

## **EXPERIMENTAL AND NUMERICAL MODAL ANALYSIS OF THE BACKWARD BLADED IMPELLER OF CENTRIFUGAL PUMP.**

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***ABSTRACT:*** A rotating centrifugal pump impeller is the component which converts the energy of flowing fluid into mechanical energy. Forces are exerted on a centrifugal pump impeller due to the asymmetry of the flow caused by the volute or diffuser and to the motion of the center of the impeller whenever the shaft whirls. The blades of the impeller experiences very high cycle fatigue and failure of a single blade may lead to major secondary damage of the machine. To design reliable impellers, the blade and disk, modal analyses are of the utmost important. In this research attempt has been made to study the dynamic behavior of the backward bladed impeller. Software Modal analysis has been carried out using Creo 2.0. Total 10 mode shapes & frequencies has been extracted from the software. The maximum deformation found from the mode shape is 1mm. The frequencies found from the software analysis is in the window of 0- 38 Hz.

***Keywords:*** centrifugal pump impeller, dynamic behavior, mode frequency, mode shape.

### **INTRODUCTION**

In the past two decades, modal analysis has become a major technology in the quest for determining, improving and optimizing dynamic characteristics of engineering structures. Not only has it been recognized in mechanical and aeronautical engineering, but modal analysis has also discovered profound applications for civil and building structures, biomechanical problems, space structures, acoustical instruments, transportation and nuclear plants. The application scope of modal analysis is expected to undergo significant expansion in the coming years. Practical applications of modal analysis are largely related to the advances in experimental technology. It is impossible to introduce all these applications; however, a narration of these practical applications embracing a number of typical areas will help to illuminate the understanding of modal analysis and it's potential. The majority of practical application cases reported in the literature have been those from aeronautical engineering, automotive engineering and mechanical engineering in particular.

### **EXPERIMENT ANALYSIS AND RESULT**

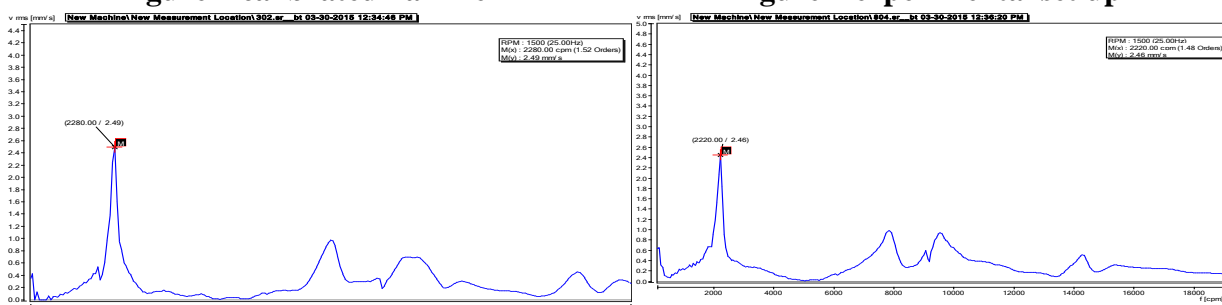
In experimental testing the basic need is to excite the structure. For that impact hammer test is adopted in this research. As shown in figure 1 an impact is made on the structure with the help of calibrated hammer having a different magnitude.



Figure 1 calibrated hammer



Figure 2 experimental set up



(a) 302 gm hammer result

(b) 804 gm hammer result

Figure 3 experimental study results

The two hammers having 302 gm and 804 gm is used for impact purpose. In figure 2 the experimental set up shown. A sensor is placed on the structure in order to record the frequency of the object. As the sensor senses the frequency of the structure it gives signal to Vib-expert which shows the output of the frequency by which the structure is vibrating. In figure 3 the results of experimental study are shown. From the experimental results. From the experimental results it can be concluded that the natural frequency of the structure does not depend upon the magnitude of the excitation force.

### NUMERICAL MODAL ANALYSIS AND RESULT

For the numerical modal analysis Creo 2.0 is used. The numerical modal analysis works on the theory of the Eigen value Eigen vector theorem. The Eigen value represent the mode frequency and the Eigen vector represents the mode shape.



