Review on Modelling and Analysis of an EN19 Crankshaft Material in Comparison with Forged Steel Crankshaft

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ABSTRACT

Crankshaft is a key element of Engines. Crankshaft converts reciprocating motion into rotational motion through connecting rod. Fatigue forces, bending stress, strain etc. starts to act on crankshaft during performance. So the material property should be like that which can meet all requirements of crankshaft. The objective of the present work is to develop and analyze a two-wheeler crankshaft 3D model using Catia and ANSYS. EN19 and Forged steel are selected as crankshaft materials and their performance is evaluated and compared. Finite Element Analysis was used to determine the stress variation on the crankshaft's surface. The load and boundary conditions are applied to the FE model in ANSYS. The obtained results from the analysis are being used to find the total deformation and stress conditions of the crankshafts. This allows the stress range in the original crankshaft not to surpass the magnitude of the stress range. Static analysis is also conducted and tested by simulations in ANSYS. ANSYS simulations were done for static analysis of the crankshaft model. This study will help to choose material for crankshaft in upcoming days for mass production.

Keywords*:* EN19 material, crankshaft, forged steel

1. INTRODUCTION

The crankshaft is one of the most heavily loaded parts, and it is subjected to cyclic loads such as bending and twisting moment during its lifespan. Crankshafts of motor vehicles generally run at high rotation, between 700 and 8000 rpm, depending on the engine type. When a power impulse strikes a crankpin toward the front and the power stroke stops, the torsion vibration occurs. Since crankshaft durability optimization is a significant subject in engine engineering, many studies have been conducted based on experimental or analytical approaches which deal with testing and evaluation of fatigue performance. It must be able to withstand the downward force from the piston without bending excessively. Crankshafts in automotive engines can experience a significant number of cyclic loads. Since fatigue fracture initiated is one of the primary failure mechanisms of automotive crankshafts. As a result, the crankshaft's durability determines the reliability and life of an IC engine. So, our concern is to improve the load carrying capacity by choosing the appropriate material and compared that with the forged steel by using Finite Element Analysis. Recently many research has been done for improving performance of crankshaft by changing material.

1.1. Methods Used

I will use Catia for 3D modeling of crankshaft and with the help of ANSYS, I will conclude static analysis and compare that with the forged steel crankshaft. As EN19 material have high toughness, high resistance bearing capacity, and have the good shock loading capacity. Applying Boundary condition and meshing in FE analysis, I will tabulate the fatigue load, maximum stress, maximum strain, equivalent bending moment, and equivalent twisting moment**.**

2. LITERATURE REVIEW

Generally, crankshaft is manufactured of cast iron or forged steel.**(Clausen & Wood, 1999)(Vijaya Ramnath et al., 2018).**have taken three different material and try to optimize the weight reduction and also compare the total deformation ,shear stress, shear strain by using structural analysis on ANSYS. Refer table no. (1)

Properties	Cast iron	forged steel	aluminum alloy
Density(kg/m^3)	6800-7800	7800	2600
Poission`s Ratio	0.3	0.3	0.3
Young Modulus	1.78e5MPa	2.21e5MPa	7.1e5MPa

Table No. (1) Material properties

In table no. (2) obtained data is tabulated and have observed that forged steel is better.

Title	cast iron	forged steel	aluminum alloy
Total deformation	1.6304e-3	1.2543e-3	3.888e-3
Shear Stress	5.4711MPa	5.1048MPa	6.024MPa
Shear Strain	8.365e-5	6.0056e-5	6.9967e-5

Table No. (2) Deformation, stress and strain values of material

Thus, comparing above results the feasible material after weight reduction is doesn't very much in their performance, efficiency, and durability. Thus, forged steel is suitable material for crankshaft. An optimization study was performed on a forged steel crankshaft that considered the geometry, performance, manufacturing process, and cost. A major constraint of this optimization was for the optimized crankshaft to replace the original crankshaft in

the engine without any changes to the engine block or the connecting rod. An optimization in the geometry included local changes at different locations on the crankshaft, which were then combined to obtain the final optimized geometry.

2.(Karthick et al., 2021) Finite Element Method is approached to analyzing the crankshaft, models were evaluated for static structural analysis. EN8 and Forged steel material compositions were given as input, and stress induced was calculated for specified boundary conditions. In the ANSYS workbench 17.2 software kit, the CAE technique of investigation is used. The values attained using the CAE method are like those achieved results experimentally, so the technique developed can be considered for material testing and assessment of crankshafts for structural analysis, and it is developed using the SolidWorks software program. The total deformation of EN8 and Forged steel two-wheeler crankshaft, it is observed that maximum deformation for EN8 and Forged steel is 0.017289 m and 0.01712 m, respectively. The Equivalent strain of the two- wheeler crankshaft for two materials is observed. Comparatively the maximum equivalent strain in EN8
(6.6602) material is higher than in Forged Steel (6.595) material. The equivalent stress analysis for the EN 8 and forged steel materials of crankshaft and, according to the static analysis it is found that both the materials have the same equivalent stress.

