International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 9 Issue 03, March-2020

Spur Gear Designing and Weight Optimization

Mr. Naveen Kumar[1], Mr. Vaibhav Chittoria[2], Mr. Utkarsh Upadhyay[2]
[1]Assistant Professor, [2]Student,
Department of Mechanical Engineering, ABES Engineering College,
Ghaziabad, U.P., India.

***Abstract* :- In this paper, we are designing and optimizing of gear for event SAE BAJA Transmission. The given values of forces, torque and factor of safety of gear are calculated in accordance to custom vehicle. The gear is designed using SOLIDWORKS Toolbox. Gear weight is optimized by material removal from specific region. After it, simulation on SOLIDWORKS and ANSYS is done giving input values from calculation. The result shows the difference in weight and factor of safety between optimized and un-optimized gear models.**

INTRODUCTION :-

Gear is used gain mechanical advantage in power transmission. Gears of different types: Spur Gear, Helical Gear, Bevel Gear, Worm and Wheel Gear. Gears are commonly used in Transmission of Automobiles via Gearbox. Transmission assembly are stated: Simple Gear train, Compound Gear train, Planetary, etc. Weight of gears in gearbox becomes a constant factor of vehicle weight as whole. In college projects like SAE BAJA, SUPERA, etc. the basic knowledge of transmission is seen by an engineer skill to design a gearbox of required strength and maintain lightweight. The vehicle this gear is designed for uses a Engine power source with CVT.

OBJECTIVE:-

- To choose material of high strength.
- To calculate the theoretical forces on spur gear by conventional formulas.
- To model the spur gears on SOLIDWORKS using toolbox spur gear.
- To remove material and optimize weight of spur gear.
- To simulate gear on SOLIDWORKS and ANSYS.

ANALYSIS:-

THEORETICAL ANALYSIS

Gear Material

Material for Gear is chosen based on yield strength of material. Materials commonly used are AISI 4340, EN 353, etc. We have taken AISI 4340 for its high strength. The properties are as in Table 1.

Table 1
AISI 4340 Properties

Density	7.8gm/cm3
Hardness(BH)	320
Young's modulus	200GPa
Poisson's ratio	0.30
Yield strength	710MPa
Ultimate tensile strength	1110MPa

Engine

Engine used here is Briggs and Stratton engine, Model 19(Fig. 1). Its specifications are given in Table 2.

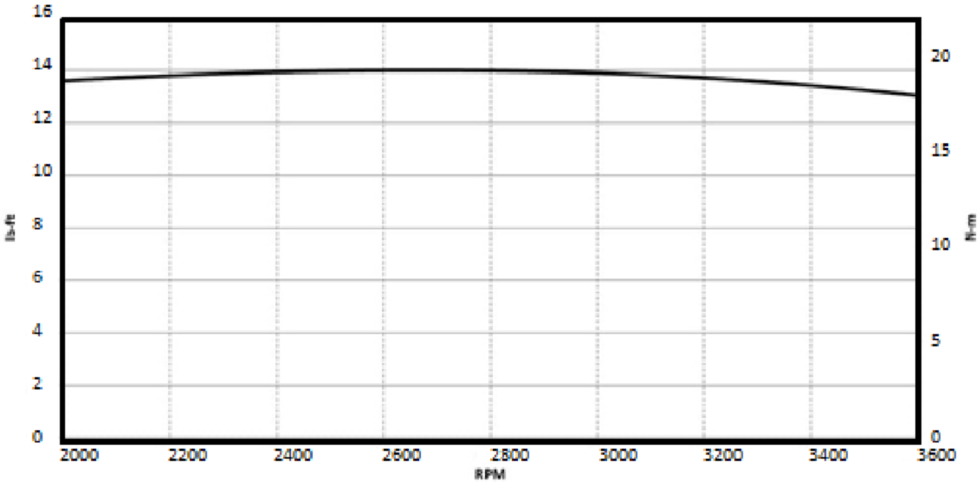


Fig. 1 B&S Power Graph

Table 2
Input Engine

Model	19L232-0054 G1
Compression ratio	8.1 to 1
Bore/Stroke	3.12" / 2.44"
HP(Gross)	10.0 Hp
Max. RPM	3800 rpm
Max. Torque	19.6 Nm at 2800 rpm

Continuous Variable Transmission (CVT) is used as constant reduction between engine output and gearbox input. Specifications are given in Table 3.

