



IJRTSM

INTERNATIONAL JOURNAL OF RECENT TECHNOLOGY SCIENCE & MANAGEMENT

“DESIGN & THERMAL TRANSIENT ANALYSIS OF SPUR GEAR USING DIFFERENT MATERIAL BY ANSYS SOFTWARE”

Gauri Shankar Vishwakarma¹, Rajneesh Kumar Gedam²

¹PG, Scholar, Dept. of Mechanical Engineering, RKDF Bhopal, MP, India

²Assistant Professor, Dept. of Mechanical Engineering, RKDF Bhopal, MP, India

ABSTRACT

In the gear design the bending stress and surface strength of the gear tooth are considered to be one of the main contributors for the failure of the gear in a gear set. Thus, the analysis of stresses has become popular as an area of research on gears to minimize or to reduce the failures and for optimal design of gears. In this paper contact stresses are calculated by using analytical method as well as Finite element analysis. To estimate bending stress modified Lewis beam strength method is used. CATIA solid modeling software is used to generate the 3-D solid model of spur gear. ANSYS workbench software package is used to analyze the bending stress. Contact stresses are calculated by using modified AGMA contact stress method. In this also CATIA modeling software is used to generate contact gear tooth model. ANSYS software package is used to analyze the contact stress. Finally these two methods contact stress results are compared with each other.

Keyword: CATIA, ANSYS, Contact stress, Gear, Spur gear, FE method.

I. INTRODUCTION

Gears are used for a wide range of industrial applications. They have varied application starting from textile looms to aviation industries. They are the most common means of transmitting power. They change the rate of rotation of machinery shaft and also the axis of rotation. For high speed machinery, such as an automobile transmission, they are the optimal medium for low energy loss and high accuracy. Their function is to convert input provided by prime mover into an output with lower speed and corresponding higher torque. Toothed gears are used to transmit the power with high velocity ratio. During this phase, they encounter high stress at the point of contact. A pair of teeth in action is generally subjected to two types of cyclic stresses:

- i) Bending stresses inducing bending fatigue
- ii) Contact stress causing contact fatigue.

1.1 SPUR GEAR:

Spur gears are the most common type of gears. They are used to transmit rotary motion between parallel shafts i.e., they are usually cylindrical in shape, and the teeth are straight and parallel to the axis of rotation. Sometimes many spur gears are used at once to create very large gear reductions. Spur gears are used in many devices but not in cars as they produce large noises.



Fig 1.1 Spur Gear

II. PROBLEM DEFINITION

One of the main causes for failure of the gear tooth is bending stresses near the root of the gear and the contact stresses where the gears meet. The main objective of this paper is to analyze the bending stresses in the spur gear. When the spur gears mesh a tangential and a radial load acts upon the gear tooth and this generates stresses in the gear tooth. The radial load induces compressive stress of relatively small magnitude therefore its effect on the tooth may be neglected. The tangential load induces a bending stress which tends to break the tooth.

Failure by bending will occur when the significant tooth stress equals or exceeds either the yield strength or the bending endurance strength of the material. This paper investigates bending stress developed in gear set while transmitting power for both the steel and Aluminium as gear material. Both above said material find many applications and also each material exhibits their own characteristics during service condition, high strength, durability and load carrying capacity creates an opportunities to use Steel as gear material and in contrast aluminium as a gear material shows up unique characteristics like corrosion resistance, light weight and easy of machining.

III. SPECIFICATION OF THE GEAR

Histogram equalization is used for enhancing the gray level contrast of the image [2]. The contrast of the image is enhanced by transforming these values using contrast limited adaptive histogram equalization, which operates on small regions in the image called tiles. Each tile's contrast is enhanced in such a way that the histogram of the output region approximately matches the histogram specified by the distribution parameters. While combining the neighbouring tiles the problem of artificially induced boundaries are found and it is eliminated using bilinear interpolation [3].

Table. 3.1: Specifications of Gear.

