PRESSURE DIE CASTING TOOL DESIGN FOR SIDE ENGINE COVER OF GEAR BOX CASING

Mr. P.VINOD, Mr. K. VIJAY KUMAR, Mr. A.VENKATRAM REDDY

Assistant Professor in Mechanical Engineering Department, Vignan Institute of Technology & Science, Hyderabad-508284

ABSTRACT

Pressure die-casting is about 150 years old and one of the widely used processes for the mass production of components required in many applications like automobiles, electrical equipment, motors, telecommunications equipment, building hardware, home appliances, etc.

The design of die-casting dies requires considerable skill and expertise based on experience. The designer proposes designs of dies employed to cast parts from various alloys, and perform a variety of other operations. Every new job requires original thought in its design and the solving of individual problems in its manufacture. Each die-cast component, currently in production, presents a challenge for the improvement of its output and quality.

The objective here is to design dies to be fit for the purpose, operate at optimum shot rate and is of reasonably simple construction. The main purpose of this report is to present the systematic design procedure for pressure die-casting dies. The scope of the project involves

The model is designed on CATIA V5 software. These project has done analysis by using three materials to find the stresses and maximum temperature and heat flux values to make comparison by doing structural and thermal on ANSYS software .

KEY WORDS: CATIA V5, ANSYS, ALUMINUM ALLOY, CAST IRON, STEEL

I. INTRODUCTION

Gears are used to increase or decrease the input speed. These gears are enclosed in rigid closed housing called as casing. This casing supports the shaft, hold the lubricant inside and protect the gears from dust and moisture. Also it provides the necessary cooling surface to dissipate the heat generated during operation. The gear box is widely used for variation of speeds in automobile. A gear box housing in general consists of two halves-the upper half and the lower half. The plane of separation of the two halves also normally contains the axes of the shafts and bearings. Such arrangement facilitates easy mounting and dismantling of shafts and bearings.

The mating surfaces of the two halves are properly machined and suitable gaskets are provided between them to secure tightness against entry of dust and leakage of oil. The upper and the lower casings are then bolted together and are also provided with dowel pins for proper alignment. Oil seals are fitted inside the grooves on the bearing covers through which the shafts project out. These serve the dual purpose of preventing the gear oil from leaking out and extraneous contaminants from entering the gear box. Felt sealing rings are also used for the purpose. The radial oil seals, which are usually fitted to the gear box bearing covers, are of specifications as per IS: 5129-1969.Bolt holes are bored on the bottom flange of the lower casing for securing the gear box to its support or to the civil foundations.

While almost all teams have seamless boxes, the choice of gear case material varies, with the choice being between aluminum, magnesium, titanium or carbon fiber, along with the additional choice of hybrids of the metals bonded with carbon fiber. Gear case stiffness and weight are very important. Back part of rear suspension wishbones and dampers are connected to the 'box and stiffness is a paramount. Also, back crash structure is fitted on gearbox. 'Box is located behind engine on relatively high position and behind rear wheels axel, and that is the reason why weight is also very important. In 2007, only Honda and McLaren ran full carbon fiber cases, and Ferrari evolved their titanium skeleton with bonded carbon skins. All of the other teams ran a metallic (Magnesium, Titanium) gearbox, albeit with some level of carbon fiber bonded to specific areas for stiffness.

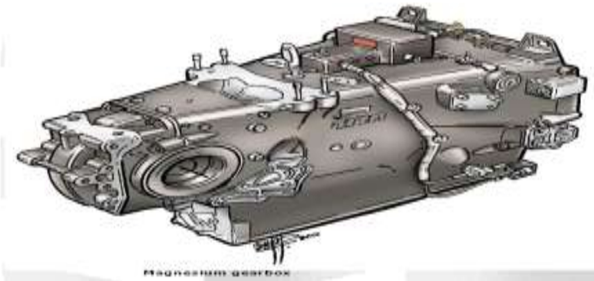

Fig 1. Magnesium gear box

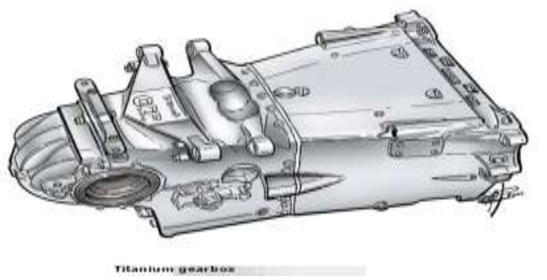

Fig 2. Titanium gear box

2. LITERATURE REVIEW

[1] Mr.Vijaykumar, Mr.Shivaraju, et al In this paper author has discussed about the vibration analysis of gear-box using FEA. An ANSYS Software is used to find out the natural frequency and harmonic frequency of gear-box casing resulting into the determination of range of frequencies to prevent resonance. The modal analysis is done to find Natural Frequency and Harmonic Frequency. The results of both are compared and vibration analysis is done on the gear-box. The fault detection and diagnosis is done from above vibration analysis. The author has also used advanced signal processing techniques for the vibration analysis.

