ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

MODELING, DESIGN & ANALYSIS OF DIFFERENTIAL GEAR BOX THROUGH FEM, SOLIDWORK & ANSYS BENCHWORK 14.0

Shashank Pandey*[1], Nikhilesh N. Singh[2] & Dr. Prabhat Kumar Sinha[3]
[*1]M. Tech. Scholar, Dept. of Mechanical Engineering, SHUATS, Allahabad, U.P., India
[2&3]Assistant Professor, Dept. of Mechanical Engineering, SHUATS Allahabad, U.P., India

DOI: 10.5281/zenodo.834600

ABSTRACT

In this research the differential gears analyzed for vibration effect on whole system to optimize the life of the gears under different frequency in the platform of Ansys-14.0 with help of solid work modelling. In this analysis the gear housing also affected by vibration in casing that surrounds the gear box. The function of gear is to protect and provide a platform for gear transmission. It also provides supports for moving parts and protection from outside environmental condition. The differential couples, the propeller shaft to the pinion, which in turn runs on the ring gear of the differential & it also helps as reduction gearing. Hence will get subjected to vibration so it becomes necessary to evaluate the response of differential gear housing in such vibrations and also to find out there natural frequencies. This can be an important tool while designing the differential gear housing free from fatigue failures caused by the resonance. The design of the gear housing should incorporate a methodology for dealing with factors causing vibrations and to promote scientific means to minimize the effects of frequencies. This vibration analysis is done by using Ansys 14.0 software as a computational technique and validation.

KEYWORDS: differential gears, natural frequency, Ansys 14.0.

I. INTRODUCTION

In automobiles and other wheeled vehicles, the differential permit each of the driving wheels to rotate at different speeds, while for most vehicles supplying equal torque to each of them. A vehicle's wheels rotate at divergent speeds, mainly when turning corners. The differential is designed to operate a pair of wheels with same torque while permit them to rotate at different speeds. In vehicles without a differential, such as karts, both driving wheels are forced to rotate at the equal speed, generally a common axle driven by a simple chaindrive mechanism. When cornering, the inner wheel needs to travel a shorter distance than the outer wheel, so with no differential, the result is the inner wheel spinning and/or the outer wheel dragging, and this results in difficult and unpredictable handling, damage to tires and roads, and strain on the entire drive train. The Differential transmits mechanical energy from a prime mover to an output device. It also varry the speed, direction of mechanical energy. Differential gearbox is used when high speed, large power transmission where noise abatement is important. In this present work the analysis is conducted on the gearbox, to verify the natural frequency For this purpose the modelling of the transmittiing power gear assembly on solidwork were made and fem based structural behaviour were carried out on the ansys 14.0 analysis tool.

II. RESEARCH WORK

- To design a gear box housing under the plateform of solodwork.
- To findout the natural frequency of gearbox under different condition through ansys 14.0.

III. ANALYSIS WORK

The project is divided into two domains:

1. Modal Analysis
2. Stress analysis

Modal Analysis: The natural frequencies of in free conditions are calculated using Ansys14.0 and by the application of boundary conditions to compare with experimental and operating frequencies.

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

Stress Analysis: it is static analysis of the model by applying boundary conditions and forces which are calculated according to the data provided by the instructor .

1.1 Model analysis Modal analysis is a term used to describe any of the processes employed to extract a structure's modal properties (natural frequencies, modal damping factors, and mode shapes) from information about the structure that is presented in a different format. When these properties are extracted from a theoretical analysis of the dynamic behavior

1.2 Gear mesh frequency This is the frequency most commonly associated with gears and is equal to the number of teeth on the gear multiplied by the actual running speed of its shaft. A typical gearbox will have multiple gears and therefore multiple gear meshing frequencies. A normal gear mesh signature will have a lowamplitude gear mesh frequency with a series of symmetrical sidebands, spaced at the exact running speed of the shaft, on each side of the mesh components. The spacing and amplitude of these side bands will be exactly symmetrical if the gearbox is operating normally. Any deviation in the symmetry of the gear mesh signature is an indication of incipient gear problems. Fig. 2 shows a diagram of a basic test system configuration.

