CHAPTER - 1

INTRODUCTION

Gear is an essential component in many machine parts; its application varies from small geared motor to and complicated aerospace accessories. Human has been familiar about the idea that the repeated bending of wood or metal back and forth with high amplitude could rupture it. He found that the repeated stress can produce fracture with stress within elastic limit of material. The fatigue analysis for structure designing relies on approach which has been progressed over the last 100 years or so. The very first fatigue analysis has been done by German mining engineer, W.A.S. Albert who performed number of repeated loading test on iron chain. Fatigue is the most important failure mode to be considered in a mechanical design. Fatigue is the process of continuous localized permanent structural change appearing in a material subjected to fluctuating stress conditions. If the loading limit does not exceed the elastic limit, the body will regain its original state. Designer should have a good knowledge of analytical and empirical techniques to get effective results in averting failure. Mechanical failure is observed mainly due to fatigue design therefore fatigue becomes an obvious design, consideration for many structure such as aircraft, rail cars, automotive suspension, Vehicle frame and bridges in normal conditions, contact fatigue is one of the most common failure modes for gear tooth surfaces. Gear tooth interaction causes adhesive wear throughout the life of gear drive. Under periodic loads, most materials will fracture when submitted to periodic loads over a large number of cycles. There are two prominent modes of fatigue damage that is root bending stress and contact stress. The tooth damage is mostly because of maximum bending stress. Mining machine uses traction gear boxes in transmission system. It consists of single pinion and gear setup and these gears are also known as speed reducer, gear head, gear reducer etc. which consists of bearings and set of gear shafts. Gear analysis was performed using analytical methods approach but nowadays computers have become more developed and use for numerical models to predict fatigue behavior. Gear is an essential component in many machines. They are used in many high speed applications.

Fig. : 1 Spur Gear

As gears transmit motion and power through surface contact, their performance depends on reliability of their teeth surface. There are some wear modes such as contact fatigue, adhesion, abrasive, corrosion. In case of gears, bending stress and contact stress are prominent modes of fatigue failure. The contact fatigue process can be divided into two main stages: initiation of micro-cracks and crack propagation. Initiation of fatigue cracks represents one of the most important stages in which cracks can be initiated either on the surface or at some distance under the surface depending on the contact conditions. The main aim of this study is to predict contact fatigue crack initiation resulting from high stresses or strains during the meshing process. These contact stresses are generally at their highest at some distance under the surface, where initial cracks are most likely to appear. In order to increase the bending fatigue strength at the tooth root fillet of gears, gears with high pressure angle and positive addendum modification factor are generally adopted. Bharat Gupta ET. Al. has considered contact stress, the deciding factor to determine the required dimension of gears. Thorough studies of contact stress developed between the different mating gears are mostly important for gear design. Analytic methods of calculating gear contact stresses use Hertz's equations, which were originally derived for contact between two cylinders Gears are commonly made from metal, plastic, and wood. Although gear cutting is a substantial industry, many metal and plastic gears are made without cutting, by processes such as die casting or injection molding. Some metal gears made with powder metallurgy require subsequent machining, whereas others are complete after sintering. Likewise, metal or plastic gears made with additive manufacturing may or may not require finishing by cutting, depending on application.