Parameters	Symbols	Unit	Value
Number of teeth	Z	---	40
Module	m	mm	6
Power	P	kW	1500
Speed	N	RPM	1500
Pitch circle diameter	D	mm	250
Pressure Angle	α	Degree	14.5
Face width	b	mm	22

IV. SPECIFICATION OF THE GEAR

Table 4.1 Structure Steel Mechanical properties

Material Field Variable	Value	Units
Density	7750	Kg/m ³
Young's modulus	1.93E+05	Mpa
Poisson Ratio	0.31	
Shear modulus	76664	Mpa
Bulk Modulus	1.6937E+05	Mpa
Tensile Yield Strength	207	Mpa
Compressive Yield Strength	207	Mpa
Tensile Ultimate Strength	586	Mpa

Table 4.2 Aluminium Alloy Mechanical

Material Field Variable	Value	Units
Density	2770	Kg/m ³
Young's modulus	7.1E+10	Mpa
Poisson Ratio	0.33	
Shear modulus	2.6692E+04	MPa
Bulk Modulus	6.9608E+04	MPa
Tensile Yield Strength	280	Mpa
Compressive Yield Strength	280	Mpa
Tensile Ultimate Strength	310	Mpa

Material Field Variable	Value	Units
Density	4620	Kg/m ³
Young's modulus	9.6E+10	Mpa
Poisson Ratio	0.36	
Shear modulus	3.528E+11	Mpa
Bulk Modulus	1.1429E+11	Mpa
Tensile Yield Strength	930	Mpa
Tensile Ultimate Strength	930	Mpa

V. THEORETICAL STRESS CALCULATION

Pitch line velocity

$$V = \pi D_p N_p / 60 = \pi \times 0.125 \times 1500 / 60 = 9.81 \text{ m/s}$$

Lewis equations 14.5° involute teeth, then Tooth form factor

$$Y_G = 0.124 - 0.684/T_p = 0.124 - 0.684/20 = 0.089$$

Ordinary cut gears and operating at velocity ratio is up to 12.5m/s

$$C_v = 3/3+v$$

$$C_v = 3/3+9.81 = 0.234$$

Design Tooth load

$$W_T = P \cdot C_s / v$$

$$W_T = 15000 \times 1 / 9.81 = 1529.1 \text{ N}$$

$$W_T = \sigma_w \cdot b \cdot pc \cdot y = \sigma_w \cdot b \cdot \pi m \cdot y = (\sigma_o \cdot C_v) \cdot b \cdot \pi m \cdot y$$

$$\sigma_w = W_T / b \cdot \pi m \cdot y$$

$$\sigma_w = 1529.1 / 22 \times 3.14 \times 6 \times 0.089$$

$$\sigma_w = 116.5 \text{ MPa}$$

Theoretical bending stress of the designed gear = 116.5 Mpa

VI. BENDING STRESS CALCULATION USING ANSYS

The gear is first designed in the ANSYS designer workbench. The calculated co-ordinates are plotted and an involute profile is generated. The addendum circle and dedendum circles are drawn and the profile is connected to for the individual gear tooth.

