Design and Analysis Go-Kart Chassis with Rear Movement on 150cc Motor Engine

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Abstract: Go-kart is a type of sports car, open vehicle, four wheeler, or quadracycle. The Go-kart chassis experiences loads from, the engine, drivers and the mass of the chassis itself. In this design, the Go-kart frame is made using hollow iron material 40 x 12mm, 1.2mm thick with a rear-wheel drive engine with a capacity of 150cc combustion chamber. Steel plate material is used using SMAW welding with welding wire RB E6013 2.6mm with a current of 70A, welding position 1G (or flat position). The test is carried out with the Universal Tensile Testing Machine, the material is pulled past the maximum stretch elasticity limit until the test object finally reaches the limit (break). Tensile testing takes approximately 3-5 minutes with a load of 10-20N. For the chassis frame, the strength is done by knowing the magnitude of the bending moment acting on the chassis frame and the maximum bending stress that occurs. With a driver's weight of 55 kg, the flexural stress received is 300kg.m, and the maximum flexural stress received by the chassis is 0.4477kg/cm2, which is smaller than the allowable stress for the material 5.7kg/cm2. From these results, the chassis design is considered safe.

1 INTRODUCTION

Go-kart is a simple, light, four wheeled sports car, single seater racing car, without suspension and differential gear and is used by people who are interested in auto racing sports like Formula 1 or Formula E etc(Krishnamoorthi et al., 2021; Srivastava, J. P, 2021). This type of vehicle is designed and manufactured specifically for racing purposes. Go-karts are small racing vehicles without suspension and are rarely used with differentials (Shaik Himam Saheb et al., 2016; J.D. Andrew Pon Abraham, 2017; Govardhana Reddy, 2016). Go-karts are often used as light entertainment in spare time and for racing sports that are included in the Formula 9 category (Prof. Ambeprasad Kushwaha, 2018; Syed Azam Pasha Quadri, 2017; Harshal D. Patil, 2016; V.S. Shaisundaram, 2020). Go-kart consists of various types such as internal combustion engine, electric powered, and Hybrid. Go-karts are compact, simple, light and easy to operate vehicles, designed for flat track racing so that the ground clearance is very small compared to other vehicles(Koustubh Hajare, 2016). The basic components are the chassis, steering, axle, engine, bumper and wheels. The vehicle is under a low speed race car which has low ground clearance and hence no suspension system(U. Kalita,2018).

The creation of this Go-kart is intended as a learning tool for someone to start a racing career. Some people ride it as entertainment or as a hobby by non-professionals (S.A.P. Quadri, 2017). The car chassis is analogous to the human body frame. The chassis, also known as the 'Frame', is the basic structure of any car that supports it from below. The purpose of the chassis is to support the weight of the car both in idle and dynamic conditions. As a result of engine vibration, unbalanced mass, and irregularity in the way the vehicle can experience complex vibrations, which are detrimental to the health of passengers and vehicle parts (M. Mohanta, 2018). In addition, vibration cannot be completely eliminated from the mechanical structure of the element, but can be reduced (N. K. Saini, 2019). In general, suspension systems are used to reduce vibration. However, the Go-kart has no suspension. Therefore, it is very important to control the vibration of the vehicle within the permissible limits to protect the safety and physical health of the driver. In the future composite materials can be used to design Karts which will help to reduce the weight of the frame material, have good control and fast acceleration. Electric vehicles are

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becoming the most promising in the current situation as the industry turns to renewable and pollution-free energy (Krishnamoorthi,2021).

In this paper, a chassis for a Go-kart with rear wheel drive is made which is driven by a 150cc motor engine. The chassis is made of hollow steel measuring 40 x 12mm, 1.2mm thick, which is designed in such a way that it can withstand the weight of the engine and its drivers. In addition, to determine the performance of the kart engine using 2 steps on a 150cc motorcycle engine, namely regarding the strength of the welded connection and the strength of the frame in accepting the load from the engine and driver.

2 MATERIALS AND METHODS

Before the Go-kart making process is carried out, the steps taken are to make the design of the main frame, followed by the design of other supporting components. The Go-kart chassis is made using hollow steel with a size of 40 x 12 mm, 1.2 mm thick. Hollow iron is made of carbon steel with 1.7% carbon content and 1.65% manganese along with a number of other alloying materials.