The gear mesh frequency is considered for following conditions:

1. Idling
2. Cruising
3. Maximum speed

Gear mesh frequency (F)= k* (N/60) Hz Where, k= number of teeth on gear N= speed of the rotating shaft (on which gear was mounted)

IV. CALCULATIONS OF A CROWN GEAR AND PINION

The main aim of the project is to verify the best material for the gears in the gear box at higher speeds by analyzing stress, displacement and also by considering weight reduction focus on the mechanical design and contact analysis on assembly of gears in gear box when they transmit power at different speeds at 2400 rpm, 5000 rpm and 6400 rpm. Analysis is also conducted by varying the frequencies. Differential gear is modeled in Solidwork . The ANSYS 14.0 fem software were used as the analysis tool for determing the structural behaviour of various composites under the given loading conditions.

Specifications Of Used Heavy Vehicle
Assumptions:

- Gear profile: -20 degree full depth involute profile (standard)
- pressure angle (α):-20 degree
- bevel gear arrangement = 90 degree
- Pitch cone Angle (φ) = 45
- Back cone Angle (β) = 45
- Module (M) = 10
- Number of teeth on gear = Zg =50
- Number of teeth on pinion = Zp = 8

Velocity Ratio (V.R)
V.R=TG/TP= DG/DP=NP/NG
V.R=TG/TP=50/8=6.25
V.R=NP/NG
6.25=2400/NG
NG=384rpm
Minimum no. of teeth on pinion (Zp)
For satisfactory operation of bevel gears the number of teeth in the pinion must not be less than
hence the assumed value of the pinion is in safe condition
Pitch circle diameter (D)
Pitch circle diameter for the gear (Dg) = M*Zg
Pitch circle diameter for the pinion (Dp) = M*Zp
Pitch angle (θ)
Since the shafts are at the right angles , the pitch

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

angle were given as:
For the pinion = θp1=tan-1(1/v.r)
Pitch angle of gear θp2=90°-9=81
formative number of teeth (Te)
for the pinion Zep= Zpsecθp1=8sec9 =8
for the gear = Zeg=Zgsecθp2=50sec81 =319.622

1. Pitch Cone Distance (AO):
   $AO=((d_1/2)^2+(d_2/2)^2)^{1/2}$
   AO=250mm
2. Face width (b)
   b=AO/3

or } which is lesser
b=10

V. CALCULATION OF GEAR AND PINION

1. Pitch circle diameter (D)

Diameter of sungear =Dg=150mm
Diameter of pinion =Dp=70mm

2. Number of tooth on gear

Number of teeth on gear = Zg =18
Number of teeth on pinion = Zp = 15
D=Dg+Dp=220
T= Zg+ Zp = 33

3. Module = M=D/T=220/33=6.66=7(according to stds)

4. Velocity Ratio

V.R = Zg/Zp = DG/DP=NP/NG
V.R = Dg/Dp =150/70=2.142
V.R=NP/NG
2.142=2400/NG
NG=1120.448rpm

5. Pitch angle

Since the shafts are at right angles therefore pitch angle
for the pinion = θp1=tan-1(1/v.r)
=tan-1(1/2.142)=25.025
Pitch angle of gear θp2=90°-25.025=64.974

6. Formative Number Of Teeeth

For the pinion = Zep = Zp secθp1=15sec25.025 =16.554
For the gear = Zeg = Zg secθp2= 8sec64.974 =42.55

