

# FEA of the crankshafts Design by using Ansys workbench

## For nickel chrome steel and structural steel

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**Abstract**— In this present work statics analysis was conducted on a nickel chrome steel and structural steel crank shafts from a single cylinder four stroke engine. Finite elements analysis was performed to obtain the variation of stress magnitude at critical locations. Three dimensional model of crankshaft was created in Pro/E soft ware .The load was then applied to the FE model and boundary condition where applied as per the mounting conditions of the engine in the ANSYS Workbench.

**Keywords**- Finite element analysis, Pro/E, ANSYS Workbench, crankshaft.

### 1 INTRODUCTION

Crankshaft is a large component with a complex geometry in the engine, which convert the reciprocating displacement of the piston to a rotary motion with a four link mechanism. Since the crankshaft experiences a large number of load cycle during its service life, fatigue performance and durability of this component to be consider in the design process. Crankshaft must be strong enough to take the down word force of the power stock without excessive bending. So the reliability and life of internal combustion engine depend on the strength of the crankshaft largely for the engine runs, the power impulse hit the crankshaft in one place and then another. The torsion vibration appears when a power hits a crank pin to word the front of the engine at the power stock ends. If not controlled, it can break the crankshaft.

#### 1.1 Literature Review-

An extensive literature review on crankshaft was performed by zoroufi and fatemi (2005). There study present a literature survey focus on fatigue performance evaluation and compression of forge steel and ductile cost iron crankshaft in their study ' crankshaft specification ' operation condition and various fouler source are discussed. There survey includes a review of the effect of influent ion parameter such as residual stress on fatigue behavior and method is inducing compressive residual stress on crankshaft.

Therefore we followed the stress analysis and model analysis of 4 cylinder crankshaft. Fem software Ansys was used to analysis the vibration model distortion and stress states are crank throw. The

relationship between frequency and the vibration model are explained by the model analysis of crankshaft. This provides a valuable theoretical foundation for the optimization and improvement of engine design the maximum deformation appear at the center of the crankpin neck surface.

#### 1.2 FINITE ELEMENT METHOD:-

The finite element method is numerical analysis technical of op-tening approximate solution to a wide verity of engineering problems. Because of its diversity and flexibility as an analysis tool , it is receiving much attention in engineering school and industries in more and more engineering situation today , we find that it is necessary to obtain approximate solution to problems rather than exact close from solution it is not possible to obtain analytical mathematical solutions are many engineering's problems. An analytical solution is a mathematical expression that gives value of the desire unknown quantity an any location in the body, as consequence it is valid for infinite number of location in the body. For problem involving complex material properties and bounder condition, the engineer resource to numerical method that provide approximate that eatable solution.

### 2. FUNCTION OF CRANKSHAFT

The crankshaft, connecting rod and piston to a rotary motion. Since the rotation output is more practical and applicable for input to other devices, the concept design of an engine is that the output would be rotation. In addition, the linear displacement of an engine is not smooth, as the displacement is caused by the combustion of gas in the combustion chamber. Therefore, the displacement has sudden shocks and using this input are another device may cause damaged to it. The concept of using crankshaft is to change these sudden displacements to smooth rotary output, which is the input to many devices such as generators, pumps and compressor.

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### 3. DESIGN CALCULATION FOR CRANKSHAFT

The configuration of the diesel for the crankshaft is shown in table

capacity	395cc
Number of cylinder	Single cylinder
Bore * stroke	86*86 mm
Compression ratio	18:1
Maximum power	8.1hp @3600 rpm
Maximum torque	16.7Nm @2200rpm
Maximum gas pressure	25 Bar

#### 3.1 Methodology

##### 3.1.1 Procedure of static analysis

First of all, we have prepared assembly in Pro/E for crankshaft and save as this part as IGES for Exporting into ANSYS workbench Environment. Import IGES mode in ANSYS workbench simulation module.

Apply material for Crank Shaft (structural steel).

##### 3.1.2 Meshing criteria

Element type solid10 node quadratic tetrahedral

##### 3.1.3 Define boundary condition for analysis

Boundary condition play the important role in finite element calculation here, I have taken both remote displacement for bearing supports are fixed.