Table 3
CVT Specifications

CVT	Polaris
Max. ratio	3:1
Min. ratio	0.7:1

Calculation

Torque on gear

Torque is transferred from engine to gearbox after reduction from CVT. The final torque on gear is:-

M_t – torque input at gear

M_t = max. torque of engine * max. CVT ratio * Gear reduction ratio

$M_t = 19.6 * 3 * 7.54$

$M_t = 443 \approx 450$ Nm

Spur Gear nomenclature

Basic dimensions of Gear are given:-

Module(m)=2.5

Number of Teeth(z)=59

Pitch Circle Diameter(d)= m*z = 147.5mm

Width of Gear(b)=20mm

Output Shaft Diameter=36mm

Calculation of Tangential Force

The two components of net force on gear tooth are: Radial force(F_r), Tangential force(F_t). The only force responsible of gear rotation is F_t, calculated below:-

F_t – Tangential force applied on gear tooth/teeth

$Ft = 2*Mt / d$ [1]

$Ft = 2*450*1000 / 147.5$

Ft = 6101.6949 N

Calculation of Beam Strength of Gear Teeth

The resistive force offered by gear tooth is calculated below:-

F_{en} – Resistive force of Gear tooth

σ_{en} – Allowable permissible stress of material

σ_{ut} – Ultimate tensile stress of material

$\sigma_{en} = \sigma_{ut} /3$ [2]

$F_{en} = \sigma_{en} * b*Y*m$

$F_{en} = (1110/3) *20*[\pi*(0.175 - 0.95 / 59)]*2.5$

F_{en} = 9235.0843 N

Calculated Factor of Safety(FOS)

Factor of Safety is calculated:-

$FOS = F_{en} / F_t$

FOS = 9235.0843 / 6101.6949

FOS = 1.51

GEAR DESIGNING

For Gear model, we take a standard spur gear from SOLIDWORKS Toolbox. Assign the Module and Teeth number. The software will generate a gear using Global Equations. We optimize it according to design using Static Simulation.

For simulation the center hub is fixed fixture and tangential force is applied on teeth for worst condition possible.

Simulation of Gear on SOLIDWORKS Fig. 2, 3.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 9 Issue 03, March-2020

