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REVIEW OF OPTIMIZE AND DESIGN OF GEARBOX WITH MINIMUM WEIGHT

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Abstract – *Gear box have complicated geometry and must satisfy Design criteria such as strength, weight, manufacturability and performance. Gearbox need to accomplish a lot of engineering objectives including some necessary performance durability requirements. Gearbox design and development is very time consuming, because it needs a number of tests and design iterations before going into production. In modern industry how to shorten development time and to reduce the number of times test are important issues.*

Key Words: **Gear box, strength, weight, durability.**

1. INTRODUCTION

Engineering design is the process of devising a system, component, or process to meet desired needs. It is a decision making process (often iterative), in which the basic sciences, mathematics, and engineering sciences are applied to convert resources optimally to meet a stated objective. Among the fundamental elements of the design process are the establishment objectives and criteria, synthesis, analysis, construction, testing and evaluation.

The primary way that engineers utilize the forces and materials of nature for the benefit of mankind is through new and innovative designs. The first step into a design study is to recognize the need. The need, which is the purpose of the design study, is established via a general statement of the client's dissatisfaction with the current situation. Problem definition is the second step of design which should include all the specifications for the thing that is to be designed, the constraints on the design, design considerations (strength, fatigue life, cost etc.) and the criteria to be used for evaluating the design according to the design considerations. The third step is information gathering which requires collection of related information, including theoretical information and previous studies on the subject, from the available sources. Concept generation comes as the fourth step of design, which is the most creative part of the design process. Concept generation is followed with concept selection, in which the generated concepts are compared with respect to basic design criteria. This step may require some simple analysis. After the selection of the concept to be applied for the solution, the detailed design and analysis are performed as the sixth step of design.

Vasim Bashir Maner, M. M. Mirza, Shrikant Pawar [1]: 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. 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.

R. V. Nigade Prof. T.A.Jadhav A.M.Bhide [2]: The 3-D solid model of the gearbox top cover was built using Autodesk Inventor®. ANSYS workbench 13® was used for preprocessing, solving and post processing. Modal analysis involved extraction of mode shapes and natural frequencies. Impact testing using hammer excitation was used to experimentally determine the vibration properties of the gearbox top cover. The results obtained by FEA modal analysis are compared and validated against modal test data.

M. Sofian D. Hazry K. Saifullah M. Tasyrif K.Salleh I.Ishak [3]: This paper contains 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 vibration modes and forced harmonic frequency response for gearbox casing. The important elements in vibration analysis are the modeling of the bolted connections between the upper and lower casing and the modeling of the fixture to the support. This analysis is to find the natural frequency and harmonic frequency response of gearbox casing in order to prevent resonance for gearbox casing. From the result, this analysis can show the range of the frequency that is suitable for gearbox casing which can prevent maximum amplitude.

P. Gulaxea, N. P. Awate [4]: CAE techniques can be used to increase the performance of gearbox and thereby increase the efficiency of material handling trolley of cupola furnace. Also to ensure simulation and experimental results, a prototype model was tested with the help of FEM software. This paper reviews the modeling and computer simulation as a tool for aiding gearbox used by various researchers earlier. The results of computer simulations and results obtained by actual experimentation were compared to get detailed idea about the parameters which can affect the increase in speed drastically. The factors were divided into four groups: design factors, production technology factors, operational factors and change of condition factors.

Shrenik M. Patil 1, Prof. S. M. Pise [5]: Analyze differential gearbox casing of pick up van vehicle for modal and stress analysis. The theoretical modal analysis needs to be validated with experimental results from Fourier frequency transformer analysis. Natural frequency of casing with constraints is obtained using ANSYS and compared with gear mesh frequency i.e. operating frequency. There is no resonance condition found. Natural frequency of the model without stiffeners had compared with the natural frequency of model with all stiffeners and with operating frequency. Proposed model is safe from resonance point of view. As the stiffeners are removed from casing there is a chance of increase in stress, from static analysis results we conclude that proposed model is in safe stress limit.

Bagul A. D. ,Barijibhe R. B. and Patil A. V. [6]: This Paper is concerned with the application of ANSYS software and also FFT analyzer to determine the natural vibration modes and find the free frequency of the Gearbox casing. Finding natural frequency of the Gearbox casing component in order to prevent resonance for gearbox casing component. From the result this analysis can show the range of natural frequencies of gearbox casing component with maximum amplitude of it.

Syed Rizwan UI Haque [7]: The gear box casing houses important transmission component like gear and shafts. Thus the strength of gearbox casing is an important parameter to be taken into account while designing. In order to access the strength of gear box step by step approaches are adopted for Higher durability target, reduced product cycle development time and lower design costs. Simulation happens to be an effective and reliable to meet this demand.

