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Design and Finite Element Analysis of Traditional and Composite Drive Shaft

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ABSTRACT:

This study examines the modelling and analysis of a composite drive shaft that uses materials other than traditional stainless steel. The standard drive shaft is a two-piece steel drive shaft, therefore we used composite materials to create a single, long continuous shaft. ANSYS software is used to perform static, model, and stress analyses on these materials. E-glass epoxy, regular steel, and stainless steel were the materials used in this investigation.

Keywords: Driveshaft, finite element analysis, ANSYS, composite material, CATIA V5.

1. INTRODUCTION:

A shaft that is used to convey motion from one location to another is referred to as a "drive shaft." The propeller shaft, on the other hand, is the shaft that propels. Propellers are often linked with ships and aeroplanes because they employ a propeller shaft to propel themselves through the air or water in addition to delivering rotational motion from the front to the back of the moving object. The shaft serves as the main link between the front and back ends and is responsible for both motion and pushing the front end. As a result, the phrases "Drive Shaft" and "Propeller Shaft" are used synonymously.

When the engine is located at the other end of the vehicle from the driven wheels, a longitudinal drive shaft called the propeller shaft is employed. An assembly of one or more tube shafts joined together by universal, constant velocity, or flexible joints forms a propeller shaft. The distance between the gearbox and the axle affects both the number of tubular sections and the joints. As with rear wheel drive, some four wheel drive vehicles employ one propeller shaft to power the back wheels and a second propeller shaft to power the front wheels. In this instance, the front axle is replaced between a transfer gear box and the second propeller shaft. As a result, it is clear that a drive shaft is among the most crucial parts since it is it that really moves the car after the engine generates motion. A key component of this importance is often designed with great care since even a little crack might cause the vehicle to crash catastrophically while it is moving.

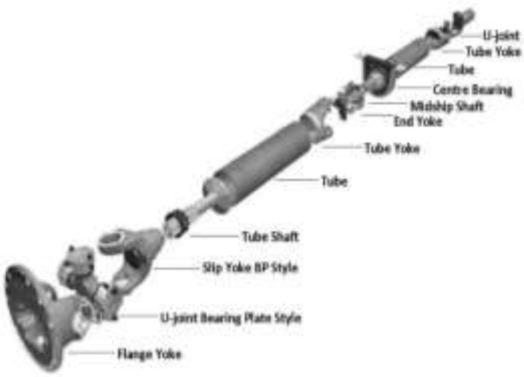


FIGURE 1: DRIVE SHAFT DESCRIPTION

2. PROBLEM STATEMENT

The major reason stainless steel was utilised was due to its great strength. However, the specific strength and modulus of this shaft made of stainless steel are lower. There is less damping capacity in stainless steel. Its weight is very high due to the increased density of stainless steel molecules. Fuel consumption will rise as weight increases, and inertia's effects will be more pronounced.

Due to the propeller shaft's increased weight, we are switching out the stainless steel for composite materials, which are much lighter than stainless steel. Stainless steel is more expensive than composite materials, which are less expensive.

3. OBJECTIVE AND SCOPE

This project's major goal is to use finite element analysis to study the composite propeller shaft. to provide the necessary technological foundation for the effective design, specification, and production of composite shafting in future vehicles and to show the viability of this technology. Validate utilising intuitive computer tools and empirical formulas for composite shaft design.

4. PROJECT METHODOLOGY

The methodology to be used relies on how we approach a certain scenario and the circumstances under which the experiment is conducted. The identical experiment might be approached in a variety of ways**.**

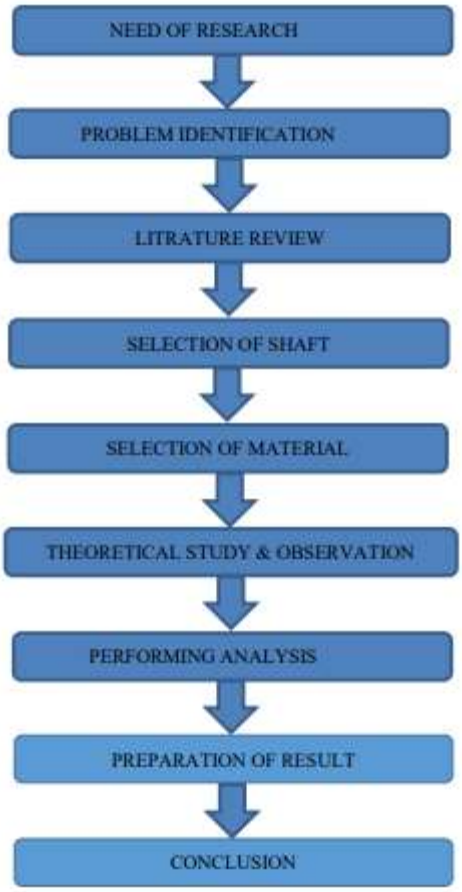


FIG 2: METHODOLOGY CHART

5. DRIVE SHAFT DESIGN IN CATIA V5

CATIA offers a system that incorporates form design, style, surfacing process, and visualisation to develop and modify forms. The drive shaft will be modelled using CATIA V5. It permits the creation of 3D components such as mechanical assembly, sheet metal, composites, moulded, forged, or tooling parts, as well as 3D sketches.