7. Pitch Cone Distance (AO):

$AO=((D_1/2)^2+(D_2/2)^2)^{1/2}$
AO = 82.7mm

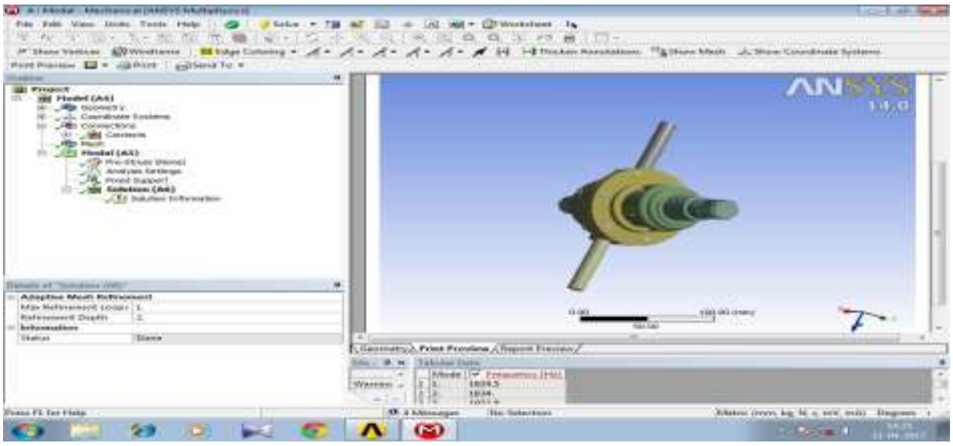
8. Face Width (b): 82.7/3 = 27.5 mm

VI. FEM ANALYSIS OF THE GEAR

FEM, A computer based analysis technique for calculating the strength and behaviour of model during the given limits. In the FEM the model is represented as finite elements and are joined at special points which are called as nodes. Finite element analysis is the numerical solution of the mechanical components that are acquired by discretizing the mechanical elements into a small finite number of building blocks (known as elements) and by investigation those mechanical components for their acceptability and reliability. FEM is the simple technique as compared as the theoretical methods to discover the stress developed in a pair of gears. Models for numerical analysis have been prepared in SOLIDWORK and these have been bring in into ANSYS as IGES files for further analysis. The proportions of gear obtained from theoretical analysis have been used for preparing geometric model of gear. The condition for analysis has been assumed as static.

VII. MESHING OF GEAR ASSEMLY

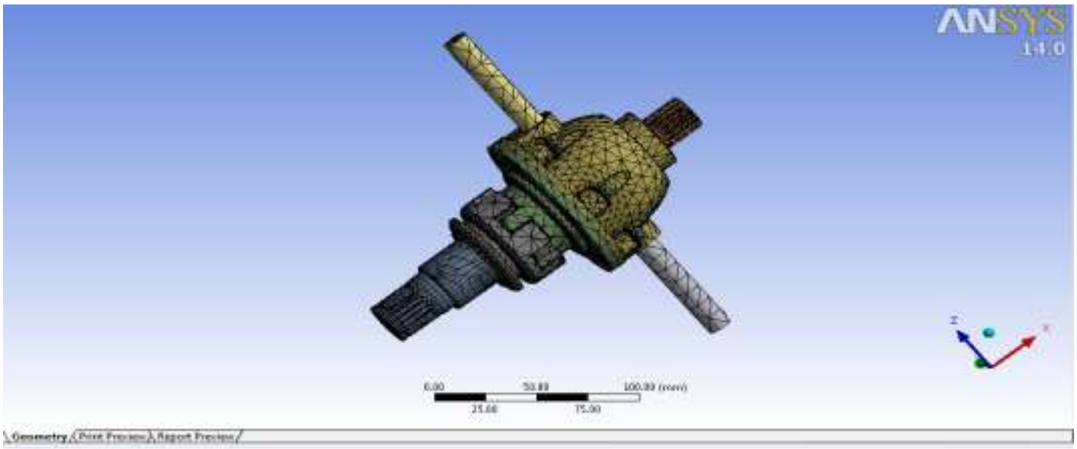
In the analysis of the gear assembly it is mendatory to study of its structural behaviour at different load and condition. 3–D model of the gear assembly were made in solidwork and were carriedout in ansys analysis software as an iges file format . thereafter importing the model in ansys the suitable material was applied to the model and then meshing were done in ansys bywhich the whole body is devided into small tethydral element connected by nodes . the tottal node and element for the two were given in t



Solid model of differential gear box in ansys 14.0

Mesh model

Coarse meshing along with the refined meshing on joints is done to get accurate results.



