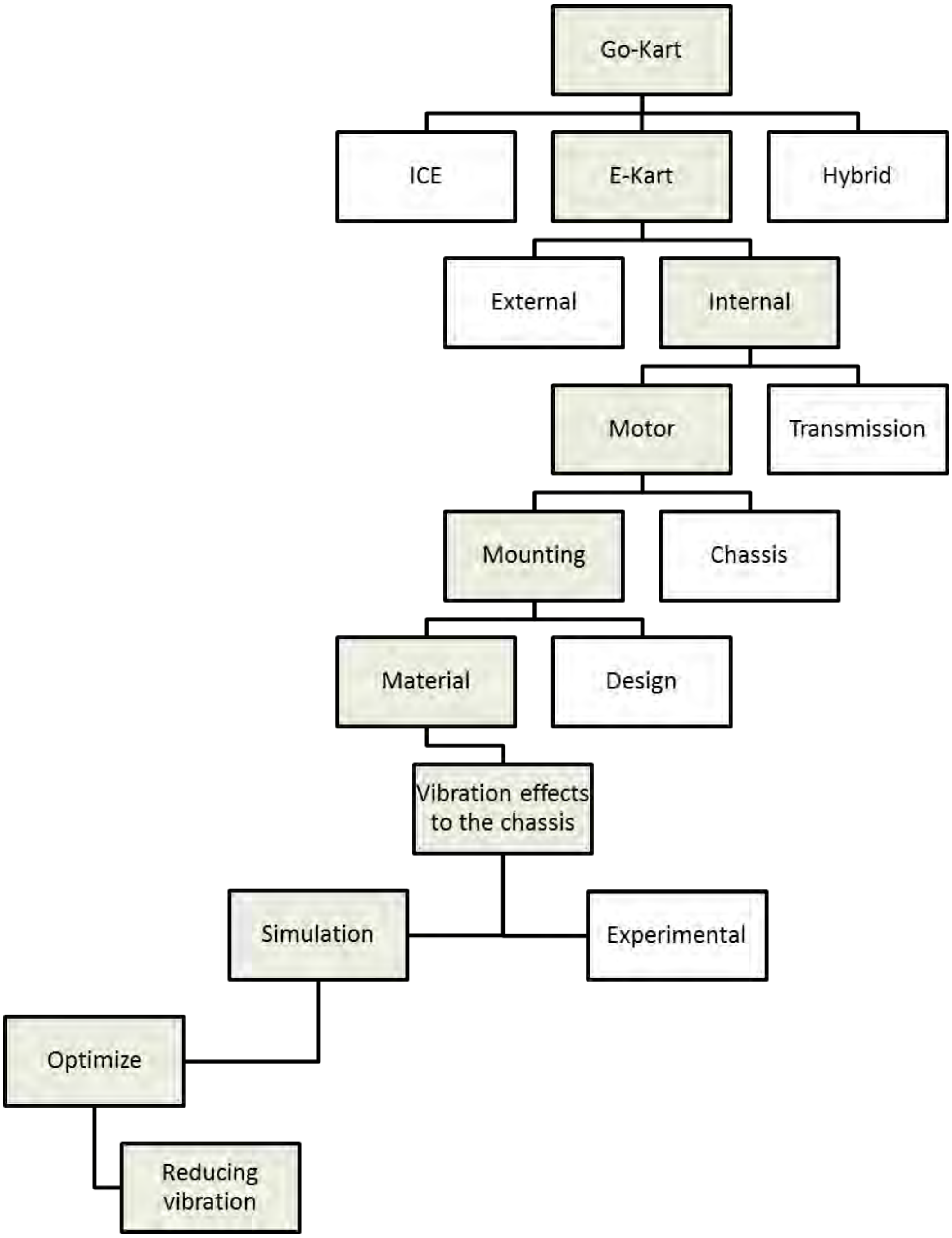

Figure 1: K-Chart

2.2 Scope of Studies

There are components that will cover and not cover in this project, the internal component that will cover is a motor that will contribute vibration towards chassis and the component not cover is external vibration due to the road surface and type of tire use. The wheel system encounters not only low frequency (lower than 20 Hz) vibration excited by road roughness but also high frequency electromagnetic excitation from in-wheel motor (Mao et al. 2017). The vibration from the motor will be reduce by designing new mounting to hold the motor.

