

# FE Analysis of Gear Box Casing used for Permanent Magnet D.C. Motors

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**Abstract:** The project is mainly concerned about the analysis of a gear box casing used for permanent magnet D.C. motors with the help of ANSYS workbench software. Gear box casing is a part of the gear box, it provides support to the shaft and bearings. Thus the gear box casing is an important component to be taken into account while designing. Gear box casing i.e. the top and bottom cover casing is typically made up of an aluminum material using casting process. The objective of the project is to build the model (Gear box casing) and to analyze the gear box casing used for permanent magnet DC motors for Static stress and Modal analysis. The load for static stress analysis is calculated by Rope and pulley method setup. The gear box casing is modeled using CATIA V5 software and analyzed using ANSYS workbench software.

The static stress analysis is used to analyze the stresses and deformations of the gear box casing and the modal analysis is executed to govern the vibration features (Mode shapes and natural frequencies) of gear box casing in order to prevent the resonance for gear box casing component. The results obtained by the stress analysis is found to be in a good agreement and modal analysis i.e. vibrational characteristics like frequency and mode shapes are presented and are within the limits.

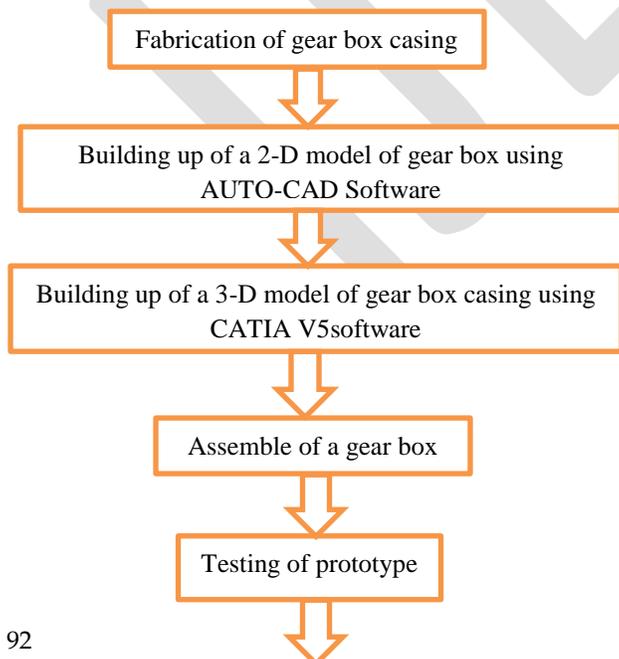
**Keywords-** Gear box casing, Static Stress analysis, Aluminum, FEA, CATIA V5, Modal analysis, Natural frequency, Mode shapes.

## 1. INTRODUCTION:

The casing of gearbox is one of the important components in a constantmesh Gearbox. The casing encloses the sets of the helical gears and the bearings to support the shaft. In this

system the vibration generated at the gear mesh are transmitted to the gear box housing through the shafts and the bearings. The gearbox casing is typically an aluminum material and is made by a casting process. Casing of this not only provides the shield to the gearbox but also supports to the gearbox assembly. Analysis of the gearbox casing is very essential in order to decide appropriate dimension and to predict the behavior of the casing under the operating conditions.

### 1.1. Flow chart:



FEA Analysis using ANSYS software



FEA results of gear box casing

### 1.2. objectives of the work:

- Building up of the model (Gearbox).
- To carry out the static analysis using ANSYS for analyzing the load effect on the gearbox casing. FEM enables to find critical locations and quantitative analysis of the stress distribution and deformed shapes under the loads.
- To carry out the modal analysis i.e. natural frequencies and the mode shapes.

## 2. MODELING AND FINITE ELEMENT ANALYSIS OF GEARBOX CASING COMPONENT:

The 3-D solid model of the gearbox casing component was build using CATIA V5R20. ANSYS workbench was used for preprocessing, solving and post processing. Material property of the gearbox casing is considered as aluminum and structural steel for gears were selected from ANSYS material library. Boundary conditions are applied to the casing. Finite element model is used to calculate stress, deformation and also the frequencies and mode shapes in the gearbox casing by ANSYS software.

