ANALYSIS ON SPUR GEAR CUTTING ATTACHMENT TO LATHE

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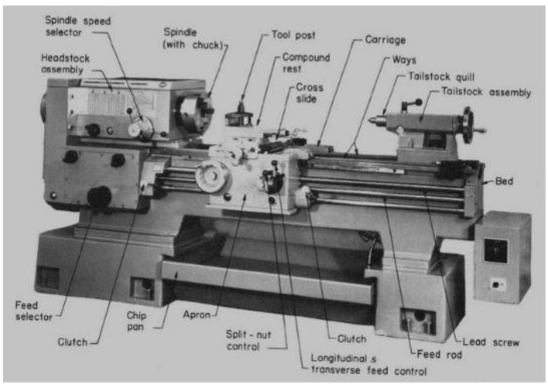
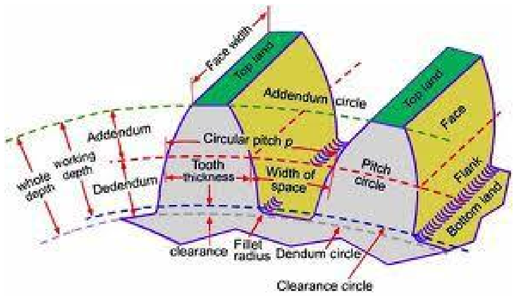
Abstract—
Today, Gears are extensively used in power transmission, but spur gears are used for connecting machine parts with parallel axis. In the present work, I made an attempt to analysis an attachment for a gear cutting for a medium duty lathe. This attempt will reduce the investment for medium and small scale industries, sub sequently reduce the manufacturing cost of gears. The attachment was carefully designed after studying the proper mechanisms, power requirements and force analysis on work material and a cutting tool. The multi point cutting tool is also redesigned according to our requirements. The analyses of various parts were carried out by ANSYS 13.0 and the results were satisfaction and within the allowable region or safe limits. The fabricated model was very successful in performing the desired gear cutting on medium duty lathe. We were succeeded in gear cutting a soft material like Al, Brass and Mild Steel.

There are some limitations with this attachment, when we made an attempt to cut hard materials like EN36. We observed failure of cutting tool. The limitation even extended to PCD of a gear also. The Permissible PCD of the gear is up to 30mm
Keywords: Gear, Spur, Attachment, ANSYS

I. Introduction

The lathe is one of the oldest machine tools and is to remove metal from a piece of work to give it the required shape and size. The lathe machine used for the project is centre lathe, a lathe consists of a bed, a head stock, a carriage with a cross slide, and a tool post mounted on the cross slide. The spindle which carries the work holding device is driven by a motor usually through a gear box for obtaining various speeds. The carriage moves on the bed guide ways, parallel to the axis of the work spindle, and the cross slide provides the transverse motion. The required power for the movements is obtained through a feed shaft geared to the spindle drive. Lathes are designed in a variety of versions to suit different applications. They are also produced in different precision classes and in different sizes. The cutting speed, feed, and depth of cut is adjusted accordingly on the lathe machine. The various cutting speeds can be adjusted by changing the lever on the lathe. The recommended feed rates are given on the machine. Depth of cut can be adjusted on the tool post. Instructions are followed from the lathe manual.





Types of Gears

1. External vs. Internal Gears

The above attachment is successful in producing gears made from soft materials which will be helpful for medium and small scale industries.

An external gear is one with the teeth formed on the outer surface of a cylinder or cone. An internal gear is one with the teeth formed on the inner surface of a cylinder or cone

2. Spur Gears

Spur gear consists of cylinder or disk with the teeth projecting radially, and although they are not straight-sided in form, the edge of each tooth is straight and aligned parallel to axis of rotation.

3. Helical Gears

The Helical gear edges of the teeth are not parallel to the axis of rotation, but are set at an angle. Since the gear is curved, this angling causes the tooth shape to be a segment of a helix.

4. Double Helical Gears

A double helical gear can be thought of as two mirrored helical gears joined together. However, double helical gears are more difficult to manufacture due to their more complicated shape.

5. Bevel Gears

A bevel gear is shaped like a right circular cone with most of its tip cut off.

6. Spiral Bevels Gears

Spiral bevel gears have curved teeth at an angle allowing tooth contact to be gradual and smooth.

