Design, Comparison and Analysis Of APropellerShaftAutomobileFatigueLife

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Abstract
Because of their better particular stiffness and strength, composites are preferable over metal when it comes to structural support. Fibre reinforced polymer composites have emerged as a possible answer to the increasing need for lightweight building materials. The broad interest in these chemicals may be due to their application in a variety of market areas, including vehicles, aeroplanes, sports equipment, healthcare, and household goods. The goal of this research is to figure out how various propeller shaft materials work as power transmitters. Because of its better specific stiffness and strength, composites have significant benefits over metal for structural applications. This study investigates the possibility of replacing standard steel propeller shafts in vehicles with a composite propeller shaft consisting of Aluminum alloy (2024) and Titanium alloy (TI6AL4V). Propeller shafts are often made out of sm45 c steel. The goal of the project is to reduce the driving shaft's weight. This research used finite element analysis to analyse deflection, stresses, and natural frequencies under applied loads (Ansys). FEA was used to provide a more detailed comparison between the two loads. Between steel and composite drive shafts, optimal and stress intensity factor comparisons were also made.
Keywords: Automobile,Powertransmission,forgedsteel,Strength,aluminium2024,titaniumTI6AL4V,Load,Stress,Intensityfactor,Universalcoupling,Differential, Axles,Natural frequency,Rearwheel axis,Hooke'slaw

1. INTRODUCTION

The propeller shaft, which is a spinning shaft, transmits the power from the engine to the wheels. The propeller shaft must be flexible enough to handle the changing angle between the blades. The transmission anaxle is a component of it. In building, high-quality steel (Steel SM45) is often employed. Because of the following correlations, producing a shaft in two sections out of steel increases its fundamental bending natural frequency: The specific modulus is proportional to the square root of the shaft's length, and the bending natural frequency is inversely related to the square of the beam length. Three universal joints, a cross-centre supporting bearing, and a bracket make up the two-piece steel propeller shaft. Any component sandwiched between two pieces of steel may be dismantled using drive shafts. Composites' modulus of elasticity is also much lower than that of biological materials. When the driveline experiences torque maxima, the driveshaft may operate as a shock absorber, reducing strain on the drive train and increasing its life. Hybrid drive shafts and the techniques utilised to link them to universal Joint yokes have been the subject of many studies. To counteract this, this research examines the design from a variety of perspectives. Because of their high specific strength (strength/density) and specific modulus (modulus/density), composites manufactured from sophisticated materials like graphite, carbon, kevlar, and glass with the correct resins are often utilised. Modern composites seem to be tailor-made for usage in scenarios requiring lengthy power driver shafts (propeller shafts), with elastic qualities that may boost both torque bearing capacity and maximum permitted rotation speed. Drive shafts are utilised in a broad range of vehicles as well as in the aerospace, aviation, and automotive industries. In actuality, the heavier the car, especially while travelling in the city, the more fuel it will need. [1]-[5].
Aluminum is a chemical element that belongs to the boron group and has the symbol Al. Silver is a white, soft, ductile metal. Aluminum is the most prevalent metal in the Earth's crust and the third most frequent element (after oxygen and silicon). It accounts for around 8% of the planet's overall mass.
Because aluminium is a highly reactive metal, it is difficult to find pure examples in nature.
Only extreme circumstances of reduction may be used. It's more likely to be found in one of over 270 mineral combinations. The main resource used to make aluminium is bauxite.
Aluminum is unusual because of its low density and the corrosion-resistant passivation phenomena. Aluminum and its alloys are used extensively in the manufacture of aeroplanes, as well as in other transportation and construction sectors. Aluminium oxides and sulphates are the most valuable aluminium compounds in terms of weight.
Aluminum salts are abundant in nature, yet no creature has yet discovered how to utilise them metabolically. Aluminium's widespread nature is mirrored in the fact that plants and animals tolerate it well. Questions regarding the biological consequences of aluminium compounds, whether useful or detrimental, are a constant topic of interest due to their widespread usage. [6]-[10]

2. ALUMINIUM2024ALLOY

The principal alloying component in the 2024 aluminium alloy is copper. This material is used when a high strength-to-weight ratio and excellent fatigue resistance are required. Its machinability is poor, and friction welding is the only technique that works. It is frequently encased in aluminium or Al-1Zn for protection because to its weak corrosion resistance, despite the fact that this may diminish the fatigue strength. This alloy was originally known as duralumin under the trade designation 24ST, as were others in the 2XXX family.
You may also buy alclad sheet and plate in your own dimension and form, including extruded 2024. It's not often that anything gets forged (the related 2014 aluminium alloy is, though).

Table.1. MechanicalPropertiesofAL2024

Density	2780	Kg/m3
Ultimatetensilestrength	469	Mpa
Yieldtensilestrength	324	Mpa
Modulusofelastisity	73.1	Gpa

Shearmodulus	28	**Gpa**
Shearstrength	283	**Mpa**
Fatiguestrength	**138**	**Mpa**

Because of its high strength and fatigue resistance, 2024 is extensively used in aircraft, notably in tensioned wing and fuselage components. Because the material is susceptible to thermal stress, 2024 is also used to validate liquid penetrant tests done outside of standard temperature ranges.

3. TITANIUMTI6AL4VALLOY

Ti-6Al-4V (UNS number R56400), often known as TC4, Ti64, or ASTM Grade 5, is a high-specific-strength alpha-beta titanium alloy with excellent corrosion resistance. It's one of the most widely used titanium alloys, with applications in aviation and biomechanics that need low density and good corrosion resistance (implants and prostheses).

The Watertown Arsenal, which eventually became the Army Research Laboratory, started researching titanium alloys for use in body armour in the 1950s.