1.2 Specification Of Gear

Traction gear: Traction gear or straight-cut gears are the simplest type of gear. They consist of a cylinder or disk with teeth projecting radially. Though the teeth are not straight-sided (but usually of special form to achieve a constant drive ratio, mainly involute but less commonly cycloidal), the edge of each tooth is straight and aligned parallel to the axis of rotation. These gears mesh together correctly only if fitted to parallel shafts. No axial thrust is created by the tooth loads. Spur gears are excellent at moderate speeds but tend to be noisy at high speeds. The spur gear is simplest type of gear manufactured and is generally used for transmission of rotary motion between parallel shafts. The spur gear is the first choice option for gears except when high speeds, loads, and ratios direct towards other options. Other gear types may also be preferred to provide more silent low vibration operation. A single spur gear is generally selected to have a ratio range of between 1:1 and 1:6 with a pitch line velocity up to 25 m/s. The spur gear has an operating efficiency of 98-99%. The pinion is made from a harder material than the wheel. A gear pair should be selected to have the highest number of teeth consistent with a suitable safety margin in strength and wear. The minimum number of teeth on a gear with a normal pressure angle of 20 degrees is 18.This is a cylindrical shaped gear in which the teeth are parallel to the axis. It has the largest applications and, also, it is the easiest to manufacture. They are simple in construction, easy to manufacture and cost less. They have highest efficiency and excellent precision rating. They are used in high speed and high load application in all types of trains and a wide range of velocity ratios. Hence, they find wide applications right from clocks, household gadgets, motor cycles, automobiles, and railways to aircrafts. Spur gears are regularly used for speed reduction or increase, torque multiplication, resolution and accuracy enhancement for positioning systems. The teeth run parallel to the gear axis and can only transfer motion between parallel-axis gear sets. Spur gears mate only one tooth at a time, resulting in high stress on the mating teeth and noisy operation. Dimension Specifications: Gears mate via teeth with very specific geometry. Pitch is a measure of tooth spacing and is expressed in several ways. Diametral pitch (DP) is the ratio of the number of teeth to the pitch diameter of a gear; a higher DP therefore indicates finer tooth spacing. It is easily calculated by the formula $DP = (N+2) \div OD$, where N is the number of teeth, and OD represents the circumferential measurement. Circular pitch (CP) is a direct measurement of the distance from one tooth center to the adjacent tooth center. It can be measured by the formula $CP = \Pi \div DP$. Module (M) is a typical gear discipline and is a measurement of the size and teeth number of the gear. Gears measured in inches earn 'English module' distinction to prevent confusion. $M = OD \div N$ Pressure angle is the angle of tooth drive action, or the angle between the line of force between meshing teeth and the tangent to the pitch circle at the point of mesh. Typical pressure angles are 14.5° or 20°.

Design For Space Constrains The designed gear system should fit within a space limit. So the designer could say if he sums pitch diameters of the mating gears, it should be less than or equal to allowable space limit as shown in figure below.

The blue rectangle represents space on which gear should get fit. One can take 80% of width of this space as allowable width for gear design. So following is the relation obtained by this condition. Space constrain of gear design We also know speed ratio of gears, this will lead to one more relation in terms of pitch circle diameters. By solving above 2 equations simultaneously we can obtain pitch circle diameters of both the gears.

1.3. Determination of Number Of Teeth

Interference Here we will understand how to determine number of teeth on both the gears. To do this we have to assume number of teeth on one gear(T1), say the smaller gear. Now using the relation given below we can determine number of teeth on other gear,T2.

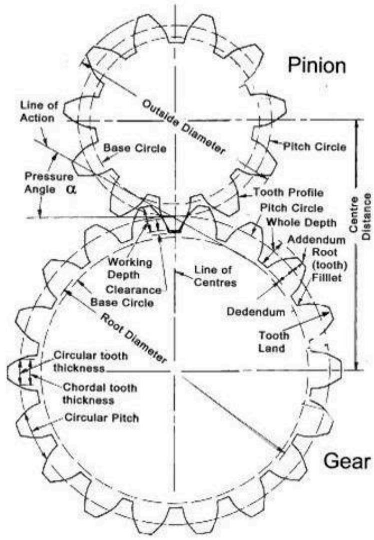

Fig : 2 terminologies of spur gear

So we got number of teeth on both the gears, but one should also check for a phenomenon called **interference** if gear system has to have a smooth operation. Interference happens when gear teeth has got profile below base circle. This will result high noise and material removal problem. This phenomenon is shown in following figure. If one has to remove interference , the pinion should have a minimum number of teeth specified by following relation. A pair of gear teeth under interference Where aw represents addendum of tooth. For 20 degree pressure angle(which is normally taken by designers) aw = 1 m and bw = 1.2 m. Module m, and pitch circle diameter Pd are defined as follows.