2.3 Electric Motor

An electric motor is an electrical machine that changes electrical energy into mechanical energy. The opposite of this is the conversion of mechanical energy into electrical energy and is done by an electric generator. In normal motoring mode, most electric motors operate through the interaction between an electric motor's magnetic field and winding currents to generate force within the motor. In certain applications, such as in the transportation industry with traction motors, electric motors can operate in both motoring and generating or braking modes to also create electrical energy from mechanical energy. Electric motors are applied to produce linear or rotary force (torque), and should be distinguished from devices such as magnetic solenoids and loudspeakers that convert electricity into motion but do not generate usable mechanical powers, which are respectively referred to as actuators and transducers. Sample of electric motor is shown in **figure 2** below.

Figure 2: Electric Motor

2.4 Mounting

The engine is the largest concentration of mass in the automobile and it vibrates due to non-linear distribution of forces during its operation. This vibration is perceived as a disturbance when not properly attenuated before it gets to the passenger compartments. An engine mount is the part that holds the engine in a car. One part of an engine mount is bolted to the car body or frame. Another part holds the engine. An engine is a source of vibration, as it has many moving and revolving parts. One of the main jobs of an engine mount is to reduce the engine vibration felt inside the car. Engine mounts are filled with rubber so that there is no direct metal-to-metal contact (Horton & Tupholme 2006). To further dampen the vibration, some engine mounts are filled with liquid. A liquid-filled engine mount acts like a shock absorber.

Some automobile manufacturers use active vacuum-controlled engine mounts that vary dampening as needed. Further technology use electromagnetic mounts to actively reduce engine vibration transferred to the body. An engine mount does not need any maintenance or regular servicing. It only needs to be replaced when it fails or wears out. Sample of mounting as shown in **figure 3** below.

Figure 3: Engine Mounting

2.4.1 Type of mounting

2.4.1.1 Elastomeric Mounting

The passive methods use the rubber as the material of choice. Elastomeric mounts, which are made of rubber, have been used to isolate engines (Ladipo et al. 2016). A set of modifications have been built over the years to improve the execution of the elastomeric mounts. For proper vibration isolation, elastomeric mounts are designed for the necessary elastic stiffness rate characteristics in all ways. They are maintenance free, cost effective and compact. It is hard to design a mounting system that satisfies a wide array of design requirements. A mounting with high stiffness or high damping rates can yield low vibration transmission at low frequency, but its performance at high frequency might be poor. On the other hand, low stiffness and low damping will yield low noise levels, but it will induce high vibration transmission. In order to achieve low vibration transmissibility, the mount stiffness must be as low as possible. However, this causes increased static deflection. Lower damping is also desirable for lower transmissibility at higher frequency ranges. On the other hand, handling and maneuverability are enhanced with higher stiffness. This type of mounts provide a trade-off between competing requirements of low static deflection and enhanced vibration isolation (Liu et al. 2015). Sample of rubber mounting is shown in **figure 4** below.

Figure 4: Rubber Mounting

2.4.1.2 Polyurethane Mounting

Polyurethanes, as a category of high performance polymeric materials, are extensively used in fields such as biomedicine, aerospace, automobile industry and also architecture. However, high-end applications in specific fields such as aerospace have demanding requirements on material‟s overall performance (Xu & Chen 2017). Polyurethane engine mounts provide a compromise between rubber and rigid solid mounts. The harder properties of the polyurethane hold the engine in place better than spongier rubber. This allows more energy to be transmitted back through the driveline. Furthermore, polyurethane will allow more vibration than rubber mounts because of it‟s increased stiffness, depending on vehicle, horsepower and the amount of vibration can vary. In general, polyurethane is stronger and more rigid than rubber. Example of polyurethane mounting as shown in **figure 5** below.