3.(Geethanjali et al., 2018) The Forged and Annealed, EN19 and EN24 steel rods were taken to carry machinability test, which is carried by a center lathe. Cutting Speed, Depth of cut and Feed were three parameters selected. During machining operation, the forces in all three direction (Fx, Fy, and ,Fz) were measured using lathe tool dynamometer. Carbide brazed cutting tool inserts were used for machining. Facing is done on both side of the work piece. The work piece is held between the live and dead centers. Carbide tool is mounted on the tool post. Carrying out machining using carbide insert for a length of cut of 10mm. Record the different cutting forces components. Determining the power required for the machining operation. It was observed that, for EN19 the cutting Speed has a significance effect on the power and DOC, with feed as least significant. Optimum Power is obtained at a speed of 150 rpm, Depth of cut of 0.75 and Feed rate of 0.11, the surface roughness for EN 19 results with Cutting Speed have significant effect whereas the feed and depth of cut results with least significant effect. For EN24, it was observed that Cutting Speed has a significance effect on the power, whereas DOC and Feed with least significant effect. Optimum power obtained speed at 150 rpm, Depth of cut of 0.5 and Feed rate of 0.05, also the surface roughness for EN 24 results with Cutting Speed have significant effect and feed and depth of cut results with least significant effect.

4. (Citti et al., 2018) The need to deepen the aspect of costs savings while designing and manufacturing mechanical components is becoming a feature of hard management by automotive manufacturers. They have compared the physical properties of quenched and tempered steel (QT steels), bainitic steels. To increase the fatigue limit of such steels, for high-loaded crankshaft applications as in sport vehicles, a nitriding thermal treatment is done after the tempering treatment. The nitriding determines high surface hardness (above 750 HV) and increased mechanical properties on the surface, but maintains the same material alloy toughness in the shaft core. This is done mainly to improve fatigue resistance behavior. Bainitic transformation has both the features of martensite transformation and perlite transformation; the former is developed between two specific temperature limits inside which bainite can develop, that are Bs (bainite start) and Bf (bainite finish), while the latter is a time depending transformation. This means there is an incubation time and a completion time for the bainite generation. All these parameters are strongly affected by the alloying element concentration. When increasing the carbon content, the Bs temperature decreases as demonstrated by Steven and Haynes (1956) and Garcia-Mateo et al. (2005), while reducing alloying element concentrations speeds up the time of transformation – which means accelerating the kinetics of transformation.

5. (Jiao et al., 2020) Experimental analysis of fracture failure With the continuous advancement of engine technology, engine design is moving toward high efficiency, increased reliability, reduced quality, reduced fuel consumption and reduced emissions. The mechanical load continuously increases which makes the working conditions of the crankshaft more and more demanding and causes the crankshaft to be susceptible to bending fatigue damage and torsional fatigue damage. Due to the facts that the crankshaft is often excited by complex

alternating shock loads during operation, the crankshaft is subjected to transverse, longitudinal and torsional vibrations. When the frequency of some motivating force was same or similar with the first order natural frequency of the crankshaft, the resonance of the shaft system occurs, which is sufficient for cause fatigue fracture of the crankshaft. Modal analysis can avoid resonance and vibration at a specific frequency. The crankshaft is an asymmetrical or anti-symmetric body. Therefore, the whole crankshaft must be taken as the research object when carrying out finite element modal analysis. They have applied boundary condition and meshed in FEA and found the static analysis As shown in fig.(1)

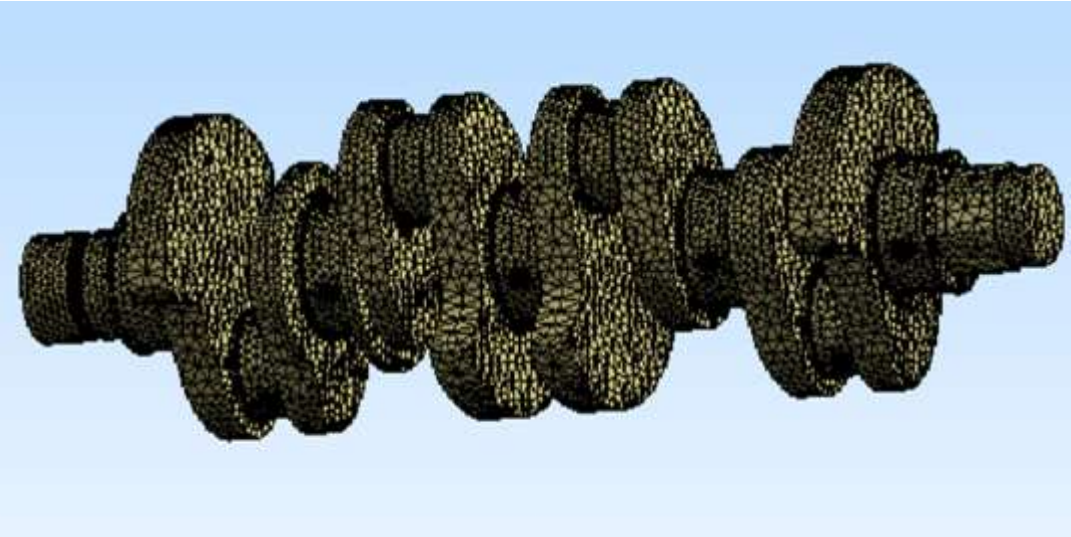

Fig.1

CONCLUSION

The static structural analysis of crankshaft is done by many researcher and try to improve life span of crankshaft. Researcher have not used Eupropean standard material i.e EN series steel in crankshaft.Only some researcher have compare the material properties of cast iron and EN series steel but they do not compare them in cyclic loading.So my analysis work in modeling and analysis of an EN19 crankshaft material in comparison with forged steel crankshaft.And also my eye on optimization of cost by optimizing weight**.**

In future it will help in commercial use in automobile and increase the life span of crankshaft and reliability.

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