Design for Mechanical Strength - Lewis Equation Now the major parameter remaining in gear design is width of the gear teeth, b. This is determined by checking whether maximum bending stress induced by tangential component of transmitted load, Ft at the root of gear is greater than allowable stress. As we know power transmitted, P and pitch line velocity V of the gear Ft can be determined using following relation. Here we consider gear tooth like a cantilever which is under static equilibrium. Gear forces and detailed geometry of the tooth is shown in figure below. One can easily find out maximum value of bending stress induced if all geometrical parameters shown in above figure are known. But the quantities t and l are not easy to determine, so we use an alternate approach to find out maximum bending stress value using Lewis approach. Maximum bending stress induced is given by Lewis bending equation as follows. Where Y is Lewis form factor, which is a function of pressure angle, number of teeth and addendum and dedendum. Value of Y is available as in form of table or graph. Using above relation one can determine value of b, by substituting maximum allowable stress value of material in LHS of equation. But a gear design obtained so will be so unrealistic, because in this design we are considering gear tooth like a cantilever which is under static equilibrium. But that's not the actual case. In next session we will incorporate many other parameters which will affect mechanical strength of the gear in order to get more realistic design.

A More Realistic Approach - AGMA Strength Equation: When a pair of gear rotates we often hear noise from this, this is due to collision happening between gear teeth due to small clearance in between them. Such collisions will raise load on the gear more than the previously calculated value. This effect is incorporated in dynamic loading loading factor, Kv value of which is a function of pitch line velocity. At root of the gear there could be fatigue failure due to stress concentration effect. Effect of which is incorporated in a factor called Kf value of which is more than 1. There will be factors to check for overload (Ko) and load distribution on gear tooth (Km). While incorporating all these factors Lewis stregth equation will be modified like this The above equation can also be represented in an alternating form (AGMA Strength equation) like shown below Where J is Using above equation we can solve for value of b, so we have obtained all the output parameters required for gear design. But such a gear does not guarantee a peacefull operation unless it does not a have enough surface resistance.

Design for surface resistance: Usually failure happens in gears due to lack of surface resistance, this is also known as pitting failure. Here when 2 mating surfaces come in contact under a specified load a contact stress is developed at contact area and surfaces get deformed. A simple case of contact stress development is depicted below, where 2 cylinders come in contact under a load F. Fig.7 Surface deformation and development of surface stress due to load applied For a gear tooth problem one can determine contact stress as function of following parameters If contact stress developed in a gear interface is more than a critical value(specified by AGMA standard), then pitting failure occurs. So designer has to make sure that this condition does not arise.

