Yaun H. Guan et al. [6] modelled the four actuation concepts for the active suppression of gearbox housing mesh frequency vibrations due to transmission error excitation from the gear pair system and compared by computing the required actuation forces and amplifier power spectra. They applied four different actuation concepts designed. They examined several key comparison criteria including the required actuation effort, control robustness and implementation cost and discussed the advantages and disadvantages of each concept. Based on the simulated data, they found the active shaft transverse vibration control scheme as the most suitable approach for this application.

Kostic and Ognjanovic [7] discussed about the noise emission of gear units (gearbox) depends both on the disturbances and on the insulating capabilities and modal behavior of housing. They found that the results of modal testing give the possibility of identification of noise structure for the chosen gearbox. Comparison and analysis of the results obtained lead to precise determination of the cause of creation of the total spectrum of gear transmission units.

Ashwani Kumar et al. [8] considered the vibration problem of truck transmission housing using FEA method. They studied the vibration pattern for first twenty modes. The analysis results shows the transmission housing is subjected to axial bending variation, torsional vibration, and axial bending with torsional vibration. They constrained the transmission housing motion by constraining the displacement of bolts holes.

Patel and Shah [9] done study of equivalent von- mises stress in linear & outer gearbox casing with the coupled method has been done using ANSYS. They carried out this study to evaluate steady state thermal stress analysis. They proves that in practice thermal stress analysis is also important factor for optimum design and reverse engineering of any mechanical structure and system.

Vasim Bashir Maner et al. [10] discussed about the design and optimization for foot casing of gearbox. Foot casing is the part of gearbox. They reduce the excessive weight of foot casing. This study has been carried out to evaluate static analysis of gearbox foot casing using commercial software ANSYS. The results found are better than existing model.

Kostic and Markovic [11] performed modal displacement excitation in gear housing walls by finite element method in a large number of modal shapes (frequency) of natural oscillation. They used direct integration method within FEM. In experimental approach, impulse excitation was realized by impact method and response was measured at appropriate point by mean of an accelerometer & FFT frequency analysis.

Choy et al. [12] have predicted the casing vibration by analytically and they compared this predicted casing vibrations to measured results from test rig. They found the natural frequency of simulated results were within 5 percentage of experimental values.

Khobragade and Priyadarshani [13] compared the analysis result of two simulation software i.e. Altair Hypermesh / Optistruct and ANSYS 11.0. The comparison obtained from results were closely matching. They used results obtained from analysis in developing an optimum design of gearbox casing. It has not only helped in building cost effective design but also have helped to reduce prototype development and testing time.

3. Techniques Used

3.1 Modal Analysis using ANSYS

Modal analysis is used to determine the vibration characteristics such as natural frequency and mode shapes of structure or machine component while it is being designed. It can also serve as a starting point for another, more detailed, dynamic analysis, such as a transient dynamic analysis, a harmonic analysis, or a spectrum analysis. The natural frequencies and mode shapes are important parameters in the design of a structure for dynamic loading conditions. They are also required if you want to perform a spectrum analysis or a mode-superposition harmonic or transient analysis. Modal analysis done on the pre-stressed structure. Another useful feature is modal cyclic symmetry, which allows you to review the mode shapes of a cyclically symmetric structure by modeling just a sector of it. Modal analysis in the ANSYS, Inc. family of products is a linear analysis. Any nonlinearities, such as plasticity and contact (gap) elements, are ignored even if they are defined [14].

3.2 FFT Analyzer

FFT analyzer is the essential tool in such fields as vibration and shock data analysis, machinery monitoring and analysis of complex waveforms. Use of the FFT analyzer is required in many industries, including military, transportation, aerospace, manufacturing and consumer products. Fourier analysis converts time (or space) to frequency and vice versa; an FFT rapidly computes such transformations by factorizing the DFT matrix into a product of sparse (mostly zero) factors. The FFT analyzer along with associated transducer such as accelerometers is the primary analysis tool used in vibrational experiment. FFT analyzer is the PC based system and operate in a familiar environment such as Windows 95. FFT analyzer uses constant bandwidth resolution. FFT analysis is a useful tool in sound and vibration analysis and is available in PULSE Lab Shop and the PULSE Reflex platform. FFT analysis uses the Fast Fourier Transformation algorithm to calculate a spectrum from a time domain signal, and is the most common type of spectral analysis tool available today [15].