7. Hypoid Gears

Hypoid gears resemble spiral bevel gears except the shaft axes do not intersect. The pitch surfaces appear conical but, to compensate for the offset shaft, are in fact hyperboloids of revolution. Hypoid gears are almost always designed to operate with shafts at 90 degrees.

8. Worm Gears

Worm gears can be considered a species of helical gear, but its helix angle is usually somewhat large (close to 90 degrees) and its body is usually fairly long in the axial direction.

9. Rack and Pinion Gears

A rack is a toothed bar or rod that can be thought of as a sector gear with an infinitely large radius of curvature. Torque can be converted to linear force by meshing a rack with a pinion: the pinion turns; the rack moves in a straight line.

10. Epicyclic Gears

In epicyclic gearing one or more of the gear axes moves.

11. Sun and Planet Gears

Sun and planet gearing was a method of converting reciprocating motion into rotary motion in steam engines.

12. Harmonic Drive Gears

A harmonic drive is a specialized gearing mechanism often used in industrial motion control, robotics and aerospace for its advantages over traditional gearing systems, including lack of backlash, compactness and high gear ratios.

13. Differential Gears

Differential gears are referred to an arrangement of gears, connecting two axles in the same line and dividing the driving force between them. One axle is allowed to turn faster than the other.

II. Literature Review

type of gear under a specified set of working conditions. It divided into three sections. It described the logic involved in the design of each of these modules. Ajoy Kumar Das [6] established the degree of heredity of the preceding machining error and the locating surface error on the machining error of the corresponding operation. The object under investigation was a spur gear being produced under mass-production conditions. Patel K.P. [7] attempted to introduce how Taguchi parameter design could be used in identifying the significant processing parameters and optimizing the surface roughness of end-milling operations.

W. K. Luk [8] emphasized the importance of normal clearance angles and proposed a modified Normal Rake System using the normal clearances angles. M. Zadshakouyan

[9] presented the precision heading process of spur gears has been investigated by means of numerical analysis. The effect of some parameters such as teeth number and module on the forming force and material flow. A. Bhattacharyya [10] presented the exacting demands for producing accurate gears make it necessary to determine the cutting forces coming on the hob-shaft which is the weakest element subjected to severe bending and torsion. A. Bhattacharyya [10] with the help of a specially designed hobbing dynamometer, have investigated the magnitude and nature of the tangential and radial component of cutting force during the conventional hobbing process.

Structural analysis on a high speed helical gear used in marine engines, have been carried out by B.Venkatesh [11]. The dimensions of the model have been arrived at by theoretical methods. The stresses generated and the deflections of the tooth have been analyzed for different material by B.Venkatesh [11]. Hob offset has shown to be an effective way to balance the dynamic response are incorporated in the process to obtain a feasible design region. Various dynamic rating factors were investigated and evaluated by Tuan Nguyen [12]. Models were presented by J.W.Sutherland [13] for end milling, face milling and cylinder boring which take into account the cutting conditions, tool geometry, workpiece geometry, and

T.Moriwaki [1] presented a comprehensive survey of system element dynamics. Furthermore, these models explicitly

multi-functional machine tools used for metal cutting, and their recognize the presence of machining process noise factors such

kinematic configurations, control and

programming as cutter runout and tool wear. The optimal design of compact

technologies. Design principles and assessment of multi- spur gear reductions includes the selection of bearing and shaft

functional machine tools are discussed mainly taking examples proportions in addition to the gear mesh parameters. Designs

of 5-axis machining centers. Evgeny Podzharov [2] presented for single mesh spur gear reductions are based on optimization

analysis of static and dynamic transmission error of spur gears of system life, system volume, and system weight including

cut with standard tools of 200 profile angle. Sachidananda HK gears, support shafts, and the four bearings reported by

[3] presented an alternate yet simple method of improving M.Savage [14].

contact strength by the way of altering the tooth-sum. Altering

the tooth-sum working between a specified center distances for The presented by Gillies Dessein [15] survey intends

a given module changes the operating pressure angle. to contribute to the identification of the speed-precision

T.T.Petry-Johnson [4] presented test methodology was relationship by highlighting the scatterings from experiences

developed for measurement of spur gear efficiency under high- led on circular interpolation cases for different speeds of

speed and variable torque conditions. Tests were conducted on displacement and radius of interpolation. From the

gears with two values of module, and two surface roughness experimental results, the quantified influences for the different

levels, operating in a dry sump jet-lubrication environment with cases can be corrected directly in the NC code program. The three different gear lubricants.

generalisation of the methodology can be applied to any

surfaces and integrated in the development of a CADCAM

G. Madhusudan [5] presented the attempts are made to post-processor taking in account the machine behaviour.

prepare a computer program capable of designing a required

The present work focuses on to design, analysis and fabricate an attachment for a gear cutting for a medium duty lathe. This attempt will reduce the investment for medium and small scale industries, sub sequently reduce the manufacturing cost of gears.

