Stress Analysis of Drive Shaft of an Automobile

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Abstract— In automobiles, axle shafts are used to connect wheel and differential at their ends for the purpose of transmitting power and rotational motion. In operation, axle shafts are generally subjected to torsional stress and bending stress due to self-weight or weights of components or possible misalignment between journal bearings. Thus, these rotating components are susceptible to fatigue by the nature of their operation and the fatigue failures are generally of the torsional, rotating-bending, and reversed (two-way) bending type.
Key words: Stress Analysis, Drive Shaft

I. Introduction

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.

THEORY OF TORSION [7]

$$\frac{T}{J}=\frac{\tau}{r}=\frac{G\theta}{L}$$

Where,
T = the internal torque at the analyzed cross-section;
G = shear modulus of elasticity for the material;
L = Length of drive shaft;
r = radial distance from the axis (center);
θ = Angular deflection;
τ = Shear stress;
J = the shaft's polar moment of inertia;

$$J=\frac{\Pi}{32}(d_o^4-d_i^4)$$

d_o = Outer diameter of shaft;
d_i = inner diameter of shaft.
Available data:
d_o=100mm; d_i = 50mm; L = 900mm; G = 7.6923E+4 MPa.
T_{max} = 59000Nmm [8]

II. Analysis

Since the domain for analysis is a complex assembly of a number of parts, ANSYS 15.0 Workbench has chosen for performing the analysis. The proper connection between each part of the assembly and the subsequent connectivity of is the key criteria for getting proper load transfer throughout the assembly. The workbench module of ANSYS 15.0 does not require the specification of element by the user, depending upon the assembly, the element types are chosen by the solver to get the best possible results. . The analytical result is compared with ANSYS result. The detailed procedure and results are as follows.

Material: Material used for the analysis is steel having the value of Young's Modulus (E) 2.1×10^5 MPa.

Geometry: In Ansys workbench 15.0 the model is inserted using the "Geometry" property.

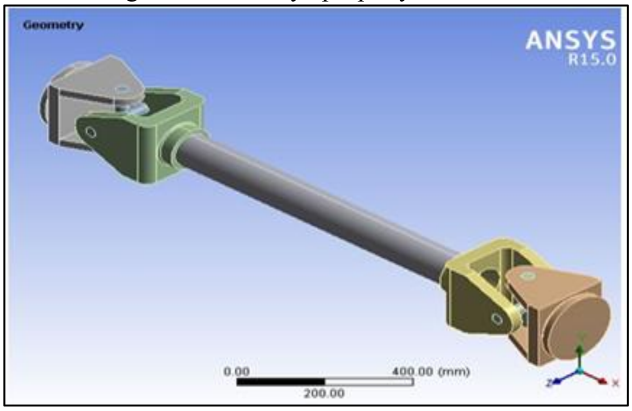

Fig. 1: Geometry of Drive Shaft

By selecting the 5 mm element size the inserted model is meshed. After meshing the model, shaft is fixed at one end by using the static support.

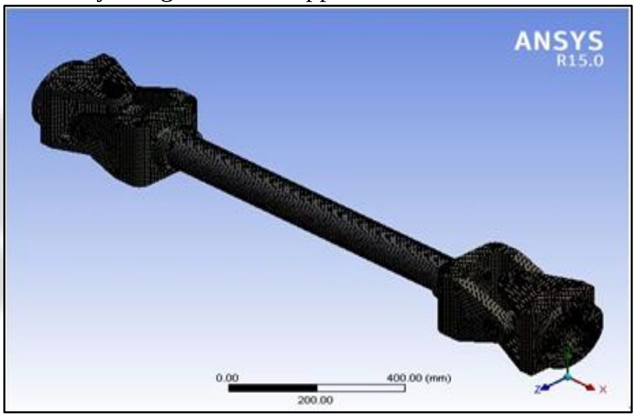

Fig. 2: Meshing of Cad Model using ANSYS

III. Loading

Moment is applied at the other end of shaft with magnitude 59000Nmm.

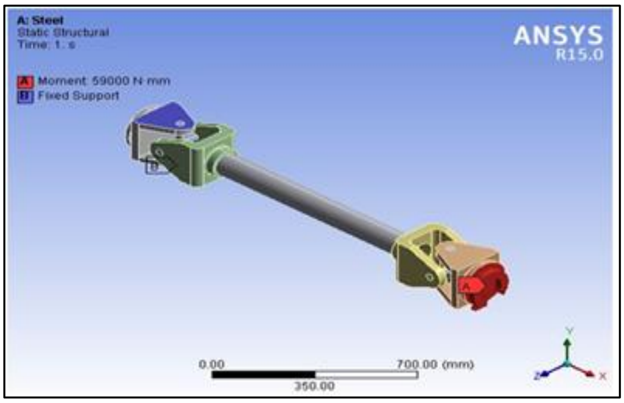

Fig. 3: Loading Condition

A. Solver

By using ANSYS solver, total deformation and maximum shear stress are found out.

B. Results

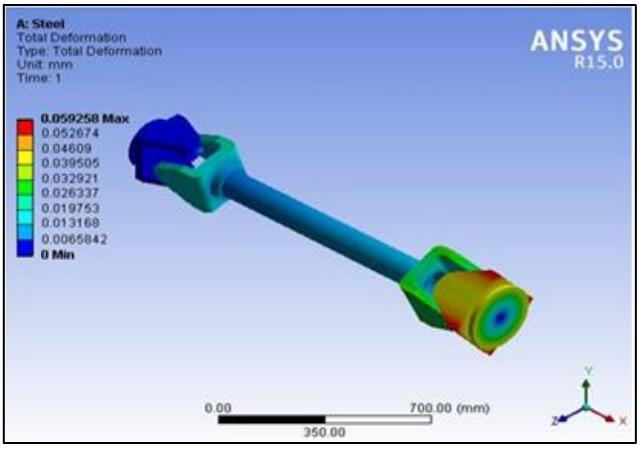

Fig. 4: Total Deformation

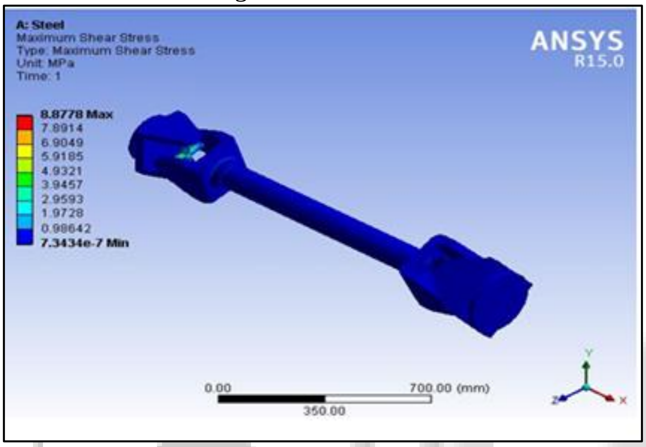

Fig. 5: Maximum Shear Stress

Results	Analytical Result	ANSYS Result
Total Deformation	0.0438	0.05925
Maximum shear	7.202	8.877

Table 1: Total Deformation and Maximum Shear Stress for Steel

IV. Future Scope

1) Fatigue failure analysis of drive shaft.
2) With usage of composite drive shaft, will find out the weight savings.
3) Finding the Natural frequency of drive shaft by FFT analyzer and ANSYS.

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