Modal and Fatigue Analysis of Decanter Centrifuge Rotor using ANSYS

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Abstract- *The functioning of a decanter centrifuge is of separating solid materials from liquids in slurry. Within few seconds the liquid gets separated from solid. At high RPM of vane drum i.e. 2000 rpm of centrifuge decanter rotor, there are chances of damage and they must be verified as rotary parts are restricted to a certain rpm. Beyond certain limit, they cause destruction to machine. Hence to select the appropriate centrifuge decanter is important. Modal and fatigue analysis of decanter centrifuge rotor is done with the obtained data to find if design is safe and results are discussed.*

Keywords- Decanter Centrifuge Rotor, solid liquid separation, Rotor speed rpm, Modal Analysis, Fatigue Analysis.

I. INTRODUCTION

A decanter centrifuge rotor has high rotational speed which separates components of different densities. Due to the gravity separation, component with a higher density falls to the bottom of a mixture, and the less dense component is suspended above it. Separation takes place in a horizontal cylindrical bowl equipped with a screw conveyor

The solid - liquid mixture enters the decanter bowl through a stationary inlet tube and it is accelerated smoothly by an inlet distributor. The centrifugal force which results from the rotation then causes sedimentation of the solids on the wall of the bowl. The conveyor and bowl rotate in the same direction and moves the solids towards the conical end of the bowl. Separation takes place throughout the entire length

II. MODAL ANALYSIS OF DECANTER CENTRIFUGE ROTOR

Modal Analysis helps in finding out the vibration characteristics like the natural frequency as well as the mode shape also called as the deformed shape of a structure or a machine component. When the rotor of decanter centrifuge machine vibrates, the various deformed shapes are found at certain frequencies. The actual objective behind performing the modal analysis is to find whether the natural frequency of component is nearer to the vibrations induced in the component. If the natural frequency of the scroll is nearer to the excitation frequency, the machine part goes into resonance and fails. Modal Analysis of decanter centrifuge rotor is as under:

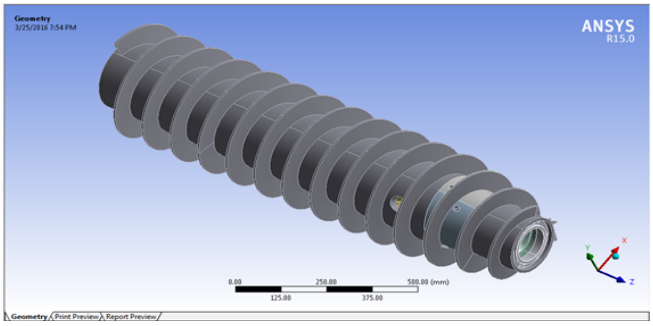

Figure 3: Geometry of rotor in modal analysis

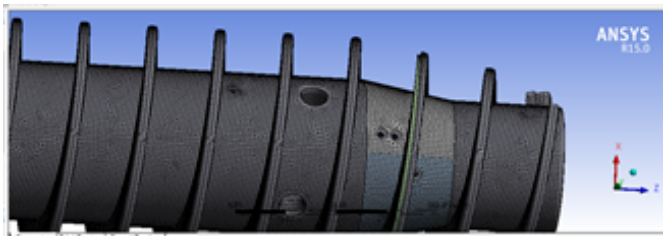

Figure 4: Meshed model of rotor in modal analysis

Quality of mesh was not fine around circular regions in the model, the next step was to discretize the model in such a manner that a smooth transition was achieved around circular edges. By expanding the Sizing node in the details of "Mesh" window, and finishing the procedure for fine meshing the total element count with the optimized model was 881970.

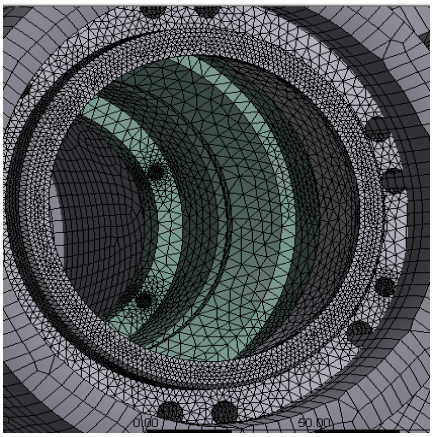
Figure 5: Fine meshing of rotor in modal analysis

Applying boundary conditions means to select the modal node in the Tree outline and give Supports>Fixed Support.