The Go-kart chassis was designed using the AutoCAD 2017 computer application. The chassis designed is a Go-kart for sprints so it uses a straight frame, where the driver's position is in the middle. The cut materials are joined by SMAW welding using 2.6 mm RB E6013 electrodes with a current of 70A. The main part of the chassis frame is what supports the engine, driver and other parts. Before being assembled into a complete frame, the chassis material is tested by welding to ensure that it has sufficient strength. The tests carried out are tensile tests carried out with the Universal Testing Machine (Figure 1). The second testing stage is load testing, the passenger weight is 56kg, and the engine weight is 40 kg. The result is the chassis is able to withstand the load.

Figure. 1: Universal Testing Machine.

3 RESULTS AND DISCUSSIONS

The results of the design, assembly and welding of the Go-kart chassis using SMAW welding can be seen in Fig. 2 and Fig. 3, while the results of the tensile testing can be seen in the Table 1.

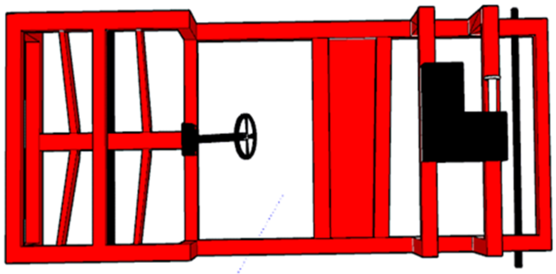


Figure 2: Design of Chasis.

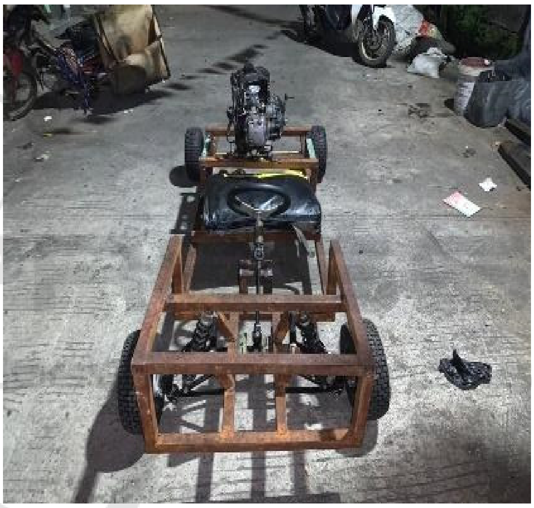


Figure 3a: Design result.

Figure 3b: Design result.

Testing the strength of the welding results is carried out by the tensile strength test method. The results of the tensile test can be seen in Table 1 below:

Table 1a: Test result data.

Uji Sampel/ Test Point	*Wo* (mm)	*A* (mm²)	*L* (mm)
Sample 1	25.4	50.8	35
Sample 2	25.4	50.8	34.8
Sample 3	25.6	50.8	34.9

Table 1b: Test result data.

Uji Sampel/ Test Point	L_A (mm)	ε (%)	F_{max} (N)	$\sigma_{t\,Max}$ (Mpa)
Sample 1	35.6	1.017	25	0.49210
Sample 2	35.8	1.028	27	0.53149
Sample 3	35.5	1.017	26	0.51180

These data are calculated using the formula for strain and stress as follows:
1. From the material sample 1 test data obtained:

Strain

$$\varepsilon = \frac{\Delta L}{L_o}$$

LA = 35.0 mm
LO = 36.5 mm

$$\varepsilon = \frac{L_A - L_o}{L_o} = \frac{35.6 - 35.0}{35.0} = \mathbf{1.017}\%$$

Stress

$$\sigma_{ty} = \frac{F}{A}$$

F = 9 *N*
A = 50.8 mm²

$$\sigma_{ty} = \frac{9}{50.8} = 0.018065\left(\frac{kg}{mm^2}\right) = 0.17716\ MPa$$

$$\sigma_{t.max} = \frac{F_{max}}{A}$$

$$\sigma_{t.max} = \frac{25}{50.8} = 0.0500182\left(\frac{kg}{mm^2}\right) = 0.\mathbf{4921\ MPa}$$

With the same way, the calculation of the results of welded joints on sample materials 1, 2 and 3, will obtain the maximum stress values respectively as follows: 0.4921 MPa, 0.53149 MPa and 0.5118 MPa.

