DESIGN OF EXTRUDER HELICAL GEARBOX: A REVIEW

Keval Dalwadi*(*corresponding author*), Unnati Joshi[a], Sankalp Bhatiya[b]
Student, Associate professor[a], Assistant professor[b]*
Mechanical Engineering department,
A. D. Patel Institute of Engineering,
Vitthal Udyognagar

ABSTRACT

This paper provides a review of the literature on designing and analysis of a gearbox casing. Gearbox is an important machinery component in any industry. Helical gears are widely used in numerous engineering applications. Industry is facing the problem of higher disassembly time and difficulty in maintenance. As a solution, split casing needs to be developed. Stress analysis is engineering discipline that determines the stress in materials and structures subjected to static and dynamic forces or loads. Vibrational analysis of casing also plays a vital role in proper working of the gearbox. Gearbox with moving parts gives rise to noise and vibration, which reveals the gearbox condition. FEA method is used for static and vibration analysis. In this paper, we have reviewed the current research state of modal analysis and harmonic frequency response on gearbox casing and also an insight into future research and challenges in this field of study.

Keywords-*Casing design, Stress analysis, Modal analysis, Natural frequency, Harmonic frequency response*

1. INTRODUCTION:

Gearing is one of the most essential part in a mechanical power transmission system. It is very economical and very effective way of power transmission. It is used almost all engineering purpose for power transmission. Gearbox is an important machinery component in any industry [2]. Helical gears are widely used in numerous engineering applications including power generation plants. Helical gearbox is used in sugar mill, plastic industry, cement industry, steel industry etc. Gearbox casing is made up in two Process, Fabrication and casting [3]. Generally, materials used for casing are steel and cast iron. gearbox are containers in which internals namely like pinion, gearwheel, shaft, bearings, bearing covers, oil seals and other component mounted shown in fig 2. When any problem occurred in gearbox, its need to be a disassemble. Higher disassembly time and difficult maintenance is main problem for users. Stress analysis is engineering discipline that determines the stress in materials and structures subjected to static and dynamic forces or loads [4]. It revels the condition of gearbox structure is safe or unsafe. Vibration and noise level revels the condition of gearbox. Modal analysis is used for detecting frequency of any object, by this we get natural frequency [5]

Fig 1 XC-16 Helical gearbox [1]

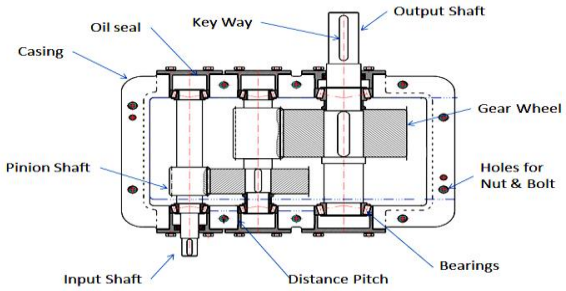

Fig 2 Helical gearbox assembly [1]

2. LITERATURE SURVEY

Helical gears are widely used in numerous engineering applications including power generation plants. Gitin M Maitra, covers the designs of helical gear and the spur gears, also the forces acting on the gears and basic parameters of casing are given [2]. Failure of gears not only results in replacement cost but also in process downtime as well as other undesirable consequences in helical gearbox [6]. Gearbox casing is made up in two Process, Fabrication and casting. The stress and rigidity levels of the two casings are compared which is made up in fabrication and casting. Generally material use for casing are steel or cast iron [3]. Higher disassembly time and difficult maintenance is main problem for users. When industry is looking at the best ways to increase efficiency, reduce downtime, and increase profitability, gearbox performance and reliability are key factors. Gearbox housing contain internals like shaft, bearing, bearing covers, pinion, gearwheel etc. In this paper, Basic Types of Component and Assembly Interfaces, assembly techniques and disassembly techniques have been discussed [7].

