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Stress Analysis of a Shaft Using Ansys

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Abstract: This project deals with the stress analysis of a shaft using Ansys. The shaft which is fixed at one end is selected and forces are given at particular points. The reactant forces acts in opposite directions. Torque acts at two points in opposite directions. The reactant forces and bending moments are initially calculated. Based on these parameters, the maximum shear stress, normal stress are calculated. The same values are used then calculated by using ANSYS software. Finally the theoretical and analytical results are compared and verified.

Key words: Splines · Keyways · Gears · Pulleys · Bearings

INTRODUCTION

Shaft: 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. 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.

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.

Classification of Shafting
For Prime Movers:

- Engine shafts
- Generator shafts
- Turbine shafts

For Power Transmission:

- Line shafts
- Contour shafts

Materials: Mild-steel for ordinary shafts. Alloy steel (nickel, nickel-chromium and nickel-vanadium steels) when greater strength is required, as in high speed machinery. Alloy steel shafts are always heat-treated (surface hardening).

Manufacture of Shafts:

- Hot rolled bar is turned and ground.
- Cold rolled or cold drawn shafts are of fairy uniform diameter and good surface finish. They canbe directly used for transmission shafting without machining. Machinery shafts are made of stepped to provide shoulders for locating gears, pulleys, bearings etc.Splines, keyways etc., are machined on the shafts to secure gear wheels, pulleys etc.

Design of Strength: At various sections of the shaft will lead to misalignment of mating parts and non uniform distribution of loads. In machine tool spindles deflection will affect the accuracy of parts machined. In these cases, strength as well as bending stiffness and torsional stiffness are the criteria for design. While designing as per

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standards, for line shafting, deflection should not exceed 0.2 mm per metre length of the shaft. Twist should not exceed 0.25 degrees per metre for machine tools. Bending deflection is inversely proportional to EI (flexural rigidity) and torsional twist is inversely proportional to to GJ (torsional rigidity).

Wear Resistance: Wear resistance is obtained by hardening shaft surface. Low carbon steel shafts are carburised or nitride. If the steel has sufficient carbon content, surface hardening is given.

Hollow Shafts: For the same cross sectional area (weight), hollow shafts are stronger and more rigid than solid shafts. But hollow shafts are more expensive.

Critical Speed Shafts:

- The centre of gravity of the loaded of the loaded shaft will lbe displaced from the axis of the rotation due to one or more of the following reasons.
- Eccentric mounting of rotors
- Lack of straightness of the shaft
- Bending under the action of gravity in case of a horizontal shaft

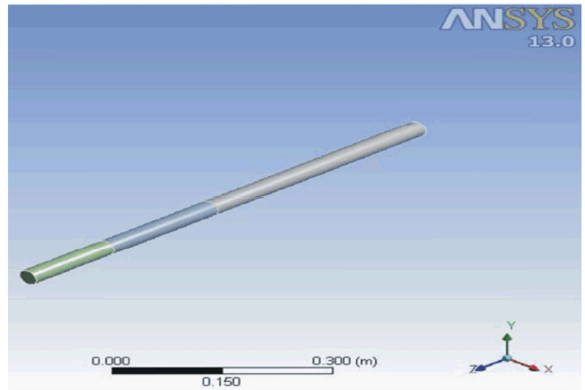
When the shaft begins to centrifugal force is balanced by the inward elastic pull. The shaft deflection is a function of shaft speed and it reaches maximum value at a particular speed known as the critical speed. The natural frequencies of lateral vibrations of the shaft is same as that of critical speed. The shaft should not be run at the critical speed. Because excessive defletion will result in the failure of the shaft. Due to damping, friction in bearings and effect of environment the shaft does not fail instantaneously. If the shaft passes quickly through the zone of critical speed, no damage will be done.

Objective of the Project: The objective is stre analysis and to calculate various stress acting on it by the given values. Then, the dimensions are introduced in the Ansys software and then the results are tabulated. Finally the theoretical and analytical results are compared and then concluded.

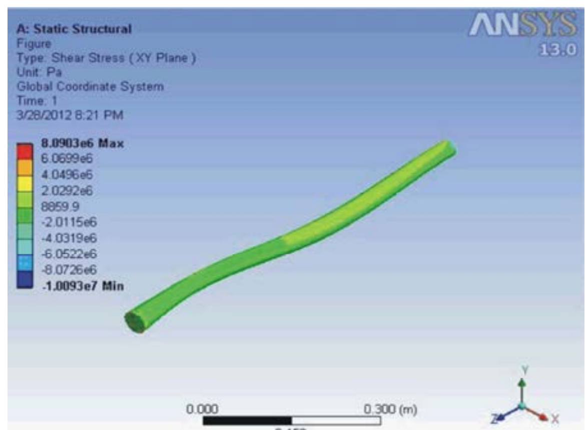
Design Calculation: Dimensions:
Diameter of the shaft = 32 mm
Length of the shaft = 750 mm
Force at the point A = 5.4 KN
Force at the point B = 5.4 KN
Torque = 600 Nm
Equivalent force

$R_O + R_B - F_A - F_C = 0$

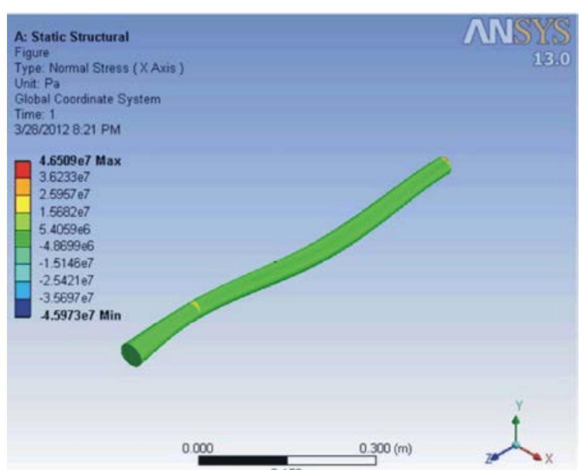
$R_O + R_B = F_A + F_C$



SHAFT



SHEAR STRESS



NORMAL STRESS

CONCLUSION

The design parameters of the shaft has been taken from standard values and it has been designed to ansys. It was found that the maximum shear stress value found by theoretically is 8.01 Mpa and by ansys is 8.09 Mpa. Therefore the stress values are with the permissible limit and the design is safe.

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