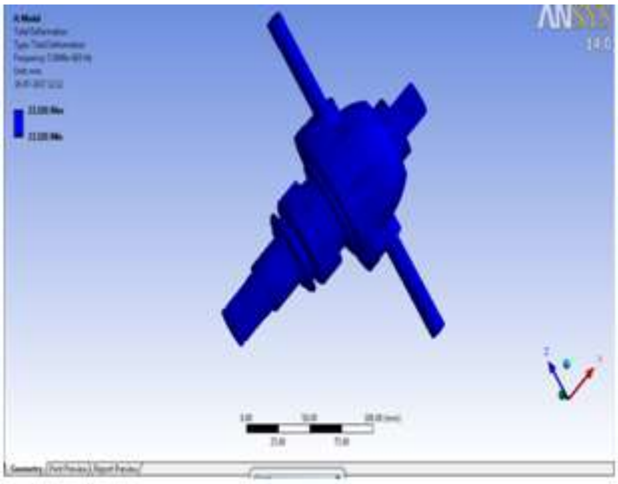
Problem formulation

A natural frequency, epitomize by resonance is the characteristics of the part or subassemblies of a required product. This becomes noteable while assess performances of applications where human comfort of the component life has a prominence on the function. Automobiles for example, are subjected to vibrations in terms od caused by the engine. The components making up the subassemblies need to be evaluated for this phenomenon. The design of the component should incorporate a mode for dealing with factors causing undesirable levels of vibration or to support any scientific means of problem solving that would decrease the harmful effects of resonance

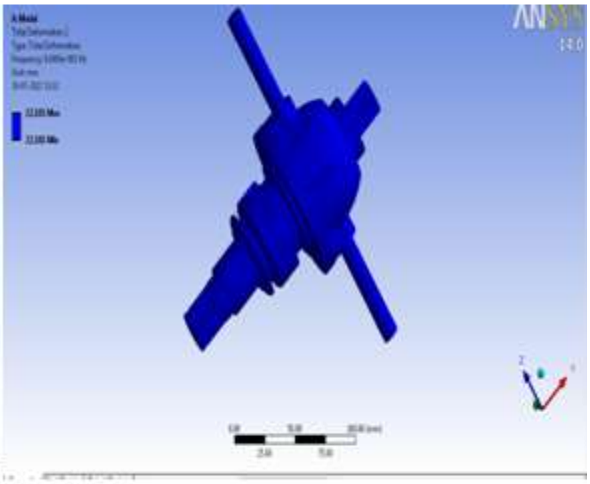
RESEARCHERID
THOMSON REUTERS
ISSN: 2277-9655
[Pandey * *et al.*, 6(7): July, 2017] Impact Factor: 4.116
IC™ Value: 3.00 CODEN: IJESS7

Result

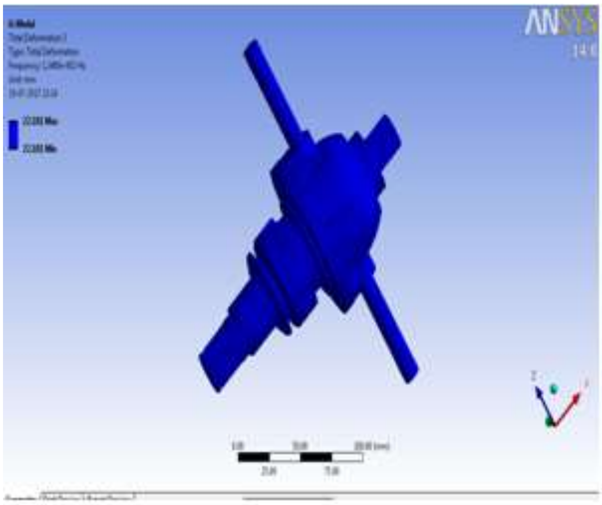
After analysis of all the stresses and formulation the following natural frequencies are obtained.



