

DESIGN AND FABRICATION OF UMP GO-KART CHASSIS

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## ABSTRACT

Go-kart has become more and more popular sport in these days and Go-kart chassis have made a major development over the last few years. The performance of a Go-kart is depends a lot on the chassis design. A good chassis needs to be able to flex and twist. Thus, this project takes a look at the investigation of chassis design, simulation and fabrication. The first criteria have to be consider is that would be certain amount of flexing in the chassis but not too much that would reduce the strength of the kart. Therefore, the design will focused on the front end and the middle section of the chassis. In order to ensure that the design of the chassis achieve the standard level. Type of simulation used is Finite Element Analysis (FEA) by using COSMOSWork 2004. The purpose of this simulation was implementing to investigate the strength and the flexibility of the chassis. The simulations carried out with several altered parameters for flexibility investigation. The maximum stress of all cases are normally acting upon at the point of the bending parts but the value is under the maximum allowable stress of mild steel which is 420 MPa and achieved the factor of safety as well. Fabrication process including three processes, there are cutting process by using rotary disc cutter, bending process by using manually hydraulic bender and welding process by using MIG welder.

## ABSTRAK

Go-kart merupakan salah satu sukan extreme yang semakin umum pada masa kini dan casis Go-kart telah mencapai kemajuan dalam tahun-tahun sebelum ini. Prestasi Go-kart adalah banyak bergantung kepada reka bentuk casis. Sesuatu casis yang baik haruslah berfleksibel. Dengan itu, kajian ini akan untuk melaksanakan penyiasatan tentang reka bentuk casis, simulasi dan fabrikasi. Kriteria yang harus ditimbang adalah tahap fleksibel casis itu yang sesuai dan tidak akan mengurangkan kekuatan kart itu. Dengan itu, reka bentuk casis akan memberi tumpuan pada depan dan tengah casis tersebut. Untuk memastikan kepuasan taraf reka bentuk chasis. Jenis simulasi yang digunakan adalah "*Finite Element Analysis*" dengan menggunakan COSMOSWork 2004. Tujuan kajian ini adalah untuk melaksanakan analisis tentang fleksibel dan kekuatan casis Go-kart. Simulasi ini akan menggunakan beberapa jenis parameter untuk analisis fleksibel. Tekanan maksimum dalam kes-kes simulasi biasanya pada titik yang membengkok, tetapi masih berada di bawah tekanan maksimum "*mild steel*" iaitu 420 MPa juga telah mencapai faktor selamat. Proses fabrikasi termasuk memotong, membengkok dan mengimpal.

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## **CHAPTER 1**

### **INTRODUCTION**

#### **1.1 Introduction**

University Malaysia Pahang (UMP) is going to produce a go-kart chassis. In this project, my objective is to construct a chassis prototype and analyze the chassis. This project required me to employ my understanding of the skill to areas in design, software and fabrication.

Design and fabricate a go-kart chassis seem to be as much art as science. It is because it is difficult for anyone to understand the best set up solutions, even major championship repeat winners often differ greatly with regard to set-up solutions. Hence, we should always keep in mind that when making go-kart chassis, “If it doesn’t get better going one way, try going the other”.

#### **1.2 Objectives**

The objectives of this project are to:

- a. To design and fabricate UMP Go-Kart Chassis
- b. To analyze the Go-Kart chassis structure.