Calculation of Chassis / Frame Strength due to Loading

3.1 Loading on Transverse Frame

3.1.1 Distribution of Engine Load on Vehicle Chassis

M_2 = 40 *kg* (machine weight)
$l_1 = l_2 = 17\ cm$

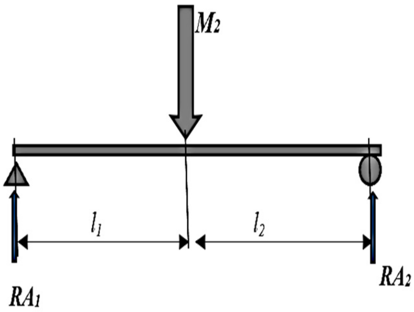


Figure 4: Front View of Machine Load.

Reaction force at the end of the frame
$\Sigma MA_1 = 0$
$(M_2 . l_1) - (RA_2 .(l_1 + l_2)) = 0$
$40 \times 17 - RA_2 \times 34 = 0$
$RA2 = \frac{680}{34} = 20$ kg
$l_1 = l_2$,
So:
$RA_1 = RA_2 = 20$ kg

Bending moment in C
$M_C = 17 \times 20 = 340$ kg.cm

3.1.2 Load Due to Driver's Weight

$M_1 = 56$ kg
$l_1 = l_2 = 30$ cm

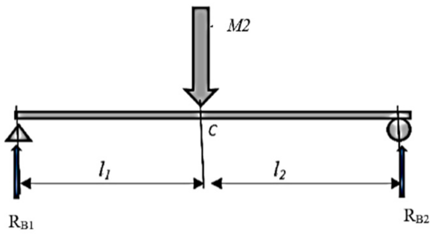


Figure 5: Front view driver's weight load.

Reaction force at the end of the frame
$\Sigma MA = 0$
$M_1 \times l_1 - (R_{B2} \times (l_1 + l_2)) = 0$
$56 \times 30 - R_{B2} \times 60 = 0$

$$RB2 = \frac{1680}{60} = 28 \text{ kg}$$

$R_{B1} = R_{B2} = 28$ kg

Bending moment at point C

$M_C = 28 \times 30 = 840$ kg.cm = 8.4 kg.m

3.2 Calculation of the Load on the Side Frame

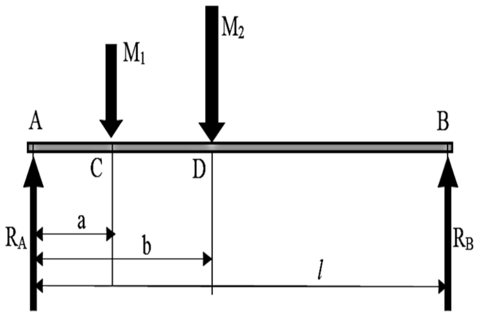


Figure 6: Frame load from side view.

M_1 (Mass of Engine) = 56 kg

M_2 (Mass of Driver) = 40 kg

3.2.1 Reaction Force at Point A and Point B

$\Sigma M = 0$

$(M_1 \times a) + (M_2 \times b) – R_B \times l = 0$

$(56 \times 40) + (40 \times 75) – R_B \times 175 = 0$

$$RB = \frac{(M1 \times A)+(M2 \times B)}{l} \; \frac{5240}{175} \approx 30 \text{ k}$$

$R_A = M_1 + M_2 – R_B = 56 + 40 – 29{,}94 \approx 66$ kg

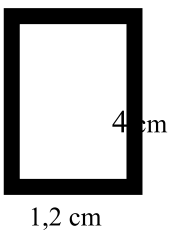
3.2.2 Bending Moment

$M_C = R_A \times a = 66 \times 0{,}40 = 26{,}4$ kg.m

$M_D = R_B \times (l – b) = 30 \times ((175-75))/100 = 300$ kg.m

The greatest bending moment occurs at point D

Bending Stress



$$\sigma b = \frac{M}{\frac{bh^2}{6}} = \frac{M \,.\, 6}{bh^2} = \frac{300}{0{,}012 \times (0{,}04)^2}$$

$$= 4.477 \text{ kg/m}^2$$

$$= 0{,}4477 \text{ kg/cm}^2$$

4 CONCLUSIONS

In a very competitive world of racing, it takes a Go-kart that is safe, comfortable, and has good engine performance when driven in the racing arena. To determine the reliability of the chassis from the design results, it is carried out through a load test on the chassis/Go-kart frame and a road test. Go-kart engine used is a static engine with a capacity of 150 cc and a maximum power of 6 HP with a transmission using a chain. The results of the chassis test with a driver weight of 56 kg, experienced a very small deflection, so it could be ignored, the turning behavior was known that the kart was oversteered, the results of the frame strength test found that the kart had a deflection in the frame, it is recommended that the maximum driver weight be 55 kg.

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