Analysis Of Gearbox Casing Using FEA

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Abstract— Gearbox casing is the main component in automobile world which is used to protect components inside the gearbox. It consists of gears, shafts, bearings and oil. It is fluid containing casing which gives support to the moving parts. Gearbox failure occurs mainly due to the design issues, manufacturing defects, oil deficiency, excessive time at stoppage and high loading. In this project loading case is considered. Major challenge for such problems are whether to consider static analysis, dynamic analysis, or perturbation analysis and conditional circumstances for it to be performed. In this work static dynamic as well as perturbation analysis have been performed on gearbox casing. Model is to be developed in Abaqus/CAE and then same model is used for Finite Element Analysis by using Abaqus/Standard 6.10.1 for static analysis and dynamic analysis. Harmonic analysis is also performed by Abaqus software called as perturbation analysis for strain and frequency. Stress and frequency graph in both the cases that is in static and dynamic analysis is performed and results from static and dynamic are compared. Frequency effect on strain levels are linear and no surplus strain linearity is produced due to dynamic effect as compared to the static case. By using Abaqus/ standard it is found that results boost for dynamic case as compared to static case.

Keywords— Abaqus/CAE, Gearbox casing, Static stress analysis, Maximum principle stress, Minimum principle stress,

INTRODUCTION

Gearbox casing is the shell in which assembly of gears are sealed. The components of gearbox casing are gears, bearings, shafts and oil. The gearbox casing act as house the transmission components. The movement of the gear produces vibration in the gearbox casing. Any automobile vehicle requires high torque when they are climbing an elevated surface like a mountain and also at the initial idling, as its speeds is very low. But when vehicle is running with high speeds on plane road high torque is not required due to momentum. Therefore, the device which is required for two reasons, torque speed combination range and to maintain engine speed according to road condition as per drivers need. This device is known as gearbox or transmission box.

Lower gears have high torque and low power. Higher gears have high power but low torque. Due to the engine power stroke, the input shaft rotates once. Hence, the output shaft rotates. Then two such power strokes are required for one full rotation of output shaft which means that all power is transferred into one rotation. Hence, it has high torque. In case of high gear, the input shaft rotates only once means one power stroke, and the output shaft rotates several times. One power stroke rotates the output shaft several times. Hence the high speed, high power but low torque. Therefore, torque, speed and power are important factors in gearbox.

LITERATURE REVIEW

This chapter provides Review of Literature on topics related to gearbox casing. More work has been done for analysis of gearbox casing by using vibrational analysis by condition monitoring techniques, FFT analyzer, time frequency domain analysis also FEA analysis by using ANSYS.

Mirunalini Thirugnanasambandam, [1] determined the design and static analysis, natural frequency of casing and torsional, lateral critical speed of two stage gearbox casing. Amit Aherwar, [2] Studied vibration based techniques for condition monitoring in transmission system, in time frequency domain removes noise. Vijaykumar, Mr. Shivaraju, [3] Presented vibration based technique for condition monitoring in gearbox system also determined vibration analysis of gearbox casing using Finite Element Analysis (FEA), ANSYS software for natural vibrational modes and harmonic frequency response for casing to prevent resonance. M. S. Patil, [4] Studied vibrational analysis for gearbox casing using finite element analysis (FEA) by applying ANSYS software to determine the natural frequency of gearbox casing. Ashwani Kumar, [5] Studied gearbox casing of heavy vehicles and effect of mechanical properties of material on natural frequency and mode shapes. Vijay N.A., [6] have studied the gear box casing for permanent magnet dc motors. According to author, it is essential to analyze gearbox casing to decide dimensions and predict its behavior under operating conditions, also it support to shaft and bearings. Ramamurti V. [7] presented design methodology for two stage gearbox, it involves comparison of design stresses obtained from classical methodology and FEM model, also raised due to stress.

PROBLEM DEFINATION

The main aim of this project is static analysis of casing in presence of generalized modes and critically studying the things for future improvements, in vibration characteristics raised due to stress. Also providing dynamic analysis of casing in presence of generalized modes and critically studying the things for future improvements from stress perspective.

SCOPE

To complete this project successfully, following scope has been defined

- Development of new methods for analysis
- Development of analytical technique and finite element implementation

OBJECTIVES

- To achieve the above stated aim the following objectives are implemented in the project.
- To determine casing response to fluctuations in terms of vibration level
- To carry out static stress analysis by applying load effect in the gearbox casing
- To simulate the observed facts in Abaqus

METHODOLOGY

The following are incorporated the research and further to utilize the information gained by the above stated literature review the under defined are used.

