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Study On Speed Control Mechanism With Differential Gear Box By Cae Tools

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Abstract:

This paper gives the comparative study among various techniques used to control the speed of three phase induction motor. Gear trains are one of the major reduction control technique in automobiles and the industrial sector. Present work focuses on the design development and analysis of a gear box with reduction. The objectives taken from the prior necessity, checked for three different motor speeds for better quality with low normal and high RPM. The motor connected to a reduction gear box known as differential gear box. The design analysed on the basis of motor speed that is RPM (2400 rpm, 6400rpm and 500 rpm). Material used for gear box and gears are EN24, the whole model developed in CATIA and the stresses observed in ANSYS. The possible output of initial analysis looks better than normal conventional materials.

Key words: speed control technique, reduction gear box, materials

1.0 Introduction

Multidisciplinary design optimization evolved in the area of structural optimization, which has been a field of intensive research since the "Structural optimization seeks the selection of design variables to achieve, within the limits (constraints) placed on the structural behavior, geometry, or other factors, its goal of optimality defined by the objective function for specified loading or environmental conditions." Structural optimization is of great interest within the automotive industry, where the mass is typically minimized subject to a number of performance constraints. Three types of structural optimization can be distinguished: size, shape, and topology optimization. There had been problems like noise, Vibration, backlash, and with gradual time lapse, bearing failure and lubrication problem was also observed. But they didn't have any personnel to work for the same, and hence for their goodwill they decided to import readymade gear box and install it in their machine. By doing so, they had to change their earlier design and had to mount gear box externally, also the cost being high. Hence they wanted to sort the error as soon as possible.

2.0 Literature review

Rushil H. Sevak Researcher suggests that before making gearbox, verification of its work, performance, efficiency, which effects gearbox performance, is necessary. He used DOE techniques to achieve desired design of gearbox for control the temperature and noise levels

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in gearbox. He reached to the conclusion that it seems that the input speed, back lash, axial play of pinion and output shaft, oil viscosity are very crucial for the gearbox noise and temperature of oil. By optimizing input parameter, life of the gearbox will be increase [1]. The rotordynamic analysis showed that vibration response varied nonlinearly with the amount of rotor imbalance. Moreover, the increase in stiffness as critical speeds were approached caused a large increase in rotor and bearing vibration amplitude over part of the speed range compared to the case of constant stiffness bearings. Regions of bistable operation were possible, in which the amplitude at a given speed was much larger during rotor acceleration than during deceleration [2].

Dynamic models of the system consisting of gears, shafts, bearings and gearbox casing are useful in order to understand and predict the dynamic behaviour of a gearbox. For relatively simple gear-systems it is possible to use lumped parameter dynamic models with springs, masses and viscous damping. For more complex models, which include for example the gearbox casing, finite element modelling is often used. Noise and vibration measurement and signal analysis are important tools when experimentally investigating gear noise because gears create noise at specific frequencies, related to number of teeth and the rotational speed of the gear [3]. The challenges posed by trying to replicate insect flight were discussed, with generalized kinematic parameters and biomimetic design guidelines proposed as a result. As well as identifying absolute values of kinematic parameters, a summary of how insects manipulate these parameters to enact aerobatic man oeuvres has been compiled. These provided a specification upon which an actuated flapping mechanism can be designed to meet. Due to the variety of potential mechanisms suitable for this task, an original method of classifying and ranking flapping mechanisms was conceived. This method takes account of a mechanism’s mechanical and control complexity in relation to its performance. A novel mechanism called the PCR was compared with previously published flapping mechanisms using this classification method [4].

3.0 Aim &scope

This mechanism is important since both of those processes involve negotiations for optimization. A set of design and planning software agents has been developed. These agents are used in a computer-based collaborative environment, called a multi-agent platform. The main purpose of developing such a platform is to support product preliminary design, optimize product form and structure, and reduce the manufacturing cost in the early design stage. The fundamental commitment concentrated on proficient resilience examination and combination of gatherings subject to loads, inside the local CAD/E displaying condition, utilizing a general loading effects and speed control mechanisms instrument based stage.

4.0 Materials and specifications

Many parameters have been gathered from the present ATVs. Table mentions the requirements that should be fulfilled by a Gearbox, the final product should comply with all these parameters. The components must structurally comply without any failure.

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Material selection plays an important role. Material takes up most of the cost required to make a gear box. So many alloys are available in the market at low prices. But keeping the weight in mind as well as performance optimal materials that can sustain the above requirements are selected for each component of the Gearbox. In order to reduce the variety of materials that are being used, it was decided that only one material should be used for all the shafts, another for Gear and another for the casing.