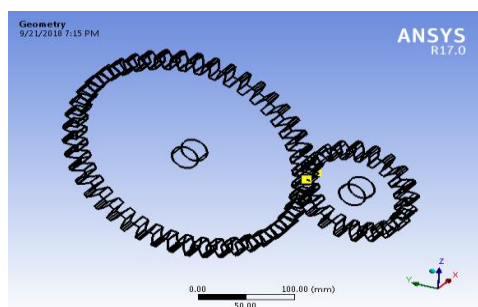


Fig. 6.1 Geometry of Spur gear for Structural Steel

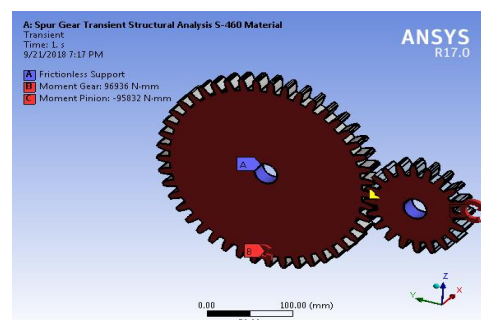


Fig.6.2 Boundary Condition applied moments on Structural Steel Gears

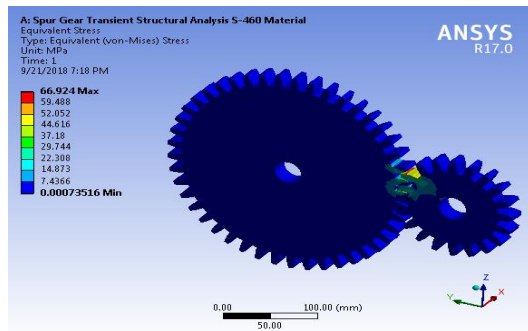


Fig. 6.3 Equivalent Von misses Stress for Structural Steel

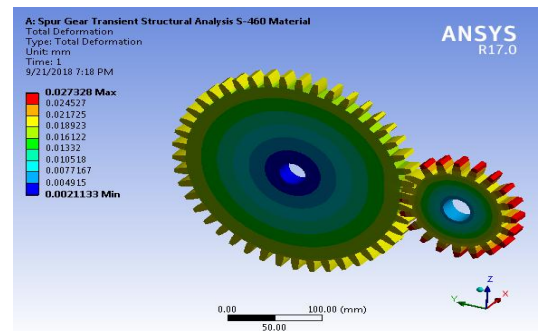


Fig. 6.4 Total Deformation on Spur gears for Structure steel

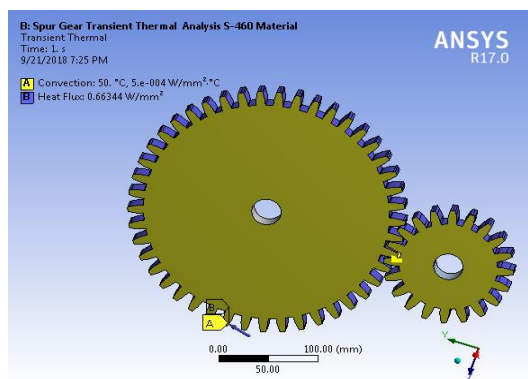


Fig.6.5 Transient Thermal S-460 Boundary Condition

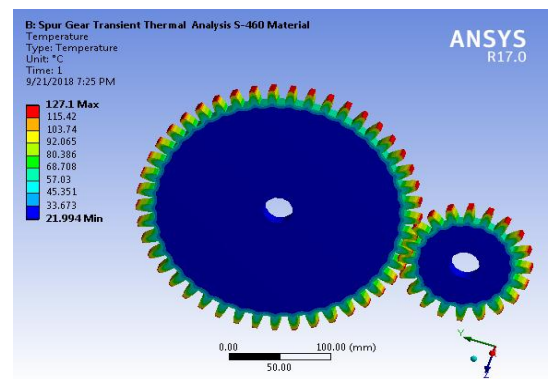


Fig.6.6 Temperature S-460 materials

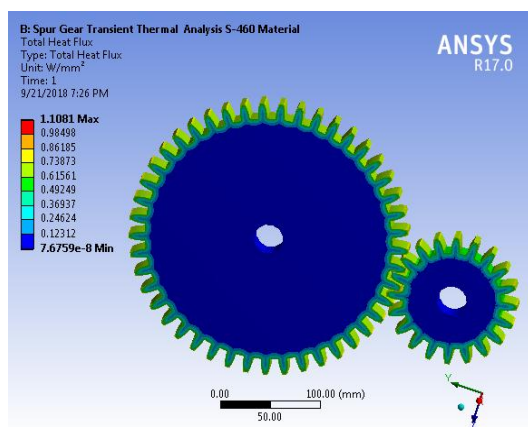


Fig. 6.7 Total heat Flux S-460

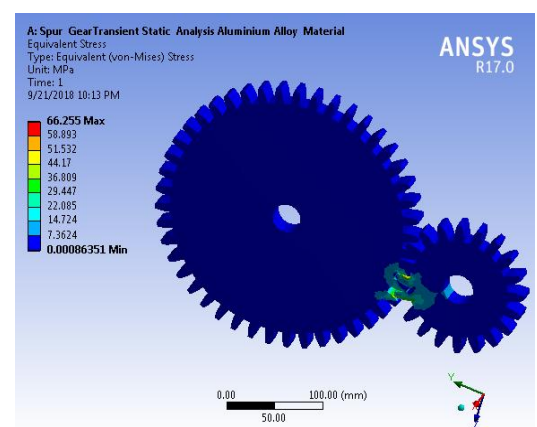


Fig.6.8 Equivalent Von misses Stress for Aluminium Alloy

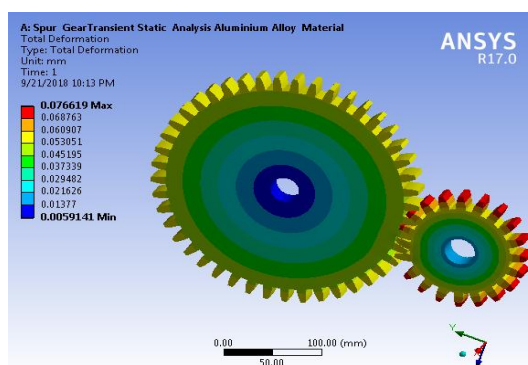


Fig. 6.9 Total Deformation on Spur gears for Aluminium Alloy