- Motivation and literature survey
- Casing problems and evaluation measures
- Modeling and analysis tools
- Harmonic response and interpretations
- Comparison within themselves

FINITE ELEMENT ANALYSIS BY ABAQUS

- In this analysis dimensions are taken from one of the literature [1]. Dimensions of the housing provided are of 700*450*200. Material used is gray cast iron because it has excellent vibration damping capacity. It has high compressive strength, low tensile strength, self-damping, does not vibrate, high resistance to wear. It contains 2.5-3.8% C, 1.1-2.8% Si, 0.4-1 % Mn, 0.15 % P and 0.10 % S. [8]. Also, density- 7200kg/m³, Elastic- Young's modulus- 2 e11 N/m², Poisson's ratio- 0.28 [9]. Due to higher complexity and nonlinearity, Aabaqus has been used. First solid model is to be developed in Abaqus /CEA 6.10.1 and then that can be used for further analysis.[10]

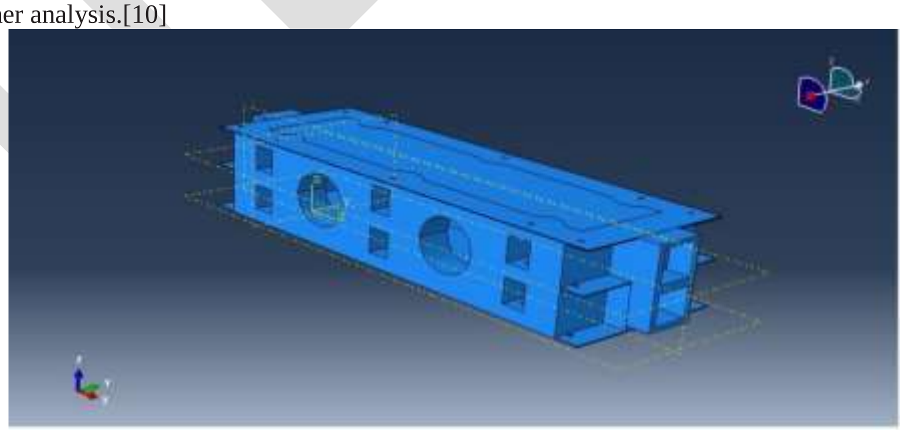

Fig -1: Model of gearbox casing

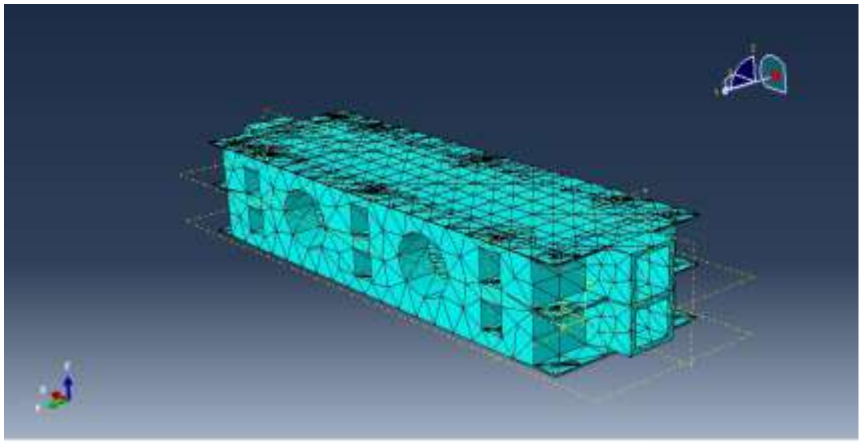

Fig -2: Meshing of gearbox casing

A. Static Analysis

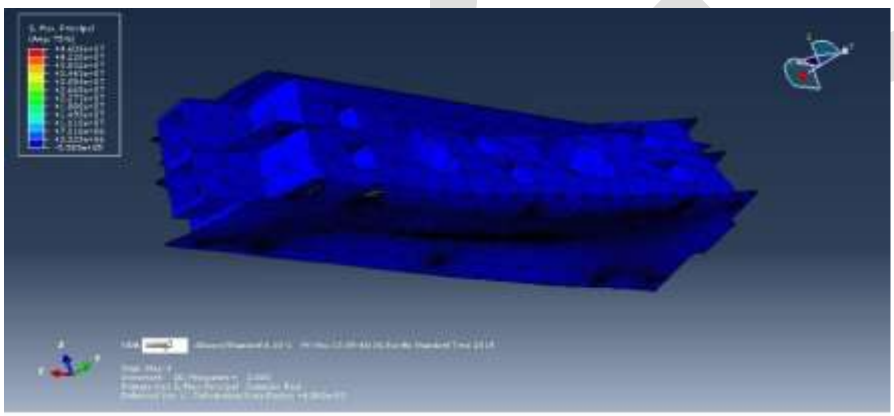