Table: 1 Minimum requirements a Gearbox should meet.

SPECIFICATION	VALUE
Input Power	Briggs & Stratton 300cc Engine
Horse Power	8 HP(7.365 KW)
Maximum Torque	19.659 N.m
Engine Speed(RPM)	Minimum: 1750 Maximum: 3800
Engine Vibration	50 Hz
Wheel Speed(RPM)	Minimum 47.3 RPM Maximum 669 RPM
Maximum Acceleration	7.8 m/s^2
Maximum Speed	60 Km/h
Maximum Output Torque	520 N.m
Maximum Dimensions	500*80*130 mm
Maximum Weight	8 Kg
Operating Temperatures	60°C to 180°C
Vehicle weight	290 Kg

EN24 is a very high strength steel alloy which is supplied hardened and tempered. The grade is a nickel chromium molybdenum combination - this offers high tensile steel strength, with good ductility and wear resistance characteristics. With relatively good impact properties at low temperatures, EN24 is also suitable for a variety of elevated temperature applications**.**

Table: 6.7 Chemical Compositions for EN24

%	EN24
c	0.36-0.44%
Mn	0.45-0.70%
SI	0.10-0.35%
P	0.035 Max
S	0.040 Max
Cr	1.00-1.40%
Ni	1.30-1.70%

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Table: 6.8 Mechanical properties of EN24

Max Stress	850-1000 n/mm2	-
Yield Stress	680 n/mm2 Min	(up to 150mm LRS)
Yield Stress	650 n/mm2 Min	(over 150 to 250mm LRS)
0.2% Proof Stress	665 n/mm2 Min	(up to 150mm LRS)
0.2% Proof Stress	635 n/mm2 Min	(over 150 to 250mm LRS)
Elongation	13% Min	(9% if cold drawn)
Impact KCV	50 Joules Min	(up to 150mm LRS
Impact KCV	35 Joules Min	(over 150 to 250mm LRS)
Hardness	248-302 Brinell	(850-1000 n/mm2)

5.0 Results and discussions

Meshing of Differential Gear Box:

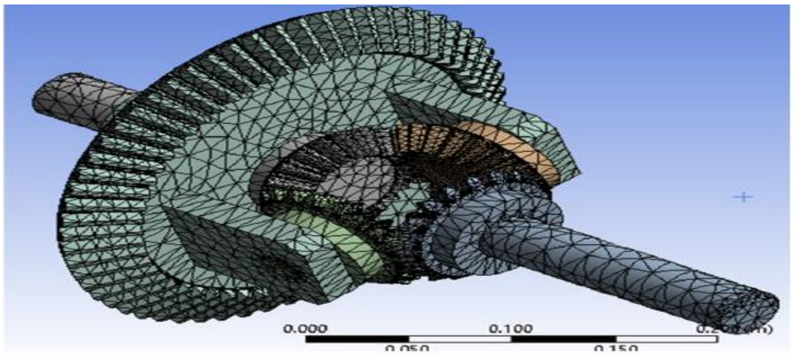

Figure 5.1 meshing on the **EN24** of element size of 0.6 and fine meshing of span angle center.

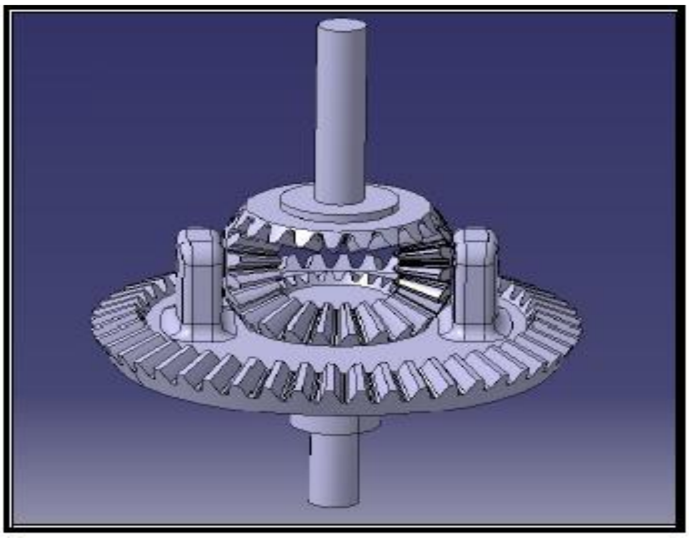

Figure 5.2 Main Assembly Solid model models of gears.

