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VIBRATION ANALYSIS OF GEARBOX CASING USING SOFTWARE TOOL ANSYS AND FFT ANALYZE

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ABSTRACT

This paper contain the study about vibration analysis for gearbox casing using finite element analysis (FEA).The aim of this paper is to apply ANSYS software to determine the natural frequency of gearbox casing.The objective of the project is to analyze differential gearbox casing of tata indigo cs vehicle for modal and stress analysis. The theoretical modal analysis needs to be validated with experimental results from Fourier frequency transformer (FFT) analysis. The main motivation behind the work is to go for a complete FEA of casing rather than empirical formulae and iterative procedures**.**

KEYWORDS: FEA, Modal Analysis, FFT, Differential Gearbox, Natural Frequency

INTRODUCTION

Most of the structure or in mechanical system are failed due to excessive vibration in their working life. The study of vibration is more important to avoid failure or to determine the faults. The vibration having certain amplitude and frequency may be reliable for human being. If the excessive vibration from machine transmitted to earth surface then the effect of excessive vibration will be on human being as well as environment that time study of vibration is important to avid effect. In this paper gearbox casing is used to analyse to determine the vibration. Gearbox casing is a main component in vehicle because in casing sets of gear, bearing and support shaft is enclosed. In this paper to analysed the gearbox casing with help of FFT analyser and software tool ansys. FEM enables to find critical location and quantitative analysis of the stress distribution and deformed shapes under loads.

DESIGN

Design is the important element to reduce the vibration in gearbox casing. Size of rib, position of rib, shape of rib and shape of casing this is the important factor to reduce the vibration in differential gearbox casing

Fig.1(a)-Gearbox casing Component Front View

Fig,1(b)- Gearbox casing Component Back View

PROCEDURE

The work of the analysis will be done in six stage as follows.

Stage A.

1. Study of Literature review
2. Study the types of gear, Bearings and its location

Stage B.

1. Make 3 D modeling of Casing in Pro-E (WF3.0)
2. Mesh Generation
3. Establish boundary condition.
4. Mass and Inertia Properties calculation for Casing.

Stage C.

1. Analytical calculation for Gear Forces.
2. Analytical calculation for Bearing Reaction

Stage D.

1. Torsional and Bending mode Calculation of Casing
2. Vonmises Stress and Deformation calculation using Bearing Reaction and Bolting Torque.

Stage E.

1. FFT equipment study.
2. Mode shape Calculation using FFT.
3. Error Estimation and Comparison with ANSYS output.

Stage F.

1. Mode shape calculation for different layout and Nos. of Stiffeners.
2. Comparison with Resonance frequencies / Gear Meshing frequencies.
3. Selection of optimum no and layout of stiffeners based on Dynamic Vibration.

4 .Re FEA for the optimum structure.

4. Report generation and future scope defining.
5.

ANALYSIS

1.1 Model analysis

Modal analysis is the study of dynamic properties of structure. The aim of modal analysis is to determine the natural mode shape and frequency of modal or object. This is a comman to use the finite element method to preform this analysis because like other calculation using the FEM. The object being analyzed can have arbitary shape and the result of the calculation are accepted. The most suitable example of the modal analysis is tuning fork.The gearbox casing or modal is created in ProE and meshed with the help of hypermesh. The stress analysis is done in ansys and calculate natural freqquency in free free condition. Experimental calculation is done in FFT analyzer this is also in free free condition

