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DESIGN AND ANALYSIS OF A DRIVE SHAFT SUBJECTED TO STATIC LOADS

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ABSTRACT: Drive shaft is a mechanical component which is used in transmitting the torque and the rotation and can be used in for connecting the components of drive train which can be directly connected to allow a relative movement. The process done here is a drive shaft is designed by using CATIA and it is analyzed a in ANSYS which is software that works on the basis of finite element method.For this process a design is created with some respected dimensions in CATIA software. After the completion of the design model the model is imported into ANSYS and analyzed under some static load conditions, which were considered in designing it and then checked for the hardness and life time. The specifications required for the design are taken for the drafted design.The results obtained in the analysis of a driveshaft, the design is find out to produce more stresses and some modifications were done to the design and again it is analyzed and the stresses developed were lesser when compared to the previous design.

Key words: Drive shaft, CATIA, ANSYS.

1.0 INTRODUCTION

Drive shaft is a mechanical instrument which is used material that has superior properties to those of itsin automobiles. Most popularly this drive shaft is known individual constituents. The constituents areas the propeller shaft, while coming to the construction it combined at a macroscopic level and or not solublewas long cylindrical structure consists of thee universal in each other. The main-difference between joints. Drive shaft is used to transfer the rotary motion to composite and an alloy are constituent materialsthe differential by using the helical gear box. This rotary which are insoluble in each other and the individualmotion is used to run the rear wheels. In many cases we constituents retain those properties in the case ofuse stainless steel shaft for the fabrication of drive shaft. composites, whereas in alloys, constituent materialsThis drive shaft has wide applications in automobile are soluble in each other and forms a new materialworld, used in the vehicles like trucks, buses, aero planes which has different properties from their constituents .

1.1 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 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

1.3 APPLICATIONS OF COMPOSITE MATERIALS:

- The common applications of composites are extending day by day. Nowadays they are used in medical applications too. Some other fields of applications are,
- Automotive : Drive shafts, clutch plates, fiber Glass/Epoxy leaf springs for heavy trucks and trailers, rocker arm covers, suspension arms and bearings for steering system, bumpers, body panels and doors.
- Aerospace: Drive shafts, rudders, elevators, bearings, landing gear doors, panels and floorings of airplanes,
- payload bay doors, remote manipulator arm, high gain antenna, antenna ribs and struts etc.
- Marine: Propeller vanes, fans & blowers, gear cases, valves &strainers, condenser shells.
- Chemical Industries: Composite vessels for liquid natural gas for alternative fuel vehicle, racked bottles for fire service, mountain climbing, underground storage tanks, ducts and stacks etc.
- Electrical & Electronics: Structures for overhead transmission lines for railways, Power line insulators, Lighting poles, Fiber optics tensile members etc.

1.4 TYPES OF DRIVE SHAFT:There are various type of transmission shaft among them following are important

• Transmission shaft.

• Machine shaft.

• Spindle.

• Automobile drive shaft.

• Ship propeller shaft.

• Helicopter tail rotor shaft.

These drive shafts can be manufactured by replacing the stainless steel with the composite materials.

1.5 DESCRIPTION OF THE PROBLEM

Almost all automobiles (at least those which correspond to design with rear wheel drive and front engine installation) have transmission shafts. The weight reduction of the drive shaft can have a certain role in the general weight reduction of the vehicle and is a highly desirable goal, if it can be achieved without increase in cost and decrease in quality and reliability. It is possible to achieve design of composite drive shaft with less weight to increase the first natural frequency of the shaft and to decrease the bending stresses using various stacking sequences. By doing the same, maximize the torque transmission and torsional buckling capabilities are also maximized

MERITS OF COMPOSITE DRIVE SHAFT

- They have high specific modulus and strength.
- Reduced weights.
- Due to the weight reduction, fuel consumption will be reduced
- They have high damping capacity hence they produce less vibration and noise
- They have good corrosion resistance
- Greater torque capacities than steel or aluminum shaft
- Longer fatigue life than steel or aluminum shaft
- Lower rotating weight transmits more of available power

BACKGROUND:A drive shaft is a mechanical device for transferring power from the engine or motor to the point where useful work is applied. Most engines or motors deliver power as torque through rotary motion. This is extracted from the linear motion of pistons in a reciprocating engine. From the point of delivery, the components of power transmission from the drive train. The drive shafts are carriers of torque which are subject to torsion and shear stress, which represents the difference between the input force and the load. They thus need to be strong enough to bear the stress, without imposing too great an additional inertia by virtue of the weight of the shaft. Today, composite drive shafts are mostly used in vehicles.