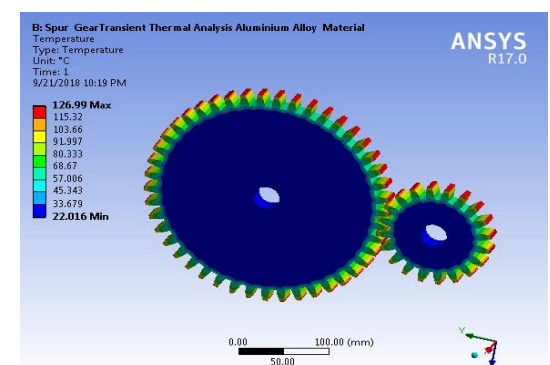


Fig.6.10 Temperature Aluminium Alloy

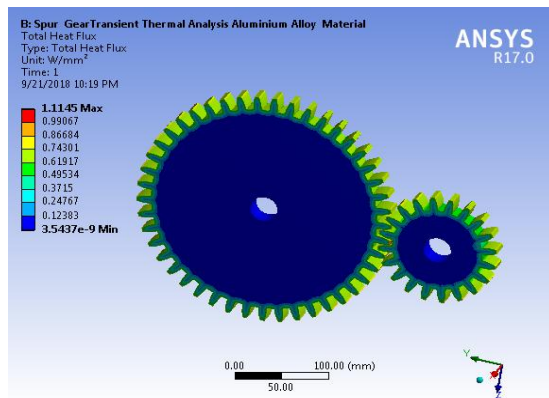


Fig.6.11 Total Heat Flux Aluminium Allo

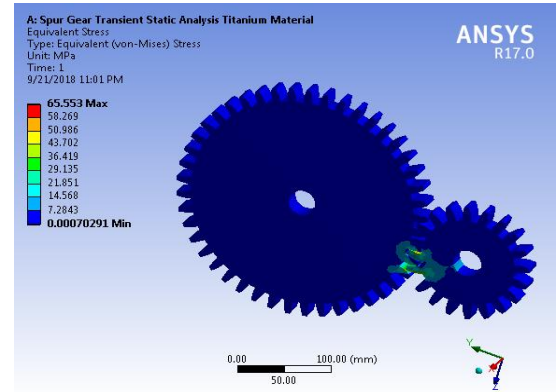


Fig. 6.12 Equivalent Von misses Stress for Titanium Alloy

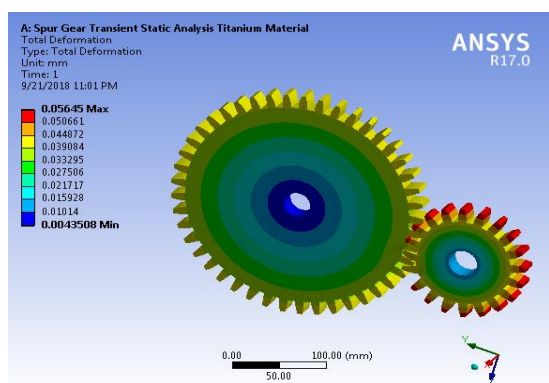


Fig. 6.13 Total Deformation on Spur gears for Titanium Alloy

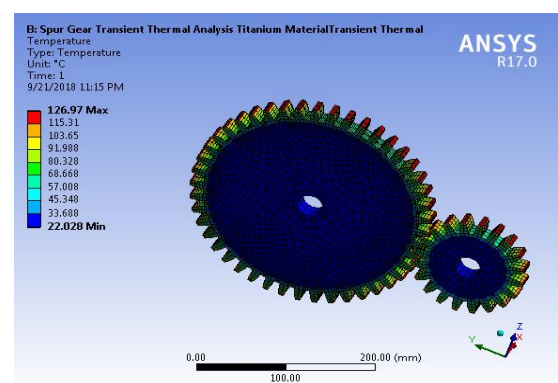


Fig.6.14 Temperature Aluminium Alloy

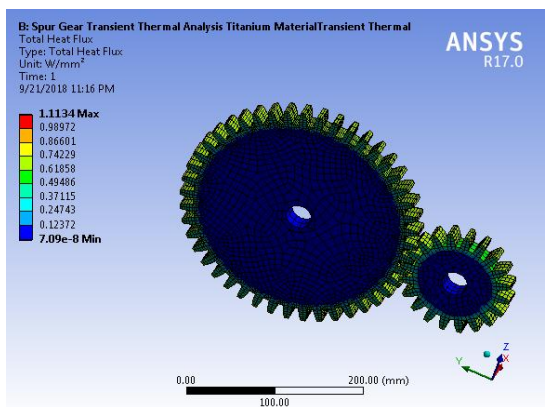


Fig.6.15 Total Heat Flux Titanium Alloy

VII. RESULT AND DISCUSSIONS

In this work we find value of vonmises stresses, Aluminium Alloy, Structural Steel, Titanium Alloy are respectively 66.255 MPa, 66.924MPa and 65.553MPa and total deformation for these materials likes Structural Steel, Aluminium Alloy and Titanium Alloy and, are respectively 0.027328 mm, 0.076619 mm and 0.05645 mm.

Temperature for these materials likes Structural Steel, Aluminium Alloy and Titanium Alloy and, are respectively 127.1 C , 126.99 C and 126.97C.

Total heat flux for these materials likes Structural Steel, Aluminium Alloy and Titanium Alloy and, are respectively 1.1081 w/mm² , 1.1145 w/mm² and 1.1134 w/mm² .

Here we can see that we have used four different materials in all materials we will be selected Aluminium Alloy material to other than because it is light weight and heavy duty its deformation and stresses range are considerable and heat flux value is maximum from other materials.

Here we can see that we have used four different materials in all materials we will be selected Aluminium alloy material to other than because it is light weight and heavy duty its deformation and stresses range are considerable.