CHAPTER- 2

LITERATURE REVIEW

The purpose of the paper is to examine the load capacity of PC/ABS spur gears and investigation of gear damage. Further in this study usability of PC/ABS composite plastic material as spur gear was investigated and was defined that PC/ABS gears were tested by applying three different loading at two different numbers of revolutions on the FZG experiment set. The experiment result summarized that the usage of PC/ABS materials brings an advantage in many industrial area because such materials are durable against flame, air, ultraviolet lights and holding lower moister than PA66 GFR 30 materials. The another result of this study was that good operating condition are comprised at low numbers of revolution and the tooth loads. Further the suitable environmental condition must be revolutions and the tooth load for gears. PC/ ABS gear should be preferred at low tooth and unwanted high power transmission. 2.1.1 Polymer gears in sugarcane juice machine This paper describes design and analysis of spur gear and it is proposed to substitute the metallic gears of sugarcane juice machine with polymer gears to reduce the weight and noise. A virtual model of spur gear was created in PRO- E, Model is imported in **ANSYS 14.5** for analysis by applying normal load condition. The main purpose of this paper to analysis the different polymer gears namely nylon, polycarbonate and their viability checked with counterpart metallic gear like as cast iron. Concluding the study using the FEA methodology, it can be proved that the composite gears, if well designed and analysed, will give the useful properties like as a low cost, noise, Weight, vibration and perform its operation similar to the metallic gears. Based on the static analysis Nylon gear are suitable for the application of sugarcane juice machine under limited load condition in comparison with cast iron spur gears. 2.1.2 Stress Analysis of Mating Teeth in Spur Gears This paper presents the stress analysis of mating teeth of the spur gear to find maximum contact stress in the gear tooth. The results obtained from finite element analysis are compared with theoretical Hertz equation values. The spur gear are modelled and assembled in ANSYS DESIGN MODELER and stress analysis of Spur gear tooth is done by the ANSYS 14.5 software. It was found that the results from both Hertz equation and Finite Element Analysis are comparable. From the deformation pattern of steel and grey cast iron, it could be concluded that difference between the maximum values of steel and grey CI gear deformation is very less. Material Investigation In this paper, Metallic material Cast iron and Non Metallic material Nylon are investigated. The stress analysis of the lathe machine headstock gear box are analyzed by finite element analysis. Analytical bending stress is calculate by two formula Lewis formula and AGMA formula. Analytical results is compared with the finite element method result for validation. Concluding the study, we observed that finite element method software ANSYS have values of stress distribution were in good agreement with the theoretical results. Besides non metallic material can be used instead of metallic material because non metallic material provide extra benefits like as less cost, self lubricating, low noise, low vibration and easy manufacturing. Free Vibration Behaviour of Composite Spur Gear The objective of this paper is to study the free vibration behaviour of composite spur gear using finite element method which is also known as first order shear deformation plate theory (FSDT). The finite element analysis has been carried out for composite gear as a 4 nodded and 8 nodded quadrilateral element with each nodes has five degree of freedom. Finite element formulation of composite gear is modelled and coded using MATLAB. Based on the numerical analysis which is carried out for of spur gear the following important conclusion can be drawn. The developed MATLAB code is validated with the available result and it can be concluded that the present FE code result are in good agreement with those of reference. Fundamental frequencies obtained for composite spur gear using MATLAB are presented. It is found that natural frequency increases with increase in fibre orientation. Parametric model of Differential Gear Box In this paper the parametric model of differential gear box is developed using some parameters i.e. (number of teeth, Pressure angle, helix angle, tooth thickness, module) in CATIA-V5 and weight analysis of differential gear box for different material (Aluminium alloy, alloy steel, cast iron, Glass filled Polyamide) under static loading condition using FEA. The case study shows that the composite material can be used effectively in place of metallic material because the weight of Glass filled Polyamide composite material of differential is reduced by 60% Comparing with the traditional materials

(Aluminium alloy, Alloy Steel, Cast iron). So, we conclude that Glass filled Polyamide Composite material is selected as a best material for differential gear box. Comparative

Peformance of Materials In this study the comparative performance spur gear of 30% Glass filled PA66 and 30% Glass filled PEEK was investigated at different torque and speed. Wear test of the spur gear pairs and the experiment spur gear tooth were performed on a FZG test machine. A weight loss is measured by 0.0001g sensitive weighing machine and the tooth temperature of gear is measured by Impact infrared thermometer. After summarized the experimental result of PA66 GF30 gears and PEEK GF30 gears are at different torque and speeds. The tooth temperature increases with increase in torque and increased temperature resulted into thermal softening of gear tooth which further increases specific wear rate. The comparative results of PA66 GF30 and PEEK GF30 gears show that the specific wear rate of PA66 GF30 is much higher than PEEK GF30 at all torque and speeds. Therefore the torque transmission capacity of PEEK GF30 is higher than PA66 GF30. Computer Aided Analysis of Spur Gears In this paper using ANSYS workbench software, bending stress, contact stress and static load on the tooth of spur gear drive is found. The Hertz theory and Lewis formula also are used for theoretical calculation of contact stress and bending stress of spur gear. We observed that Theoretically results obtained by Lewis formula and Hertz equation are comparable with finite element analysis of spur gear, keeping in mind the comparison we can conclude that the finite element analytical result can be better as a problem solving software and used for other analyzing purpose. Stress Calculations at Various States The objective of paper is to study the various stress state of spur gear. They calculated the tangential and radial forces which acts on various point upon that basis we can analyze by applying the forces. By using Ansys software bending stress and contact stress on the tooth of spur gear drive is found Gears are machine elements used to transmit power between rotating shafts by means of engagement of projection called teeth. Gears are most common means of transmitting power in the wooden mechanical world. They vary from a tiny size used in watches to larger gears used in massive speed reducers, bridge lifting mechanism and rail road turn table drive. The gears are vital elements of main and auxiliary mechanism in many machines such as automobiles, tractors, metal cutting machine tools rolling mills hosting and transmitting and transporting machinery, massive engines etc.