### A. CATIA V5 Model:

The figure 1 and figure 2 shows the pictorial representation of the Gearbox casing. The Gearbox casing is modeled in design software CATIA V5

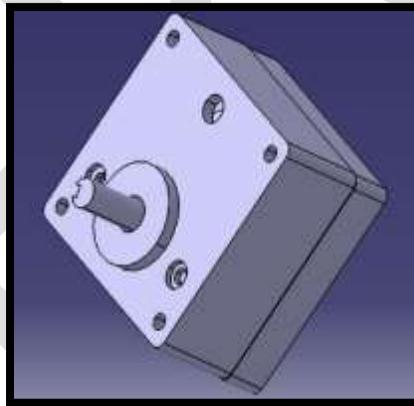


Figure 1: 3-D model of gear box

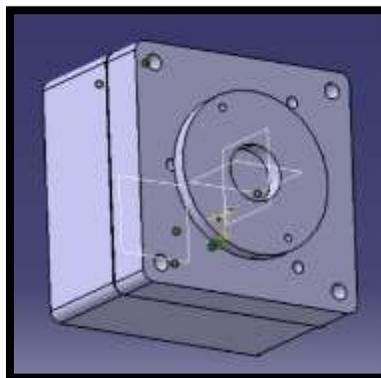


Figure 2: 3-D model of gearbox

The CATIA model is imported into the respective file format of the FEM design software ANSYS R15.0.

## B. FEM Model:

The project is divided into two domains:

1. Static analysis
2. Modal analysis

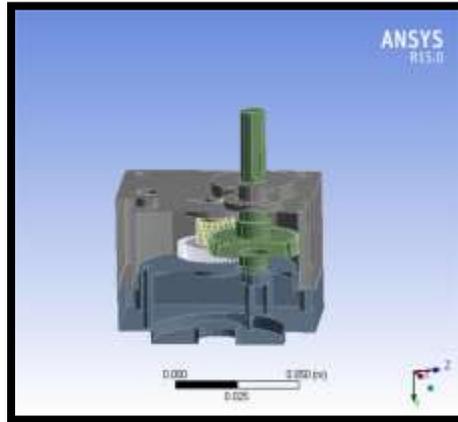


Figure 3: 3-D Model

FEA Modeling helps in efficient managing of deformation, von misses stress and shear stress and also in finding the natural frequencies and mode shapes in any mechanical component and system. The figure no. is the discrete modeling of gearbox casing.

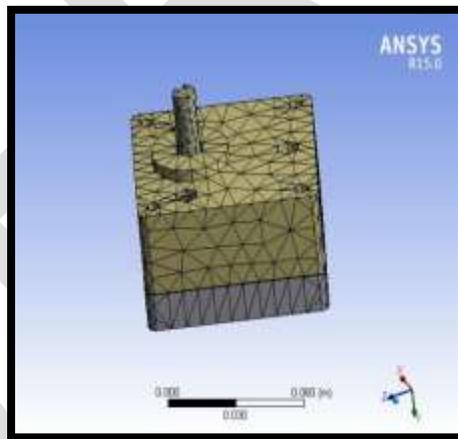


Figure 4: Meshing model of gear box

Meshing Details:

Nodes – 31860

Elements – 14204

## 3. RESULTS AND DISCUSSION:

### 3.1. STATIC STRESS ANALYSIS:

It is used to define the displacements, stresses etc., due to the influence of static loading conditions. It estimates the properties of steady loading conditions on a component, but overlooking the inertia and damping effects, such as the one affected due to time

varying loads. This analysis can nevertheless, include steady inertia loads and time varying loads that can be estimated as static equivalent loads.

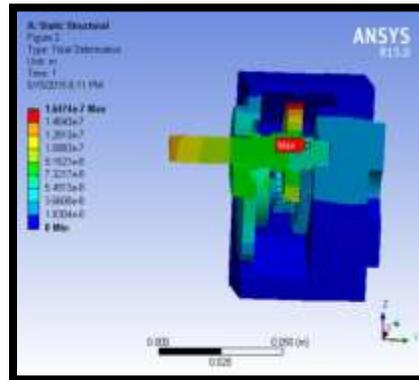


Figure 5: Deformation occurs in gear box casing

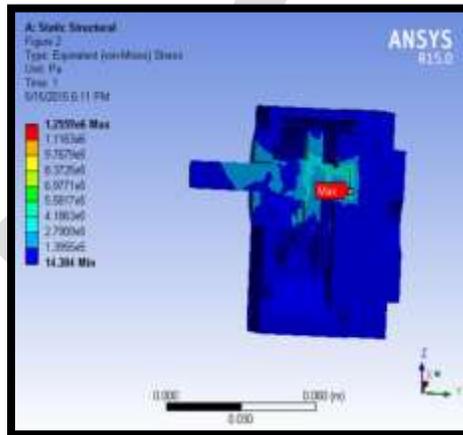


Figure 6: von-mises stresses occurs on gearbox casing

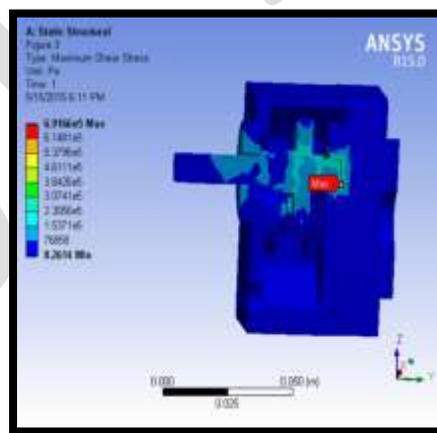


Figure 7: Maximum shear stress occurs on gear box casing

The static analysis results were tabulated as follows:

Description	Results
Total Deformation	1.6474e-007m
Von misses stress	1.2559e+006 Pa
Maximum Shear Stress	6.9166e+005 Pa

These results were captured in ANSYS software workbench.

