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# DESIGN AND FABRICATION OF DRIVE A SHAFT

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**ABSTRACT**

Self-weight of conventional shaft made upof steel, copper is more compared to composite materials. Therefore stresses due to self-weight in conventional materials are more compared to composite materials. To withstand the induced stresses more amount of material is required over composite materials. Due to large diameter, material consumption is more. In order to overcome the above problems we are substituting composite structures for conventional metallic structures,as they have many advantages because of higher specific stiffness and strength. The drive shafts are used in automotive, aircraft and aerospace applications for power transmission.

In this process, the composite materials Aluminium, Tungsten, Glass -powder, Graphite are used for the preparation of composite drive shaft. By conducting various tests such as tension test on UTM, Impact test, Rockwell hardness test, the result is compared with the conventional shaft. And by using result we calculated the diameter of shaft required. This work deals with replacement of a conventional drive shaft with high strength and high modulus composite drive shaft for an automobile application. The aim of the project is to fabricate and test the composite material for finding the diameter required for our specifications like torque. There are various theoretical and experimental methods to find the diameter. We used the design method and found out the diameter required, both theoretically and practically using theories of failure by the values obtained from the tensile test conducted on UTM

**Keywords**—Drtive shaft,UTM,Rockwell Hardness

## I.INTRODUCTION

Several performance characteristics are expected from these materials. They are

1. The materials to be used for sophisticated applications like aircraft and space applications should have higher performance, efficiency and reliability.
2. Materials have to be of light-weight for many applications so that the resulting products can be efficient and cost effective.
3. Materials must have combinations of properties for specific uses since present day products of modern technological origins operate in environment that are special or extreme like very high temperature, cryogenic condition, vacuum, high hydrostatic pressure.

The conventional material may not always be capable of meeting the demand of such environments. Hence new materials being created for meeting these performance requirements and composite materials form one class of such materials developed. Knowledge of composite materials resistance is useful for product development and material selection which should satisfy all the conditions which are necessary.

## II.DRIVE SHAFT

Shaft is a machine element which is used to transmit power from one machine element to another machine element.

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## III. REASONS FOR ADOPTING COMPOSITES

Composites have many benefits. The selection of materials depends upon the performance and intended use of the product. The composite designer can tailor the performance of the end product with proper selection of the materials. A summary of the benefits are as follows

- Light weight
- High strength to weight ratio
- Directional strength
- Corrosion resistance
- Dimensional stability
- Low thermal conductivity
- Low coefficient of thermal expansion

The composite materials used for preparing shaft are:

- Aluminium
- Tungsten
- Glass powder
- Graphite

## IV. FABRICATION OF COMPOSITE SHAFT

A mould is formed into the geometric shape of a desired part. Molten metal is then poured into the mould, it holds the material in shape as it solidifies and metal casting is created.

**PROCEDURE:**

1. Firstly, the selected composite materials should be taken as per the required quantity needed for the preparation of the shaft.
2. As Aluminium is the base metal, it is melted until it reaches melting point temperature i.e., it gets converted into molten state.
3. Immediately the remaining composite materials which are measured in specific quantities are added into the molten Aluminium metal.
4. They are stirred thoroughly until proper mixing of materials takes place.
5. It is collected in a beaker and poured into the die of required shape.
6. It is allowed to cool at room temperature until it gets completely solidified.
7. It is removed by opening the two halves of the die.
8. Required specimen is collected.

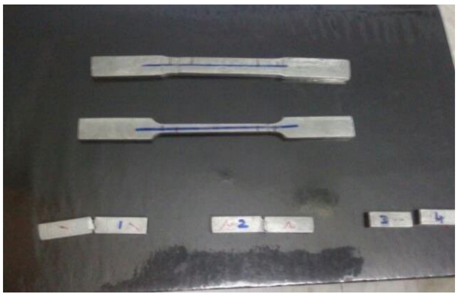
MOLTEN STAGE OF ALUMINIUM

RECTANGULAR ROD AFTER CASTING

## V.TEST CARRIED OUT

### TENSION TEST

UTM TESTING MACHINE



SPECIMENS FOR TESTING

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## VI. TENSILE TEST EXPERIMENTAL RESULTS

| S.NO | MATERIAL | STRESS AT YIELD POINT($N/mm^2$) |
|---|---|---|
| 1 | MILD STEEL | 250 |
| 2 | COMPOSITE MATERIAL | 268.972 |

## VII. DESIGN OF SHAFT BY USING THEORIES OF FAILURES

### REQUIREMENTS AND SPECIFICATIONS

| NAME | NOTATION | UNIT | VALUE |
|---|---|---|---|
| ULTIMATE TORQUE | Tmax | N-m | 3000 |
| MAX LENGTH | L | MM | 2000 |
| MAX SPEED SHAFT | N | RPM | 6500 |

