Modelling, Analysisand Optimization Of Crankshaft

B D N S Murthy
B.Tech 4th year, Mechanical Engineering, DVR College of Engineering and Technology, Kandi

N S Teja Kollati
B.Tech 4th year, Automobile Engineering, Bhaskar Engineering College, Moinabad

Abstract

The modelling and analysis of a 4-cylinder crankshaft is discussed using finite element method in this paper. The analysis is done on two different materials which are based on their composition. 3-Dmodel of engine crankshaft was created using CATIA V5 R19 software. The finite element analysis (FEM) software ANSYS 14.0was used to analyse the static and modal analysis of the crankshaft. The maximum stressand deformations are found by analysingthe crankshaft. The results would provide a valuable theoretical foundation for the optimization and improvement of crankshaft of an engine.

1.Introduction

Crankshaft is one of the most important moving parts in IC engine. It must be strong enough to resist the forces and pressure created in cylinder during combustion. If it doesn't sustain to that forces, crankshaft will break. So the reliability ofIC engines depends on the strength of the crankshaft.Computer Aided Modelling made the engineers to visualize the 3-D objects as in the real world and can alter the design according to their requirements. Finite element analysis (FEA) allows an inexpensive study of arbitrary combinations of input parameters including design parameters and process conditions to be analysed.

2. Modelling the Crankshaft

In this research, the crankshaft details are studied. The crankshaft has four crankthrows, three rod journals and two main journals, and it is modelled in CATIA as per the dimensions and figure of the model is shown below in Figure 1.

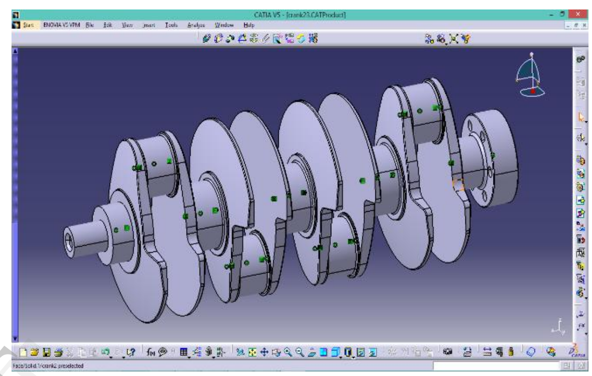


Figure 1. Modelling of Crankshaft in Catia

The software used for rendering the crankshaft is Keyshot 3.3 Pro and the rendered model is shown below.

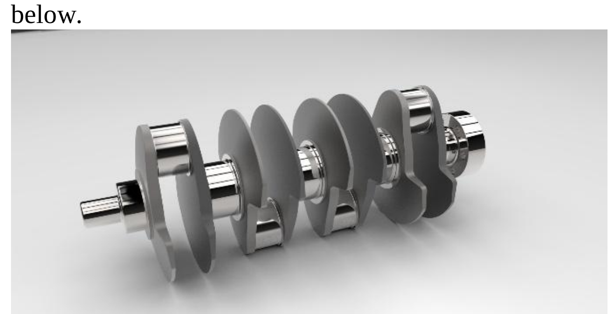


Figure 2. Crankshaft Rendering in Keyshot

3. Finite Element Method

The finite element method (FEM) is numerical analysis technique for obtaining approximate solutions to a wide variety of engineering problems. Because of its diversity and flexibility as an analysis tool, it is receiving much attention in engineering colleges and industries. In moreand more engineering situations today, we find that it isnecessary to obtain approximate solutions to problemsrather than exact closed form solution.

Meshed Model of Crankshaft done in Ansys Software is shown in Figure 3.