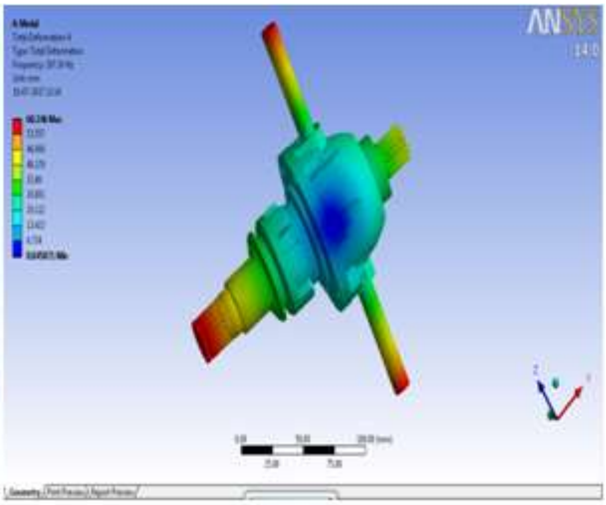
Total deformation 1



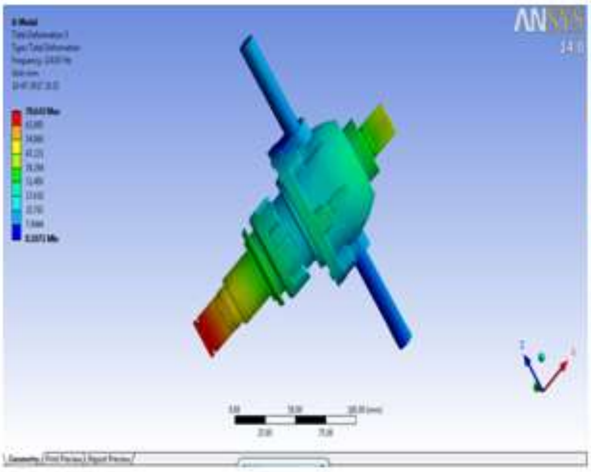
Total deformation2



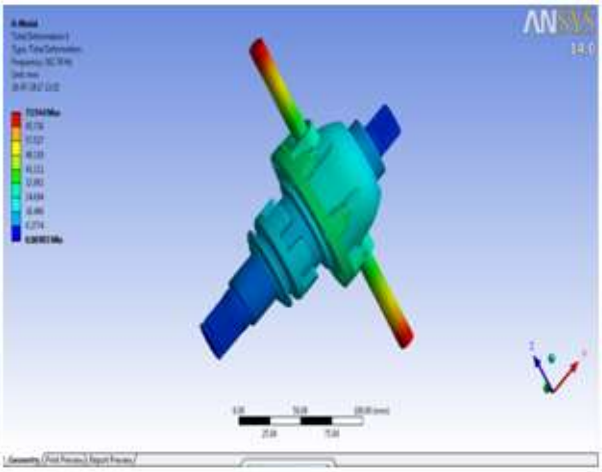
Total deformation 3



Total deformation 4

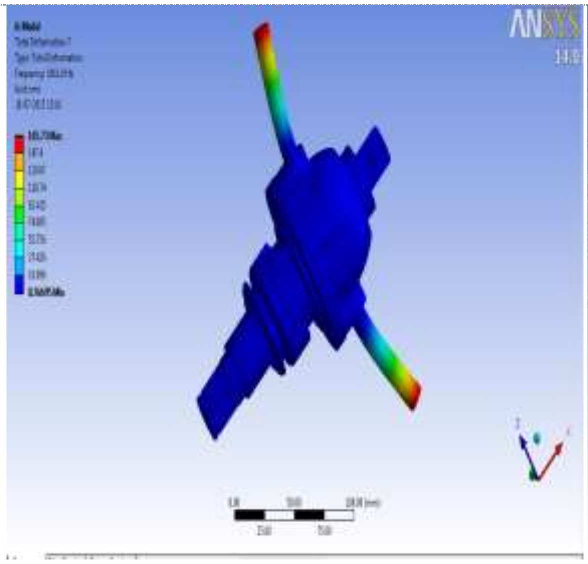


Total deformation 5

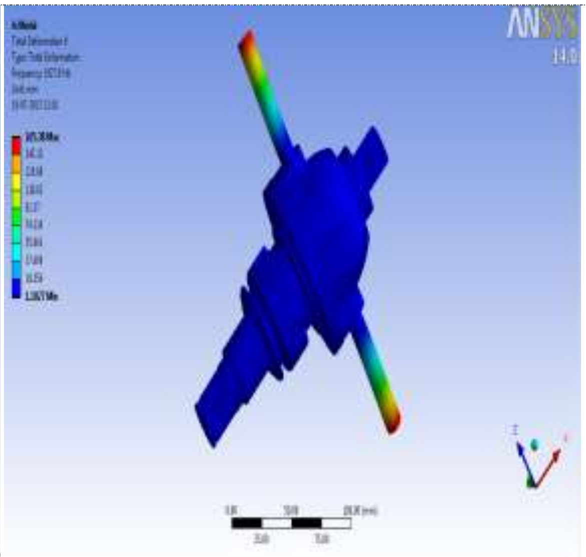


Total deformation6

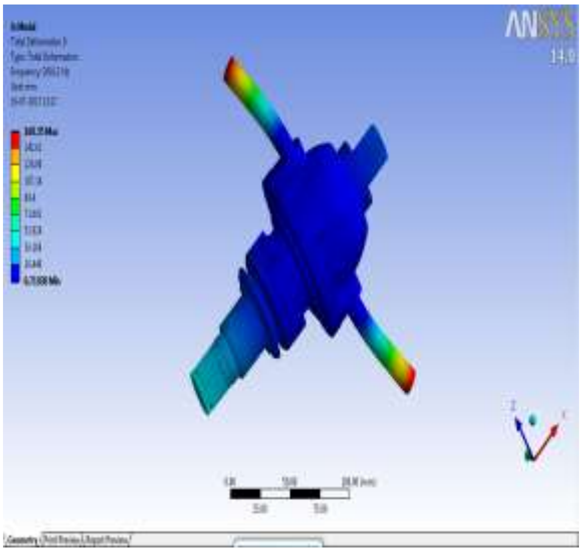
ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7



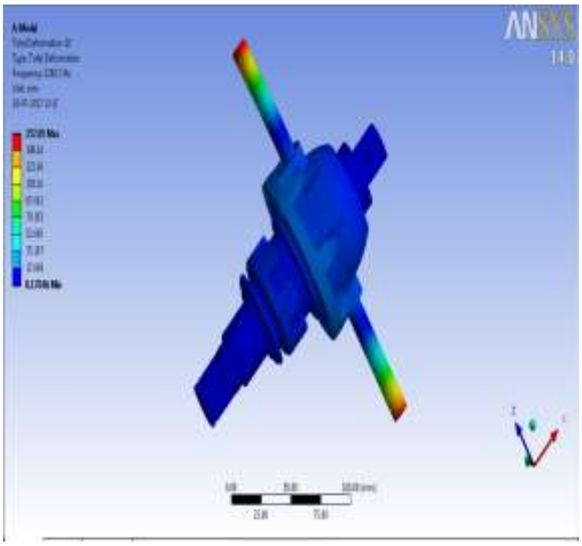
Total deformation 7



Total deformation 8



Total deformation 9



Total deformation 10

VIII. CONCLUSION

After analysis of the differential gear assembly the natural frequencies on different modes it has been obtained which are as under :-

Tabular Data

	Mode	Frequency [Hz]
1	1.	5.9949e-003
2	2.	9.6809e-003
3	3.	1.3488e-002
4	4.	187.36
5	5.	224.97
6	6.	262.74
7	7.	1861.8
8	8.	1927.8
9	9.	2018.2
10	10.	2288.7

Mes...es Tab...ta Graph

IX. REFERENCES

[1] F. K. Choy, H. Chen & J. Zhou, 2006, 'Identification of Single and Multiple Teeth Damage in a Gear Transmission System', Tribology Transactions, Vol. 49, No. 3, page. 297-304.

[2] Erwin V. Zaretsky, David G. Lewicki, Michael Savage & Brian L. Vlcek 25, 2008, 'Determination of Turboprop Reduction Gearbox System Fatigue Life and Reliability', ISSN Taylor & Francis, Tribology Transactions, 50:4, page. 507-516.

[3] Lei Wang, Jiancheng Yang &Xiaoqin Han, 2009, 'The Performance Study of Hybrid-driving Differential Gear Trains', Modern Applied Science, vol. 3, No. 9, page. 95-102.