### **1.3 Scopes**

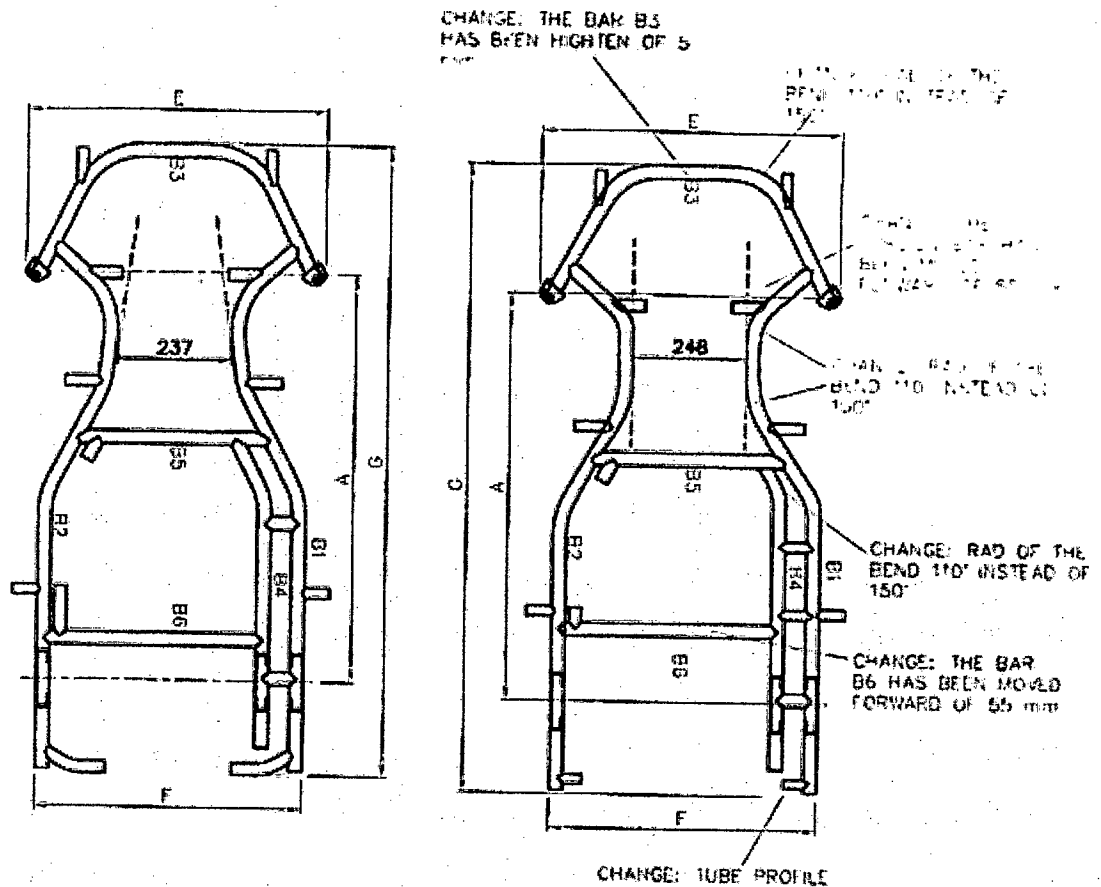
The scopes of this project are to:

- a. Create conceptual design for a go-kart chassis and analyze the structure by stress analysis.
- b. Develop the SolidWorks drawing for concept chassis, welding fixtures for chassis and assembly part for final go-kart.
- c. Initiate and coordinate the Finite Element Analysis (FEA) of the chassis design.
- d. Fabricate the chassis by using welding and bending process.

### **1.4 Project Background**

In this project, I will be able to do sketching, drawing and fabricate the new design Go-kart chassis and do the analysis of stress of the chassis. Fabrication main structure should be done by joining (welding) and deforming process such as bending. At the end of this project, prototype of UMP Go-kart chassis should be produced.

## 1.5 Scenario



**Figure 1.1:** Chassis Model ( Company Intrepid)

**Figure 1.1** shows some of the current chassis model with some difference between each other. There are some difference parts between the chassis models.

The first change is the height of the front bar, the front bar has been heighten of 5mm. This change can reduce understeer of the go-kart which means the kart will not turn into the corner due to the lack of front end grip and increased the front end bite, and also loosen the back end at the entrance of the corner.

The second change is increased the radius of the bend at the front bar from 110 degrees to 150 degrees. This will affect the toe settings which increased the toe in and toe out. By increasing the toe in or out setting will increase the initial cornering response, this will cause the driver to have a better turn and reducing understeer too.

The third change is the position of the torsion bar. Actually the torsion bar is used to add or reduced the chassis stiffness by adding reinforcement to the kart frame. If the torsion bar is set to vertical, it will increase the site bite on all four wheels by increase the rear grip. In contrast, the rear grip will reduce if the torsion bar is set to horizontal.

## **1.6 Gantt Chart**

Refer to **APPENDIX E**.

## **1.7 Outline**

The outline of this project draft report is as below:

**Chapter 1:** Introduction which include objectives, scopes, background and Gantt chart.

**Chapter 2:** Literature study.

**Chapter 3:** Methodology which include problem solving method, activities in each methodology and flow of problem solving.

**Chapter 4:** Discussion of the results obtained by software and fabrication.

**Chapter 5:** The conclusion of the project to summarize the process of the whole project with attachment of recommendation for future development.