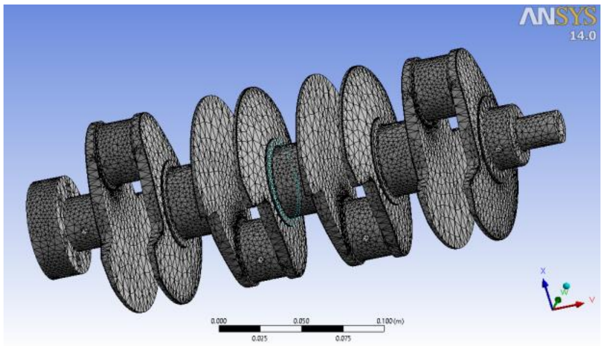


Figure 3. Meshing of Crankshaft in Ansys

Table 3.1: Properties of Annealed 4340 Steel

Property	Values	Units
Density	7800	kg/m^3
Young's Modulus	2.05e+11	Pa
Brinell Hardness	217	-
Poisson's Ratio	0.28	-
Tensile Yield Strength	470	MPa
Ultimate Tensile Strength	745	MPa
Thermal Conductivity	37	W/m-K

3.1 Static Structural Analysis on Crankshaft

Material: Annealed 4340 Steel

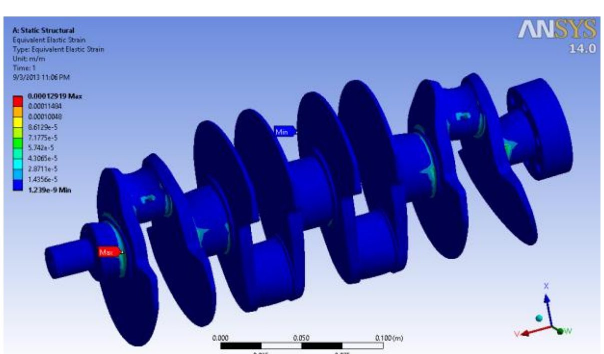


Figure 4. Equivalent Elastic Strain

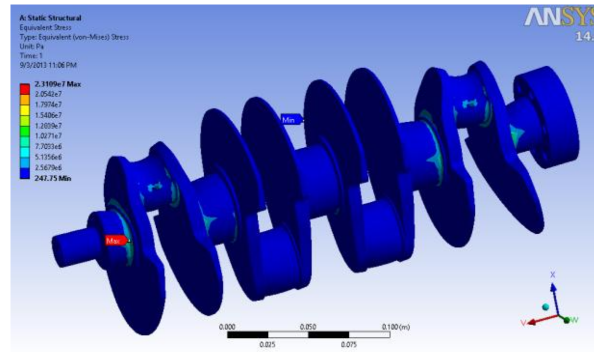


Figure 5. Equivalent Stress (Von-Mises Stress)