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Total Deformation of EN24 Material:

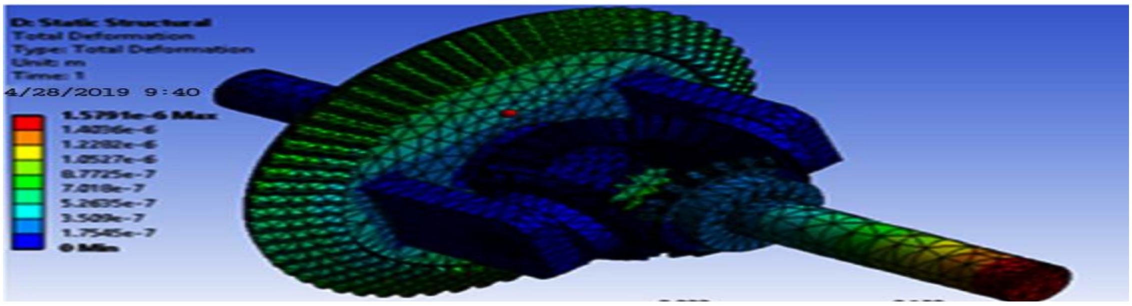

Figure 5.3 Von-Mises stress values of the 190 (N-m) on EN24

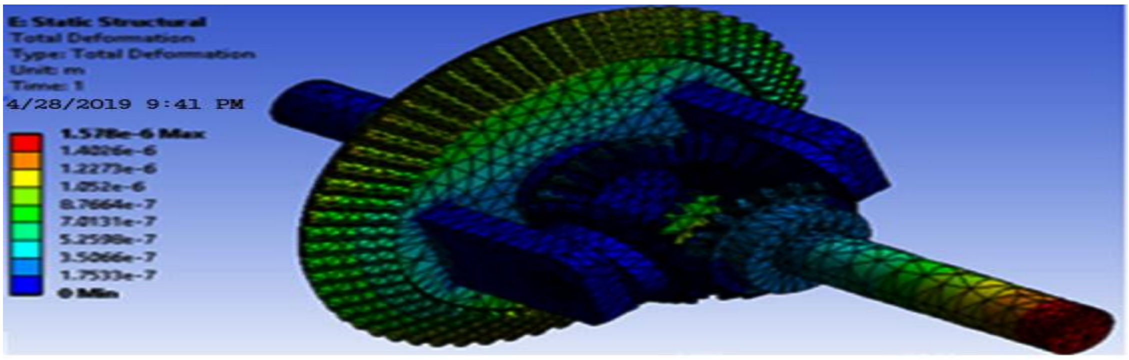

Figure 5.4 Von-Misses stress values of the 235 (N-m) on EN24

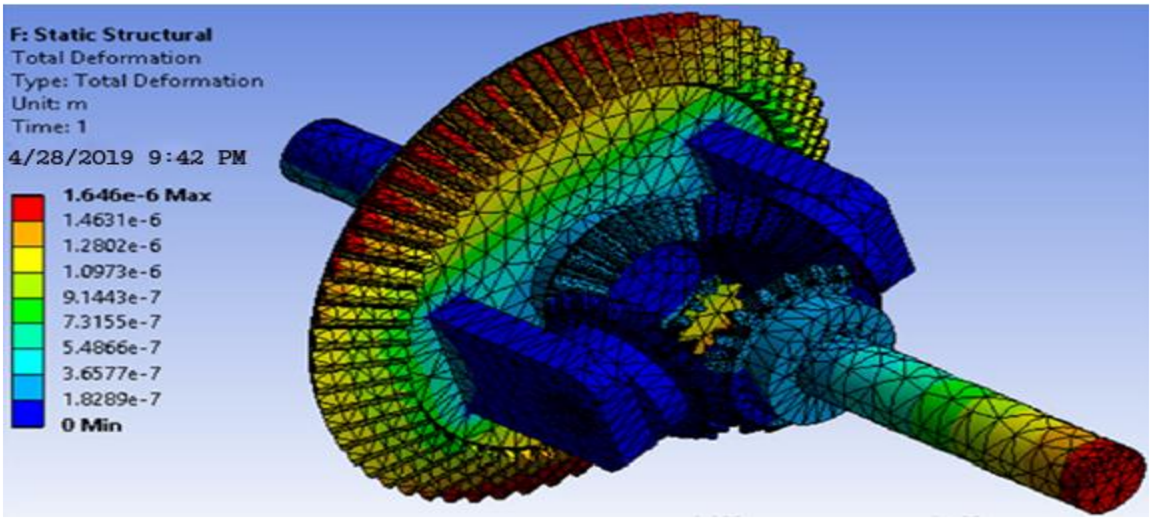

Figure 5.5 Total Deformation stress values of 320 (N-m) on EN24

Total Deformation and Von-Mises Stresses of EN24

