To Development of Design and Analysis of Spur Gear (And Bevel Gear) Forming by Using Conventional Lathe

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Abstract - Spur gear is produce with the help of conventional lathe and also it will be aid to mass production possibility. The gear forming method is also used to internal and external type of gear generate. This type of gear forming process to no need of indexing head, flushing of chip removal system, cooling system, free of complexity operation and to eliminate the parametric design difficulties. In the gear forming process is resembles to the knurling operation. In the gear forming tools is to be similar shape and dimensions of Spur gear. This forming tool is constantly pressed against the rotating cylindrical job. Each passes (feed) the form tool travel by whole length of job for simultaneously tool rotates. The form tool having three steps of gradually forming teeth. First stage teeth is V-shaped notch make on the work piece surface is primarily creating as per the requirement number of teeth. Then, second stage teeth of tool is to be intermediate dimensions of the gear and final stage of form tool teeth has to be original dimensions of gear teeth. Thus, the gear form tool teeth impression creates on the job surface to full depth of teeth forming. In the method is generally utilized to fine and medium depth and pitch forming and mass production of conventional lathe machine by economically increased in the GFT design.

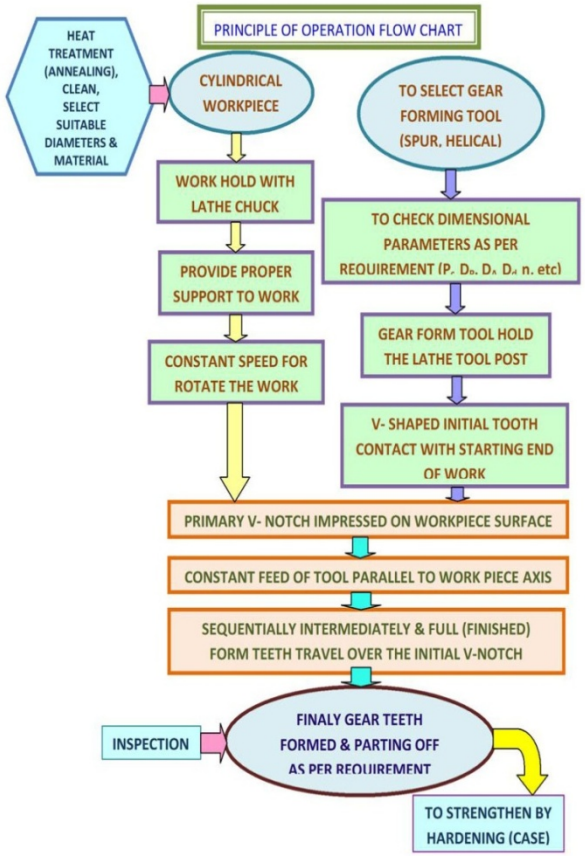
Keywords: force, teeth, speed, form, chip less, mass production.

I. INTRODUCTION

In the gear forming method is a gear producing process for entire length of cylindrical job by single or multiple pass feed the forming tool. The single pass feed is enough to fine depth and space thickness of gear generation. Such as the multiple passes feed is utilize to high depth of gear forming and hardened materials. Also, after finishing the forming of gear is strength level increase than before forming the cylindrical work piece of strength condition. Hardened steel material is heat treatment of annealing to take before forming the work piece material. Thus the conversion of softened work piece material is bringing easy to impression on the surface of work.

Finally obtained from the shape of gear is high surface finish. Also, no need the grinding or other finishing of the flank, root, fillets of gear tooth etc. Important parameters of the gear forming process are following consideration a) selection the work piece diameter according to the gear form tool specifications, b) selection of material and pre heat treatment (annealing), c) To select support, depth adjustment, feed, and parting off, d) final stage of heat treatment of hardening (case hardening). In the GF method of forming gear materials are steel, bronze, alloy steel, aluminum and its alloy, phosphor bronze, and more non metallic materials, etc,.

II. METHODOLOGY



Selection of Work-piece Parameter:

Selection (before teeth forming) of work piece diameter = PCD of finished gear + Tolerance

Actual selection of work piece outer diameter for before form the gear teeth is determine to require geometric size of gear in pitch circle diameter. Herewith the tolerance ranges are varies along from types of work piece material, types of form tool material, physical properties, material extrusion capability of material, etc.