A. M. Davis et al. [8]: analysed designing for static and dynamic loading of a gear reducer housing with FEA which was used to test the cast iron housing to determine any potential problem areas before production begins. The entire system was analysed as an assembly in which FEM model has number of element. After that stress analysis was carried out on housing [8]. Materials plays an important role in analysis. Gray cast iron, steel, Al & Mg alloys materials are used for analysis purpose to selecting appropriate material for the process here gray cast iron has lower frequency than steel, Al & Mg alloys materials.FEA base ANSYS tool used for simulation of structure optimization at initial stage in casing design[9].
The gearbox casing houses important transmission component like gears and shafts. Thus the strength of the gear box casing is an important parameter to be taken into account while designing. In order to assess the strength, of the gearbox casing, a step by step approach is adopted. It was statically analyzed using simulation software Ansys. The strength of the gearbox casing's hooks and bolts has important during the lifting off and fixing the gearbox especially in split casing [10].
P. D. Patel & D. S. Shah et al [11]: Presented steady state thermal stress analysis of gearbox casing by using finite element method. From this paper I have taken some techniques like mashing strategy, how to give boundary condition and fixed support on casing. In this paper, von-misses stress analysis have been done using ansys software. The main objectives of the work to impotence have to show in figure.

- Creo model for analysis:

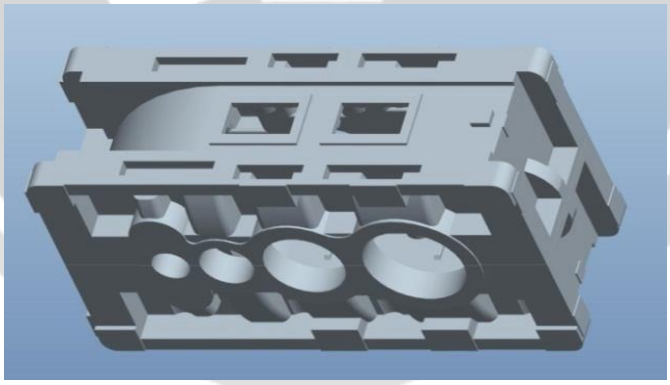

Fig. 3: 3-Dimesional assembly modeling of gear case in Pro-E [11]

- Meshing strategy:

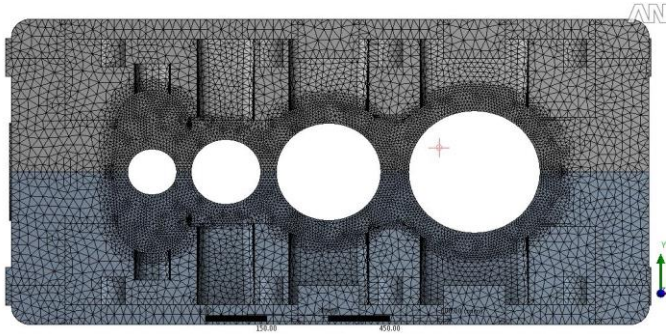

Fig. 4: FEA model of gearbox casing [11]

- Boundary condition and applied load:

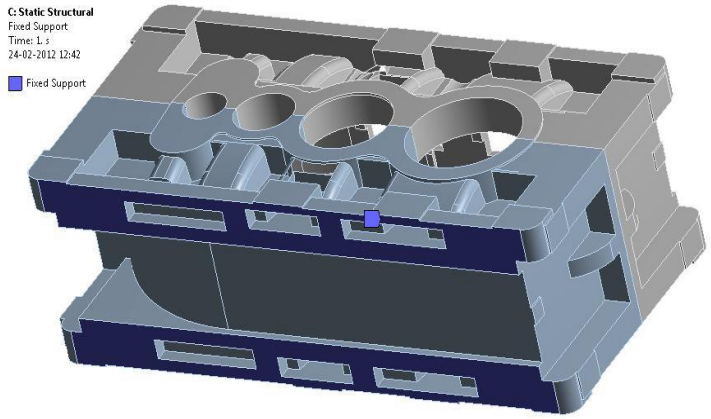

Fig. 5: Fixed support of bottom in gearbox casing [11]

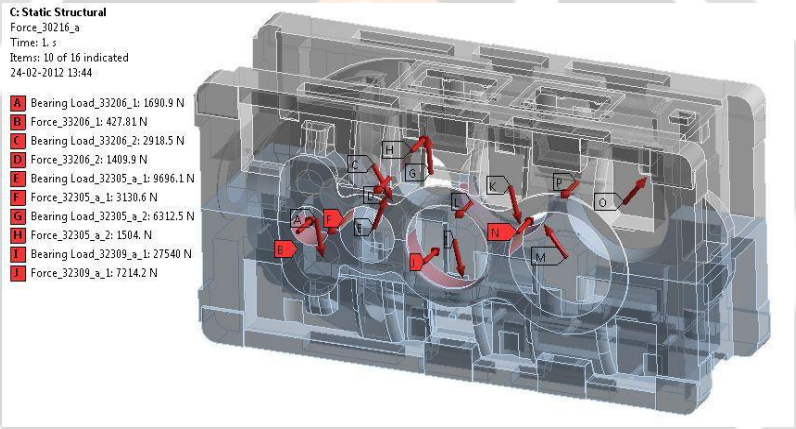

Fig. 6: Loads in gearbox casing [11]