2.LITARATURE REVIEW:

[1] Weston et al. (2010):the possibilities of replacing the conventional steel material by composites in the field of automobile. Describe the possibilities of composites used to replace the steel leaf spring as well as steel drive shaft. The advanced composite materials such as graphite, carbon, Kevlar and glass with suitable resins are widely used because of their high specific strength (strength / density) and high specific modulus (modulus / density). The first application of composite drive shaft to automotive was the one developed by Spicer U-joint divisions of Dana Corporation for the Ford economize van models in 1985.

[2] Beard more et al. (2012): It is also states the potentials of composites in structural applications. Conventional steel drive shafts are manufacture in two pieces to increase its fundamental natural bending frequency. The conventional assembly of drive shaft is made up in two pieces and joined together by u-joints due to which the overall weight of the assembly is increased. The composite drive shaft has advantages like considerable weight reduction, symmetric composite assured the dynamic balance of increasing operating speed, electrically non-conductive, custom end fitting considerations, vibrations and harshness (NVH), long fatigue life and also it reduce the bearing & journal wear.

[3] Proskuryakov [2009]The demonstrated successful burnishing on thin walled components. He also developed empirical relations for elongation and burnishing inference in case of bush blanks. investigated the plasticity effects as compared with tool-like machining of unhardened steels. The efficiency of the surface work hardening method in increasing fatigue strength of martensitic stainless steel in assessed developed an automatic control system for plastic deformation, when components are being burnished. Developed a vibratory burnishing method for improving lubrication - retention in precision joints.

[4] Chaithanya G Rothe[2010] et., al.broke down the outline requirements because of the physical geometry (bigger range)range) of the drive shafts utilized as a part of the said applications, including car applications, the shear quality which determines the heap conveying limit, is of minor plan significance since the disappointment mode is commanded by clasping; along these lines, the fundamental outline components are the twisting common recurrence and the torsional clasping quality, which are elements of the longitudinal and loop bowing firmness, individually. The variable of the cover thickness bigly affects the clasping quality, and a slight impact on the bowing regular recurrence.

METHODOLAGY:

3.1 The methodology as per follows:

- The specification of the shaft for its loading and operating conditions
- Obtaining 2D drawing loading conditions from design conditions
- Preparation of 3D finite element model using hyper mesh
- The above hyper mesh model analysis in Ansys 14.0 or 16.0 comparison between the results

  Obtained from theoretical calculation and the result taken from Ansys 16.

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Parameter of Shaft	Symbol	Value	Unit
Outer Diameter	do	90	mm
Inner Diameter	di	83.36	mm
Length of the Shaft	L	1250	mm
Thickness of shaft	T	3.32	mm

3.2 DESIGN OF STEEL DRIVE SHAFT

mass of the steel drive shaft, "m= ρal= ρ × π/4 × (do2- di2) ×l"… (1)

= 7600 x 3.14/4 x (902 – 83.362) x 1250

[m = 8.58 kg]

torque transmission capacity of steel drive shaft, "t= ss× π /16 × [(do4- di4) × do]" … (2)

[t = 55.93 ×103 n-m]

Fundamental natural frequency, the natural frequency can be found by using the two theories:

1) Timoshenko beam theory

2) Bernoulli Euler theory

Timoshenko beam theory-ncrt "fnt= ks (30 π p2) / l2 x √ (er2 / 2ρ)"…..(3)