[2] E. Tomeh, et al In this paper the author has outlined the importance of using technical diagnostics methods for the measurement of vibrations of gear-box of the car. The measured vibrations of the gear-box can be used as a predictive maintenance tool which directly minimizes the maintenance activities and also improves the performance of the car in the most efficient way. Since the noise created by a car has a negative effect on its vicinity which includes car driver also. This disturbance can affect the driver’s concentration during driving resulting into the safety issues for road traffic. Also the De-assembling the gear-box often deteriorates its technical condition which results in the vibration and noise. There is no use of replacing just a damaged part unless and until the cause of vibration is not eliminated.

3. DESIGN AND EXPERIMENTATION

3.1 INTRODUCTION TO CAD

CAD/CAM(computer-aided design and computer-aided manufacturing) refers to computer software that is used to both design and manufacture products.

CAD is the use of computer technology for design and design documentation. CAD/CAM applications are used to both design a product and program manufacturing processes, specifically, CNC machining. CAM software uses the models and assemblies created in CAD software to generate tool paths that drive the machines that turn the designs into physical parts. CAD/CAM software is most often used for machining of prototypes and finished parts.

CAD is mainly used for detailed engineering of 3D models and/or 2D drawings of physical components, but it is also used throughout the engineering process from conceptual design and layout of products, through strength and dynamic analysis of assemblies to definition of manufacturing methods of components. It can also be used to design objects. Furthermore, many CAD applications now offer advanced rendering and animation capabilities so engineers can better visualize their product designs.4D BIM is a type of virtual construction engineering simulation incorporating time or schedule related information for project management.

CAD has become an especially important technology within the scope of computer-aided technologies, with benefits such as lower product development costs and a greatly shortened design cycle. CAD enables designers to layout and develop work on screen, print it out and save it for future editing, saving time on their drawings

3.2 INTRODUCTION TO CATIA

CATIA version 5 is a process-centric computer-aided design/computer-assisted manufacturing/computer-aided engineering (CAD/CAM/CAE) system that fully uses next generation object technologies and leading edge industry standards. Seamlessly integrated with Dassault Systems Product Lifecycle Management (PLM) solutions, it enables users to simulate the entire range of industrial design processes from initial concept to product design, analysis, assembly, and maintenance.

CATIA V5 features a parametric solid/surface-based package which uses NURBS as the core surface representation and has several workbenches that provide KBE (Knowledge Based Engineering) support. Catia V5 features a parametric solid/surface-based package which uses NURBS as the core surface representation and has several workbenches that provide KBE (Knowledge Based Engineering) support.

3.3 Parametric modeling:

The parametric nature of a software package is defined as its ability to use the standard properties or parameters in defining the shape and size of a geometry.

3.3.1 Sketched Features

It is based upon a 2D sketch. Generally that sketch is transformed into a solid by extrusion, shafts, sweeping or lofting.

3.3.2 Constraints

By which you can guarantee that design concepts such as through holes and/or equal radii etc are captured and maintained is called constraints. Parallel, perpendicular, horizontal, vertical, etc know as geometrical constraints and length, height, width, etc know as dimensional constraints.