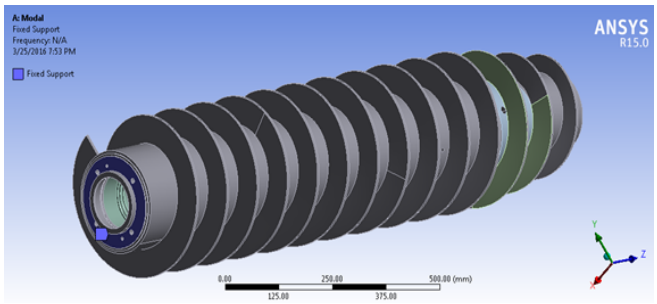

Figure 6: Applying boundary conditions

IV. FATIUGE ANALYSIS OF DECANTER CENTRIFUGE ROTOR

Machine parts do work properly while the initial phase of life but they fail in service due to fatigue failure caused by repeated cyclic loading. If the load is repeated sufficient number of times, in actual practice, loads significantly below static limits can cause failure. The aim of fatigue analysis is finding the capability of a material to survive the many cycles a component may experience during its lifetime. Strain can be directly measured and is an excellent quantity for characterizing low-cycle fatigue. Strain Life is typically concerned with crack initiation. In terms of cycles, Strain Life typically deals with a relatively low number of cycles and therefore addresses Low Cycle Fatigue (LCF), but works with high numbers of cycles as well. Low Cycle Fatigue usually refers to fewer than 105 (100,000) cycles. The Strain Life approach is widely used at present. Fatiuge analysis is done below:

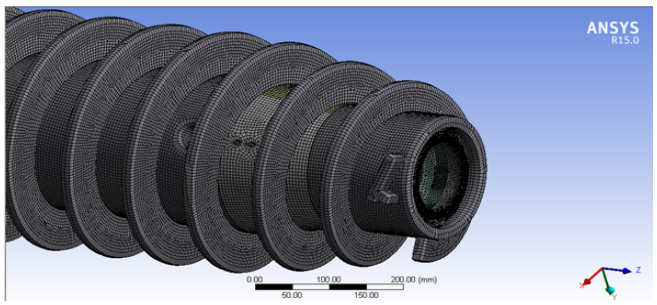

Figure 7: Fine Meshing in Fatigue Analysis

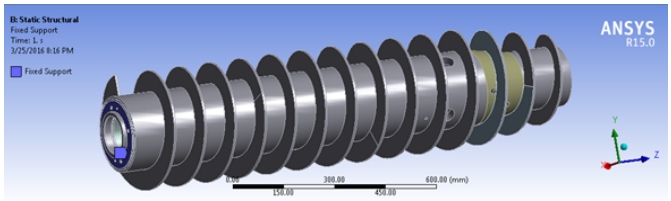

Figure 8: Apply constraints i.e. Fixed Support in Fatigue Analysis

The next step is to apply moment. Moment is the product of force into radius and the magnitude received is applied on the end of the decanter centrifuge rotor.

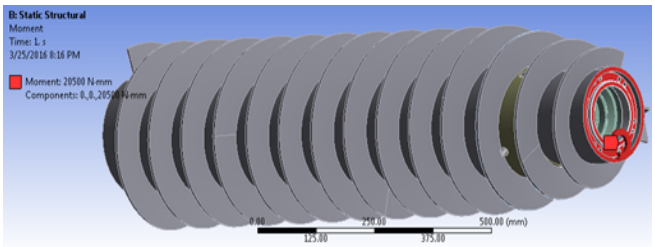

Figure 9: Apply Boundary conditions i.e Moment in Fatigue Analysis

V. RESULTS OF MODAL AND FATIGUE ANALYSIS

There were total 10 modes selected while doing the modal analysis of decanter centrifuge rotor machine. After the model is solved, the mode shapes are found. The frequencies and the total deformation of all the 10 mode shapes are illustrated in the following figures.