Dr. inż. Zbigniew Zdziennicki, Dr. inż. Andrzej Maciejczyk [8]: They discuss the size and selection of gear box, stages of gear box, To obtain the nominal torque at the output shaft is calculated using the absorbed torque at the driven machine or the prime mover, material and heat treatment process, determining the approximate center distances for the rest of the gearbox and will give a fair distribution of economical gear size throughout the unit.

Dr. Ing. U. Kissling, KISSsoft AG, Hombrechtikon [9]: Designing gears, the size, weight and manufacturing cost can be influenced to a great extent by both strategically splitting the overall reduction over the individual stages and by optimizing the geometric relationships. A newly developed tool, the KISSsoft "Gearbox Variant Genera-tor" is able to automatically generate different gear variants, all of which have the same total reduction and performance, but have different numbers of stages and distribution of reduction across their stages. Each of these different solutions is numbered sequentially and displayed as a 3D diagram to make the best solutions easy to identify. This used the Gearbox variant generator to analyze and optimize gears.

Viraj Rajendra Kulkarni, Amey Gangaram Tambe [10]: Steering Knuckle is one of the critical components of vehicle which links suspension, steering system, wheel hub and brake to the chassis. It undergoes varying loads subjected to different conditions, while not affecting vehicle steering performance and other desired vehicle characteristics. This paper focuses on optimization of steering knuckle targeting reducing weight as objective function, while not compromising with required strength, frequency and stiffness. Taking into consideration static and dynamic load conditions, structural analysis and modal analysis were performed. Finite element model was developed in HyperWorks. 10 node tetrahedral elements were used for meshing, providing better results in less time. On constraining the knuckle, combined load of brake torque on the caliper mounting, longitudinal loads due to traction, vertical reactions due to weight and steering reaction, the finite element model was solved using Radioss solver. The stress levels and deformation was checked using HyperView for static as well as dynamic conditions. FEA results were verified by analytical calculations. OptiStruct solver was used for performing Topology Optimization to minimize the amount of material to be used and setting geometric parameters as design variables. Considering the results obtained from optimization, geometric model was modified and iterated until satisfactory results were achieved.

Lothar Harzheim, Gerhard Graf [11]: In recent years, there has been considerable progress in the optimization of cast parts with respect to strength, stiffness, and frequency. Here, topology optimization has been the most important tool in finding the optimal features of a cast part, such as optimal cross-section or number and arrangement of ribs. An optimization process with integrated topology optimization has been used very successfully at Adam Opel AG in recent years, and many components have been optimized. This two-paper review gives an overview of the application and experience in this area. This is the first part of a two-paper review of optimization of cast parts. Here, we want to focus on the application of the original topology optimization codes, which do not take manufacturing onstraints for cast parts into account. Additionally, the role

of shape optimization as a fine-tuning tool will be briefly analyzed and discussed.

Waqas Saleem, Hu Lu, Fan Yuqing [12]: Structural optimization tools have grasped enormous applications in engineering design and development activities because of increasing demands of lightweight and rigid products. In this milieu, researchers have exploited the potentials of nonparametric structural optimization tools like topology optimization by coupling and integrating with other compatible softwares. The objective is to find the optimal design proposal of a thing walled aerospace component, for which a predecessor design subsists. ANSYS is used to develop the FE model of initial design space of component. The optimized model is then imported in CATIA to incorporate necessary refinements for manufacturing, machining and geometric restrictions. To validate this new design proposal, optimized model is then imported in ANSYS and analyzed again under the stipulated loads and boundary conditions. At the end, a comparison is made between the predecessor design and the new optimized design proposal. Comparison validates the new design proposal assisted by optimization and simulation is more reliable and reduced weight with enhanced structural performance.

Bhavik S. Modi [13]: The gearbox manufacturing Companies are proposing three to five stage epicyclic gearboxes and it is widely used in sugar mill and wind mill drives. It was found that high volume gearbox costs are very dependent upon material cost and the weights of the planetary drives. It was difficult to quickly find an optimum solution, while the space restriction was given and weight was to be minimized. For most of the gearboxes; housing dimensions are derived from thumb rule or empirical relations. Such process of design lead to conservative dimensions leading to bulky housing and such process was very time consuming. Today's computational hardware and software offers quick analysis and design modifications capabilities which can be used for design improvement and optimization of products. So, here aims are stress analysis of the housing using ANSYS workbench and reduce the mass of the epicyclic gear train housing by using MATLAB optimization tool box.

2. CONCLUSION

Study of these papers help us to understand design and analysis of gearbox. After this complete study we can able design and model gearbox, we can able perform different types of analysis and to conclude the effect of various load on that..

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