Finite Element Analysis of Propeller Shaft for Automotive and Naval Application

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ABSTRACT

The Drive shaft is mainly used for power transmission from the engine to the rear differential. Parts are created by using creo software and the assembled model is exported to analysis Parasolid file and various analysis are performed. Structural analysis of drive shaft to withstand a torque of 10000nm at one where other side is fixed. Use of conventional steel for manufacturing of drive shaft has many disadvantages such as low specific stiffness and strength. Conventional drive shaft is made up into two parts to increase its fundamental natural bending frequency. Two-piece drive shaft increases the weight of drive shaft which is not desirable in today’s market. Many methods are available at present for the design optimization of structural systems and these methods based on mathematical programming techniques involving gradient search and direct search. These methods assume that the design variables are continuous. But in practical structural engineering optimization, almost all the design variables are discrete.

Keywords: Structural analysis, Conventional drive shaft, Static analysis

1. INTRODUCTION

A shaft is a rotating member which transmits power. A shaft may be subjected to bending moment as well as twisting moment. Gears, pulleys etc., are usually keyed to the shaft and the shaft rotates in the bearings. An axle is chiefly subjected to bending moment. It may carry freely rotating parts (without key) pulleys, gears etc. (e.g., industrial car wheels freely rotates on their axle). Sometimes, wheel is fastened rigidly to the axle rotates in the bearings. No torque is transmitted. A propeller shaft or Cardin shaft is a mechanical component for transmitting torque and rotation, usually used to connect other components of a drive train that cannot be connected directly because of distance or the need to allow for relative movement between them like in automobiles.

Drive shafts carries torque and they are subjected to torsion and shear stress, equivalent to the difference between the input torque and the load. They must therefore be strong enough to bear the stress, whilst avoiding too much additional weight as that would in turn increase their inertia. Drive shafts frequently incorporate one or more universal joints or jaw couplings to allow for variations in the alignment and distance between the driving and driven components. Thus propeller shafts have become an indispensable transmission component in automotive engineering and industry.

Modern condition monitoring techniques encompass many different themes; one of the most important and informative is the vibration analysis of rotating machinery. Using vibration analysis, the state of a machine can be constantly monitored and detailed analysis may be made
concerning the health of the machine and any faults which may arise or have already arisen. Machinery distress very often manifests itself in vibration or a change in vibration pattern. Vibration analysis is therefore, a powerful diagnostic and troubleshooting tool of major process machinery. On-load monitoring can be performed mainly in the following three ways. A line shaft or transmission shaft, is a comparatively long shaft which is driven by the motor. The line shaft transmits motion to various machines through various machines through counter shafts. Front wheels of rear wheel drive vehicles are supported on the stub axles. The rear axle of the wheel drive of the automobile is really a shaft, because it transmits torque to transmit propelling force for the vehicle. Such shaft in the machinery is called spindles.

1.1. Purpose of the Drive Shaft (or) Propeller Shaft

- It must transmit torque from the transmission to the differential gear box
- The drive shaft must also be capable of rotating at the very fast speed required by the vehicle.
- The driveshaft must also operate through constantly changing the angles between the transmission, the differential and the axles.
- The length of the drive shaft must also be capable of changing while transmitting torque.
- The drive shaft should provide a smooth, uninterrupted flow of power to the axles.

1.2 Functions of the Drive Shaft

First, it must transmit torque from the transmission to the differential gear box. During the operation, it is necessary to transmit maximum low-gear torque developed by the engine. The drive shaft must also be capable of rotation at the very fast speeds required by the vehicle. The drive shaft must also operate through constantly changing angles between the transmission, the differential and the axles. As the rear wheels roll over bumps in the road, the differential and the axle move up and down. This movement changes the angle between the transmission and the differential. The length of the drive shaft must also be capable of changing while transmitting torque. Length changes are caused by axle movement due to torque reaction, road deflections, braking load and so on. A slip joint is used to composite for this motion. The slip joint is usually made of an internal and external spline. It is located on front end of the drive shaft and is connected to the transmission.

2. LITERATURE SURVEY

V.S Bhajantri et.al., Substituting composite structures for conventional metallic structures has much advantage because of higher specific stiffness and strength of composite materials. This work deals with replacement of conventional two piece steel drive shaft with a single-piece e-glass/epoxy, high strength carbon/epoxy and high modulus carbon/epoxy composite drive shaft for automobile shaft for an automotive application. According to this paper it is found that optimum fiber angle orientation will play important role in composite shaft which depends on requirement of composite shaft [1].