Fig 3: Static Stress by Maximum Principal Stress

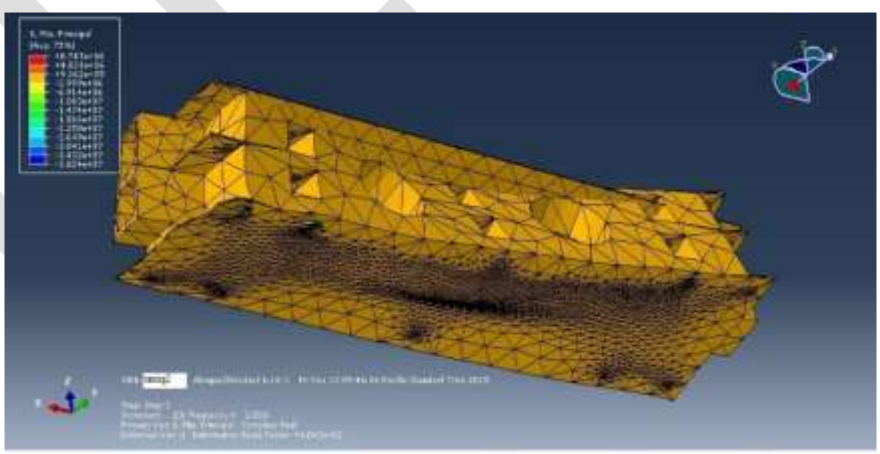

Fig -4: Static Stresses by Minimum Principal Stress

B. Dynamic Results

Step- Steady state dynamic
Load applied- 60000N

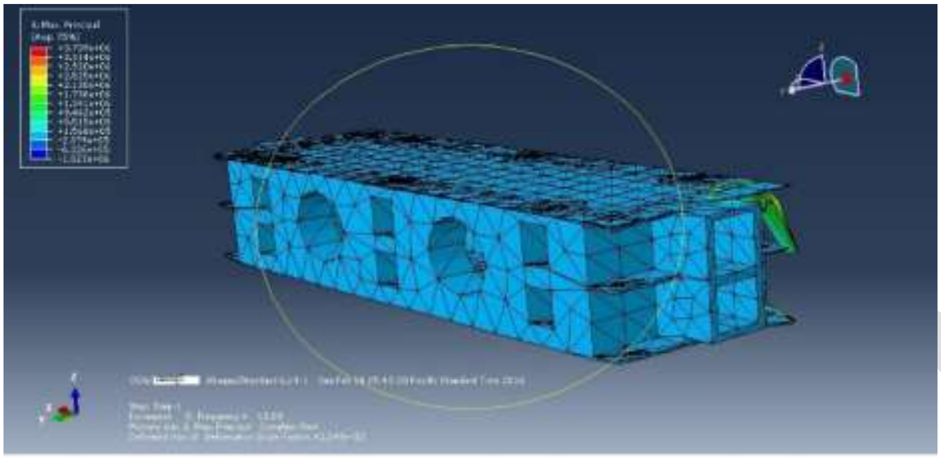

Fig -5 : Dynamic-Stress by Maximum Principal Stress

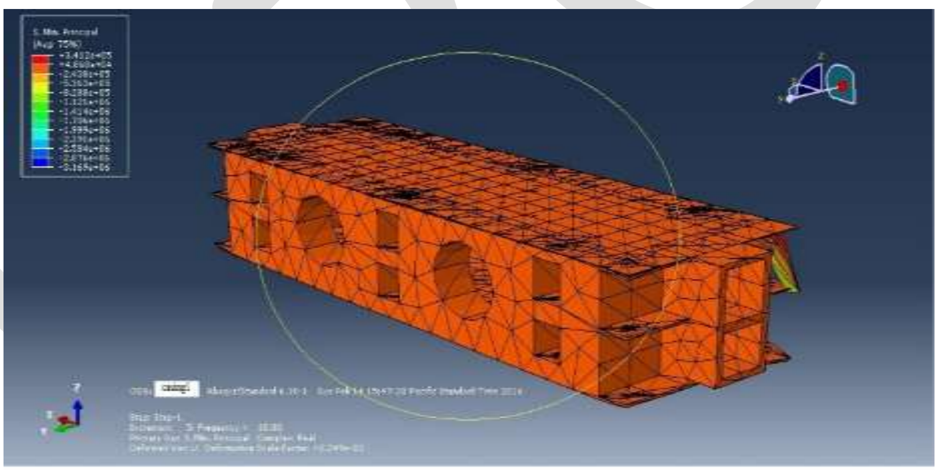

Fig -6: Dynamic stress by Minimum Principle Stress

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CONCLUSION

Static analysis and dynamic analysis is to be done with Abaqus/Standard 6.10.1 results shows that dynamic stress boost than static stress. Von Mises stress are significant as against earlier predictions of maximum principle stress & deformations are less significant.

Harmonic analysis is performed for static and dynamic case shows that Frequency effect on strain levels is linear and no surplus strain linearity is produced due to dynamic effect as against static case. All modes are equally responsive to nearly all frequencies. But response boost up lot when forcing frequency matches with corresponding casing frequency.

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