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Free Vibration Analysis of Truck Transmission Housing Based on FEA

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Abstract

The Transmission housing protect the components of gearbox. It provides the fluid tight casing to hold the lubricants and provides support to moving components. Transmission housing or gearbox casing failure is the main problem for the vehicle manufacturer. Noise and vibration are the main reason for failure. So it is required to reduce the level of noise and vibration. In order to prevent failure the natural frequency and natural mode shapes should be known. In this paper ,the vibration analysis of transmission housing were performed by finite element simulation using ANSYS 14.5 software. The vibration pattern for first twenty mode were studied. The analysis show that the natural frequency of vibration varies from 1306.3 Hz to 3879 Hz. The External excitation on transmission housing must be eliminated to prevent the fracture of housing. The reason for the fracture is matching of external excitation frequency to natural frequency of transmission housing. Transmission housing design is a complex procedure. Design of transmission housing was done using Solid Edge software and the model is imported in ANSYS 14.5 (FEM based software) for vibration analysis.

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Keywords- Vibration Analysis; FEA; Transmission Housing; ANSYS; Modes.

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1. Introduction

A gearbox is a combination of gears that is used to transmit energy through different parts of vehicle. It function like to increase torque while reducing speed.

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Gearbox casing is often used interchangeably with transmission Casing or housing. Housing is a complex system to design and analysis. It consist of various types of fixturing and inaccurate fixturing cause excessive vibration and noise production. Automobile transmissions consist of multiple gears to increase torque while slowing down the speed. Automatic, manual and continuously variable are three types of transmission used in automobiles. A manual transmission is a simple gearbox assembly. Manual transmission is of two types: sliding mesh and constant mesh. In manual transmission all the requirement is handled by the driver and the engine speed according to road is vary by driver. If the shifting of gears is not timed correctly, clashing may happen. Clashing is a loud noise produced during collision of gear tooth and this collision leads the transmission failure. In automatic and continuously variable transmissions there is less driver interaction.

In transmission the power is transmitted in this order - engine, clutch, gearbox, prop shaft, differential, half shafts, hubs and tyres. During power transmission if there is a slack in drive train it may cause high vibration known as transmission Shock. It is the main reason for gearbox assembly and housing failure.

2. The Cad Model

The transmission housing model was constructed using software Solid Edge (2006). The CAD software SOLID EDGE have good modeling features so it is selected for solid model of the transmission housing. The CAD model is shown as figure 1. For free vibration analysis the IGES file of solid model is imported to ANSYS 14.5 (2013) software. Figure 2 shows the meshed model of transmission housing. ANSYS 14.5 provide high quality meshing facility. The meshed model consists of 2,52,786 nodes and 1,56,307 elements. Linear tetrahedral elements are used for meshing.

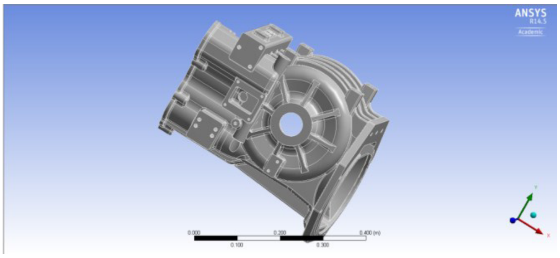


Fig.1. Cad Solid model of Transmission Casing.

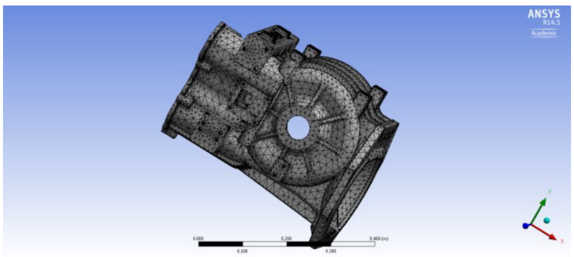


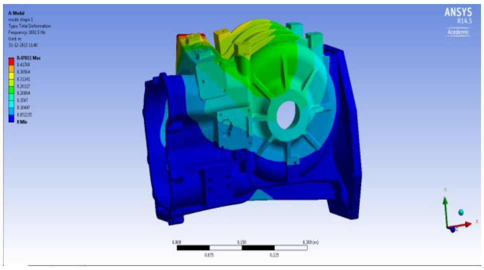
Fig.2. Meshed Model of Transmission Casing in ANSYS 14.5