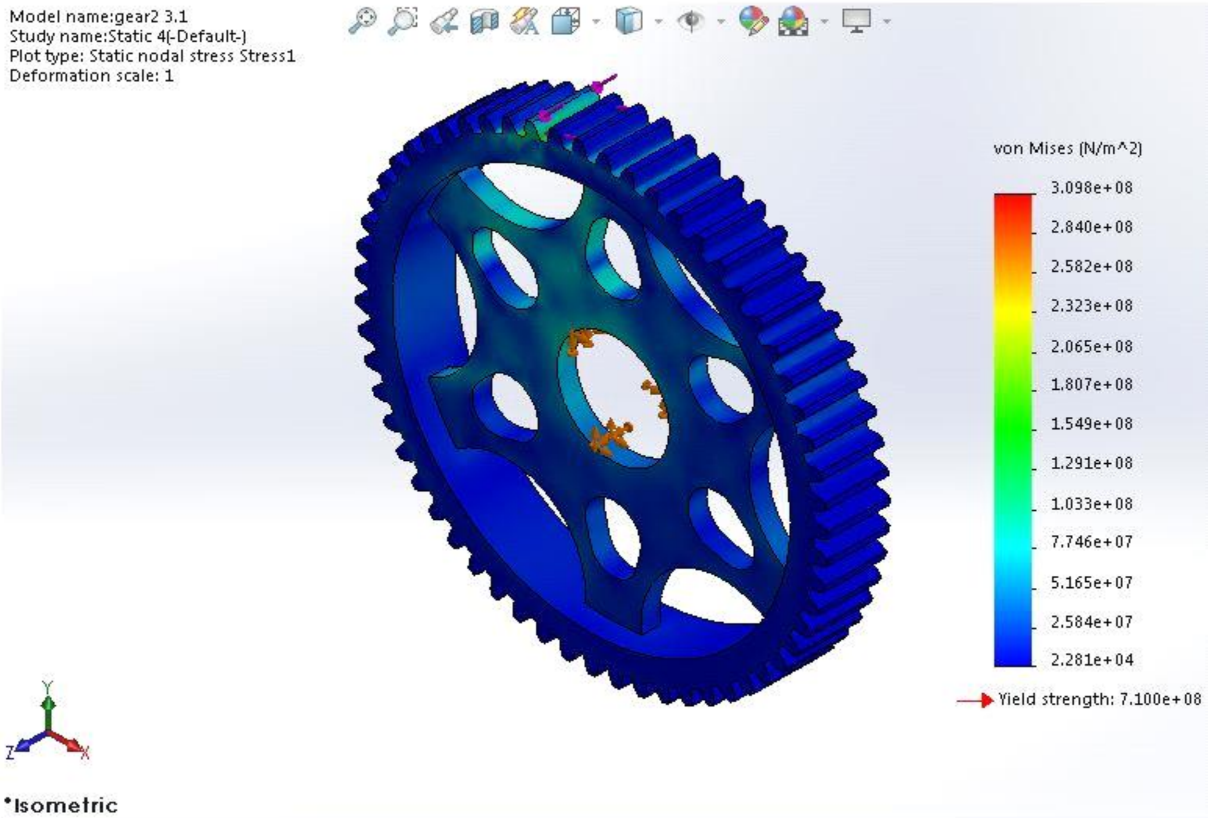


Fig. 2 Stess

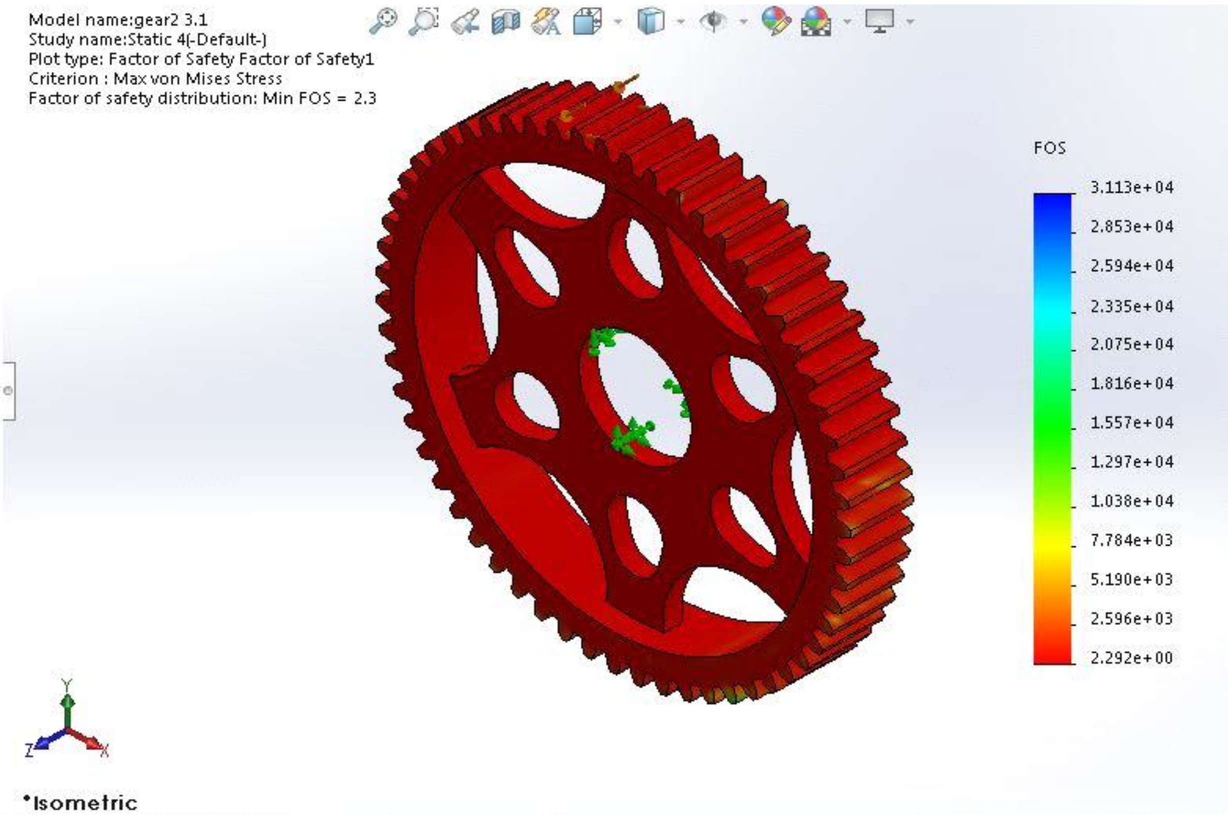


Fig. 3 Factor of Safety

Simulation of Gear on ANSYS Fig. 4, 5.

