DESIGN AND ANALYSIS OF ROTARY HEAD GEARBOX

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ABSTRACT

Rotary head is Heavy duty hydraulic driven top head rotation head unit with single speed or dual speed arrangement having infinitely variable speed (0 to 500 rpm) and is designed for required user torque and speed. This unit travels on the mast and is of sturdy construction to absorb sudden & varying shock loads generally encountered during drilling operations. Based on requirement selecting the type of Drive whether it is a direct drive or Gear transmission. If we select Direct Drive then the torque and speed to be achieved by the rotary head will depend upon the torque and speed hydraulic motor. Only one motor can be used when user selects the Direct Drive. In Direct Drive the Main spindle of Rotary Head is directly connected to the motor shaft by Providing the key slot on Main Spindle. Based on application we will be selecting the speeds of gearbox 1 speed or 2 speeds or 4 Speed Gear box. Only for Core Drilling we use 2 speeds or 4 speed gear box. In all other drilling applications single speed gear box has to be used. Doing analysis for maximum loads. In the present work the geometric model is created in Catia Software and imported to hyper mesh for convergent Finite element mesh and analysis. Stress and displacement on gear box are calculated by using Ansys software.

INTRODUCTION TO CATIA

CATIA is a robust application that enables you to create rich and complex designs. The goals of the CATIA course are to teach you how to build parts and assemblies in CATIA, and how to make simple drawings of those parts and assemblies This course focuses on the fundamental skills and concepts that enable you to create a solid foundation for your designs. The French Dassault Systems is the parent company and IBM participates in the software's and marketing, and CATIA is invades broad industrial sectors, and has been explained in the previous post position of CATIA between 3d modeling software programs. Before we come to learning any 3D modeling software's, You must know their classification as a drawing program, Where CATIA classified under the following software packages:

CAD (Computer Aided Design) CAM (Computer Aided Manufacturing)

CATIA name is an abbreviation for Computer Aided Three-dimensional Interactive Application CATIA is mechanical design software. It is a feature-based, parametric solid modeling design tool that takes advantage of the easy-to-learn Windows graphical user interface. You can create fully associative 3-D solid models with or without constraints while utilizing automatic or user-defined relations to capture design intent. To further clarify this definition, the italic terms above will be further defined .Like an assembly is made up of a number of individual parts, a CATIA document is made up of individual elements. These elements are called features. When creating a document; you can add features such as pads, pockets, holes, ribs, fillets, chamfers, and drafts. As the features are created, they are applied directly to the work piece. Features can be classified as sketched-based or dress-up Sketched-based features are based on a 2D sketch. Generally, the sketch is transformed into a 3D solid by extruding, rotating, sweeping, or lofting.

Dress-up features are features that are created directly on the solid model. Fillets and chamfers are examples of this type of feature.

Parametric:
The dimensions and relations used to create a feature are stored in the model. This enables you to capture design intent, and to easily make changes to the model through these parameters.

Driving dimensions are the dimensions used when creating a feature. They include the dimensions associated with the sketch geometry, as well as those associated with the feature itself. Consider, for example, a cylindrical pad. The diameter of the pad is controlled by the diameter of the sketched circle, and the height of the pad is controlled by the depth to which the circle is extruded.

Concentricity:
This type of information is typically communicated on drawings using feature control symbols. By capturing this information in the sketch, CATIA enables you to fully capture your design intent up front.

Fully Associative
A CATIA model is fully associative with the drawings and parts or assemblies that reference it. Changes to the model are automatically reflected in the associated drawings, parts, and/or assemblies. Likewise, changes in the context of the drawing or assembly are reflected back in the model.

Constraints
Geometric constraints (such as parallel, perpendicular, horizontal, vertical, concentric, and coincident) establish relationships between features in your model by fixing their positions with respect to one another. In addition, equations can be used to establish mathematical relationships between parameters. By using constraints and equations, you can guarantee that design concepts such as through holes and equal radii are captured and maintained.