Selection of Gear Form Tool:

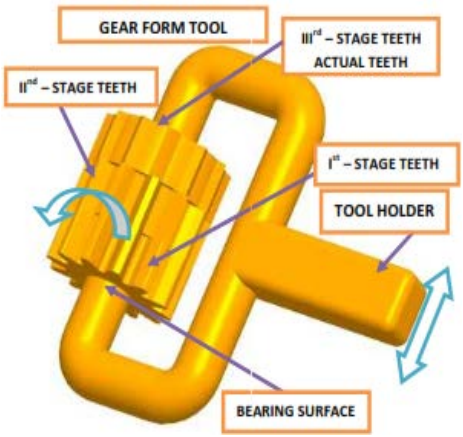
The gear forming tool selection is similar to required geometrical size and shape of work piece. But the GFT of pitch circle diameter, OD, ID, and number of teeth only vary from the work piece. Other parameters are not changed like as module, circular pitch, teeth thickness, tooth flank angle, standard ratio (i), fillet of teeth, etc,.

The gear form tool has to be hardness, toughness, low wear rate of material is higher than that of work piece. Such reasons belong to create impression on the work piece surface produce by easy.

When the rotational friction force with crushing load and linear feed force lead to affect gear form tool life. So, in this problem rectified by using roller bearing to support between the gear form tool and work piece. Thus the gear form tool is prevent from the back lash.

First and second stages of teeth is used to guide the final stage of teeth. The first stage teeth is V- shape notch for 1:3 of actual dimensional gear teeth. Second stage teeth has to be 2:3 time of gear dimension and final stage of teeth has 3:3 time of gear dimension. In the reason is mainly guide to easiest formation of gear.

GF-Tool Major Parts:



III. DESIGN CALCULATIONS OF SPUR GEAR FORM TOOL

Standard ratio (i) = Z_1/Z_2, z_1=12, z_2=38, a=75mm.

Design Parameters	Formulas	Results Based From Values -i, z_1, z_2, a
Module	(m) = 2a / (z_1+z_2)	=2*75/(12+38)=3mm,
Height factor	fo	= 1
Bottom clearance	c= 0.25 m	=0.25* 3 = 0.75mm
Tooth depth	h = 2.25 m	=2.25 * 3 =6.75 mm
Pitch circle diameter	d1 = m*Z1 d2 = m*Z2	= 3*12 = 36mm, = 3*114 = 114mm
Numbers of teeth	Z1 = 2*a/m(i+1), Z2= i*Z1	= 2*75/3(3.16+1)=12, Z2= i*Z1 = 38
Tooth thickness	= 1.5708m	= 4.71mm,
Fillet	= 0.38m	= 1.14mm,
Tip diameter	d_1 = (Z_1+2f_O)*m, d_2 = (38+2*1)*3	= (12+2*1)*3=42mm, = 120mm,
Root diameter	d_1 =(Z_1-2f_O)*m–2c d_2 =(Z_2-2f_O)*m–2c	= (12-2*1)*3 – 2*0.75 = 28.5mm, = (38-2*1)*3 – 2*0.75 =106.5mm

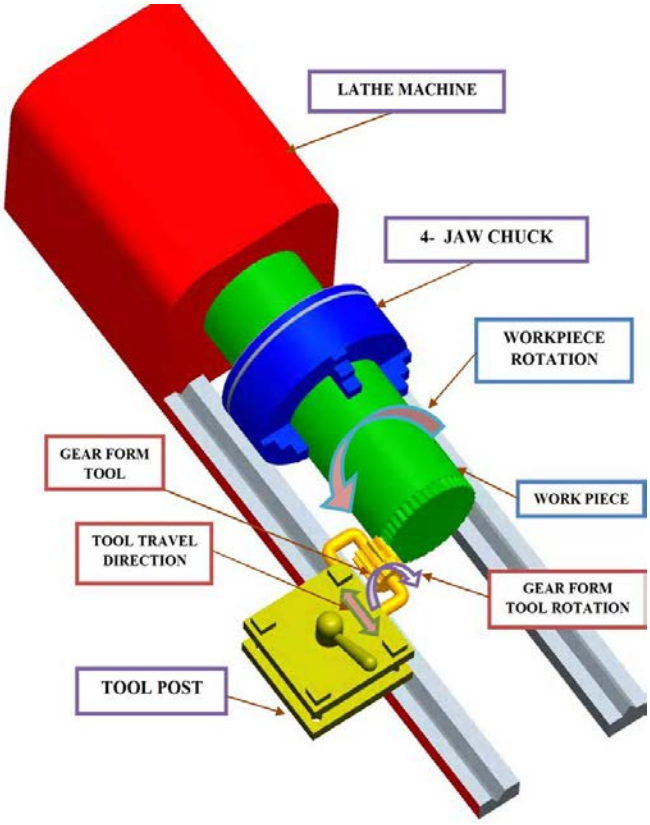
Here, suffix – 1 is indicate the gear form tool and 2 - is indicated to gear

Selection of Form Tool Material Characters and Its Types:

The gear form tools of must required properties of hardness, wear resistance, toughness, impact strength, resilience, stiffness, high strength, thermal conductivity, low co-efficient of friction. In the properties are changes from one material to other material. So, it will be selection of tool materials varies from different applications. Major reasons of factors is cost of tool material, work piece material, production cost, tool life, speed of operation, etc,. The form tool materials are following as carbon steel, tool steel, cemented carbides, ceramic tools, etc,.