S.no	Torque (N-m)	Total Deformation (mm)	Von-Mises Stresses (MPa)
1	190	1.5791*e^-3	25.029
2	235	1.578*e^-3	30.773
3	320	1.646*e^-3	44.18

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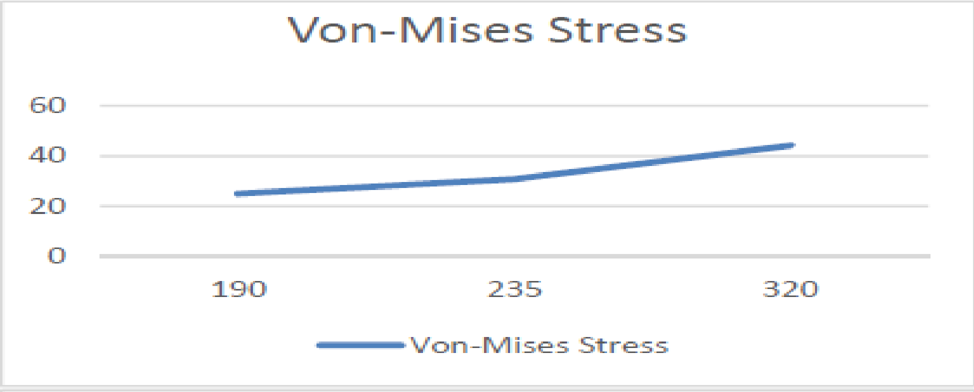
EN24 Material:



Graph: 5.1 von-misses stress

Tangential Loading:

For2400 rpm Von-Misses stress, Displacement (Total Deformation) and Maximum Shear Elastic Strain for EN24 Differential Gear box