Wearing of Spur gears Says that Spur gear wears either due to rubbing action between the meshed gears or by the occurrence of unwanted elements like dust particles, metal fragments, etc. which reduces its efficiency and service life. It is always a challenging task to determine the remaining life of a component or the strength of a component once wear has occurred on teeth surface. This paper presents an application of reverse engineering approach for reconstruct the spur gear 3D CAD model using scanned data. A gear has been scanned using PICZA 3D laser scanner (RolandLPX60).

Contact Stresses developed in Mating Spur Gear Made an attempt to summarize about contact stresses developed in a mating spur gear which has involute teeth. A pair of spur gears are taken from a lathe gear box and proceeded forward to calculate contact stresses on their teeth. Contact failure in gears is currently predicted by comparing the calculated Hertz contact stress to experimentally determined allowable values for the given material. The method of calculating gear contact stress by Hertz"s equation originally derived for contact between two cylinders. Analytically these contact stresses are calculated for different module, and these results are compared with the results obtained in modeling analysis in ANSYS.

INTRODUCTION TO SOFTWARE GENERATION

2.1 Introduction to AUTOCAD

AutoCAD is a commercial computer-aided design (CAD) and drafting software application. Developed and marketed by Autodesk

AutoCAD was first released in December 1982 as a desktop app running on microcomputers with internal graphics controllers. Before AutoCAD was introduced, most commercial CAD programs ran on mainframe computers or minicomputers, with each CAD operator (user) working at a separate graphics terminal. Since 2010, AutoCAD was released as a mobile- and web app as well, marketed as AutoCAD 360.

AutoCAD is used across a wide range of industries, by architects, project managers, engineers, graphic designers, town planners and many other professionals. It was supported by 750 training centers worldwide in 1994.

2.2 Introduction To CATIA

CATIA (Computer Aided Three-dimensional Interactive Application) is a multi-platform CAD/CAM/CAE commercial software suite developed by the French company Assault Systems. Written in the C++ programming language, CATIA is the cornerstone of the Assault Systems product lifecycle management software suite. CATIA competes in the CAD/CAM/CAE market with Siemens NX, Pro/E, Autodesk Inventor, and Solid Edge as well as many others.

2.2.1 History Of Catia

CATIA started as an in-house development in 1977 by French aircraft manufacturer Avions Marcel Dassault, at that time customer of the CADAM CAD software to develop Dassault's Mirage fighter jet, then was adopted in the aerospace, automotive, shipbuilding, and other industries. Initially named CATI (Conception Assisted Tridimensional Interactive - French for Interactive Aided Three-dimensional Design) - it was renamed CATIA in 1981, when Dassault created a subsidiary to develop and sell the software, and signed a non-exclusive distribution agreement with IBM. Developer(s) Dassault`s Systems Stable release V6R2011x / November 23, 2010 Operating system Unix / Windows Type CAD software License Proprietary Website WWW.3ds.com

In 1984, the Boeing Company chose CATIA as its main 3D CAD tool, becoming its largest customer. In 1988, CATIA version 3 was ported from mainframe computers to UNIX. In 1990, General Dynamics Electric Boat Corp chose CATIA as its main 3D CAD tool, to design the U.S. Navy's Virginia class submarine. In 1992, CADAM was purchased from IBM and the next year CATIA CADAM V4 was published. In 1996, it was ported from one to four UNIX operating systems, including IBM AIX, Silicon Graphics IRIX, Sun Microsystems SunOS and Hewlett-Packard HP-UX. In 1998, an entirely rewritten version of CATIA, CATIA V5 was released, with support for UNIX, Windows NT and Windows XP since 2001. In 2008, Dassault announced and released CATIA V6. While the server can run on Microsoft Windows, Linux or AIX, client support for any operating system other than Microsoft Windows is dropped.