III. Analysis

ANSYS is commercial finite-element analysis software with the capability to analyse a wide range of different problems. ANSYS runs under a variety of environments, including IRIX, Solaris, and Windows NT. Like any finite-element software, ANSYS solves governing differential equations by breaking the problem into small elements. The governing equations of elasticity, fluid flow, heat transfer, and electro-magnetism can all be solved by the finite element method in ANSYS. ANSYS can solve transient problems as well as nonlinear problems.

Regardless of the type of problem involved, an ANSYS analysis consists of the same steps: modelling, meshing, solution, and post processing. The modelling phase entails geometry definition. This is where you draw a 2D or 3D representation of the problem.

During the meshing phase you will define material properties and choose a finite element suitable for the problem. The last step of the meshing phase is to discretize the model.

Create the mesh. In the solution phase, boundary conditions and loads need to be defined. The types of loads and boundary conditions you select depend on the simplifications being made. ANSYS will then attempt to solve the system of equations defined by the mesh and boundary conditions. Finally, when the solution is complete, you will need to review the results using the post processor. These results may be colour contour plots, line plots, or simply a list of DOF results for each node.

In ANSYS the gear cutting attachment to lathe is considered as a problem of simply supported beam with point load. By using ANSYS the maximum displacement and maximum stress value can be determine on the wormwheel shaft.

The steps are followed in Analysis are:

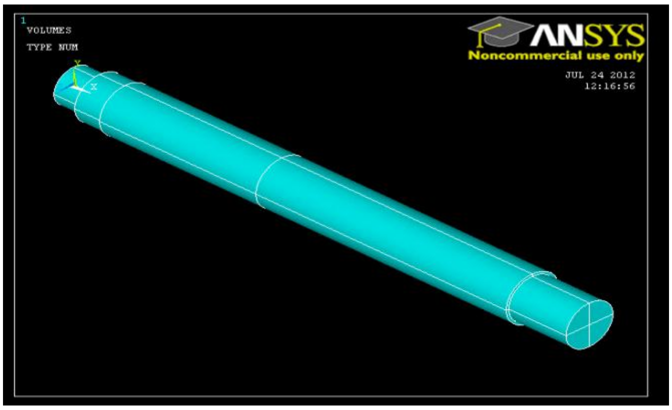
1. Create the model of the shaft.

