# VIBRATION ANALYSIS ON A PROPELLER SHAFT

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**Abstract-**

A simple, practical and sufficiently accurate method for finding the natural frequencies of a propeller shaft assembly is described. The need for such methods is felt at the early design stages. when sufficient data about the system are not available and the need to restrict the cost of analysis is important. Forward and reverse whirl speeds are calculated. A propeller shaft or Cardan shaft is a mechanical component for transmitting torque and rotation, Crack is a common structural defect which may lead to improper functioning which may destroy the structure. 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. It is necessary to identify the presence of crack in a propeller shaft and its response with respect to location and depth of the crack at various operating angles. The modeling of propeller shaft, universal joint and the experimental setup is done using Pro/ENGINEER Wildfire Modal and Harmonic analysis on propeller shaft with crack is done using Finite Element Analysis, with help of ANSYS. The parameter like deflection, stresses, and natural frequencies under subjected loads using FEA will be studied. The natural frequency, Harmonic Analysis of Propeller Shaft with system at operating angle $\alpha = 0°$, $10^o$ and $15^o$ are studied.

## I. INTRODUCTION

Cracks appear in the propeller shafts either due to manufacturing flaws or fatigue during operation. Failures may occur due to high or low cycle fatigue, appeared crack potentially propagates sufficiently to cause total failure of the propeller shaft. Transverse cracks frequently occur in the rotating shafts under rotating forces. Hence it's necessary to identify the presence of crack in a propeller shaft and its response with respect to location and depth of the crack at various operating angles.

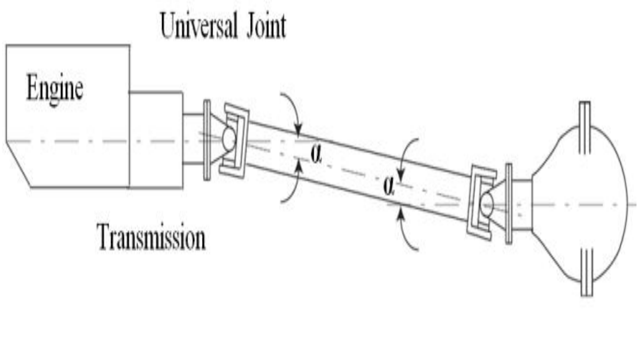
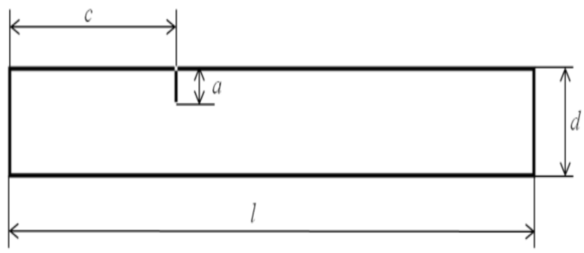



Fig 1: Propeller shaft




α–Operation angle of propeller shaft
*l*–Length of the propeller shaft
*c*–Location of crack
*d*–Diameter of shaft and *a*–Depth of crack?><
Fig 2: Line diagram of propeller shaft

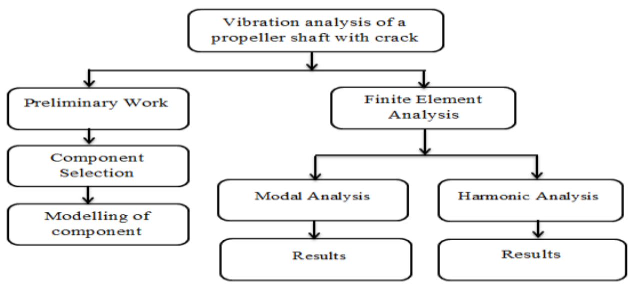



Fig 3: Theme of work

## II. EXPERIMENTAL WORK

Specifications of the Propeller shaft and Universal joint

For the finite element analysis a propeller shaft of length 615 mm and 50 mm diameter with wall thickness of 27 mm. The joint length is 55 mm, 65 mm yoke length and 25 mm yoke diameter. The Material of universal joint, propeller shaft is chosen as H-Steel Alloy as per AISI 5046H and AISI 94B30H respectively and their properties are shown in following tables Table 1.

**Table. 1 Mechanical Properties of Universal Joint and Propeller shaft**

| Properties | Values at 25 °C |
|---|---|
| Density | $7.7 \times 10^{-3}$Kg |
| Poisson's Ratio | 0.27 |
| Young's Modulus | $190\times10^{9}$ N/m$^{2}$ |

2.2 Propeller Shaft and Universal Joint

The propeller shaft and universal joint is modelled using Pro/ENGINEER Wildfire 4, according to the dimensions and then assembled. The modelled propeller shaft with Universal joint is shown in the Figure.1 followed by the assembly of propeller shaft and universal in Figure 3.

Fig.4 Propeller Shaft with U-Joint

Fig.5 Assembled Propeller Shaft with U-Joint

## III. RESULTS AND DISCUSSION

3.1 Harmonic Analysis of Propeller Shaft with Crack

Harmonic Analysis at Operating Angle α = 0°

Harmonic analysis of the propeller shaft system at operating angle α = 0° is carried out without crack and with crack at various crack depth and crack locations. The following diagram Figure 4 shows the propeller shaft system at operating angle α = 0°.


