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EXPERIMENTAL AND NUMERICAL MODAL ANALYSIS OF FOUR STROKE PETROL ENGINE PISTON

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Abstract: The research deals with the study of the dynamic behavior of a piston of a four stroke petrol engine. In this study experimental modal analysis has been carried out on the piston to extract the mode frequency of the piston and numerical modal analysis has been carried out to obtain the mode shapes of the piston using Creo 2.0. From the research it can be concluded that the impact hammer test can successfully be used to extract the mode frequency of any mechanical component. Also the deformation found from the numerical modal analysis is having a maximum value of 1mm.

Keywords: **experimental modal analysis, mode frequency, mode shape, numerical modal analysis.**

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.

LITERATURE SURVEY

A. R. Bhagat *et.al*. [1] describes the stress distribution of the seizure on piston four stroke engine by using FEA and analyzed the thermal stress distribution of piston at the real engine condition during combustion process. As a result it was observed that stress distribution on the piston mainly depends on the deformation of piston. Therefore, in order to reduce the stress concentration, the piston crown should have enough stiffness to reduce the deformation. **Watanabe *et al.*** [2] it indicated that during the centrifugal casting, there are two types of forces on each particle in the molten metal: the radial centrifugal force which points to the mold wall, and the viscous drag force in the opposite direction. **Sasi Kiran prabhala *et.al.*** [3] Aluminum is having very less weight comparing to that steel so that we can conclude that modified assembly is having more mechanical efficiency and also we can reduce the cost of the product are production. **Xiaoyu Huang** ***et al*** **[4]** concluded that three different zones from the piston skirt to the piston head exist, i.e., defects gathering zone, metal matrix zone and SIC segregation zone. As the temperatures of the slurry pouring and the molds increase, the better the effects of the purification of molten melt and the segregation of SiC particles become. **Mohana kumara k.c** ***et.al*** **[5]** The hardness ,tensile strength and ductility of the composites is found to increase with increase in reinforcement content and the higher hardness and tensile strength and ductility noticed for the 12wt% of SIC powder addition. **Guohua Zhanga.c** ***et .al*** **[6]** suggested that the typical microstructure of the Al–Si alloy can be regarded as the hard and brittle Si particles embedded in a soft and ductile aluminum matrix.

EXPERIMENTAL MODAL ANALYSIS

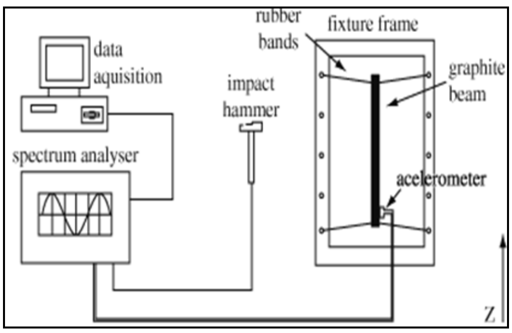
To extract the mode frequency of the piston using experimental modal analysis impact hammer test has been carried out. The test has been conducted at DYNAMECH, MAKARPURA GIDC, VADODARA. During the analysis 3 different hammer having different weight has been used as shown in figure 1.

Figure 1 Impact hammer

The weight configurations of hammer are:

1. 303 gm
2. 583 gm
3. 1253 gm

The block diagram of the experimental modal analysis and the actual setup of the same are shown in the figure 2.



(a) **(b)**

Figure 2 block diagram & actual experimental setup

The basic requirement of the experiment set up is that the piston should be rigidly fixed to any frame or structure. As the impact is made the piston vibrates with the frequency and that