Deformation is shown in figure 5, von misses stress is shown in figure 6 and maximum shear stress is shown in fig 7 obtained results were efficient and are found to be within the limits.

### 3.2. MODAL ANALYSIS:

It is used for determining the mode shapes i.e. vibration characteristics and the natural frequencies of a machine structure or component while it is being designed.

The modes are used as easy and an effective way of describing the resonant vibration and majority of the structures can be made to resonate i.e. under the proper conditions, a structure can be made to vibrate with sustained, excessive and oscillatory motion. When the elastic and inertial properties of the material interacts then the resonant vibration occur which is the major vibration related problems in the machine components or structures. The resonance is the fundamental for better understanding many of the structural vibration problems hence it necessary to identify and quantify. This can be accomplished by defining the structure's modal parameters.

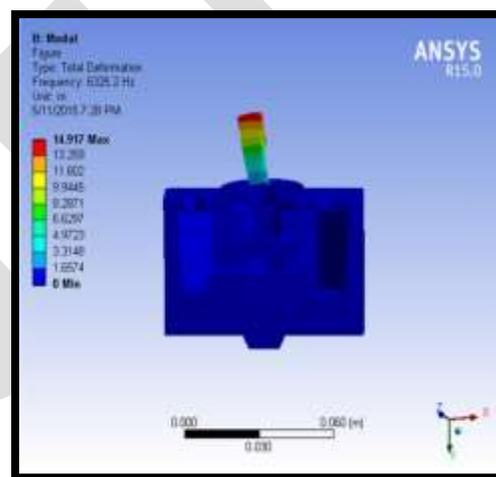
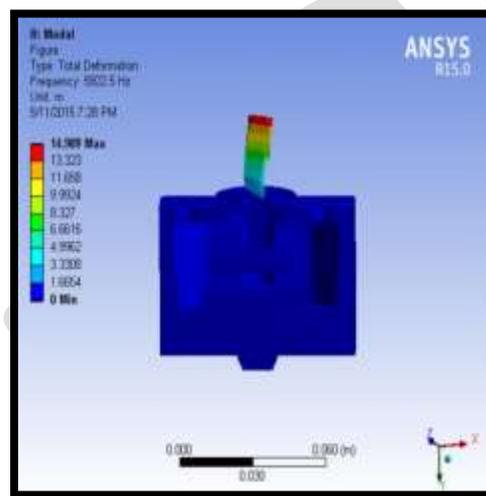
Performing the modal analysis:

- Build the model
- Obtain the solution
- Developing of modes
- Evaluate the results

The first six natural frequencies and mode shapes of the model are listed in the Table no.1 at the defined boundary condition.

Table no. 1

Mode No.	Natural Frequency [HZ]
1	5922.5
2	6325.2
3	7076.1
4	8850
5	10074
6	11095



