Stress Analysis of Spear Gear

Umar Mukhtar , Veeyan Sequeira, Shriram Pai, Sampath Naik

*[1]Department of CSE, SJEC, Mangaluru, Karnataka, India
21j56.umar@sjec.ac.in
[2]Department of CSE, SJEC,Mangaluru,Karnataka, India
21d59.veeyan@sjec.ac.in
[3]Department of CSE, SJEC, Mangaluru, Karnataka, India
21j47.shriram@sjec.ac.in
[4]Department of CSE, SJEC,Mangaluru,Karnataka, India
21j41.sampath@sjec.ac.in

ABSTRACT

This document provides some minimal guidelines (and requirements) for writing a research paper. Issues related to the contents, originality, contributions, organization, bibliographic information, and writing style are briefly covered. Evaluation criteria and due dates for the research paper are also provided.

Keywords: Research Paper, Technical Writing, Science, Engineering and Technology

i.INTRODUCTION

Spur gears are the simplest and most common type of gear. Their general form is a cylinder or disk. The teeth project radially, and with these straight-cut gears, the leading edges of the teeth are aligned parallel to the axis of rotation. These gears can only mesh correctly if they are fitted to parallel axles. The torque ratio can be determined by considering the force that a tooth of one gear exerts on a tooth of the other gear. Consider two teeth in contact at a point on the line joining the shaft axes of the two gears. The force will have both a radial and a circumferential component. Gears are a very useful simple machine.

A gear is a component within a transmission device. Transmit rotational force to another gear or device. A gear is different from a pulley in that a gear is a round wheel. Mesh with other gear teeth, allowing force to be fully transferred without slippage. Depending on their construction and arrangement, geared devices can transmit forces at different speeds, torques, or in a different direction, from the power source. Gears are a very useful simple machine. The most common situation is for a gear to mesh with another gear, but a gear can mesh with any device having compatible teeth, such as linear moving racks.

The main purpose of gear mechanisms is to transmit rotation and torque between axes. The gear wheel is a machine element that has intrigued many engineers because numerous technological problems arise in a complete mesh cycle. In order to achieve the need for high load carrying capacity with reduced weight of gear drives but with increased strength in gear transmission, design, gear tooth stress analysis, tooth modifications and optimum design of gear drives are becoming major research area. Gears with involute teeth have widely been used in industry because of the low cost of manufacturing.

ii. LITERATURE REVIEW

PINAKNATH PEWANJI., This paper analyses the bending stresses characteristics of an involute spur gear tooth under static load conditions. The tooth profile is generated using catia and analysis is carried out by ansys software. The stress at the tooth root are evaluated analytically using existing theoretical models.

ANUJ NATH ET., This paper modeled the spur gear using pro-e software. The impact analysis for cast steel and composite materials are studied. Finally comparing and analyzing the composite gears with existing cast steel gear is to be done using ANSYS 13.0.

S.MAGENDRAN, K.M.EAZHIL ., This paper modeled the spur gear using solid works software. The weight reduction and stress distribution for cast steel and composite materials are studied. Finally compare and analyzing the spur gear using ansys software.

DEVENDRA SINGH ., In this paper modeled the spur gear and study about gear drive design and analysis is carried out with the help of pro-e and ansys and improve the static and dynamic characteristics of gear drive.

I.MATERIAL PROPERTIES

Stainless steel is a highly versatile material prized for its exceptional corrosion resistance, mechanical strength, and durability. Its chromium content forms a protective layer, preventing rust and corrosion. Stainless steel's mechanical properties vary by grade, with good ductility and moderate to high hardness. It maintains its integrity across a wide temperature range and can be both magnetic and non-magnetic, depending on the alloy. Its density and moderate thermal conductivity make it suitable for various applications. Easy cleanability, aesthetic appeal, and a range of grades, such as 304 and 316, make stainless steel a vital material in industries from construction to healthcare, offering tailored solutions to diverse needs.

