DESIGN ANALYSIS AND OPTIMIZATION FOR FOOT CASING OF GEARBOX

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Abstract- This paper contains the gearbox foot casing optimization. Foot casing is a part of gearbox, it provides support to the shaft, bearings and hence the gear loadings. Thus the gear box casing is an important component to be taken into account while designing. Foot casing is typically a metallic material and made by casting process. In Top Gear Transmissions industry, foot casing is made by cast iron material which weights around 71.6 kg. It is approx 32.6% of entire gear-box assembly. Now, industry is facing problem in excessive weight of foot casing. It is not as per optimum design. So there is more wastage in material and ultimately consumes more cost for casting as well as for machining. To solve this problem it is essential to carry out the analysis of foot casing and redesign the existing foot casing in order to save material as well as cost. 3D model is generated in PRO-E software, while static analysis is done in ANSYS software. Optimization is based on ANSYS results, which can be used to enhance the efficiency of the design process. The process is repeated until all specified criteria are met. Final results are more optimize than existing design.

Index Terms- CAD, Gearbox foot casing, Optimization, Static analysis.

I. INTRODUCTION

This research work has been carried out at Top Gear Transmissions industry, plant located at Satara, India. Top Gear Transmissions is a leading name in gearbox manufacturing. Various types of gearboxes are manufactured in the company as per the customer requirements. Foot casing is a part of gearbox, it provides support to the shaft bearings and hence the gear loadings. Foot casing is typically a metallic material and made by casting process. Foot casing not only provides shield to the gear box but also support to the gearbox assembly. Foot type arrangement made in foot casing at the bottom for better support to the assembly. Thus, the strength of the foot casing should be more essential parameter.[1]

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The main objective of the dissertation work is to optimize foot casing and finding out the effective design of gearbox with respect to cost.

Following are the objectives of the work:

- To carry out static analysis using ANSYS for analyzing load effect on gearbox casing.
- In future for optimization and design modification of gearbox casing for better output performance.
- It has helped in selection of appropriate material for cost effective design.
- The most important advantages are decreased prototype development and assessment time.

II. MATERIAL SELECTION

Various ranges of material are available for casing structure. Among from those material selection criteria on various bases such as strength, rigidity, cost etc. Characteristics and parameter are as per Top Gear transmissions catalogue [08]. Various grades of cast iron have been widely applied and used in a multitude of industrial machinery for many years. The use of cast iron as a housing material in gearboxes of all sizes and configuration has been especially prevalent.[07] That trend continues today, with the majority of the medium to large reducer housings being made of cast iron. FG260 is grey cast iron material which is specially used for casting purpose. For casting, there are many factors to be considering for better result. Such as material properties, mechanical properties, chemical composition, fluidity, boundary clearance, thermal properties etc. to fulfill all this criteria, FG260 is appropriate element select for foot casing.

III. METHODOLOGY OF MODELLING AND ANALYSIS

Gearbox foot casing is analyzed under certain load conditions including static and dead weight conditions.

Finite element model is used to calculate stress and deformation in the gearbox casing by ANSYS software [06].

A. CAD model

The figure 01 gives the pictorial representation of the gearbox foot casing. The foot casing is modeled in high end design software Pro-Engg 4.0. The important parametric quantity while designing the gearbox foot casing is the ribbing which is to be provided in order to attain the required strength, thus analysis happens to be an effective tool in proper design detailing [01]. The CAD model of gearbox casing specification is Length-300mm Width- 391mm Height-400mm.

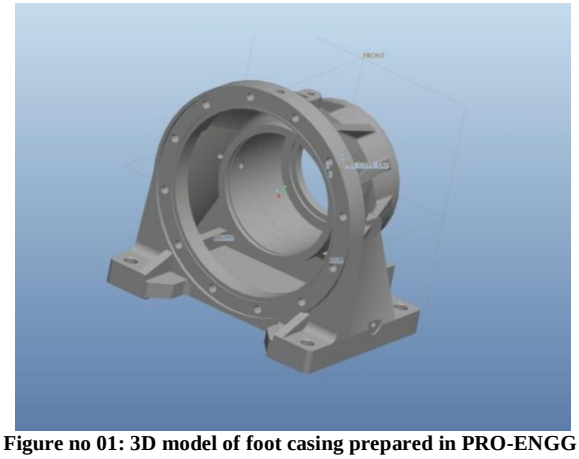

Figure no 01: 3D model of foot casing prepared in PRO-ENGG 4.0

The CAD model is imported into the respective file format to the FEM design software ANSYS 12.0.