2.2.2 Release History

Name/Version Latest Build Number Original Release Date Latest Release Date CATIA v4 R25 1993 January 2007 CATIA v5 R20 1998 February 2010 CATIA v6 R2012 29/05/2008 May 2011 SUPPORTED OPERATING SYSTEMS AND PLATFORMS CATIA V6 runs only on Microsoft Windows and Mac OS with limited products. CATIA V5 runs on Microsoft Windows (both 32-bit and 64-bit), and as of Release 18Service Pack4 on Windows Vista 64.IBM AIX, Hewlett Packard HP-UX and Sun Microsystems Solaris are supported. CATIA V4 is supported for those Unixes and IBM MVS and VM/CMS mainframe platforms up to release 1.7. CATIA V3 and earlier run on the mainframe platforms.

2.2.3 Scope Of Application

Commonly referred to as 3D Product Lifecycle Management software suite, CATIA supports multiple stages of product development (CAD), from conceptualization, design (CAD), manufacturing (CAM), and engineering (CAE). CATIA facilitates collaborative engineering across disciplines, including surfacing & shape design, mechanical engineering, equipment and systems engineering.

SURFACING & SHAPE DESIGN: CATIA provides a suite of surfacing, reverse engineering, and visualization solutions to create, modify, and validate complex innovative shapes. From subdivision, styling, and Class A surfaces to mechanical functional surfaces.

MECHANICAL ENGINEERING: CATIA enables the creation of 3D parts, from 3D sketches, sheet metal, composites, and molded, forged or tooling parts up to the definition of mechanical assemblies. It provides tools to complete product definition, including functional tolerances, as well as kinematics definition.

EQUIPMENT DESIGN: CATIA facilitates the design of electronic, electrical as well as distributed systems such as fluid and HVAC systems, all the way to the production of documentation for manufacturing.

2.2.4 Generative Drafting

Generative Drafting is a new generation product that provides users with powerful functionalities to generate drawings from 3D parts and assembly definitions.

The Generative Drafting has been designed to show you how to generate drawings of varying levels of complexity, as well as apply dimensions, annotations and dress-up elements to these drawing.

Starting Catia : To start CATIA there may be icon on the desktop or you may have to look in start menu at the bottom of leaf of the screen windows taskbar .The program takes a while to load, so be patient the start-up is complete when your screen looks like the following figure ,which is a default CATIA screen. There are different modules in CATIA using which different tasks can be performed. The main window and modules of CATIA .

Drafting Views Front View - A front view is a projection view obtained by drawing perpendiculars from all points on the edges of the part to the plane of projection. The plane of projection upon which the front view is projected is called the frontal plane.

Projection View – Projection views are views conceived to be drawn or projected onto planes known as projection planes. A transparent plane or pane of glass representing a projection plane is located parallel to the front surfaces of the part.

Isometric View - The Isometric View command enables to create a 2D view with any orientation, this orientation being the same as the one in the 3D viewer. Among other results, and depending on how the 3D viewer is oriented when created the view, can obtain a regular X-Y-Z isometric view.

Dimensioning Generate Dimensions - To generate dimensions in one shot from the constraints of a 3D part.

Only the following constraints can be generated: distance, length, angle, radius and diameter.

Dimensions- To create and modify dimensions. These dimensions will be associative to the elements created from a part or an assembly. When created, these elements are associated with a view.

2.3 Introduction to ANSYS

ANSYS is universally useful limited component investigation (FEA) programming bundle. Limited Element Analysis is a numerical technique for deconstructing a mind boggling framework into little pieces (of client assigned size) called components. The product executes conditions that administer the conduct of these components and illuminates them all; making an extensive clarification of how the framework goes about overall. These outcomes at that point can be introduced in arranged or graphical structures. This sort of investigation is regularly utilized for the outline and advancement of a framework extremely complex to break down by hand. Frameworks that may fit into this class are excessively mind boggling due, making it impossible to their geometry, scale, or representing conditions. ANSYS is the standard FEA showing instrument inside the Mechanical Engineering Department at numerous schools. ANSYS is likewise utilized as a part of Civil and Electrical Engineering, and additionally the Physics and Chemistry divisions. ANSYS gives a financially savvy approach to investigate the execution of items or procedures in a virtual domain. This kind of item advancement is named virtual prototyping. With virtual prototyping procedures, clients can repeat different situations to streamline the item well before the assembling is begun. This empowers a lessening in the level of hazard, and in the cost of inadequate plans. The multifaceted idea of ANSYS additionally gives a way to guarantee that clients can see the impact of a plan in general conduct of the item, be it electromagnetic, warm, mechanical and so on.