Here, creo model of gearbox casing is shown in fig 3, the details of mesh strategy are defined and this mesh is applied to whole object as one body meshing in figure 4, also fixed support and boundary condition applied on casing is shown in figure. Bearing load have been applied as a boundary condition which has been found by using bearinX software [11].

Bagul A. D and Patil A. V studied gearbox casing 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. By 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 [12]

Amit Aherwar studied review about current vibration techniques used for condition monitoring in geared transmission system. The main causes of mechanical vibration are unbalance, misalignment, defective bearings, bent rotor shaft etc. [13]. SinisaDraca studied the primary goal of research involves the description and creation of an analytical finite element model of a double-stage helical gear reduction. This model is used to gain additional insight into the vibration generation that results from helical gear meshing action [14]. Milosav studied modal analysis of gearbox using FEA and has been find different mode shapes and natural frequency, also determined many mode shape for 0-3000hz frequency range [5]

R. V. Nigade researched on Gearbox top cover which is a vital component of horizontally split integrally geared centrifugal compressor. The top cover is designed within the mechanical limits of its construction material, one of the most common causes of to cover failure is resonance. In this paper, covered vibration characteristics of casing analytically and excrementally. From FEA analysis the effect of varying casing wall thickness on the natural

frequencies of the gearbox top cover was not significant, as compared to increase in the weight of the gearbox top cover. They observed that the obtained natural frequencies are separated by 20% from first and second harmonics of the excitation frequency [15].

Choy F.K et al. [16] have compared gearbox mode shapes and vibration predictions obtained from analytical model with those of experimental results obtained from the test rig at the NASA Lewis Research Center. It was found that the natural frequencies of the simulated results were within 5 percent of the experimental values [16].

C. M. Sofian Et Al. [17]: Described the study about vibration analysis for gearbox casing using Finite Element Analysis (FEA).In this paper they have been used 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. 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, analysis can show the range of frequency to prevent maximum amplitude and also show a frequency vs. amplitude graph [17].

D. Shrenik M. Patil & Prof. S. M. Pise [18]: Summarized modal and stress analysis of differential gearbox casing with optimization. Complex structures can be meshed and analyzed over a relatively short period of time. Dynamic correlation, comparison of mode shapes and natural frequencies, is a robust tool for evaluating the accuracy of a finite element model [18]. The most commonly used method for rotating machine is vibration analysis measurements can be taken on machine bearing casings with piezo-electric transducers to measure the casing vibrations. From frequency vs. amplitude graph conclusion is the amplitude of vibrations decrease as the load on the gearbox increase [19]. Mr.vijaykumar studied the natural frequency and harmonic frequency response of gearbox casing in order to prevent resonance and also conclude frequency range suitable for prevent maximum amplitude of casing. In lightly damped system when forcing frequency near the natural frequency the amplitude of vibration can get high [20].

3. CONCLUSION:

Gearbox is an important machinery component in any industry. Helical gears are widely used in numerous engineering applications. The literatures on the gearbox casing recent papers provide design parameters and stress analysis in ansys software. From literatures we can get meshing strategy, boundary condition for gearbox casing. Some researchers studied about vibration analysis on casing. From this modal analysis have been done on gearbox casing and find natural frequency & mode shape. Harmonic frequency response has been applied on casing and find amplitude vs. frequency graph to prevent resonance of gearbox casing.