3.4 Modules in CATIA

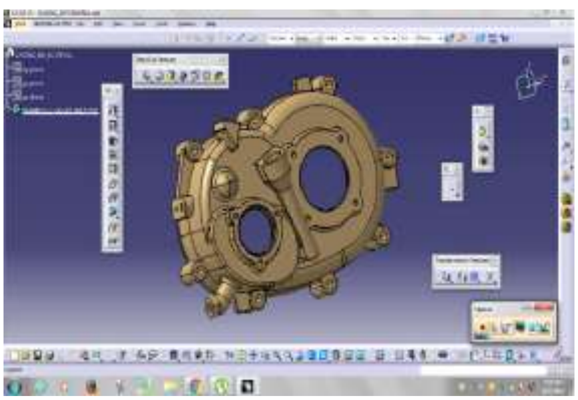

Fig.3. Sketcher

- Part Design
- Assembly Design
- Drafting
- sheet metal

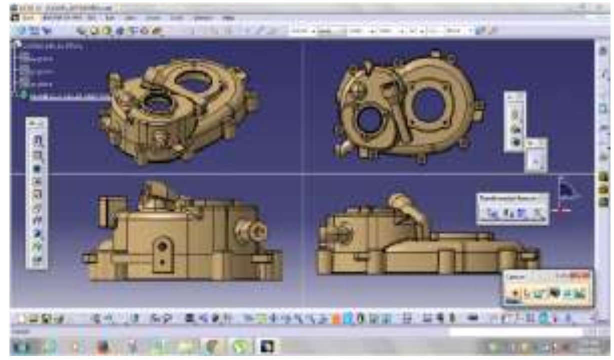

Fig.4. All views if gear box casing

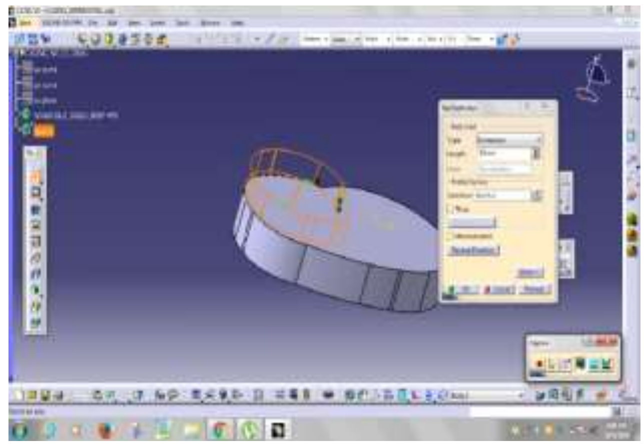

Fig .5 Casing sketch Dimensions

4. RESULTS AND DISCUSSIONS

4.1 INTRODUCTION TO FEA

Finite Element Analysis (FEA) was first developed in 1943 by R. Courant, who utilized the Ritz method of numerical analysis and minimization of variational calculus to obtain approximate solutions to vibration systems. Shortly thereafter, a paper published in 1956 by M. J. Turner, R. W. Clough, H. C. Martin, and L. J. Top established a broader definition of numerical analysis. The paper centered on the "stiffness and deflection of complex structures".

Analysis: The dataset prepared by the preprocessor is used as input to the finite element code itself, which constructs and solves a system of linear or nonlinear algebraic equations

$$K_{ij}u_j = f_i$$

Where u and f are the displacement and externally applied force at the nodal points. The formation of the K matrix is dependent on the type of problem being attacked, and this module will outline the approach for truss and linear elastic stress analyses. Commercial codes may have very large element

Post processing: In the earlier days of finite element analysis, the user would pore through reams of numbers generated by the code, listing displacements and stresses at discrete positions within the model. It is easy to miss important trends and hot spots this way, and modern codes use graphical displays to assist in visualizing the results. A typical post-processor display overlay colored contours representing stress levels on the model, showing a full field picture similar to that of photo elastic or moiré experimental results.

4.2 INTRODUCTION TO ANSYS

ANSYS provides a cost-effective way to explore the performance of products or processes in a virtual environment. This type of product development is termed virtual prototyping. With virtual prototyping techniques, users can iterate various scenarios to optimize the product long before the manufacturing is started. This enables a reduction in the level of risk, and in the cost of ineffective designs. The multifaceted nature of ANSYS also provides a means to ensure that users are able to see the effect of a design on the whole behavior of the product, be it electromagnetic, thermal, mechanical etc.

4.3 SPECIFIC CAPABILITIES OF ANSYS

4.3.1 STRUCTURAL

Structural analysis is probably the most common application of the finite element method as it implies bridges and buildings, naval, aeronautical, and mechanical structures such as ship hulls, aircraft bodies, and machine housings, as well as mechanical components such as pistons, machine parts, and tools.

Static Analysis - Used to determine displacements, stresses, etc. under static loading conditions. ANSYS can compute both linear and nonlinear static analyses. Nonlinearities can include plasticity, stress stiffening, large deflection, large strain, hyper elasticity, contact surfaces, and creep.

Transient Dynamic Analysis - Used to determine the response of a structure to arbitrarily time-varying loads. All nonlinearities mentioned under Static Analysis above are allowed.

4.3.2 THERMAL

ANSYS is capable of both steady state and transient analysis of any solid with thermal boundary conditions. Steady-state thermal analysis, calculate the effects of steady thermal loads on a system or component. Users often perform a steady-state analysis before doing a transient thermal analysis, to help establish initial conditions. A steady-state analysis also can be the last step of a transient thermal analysis; performed after all transient effects have diminished. ANSYS can be used to determine temperatures, thermal gradients, heat flow rates, and heat fluxes in an object that are caused by thermal loads that do not vary over time. Such loads include the following:

- Convection
- Radiation
- Heat flow rates
- Heat fluxes (heat flow per unit area)
- Heat generation rates (heat flow per unit volume)
- Constant temperature boundaries

A steady-state thermal analysis may be either linear, with constant material properties; or nonlinear, with material properties that depend on temperature. The thermal properties of most material vary with temperature. This temperature dependency being appreciable, the analysis becomes nonlinear. Radiation boundary conditions also make the analysis nonlinear. Transient calculations are time dependent and ANSYS can both solve distributions as well as create video for time incremental displays of models.

4.4 Structural analysis for casing aluminum alloy

Material properties:-
Density:-2.89g/cc
Modulus of elasticity:-68.0 Gpa
Poisons ratio:-0.36