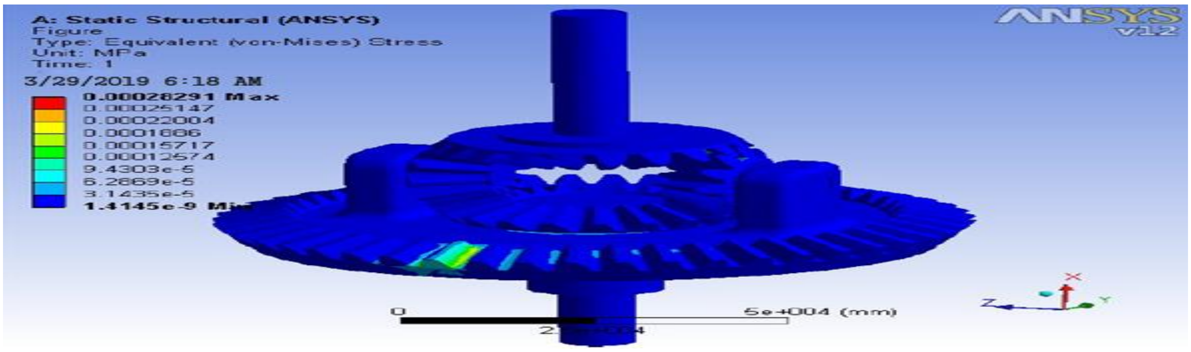


Figure 5.6 Von-Misses Stress

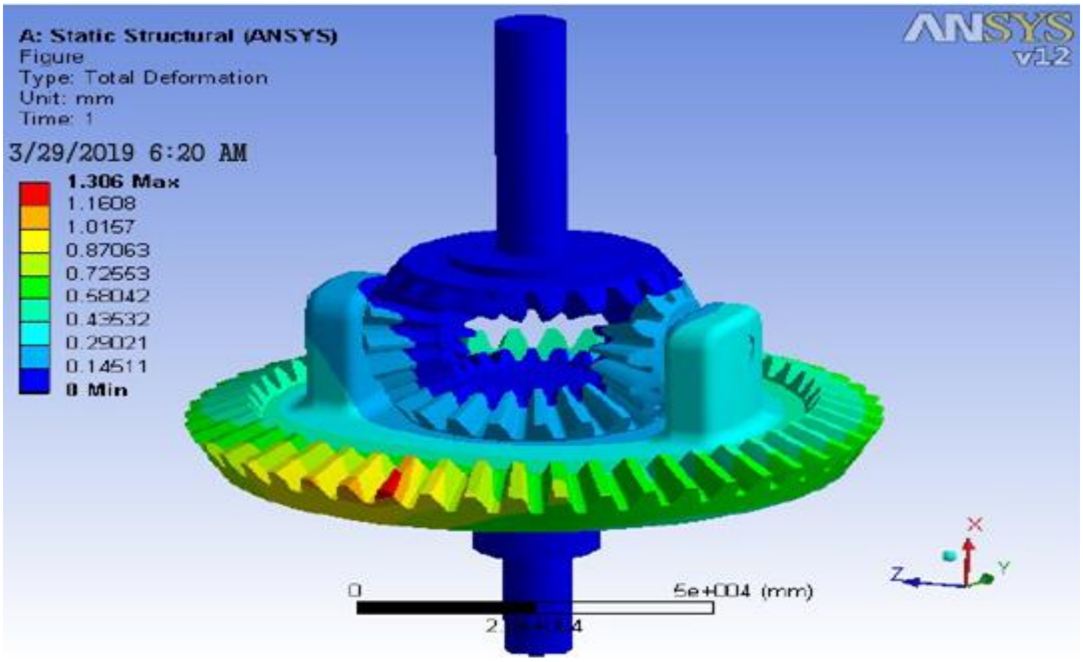


Figure: 5.7 Displacements (Total Deformation)

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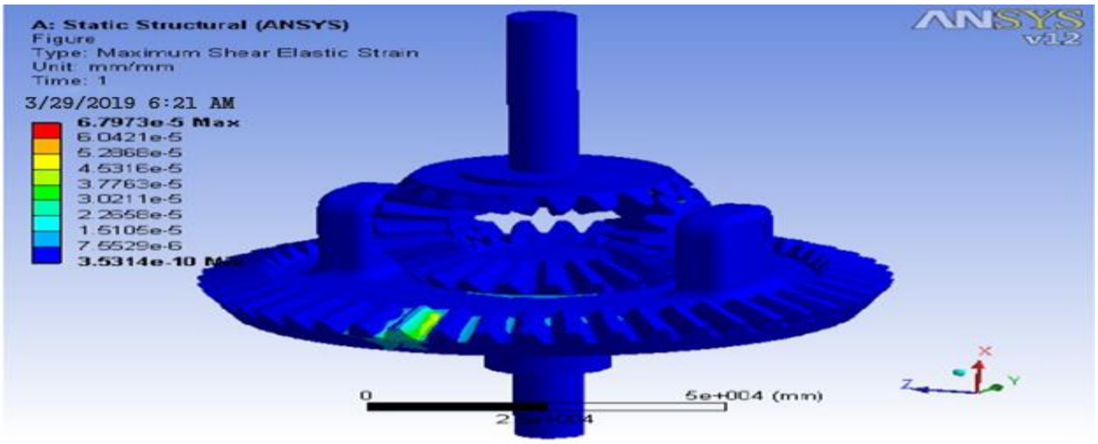

Figure: 5.8 Maximum Shear Elastic Strain

For 6400 rpm:

Von-Misses stress, Displacement (Total Deformation) and Maximum Shear Elastic Strain for EN24 Differential Gear box