Generic Steps To Taking Care Of Any Problem In Ansys: Like taking care of any issue diagnostically, you have to characterize (1) your answer space, (2) the physical model, (3) limit conditions and (4) the physical properties. You at that point take care of the issue and present the outcomes. In numerical techniques, the fundamental distinction is an additional progression called work era. This is the progression that partitions the unpredictable model into little components that wind up plainly feasible in a generally excessively complex circumstance. Beneath portrays the procedures in phrasing marginally more adjust to the product.

Build Geometry : Build an a few dimensional portrayal of the protest be demonstrated and tried utilizing the work plane directions framework inside

Ansys Define Material Properties: Since the part exists, characterize a library of the fundamental materials that make the question (or venture) being displayed. This incorporates warm and mechanical properties.

Generate Mesh: Now ANSYS comprehends the cosmetics of the part. Presently characterize how the displayed framework ought to be separated into limited pieces.

Apply Loads: Once the framework is completely composed, the last assignment is to trouble the framework with imperatives, for example, physical loadings or limit conditions.

Obtain Solution: This is really a stage, in light of the fact that ANSYS needs to comprehend inside what state (enduring state, transient… and so on.) the issue must be illuminated.

Present The Results: After the arrangement has been gotten, there are numerous approaches to display ANSYS' comes about, browse numerous choices, for example, tables, charts, and shape plots.

SPECIFIC CAPABALITIES OF ANSYS

Thermal Analysis: ANSYS is equipped for both consistent state and transient examination of any strong with warm limit conditions. Unfaltering state warm examinations ascertain the impacts of relentless warm loads on a framework or part. Clients regularly play out a relentless state examination before doing a transient warm investigation, to help build up introductory conditions. An enduring state investigation likewise can be the last stride of a transient warm examination; performed after every single transient impact have reduced. ANSYS can be utilized to decide temperatures, warm angles, warm stream rates, and warmth fluxes in a protest that are caused by warm loads that don't shift after some time. Such loads incorporate the accompanying: • Convection • Radiation • Heat stream rates • Heat fluxes (warm stream per unit territory) • Heat era rates (warm stream per unit volume) • Constant temperature limits An enduring state warm examination might be either straight, with steady material properties; or nonlinear, with material properties that rely upon temperature. The warm properties of most material change with temperature. This temperature reliance being calculable, the examination ends up plainly nonlinear. Radiation limit conditions additionally make the investigation nonlinear. Transient counts are time ward and ANSYS can both explain appropriations and in addition make video for time incremental presentations of models.

Fluid Stream Analysis : The ANSYS/FLOTRAN CFD (Computational Fluid Dynamics) offers extensive instruments for dissecting two-dimensional and three-dimensional liquid stream fields. ANSYS is equipped for Demonstrating a tremendous scope of investigation sorts, for example, airfoils for weight examination of plane wings (lift and drag), stream in supersonic spouts, and mind boggling, three-dimensional stream designs in a pipe twist. What's more, ANSYS/FLOTRAN could be utilized to perform errands including:

- Calculating the gas weight and temperature dispersions in a motor ventilation system • Studying the warm stratification and separation in funneling frameworks • Using stream blending concentrates to assess potential for warm stun.
- Doing normal convection examinations to assess the warm execution of chips in electronic nooks.
- Conducting heat exchanger ponders including distinctive liquids isolated by strong locales FLOTRAN investigation gives a precise approach to compute the impacts of liquid streams in complex solids without using the run of the mill warm exchange similarity of warmth flux as liquid stream. Sorts of FLOTRAN investigation that ANSYS can perform include:
- Laminar or Turbulent Flows

- Thermal Fluid Analysis
- Adiabatic Conditions
- Free surface Flow
- Compressible or incompressible Flows
- Newtonian or Non-Newtonian Fluids
- Multiple species transport
- NOTE: These sorts of investigations are not totally unrelated. For instance, a laminar investigation can be warm or adiabatic. A turbulent examination can be compressible or incompressible.