3. Material Properties

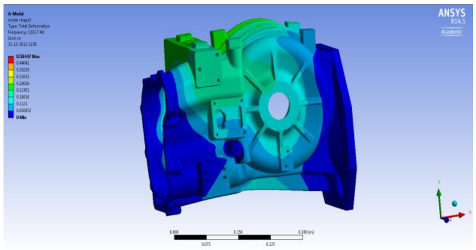
The complex geometry of transmission housing is analysed using fixed-fixed boundary condition. Transmission housing is connected on truck frames by bolts. Fixed-fixed condition is applied by limiting nodal displacement. Gray Cast iron have damping property and since many years it has been used as prime material for housing. Housing is cast in two parts known as upper and lower half symmetrical about shaft axes. Mechanical properties (Elastic modulus, Poisson ratio and density) are required for free vibration analysis. The Gray Cast Iron, Grade FG 260 material properties selected for the study of the transmission housing are Elastic modulus-1.28x 10^{11} Pa , Poisson ratio- 0.26, density-7200 kg/m3. The Metals Databook (2008).

4. Results and Discussion

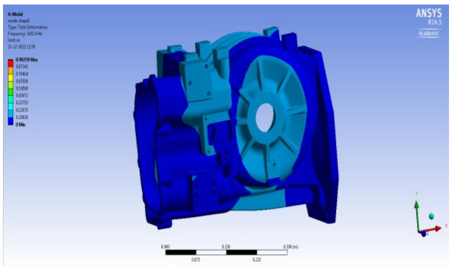
FE code-ANSYS 14.5 is used to find the natural frequency and mode shape of transmission housing. Simulation is performed for fixed - fixed motion supported boundary conditions. The load freedom is selected by ANSYS itself. The FEM based software Ansys.14.5 provides the first 20 natural frequency and mode shapes (Table 1) . ANSYS software has good analysis capability. It is used for the structural, thermal, magnetic, vibration analysis. The result consist of stresses, strain, modes and so on are provided by ANSYS. The first 20 order vibration mode of transmission is shown in Figure 3. From the figure 3. 1, 3 and 5 modes is torsional vibration. This torsional vibration is performed at single right side on transmission housing. The 8,10 and 12 modes is axial bending vibration. In axial bending vibration the transmission body try to bend from the centre line figure 3. The 14 and 17 modes is torsional vibration. The 18 and 20 modes is axial bending vibration with torsional vibration. Both axial bending and torsional vibration happen in upper and lower side. In case the bolt is loose or failed the transmission housing will vibrate heavily and the transmission system will break down.