Solid Modeling
A solid model is the most complete type of geometric model used in CAD systems. It contains all the wireframe and surface geometry necessary to fully describe the edges and faces of the model. In addition to geometric information, solid models also convey their ―topology‖, which relates the geometry together. For example, topology might include identifying which faces (surfaces) meet at which edges (curves). This intelligence makes adding features easier. For example, if a model requires a fillet, you simply select an edge and specify a radius to create it.

CATIA User Interface.

CATIA Modules

Fig: CATIA Modules

Sketcher: This module is responsible for the implementation of two-dimensional shapes , in preparation for make a three-dimensional commands on it.

Part Design
This module is responsible for converting two-dimensional graphics to three-dimensional objects which is most famous in CATIA and is closely linked with sketcher module. The part design Module it is considered from most important modules, that used by the

designer to get the additional advantage from cad programs, which is stereotaxic drawing or three-dimensional drawing.

Assembly

This module is responsible for assembling the parts previously produced in Part Design, and it is most important for those who work in the field of machinery design or design in general, because it is the one who shows the inter-relationships between the parts of the machine or any mechanical establishment.

Stress Analysi

This module is responsible for testing parts designed to withstand the loads expected occurrence on it, and shows how the mechanical parts are affected by the colors, where they can learn the most dangerous points in terms of emotion through the distribution of colors.

Drafting

This module is responsible, for converting what you see on the screen to standard engineering drawings can be traded in the workshop for manufacturing or save them for documentation.

Surface and Wire Frame

With this module surfaces can be drawing with zero size and weight and has its uses in the aerospace, automotive, ships and Mold Design.

Simulation:

This module is responsible for obtaining a similar movement of the natural movement, which is expected to occur during the actual operation of the machine or mechanical establishment whatever.

Free Style

Which is a free drawing, product designers needs it, such as Mobile or furniture or antiques designers. and other modules such as: Sheet Metal, Mold Design, Welding, Aerospace Sheet Metal.

LITERATURE REVIEW

Pratik Gulaxea1., the efficiency of material handling trolley of cupola furnace. Also to ensure simulation and experimental results, a prototype model was tested with the help of FEM software. This paperreviews the modeling and computer simulation as a tool for aiding gearbox used by various researchers earlier. The results of computer simulations and results obtained by actual experimentation were compared to get detailed idea about the parameters which can affect the increase in speed drastically. The factors were divided into four groups: design factors,production technology factors, operational factors and change of condition factors.The present paper works on new design and analysis of gear box for cupola material handling trolley. Due to large time taken by an existing gear box, the lead time of production was more. Casting processes now a day's becoming the key process of metal manufacturing because of wide range of materials suitability and also economic. The apparently simple looking activity involves several steps; the first of which is the design of the part itself and the specification of the material to be used. This information is used by an engineer while choosing the right casting process, and then designs the system necessary to get the molten metal into all regions of the part to produce a sound casting. Two major considerations in the casting design are the quality of the final product and the yield of the casting; both of which heavily depend upon the rigging system used

Gearboxes are frequently used in machine systems for power transmission, speed variation and/or working direction. Dynamic modeling of gear vibration offers a better understanding of the vibration generation mechanisms as well as the dynamic behavior of the gear transmission in the presence of gear tooth damage. Because of their ubiquity and importance, gearboxes have received a considerable amount of attention in this respect. A significant number of papers have been published concerning the problem. The different technique like Finite Element Approach, Mathematical Modeling, Optimization Approaches, Wavelet Approach, Experimental Set-Up Approach etc was used by various researchers earlier. The trolleys speed can be increased by increasing the gearbox speed and reducing the failures in the gearbox and loading trolley.

Hayrettin Duzcukoglu., In polyamide based gears, thermal damage of the gear tooth surfaces occurs during gear meshing due to accumulated heat in the tooth body. In the experimental study reported in this paper, polyamide gear teeth have been modified in order to distribute the generated heat on the tooth surface by means of drilled cooling holes at different locations on the gear tooth body. The main aims of this paper were to study the effect of cooling holes on the accumulated heat on the tooth surface and on the measured wear. It was shown that the drilled cooling holes on the tooth body decreased the tooth surface temperature and led to an increase in the load carry capacity and improved wear resistance. Geometrically modified gears have showed an improved service life and a decreased surface temperature.