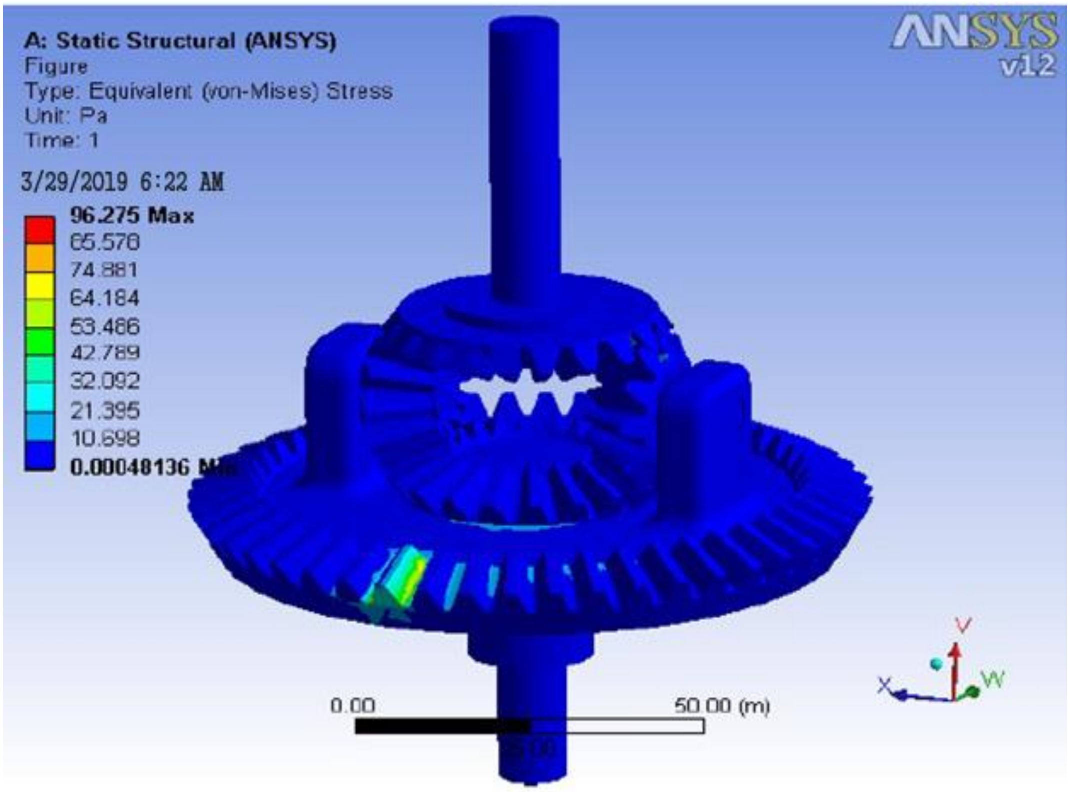

Figure: 5.9 Von-Misses Stress

Existing metallic differential gearbox

Computer aided engineering is found to be useful tool for various design stages. Reference model of Differential gear box is selected and CATIA is used to develop various parametric models. EN24 and EN8material is used for gears and are analyzed using ANSYS for equivalent (Von-Misses) stress, displacement (total deformation) and maximum shear elastic

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strain for different revolutions (2400 rpm, 6400rpm and 500 rpm) under static conditions. Comparisons of various stress and strain results with composite and metallic material (EN24) are also being performed and found to be lower for composite material. By observing these analysis results, material is selected as a best material for Differential gear box which in turn increases the overall mechanical efficiency of the system.

6.0 Conclusions

The optimization involved within all studies above was conducted for given reduction ratios, or at least for a given speed-torque scenario or cycle. However, most applications that include a gearbox (such as vehicles) are subjected to a large span of uncertain load requirements, as a result of a variety of possible environmental conditions. The stochastic nature of the required torque and speed must be considered during the design phase.

7.0 References

1. Deng Xingqiao, Wang Jinge, Wang Qiang, Liu Qin-qin,Zhang Junfu, “The study and analysis of a new Anti-backlash worm gear”, Paper Ref: S0601_P0216, 3rd International Conference on Integrity, Reliability and Failure, Porto/Portugal, 20-24 July 2009.

2. Kurapati, A., and S. Azarm. 2000. “Immune Network SimulationWith Multiobjective Genetic Algorithms for Multidisciplinary Design Optimization.” *Engineering Optimization* 33 (2): 245–260.

3. Swantner, Albert, and Matthew I. Campbell. 2012. “Topological and parametric optimization of gear trains.” *Engineering Optimization* 44 (11): 1351–1368.

4. Thompson, David F, Shubhagm Gupta, and Amit Shukla. 2000. “Tradeoff Analysis in Minimum Volume Design of Multi-Stage Spur Gear Reduction Units.” *Mechanism and Machine Theory* 35 (5): 609–627.

5. Alicino, S, and M Vasile. 2014. “An evolutionary approach to the solution of multiobjective min-max problems in evidence-based robust optimization.” In *Evolutionary Computation (CEC), 2014 IEEE Congress on*, 1179–1186.

6. Prakash D Patel, J.M.Patel, “An Experimental Investigation of Power Losses in Gear box at different operating condition”, Proceedings of TFMS 2012, National Conference on Thermal, Fluid and Manufacturing Science, January 20 – 21, 2012, Surat, Gujarat, India.

7. Milosav Ognjanovic1 – Miroslav Milutinovic2,” Design for Reliability Based Methodology For Automotive Gearbox Load Capacity Identification”, 2012