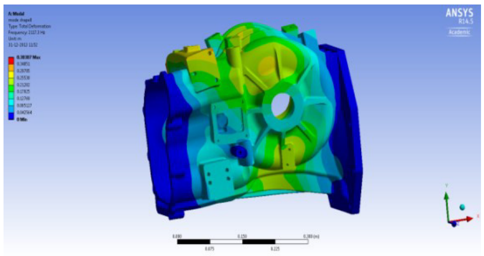
Mode 1 f_1 = 1002.5 Hz



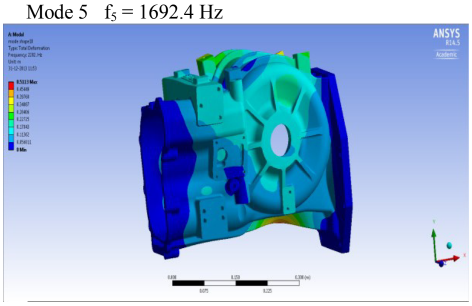
Mode 3 f_3 = 1332.7 Hz



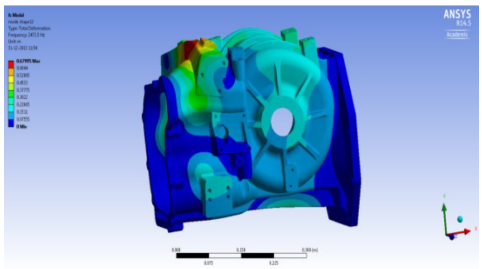
Mode 5 f_5 = 1692.4 Hz



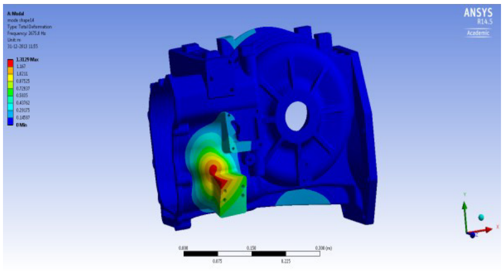
Mode 8 f_8 = 2117.3 Hz



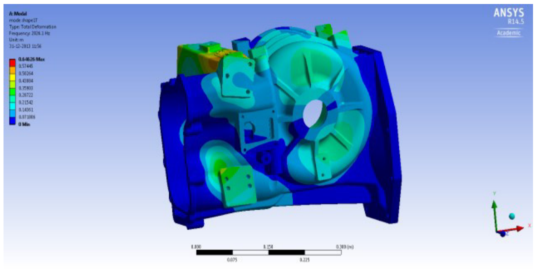
Mode 10 f_{10} = 2282 Hz



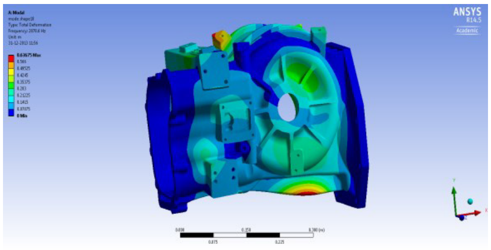
Mode 12 f_{12} = 2473.5 Hz



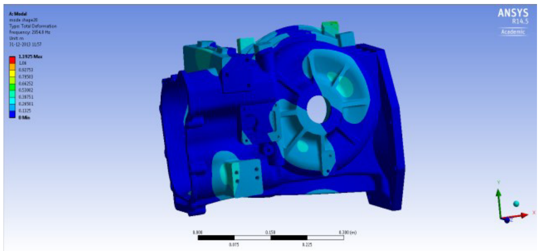
Mode 14 f_{14} = 2675.8 Hz



Mode 17 f_{17} = 2826.1 Hz



Mode 18 f_{18} = 2878.6 Hz



Mode 20 f_{20} = 2954.8 Hz

Fig. 3. Ten different mode shape of the Transmission Casing.

Table. 1 Mode number and corresponding natural frequency.

Mode	Frequency [Hz]
1	1002.5
2	1119.5
3	1332.7
4	1666.5
5	1692.4
6	1805.2
7	1916.1
8	2117.3
9	2151.7
10	2282.0
11	2301.3
12	2473.5
13	2488.6
14	2675.8
15	2747.1
16	2766.1
17	2826.1
18	2878.6
19	2885.5
20	2954.8

5. Conclusion

It is observed that heavy vibration excitation is the main reason for transmission housing failure. The analysis results shows that transmission housing is subjected to Axial bending vibration , torsional vibration and Axial bending with torsional vibration. The transmission housing motion is constrained by constraining the displacement of bolt holes. ANSYS14.5 software has powerful analysis capabilities and SOLIDEDGE software has a powerful function of solid modeling. They are suited for Finite Element Analysis of complex shapes. The3D solid model is prepared by applying SOLIDEDGE software and is transferred to ANSYS 14.0. In this research work we have considered the vibration problem of the transmission housing using FEA method. Finite Element Analysis offers satisfactory results. First 20 Vibration mode shape has been calculated. The experimental and analytical analysis is not available in literature for the transmission housing. So it is a new simulation analysis for transmission housing.

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References

ANSYS R 14.5, 2013. Academic, Structural analysis Guide.
Huang Minfeng, Jiang Yingchun,2008. Fatigue life analysis of automobile component based on FEM. Mechanical Research and Application 21, 57-60.
Liu De-gang, HOU Weixing, WANG Fengzhou, 2004. Fatigue Life Analysis of a Component Based on the Finite Elements Technology. Journal of The China Railway Society 26,47-51.
Saada A, velex P,1995. An extended model for the analysis of the dynamic behavior of planetary trains. ASME Journal of Mechanical Design 117, 241-247
SOLIDEDGE, 2006. Version 19.0.
The Metals Databook, 2008.Tata McGraw- Hill. Fourth Edition. ISBN-13: 978-0-07-462300-8
Velex P, Flamand L, 1996. Dynamic response of planetary trains to mesh parametric excitations. Journal of Mechanical Design. Transactions of the ASME 118, 7-14
Yu Li, Wu Guagnqiang. 2006 Analysis on Fatigue Life of Rear Suspension Based on Virtual Test Tig. Computer Aided Engineering 15, 128-130.