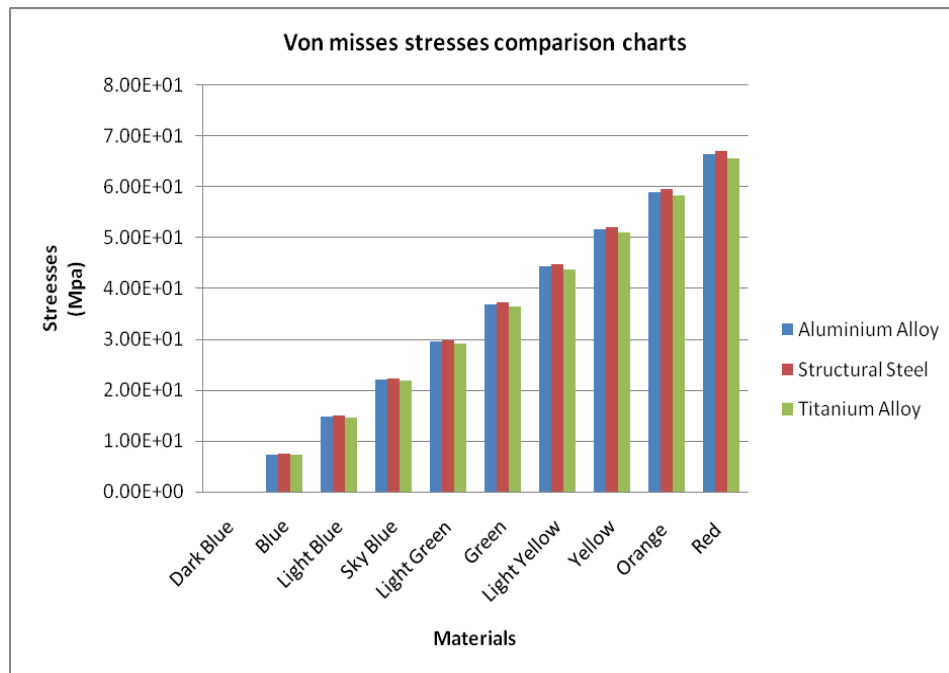


Fig.7.1 Frictional Von misses comparison graph for different materials

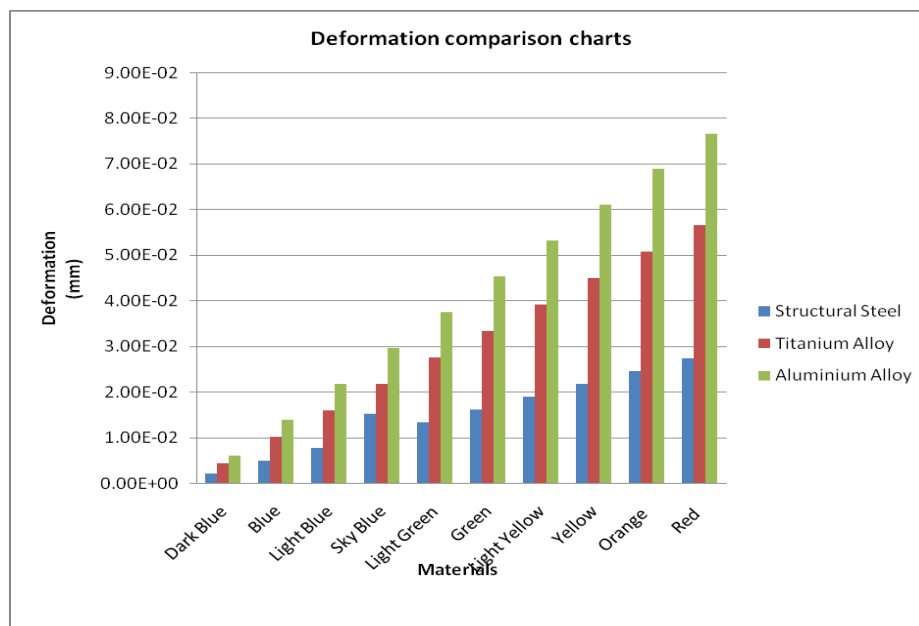


Fig.7.2 Deformations comparison graph for different materials

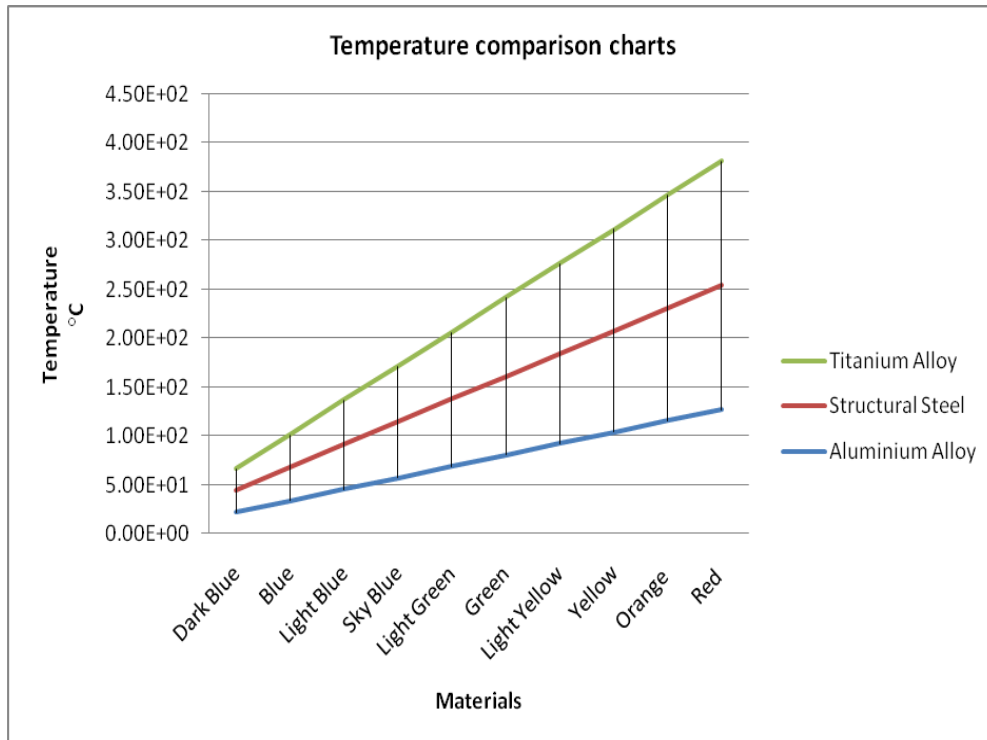


Fig.7.3 Temperature comparison graph for different materials

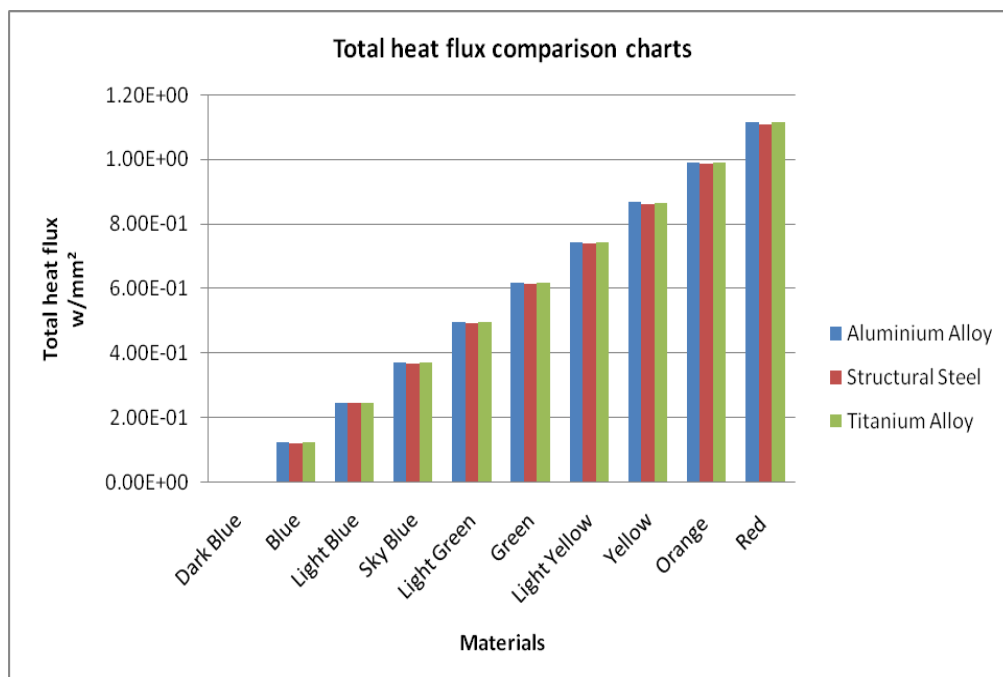


Fig.7.4 Total heatFlux comparison graph for different materials

VII. CONCLUSION

In this work analytical and Finite Element Analysis methods were used to predicting the Bending stresses of involute Spur gear. Bending stresses are calculated by using AGMA and ANSYS software package. Bending stresses are calculated by using ANSYS software package.

