

Design and Analysis of Shaft for Electric Go-Kart Vehicle

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Abstract- This study focuses on the design and analysis of a hollow shaft for an EV go-kart, optimizing weight reduction and structural integrity. Using SolidWorks for design and ANSYS for Finite Element Analysis (FEA), the shaft's performance under mechanical stresses and cyclic loads was evaluated. Results demonstrated significant weight savings while maintaining strength, rigidity, and durability, enhancing the go-kart's efficiency and reliability. This work highlights the potential of hollow shafts in improving EV performance through lightweight design.

Keywords – Hollow shaft, weight reduction, structural integrity, SolidWorks, Finite Element Analysis (FEA), ANSYS.

I. INTRODUCTION

In an EV go-kart, the shaft is a critical component transmitting torque from the motor to the wheels, ensuring efficient motion. Supported by strategically placed bearings, it minimizes friction and maintains stability, preventing misalignment and wear. Secure attachments, such as keyways or splines, ensure effective power transfer to the wheels, while precise design accommodates torque, vehicle weight, and dynamic forces.

II. WORKING OF SHAFT

In an EV go-kart, the shaft is essential for transmitting torque from the motor to the wheels, enabling efficient motion. Torque is transferred through a coupling or direct connection, and the shaft channels it to drive gears or wheels without twisting or deformation. Bearings strategically placed along the shaft minimize friction ensure smooth rotation, and prevent bending or misalignment. Secure attachments like keyways or splines lock components in place, allowing effective power transfer. The shaft must handle torque, vehicle weight, and dynamic loads while maintaining balance to prevent vibration or instability, ensuring reliable and efficient drivetrain performance.

III. TYPES OF SHAFTS

There are different types of shafts are used such as solid shaft, hallow shaft, Step Shaft, Tapered Shaft, Splined Shafts, Tubular Shafts, Splined Shafts, Keyed Shafts, Flexible Shafts, Universal Shafts, Crank shaft and Cam shaft.

1.Solid Shaft: A solid shaft is a cylindrical mechanical component that is completely solid throughout its length, without any hollow sections.

2.Keyed Shaft: A keyed shaft is a type of shaft that features one or more longitudinal slots, known as keyways, machined along its surface. These keyways are designed to accommodate a matching key, which is a small, usually rectangular piece of metal. These types of keys are used in to the Keyways

3.Hollow Shaft: A hollow shaft is a cylindrical mechanical component with a hollow core, meaning it has an empty interior along its length.

IV. DESIGN OF SHAFT



Fig. 1: Shaft model created in Solid Works .

This part was modelled by using SolidWorks 2021 Software and ANSYS (Student Version) Software was used for Static Structural Analysis to determine the svarying loads under different conditions.

1. Material and its Properties:

Material name: Stainless Steel-304

Table 1: Material and its properties

Properties	Values
Density	8e-06 kg/ m ³
Young's Modulus	1.9907+05 Mpa
Poisson's Ratio	0.29264
Bulk Modulus	1.6e+05 Mpa
Shear Modulus	77000 Mpa
Compressive Ultimate Strength	250 Mpa
Compressive Yield Strength	410 Mpa
Tensile Yield Strength	515 Mpa
Tensile Ultimate Strength	750 Mpa

2 Design Calculations

By using the According to the Maximum normal stress theory, we are determining the Inner diameter of shaft. Let us consider the Outer diameter as 35mm
 From the calculations we got the below mentioned values:

- Maximum Vertical bending moment = 274.2 N-m
- Maximum Horizontal bending moment = 49.538 N-m
- Maximum shear force in Horizontal = 439.606 N
- Maximum shear force in Vertical = 600 N
- Maximum Bending moment = 274.2) 2 + (49.538) 2
- Maximum Bending moment = 278.638 N-m

From the motor output we know that
 Twisting moment acting on the shaft = 56 N-m
 By using the Maximum normal stress theory:
 As we considering outer diameter of shaft as 35mm
 (Do)

$$3 = [[KbMb + \{(KbMb) + (KbMb) \} 1/2]]$$

$$(35) 3 = [[1.5 \times 278.638 \times 10^3 + \{(1.5 \times 278.638 \times 10^3) + (1.0 \ 56) \}]]$$

$$(35) 3 = [[417957 + 1.7468 \times 10^{11} + 3136000000]]$$

K = 0.71029
 We know that
 K = Di/Do

$$0.71029 = \frac{di}{35}$$

$$Di = 24.14 \text{ mm}$$

As we got Outer diameter as 35mm and inner diameter as 24 mm of shaft

3. Loads Acting on the shaft

1. Vertical load acting

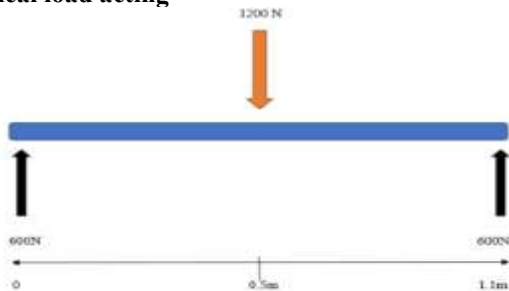


Fig. 2: Vertical load Acting on shaft

Shaft length = 1.1m
 Moment of inertia (Iz) = 10000000 mm
 Young' Modulus = 200000 Mpa
 We are applying point load as 1200 N