Figure 4 meshing of the model of impeller

Table 1 mesh statistics

|                    |             |
|--------------------|-------------|
| Number of nodes    | 2605        |
| Type of element    | tetrahedral |
| Element size       | 10          |
| Number of elements | 7947        |

Mode frequency can be defined as the frequency by which the structure vibrates after the excitation and mode shape can be defined as the parameter that represent the deformation of the structure due to the excitation force given by hammer. The basic steps to conduct the numerical modal analysis is preprocessing, boundary condition and then the solve phase. Figure 4 shows the meshed model of the impeller. Figure 5 shows the 10 number of mode shapes which are extracted from the software. From the software modal analysis it is clear that the maximum amount of deformation found in the impeller is of 1 mm.

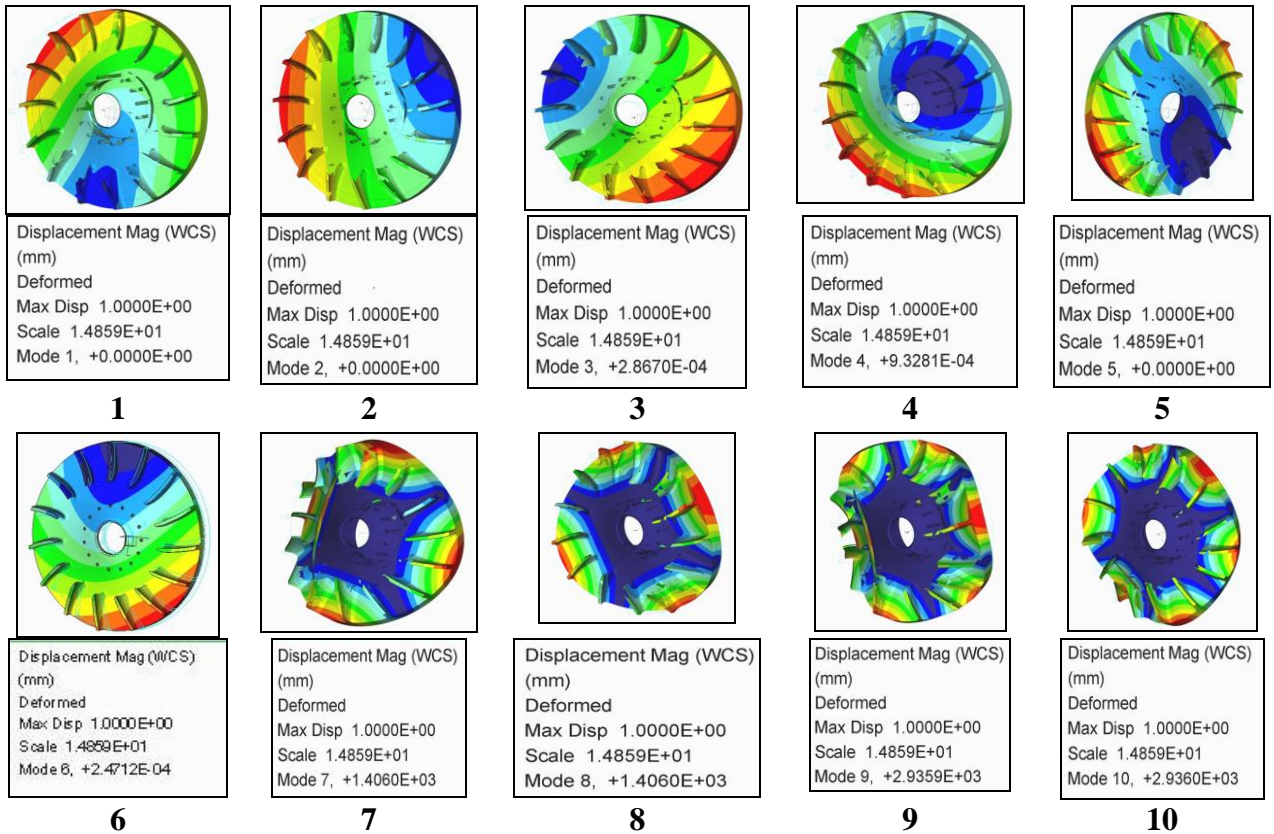


Figure 5 Ten mode shapes extracted from the software modal analysis

**CONCLUSIONS**

From the study it can be concluded that the modal analysis is a very effective method to study the dynamic characteristic of the structure. The maximum deformation found from the numerical modal analysis is maximum of 1 mm. The experimental frequency found is of max 38 Hz. The results of experimental modal analysis and numerical modal analysis can be very useful for the design modifications. Furthermore study can be conducted on shaking mechanism to excite the structure.

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