Because of its low modulus, high biocompatibility, and superior corrosion resistance, titanium alloys are used as biomaterials. In contrast to stainless steels and cobalt-based alloys, which are more often used. The popularity of these materials may be linked to their desired qualities, which led to the early introduction of (cpTi) and (Ti—6Al—4V) alloys, as well as the creation of novel Ti-alloy compositions. Biocompatibility and elastic modulus reduction are both improved, as is strain-controlled and notch fatigue resistance. Titanium alloys have not been extensively employed in the medical industry due to their low shear strength and wear resistance. While b-Ti alloys outperform ab alloys in terms of wear resistance, a better knowledge of the wear processes is required before orthopaedic titanium alloys can be extensively employed as wear components..

Table.2. TI6AL 4V alloy mechanical characteristics

Density	**4429**	**Kg/m3**
Ultimatetensilestrength	1170	**Mpa**
Yieldtensilestrength	1100	**Mpa**
Modulusofelasticity	114	**Gpa**
Yieldcompressivestrength	1070	**Mpa**
Poissonsratio	0.33	**-**
Shearmodulus	44	**Gpa**
Shearstrength	**760**	**Mpa**
Specificheatcapacity	**0.5263**	**J/g c**
Thermalconductivity	6.7	**W/mk**
Meltingpoint	**1660**	**C**

- Implantsandprostheses(wrought,castorbyAdditiveManufacturing(AM)).
- AdditiveManufacturing.
- Partsandprototypesforracingandaerospaceindustry.Usedextensivelywithinthe Boeing 787aircraft.
- Marineapplications.
- Chemicalindustry.
- Gasturbines.
- FirearmSilencer.

Table.3. Mechanicalpropertiesof SM45Csteelalloy

Density	**7600**	**Kg/m3**
Ultimatetensilestrength	686	**Mpa**
Yieldtensilestrength	490	**Mpa**
Modulusofelasticity	205	**Gpa**
Poisonsratio	**0.29**	**-**

Shearmodulus	**80**	**Gpa**
Specificheatcapacity	0.486	**J/g c**
Thermalconductivity	**49.8**	**W/mk**

4. INTRODUCTIONTOCATIA

CATIA is a powerful tool that makes it easier to create intricate and complicated designs. The objectives of this course are to teach students how to use CATIA to design and build parts and assemblies, as well as to create basic drawings of these components and assemblies. This course will teach you the principles needed to build a strong foundation for your designs.

CATIA is a well-known mechanical design program. It's a simple-to-use parametric solid modeling design tool with a user-friendly interface. To capture design intent, fully associative 3-D solid models may be created utilizing either automatic or user-defined relations. To further understand this definition, more clarification of the italicized phrases will be supplied.

A solid model is the most detailed geometric model that a computer-aided design (CAD) system can produce. The model's edges and faces are defined using all of the required wireframe and surface geometry. A solid model's topology, which connects the geometry, is also carried by the model. Determining which edges link which faces (surfaces) is an example of topology in action (curves). This intelligence facilitates the addition of additional features. If your model requires a fillet, for example, you may simply make one by picking one edge and radiusing it.

5. WORKBENCHES

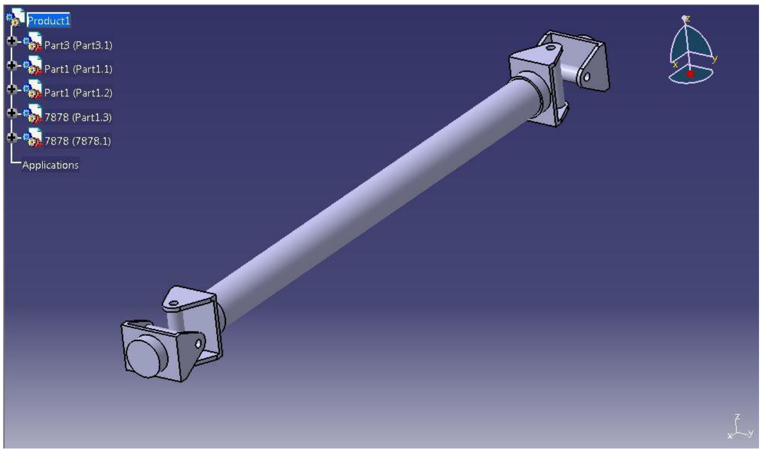

Figure.1.3DmodelofdriveshaftusingCATIA

Table.4. TAITANIUMTI6AL4VRESULTS

	Minimum	**Maximum**
Totaldeformation	0	**0.007143**
Equivalentelasticstrain	2.7413e-6	**0.011922**
Maximum principalelasticstrain	-4.1732e-7	**0.011394**
Equivalentstress	93652	**1.1303e9**
Maximum principalstress	**-3.768e8**	**1.6506e9**

Table.5. ALUMINIUM2024ALLOYRESULTS

	Minimum	**Maximum**
Totaldeformation	0	**0.011022**
Equivalentelasticstrain	3.9215e-6	**0.018821**
Maximum principalelasticstrain	-1.5756e-5	**0.018245**
Equivalentstress	**87628**	**1.1436e9**

Maximum principalstress	**-3.5198e8**	**1.6396e9**

6. CONCLUSION

When compared to traditional steel shafts, the use of composite material has resulted in a weight reduction of 24-29 percent. The study's goal was to figure out how to cut the fuel consumption of vehicles and other devices that used drive shafts. The use of aluminium alloys and other lightweight composites is common. The aluminium alloy composite stands out as the material most likely to replace steel in terms of weight savings, deformation, shear stress generated, and resonance frequencies. The mission also involves design optimization, such as the transition from a two-piece steel drive shaft to a single-piece light-weighted composite drive shaft. However, a final examination of the three alloys reveals that steel is the best and most appropriate for achieving long-term effects via deformation.

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