## **CHAPTER 2**

### **LITERATURE STUDY**

#### **2.1 Introduction**

The chassis is made of steel tube and the main condition of a good cart chassis is the chassis need to be light weight and able to flex and twist. Therefore, before making a chassis we need a lot of thought went into its design and the factors influenced in order to handle properly either on the straight or a corner.

Many of us will think that the structure of a car is more complicated compare to a go-cart. In fact, it is perhaps a more difficult to explain than an equivalent car. Both vehicles have many parts and principles in common but there two major differences, which account for a large divergence in design and in setting up. These differences are the karts lack of differential, and also its lack of any suspension components. Thus, the cart chassis is playing an important role to work as a suspension component. That is why a cart chassis need to be flexible enough not to break or give way on a turn.

The stiffness of the chassis enables different handling characteristics for different circumstances. Typically, for dry conditions a stiffer chassis is preferable, while in wet or other poor traction conditions, a more flexible chassis may work better. Best chassis allow for stiffening bars at the rear, front and side to be added or removed according to race conditions

## **2.2 Design**

The definition of design is either to formulate a plan for the satisfaction of a specific need or to find out a solution for a problem. In order to obtain a satisfaction and standard design, we have to understand some of the terms.

### **2.2.1 Functional**

The product must perform adequately to fulfill the expectation of the customers.

### **2.2.2 Safe**

We must ensure that the product is safe enough and will not bring any hazard to the user, bystanders, or surrounding property. Hazard cannot be designed out by guarding (a protective enclosure); if that is not possible, appropriate directions and warnings provided. (Mechanical Engineering Design Seventh Edition, Joseph E. Shigley. Charles R. Mischke. Richard G. Budynas (2004))

### **2.2.3 Reliable**

Reliable can be defined as the conditional probability, at a given standard level, that the product will perform its intended function without failure at a given age.

#### **2.2.4 Competitive**

The product is capable to compete with others in its market.

#### **2.2.5 Useable**

The product is considered “user friendly”, suit to human size, strength, posture, reach, force, power, and control.

#### **2.2.6 Manufacturability**

The product has been reduced to a minimum number of parts and suitable to mass production, with dimensions, distortion, and strength under control.

#### **2.2.7 Marketable**

The product can be bought, and service (repair) is available.

### **2.3 Class of Kart Chassis**

Kart chassis are classified in four types in USA as below:

- a) Open karts have no roll cage.
- b) Caged karts have a roll cage surrounding the driver, they are mostly used on dirt tracks.

- c) In Straight chassis the driver sits in the center. Straight chassis are used for sprint racing.
- d) In Offset chassis the driver sits on the left side. Offset chassis are used for left-turn-only speedway racing.

## **2.4 Basic Chassis Setup**

### **2.4.1 Base Setup**

The following setup is recommended as a starting point for a dry track with normal levels of grip.

- a. Weight distribution should be 43.0% front, rear 57% and 50/50% side to side.
- b. Front toe should be set out to 1/16" to 1/8" (1-3mm). For hard compound tires, set toe out at
- c. 1/8" to 1/4" (3-6mm).
- d. Caster/Camber adjusters at front spindles should be set at II top & II bottom.
- e. More caster may be needed over the weekend to fight tire wear and/or loss of grip.
- f. Front bumper should always be tight.
- g. Front width should be 45-1/2" to 46".
- h. Side pod bars need to be loose, but with bolts tight.
- i. Seat should be at standard mounting points.
- j. Rear wheel hubs should be medium length.
- k. Rear ride height should be as low as possible.
- l. Seat struts should be in place.
- m. Torsion bar should be in horizontal position.

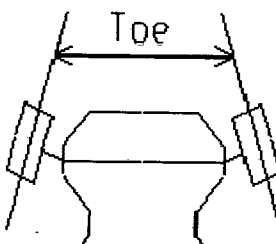
( <http://www.pitstopkartshop.com/crg-setup-guide.pdf>. )

## 2.5 Front End Geometry

In order to produce a good chassis, front end geometry of a go kart is very important. In order to explain how the front end geometry can affect the go kart, there are several settings and terms we need to understand indeed.

### 2.5.1 Toe

Toe can be defined as the angle at which the front wheels either point in towards each other, or away from each other. There are two types of toe, toe in and toe out. Toe in is when the front wheels are pointing towards each other. Toe out is the opposite of toe in.