REFERENCES

1. Prashant Kumar Singh , Siddhartha, Akant Kumar Singh An investigation on the thermal and wear behavior of polymer based spur gears, Tribology International 118 (2018) 264–272
2. Wu Jiateng, Yang Yu, Yang Xingkai, Cheng Junsheng, Fault feature analysis of cracked gear based on LOD and analytical-FE method, Mechanical Systems and Signal Processing 98 (2018) 951–967
3. Franulovic, Kristina Markovic, Zeljko Vrcan, Matija Soban, Experimental and analytical investigation of the influence of pitch deviations on the loading capacity of HCR spur gears, Mechanism and Machine Theory 117 (2017) 96–113
4. Naresh k. Raghuwanshi et al. "Effect of Back-Side contact on mesh stiffness of spur gear pair by Finite Element Method." Procedia Engineering 173 (2017) 1538 – 1543
5. Paras Kumar, Harish Hirani, Atul Agrawal Fatigue failure prediction in spur gear pair using AGMA approach, Materials Today: Proceedings 4 (2017) 2470–2477
6. Miryam B. Sánchez, Miguel Pleguezuelos, José I. Pedrero, Approximate equations for the meshing stiffness and the load sharing ratio of spur gears including hertzian effects, Mechanism and Machine Theory 109 (2017) 231–249
7. Dattatray B. Vaitkar1a, Prashant N. Ulhe, Experimental Investigation and Finite Element Analysis of Contact Stresses of Spur Gear Used in Automated Lathe Machine, International Journal of Innovative and Emerging Research in Engineering Volume 4, Issue 6, 2017
8. Xihui Liang, Hongsheng Zhang, Libin Liu , Ming J. Zuo, The influence of tooth pitting on the mesh stiffness of a pair of external spur gears, Mechanism and Machine Theory 106 (2016) 1–15.
9. Santosh S. Patil, Saravanan Karuppanan, Ivana Atanasovska , Experimental measurement of strain and stress state at the contacting helical gear pairs, Measurement 82 (2016) 313–322
10. Miriam B. Sánchez, Miguel Pleguezuelos, José I. Pedrero, Calculation of tooth bending strength and surface durability of internal spur gear drives, Mechanism and Machine Theory 95 (2016) 102–113
11. Ankur Saxena, Anand Parey, Manoj Cooksey, Effect of shaft misalignment and friction force on time varying mesh stiffness of spur gear pair, Engineering Failure Analysis 49 (2015) 79–91
12. Putti Srinivasa Rao, Nadipalli Sriraj, Mohammad Farookh, Contact Stress Analysis of Spur Gear for Different Materials using ANSYS and Hertz Equation, International Journal of Modern Studies in Mechanical Engineering (IJMSME) Volume 1, Issue 1, June 2015, PP 45-52
13. Deepika Potghan, Prof. Suman Sharma Potghan, Finite element analysis of spur gear used in lathe headstock, 4.(7): July, 2015 ISSN: 2277-9655 (I2OR), Publication Impact Factor: 3.785
14. I.S. Al-Tubi, H. Long, J. Zhang, B. Shaw, Experimental and analytical study of gear micropitting initiation and propagation under varying loading conditions, Wear 328 329 (2015) 8–16.
15. P.B. Pawar, Abhay A Utpat, Analysis of Composite Material Spur Gear under Static Loading Condition, Materials Today: Proceedings 2 (2015) 2968 – 2974
16. Sanjay K. Khavdu1, Prof. Kevin M. Vyas, comparative finite element analysis of metallic spur gear and hybrid spur gear, Volume 6, Issue 4, April (2015), pp. 117-125
17. Abhijit Mahadev Sankpal, M. M. Mirza, Contact Stress Analysis of Spur Gear by Photoelastic Technique and Finite Element Analysis, ISSN (Print): 2319-3182, Volume -3, Issue-2, 2014