Table 1 . properties of stainless steel

Young's modulus	200 GPa
Poisson's ratio	0.29
Density	7870 kg/m ^{3}

II.CALCULATION

Calculation of Gear tooth properties

Pitch circle diameter (p.c.d) = z*m = 18*10 = 180mm

Base circle diameter (Db) = D cos α
= 180*cos20
= 169.145mm

Outside circle diameter = (z+2)*m
= (18+2)*10
= 200mm

Clearance = circular pitch/20
= 31.4/20 = 1.57mm

Dedendum = Addendum + Clearance
= 10+1.57 = 11.57mm

Module = D/Z = 180/18 = 10mm

Dedendum circle diameter = P.C.D -2*dedendum = 80-2*11.57= 156.86mm

Fillet radius = Circular pitch/8 = 31.4/8 = 3.9mm

Pitch circle diameter (Pc) = m*z = 10*18 = 180mm Hole depth = 2.25*m = 2.25*10 = 22.5mm

Thickness of the tooth = 1.571*10 = 15.71mm

Face width (b) = 0.3*180= 54mm

Center distance between two gears = 180mm

Diametral pitch = Number of teeth/P.C.D
= 18/180= 0.1mm

Properties of Cast Steel

Density = 7870 kg/m3
Young modulus = 200 GPa
Poisson's ratio = 0.29
Tensile strength = 518.8 MPa
Ultimate Tensile Strength = 540 MPa
Yield Tensile Strength = 415
MPa Bulk modulus = 140 GPa

III.METHODOLOGY

To analyze the stress distribution in a spur gear using ANSYS or similar finite element analysis (FEA) software, a systematic approach is essential. The process begins with a clear definition of the problem, specifying gear details, operating conditions, and constraints. Next, a 3D CAD model of the spur gear is either created or imported into ANSYS, ensuring correct scaling and orientation. Subsequently, a finite element mesh is generated for the gear model with careful consideration of mesh density and element types. Material properties, including Young's Modulus, Poisson's Ratio, and density, are defined.

Boundary conditions are then applied to simulate the gear's operating environment, involving constraints and external loads such as torque or forces. Given that spur gears are in contact, contact interactions between gear teeth must be defined, ranging from frictionless to frictional or bonded contacts. These actions create a realistic representation of the gear's operational conditions.

The analysis is initiated by configuring the solver, specifying settings such as convergence criteria, time-stepping for dynamic analyses, and solution controls. Once everything is in place, the analysis is executed, and ANSYS calculates stress distributions and deformations throughout the gear.

Post-processing follows, where the results are analyzed and visualized. The focus is on the von Mises stress distribution to assess the gear's structural integrity, with particular attention to high-stress concentration regions that may indicate potential failure points. If necessary, an iterative process may be employed, making design adjustments and rerunning the analysis.

Documentation is critical throughout this process, encompassing assumptions, boundary conditions, material properties, and key findings. Validation and verification are performed by comparing FEA results with theoretical calculations or experimental data. If optimization is part of the project, FEA results can be used to refine the gear design for enhanced performance and stress reduction. Finally, a comprehensive report is generated to summarize the analysis, its findings, and any recommendations for design enhancements. This structured methodology ensures a rigorous and effective approach to spur gear stress analysis.