[4] C. Fetvaci, 2010, 'Definition of Involutes Spur Gear Profiles Generated by Gear-Type Shaper Cutters', Mechanics Based Design of Structures and Machines: An International Journal, Vol. 38, No. 4, page. 481- 492.

[5] B.Venkatesh, V.Kamala, A.M.K.Prasad, 2010, 'Modelling and Analysis of Aluminium A360 Alloy Helical Gear for Marine Applications', International Journal Of Applied Engineering Research, Dindigul Volume 1, No 2, 2010, page. 124-134.

[6] C.Veeranjaneyulu, U. HariBabu , 2012, 'Design And Structural Analysis of Differential Gear Box at Different Loads' , International Journal of Advanced Engineering Research and Studies, Vol. 1, Issue II, January-March, 2012, page. 65-69.

[7] Riccardo Morselli a , Roberto Zanasi a &GermanoSandoni, 2006, 'Detailed and reduced dynamic models of passive & active limited-slip car differentials' ISSN Taylor & Francis, Vol. 12, No. 4, Aug 2006, page. 347 – 362.

[8] CuneytFetvaci&ErdemImrak, 2008, 'Mathematical Model of a Spur Gear with Asymmetric Involutes Teeth and Its Cutting Simulation', Mechanics Based Design of Structures and Machines: An International Journal, Vol. 36, No. 1, page. 34-46.

[9] IsadŠarić; AdilMuminović, 2010, 'Parameter Modelling of Gear', International Research/Expert Conference, "Trends in the Development of Machinery and Associated Technology", TMT 2010, Mediterranean Cruise, 11-18 September 2010, page. 557-560.

[10] Dong Yang, Huanyong Cui, XijieTian, Qingping Zhang and PengfeiXu, 2011, 'Research on Tooth Modification of Spur Bevel Gear', the Open Mechanical Engineering Journal, 2011, 5, page. 68-77.

[11] AnoopLega, PuneetKatyal, Vishal Gulati, 'Computed Aided Design and Analysis of Composite Gearbox Material', International Journal of Mechanical Science and Civil Engineering (IJMSCE), Volume-1, Issue- 1, December 2012, page.

[12] Chawathe D.D, "Handbook of Gear Technology", New Age International Publication,(2011) pp 26-89,305- 536, 579-706.

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

[13] Chabra Pankaj , Bhatia Amit , "Design and Analysis of Composite Material Gear Box", International Journal of Mechanical and Civil Engineering, Vol.1(2012), Issue1,pp 15-25.
[14] Devi Neelima, Mahesh.V, Selvaraj. N., "Mechanical characterization of Aluminium silicon carbide composite", International Journal Of Applied Engineering Research, Volume 1(2011), Issue No 4.pp126- 131.
[15] Gulaxea Pratik , Awate N.P.,"Design, Modelling & Analysis of Gear Box for Material Handling Trolley: A Review", Mechanica Confab, Vol 2, Issue1,(2013),pp63-70.
[16] Hashim J.,Looney L Hashmi M.S.J., Metal Matrix Composites: Production by the Stir Casting Method, Journal of Material Processing and Technology,(1999),pp. 17.
[17] R. Yakut, H. Duzcukoglu, M. T. Demirci, " The load capacity of PC/ABS spur gears and investigation of gear damage", Archives of Materials science and Engineering, November 2009, 40/1, page 41-46.
[18] V. Siva Prasad, Syed Altaf Hussain, V. Pandurangadu, K. PalaniKumar, " Modeling and Analysis of spur gear for Sugarcane Juice Machine under Static Load Condition by Using FEA",July-Aug 2012,International Journal of Modern Engineering Research,Vol- 2/4, pp-2862-2866.
[19] Vivek KaraveerȦ*, Ashish MogrekarȦ and T. Preman Reynold JosephȦ, " Modelling and Finite Element Analysis of Spur Gear", Dec 2013, International Journal of Current
[20] Gintin mitra ," the hand book of gear design "SECOND EDITION Tata McGraw-Hill Publishing Company Limited NEW DELHI

CITE AN ARTICLE

Pandey, Shashank , and Nikhilesh N. Singh. "Differential gears, natural frequency, Ansys 14.0." *INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY* 6.7 (2017): 887-94. Web. 25 July 2017.