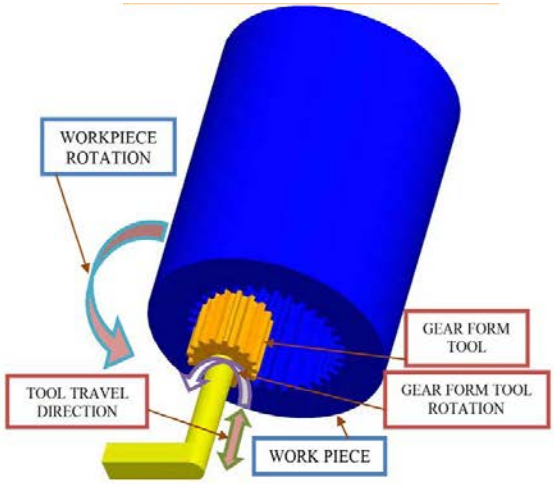
External Gear Forming Method:

In the external gear forming method working principle is more suitable to the continuous and moderate production lines of recent industries. Reasons for the method is adoptable to manual, semi and full automated of involvement. The work piece is rotated with the help of work holding chuck of lathe. Then the gear forming tool is hold with the help of tool post. Thus the form tool gradually approach with work piece towards in simultaneously take linear and rotational motions of the method of operation. Finally the gear form tool impression creates on the work piece surface.



Internal Gear Forming Method:

Internal gear forming by the method is manual, semi or automatic system may be using the conventional lathe machine. The method is explanation shown by following figure.



Application:

Internal Gear Forming,

External gear Forming, Spline shaft Forming, etc,.

Procedure of Analysis:

Step: 1 (Design & Import)

First of all, we have prepared assembly in Pro/E for spur gear & save as this part as IGES. Then ansys workbench explicit analysis of geometry environment to import the save IGES file.

Step: 2 (Engineering Data of Design)

To select work piece and form tool material respectively aluminium & steel 1006. Here, the two materials properties available for default as density, youngs modulus, poission ratio, tensile strength, etc,.

Step: 3 (Model Setting)

Unit setting as meter and assigning material to work piece & form tool.

Step: 4 (Connections)

Body interaction – Trajectory, penalty, frictionless and other values are default.

Step: 5 (Mesh)

Element is Quadratic tetrahedron and size = 3e-3m, nodes = 103518, elements = 97705.

Step:6 (Analysis setting & Boundary conditions)

Analysis setting is the end time = 6e-4s,automatic mass scaling = No, Solve units = mm,mg,ms. Boundary condition to select fixed support and initial condition.

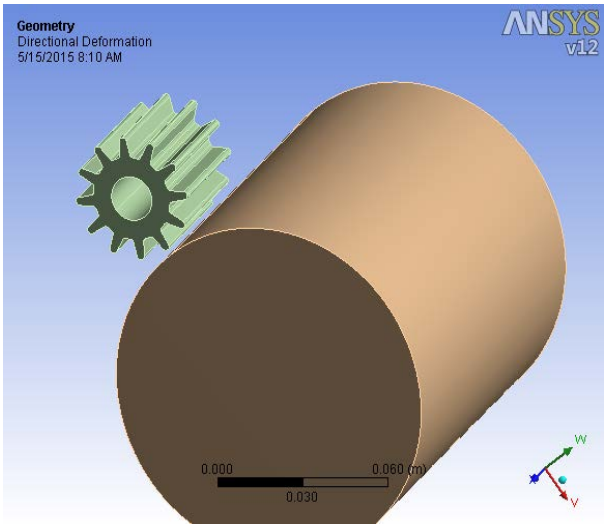
Step: 7 (Solution)

To select from solution-insert-1) deformation-total deformation,2) stress-equivalent (von-Mises),3) strain – Equivalent plastic, 4) directional deformation.