4. REFERENCES:

[1] Elecon EP series catalogue, Elecon engg. co.ltd
[2] Gitin M Maitra, “Handbook of gear design’’
[3] V. ramamurti, p. s. arulkumar and k. jayaraman, “performance comparison of cast and fabricated gearbox casings’’, technical note, IITMadras. (1989)
[4] Tushar. N. Khobragade, P. Priadarshni, “static analysis of gearbox casing”, Greaves Cotton Limited, Aurangabad
[5] Snežana Ćirić Kostić, Milosav Ognjanović, "Excitation of the Modal Vibrations in Gear Housing Walls" April 2016
[6] Samroeng Netpu, Panya Srichandr, "Failure of a helical gear in a power plant" December 2012
[7] Jodi Bello," Best Practices for Gearbox Assembly and Disassembly" Power Transmission Engineering, March 2014
[8] M. Davis, Y. S. Mohammed, A. A. Elmustafa, P. F. Martin and C. Ritinski, " Designing for static and dynamic loading of a gear reducer housing with FEA”, (February 2010)
[9] Ashwani Kumara, HimanshuJaiswala, RajatJaina and Pravin P. Patila, “Free vibration and material mechanical properties influence based frequency and mode shape analysis of transmission gearbox casing”, Procedia Engineering, (2014) 1097–1106
[10] Syed Rizwan Ul Haque, Prof. Dongyan Shi," Static Analysis of Gearbox Casing Using Sub modeling Approach in ANSYS"

[11] P. D. Patel & D. S. Shah; "Steady state thermal stress analysis of gearbox casing by finite element method", International Journal of Mechanical and Industrial Engineering (IJMIE) ISSN No. 2231 –6477, Vol-2, Iss-4, 2012

[12] Shrenik M. Patil, S. M. Pise, "Modal and stress analysis of differential gearbox casing with optimization", International Journal of Engineering Research and Applications, Vol. 3, Issue 6, (2013) 2248-9622, pp.188-193

[13] AmitAherwar and Saifullah Khalid, "Vibration analysis techniques for gearbox diagnostic: a review", International Journal of Advanced Engineering Technology, Vol.3, (2012) 0976-3945

[14] SinisaDraca, "Finite element model of a double-stage helical gear reduction'' University of Windsor, Ontario, Canada 2006

[15] R. V. Nigade, Prof. T.A.Jadhav, A.M.Bhide "Vibration Analysis of Gearbox Top Cover" Research and Engineering Kirloskar Pneumatic Co Ltd., Pune, Maharashtra, India

[16] Choy F.K and Ruan Y.F., Fred K. Choy and Yeefeng F. Ruan "Modal Simulation of Gearbox Vibration with Experimental Validation", NASA paper AIAA 92-3934, July 1992, pp 1-15.

[17] M. Sofian, K. Saifullah, M. Tasyrif, K. Salleh, I. Ishak; "A study of Vibration Analysis for Gearbox Casing Using Finite Element Analysis", Proceedings of International Conference on Applications and Design in Mechanical Engineering (ICADME), 11 – 13 October 2009,

[18] Shrenik M. Patil & Prof. S. M. Pise; "Modal and Stress Analysis of Differential Gearbox Casing with Optimization", Shrenik M. Patil et al Int. Journal of Engineering Research and Applications, ISSN: 2248-9622, Vol. 3, Issue 6, Nov-Dec 2013, pp.188-193

[19] Saurabh S. Shahapurkar, Hemant S. Pansare, Prashant P. Dhebe, Chetan S.Wagh," detection of fault in gearbox system using vibration analysis method", International Journal of Engineering and Applied Sciences (IJEAS) ISSN: 2394-3661, Volume-2, Issue-5, May 2015.

[20] Mr.vijaykumar, 2, Mr.shivaraju, 3, Mr.srikanth," Vibration Analysis for Gearbox Casing Using Finite Element Analysis", The International Journal Of Engineering And Science (IJES) ‖Volume‖ 3 ‖Issue‖ 2 ‖Pages‖ 18 - 36 ‖ 2014 ‖ ISSN (e): 2319 – 1813 ISSN (p): 2319 – 1805 www.theijes.com The IJES Page 18

[21] Svend Gade, Bruel and Kjaer, "Operational Modal Analysis on a Wind Turbine Gearbox"Sound & Vibration Measurements, Germany and Christian Fenselau, Technology R&D – NVH, Germany.

[22] Wan Xudong, 2006 "Vibration Analysis and Structure Noise Prediction of Marine Gearbox", Mechanical Design and Theory, Chongqing University.

[23] A. Anderson and L. Vedmar, A dynamic model to determine vibrations in involute helical gears, Journal of Sound and Vibration 260 (2003), 195–212.

[24] R.G. Budynas, C.R. Mischke, and J.E. Shigley, Mechanical Engineering Design, 7th edition, McGraw-Hill, New York, 2004.

[25] R. Singh and H. Vinayak, Multi-body dynamics and modal analysis of compliant gear bodies, Journal of Sound and Vibration 210(2) (1998), 171–214.