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BENDING STRESSES AND WEAR REDUCTION IN AN INVOLUTE SPUR GEAR

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ABSTRACT

Generally teeth failure of the gear happens due to fatigue. Since the minor decrease in root bending stress results in a greater fatigue life and in turn decreases the wear. This paper shows that gear design has been improved by using better materials, optimization technique and by changing the root fillet radius. Modelling and Finite element analysis of the gear is done by CATIA V5 and ANSYS WORKBENCH respectively. Finally results are compared with each other.

Keywords— Spur gear, bending stress and optimization.

I. INTRODUCTION

Gears play a vital role in all industries. So it is important to design the gear design the spur gear with least errors and it is important to know about the stresses responsible for its failure. General modes of gear failure are fatigue, fracture and stress rupture. Gear testing helps the engineers to understand the various failures and estimation of gear life in service.

II. PROCEDURE

A. Modelling

Gear is designed by using design standards as shown intable 1.

Table 1: Gear design parameters.

Sl no	Parameters	Values
1	Module	2
2	Pressure angle	20°
3	Pitch circle radius	30 mm
4	Addendum circle radius	32 mm
5	Deddendum circle radius	28.2 mm
6	Base circle radius	27.5 mm
7	Face width	28 mm

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Gear is modelled based the design standards using CATIA 5 as shown in the figure 1.

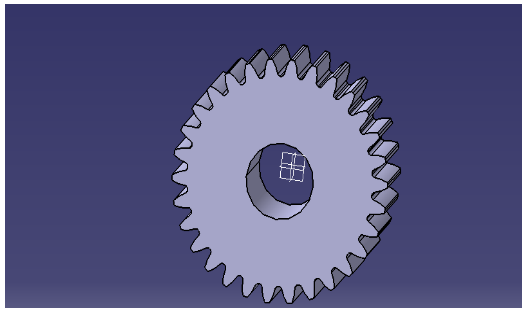

Figure 1: 3D Gear model

B. **Meshing**

3d gear model is meshed using Ansys Workbench details of meshing is shown figure 2.

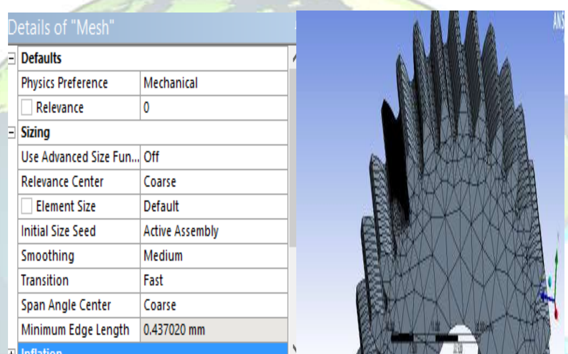

Figure 2: Details of meshing

C. **Boundary condition and analysis**

To estimate bending stress in a spur gear, gear shaft is foxed and a load of 500N acts on the face of the spur gear as shown in figure 3 and analysis is done using *Ansys workbench solver.*

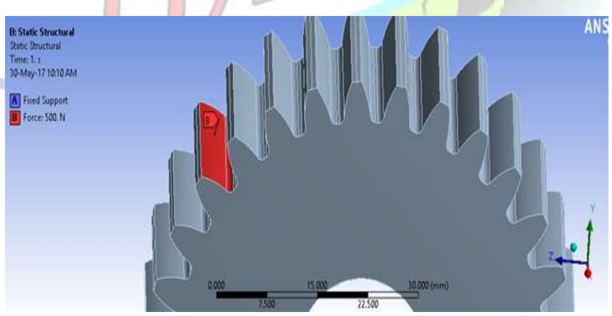

Figure 3: Boundary Condition and Analysis

III. RESULTS

CASE 1: USING BETTER MATERIALS

Bending stresses occurs at the root of the gear. That can be reduced by changing the material property of the material i.e. by using different Martials. Bending stresses of different material property is as shown in figure 4 .

