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Design & Analysis of Drive Shaft used for Power Transmission in Locomotives (Maruti Suzuki 800) – A Review

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Abstract

This paper presents a review on how important the Drive Shaft is in an Automobile Industry. Drive Shaft is a mechanical part usually used as a transmission system for transmitting the power from engine to the wheel. The usage of Drive Shaft as a power transmitter in automobile is more convenience because it is less likely to become jammed or broken compared to chain-drives. Drive shaft is generally subjected Torsional and bending stress during operation due to which fatigue and fractural failures may occur. Some common causes of failures are manufacturing, design, maintenance, raw material, and the user originated faults. This paper presents the available literature of failure analysis of drive shaft and summarized the causes of failures of FWD Drive Shaft and analyzes the premature failure in Drive Shaft. On the basis of various researches it is proposed that Induction Hardening of the Drive Shaft on the portion where it usually wears will overcome the problem of failure of Drive Shaft.

Keywords: Automobile, Drive Shaft, Induction Hardening, Power Transmission.

I. INTRODUCTION

To transmit power the rotating member of cross section (solid or hollow) is used and rotational motion in machinery and mechanical equipment in various applications. Most shafts are subjected to fluctuating loads of combined bending and torsion with various degrees of stress concentration. For such shafts the problem is fundamentally fatigue loading. Failed components and structures have engaged scientists and engineers extensively in an attempt to find their main causes and thereby offer methods to prevent such failures.

The movement of vehicles can be provided by transferring the torque produced by engines to wheels after some modification. Today rigid drive shaft is mostly used by automobiles to deliver power from a transmission to the wheels. Cars commonly use a pair of short flexible driveshaft to send power from a differential to the wheels.

Drive shaft is a mechanical part of transmission system which is used to transfer the power from engine to the wheel. Two constant velocity (CV) joints and the actual shaft comprise in almost universally used in front wheel drive (FWD) vehicles. Machine elements and assemblies in the cases of the variable loads are subject to fatigue stress, which under certain circumstances can lead to fatigue fractures and ultimately machine failure. Analysis of failures caused by fractures shows that the majority of them can be attributed to material fatigue.

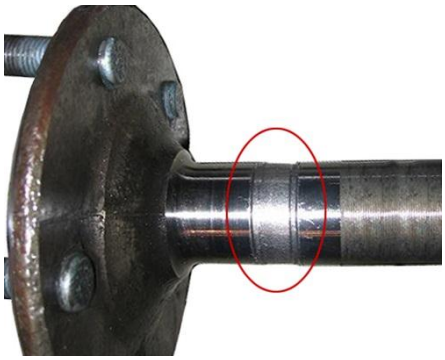

Fig.: Worn out Drive Shaft

Drive shafts are carriers of torque. They are subject to torsion and shear stress, equivalent to the difference between the input torque and the load. Drive shafts must therefore be strong enough to bear the stress, whilst avoiding too much additional weight as that would in turn increase their inertia.

II. LITERATURE SURVEY

1. R. P. Kumar Rompicharla, Dr. K. Rambabu, "Design and Analysis of Drive Shaft with Composite Materials", *Research Expo International Multidisciplinary Research Journal Volume - II, Issue - II June – 2012 ISSN: 2250 - 1630*.

Composite drive shaft with minimum weight was optimized with design parameters is the main objective. The design optimization also showed significant potential improvement in the performance of drive shaft. The drive shaft of Toyota Qualis was chosen, the modeling of the drive shaft assembly was done using CATIA V5R19 and HYPERMEH 10 used to create FEM model from Geometric assembly model which is created in CATIA, Ansys 12 used for predicting analysis results. To estimate the deflection, stresses, natural frequencies under subjected loads using FEA. On both steel and composite materials further comparison is carried out and weight of the shaft is optimized.

2. Aniket Deshmukh, Prof. D. H. Burande, "A review: Induction Hardening on Axle shaft", *International Journal of Engineering Trends and Technology (IJETT) – Volume 35 Number 1- May 2016*.

Bolero car's axle shaft has been taken into consideration in this paper. Data for CAD modeling is extracted from reverse engineering. In analysis results it is clear that the shaft will break at the joint location. So, an attempt is to be made to improve its strength by placing a bush at the region of failure and induction hardening on the place where bush is to be placed. This paper shows the study of different authors who have been worked in this area of research.

3. Mr. Niket N. Lachake, Prof. A. B. Gaikwad, "Experimental & FEA Assessment of Modification in Portal Axle Shaft", *IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 13, Issue 5 Ver. I (Sep. - Oct. 2016), PP 69-79.*

Portal axles (or portal gear) are designed for off-road driving conditions. The center of the wheel hub is below the axle tube and a reduction gearbox present within the hub. Axle tube is installed between the wheel and the axle shaft to give more ground clearance to the vehicle. It is the shaft which must have higher strength and toughness. Since composite materials are having promising properties, which can reduce the weight and almost equal to conventional material properties. In this paper portal axle shaft is analyzed by Finite Element Analysis considering varying parameters i.e. rib thickness and hollow shaft thickness and are consider. Some of the parameters are kept constant which are the depth of spokes, the rib fillet radius and the number of spoke. Shaft's torsional strength is compared for three different models. The modeling and simulation of spur gears in placed portal axle is important to predict the actual motion behavior. However, portal axle with gear train design is difficult to study comprehensively due to their relatively low cost and short product life cycle. Portal axle's shaft modal analysis is simulated using Finite Element Method (FEM) in this study.