TABLE 1: DRIVE SHAFT DIMENSIONS

DIMENSIONS	VALUE	UNIT
Length, L	1250	mm
Outer diameter, D_o	90	mm
Inner diameter, D_i	76.4	mm
Thickness, t	6.8	mm

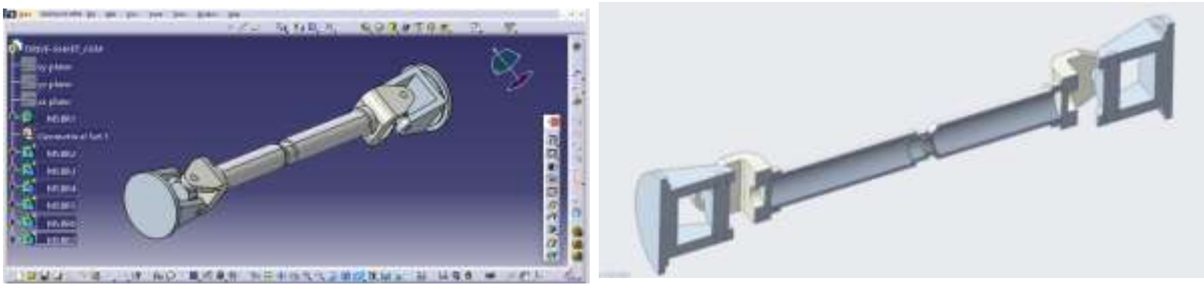


FIGURE 3: DRIVESHAFT IN CATIA

6. FINITE ELEMENT ANALYSIS USING ANSYS

6.1 Meshing

Tetrahedral elements and precise sizing with curvature effects are used to mesh the CAD model. As indicated in the diagram above, model generates 38952 elements and 25734 nodes. It is made up of four nodes that are joined by a tetrahedral shape. After meshing, the CAD model of the suspension is applied with the required loads and boundary conditions.