B. FEM model

FEA modeling helps in efficient managing of deformation, Equivalent Stress and Equivalent Elastic Strain in any mechanical component and system [06]. The Figure No 02 is the discrete modeling of foot casing. Standard methods are adopted while preparing analysis in order to get appropriate results. FEM modeling is the most important step in analysis as the meshing quality determines and role is important in achieving realistic simulation [05].

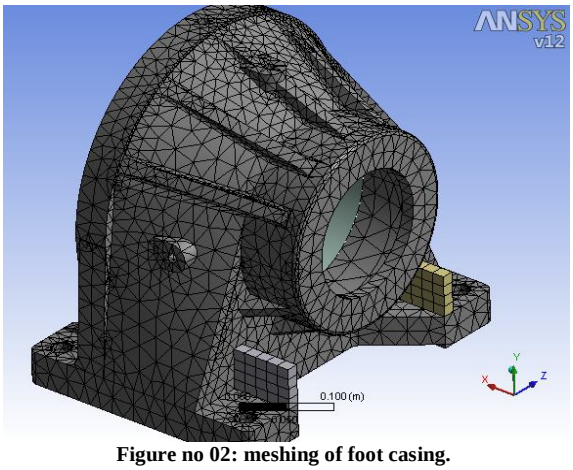

Figure no 02: meshing of foot casing.

Details of mesh strategy are defined in the table no 01 and figure no 02. This mesh is applied to entire body. Tetrahedron Element Method is selected to solve foot casing model.

Meshing strategy is explained in the following table.

Table no 03: meshing properties

Meshing strategy	
Object Name	Foot casing
State	Solved
Defaults	
Physical preference	Mechanical
Relevance	100
Advanced and sizing	
Relevance centre	Fine
Element size	15 mm
Shape checking	Shape checking
Statics	
Nodes	35721
Elements	19184

C. BOUNDARY CONDITIONS

Here are descriptions of load conditions over the foot casing. There is two types of loads are applicable over the foot casing. Those are static load and dead weight of output shaft and bearing. So, overall load is the combination of static load and dead weight. Static load of transmission gear and drive shaft act on bearing. As shown in fog no 03, loading conditions are occurs and we have to find out bearing load Rv & Rh situated at location B. Force F is acting perpendicularly to the shaft from planet-gear carrier.

Force F will be. Where torque T and distance r are known,

$$T = F/r$$

$$F = T/r = (25906/0.09991)$$

$$F = 2.592 \times 10^5 \text{ N}$$

Using those load conditions we can find bearing loads by taking vertical and horizontal reactions. Those loads are as follows,

$$Rv = 171307.08 \text{ N}$$

$$Rh = 371414.91 \text{ N}$$

Total reaction will be,

$$R' = \sqrt{(Rv^2 + Rh^2)}$$

$$R' = 4.0901 \times 10^5 \text{ N}$$

Now total load acting on foot casing R is,

$$R = R' + \text{dead weight of shaft \& bearing}$$

$$R = 4.0901e5 + 353.0949$$

$$R = 4.0936 \times 10^5 \text{ N}$$

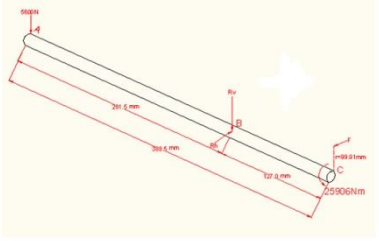

Figure no 03: load analysis of output shaft.

These loads were applied in the mechanical analysis for found the actual effects of stress on gearbox. Application of these loads is shown in figure no 04.