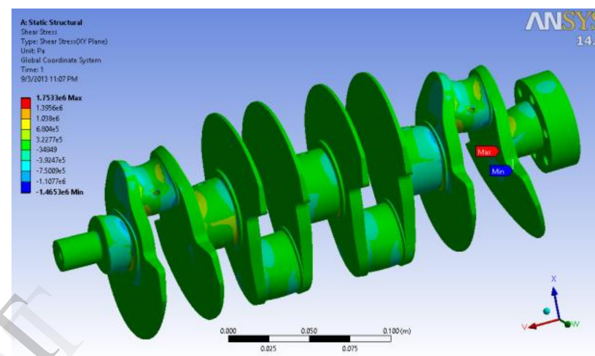


Figure 6. Shear Stress

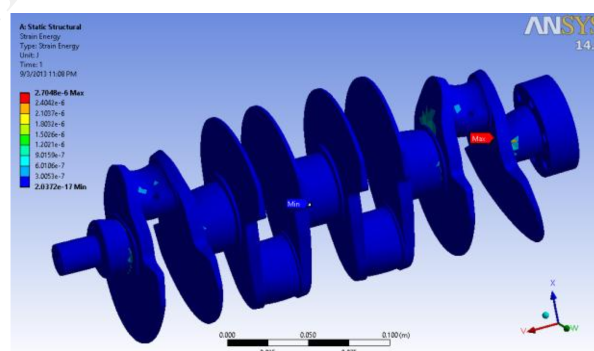


Figure 7. Strain Energy

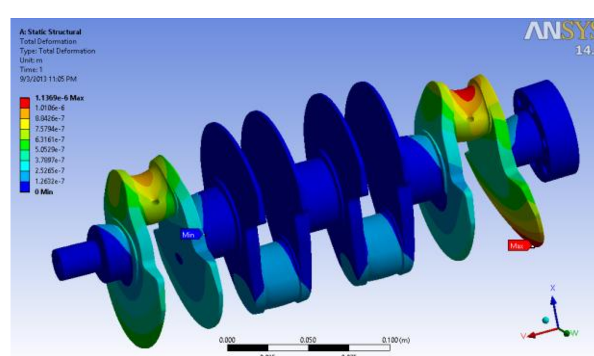


Figure 8. Total Deformation

3.2 Modal Analysis of Crankshaft

Material: Annealed 4340 Steel

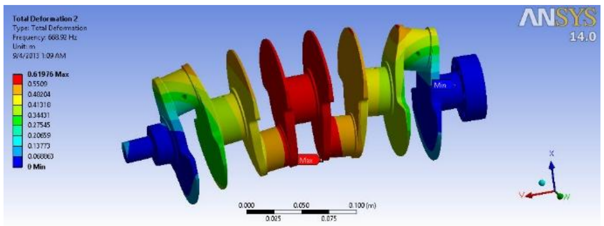


Figure 9. Total Deformation at Mode 2
Frequency: 668.92 Hz

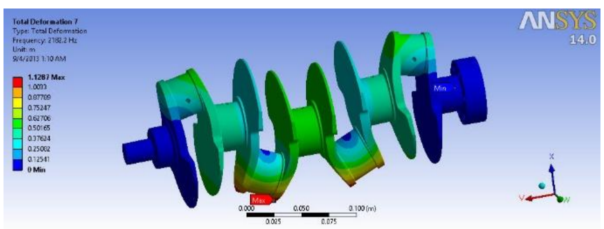


Figure 10. Total Deformation at Mode 7
Frequency: 2182.2 Hz

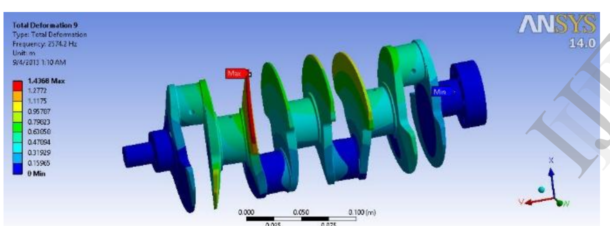
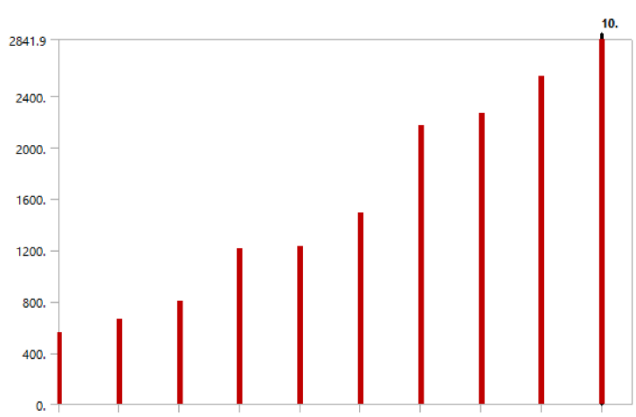


Figure 11. Total Deformation at Mode 9
Frequency: 2574.2 Hz



Graph 1. Modal Graph for Annealed 4340 Steel

Table 3.2: Properties of Inconel X 750 Alloy

Property	Values	Units
Density	8300	kg/m^3
Young's Modulus	2.15e+11	Pa
Brinell Hardness	260	-
Poisson's Ratio	0.28	-
Tensile Yield Strength	820	MPa
Ultimate Tensile Strength	1200	MPa
Thermal Conductivity	12	W/m-K