Reactions:

At initial 0m
 In X direction = 0 N
 In Y direction = 600 N
 At ending point
 In X direction = 0 N
 In Y direction = 600 N

Forces acting on it:
 Maximum bending moment = 274.2 N-m
 Minimum bending moment = 0 N-m
 Maximum shear force = 600 N
 Minimum shear force = -600 N
 Displacement in Y direction = -0.01mm

Finding the RA and RB values

$$R_A \times 1.1 = 1200 \times 0.55$$

$$R_A = \frac{1200 \times 0.55}{1.1}$$

$$R_A = 600 \text{ N}$$

$$R_B \times 1.1 = 1200 \times 0.55$$

$$R_B = \frac{1200 \times 0.55}{1.1}$$

$$R_B = 600 \text{ N}$$

2. Horizontal load acting on Shaft

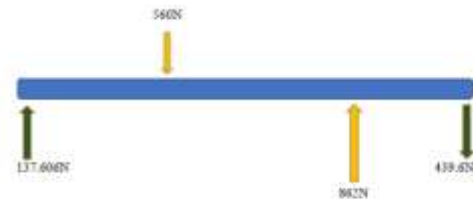


Fig. 3: Vertical load acting on shaft

Shaft length = 1.1m
 Moment of inertia (Iz) = 10000000 mm
 Young' Modulus = 200000 Mpa
 We are applying point load as 137.606 N in upward direction and -439.606 N in downward direction.

Reactions:

At initial point
 In X-direction = 0 N
 In Y-direction = 137.606 N
 At ending point
 In X-direction = 0 N
 In Y-direction = -439.606 N

Forces acting on it:
 Maximum bending moment = 49.538 N-m
 Minimum bending moment = -94.076 N-m
 Maximum shear force = 439.606 N
 Minimum shear force = -422.394 N
 Maximum Displacement in Y direction = 0.001 mm
 Minimum displacement in Y direction = 0 mm
 Finding the RA and RD values

$$RD \times 1.1 + 862 \times 0.7 - 560 \times 0.4 = 0$$

$$RD = -439.606 \text{ N}$$

$$RA + RD = 560 - 862$$

$$RA = -302 - RD$$

$$RA = -302 - (-439.606)$$

$$RA = 138 \text{ N}$$



Fig. 4: Meshing of Shaft in Ansys

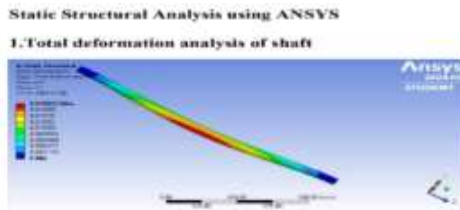


Fig. 5: Total deformation analysis

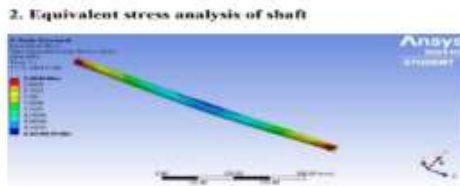


Fig. 6: Equivalent stress analysis

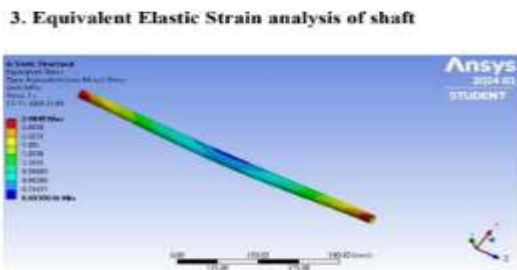


Fig. 7: Equivalent elastic strain analysis

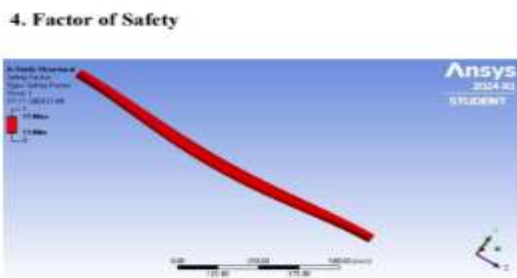


Fig. 8: Factor of safety

V. RESULT SUMMARY

1. Result Summary of ANSYS

Results	Minimum	Maximum	units	Time(s)
Total deformation	0	1.9022e-002	m	1
Equivalent stress	3.0036e-003	2.9849	Mpa	1
Equivalent elastic strain	3.7069e-008	1.4996e-005	-	1
Factor of safety	15	15	-	1

VI. CONCLUSION

The design and analysis of the shaft for an electric go-kart demonstrated the feasibility and advantages of employing a hollow shaft for improved performance. Using SolidWorks and ANSYS, the shaft was optimized for weight reduction while maintaining structural integrity and durability under operational loads. The analysis confirmed that the hollow shaft could effectively transmit torque, resist deformation, and withstand cyclic loads, ensuring reliability and efficiency. This project highlights the potential of lightweight, well-engineered components to enhance the overall performance and energy efficiency of electric vehicles, making them a viable choice for sustainable mobility solutions.

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