**Figure 2.1:** Toe In

**Figure 2.1** shows what toe in of Go-kart. Toe-in makes a kart more directionally stable, but can contribute to poor turn-in to corners. In contrast, toe-out can cause the kart to be directionally unstable, but can assist the kart turn-in to corners well. Under zero degrees condition toe in/out condition means that the wheels are parallel to each other. Toe in/out is set by changing the length of the tie rods.

### **2.5.2 Camber**

Camber can be defined as the degree to which the front wheels lean in (or out) from each other. If the tops of the tires are closer together than the bottom, then camber is negative and positive camber is the opposite of negative camber. If camber setting of 0 means that both tires sit flat on the track. In order to maximize the grip when cornering, it is highly desirable to have as much of the two outside tire's rubber on the track as possible. This is one of the aims for kart set up.

### **2.5.3 Caster Angle**

Caster angle is the angle of the king pin means that the bolts that the stub-axles pivot around. This setting is very important for inducing wheel lift when cornering. It is because if the greater the caster angle, the lower the inside front wheel and raised the outside front wheel of the cart at the corner turn in. Besides that, caster angle could also affect the camber when the steering is turn, it could resulting in more negative camber on the outside front wheel and more positive camber on the inside front wheel.

### **2.5.4 King Pin Inclination**

King pin inclination is the inward lean of the kingpin (up, towards the centerline of the kart). KPI causes some of the self centering action of the steering. It also modifies the amount of camber change caused by the caster angle when the steering is turned, lessening negative camber gain on the outside front wheel and increasing positive camber gain on the inside front wheel. It is not usually necessary to adjust the KPI although some camber adjust systems may let you do it.

### 2.5.5 Scrub

Scrub radius can be defined as the distance from the center of the tire at ground level to the line which is drawn from the kingpin axis to the ground. Scrub radius could work with caster angle to affect wheel lift during cornering. The greater the scrub radius, the greater the front wheel height change. Increasing scrub radius will also widen the front track. This track increase effectively softens the front end of the chassis, possibly increasing grip. Scrub radius is adjusted using the track spacers on the stub axles.

### 2.5.6 Ackermann Steering

Ackermann steering, it uses the angle of the stub axle arms (and often an offset on the steering column) to make the inside front wheel to turn substantially more than the outside front wheel. A kart uses Ackermann effect (in conjunction with caster angle and scrub radius), to maximize the inside front wheel's downward movement as much as possible (by making it turn more), in order to raise the inside rear wheel at turn-in. Some karts have adjustable Ackermann, involving the use of different length tie-rods, and mounting them in different holes on the steering arms and/or steering column.

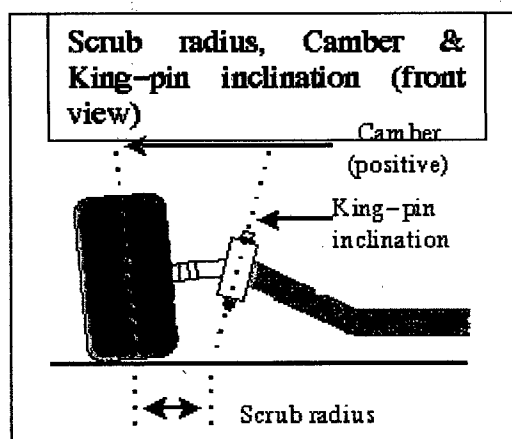


Figure 2.2: Scrub Radius, Camber and King Pin Inclination

### **2.5.7 Front Width**

The most common adjustment made to change the handling of a kart is by working with its front track, or front end width. Widening the front track will create more of a jacking effect when the wheels are turned. This will result in more front end grip and quicker turn in. Narrowing the front track will have the opposite effect. This will result in slower turn in and less front end bite. If the kart pushes or understeers entering a corner, widen the front track. If the front track is at maximum width and the kart still pushes. A very general rule of thumb is; the less available grip, the more scrub radius (increase in front width), caster and starting tire pressure should be used. For more detail on the relationship between starting (cold) tire pressures and racing (hot) tire pressures, read the selection on tires.

### **2.6 Material properties**

The most suitable material for a Go-kart chassis is Chrome-moly but for this project the material used is mild steel. **Table 2.1** is to compare the properties of Chrome-moly and mild steel.