"ncrt = 60 fnt"….. (4)

fnt= natural frequency base on Timoshenko beam theory,

hzks = shear coefficient of lateral natural frequency

p = 1, first natural frequency

r = mean radius of shaft

fs = shape factor, 2 for hollow circular cross section

n = no of ply thickness,

1 for steel shafts "1 / ks 2= 1 + (n2π 2 r2) / 2l2 x [1 + fs e / g]"…. (5)

1 / ks 2 = 1+ (12π 2 86.822) / 2 x12502 x [1 + 2x207x103 / 80 x103]

[ks= 0.982]

fnt= 0.982 (30 x π x 12) / 1250 x √ (207x103 x 86.682/2x 7600)

[fnt= 299.54 hz]

[ncrt = 17972.4 rpm]

3.3 ASSUMPTIONS:

- The shaft rotates at a constant speed about its longitudinal axis.
- The shaft has a uniform, circular cross section.
- The shaft is perfectly balanced, i.e., at every cross section, the mass center coincides with the geometric center.
- All damping and nonlinear effects are excluded.
- The stress-strain relationship for composite material is linear & elastic; hence, Hooke's law is applicable for composite materials.

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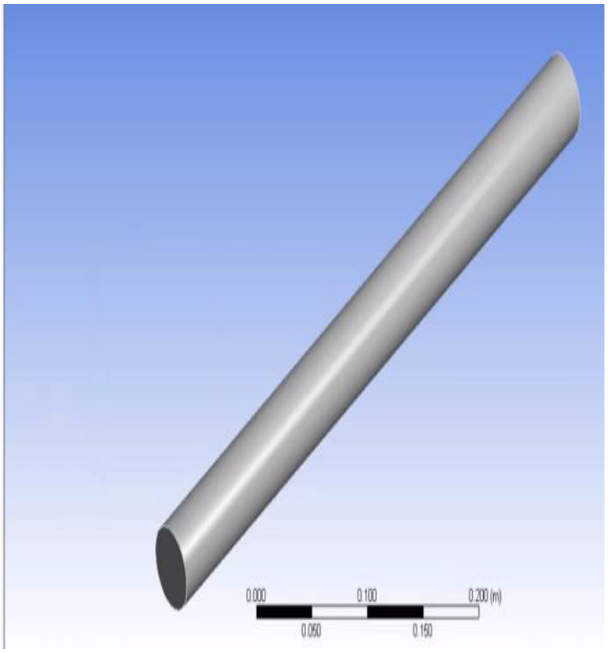
Acoustical fluid interactions are neglected, i.e., the shaft is assumed to be acting in a vacuum.



3.1 Modelling View Drive Shaft

3.4 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.

MESHING

- A static analysis can however include steady inertia loads such as gravity, spinning and time varying loads. In static
- The Figure shown is the meshed model of rigid flange coupling in the ANSYS analysis for the static structural process.
- To analyses, the FEM triangular type of mesh is used for the rigid flange coupling in the ANSYS environment.
- The number of elements used in this meshing is 71441and the number of nodes is 122228.In this process regular type of meshing is done to analyse the process.
- Using the working condition of the coupling a relative rotational movement between the shafts comes into picture consequently.

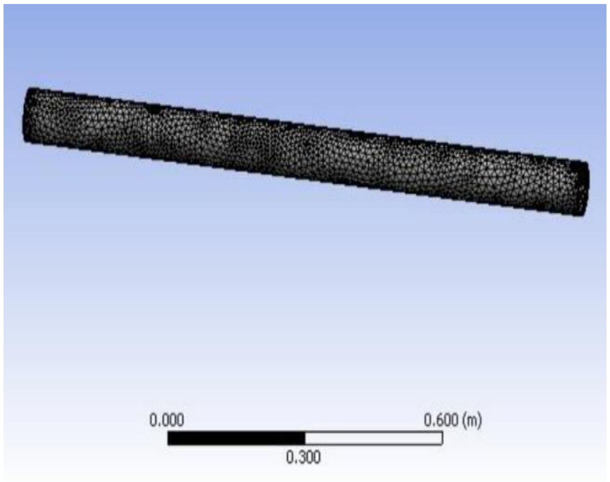
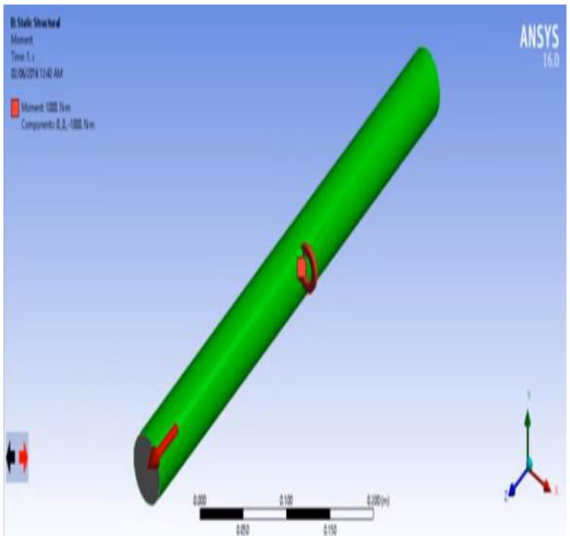