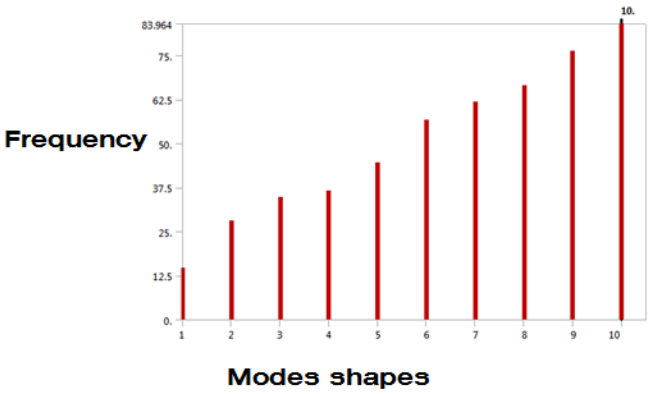

Figure 10 Graph of frequency at modes in modal analysis

By selecting the total deformation under the Solution node in the Tree outline; the results of mode shapes are displayed in the Graphics screen. The mode shapes 3 was found critical i.e. Near to the natural frequency hence their chance of getting near to resonance is more.

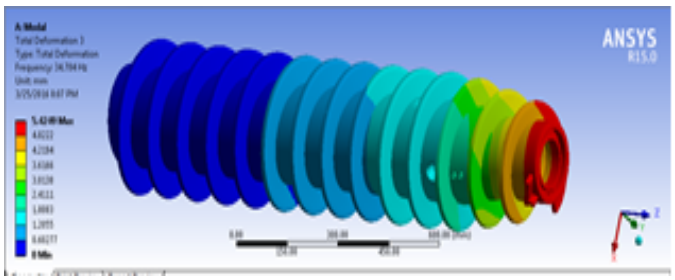

Figure 11: Mode shape 3 of modal analysis

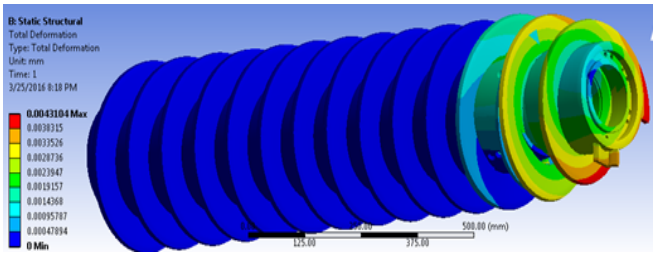

Figure 12: Result showing total deformation in Fatigue Analysis

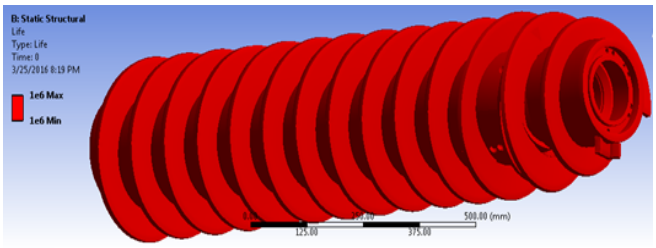

Figure 13: Result showing fatigue life in Fatigue Analysis

As seen from the above generated diagram we observe that the existing model with set parameters will fail after performing 105 successful cycles, so it is under the finite life region, and for product improvement we have to modify the design parameters so it can be transferred to the infinite life region.

IV. CONCLUSION

Results indicates that the modal and fatigue analysis of decanter centrifuge machine is attempted by various investigations for various conditions. At 2000 rpm the design is safe. Further at 3000 rpm the design can be verified hence the scroll design will be changed and further again the modal analysis and fatigue analysis can be carried out. Hence Design and Analysis of centrifuge rotor using ANSYS is an interesting area for investigation.

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