Polyamide gears are now widely used because of low friction, noiseless performance, light weight, oil-less conditions, and low cost . Polyamide gears have been used with success in the automotive industry, as well as a host of other areas. Polyamide gears are mostly used under un-lubricated conditions. However, polyamide gears have a number of drawbacks. For example,Plastic gears have a low load-carrying capacity, a short service life, and poor heat resistance. These drawbacks typically limit applications of polyamide gears, particularly in high speed, heavy load or high ambient temperature conditions . Generally, plastic gears show different damage mechanisms such as tooth fatigue, creep, excessive wear, plastic deformation, the fatigue and the plastic deformation, which are hardly separable. Over the past few decades, a considerable number of studies have been studied on the performance of polyamide gears .

It was reported that degradation of the plastic gear materials originated from high temperature caused by accumulated heat on the tooth surface, which decrease the service life. At the same time, the accumulated heat on the gear tooth surface resulted in thermal failure, severe wear, and early fracture . The fracture of part or all of a gear tooth has suddenly occurred with increase in the tooth surface temperature. Therefore, accumulated heat on plastic gear tooth surface should not be permitted, and the accumulate heat must be inspected. Because of the very low thermal conductivity of polymers, virtually all the generated heat must be removed by convection from the surface. The air temperature around the gears remains close to ambient and that there is only a small difference between the temperatures of the contacting and non-contacting flanks of the gears suggests the possibility of a simplified model .The airflow into the gaps (module width) between the gear pairs' mating as the gears came out of mesh will be extremely turbulent. This turbulence will be balanced by temperatures on contacting both tooth and non-contacting tooth of the gear. The temperature of plastic gear tooth surface was researched by Mao in 2007 and a model for gear heat transfer was developed. The gear runs effectively as a gear pump. Airflow between the gear teeth gaps is pumped from one edge of contact region to the other. Pockets of air are trapped between gear tooth during meshing and this warm air is moved around the gear. The warm air is expelled outside the gear during meshing operation and is replaced by fresh, cold air as the teeth pull apart in this approximation; it may be assumed that the warm air within each tooth pocket will reach a temperature close to that of the gearsurface. Turbulence within each pocket will ensure that the non contacting gear surface is heated to a temperature close to that of the contacting surfaces

MODELING AND MESHING OF GEARBOX.

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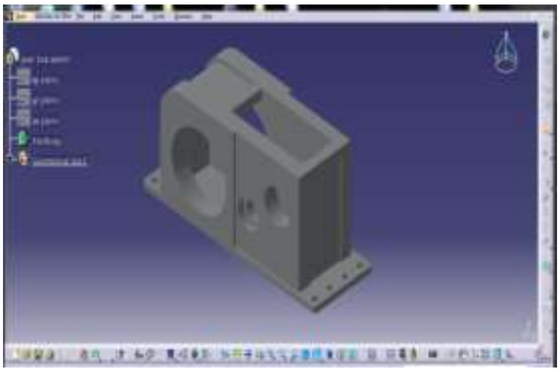
MODELING :



Isometric view

MESHING:

Meshing is generated by using hyper mesh software. Mesh the geometry by using tetra hedral elements. Element type is solid 45.