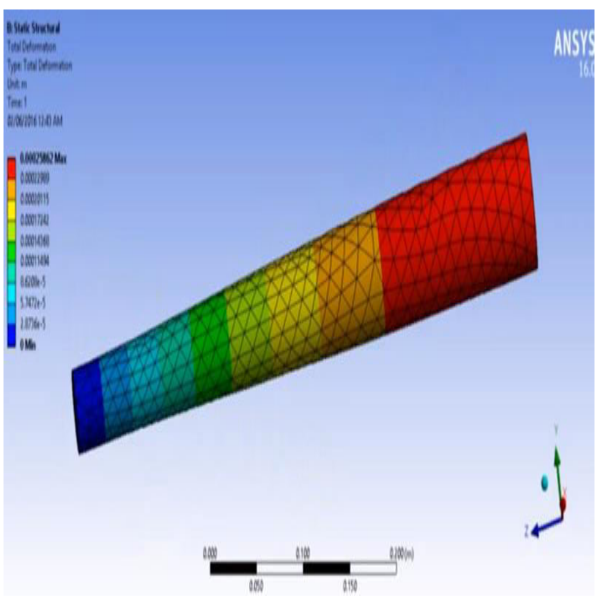
Figure 3.2 Meshing Model Of Drive Shaft

RESULTS:

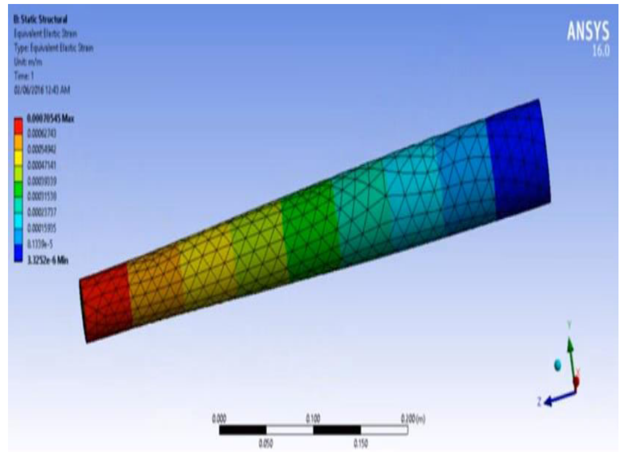
4.1 DRIVE SHAFT WITH STAIN LESS STEEL



4.1 Static Structural Of The Drive Shaft



4.2 Total Deformation



4.3 Equivalent Elastic Strain

4.2 Drive Shaft With Chromium Alloy

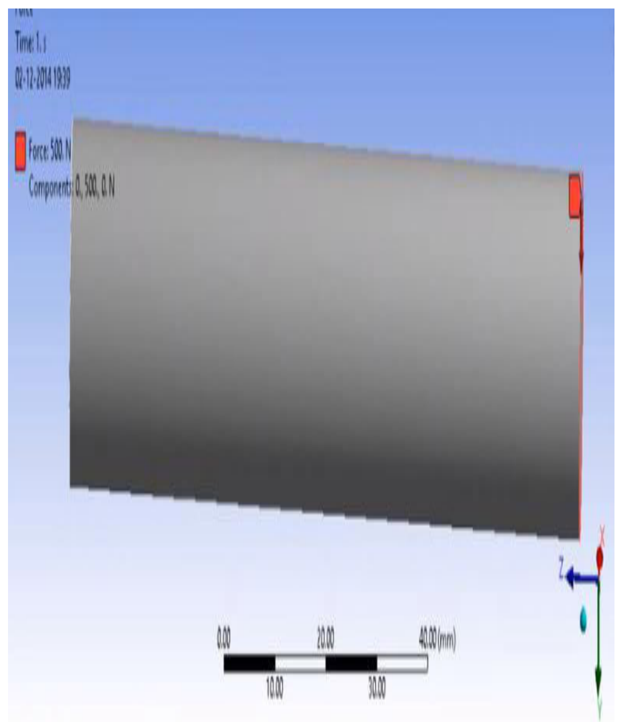


Figure 4.4 Static Structural Of The Drive Shaft Maximum Force

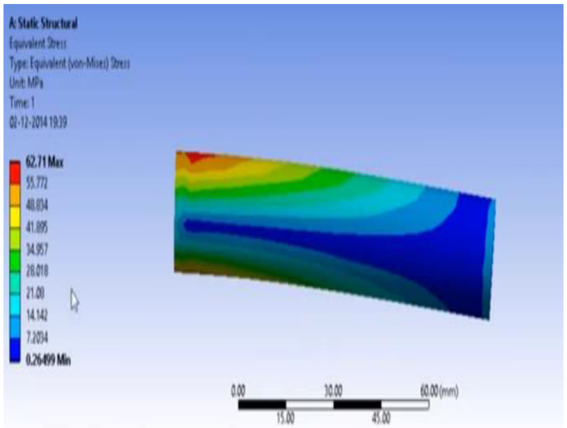


Figure 4.5 Equivalent Von Mises Stress

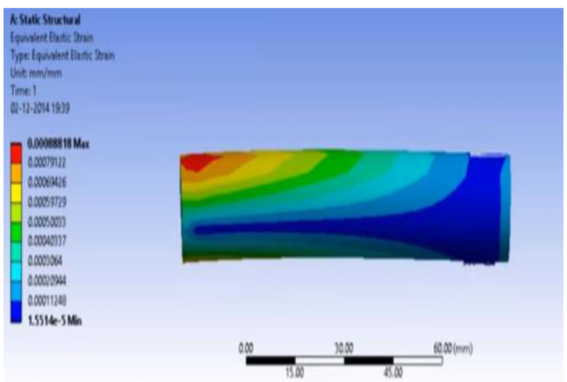
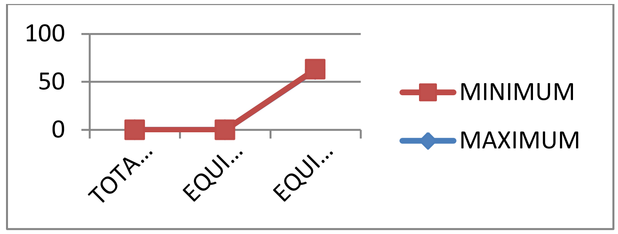


Figure 4.6 Equivalent Elastic Strains

PARAMETERS	MAXIMUM	MINIMUM
TOTAL DEFORMATION	0.00025462	0
EQUIVALENT ELASTIC STRAIN	0.00088818	1.5514e-5
EQUIVALENT VON MISSES STRESS	62.71	0.26499



CONCLUSION:

The driveshaft with modified dimensions is compared to the original dimensions and it is found that the driveshaft with modified dimensions is giving better results than the original one. The deformation of the design is lesser than the original model. Designed drive shaft using stain less steel and chromium materials applied We suggest the modified model for the required engine.The usage of composite material has resulted to inconsiderable amount of weight saving in theWhen compared to conventional steel shaft The presented work was aimed to reduce the Fuel consumption of the automobile in the particular or any machine By taking into considerations the weight saving, deformation, composite has the most encouraging properties to act as replacement for steel out of the considered two materials.

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