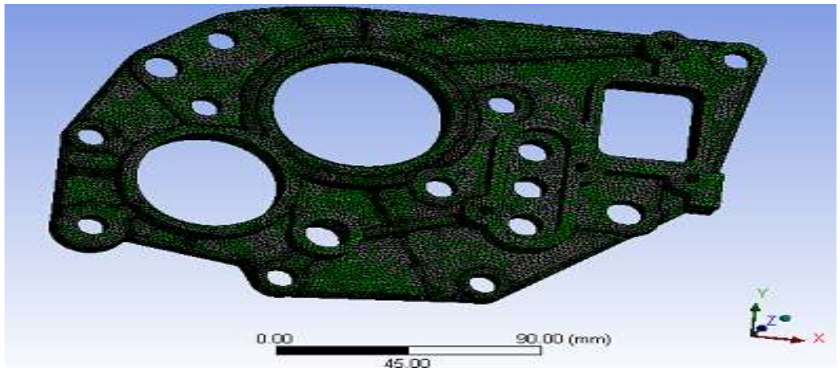

Fig 2-Finite Element model

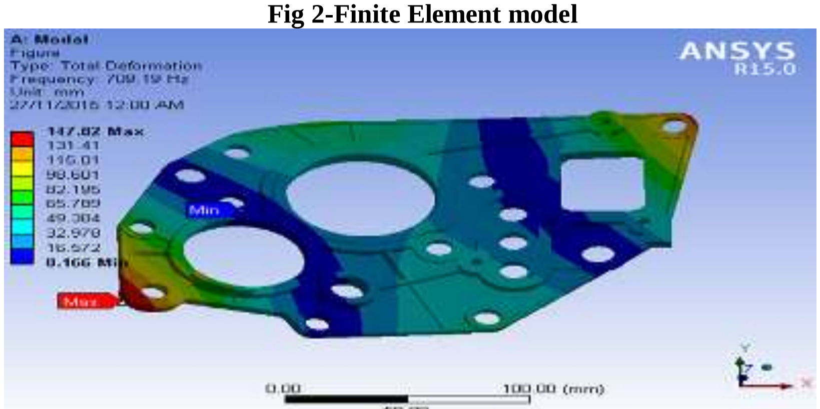

Fig 3-Total Deformation

Modal analysis had performed in free-free condition, to find out first 12 natural frequencies of the model. Block Lanczos method is used to solve the basic equation.

MODE	FREQUENCY
1	0
2	
3	2.3962e-002
4	2.4765e-002
5	2.593e-002
6	2.7057-002
7	709.19
8	950.97
9	1543.8
10	1899.5
11	2297.6
12	2742.1

Table 1- Frequencies of model

The resonant conditions are evaluated with forcing frequencies. The forcing frequencies in this case are:

1.1.1 Gear mesh frequency

It is also called as ‘Tooth Mesh Frequency’. The most powerful weapon in analysing is to determine the spectral character. The primary stage to determine the spectral character is to calculate thr gear mesh frequency. The gear mesh frequency is denoted by ‘F’

$$F=K\times(N/60)\ \text{Hz}$$

Where the K is number of teeth on gear and N is the speed of shaft. To calculate gear mesh frequency of the gear system has to account relative motion between sun, planet and ring gear must be equal to gera mesh frequency associate with planet and ring gear. The general expression for fundamental gear mesh frequency is as follows

$$Fn = Kn \times (N/60)\ Hz$$

Where the n is 1,2,3……… corresponding to. Idling. maximum speed and crushing is the main important consideration in effect of gear mesh frequency

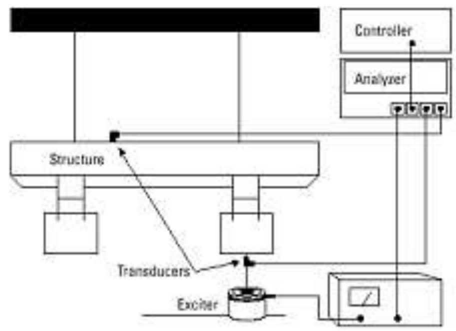

FIG-4 GENERAL TEST CONFIGURATION

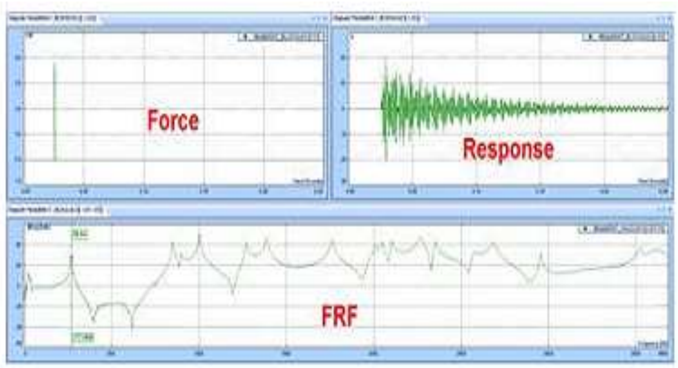

Fig 5- Experimental impact hammer modal testing data

It is also possible to test a physical object to determine its natural frequencies and mode shapes. This is called an Experimental Modal Analysis. The results of the physical test can be used to calibrate a finite element model to determine if the underlying assumptions made were correct (for example, correct material properties and boundary conditions were used).

1.1.2 Experimental Results/Procedure

- Plate of required length is taken.
- By the use of screw gauge the depth and width of plate section were measured.
- The connections of the FFT analyzer, laptop, transducers, model hammer along with the requisite power connections were made.
- The accelerometer was fixed by beeswax to the plate at one of the nodal points.
- The hammer were kept ready to strike the plate at the singular points.
- Then at each point the modal hammer was struck once and the amplitude Vs frequency graph was obtained from graphical user interface.
- The FFT analyzer and the accelerometer are the interface to convert the time domain response to frequency domain. Hence the frequency response spectrumH1 (response, force) was obtained.
- By moving the cursor to the peaks of the FFT graph, the cursor values and the resonant frequencies were recorded.
- At the time of the striking with modal hammer to the singular point precautions were taken whether the striking should have been perpendicular to the aluminium beam surface.
- The above procedure is repeated for all the nodal points and all materials plates and all structures.