Imported model – I

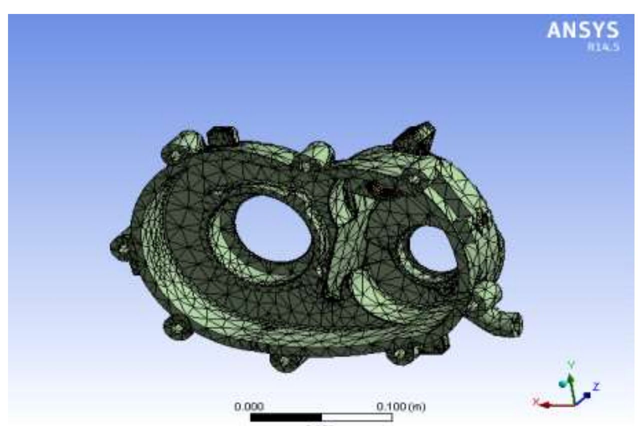

Fig.6. Meshed model of Aluminum alloy

Deformation

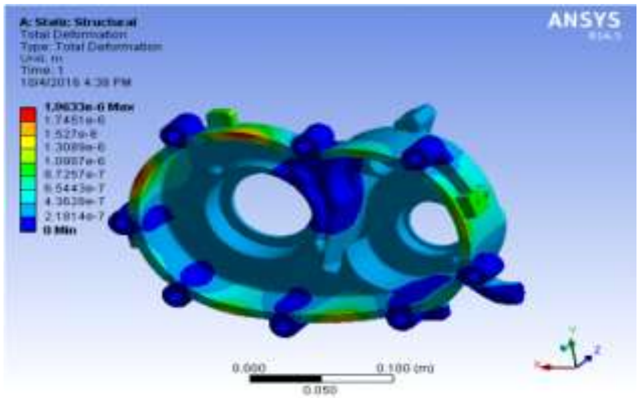

Fig.7. Deformation of aluminum alloy

Strain

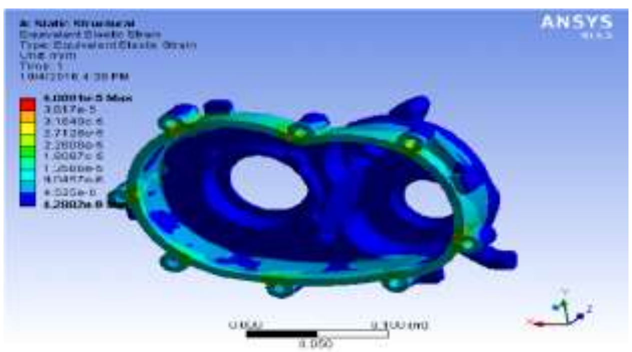

Fig 8. Strain of aluminum alloy

Stress

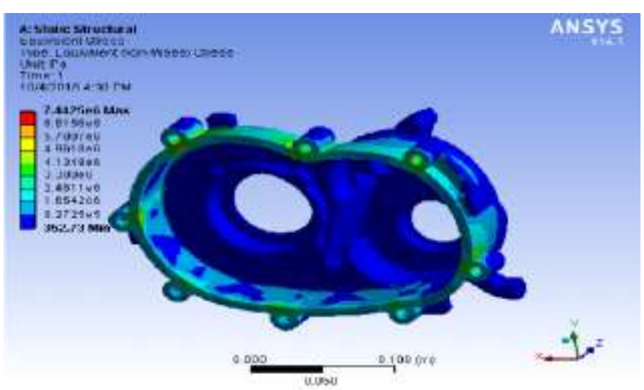

Fig.9. Stress of Aluminum alloy

4.5 Structural analysis for cast iron

Material properties:-

Density :- 7.81 gm/cc

Modulus of elasticity : - 62.1 Gpa

Poisons ratio :- 0.307

Deformation

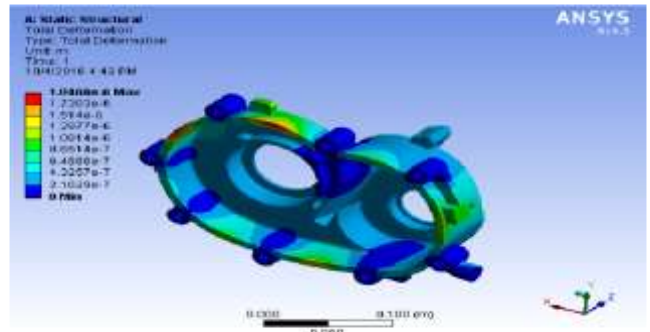

Fig.10. Deformation of Cast Iron

Strain

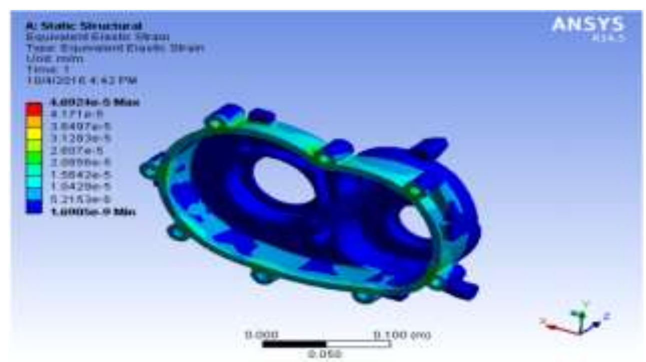

Fig.11. Strain of Cast Iron

Stress

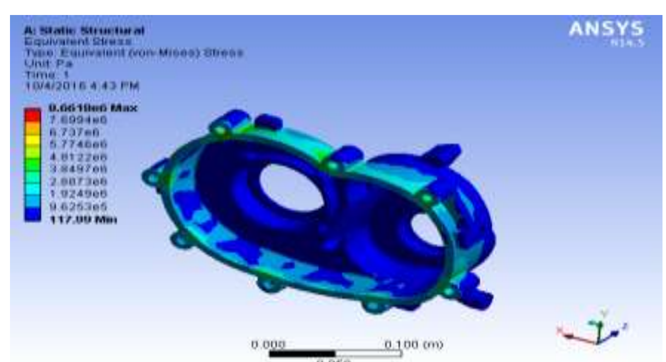

Fig.12.Stress of Cast Iron

4.6 Structural analysis for steel

Material properties:

Density :- 9.01 gm/cc

Modulus of elasticity:- 77.0 Gpa

Poisons ratio:-0.346

Deformation

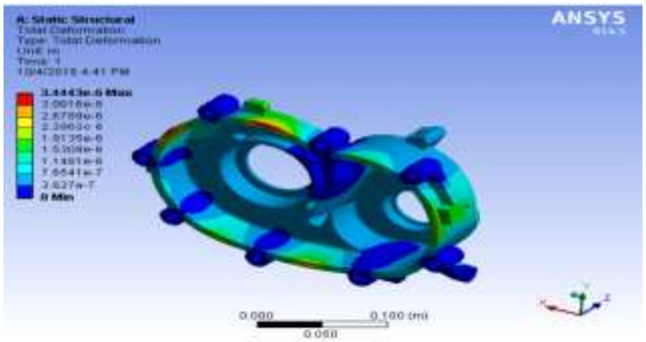

Fig.13. Deformation of Steel

Strain

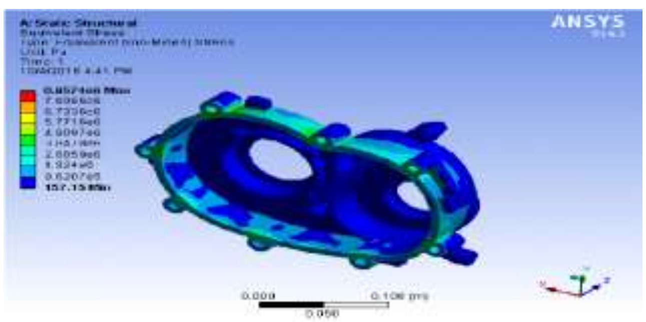

Fig.14. Strain of Steel

Stress

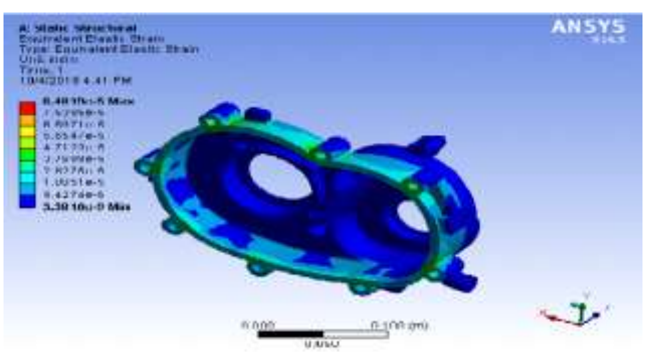

Fig 15. Stress of Steel

4.7 Thermal analysis of steel

Material properties:

Thermal conductivity ;-34.3w/m-k

Specific heat :- 0.620 j/g ^{0}c

Imported model

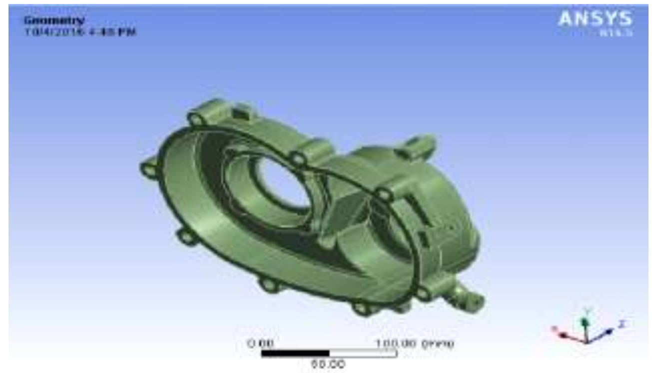

Fig. 16. Imported model

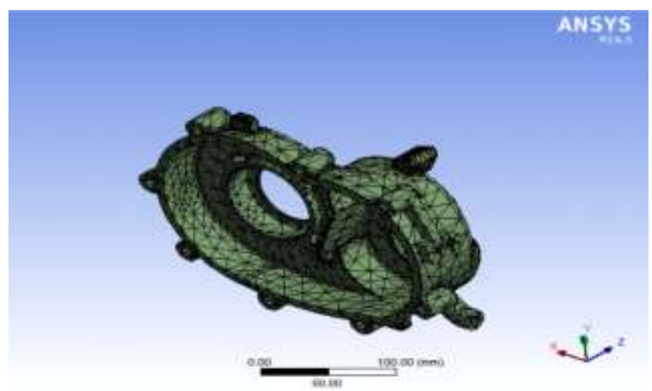

Fig 17. Meshed model

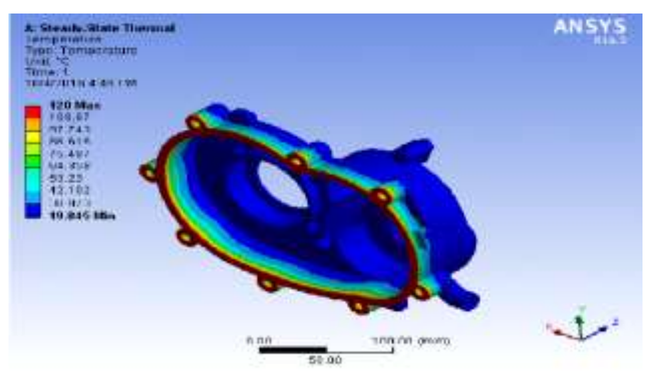

Fig 18 Temperature of Steel

Total heat flux

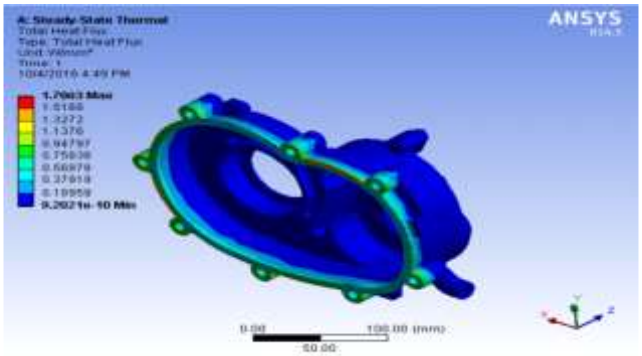

Fig 19. Total heal flux of Steel

Directional Heat Flux

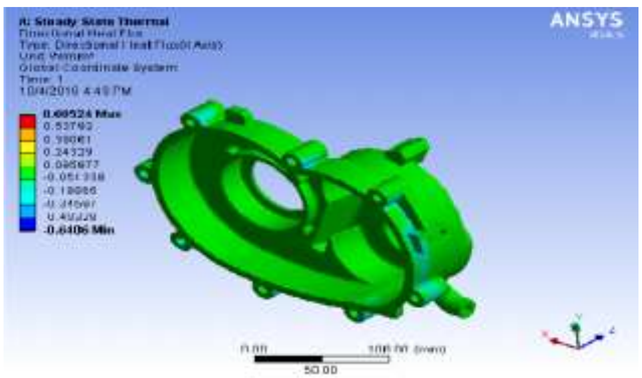

Fig 20. Directional Heat Flux of Steel

4.8 Thermal analysis of cast iron

Material properties:-

Thermal conductivity: - 53.3w/m-k

Specific heat:-0.506 j/g-0c

Imported model

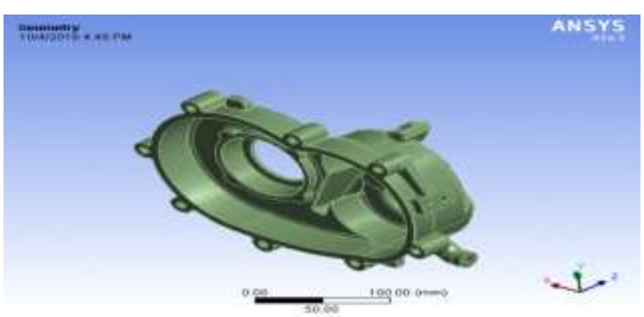

Fig 22. Imported model

Meshed model

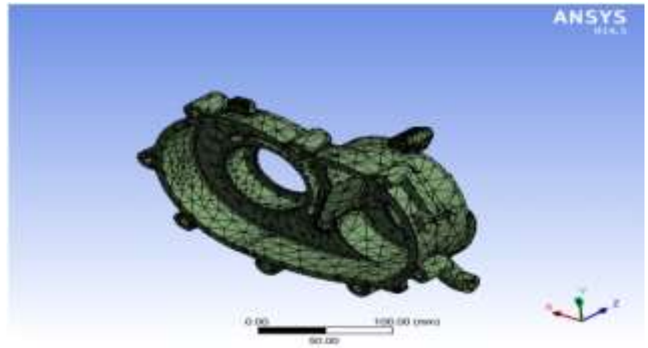

Fig 23. Meshed model of Cast Iron

Temperature

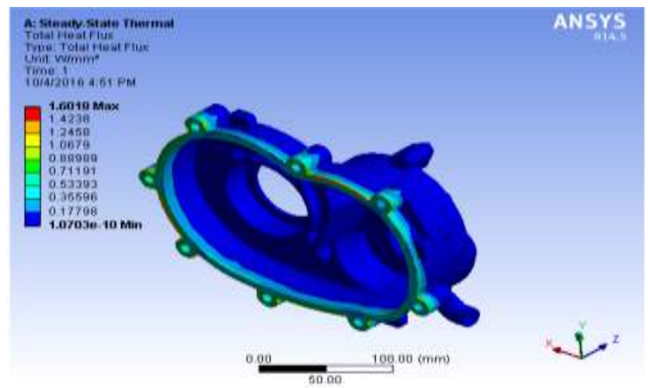

Fig 21. Thermal analysis of cast iron

Total heat flux

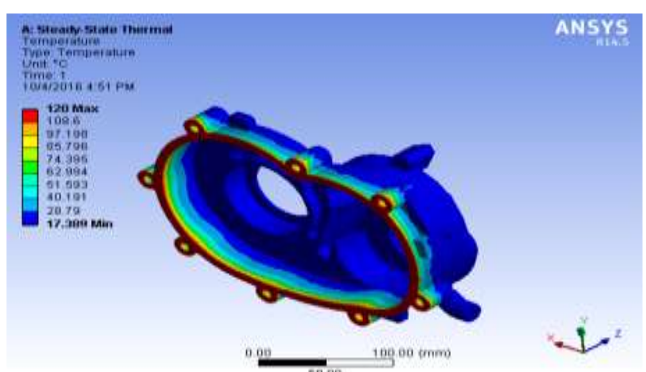

Fig 24. Temperature of Cast Iron

Directional Heat flux

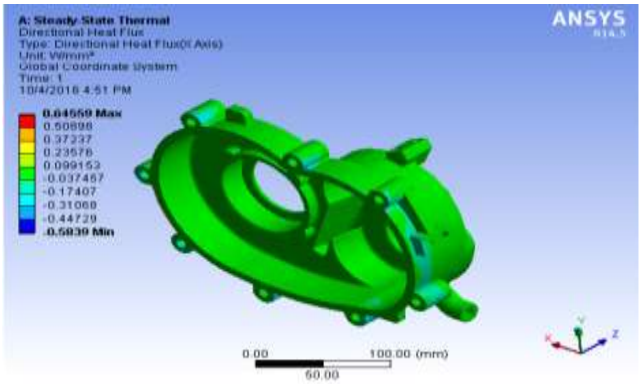

Fig 26. Directional Heat Flux

4.9 Thermal anaylsis for Aluminmum alloy

Material properties

Thermal conductivity :-210w/m-k