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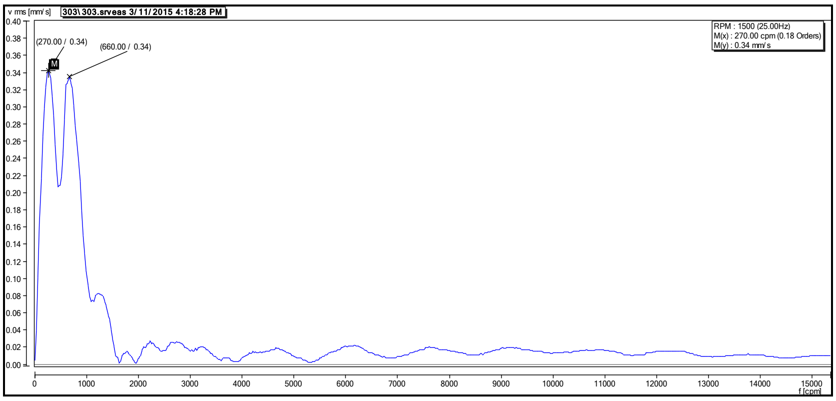
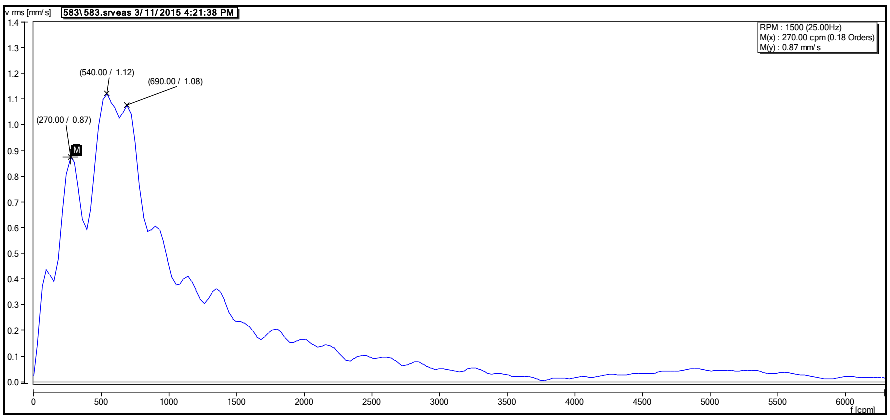
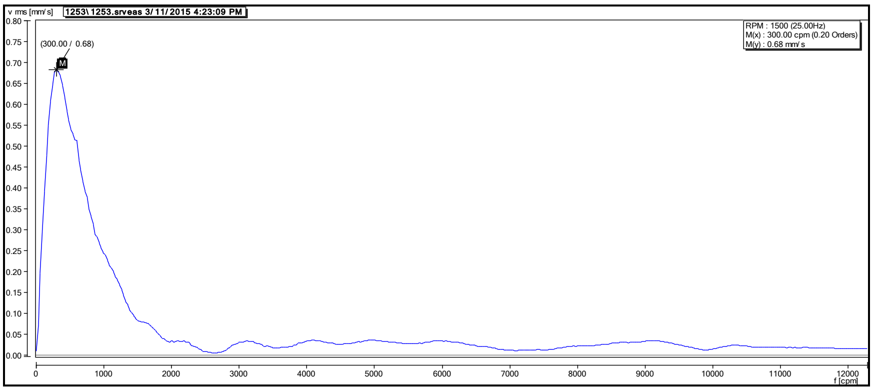
frequency is extracted with the help of data acquisition system. The experimental results of the frequencies are shown in figure 3 for different hammers.



(a) 303 gm



(b) 583 gm



(c) 1253 gm

Figure 3 Experimental results of frequencies

SOFTWARE MODAL ANALYSIS

The steps to do a numerical modal analysis using Creo 2.0 are as follows:

1. **Preprocessing**

- Geometry-For the software modal analysis modeling of the piston has been done according to the dimensions using the Creo 2.0.
- Meshing-After importing the model meshing is done automatically by the software.

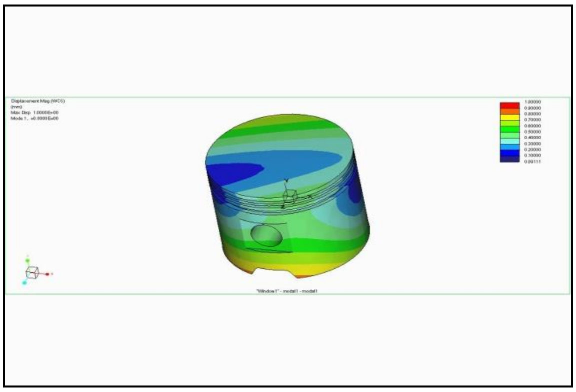
2. **Solution**

- Analysis Type and Options-In this section analysis type is selected to the modal analysis. The required numbers of mod shapes are entered in the software according to the requirements.
- Loading
- Solve

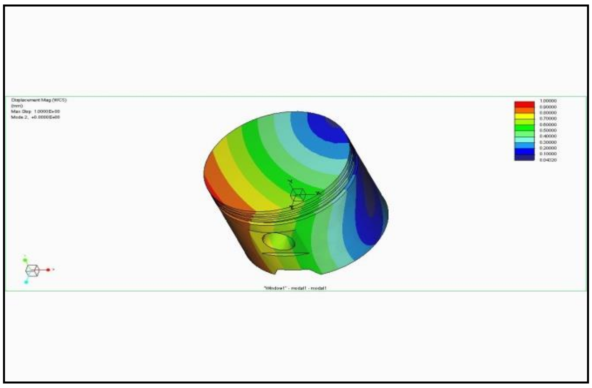
3. Post processing

- Review -In this section all the results can be viewed like mode shape, mode frequency.