4. Conclusions

Gearbox is a very important component in any machine. So as to increase the life of the gears and bearings in the gearbox assembly, vibration reduction in gearbox casing is of prime importance. An extensive research in the past clearly indicates that there is a huge scope for improvement in this field. The finite element simulation for modal analysis is the

most popular and commonly found method to find out the node shapes during vibrations. ANSYS is used in almost all cases for simulation. Some researchers used two simulation software and compared their results. Some used test rigs for experiment. Most researchers also used FFT analyzer to validate the results obtained by the simulation. It was seen that the simulation and experimental results are in close agreement with each other.

References

[1] R. V. Nigade, T.A.Jadhav, A.M.Bhide, Vibration Analysis of Gearbox Top Cover, International Journal of Innovations in Engineering and Technology (IJIET), Vol. 1, Issue 4, ISSN: 2319 – 1058, 2012, pp. 26-33, 2012.
[2] Shrenik M. Patil, Prof. S. M. Pise, Modal and Stress Analysis of Differential Gearbox Casing with Optimization, Journal of Engineering Research and Applications, ISSN: 2248-9622, Vol. 3, Issue 6, pp. 188-193, 2013.
[3] Mr.Vijaykumar, Mr.Shivaraju, Mr.Srikanth, Vibration Analysis for Gearbox Casing using Finite Element Analysis, The International Journal Of Engineering And Science (IJES), Volume 3,Issue 2, ISSN (e): 2319 – 1813 ISSN (p): 2319 – 1805, pp. 18-36, 2014.
[4] Syed Rizwan Ul Haque, Prof. Dongyan Shi, Tauseef Ahmed, Static Analysis of Gearbox Casing using Submodeling Approach in ANSYS, Harbin Engineering University publication, China, pp. 15-22, 2010.
[5] D.S.Chavan, A.K.Mahale, Dr. A.G.Thakur, Modal Analysis of Power Take Off Gearbox, International Journal of Emerging Technology and Advanced Engineering, Volume 3, Issue 1, pp. 70-76, 2013.
[6] Yuan H. Guan, Mingfeng Li, Teik C. Lim, W. Steve Shepard Jr, Comparative Analysis of Actuator Concepts for Active Gear Pair Vibration Control, Journal of Sound and Vibration, 269, pp. 273–294, 2004.
[7] Snezana Ciric Kostic, Milosav Ognjanovic, The Noise Structure of Gear Transmission Units and the Role of Gearbox Walls, FME Transactions, Vol. 35, No 2, pp. 105-112, 2007.
[8] Ashwani Kumar, Himanshu Jaiswal, Avichal Pandey, Pravin P. Patil, Free Vibration Analysis of Truck Transmission Housing Based on FEA, 3rd international conference on materials processing and characterization, pp. 1588-1592, 2014.
[9] 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, Volume-2, Issue- 4, pp. 26-30, 2012.
[10] Vasim Bashir Maner, M. M. Mirza, Shrikant Pawar, Design Analysis and Optimization for Foot Casing of Gearbox, 3rd IRF International Conference, pp. 35-38, 2014.
[11] Snezana Ciric-Kostic, Svetislav Lj. Markovic, Modal Displacemet Excitation in Gear Housing Walls. pp. 26-33.
[12] F. K. Choy, Y. F. Raun, Fred K. Choy, Yeefeng F. Raun, Modal Simulation of Gearbox Vibration with Experimental Validation, NASA paper AIAA 92-3934, pp. 1- 15, 1992.
[13] T. N. Khobragade, Priadarshani P., Static Analysis of Gearbox Casing, Driving Innovation with Enterprise Solution, pp. 12-21, 2008.
[14] ANSYS Mechanical APDL Structural Analysis Guide, ANSYS inc., Southpointe, 275, Technology Drive, Canonsburg, PA 15317.
[15] The FFT Analyzer in Mechanical Engineering Education, Robert Frey, State University of New York, Binghamton, New York.

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