Figure 5: Polyurethane Mounting

2.4.1.3 Passive Hydraulic Mounting

There are three types of hydraulic mounts are in use these days which are hydraulic mount with simple orifice, the hydraulic mount with inertia track, and hydraulic mount with inertia track and decoupler. Although there are disputes between the orifice and inertia track mounts, all of them cause damping at low frequency ranges. These mounts can be tuned to have high damping properties at the shock excitation frequency which is used to minimize the vibration levels. The dynamic stiffness of these mounts is usually higher than elastomeric mounts. Although the damping in these mount is high at low frequency, the isolation at higher frequencies is degraded. This problem is treated by adding a decoupler to the hydraulic mount which works as an amplitude limited floating piston. It allows the mount to act like an elastomeric mount to provide good vibration isolation at large displacement. On other hand, it allows it to behave like a typical hydraulic mounting that provide the damping for shock excitation (Marzbani et al. 2016). Sample of hydraulic mounting as shown in **figure 6** below.

Figure 6: Hydraulic Mounting

2.4.1.4 Active Engine Mounting

In active vibration control, a counteracting dynamic force is produced by one or more actuators in order to curb the transmission of the system disturbance force. A general active mount consists of a passive mounting such as rubber or hydraulic mounting, force generating actuator is a structural vibration sensor and an electronic controller. The passive mount is used to support the structure in case of an actuator failure. The controller can either be feedback or feed forward. The vibration control is taken out with a closed loop controller that utilizes the sensor measurement. The active mount stiffness is equivalent to the hardness of the passive setting and can overcome the limitations of passive mounts. An active elastomeric mounts can be very stiff at low frequencies and very soft at high frequencies. Meanwhile the active hydraulic mounts can be tuned to achieve adequate damping at an engine bounce frequency and have very low dynamic stiffness at high frequency. Semi active mounts are used to improve the low frequency features of the system like increasing damping. By providing superior isolation, active engine mounts can allow large engine vibration levels. This may reduce balance shaft requirements and enable the vehicle chassis to be lighter (Pfeffer et al. 2011).

2.4.2 Chassis

Chassis is the most important part of a go-kart. As there is no suspension system provided in a go-kart, the chassis built has to be flexible enough to absorb the shocks and works as a replacement for suspension (Walker 2005). The chassis are constructed of steel tube. There is no suspension on this chassis because the chassis is flexible enough to work as a suspension and stiff enough not to break or give way on a turn. Kart chassis are classified as Open, Caged, Straight or Offset. The model of the chassis is shown in **figure 7** and **figure 8** below.

Open karts have no roll cage. Caged karts have a roll cage on its surrounding the driver they are largely used on dirt trails. In Straight chassis the driver sits in the center. Straight chassis are used for sprint racing. In Offset chassis the driver sits on the remaining side. Offset chassis are used for left-turn-only speedway racing.

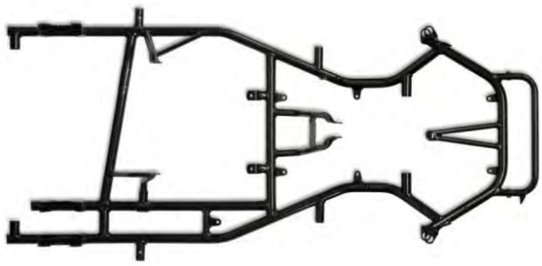

Figure 7: Chassis

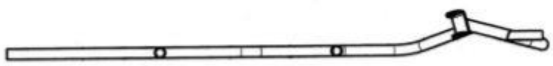

Figure 8: Chassis side view