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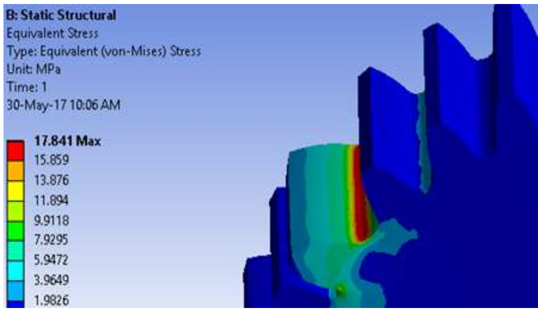

Figure 4: Equivalent stress in structural steel

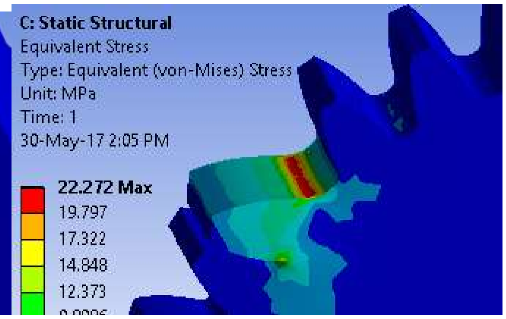

Figure 6: Equivalent stress in stainless steel

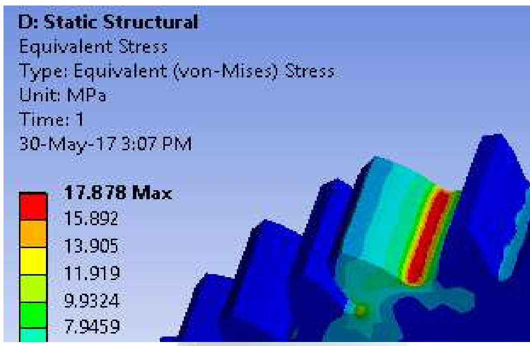

Figure 5: Equivalent stress in titanium

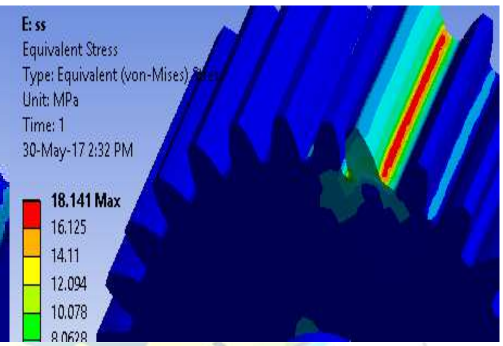

Figure 7: Equivalent stress in stainless steel

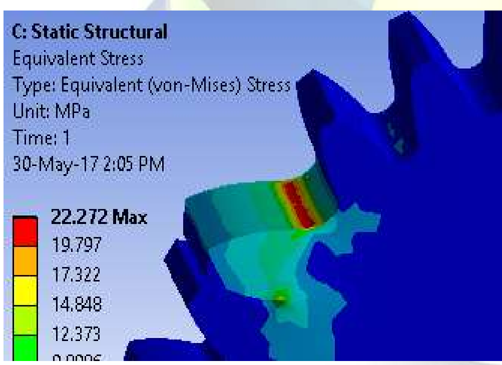

Figure 8: Equivalent stress in Aluminum

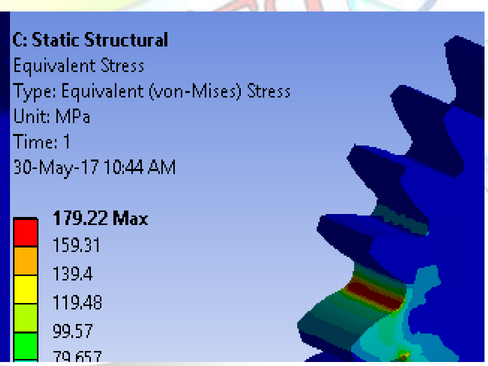

Figure 9: Equivalent stress in magnesium

The above results are tabulated in table 2.

Table 2: Optimization results

Sl no	Material	Tensile yield stress (MPa)	Equivalent stress (MPa)
1	Structural steel	250	17.841
2	Titanium	930	17.878
3	Stainless steel	207	18.141
4	Aluminum	280	22.272
5	Magnesium	193	179.22

From the above table it is seen that stresses obtained in the analysis is lesser than the tensile yield stress, hence

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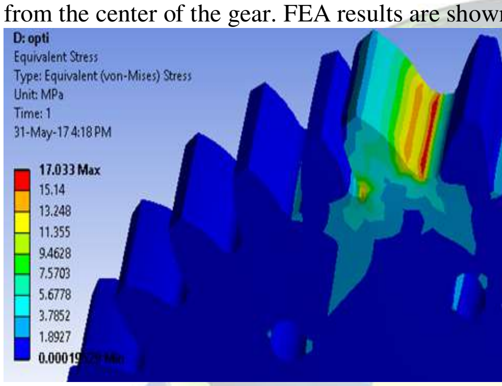
the design is safe. It is seen that bending stress of the spur gear depends on the property of the material. [4] proposed a principle in which another NN yield input control law was created for an under incited quad rotor UAV which uses the regular limitations of the under incited framework to create virtual control contributions to ensure the UAV tracks a craved direction. Utilizing the versatile back venturing method, every one of the six DOF are effectively followed utilizing just four control inputs while within the sight of un demonstrated flow and limited unsettling influences. Elements and speed vectors were thought to be inaccessible, along these lines a NN eyewitness was intended to recoup the limitless states. At that point, a novel NN virtual control structure which permitted the craved translational speeds to be controlled utilizing the pitch and the move of the UAV. At long last, a NN was used in the figuring of the real control inputs for the UAV dynamic framework. Utilizing Lyapunov systems, it was demonstrated that the estimation blunders of each NN, the spectator, Virtual controller, and the position, introduction, and speed following mistakes were all SGUUB while unwinding the partition Principle.