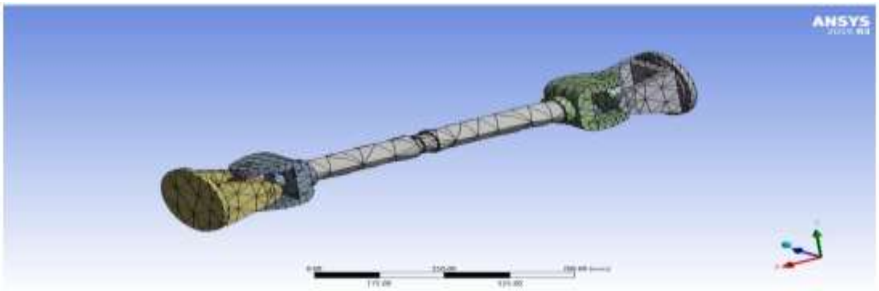


FIG 4: MESHING OF DRIVESHAFT

6.2 static structural analysis of drive shaft

Structural steel

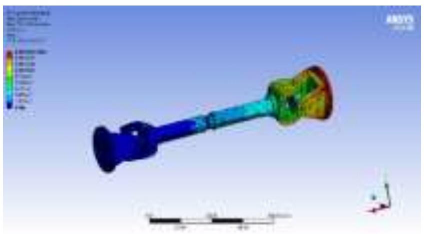


FIG 5: TOTAL DEFORMATION

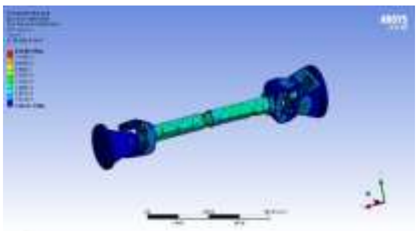


FIG 6: EQUIVALENT ELASTIC STRAIN

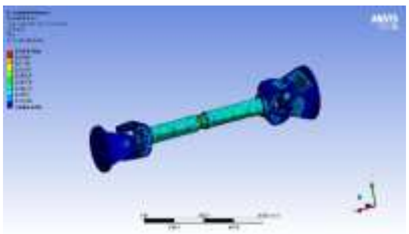


FIG 7: EQUIVALENT STRESS

Steel

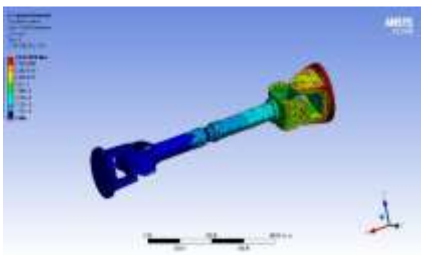


FIG 8: TOTAL DEFORMATION

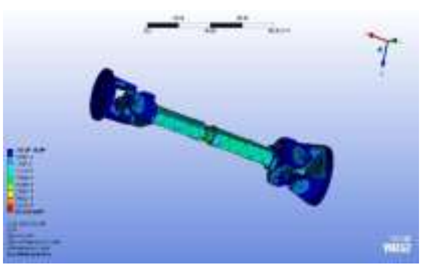


FIG 9: EQUIVALENT ELASTIC STRAIN

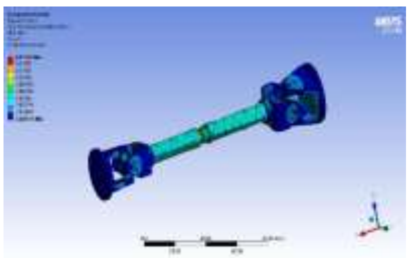


FIG 10: EQUIVALENT STRESS

Composite glass fiber

FIG 11: TOTAL DEFORMATION

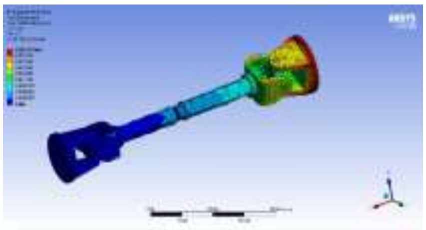


FIG 12: EQUIVALENT ELASTIC STRAIN

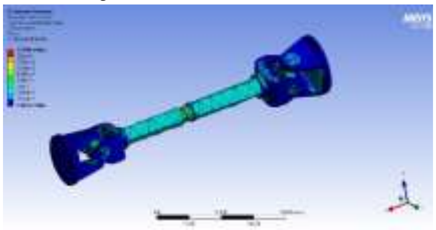
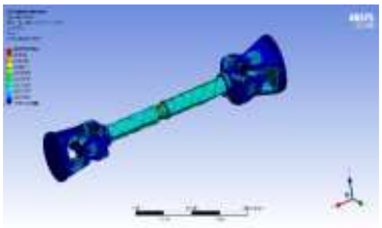


FIG 13: EQUIVALENT STRESS



7. RESULT

Table 2: structural steel result summary

Results	Minimum	Maximum	Units	Time (s)
Total Deformation	0.	1.6413e-004	mm	1.
Equivalent Elastic Strain	1.0474e-010	8.5238e-008	mm/mm	1.
Equivalent Stress	2.6696e-006	1.5161e-002	MPa	1.

Table 3: steel result summary

Results	Minimum	Maximum	Units	Time (s)
Total Deformation	0.	1.5858e-004	mm	1.
Equivalent Elastic Strain	1.0119e-010	8.2355e-008	mm/mm	1.
Equivalent Stress	2.6697e-006	1.5161e-002	MPa	1.

Table 4: Composite E-glass Fiber Result summary

Results	Minimum	Maximum	Units	Time (s)
Total Deformation	0.	8.4888e-004	mm	1.
Equivalent Elastic Strain	5.3275e-010	5.8797e-007	mm/mm	1.
Equivalent Stress	2.5507e-006	5.3117e-003	MPa	1.

8. CONCLUSION

For a lighter automobile, a single-piece composite driveshaft to replace a two-piece steel driveshaft is designed and researched in this thesis. A composite material is constructed by hand lay-up and its mechanical properties are tested. The findings below were derived using analytical calculations and finite element analysis. The weight reduction is 46% when composite materials are used in place of a steel drive shaft. When it comes to weight savings, deformation, shear stress generated, and frequency of usage as a steel substitute, composites offer the most promising qualities. This study set out to reduce the drive shaft's bulk in order to improve automotive fuel efficiency. E-glass fiber/Epoxy resin is lightweight and produces less vibration and noise.

- A one-piece composite drive shaft was proposed as an alternative to the typical two-piece steel drive shaft.
- For steel substitutes, E-Glass/Epoxy composites have the most promising qualities when weight savings, deformation, shear stress generation, and frequencies are taken into consideration.

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