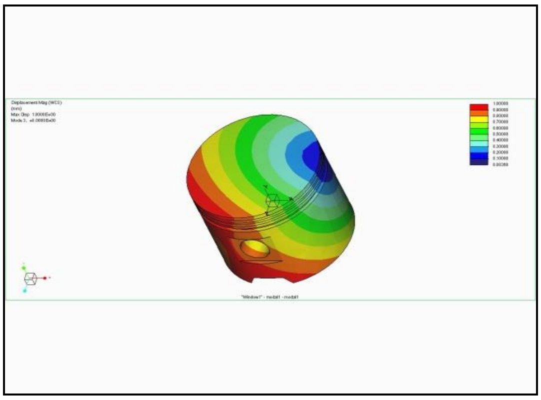
The results obtain from the numerical modal analysis is shown in the figure 4.



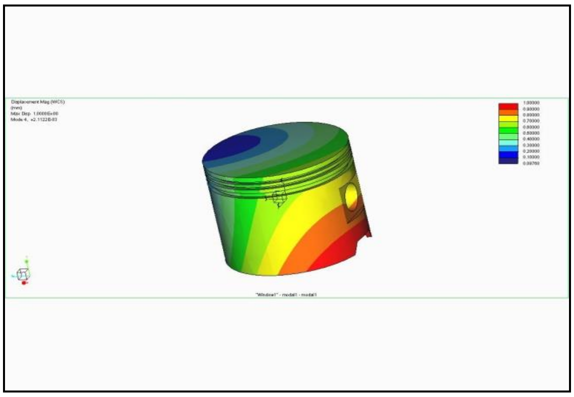
(a) mode 1



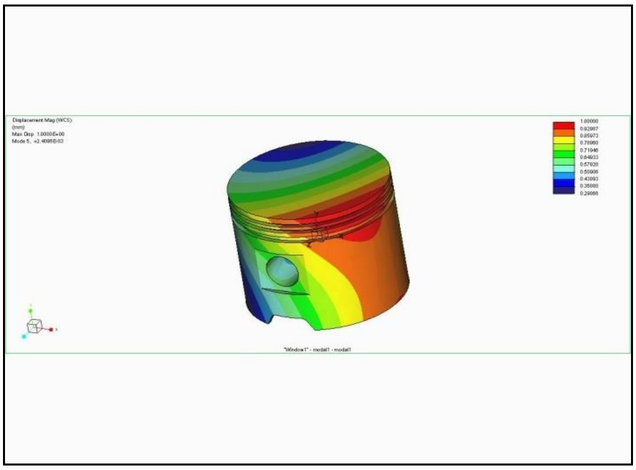
(b) mode 2



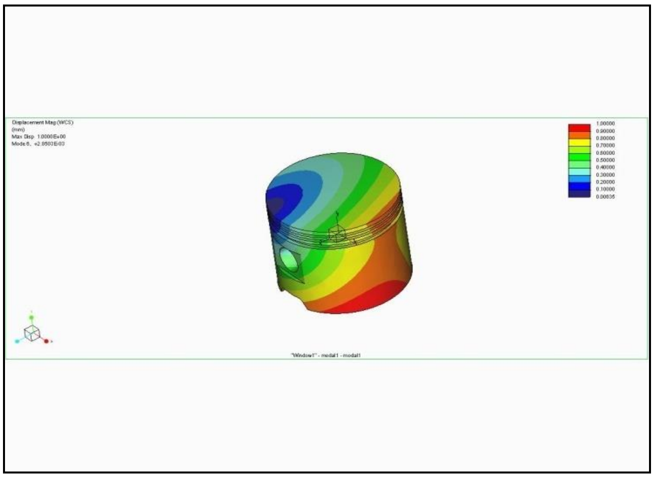
(c) mode 3



(d) mode 4



(e) mode 5



(f) mode 6

Figure 4 Different mode shapes of piston

CONCLUSIONS

From the research it can be concluded that the impact hammer test can successfully be used to extract the mode frequency of the component and the maximum deformation found from the numerical modal analysis is 1 mm.

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