Specific heat :-0.900j/g0c

Meshed model

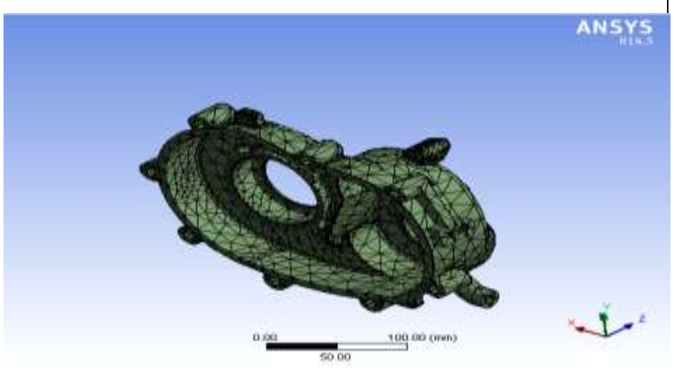

Fig 27. Meshed model of Aluminum alloy

Temperature

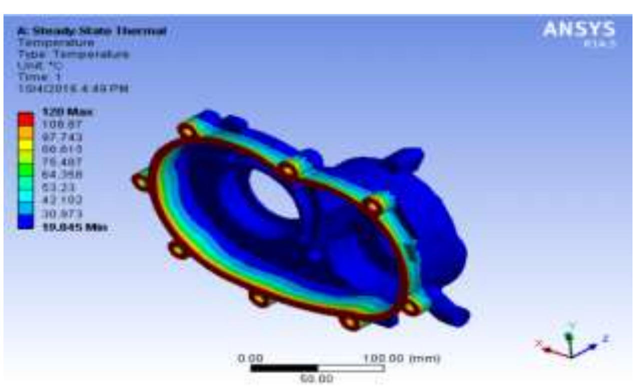

Fig 28. Temperature of Aluminum alloy

Total heat flux

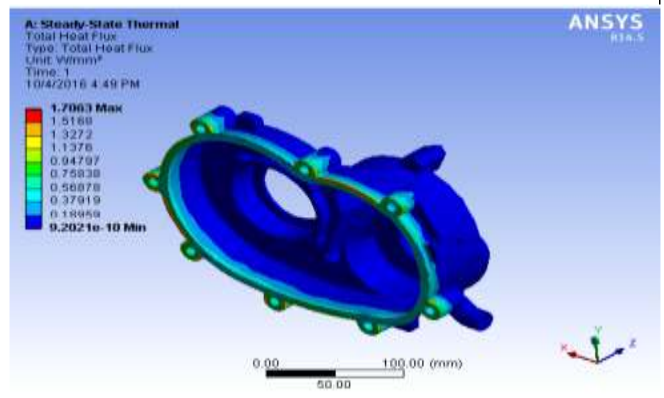

Fig 29. Total Heat Flux

Directional heat flux

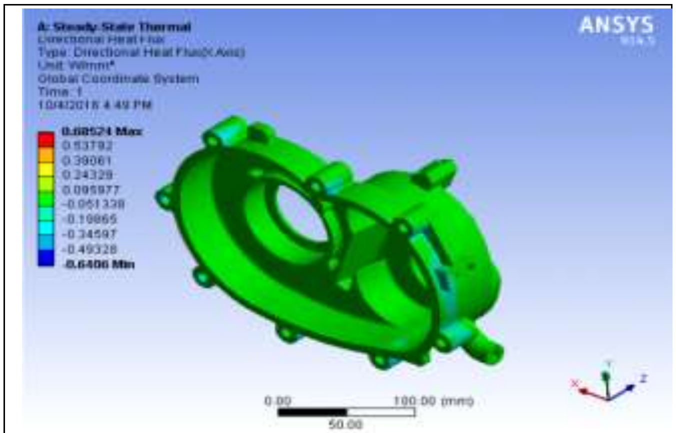

Fig 30. Directional Heat Flux

4.10 RESULT TABLE

Structural analysis

Table 1. Structural Analysis

Materials	**Deformation (m)**	**Strain**	**Stress (pa)**
Aluminum alloy	1.9633e-6	4.0619e-5	7.442e6
Cast iron	1.9466e-6	4.6924e-5	8.661e6
Steel	3.4443e-6	8.4819e-5	8.657e6

Thermal analysis

Table 2. Thermal Analysis

Materials	Temperature		Total heat flux	Directional heat flux
	Min	Max		
Aluminum alloy	18.845	**120**	1.6678	0.67086
Cast iron	17.389	**120**	1.6018	0.65
Steel	19.845	**120**	1.7063	0.68524

CONCLUSION

The gear box is widely used for variation of speeds in automobile. A gear box housing in general consists of two halves-the upper half and the lower half. The plane of separation of the two halves also normally contains the axes of the shafts and bearings.