Fig.6 Propeller Shaft System at Operating angle α = 0°

At crack location c = 25mm and crack depth a = 2mm, 4mm, 6mm and similarly with change in c =275,525 mm Graph are plotted.

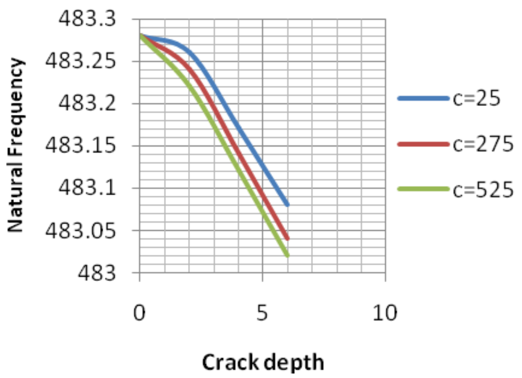



Fig 7: Title - Harmonic Analysis at Operating Angle α = 0°

3.2 Harmonic Analysis at Operating Angle α = 5°

The Harmonic analysis of the propeller shaft system at operating angle α = 5° is carried out without crack and with crack at various crack depth and crack locations. The following diagram Figure 8 shows the propeller shaft system at operating angle α = 5°.

Fig.8 Propeller Shaft System at Operating angle α = 5°

At crack location c = 25mm and crack depth a = 2mm,4mm, 6mm and similarly with change in c =275,525 mm Graph are plotted.

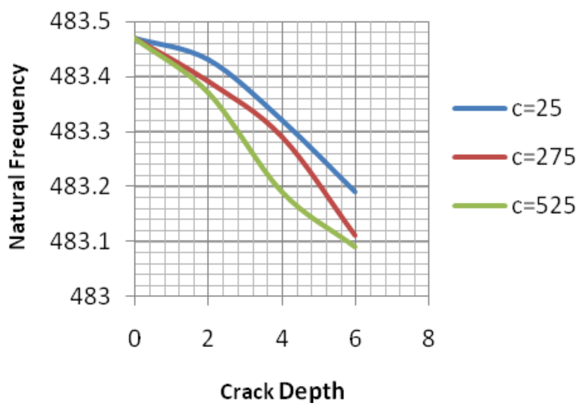



Fig 9: Title - Harmonic Analysis at Operating Angle α =5°

3.3 Harmonic Analysis at Operating Angle α = 10°

The Harmonic analysis of the propeller shaft system at operating angle α = 10° is carried out without crack and with crack at various crack depth and crack locations. The following diagram Figure 10 shows the propeller shaft system at operating angle α = 10°.

Fig.10 Propeller Shaft System at Operating angle α = 10°

At crack location c = 25mm and crack depth a = 2mm,4mm, 6mm and similarly with change in c =275,525 mm Graph are plotted.

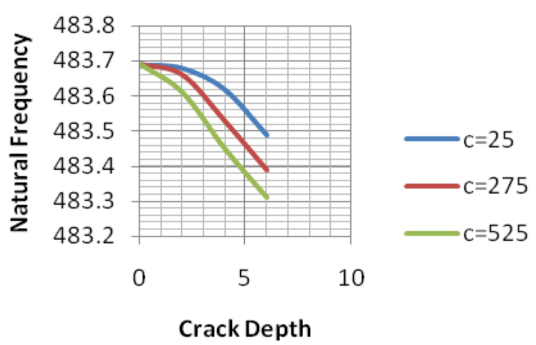



Fig 11: Title - Harmonic Analysis at Operating Angle α =10°

3.4 Results Analysis of Natural frequency

From the modal analysis the natural frequency of the propeller shaft assembly without crack and with crack at various positions and depth were obtained. The following graphs were plotted by interpolating the natural frequency obtained with crack depth. Natural frequency decrement of the propeller shaft system at operating angle α = 0°for the crack depth (a) 2mm, 4mm, 6mm and crack locations (c) 25mm, 275mm and 525mm is plotted in the Figure 7

## IV. CONCLUSION

Cracks are one of the major defects which affect the performance of the rotating machinery. Cracks may appear in the propeller shafts either due to manufacturing flaws or fatigue during operation. Failures may occur due to high or low cycle fatigue. The appeared crack potentially propagates sufficiently to cause total failure of the propeller shaft. Transverse cracks frequently occur in the rotating shafts under rotating forces.

The presence of cracks, its effects based on crack location and depth with respect to various operation angles were analyzed in the propeller shaft system. The analysis is to be done using Finite Element Analysis.

The modal analysis was carried out for the propeller shaft system and the natural frequencies of the system were obtained. It is observed that the natural frequency of the system reduces in presence of crack and further reduces when the crack depth increases. Hence the decrease in natural frequency of the propeller shaft system is a factor to identify the crack presence and to identify the increase in crack depth of the propeller shaft system.

From the harmonic analysis it is observed that the amplitude of the propeller shaft increases with the increase in the crack depth. A second peak appeared in the Frequency vs Amplitude plot when the operating angle was varied.

## REFERENCE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