Madhu K.S et.al., Automotive drive shaft is usually manufactured in two pieces in order to increase the fundamental bending natural frequency because it is inversely proportional to the square of beam length and proportional to the square root of specific modulus. Many research work have been carried out to in this direction to replace two pieces drive shaft with single piece made of composites [2]. R.Sagar et.al., This study deals with the review of optimization of drive shaft using the Genetic Algorithm and ANSYS. Substitution of composite material over the conventional steel material for drive shaft has increasing the advantages of design due to its high specific stiffness and strength. Drive shaft is the main component of drive system of an
automobile. Use of conventional steel for manufacturing of drive shaft has many disadvantages such as low specific stiffness and strength. Conventional drive shaft is made up into two parts to increase its fundamental natural bending frequency. According to this paper the replacement of conventional drive shaft results in reduction in weight of automobile. The finite element analysis is used in this work to predict the deformation of shaft [3]. T.Rangaswamy et.al., The overall objective of this paper is to design and analyze a composite drive shaft for power transmission applications. A one-piece drive shaft for rear wheel drive automobile was designed optimally using E-Glass/Epoxy and High modulus (HM) Carbon/Epoxy composites. In this paper a Genetic Algorithm (GA) has been successfully applied to minimize the weight of shaft which is subjected to the constraints such as torque transmission, torsional buckling capacities and fundamental natural frequency. The results of GA are used to perform static and buckling analysis using ANSYS software. The results show the stacking sequence of shaft strongly affects buckling torque [4-5]. S.Amol et.al., Automotive composite drive shafts offer the potential of lighter and longer life drive train with higher critical speed. This paper presents review on finite element analysis investigation of composite drive shaft in static, modal and buckling analysis in respect to advantage of using composite materials in terms of weight and stress minimization, effects of fibers winding angle and layers stacking sequence on the critical speed, optimization into single piece drive and critical buckling torque. This review study help to students, academicians and researcher’s about current status of FEA simulation work and help them to look. Forward with better and optimized simulation conditions to improve the performance of newly designed composite drive shaft [6-7].

3. WORKING PRINCIPLE

The torque that is produced from the engine and transmission must be transferred to the rear wheels to push the vehicle forward and reverse. The drive shaft must provide a smooth, uninterrupted flow of power to the axles. The drive shaft and differential are used to transfer this torque. First, it must transmit torque from the transmission to the differential gear box. During the operation, it is necessary to transmit maximum low-gear torque developed by the engine. The drive shafts must also be capable of rotating at the very fast speeds required by the vehicle. The drive shaft must also operate through constantly changing angles between the transmission, the differential and the axles. As the rear wheels roll over bumps in the road, the differential and axles move up and down. This movement changes the angle between the transmission and the differential. The length of the drive shaft must also be capable of changing while transmitting torque. Length changes are caused by axle movement due to torque reaction, road deflections, braking loads and so on. Alsip joint is used to compensate for this motion. The slip joint is usually made of an internal and external spline. It is located on the front end of the drive shaft.

4. DESIGN TOOL (SOLIDWORKS)

Solid Works is a Para solid-based solid modeler, and utilizes a parametric feature-based approach to create models and assemblies. Parameters refer to constraints whose values determine the shape or geometry of the model or assembly. Parameters can be either numeric parameters, such as line lengths or circle diameters, or geometric parameters, such as tangent, parallel, concentric, horizontal or vertical, etc. Numeric parameters can be associated with each other through the use of relations, which allow them to capture design intent. Building a model in Solid Works usually starts with a 2D sketch (although 3D sketches are available for power users). The sketch consists of geometry such as points, lines, arcs, conics (except the hyperbola), and splines. Dimensions are added to the sketch to define the size and location of the geometry. Relations are used to define attributes such as tangency, parallelism, perpendicularity, and concentricity.
5. **STATIC ANALYSIS**

A static analysis is used to determine the displacements, stresses, strains and forces in structures or components caused by loads that do not induce significant inertia and damping effects. A static analysis can however include steady inertia loads such as gravity, spinning and time varying loads. In static analysis loading and response conditions are assumed, that is the loads and the structure responses are assumed to vary slowly with respect to time. The kinds of loading that can be applied in static analysis includes, externally applied forces, moments and pressures Steady state inertial forces such as gravity and spinning Imposed non-zero displacements. If the stress values obtained in this analysis crosses the allowable values it will result in the failure of the structure.

6. **PROBLEM FORMULATION**

The main objective of this project is:
- To construct the geometry of the driveshaft using SOLIDWORK.
• To investigate the material composition of the drive shaft
• Optimization for weight reduction in existing Propeller shaft
• To investigate the stress analysis and predict the failure of driveshaft using ANSYS software.

Drive shaft is a mechanical device for transferring power from the engine or motor to the point where useful work is applied. The types of failure which can be happen to the device especially like fatigue failure, torsional stress, bending stress and etc. People often ask what are the hardness of material that use in drive shaft and how longer the shaft can stay use if the car not involved in accident. This project is to study about the failure that happens to the drive shaft. First, identify the failure cause and condition of the drive shaft. Then do the hardness test to know how hard the material that use in drive shaft. After that we can make an analysis and we try to solve the problem.

7. CONCLUSION

The following conclusions have while performing finite element analysis of a drive shaft. The total deformation obtained is 0.011729 m. The maximum elastic strain obtained is 0.04912 m. The static structural obtained is 9.87e0.98 pa. As observed in the ansys software.

REFERENCES