- The values (i.e., natural frequencies and resonant frequencies) obtained from the FRF spectrums were compared with respect to the FEM analysis.

Fig 6 (a)-Photograph of modal testing

Fig 6 (b)-Photograph of modal testing

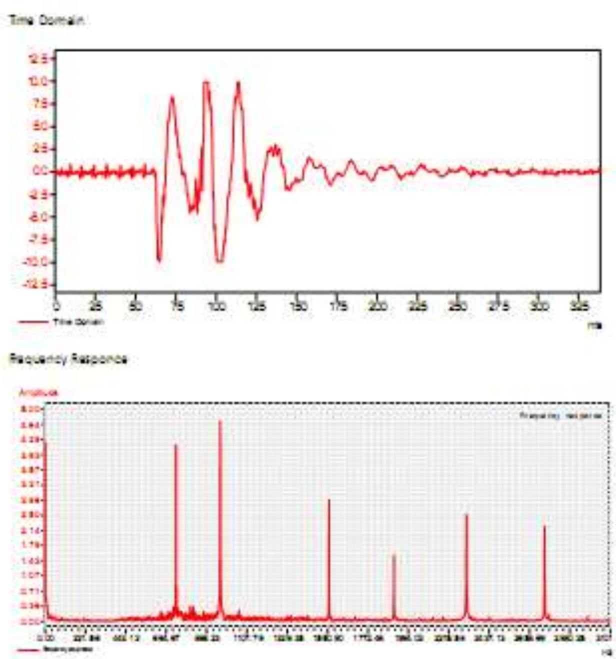

Fig. 7- Graphical results

Mode	Ansys Frequency(Hz)	Experimental Frequency(Hz)	Percentage Deviation
1	709.19	717.52	0.84
2	950.97	961.27	1.04
3	1543.8	1559.03	1.60
4	1899.5	1914.91	1.50

5	2297.6	2312.62	1.90
6	2742.1	2756.12	1.50

Table 2- Comparison of Ansys & Experimental Results

1.2 Stress analysis

In stress analysis to determine the distribution of internal stress in system for given. The external forces that are acting on it. Stress analysis is a general term used to describe analysis. Where the result quntities included stress and strain. It is also called as structural analysis The calculation of forces will be done on various gear. The natural frequency of gearbox casing is calculate in ansys and this frequency compared with gearmesh frequency.

LITERATURE REVIEW

In this a survey of the literature on gear noise and vibration. It is divided into three parts, "Transmission error", "Dynamic models" and "Noise and vibration measurement". Transmission error (TE) is considered to be an important excitation mechanism for gear noise and vibration. The definition of transmission error is "The difference between the actual position of the output gear and the position it would occupy if the gear drive were perfectly conjugate". Dynamic models of the system consisting of gears, shafts, bearings and gearbox casing are useful in order to understand and predict the dynamical behavior of a gearbox. Noise and vibration measurement and signal analysis are important tools when experimentally investigating gear noise because gears create noise at specific frequencies, related to number of teeth and the rotational speed of the gear. Transmission error (TE) is considered to be an important excitation mechanism for gear noise and vibration. The definition of transmission error made by Welbourn is "The difference between the actual position of the output gear and the position it would occupy if the gear drive were perfectly conjugate". This may be expressed as angular displacement or as linear displacement at the pitch point. The causes of transmission error are deflections, geometrical errors and geometrical modifications.

1) International Journal of Advanced Engineering Technology,E-ISSN 0976-3945 ,IJAET/Vol.III/ Issue II/April-June, 2012/04-12VIBRATION ANALYSIS TECHNIQUES FOR GEARBOX DIAGNOSTIC: A REVIEW by Amit Aherwar, Md. Saifullah Khalid Address for Correspondence Department of Mechanical Engineering, Anand Engineering College, Sharda Group of Institution, Agra Gears are important element in a variety of industrial applications such as machine tool and gearboxes. An unexpected failure of the gear may cause significant economic losses. For that reason, fault diagnosis in gears has been the subject of intensive research. Vibration signal analysis has been widely used in the fault detection of rotation machinery. The vibration signal of a gearbox carries the signature of the fault in the gears, and early fault detection of the gearbox is possible by analyzing the vibration signal using

CONCLUSION

In this paper authors have been presented a methodology of some current vibration based techniques used for condition monitoring in geared box casing .The natural frequency of casing with constraints is obtain using ANSYS R15.0 and compared with experimental result i.e operating frequency. Analysis has been carried out to examine in detail the vibration characteristics of the casing of integrally geared differential gearbox casing. In FEA modal analysis for gearbox casing component is carried out using ANSYS Work bench R15.0 software .It is observed that the obtained natural frequency and in experimental validation resuklt show close agreement with FEA result of the existing casing.natural frequencies of the predicted modes are within 2% of the measured mode.

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