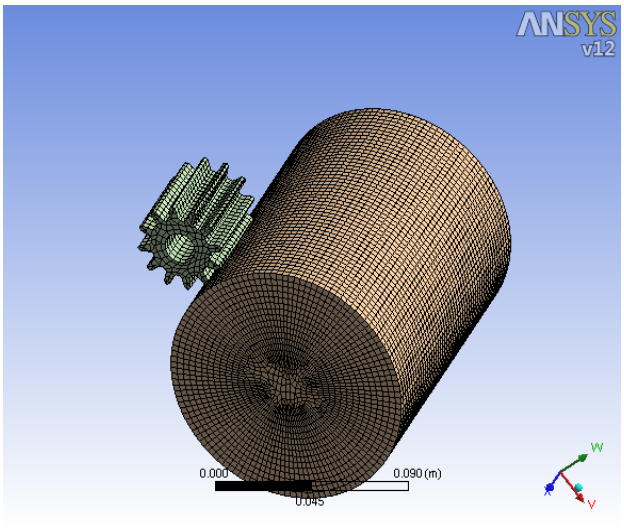
Step: 8 (solve)

Finally all resulted values are evaluated by the solve step.

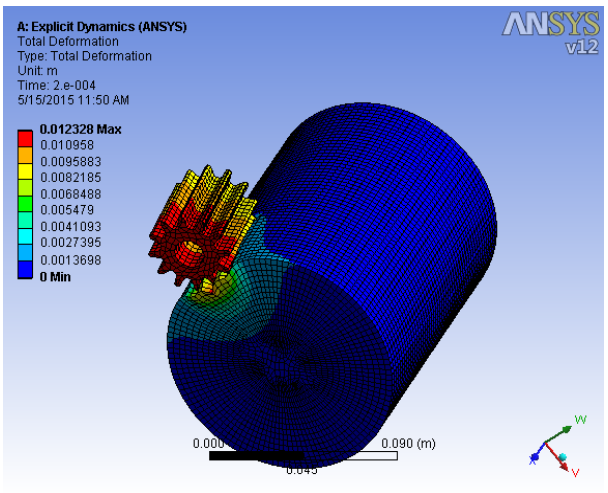
Part Assembled Design:



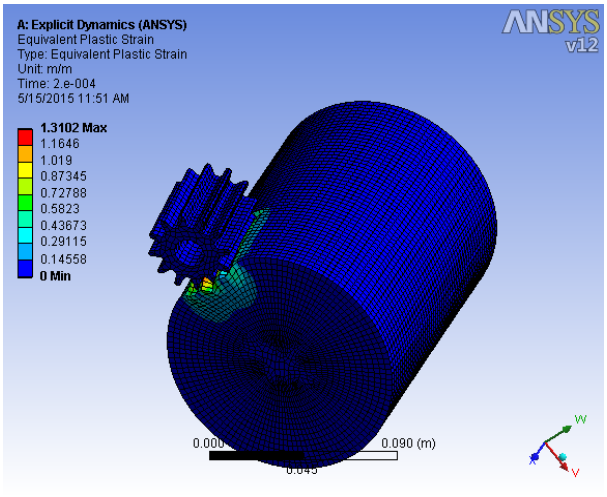
Mesh:



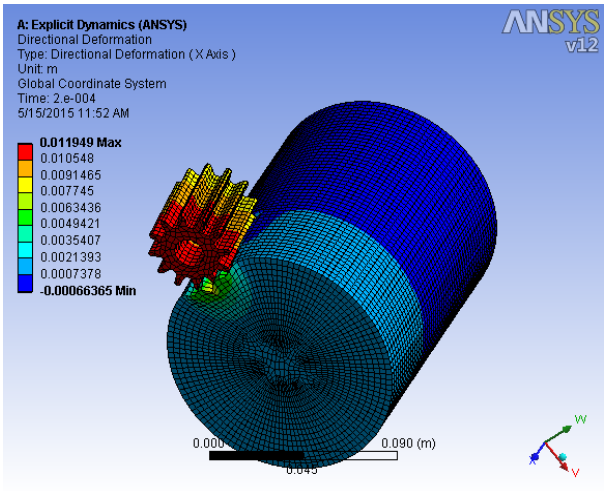
Total Deformation:



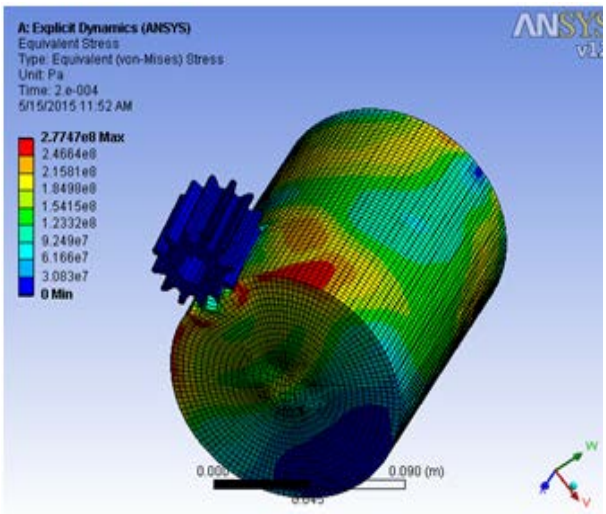
Equivalent Plastic strain:



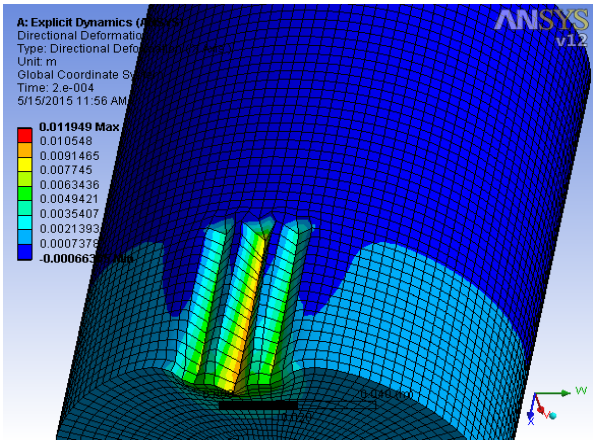
Directional Deformation:



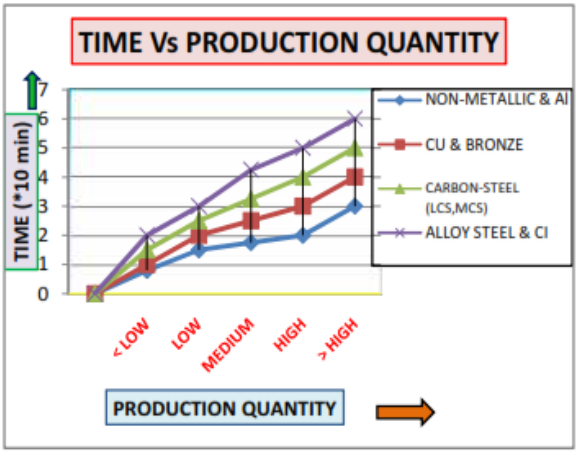
Equivalent Stress(von-mises):



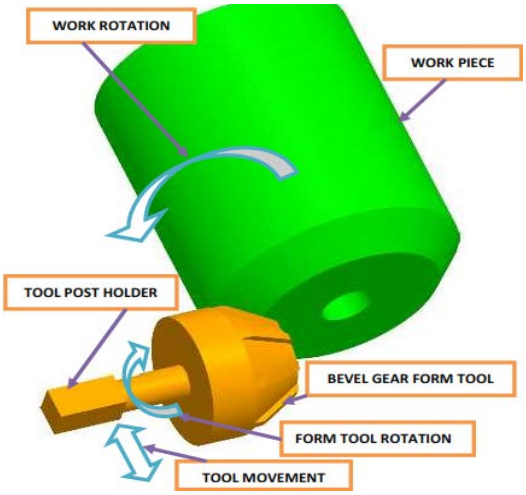
Gear Teeth Initial Impression Created on Work piece Surface:



Graphical Analysis:



The graphical analysis is provide to conditions of carbide form tool material, spur type gear teeth form, total depth is 6mm. in the productivity is increases for softened as low time consuming possibility. But, hard and brittleness materials to take more time consuming for production quantity to increasing possibility.



Future Design Development of GFT:

The gear forming concept is also implement to bevel gear generate by using conventional lathe. This possible of design given below shown in figure. Here, GF Tool is impressed on the cylindrical work piece face along by means of feed through parallel axis of work piece. Such as work and bevel GF tool rotate by form the teeth then the bevel gear is require dimensions to parting off.

IV. CONCLUSION

The gear forming method of gear production is faster than gear generation method. When the gear forming is more surface finish, accuracy, strengthening, wear resisting, etc,. In the gear forming method is more suitable to softened materials. So, high hardened steels to provide the heat treatment (annealing) along by means of softening condition. Then the softening steel surface by impression creates with the help of gear forming and after that the work piece to take the hardening or case hardening heat treatment. In the gear forming is a chip less process. So, without waste of material removal from the forming method and no need in the flushing system, cooling system. Cost of investment and production is well economically. Time consuming rate is lower than other gear manufacturing process. The gear forming methodology applicable to helical gear teeth forming and bevel gear teeth forming. Also internal gear teeth forming is possible for easy. Thus the above special features causes lead to design the GFT.

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