FEA Based Study of Loose Transmission Gearbox Housing

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ABSTRACT

Transmission gearbox housing is subjected to noise and vibration induced by internal harmonic excitation. The internal harmonic excitation produces a dynamic mesh force, which is transmitted to the housing through the shafts and bearings and causes transmission failure. The main objective of this research work is to study the relation between the transmission vibration and the positional fixed constraints of vehicle frame by comparing the free vibration results of zero displacement constraint condition to positional constraint of the different number of connecting bolts. The vehicle gearbox housing is mounted on vehicle frame using connecting bolts fixture. The present design of heavy vehicle truck transmission housing is mounted on vehicle frame using 37 connecting bolts on five different positions. The study has been completed in two parts, in first parts all 37 connecting bolts were fixed on vehicle frame and in second part of study the front and bottom positional bolts were loosened to study the relation between vibration and constraint connecting bolts. Reciprocity Principle was used to apply the loads on housing. The first 20 vibration mode shape and natural frequencies were calculated using ANSYS 14.5. The study has theoretical and practical importance for the structure optimization of gearbox housing. ANSYS 14.5 is used as FEA based analysis tool. The natural frequency for zero displacement condition varies from 1669 Hz to 3576 Hz and for loose transmission housing frequency varies from 750 Hz to 3802 Hz. The analysis results is verify with experimental results available in literature.

Keywords: Axial Bending, Connecting Bolts, Constraint, FEA, Loose Housing, Truck Transmission Housing, Zero Displacement

1. INTRODUCTION

Vehicle transmission noise and vibration problem is studied by researchers since many years. A brief description has been presented here for reference work. Ji Wang (2012) have investigated friction force on the tooth face for non-linearity in gear dynamics. To explain the non-linear phenomena frictional force, backlash and meshing stiffness is used for numerical simulation. Critical parameters were identified and bifurcation, chaos and sliding friction

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were investigated. Gabriele Vandi (2014) have presented the implementation of a simplified engine-driveline model for study of vehicle dynamic. As a special case the clutch model was studied for the situations of engaged and disengaged clutch. Lei Yulong (2011) have studied the hydraulic system of a dual clutch automatic transmission. They have calculated the structure size of each body through theory and practical algorithm. The dynamic simulation model of hydraulic system of dual clutch automatic transmission was established.

Süreyya Nejat Dogan (1999) has done significant work to reduce the transmission noise. This research work concluded that torsional vibration and axial bending causes undesirable noise rattling and clattering. The transmission parameters were optimized and verified by experimental analysis. The research work concluded that it was possible to reduce the level of noises by optimizing parameters. Shawki S. (2013) have used vibration response analysis method for the analytical analysis of car gearbox system. They have performed analytical and experimental analysis of a car transmission system. By using physical properties, they have calculated the radiation efficiency. Shaban Ghavami Jolandan (2012) this research work presents a fault classification method based on a fuzzy inference system. The research work analyses the three cases of MF285 gearbox with vibration signal from a piezoelectric transducer. The three cases of analysis were Healthy Gearbox (H), Gear with tooth face worn (W), Gear with tooth face broken (B) and three working speed (700, 1500 and 1800 rpm).

Kei-Lin Kuo (2011) the objective of this research work was to establish a system model for an Automatic Transmission powertrain using Matlab/Simulink. This paper further analyses the effect of varying hydraulic pressure and the associated impact on shift quality during both engagement and disengagement of the joint elements. Snežana Ćirić Kostić (2007) have investigated the natural vibrations of the housing walls and concluded that it can be prevented by designing parameters. Hugo Heidy Miyasato (2011) this work deals with the testing of clutch and the torsional model response will be evaluated through numerical integration. Mats Åkerblö (2013) has performed a literature review and concluded that transmission error is an important excitation mechanism for gear noise and vibration. In addition to transmission error, friction and bending moment are another reason responsible for failure. He has also analyzed the dynamic behaviour of a gearbox.

Timothy J. (2007) have studied the source of vibration. A Sports Utility Vehicle with sensor and data acquisition system is used to find the vibration source. This study was focused on vehicle vibration response from road surface features. Fujin Yu (2013) have studied the dynamic characteristic of the automobile transmission gearbox. They have used structural optimization method to reduce the noise and vibration of gearbox. Pro/E and finite element method is used for the analysis. The author have studied the casing design in very simple manner, for further study full transmission casing model can be considered.

Jiri Tuma (2009) has studied the noise and vibration of transmission system. The author solved the gear noise problem by introducing an encloser to reduce radiated noise. The Fourier Transform is used for the analytical analysis. Analytical result is verified using experimental investigation. The natural frequency of vibration is varying in between 500 Hz to 3500 Hz at varying rpm. The severe vibration occurs at the frequency range of (500-2500) Hz. Leila Nacib (2013) have studied the heavy gearbox of helicopters. To prevent break down and accident in helicopters gear fault detection is important. Spectrum analysis and Cepstrum analysis method is used to identify damage gear. Fourier analysis is used for analytical results.

Automobile gearbox is an assembly of gears to meet the torque variation for the varying speed and loading conditions. Gearbox housing is often used interchangeably with transmission housing or casing. Housing is a complex system to design and analysis. It consists of various types of fixturing bolts and inaccurate or loose fixturing cause excessive vibration and noise production. If the shifting of gears is not timed
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