Computational Fluid Dynamics: Computational fluid dynamics (CFD) is a branch of fluid mechanics that uses numerical analysis and data structures to solve and analyze problems that involve fluid flows. Computers are used to perform the calculations required to simulate the interaction of liquids and gases with surfaces defined by boundary conditions. With high-speed supercomputers, better solutions can be achieved. Ongoing research yields software that improves the accuracy and speed of complex simulation scenarios such as transonic or turbulent flows. Initial experimental validation of such software is performed using a wind tunnel with the final validation coming in full-scale testing

Methodology: In all of these approaches the same basic procedure is followed.

- During preprocessing the geometry and physical bounds of the problem can be defined using computer aided design (CAD). From there, data can be suitably processed (cleaned-up) and the fluid volume (or fluid domain) is extracted.
- The volume occupied by the fluid is divided into discrete cells (the mesh). The mesh may be uniform or non-uniform, structured or unstructured, consisting of a combination of hexahedral, tetrahedral, prismatic, pyramidal or polyhedral elements.
- The physical modeling is defined – for example, the equations of fluid motion + enthalpy + radiation + species conservation, Boundary conditions are defined. This involves specifying the fluid behaviour and properties at all bounding surfaces of the fluid domain. For transient problems, the initial conditions are also defined.

- The simulation is started and the equations are solved iteratively as a steady-state or transient.
- Finally, a postprocessor is used for the analysis and visualization of the resulting solution.

Analysis: A finite element model with a segment of three teeth is considered for analysis. Let point load of 200 N of gear width is applied at the tip of the gear. The boundary conditions used a program is developed in APDL (ANSYS Parametric Design Language)to automate the process of geometry creation, meshing, applying boundary conditions and displaying the results. The program reads an IGES file out from the CATIA for geometry of gear teeth, the location and size of the stress relieving features.

Let standard spur gear :

- module 2.5mm, number of teeth 17
- pressure angle 20 degrees
- radius factor 0.3 is considered for analysis.
- The gear material having modulus of elasticity equal to 2.1x105 N/mm2 and Poisson's ratio equal to 0.3 is considered for analysis.
- The FEA results of root fillet stress (without holes) are compared with the stress calculated using the gear rating calculation procedure specified in AGMA standards.
- The FEA results are found to be in close agreement with the calculated stresses based on AGMA standards for the specific geometric configuration of the gear.

Therefore the results that fallow are given more credibility. The convergence of the results is confirmed by experimenting with, altering grid density and monitoring difference in the displacement of a point at the tip of the gear on centerline of the gear for each conjugative trial.

RESULTS AND DISCUSSIONS

From the above data it is found that the maximum principal stress at root fillet is136.716N/mm² without any stress relieving features .Various cases are considered for analysis choosing different values of hole position and diameter .Analysis reveals that the case with a circular hole having position of the hole is x=30,y=60 and diameter=3shows the greater benefit in comparison with other cases by reducing stress at root fillet to133.36 N/mm². As the location of stress relieving feature approaches the high stress gradient zone up to a certain value, the results are found to be beneficial. Later on the benefit to the change in size of the stress relieving feature. A careful selection of more than one location for

CONCLUSION

By creating hole in the gear, we can alter stress in the gear. Stress reduction is neither directly nor inversely proportional to the Stress Relief Hole Diameter. Stress Reduction is neither directly nor inversely proportional to the position of the stress relief hole. Horizontal shift of the hole position has larger effect on the stress value then the vertical shift. Better results on stress reduction, were observed on the negative side of the load point, for each tooth by optimizing the diameter and position of the stress relief hole, we can reduce the stress value in a gear tooth by a considerable amount, without affecting the functioning of the gear.

(