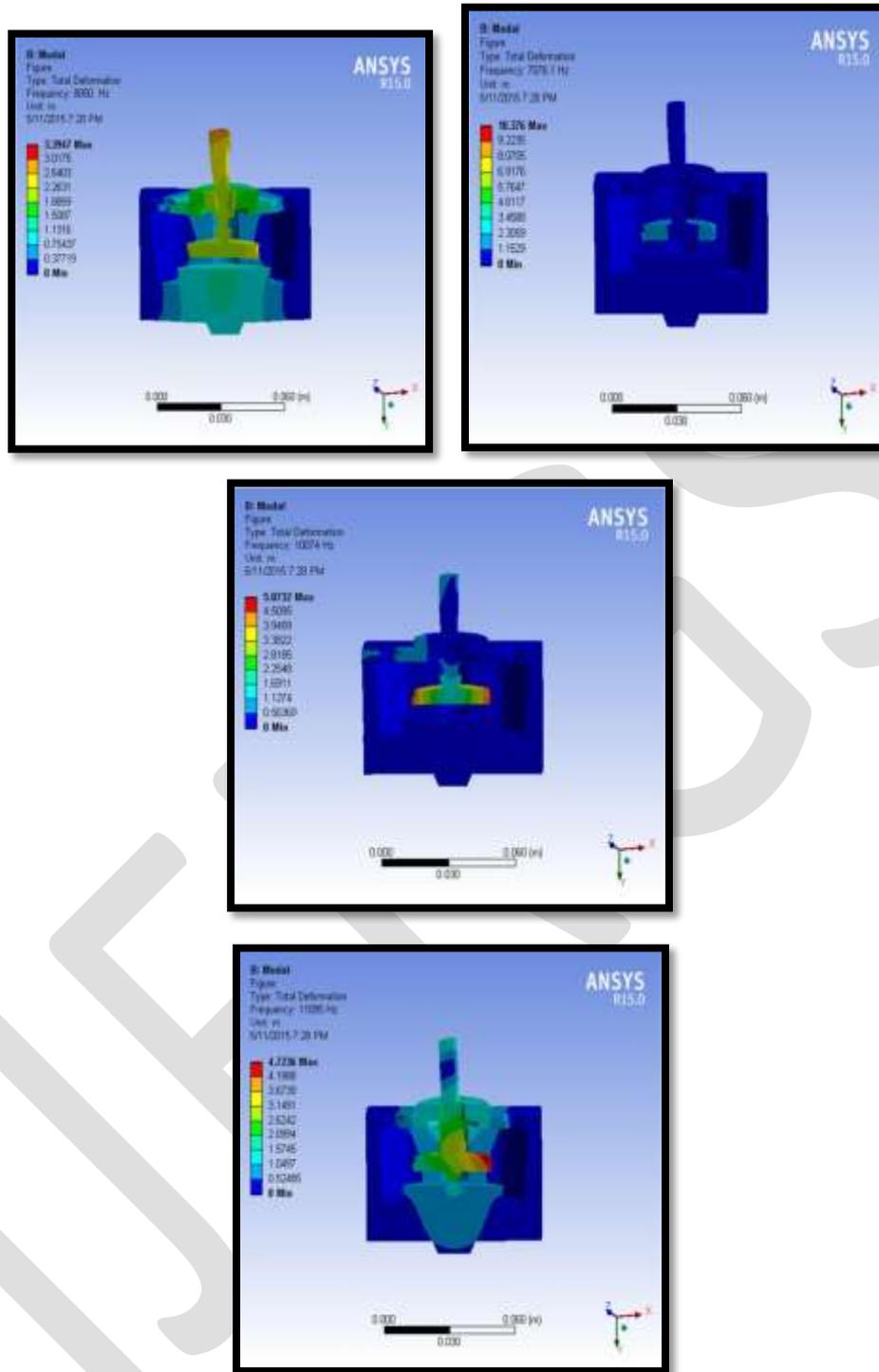


Figure 8: Mode shapes of first six Gearbox casing obtained from ANSYS Workbench.

#### ACKNOWLEDGEMENT

I wish to express my heartfelt thanks to Dr. Kiran Aithal S, Professor, Dept. of Mechanical Engineering, Chethan k s Assistant Professor, Dept. of Mechanical Engineering, NMIT, Bangalore, Ravikumar J, Technical head, Ivori motors, Yeshwantpur, Bangalore, for their knowledge, interaction and assistance they provided during the execution & successful completion of my project work. I am privileged to thanks Dr. H.C. Nagraj, Principal, NMIT, Bangalore for their support and I take this opportunity to extend our sincere thanks to all the staff members of Mechanical department for their necessary help and co-operation.

We whole heartedly thank our respective families who are the very reasons for where we stand today and without whom we are nothing. We are indebted for their sacrifices, high optimism and constant support in all our endeavors.

#### 4. CONCLUSION:

From the study, the following conclusions can be drawn:

- The gear box casing used for PMDC motors has been successfully designed using CATIA V5 and is analyzed by ANSYS workbench software.
- The deformation of the gear box casing under the application of known amount of load was found to be very minimum. This is due the fact that the majority of the load is taken up by the gears rather than the casing. As a consequence of this, the gear box casing is almost deformation free.
- The von misses stress or equivalent stress was found to be maximum (1.2559MPa) at a point where the gears attached to bearing and minimum (14.38Pa) at the point of application of load. Due to the cantilever beam like formation of the setup, the stresses behave in this manner. The similar type of results was observed in the case of max shear stress. The max shear stress (6.9166e5Pa) was found at the bearing region and min shear stress (8.2614Pa) at the point of application of load.
- The modal analysis i.e. vibrational characteristics results revealed that the natural frequency of the setup increases with the increase of number of modes selected. The setup tends to fluctuate vigorously with the increase of frequency.

It can be finally concluded that the outcomes through the analysis is found to be in a good agreement and are within the safe limits.

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