In these thesis we done designing on Catia v5 software taken three materials to find out max stress were it is bearded and to know the temperature and total heat flux we done thermal analysis .

In these project these three materials are compared every material has its own nature of finding stress and bearded up to some minimum to maximum value and comparing those materials aluminum is the best to finding stress and total deformation for these component .In thermal analysis three materials is compared the max temperature and total heat flux is more in aluminimum alloy comparing to remaining materials .so the material is safe and applicable as per our use

REFERENCES

[1] Mr.Vijaykumar, Mr.Shivaraju, Mr.Srikanth , Vibration Analysis for Gear-Box Causing Using Finite Element Analysis. The International Journal Of Engineering And Science (IJES). Volume- 3, Issue-2, Pages 18-36. (2014)ISSN (e):2319-1813 ISSN (p): 2319-1805.

[2] E. Tomeh, Identify The Sources Of Vibration And Noise On Cars Gear-Box By Spectral Analysis. Technical University Of Liberec, Czech Republic. Springer International Publishing Switzerland 2014.

[3] V. B. Maner, M.M. Mirza, ShrikantPawar, Design Analysis And Optimization For Foot Casing Of GearBox. Proceedings of 3rd IRF International Conference, 10th May-2014, Goa, India, ISBN: 978-93-84209-15-5.

[4] N. Sawalhi, R.B. Randall, Gear Parameter Identification In Wind Turbines Using Diagnostic Analysis Of Gear-Box Vibration Signals. Springer – Verlag Berlin Heidelberg 2014.

[5] Abdulla H EI Sherif, Effective Machinery Fault Diagnosis Avoids Unnecessary Gearbox Maintenance (Case Study). R.B.K.N. Rao et al. (eds.), COMADEM 89 International Kogan Page Ltd. 1989.

[6]Mitchell lebold, Katherine McClintic, Robert Campbell, Carl Byington, Kenneth Maynard, Review of Vibration Analysis Methods For Gearbox Diagnostics and Prognostics. Proceedings of the 54th Meeting of the Society for Machinery Failure Prevention Technology, Virginia Beach, VA, May 1-4, p.623-634.

[7] S. Chen, J. Tang, C. Zhou, Z. Hu, Modal Whirling Analysis of Coupled Lateral And Torsional Vibration Of Herringbone Gear. Springer-Verlag Berlin Heidelberg 2013.

[8] I.A. Bednyi, Mathematical Simulation of Epicycle Gear Vibrations in a Planetary Gearbox Using Finite Element Analysis. ISSN 1052-6188, Journal of Machinery Manufacture and Reliability, 2007, Vol. No.36, No.5, pp. 425-429. Allerton Press, Inc., 2007.

[9] Mr. BhavinGajjar, Finite Element Analysis of Gearbox Housing, International Journal for Scientific Research and Development (IJSRD), Vol.02, ISSUE 03,2014, ISSN (online): 2321-0613.

[10] Shrenik M. Patil, Prof. S.M. Pise, Modal and Stress Analysis of differential Gearbox Casing with Optimization, International Journal of Engineering Research and Applications (IJERA), Vol.03, ISSUE 6, ISSN: 2248-9622, Nov-Dec 2013, pp. 188-193.

[11] 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 (IJMIE). Vol.-2, Iss-4, 2012, ISSN No.2231-6477.

[12] M.Davis, Y.S. Mohammed, A.A. Elmustafa, P.F. Martin, C. Ritinski, Designing for Static and Dynamic

Loading of a Gear Reducer Housing with FEA. ISBN: 978-1-55589-962-2.

[13] Y. Shivraj Narayan, K. Karumanchi, Modeling and Core Cavity Preparation of Side Engine Cover of a Gear box Casing Using PRO/E Software. National Conference on Advances in Mechanical Engineering (NCAME)-2010, 18th December 2010.

[14] Syed R UL Haque, Prof. Dongyan Shi, AzouzRadhia, TauseefAhemad, Static Analysis of Gearbox Casing Using Submodeling Approach in ANSYS.

[15] Fujin Y Yongxiang, Daowen Sn, Wenquan Shen, Weiqiang Xia, Analysis for the Dynamic Characteristic of the Automobile Transmission Gearbox. Research Journal of Applied Sciences, Engineering and Technology (RJASET). 5(4): 1449-1453, 2013 ISSN:2040-7459, e-ISSN:2040-7467, Maxwell Scientific Organization, 2013.

[16] Handbook Of Gear Design By Gitin M Maitra.