CASE 2. USING OPTIMIZATION TECHNIQUE.

Bending stress in the spur gear can be reduced by using optimization technique. Optimization is done using structural steel. It is done by making pattern of 8 circular holes of diameter 3 mm at a distance of 40mm from the center of the gear. FEA results are shown in figure 9 - 10.



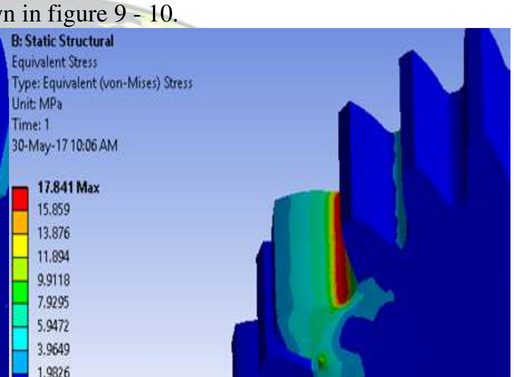


Figure 9: Optimized gear Figure 10: Un - Optimized gear

Comparison of Optimization results are shown in table 3.

Table 3: Optimization results

Sl. no	Optimized gear (MPa)	Un- optimized gear (MPa)	Difference (MPa)	Difference %
1	17.033	17.841	0.808	0.04

It is seen that bending stress obtained un-optimized and optimized gear are 17.841 and 17.033 MPa respectively. Hence by optimizing the gear bending stress can be reduced.

CASE 3. BY DECREASING THE ROOT RADIUS.

Root radius of the gear plays a major role in reduction of bending stress in the gear. Initially the root radius of the gear is 0.78mm and the root radius is reduced to 0.5 mm. This is done by using structural steel as the material. Results are discussed in figure 11 and 12.

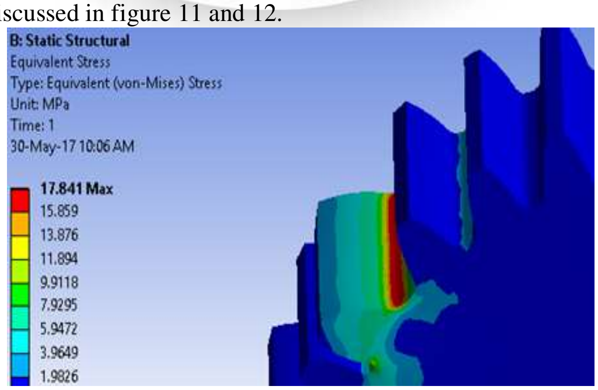


Figure 11.Equivalent stress result of root radius 0.78mm.

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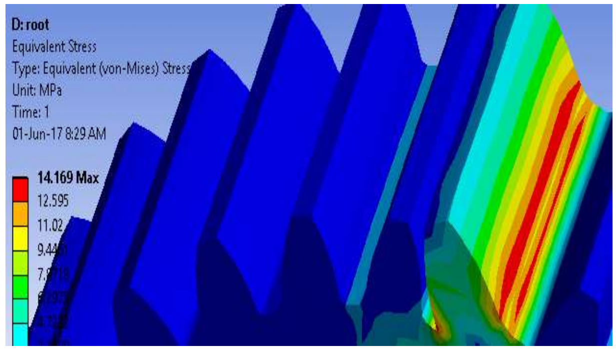

Figure 12:.Equivalent stress result of root radius 0.5mm.

Results are tabulated as shown in the table 4.

Table 4: Comparison results

Sl no	Root radius 0.78	Root radius 0.5	Difference %
1	17.841	14.169	0.2

Hence by decreasing the root radius bending stress can be reduced.

CONCLUSION

It is concluded that by changing the material property of the material, by optimizing the spur gear and by decreasing the root radius of the gear bending stress developed can be reduced. As the stress developed in the gear reduced the wear occurred in the gear reduces. So that gear can operate with less amount of stress and wear of the gears also decreased.

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