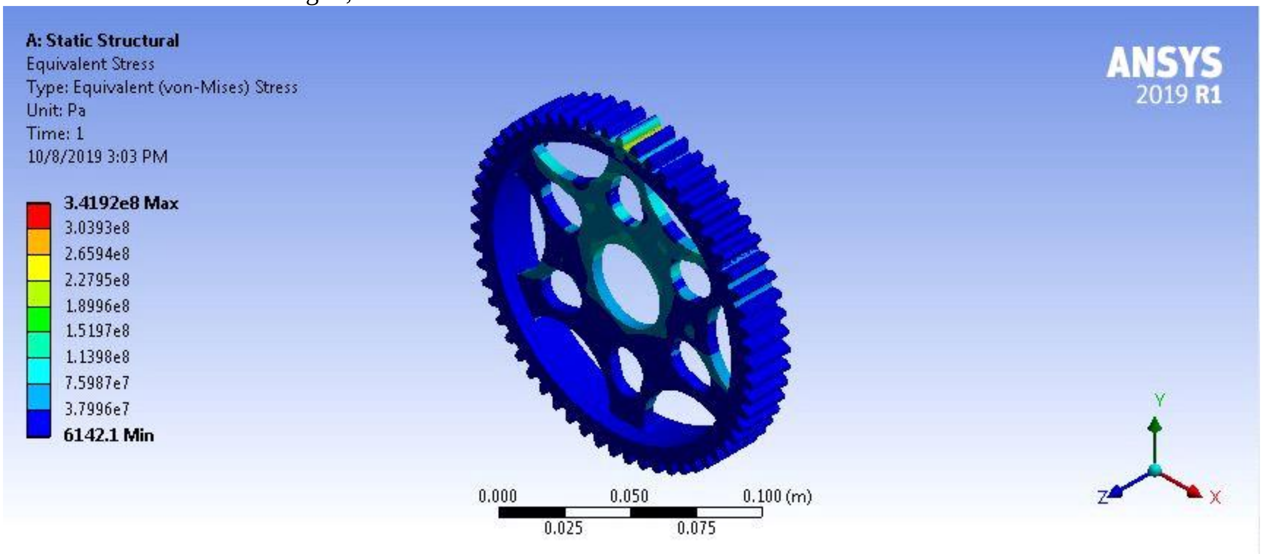


Fig. 4 Stress

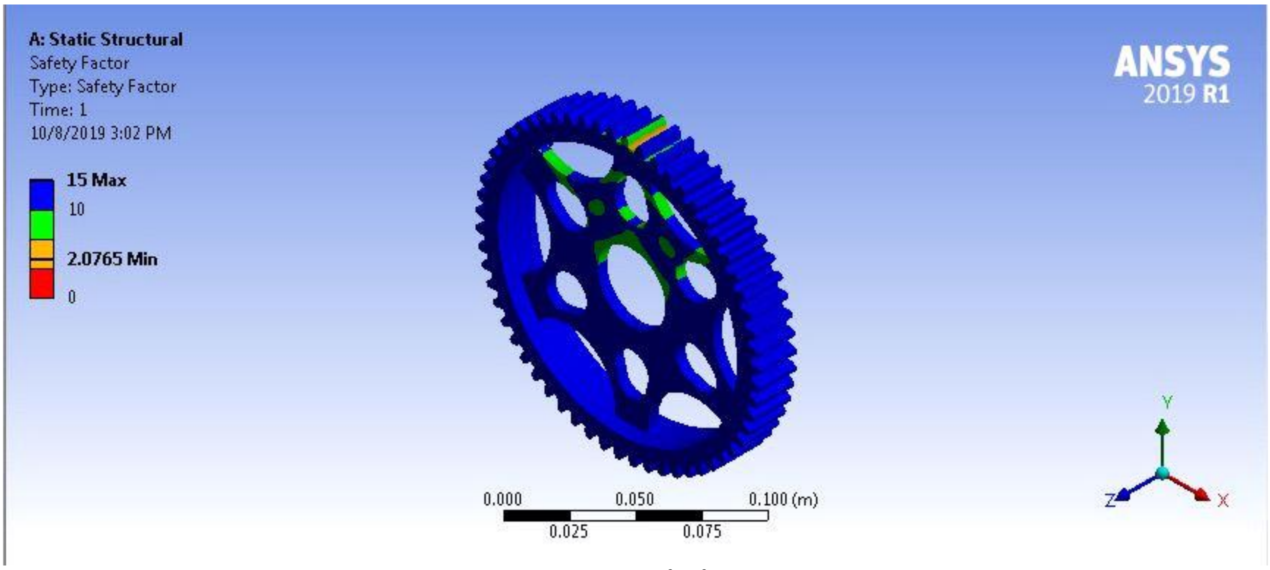
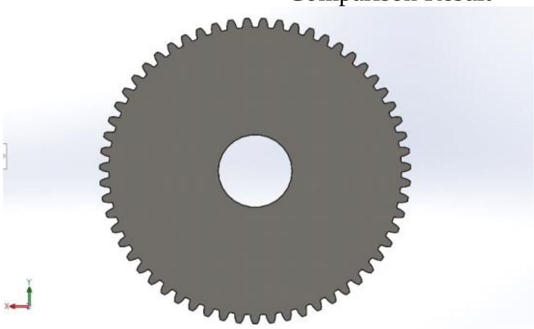


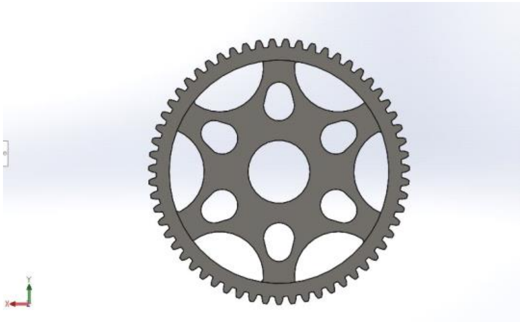
Fig. 5 Factor of Safety

RESULT :-

After simulations, we got the following results give in Table 4.

Table 4
Comparison Result





Normal Gear	Optimized Gear
FOS=2.24	FOS=2.01
Mass=2505.51gm	Mass=888.86gm

REFRENCE

[1] K. Mahadevan, K. Balaveera Reddy; *Design Data Handbook,* Fourth Edition(2019)
[2] V. N. Bhandari; *Design of Machine Elements,* Third Edition.
[3] Raja. S, Ramaswamy. K and Lokesh. M; *WEIGHT OPTIMIZATION OF HELICAL GEAR UNDER STATIC ANALYSIS,* International Journal of Mechanical Engineering and Technology (Volume 9, Issue 9, September 2018).
[4] Chinmay Shah, Swapnil Thigale, Rathin Shah; *OPTIMIZATION WEIGHT OF A GEAR USING TOPOLOGY OPTIMIZATION,* International Journal of Science, Engineering and Technology Research (Volume 7, Issue 6, June 2018).
[5] Mr. Dattatray A. Patil, Prof. Dalwe D.M.; *DESIGN AND WEIGHT OPTIMIZATION OF PINION BY USING FEA METHOD,* International Research Journal of Engineering and Technology (Volume 4, Issue 6, June -2017).
[6] Mahesh. Badhite, Srimanthula Srikanth, Jithendra Bodapali*; STRESS REDUCTION AND ANALYSIS OF A SPUR GEAR TOOTH,* International Journal of Emerging Technology and Advanced Engineering (Volume 4, Issue 3, March 2014).
[7] Amit Patil, *BENDING STRESS ANALYSIS OF SPUR GEAR,* International Journal for Research in Applied Science & Engineering Technology (Volume 5, Issue 6, June 2017).