## VIII. PRACTICAL CALCULATIONS FOR MILD STEEL:

Tensile strength obtained from UTM for mild steel shaft is 250 $N/mm^2$

Maximum bending moment

$$M = WL^2/8$$

Weight of the shaft

$$W = \rho \times V \times g$$

$$W = 7.8 \times 9.81 \times 1000 \times \pi/4 \times 2 \times D^2 \ N$$

$$= 120194.1933\ D^2\ N$$

Maximum bending moment

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M = 60097.096D²

$\sigma$b = 612143.99/D N/m2

Stress induced due to torsion:

$\tau =$ T*r/J

=30000*(D/2) / ( π/32*D⁴)

=15278.87/D³ N/m²

**USING THEORIES OF FAILURE:**

Tensile strength for steel shaft material =250 N/mm²

ACCORDING TO MAX. PRINCIPLE STRESS THEORY:

$$\sigma_{1,2} = \frac{\sigma_x + \sigma_y}{2} \pm \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + 4\tau_{xy}^2}$$

$\sigma$max ≤ $\sigma$allowable

$\sigma$y =0, when the shaft is subjected to unidirectional stresses, $\sigma$1,stresses along normal to the axis is zero.

$$\sigma_1 = \frac{612143.99/D}{2} + \sqrt{\left(\frac{612143.99/D}{2}\right)^2 + 4(15278.87/D3)^2} = 250$$

D=2500mm

ACCORDING TO MAX SHEAR STRESS THEORY :

$\tau$max=$\tau$allowable

$\sigma$ max -$\sigma$min = $\sigma$allowable

$$\sqrt{\left(\frac{612143.99/D}{2}\right)^2 + 4(15278.87/D2)^2} = 250$$

D= 2350mm

ACCORDING TO MAXIMUM PRINCILPLE STRAIN THEORY:

$\sigma$1 -μ$\sigma$2 ≤ $\sigma$ allowable²

D=2356mm

Using theories of failures we found the diameter of mild steel =2500 mm

**PRACTICAL CALCULATIONS FOR COMPOSITE SHAFT:**

Tensile strength obtained from UTM for mild composite shaft is 268.75 N/mm²

Maximum bending moment

M = WL²/8

Weight of the shaft

W= ×V× g

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$W = 3.37\times9.81\times1000\times\pi/4\times2\times D^2$ N

$=51930.05D^2$ N

Maximum bending moment

$M = 25965.02\, D^2$

$$Bending stress: \sigma = \frac{My}{I_{NA}}$$

$\sigma b = 264477.6/D$ N/m

Stress induced due to torsion:

$\tau = T*r/J$

$=30000*(D/2) / (\pi/32*D4)$

$=15278.87/D^3$ N/m²

**USING THEORIES OF FAILURE:**

Tensile strength for composite shaft material =268.45 N/mm²

ACCORDING TO MAX. PRINCIPLE STRESS THEORY:

$\sigma max \leq \sigma allowable$

$\sigma y$ =0, when the shaft is subjected to unidirectional stresses $\sigma 1$,stresses along normal to the axis is zero.

$$\sigma_{1,2} = \frac{\sigma_x + \sigma_y}{2} \pm \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + 4\left(\tau_{xy}\right)^2}$$

$$\sigma max = \frac{264477.6/D}{2} + \sqrt{\left(\frac{264477.6}{2}\right)^2 + 4\left(15278.87/D2\right)^2} = 268.97$$

D=1060 mm

ACCORDING TO SHEAR STRESS THEORY :

$\tau max = \tau allowable$

$\sigma max - \sigma min = \sigma allowable$

$$\frac{2}{D}\sqrt{\left(\frac{264477.6}{2}\right)^2 + 4\left(15278.87/D2\right)^2} = 268.97$$

D=1020 mm

ACCORDING TO MAXIMUM PRINCILPLE STRAIN THEORY:

$\sigma 1 + \sigma 2 - \mu\sigma 2 \leq \sigma$ allowable²

D =1036mm

**Using theories of failures we found the diameter of composite shaft =1060 mm**

By this, we proved practically that mild steel drive shaft requires more diameter to transmits torque of 3000N-m with length 2000mm than composite material shaft.

## IX.STRENGTH TO WEIGHT RATIO

By using the values obtained in tests, we have found that strength to weight ratio of composite is high compared to mild steel.

For mild steel = 250/(751210.3) = $3.32\times 10^4$

For composite shaft = 268.97/(51930.05*1060²) = $4.609\times10^9$

| S.No. | Material | Weight (N) | Strength(N/mm²) | Strength/Weight ratio |
|---|---|---|---|---|
| 1 | Composite shaft | 55045.85 | 268.97 | 4.609×10^-9 |
| 2 | Mild steel shaft | 751210.37 | 250 | 3.32×10^-4 |

Strength to weight ratio of Composite material and Mild steel is $1.38\times10^5$

## X. CONCLUSION

Based on our work we have found that the weight to strength ratio for composite shaft is is less when compared to mild steel during tensile test.

- Diameter of the composite shaft is less than that of mild steel shaft for transmitting same torque of 3000 NMm
- Material is less in weight than mild steel of the same dimensions.

This indicates that the composite material is having less weight and more strength, it is useful in aerospace industries and corrosion resistance places.

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