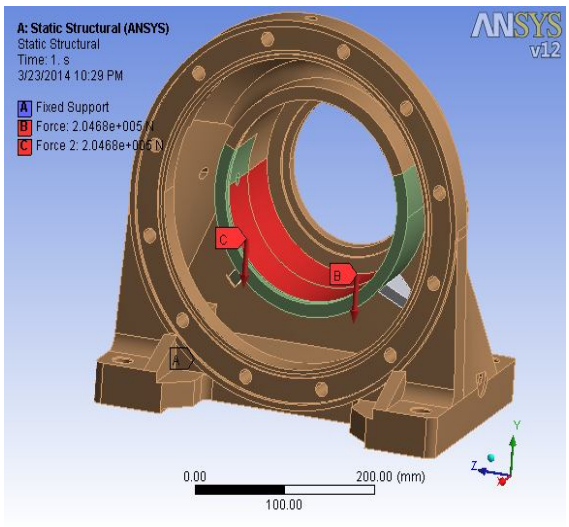

Figure no 04: loads in gearbox foot casing.

IV. RESULTS AND DISCUSSION

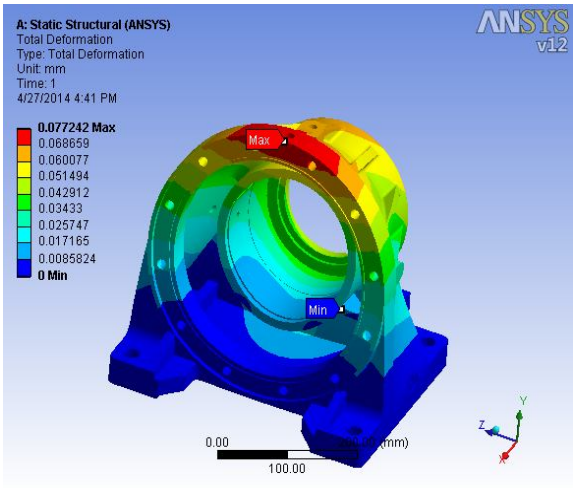

Figure no 05: deformation occurs in gearbox foot casing.

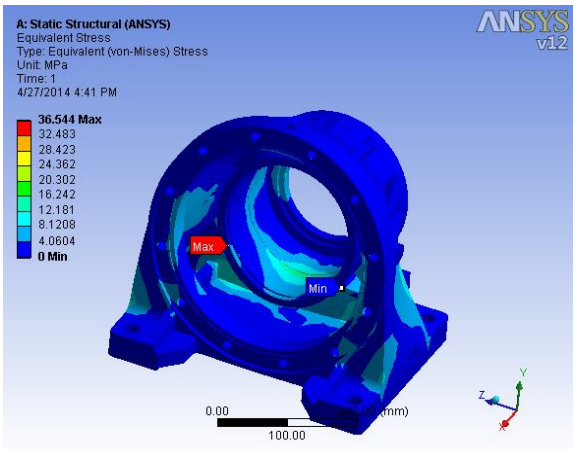

Figure no 06: Von-mises stresses occurs on gearbox foot casing.

The static analysis results tabulated as follow:

Description	Results
Von mises stress	36.544 MPa
Deformation	0.077242 mm

These results were captured in ANSYS software. Deformation is shown in figure no 05 and von-mises stresses are shown in figure no 06.

Obtained results were more efficient than existing model. So, this model is suggested for further production in industry.

V. BENEFITS SUMMERY

Benefits of this research work are as follow:

- The implementation of static analysis has helped in developing an optimum design.
- It has helped in selection of appropriate material for cost effective design.
- Reduced prototype development and testing time.

CONCLUSION

In this paper, study has been carried out to evaluate static analysis of the gearbox foot casing using commercial software ANSYS. Analysis is to find out the total amount of stresses and deformation of any structural component by load. The gearbox casing is manufactured from cast iron FG260 material. The von mises stress is 36.544 MPa. Also the maximum displacement of the casing it is found 0.077242 mm. These results are so far better than existing model. In practice analysis is also important factor for the optimum design and reverse engineering of any mechanical structure and system.

ACKNOWLEDGEMENTS

In the first place, I would like to record my gratitude to Asst. Prof. M. M. Mirza for his truthful advice & guidance from the very early stage of this paper work, which exceptionally inspire and enrich my growth as a student. I would also like to thanks Mr. Shrikant Pawar, MD, TOP GEAR TRANSMISSIONS, SATARA for giving me an opportunity to do the research work in the industry.

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