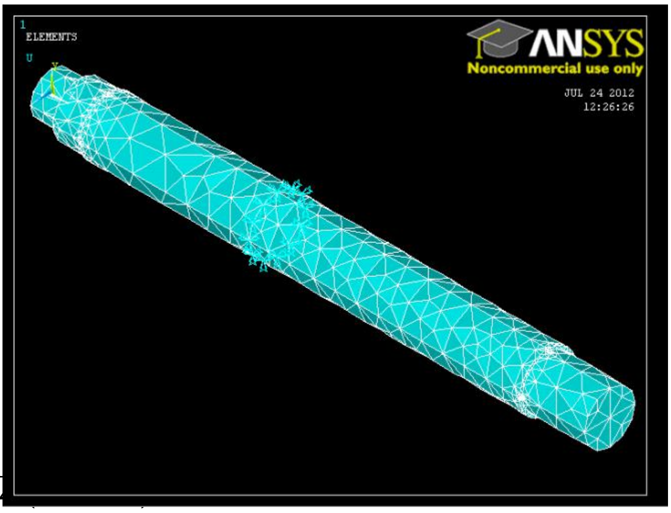
2. Meshing the shaft

3. Apply the loads on the shaft.

4. Solve the problem

5. See the results.





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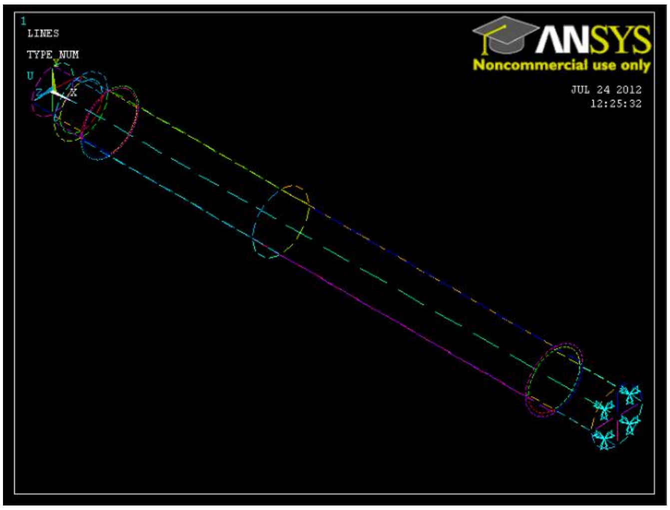

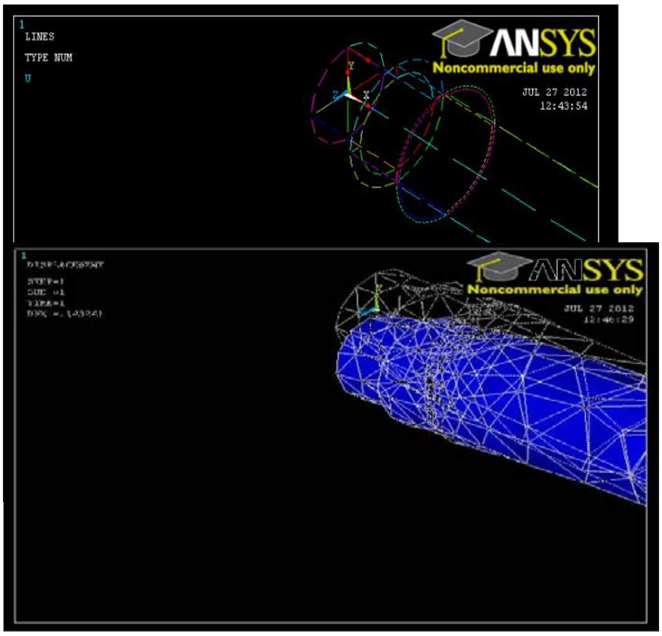

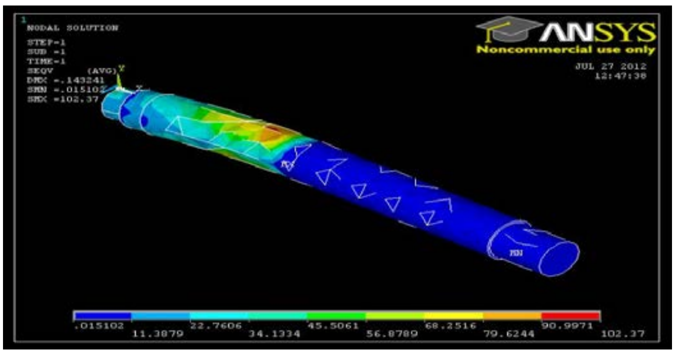

IV. Mechanism of Gear Cutting Attachment to Lathe

First remove the compound slide from lathe and the attachment is fixed on the cross slide with bolts and nuts. The cutter is tightened to the mandrel with the nut. Now the mandrel is placed in the head stock of the lathe. The workpiece is placed on the work piece and tightened that. The operation is started by switch on lathe. The mandrel is rounded around itself and its cuts the workpiece. According to mathematically calculation of Index plate workpiece is adjusted. This operation is continued till the output gets.

V. Conclusion:

1. The medium duty centre lathe of standard power

2. 5kw is capable of cutting spur gears.

2. Analysis proved that the standard medium duty centre lathe is capable of taking loads and displacements generated, while machining work material such as Aluminium and Brass.

3.Ansys is a useful tool for analysing machining problems, the max displacement observed was 0.14mm and stress magnitude of 102.37N/mm2.

4.Gears upto a diameter of 30mm and module between 1 to 2 can be generated

5.The profile comparison proved the quality obtained is comparable to milling.

6.The attachment can be up graded for machining mildsteel gears.

7.The manufacturing cost of gear may be reduced by this method which will be helpful to small and medium industry.

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