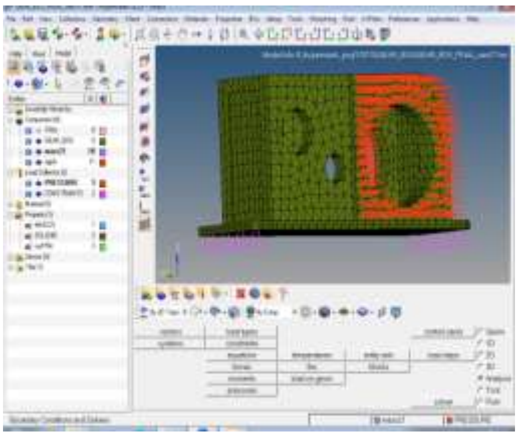


Fig:Mesh model of a gear box

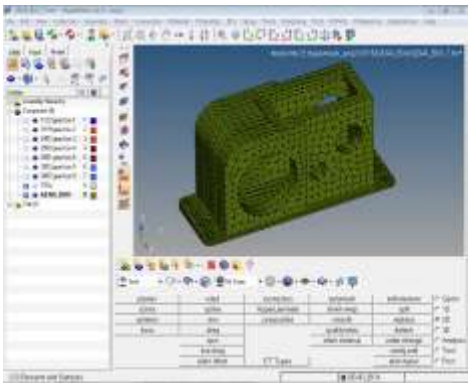


Fig: constrained model of a gear box

stress (N/mm^2	Steel	Cast iron
Shear stress in xy	40.13	40.13
Shear stress in yz	23.13	23.13
Shear stress in xz	41.36	41.36
Vonmises stress	161.98	161.98

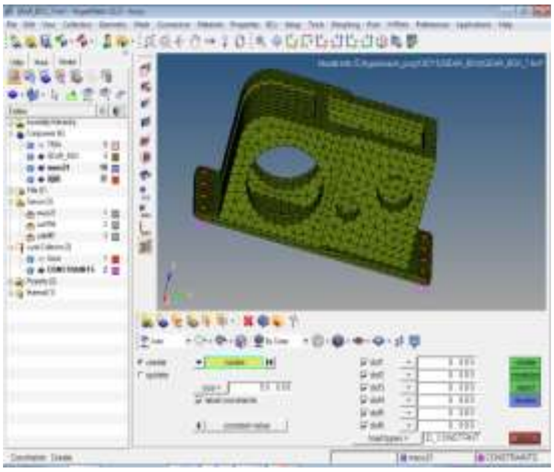


Fig: loading condition of gear box

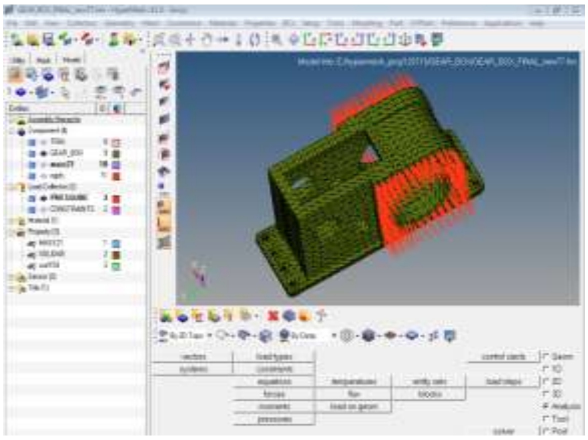


Fig: Constrained and load condition of a gear box

RESULTS & DISCUSSION

MATERIAL PROPERTIES:

Material	Youngs modulus (N/mm2)	Poisson's ratio	Density (tonn)
Steel	2.1e5	0.3	7.89e-9
castiron	1.2e5	0.28	7.2e-9

CAST IRON MATERIAL:

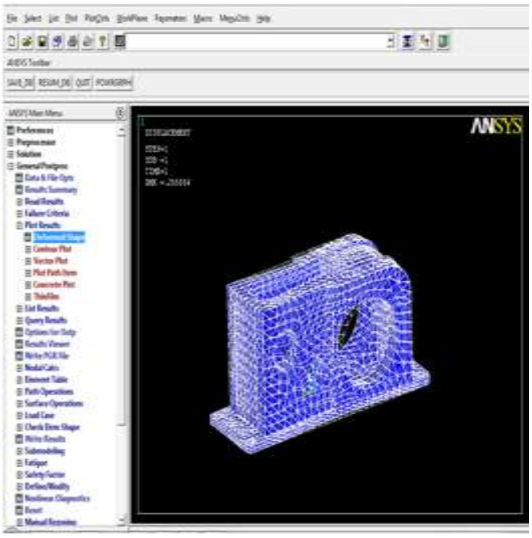


Fig: Deformed-un deformed shape of a gear box

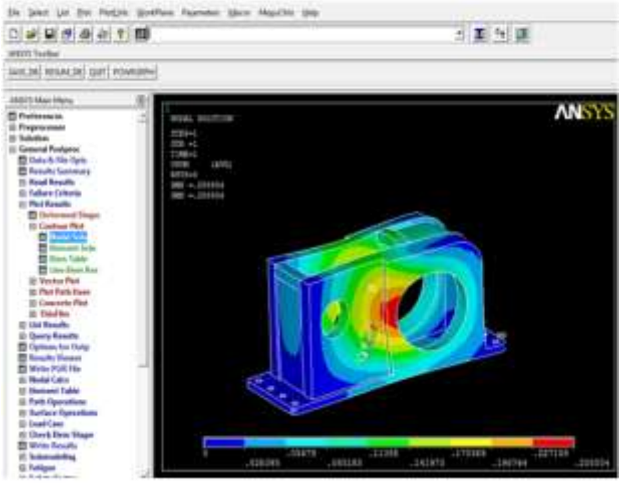


Fig: Displacement vector sum of a gear box is 0.255mm

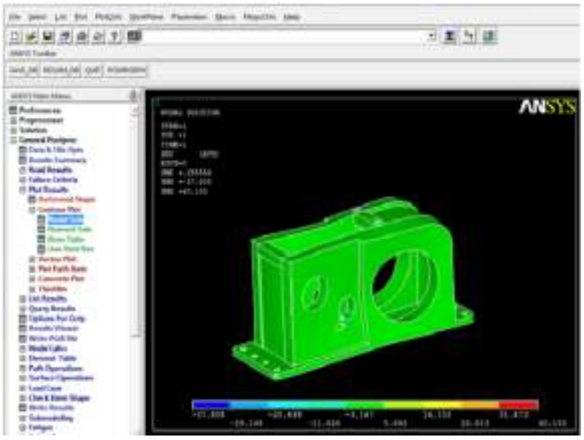


Fig: xy-shear stress of a gear box is 40.13 N/mm^2

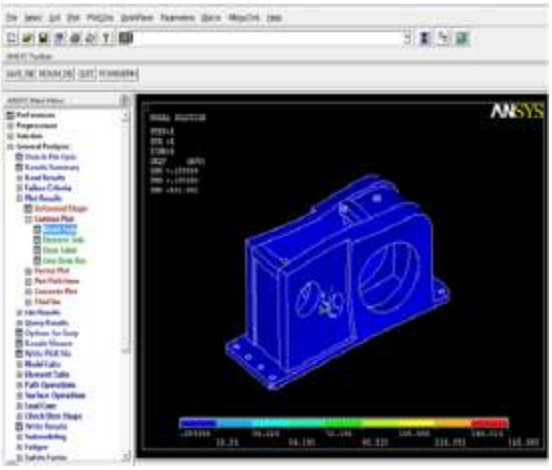


Fig: vonmises stress of a gear box is 161.98 N/mm^2

The following table represents the displacements of various materials:

Material	Displacement(mm)
Steel	0.146
Cast iron	0.255

CONCLUSION

As material for gear box casing, good quality cast iron is used in most of the cases. Steel castings or light metal castings are also popular, but they are used in special cases. Fabricated housings are also used. Cast iron housings have good damping properties and freedom from noise. The life time of these casting is also considerably efficient. Steel casting which are obviously much costlier than CI housings, are used in only those cases where CI casings are not strong enough to withstand the operational stresses involved.

In our work the gear box of different materials (steel and cast iron) was analyzed by finite element methods. From the above results the Maximum Vonmises stresses are observed for steel and cast iron materials. The values are under safe load condition for steel but not for cast iron. The Stress Levels for gear box was checked under max load condition with load of 1,81000 N and proved to be safe design and suggested to use operations and also for Heavy Engineering Equipments.

Under such load, the Von Mises stress induced in the CI casing is more than that of Steel casing.

Though the cost of manufacturing of the steel gearbox housing is more compared to CI casing, usage of Steel casing is suggested here to work without failure.

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