4. Bipin Wankhede, Prashant Awchat & Tejpal Parshiwnikar, "Failure Analysis of Automotive Front Wheel Drive Shaft", *Journal of Information, Knowledge and Research in Mechanical Engineering ISSN 0975 – 668X| Nov 15 to Oct 16 | Volume – 04, Issue – 01.*

Drive shaft is a mechanical part of transmission system which is used to transfer the power from engine to the wheel. It comprises two constant velocity (CV) joints and the actual shaft is almost universally used in front wheel drive (FWD) vehicles. Power transmission drive shaft is used in automobile is more convenience because it is less likely to become jammed or broken compared to chain-drives. In operation, drive shaft is generally subjected Torsional and bending stress due to which fatigue and fractural failures may occur. Manufacturing, design, maintenance, raw material, and the user originated faults are causes of failures. This paper presents the available literature of failure analysis of drive shaft and summarized the causes of failures of FWD drive shaft and analyzes the premature failure in drive shaft.

5. Sumit P. Raut & Laukik P. Raut, "A Review of Various Techniques Used for Shaft Failure Analysis", *International Journal of Engineering Research and General Science Volume 2, Issue 2, Feb-Mar 2014; ISSN 2091-2730*.

Failure analyses of the shaft various methodologies are used in different application by various authors are reviewed in this paper. This paper presents the comparison of the different methodology used, their application and limitation by various authors. To study the various methodologies used for the shaft failure analysis is the objective of this paper and to choose best methodology suitable for the failure analysis of shaft used in gear box which is mounted on the overhead crane to prevent repetitive failure. Due to stoppage and repairing cost associate with the breakdown, shaft failure leads to heavy loss.

III. PROBLEM DEFINITION

The passenger cars, small trucks and vans should have the torque transmission capacity more than 3500 Nm and fundamental natural bending frequency must be higher than 6500 rpm to avoid whirling vibrations. From the theory of whirling, it has been found that the critical speed of shaft is inversely proportional to the square of its length. By increasing the length of shaft the vibration problem can be solved but it cannot be permitted due to space limitations.

So that there is only an option to manufactures to manufacture the parts in two pieces.

Portal axle's shaft is weak near the point of the gear pair as it wears out due to excess torque applied over it. Thus In designing a shaft which can be used in robust conditions, engineers is seeking to design shafts which are capable to operate with sufficient strength but reduced weight for improved power to weight ratio. Hollow shaft is more favoured in recent survey of years than the solid shaft because it offers increased availability and lightweight with adequate tensional strength. However, when compared between the solid shaft and hollow shaft with equal section modulus, the tensional strength of the hollow shaft is reduced by nearly to half.

IV. OBJECTIVES

The objective of this dissertation is to make modification with the help of CAD in the existing Drive Shaft and to analyze the modified Drive Shaft with the help of Finite Element Analysis.

The objectives are:

1. To study Power transmission system of car.

2. To find out failure parameters of Drive shaft.

3. To Create Mathematical CAD - Model of front wheel drive Power transmission.

4. To Analyze Drive Shaft for dynamic loading conditions.

To develop a shaft which has higher hardness at the wear point than usual shaft of the portal axle that can accurately simulate its tensional strength by using FEA.

V. DESCRIPTION OF THE PROPOSED WORK

The proposed work for the topic is as follows:

1. A composite material can be defined as a combination of two or more materials that results in better properties than those of the individual components used alone. In contrast to metallic alloys, each material retains its separate chemical, physical, and mechanical properties. The two constituents are reinforcement and a matrix. The main advantages of composite materials are their high strength and stiffness, combined with low density, when compared with bulk materials, allowing for a weight reduction in the finished part.

2. Induction heating is an extremely versatile heating method that can perform uniform surface hardening, localized surface hardening, through hardening, and tempering of hardened pieces. Heating is accomplished by placing a steel ferrous part in the magnetic field generated by high-frequency alternating current passing through an inductor, usually a water-cooled copper coil. The depth of heating produced by induction is related to the frequency of the alternating current, power input, time, part coupling and quench delay.

VI. METHODOLOGY USED

For Design & Modification: CAD.

For Analysis: Finite Element Analysis Method.

VII. CONCLUSION

1. The usage of composite material has resulted to inconsiderable amount of weight saving in the range of 28% when compared to conventional steel shaft.

2. The weight saving, deformation, shear stress induced and resonant frequencies should be considered, it is evident that Kevalar / Epoxy composite has the most encouraging properties to act as replacement for steel out of the considered two materials.

3. The presented work is aimed to reduce the fuel consumption of the automobile in the particular or any machine, which employs drive shafts; in general it is achieved by using light weight composites like Kevelar / Epoxy.

4. The presented work also deals with design optimization i.e converting two piece drive shaft in to single piece light weighted composite drive shaft.

5. The various failure of shaft is discussed in this paper. Some of the failure of shaft is basically due to negligence in repairing and maintenance, special care is to be taken for stress relieving in welding repairing works.

6. The hardness of the shaft at the point of wear can be achieved either by using different material specification or by hardening the material.

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