3.3 Static Structural Analysis on Crankshaft

Material: Inconel X 750 Alloy

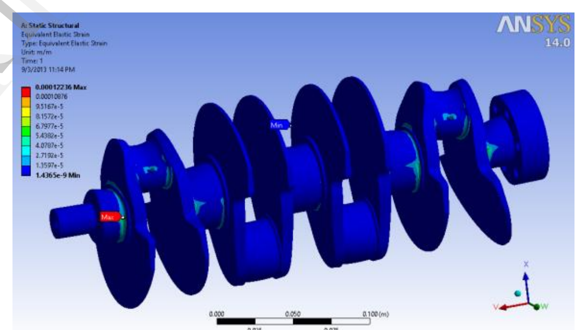


Figure 12. Equivalent Elastic Strain

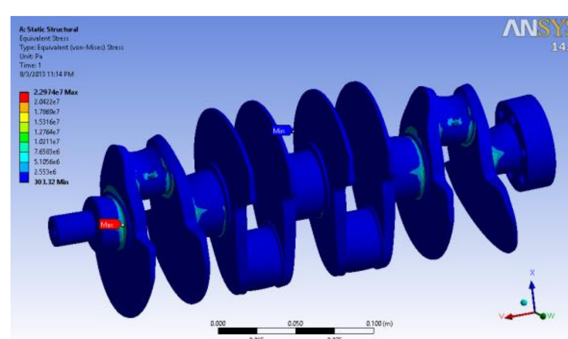


Figure 13. Equivalent Stress

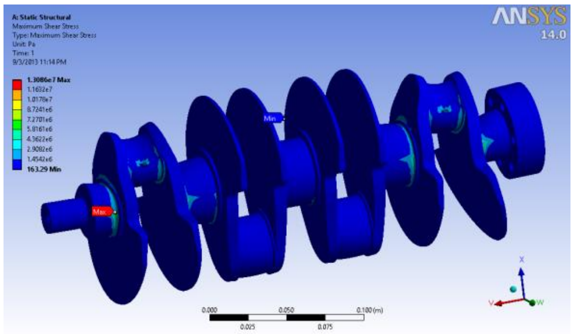


Figure 14.Maximum Shear Stress

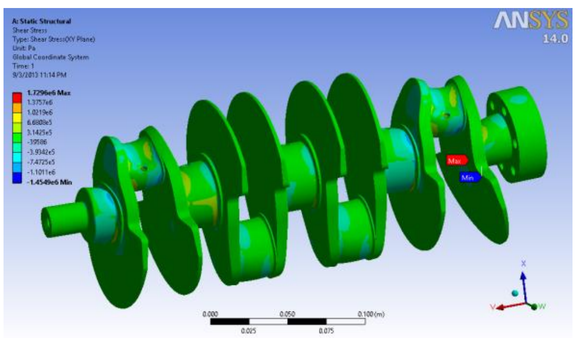


Figure 15. Shear Stress

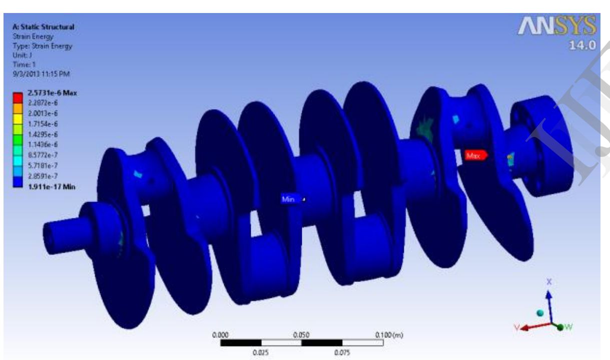


Figure 16. Strain Energy

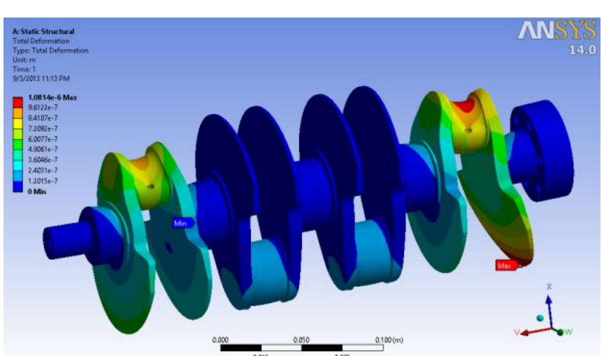


Figure 17. Total Deformation

3.4 Modal Analysis of Crankshaft

Material: Inconel X 750 Alloy

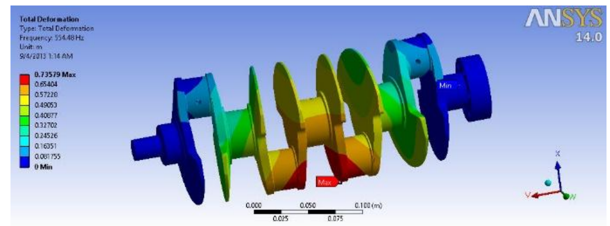


Figure 18. Total Deformation at Mode 1
Frequency: 554.48 Hz

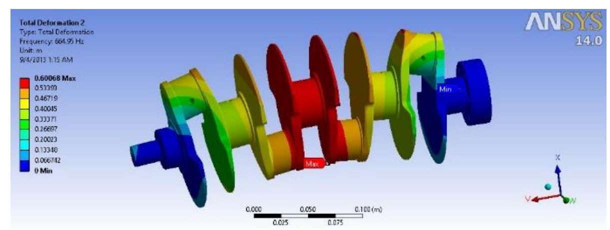


Figure 19. Total Deformation at Mode 2
Frequency: 664.95 Hz

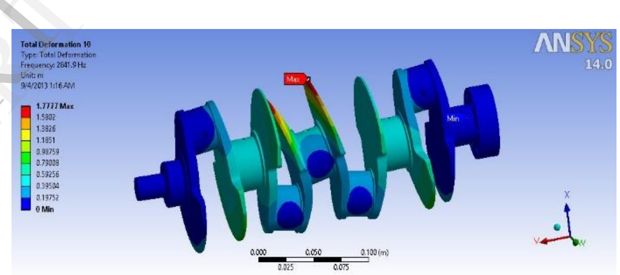
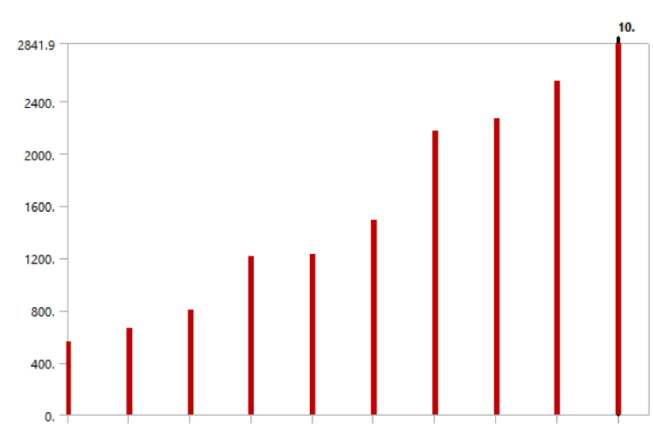


Figure20. Total Deformation at Mode 10
Frequency: 2841.9 Hz



Graph 2. Modal Graph for Inconel X 750 Alloy

4. Conclusions

In our project we have modelled a crankshaft used in IC Engines.

- We have done structural and modal analysis on crankshaft two materials Annealed 4340 Steel, Inconel X 750 Alloy to validate our design.
- By observing the results, the stress values for the materials are less than their respective permissible yield stress values. So our crankshaft design is safe.
- Although the Inconel density is greater, it can sustain heavy loads due to greater yield strength than Annealed 4340 Steel.
- So we conclude that our material Inconel X 750 is better than Annealed 4340 Steel for Crankshaft.

5. Scope in Feature

By using Inconel X 750 alloy material, crankshaft can sustain heavy loads. In future the high power generation vehicles can make use of this material.

6. References

[1] Vladimir V. Riabov, "*Computational And Analytical Methods In The Engine Crankshaft Design*", Riviera College, Nashua, New Hampshire 03060, USA.

[2] JianMeng, Yongqi Liu, Ruixiang Liu Zibo, Shandong, China "*Finite Element Analysis Of 4-Cylinder Diesel Crankshaft*" I.J.Image, Graphics And Signal Processing, 2011, 5, 22-29 Published Online August 2011 In Mecs.

[3] ZHOU Xun, YU Xiao-li, "*Reliability Analysis Of Diesel Engine Crankshaft*" Based On 2d Stress Strength Interference Model, School Of Mechanical And Energy Engineering, Zhejiang University, Hangzhou 310027, China.

[4] www.makeitfrom.com