IV. SIMULATION

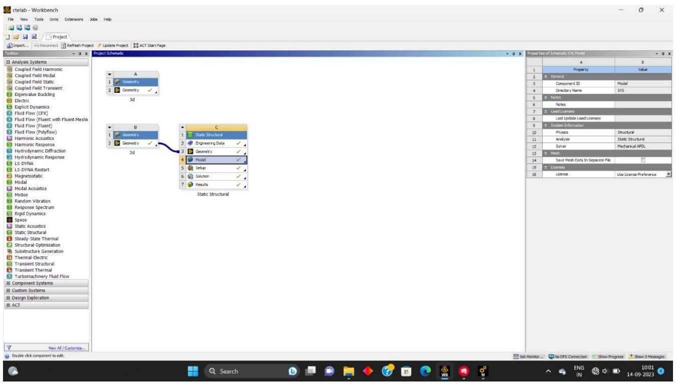

fig 3: Project schematic using static structural

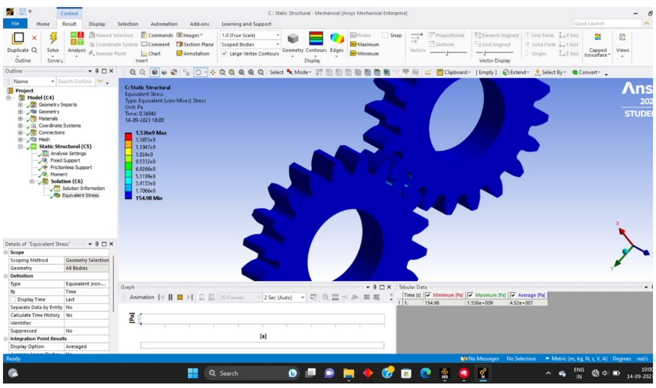

fig 4: Simulation of action of equivalent stress

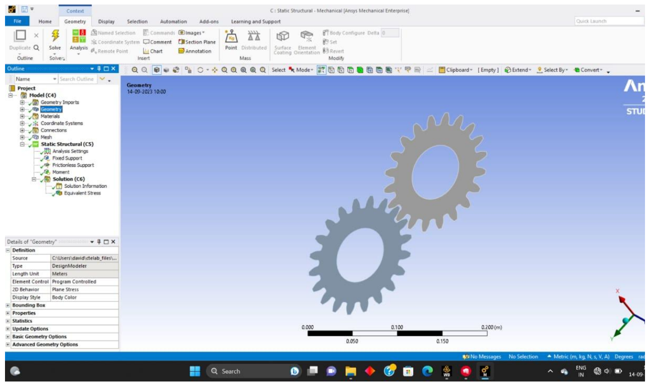

fig 1 : 2d geometry of spur gears

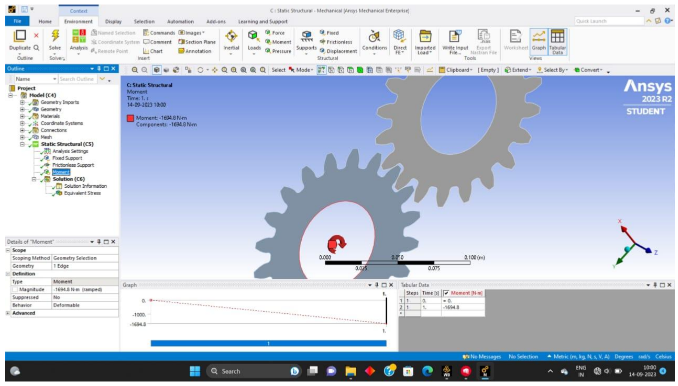

fig 2 : Application of moment on the lower gear clockwise

I. RESULT AND DISCUSSION

In the static structural analysis of Solidworks designed 2d spur gear , we used material structural steel for the spur gear, we gave 1 contact point between the tooth of gears, and we used fixed support and frictionless support on driven and driving gears.A moment equivalent to -1694.8N was applied to the driving gear during analysis.The analysis provided insights into stress levels, deformation points and strains for both gears,aiding material selection for optimal structural performance in real world applications.

II. CONCLUSION

Experimental results from testing the spur gear under moment are listed in the Table. Analysis has been carried out by optimizing the material such as carbon fiber high modulus. The results such as total deformation, equivalent elastic strain and equivalent stress for each material are determined. Comparing the optimized materials and the conventional material, carbon fiber high modulus material has the low values of total deformation, stress and strain. Hence it is concluded that carbon fiber high modulus material is suitable for the spur gear manufacturing.

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