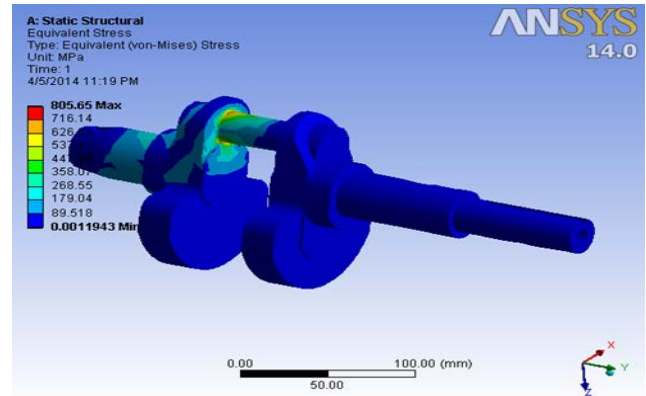


Fig.no.2: Nickle Chrome steel

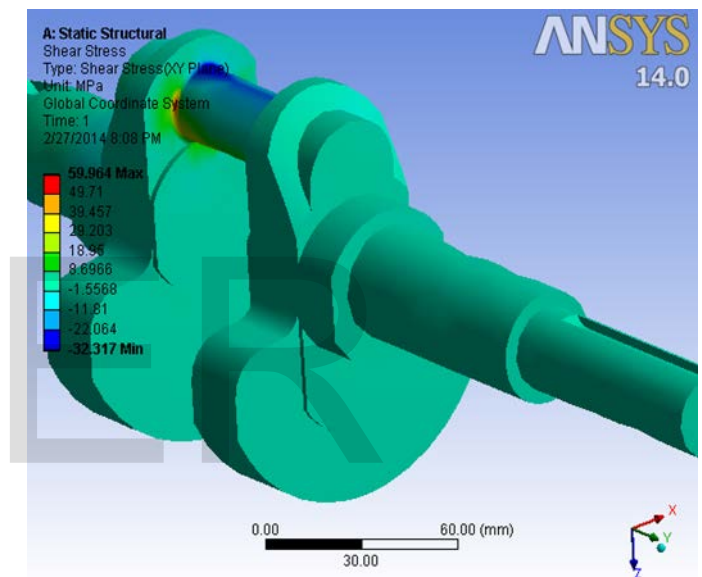


Fig. No. 3: Shear stresses.

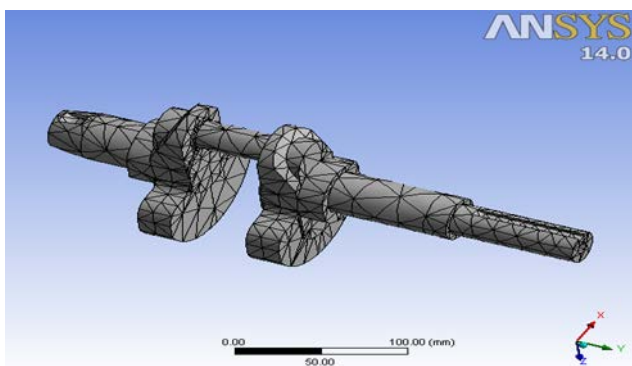
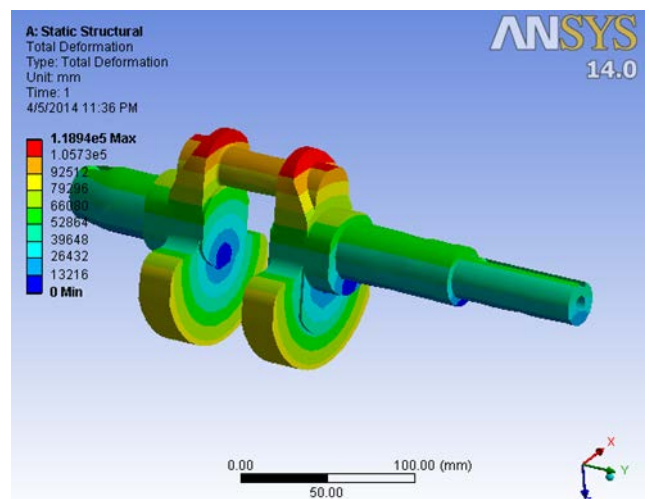


Fig. No. 1: Mess of the crank shaft.



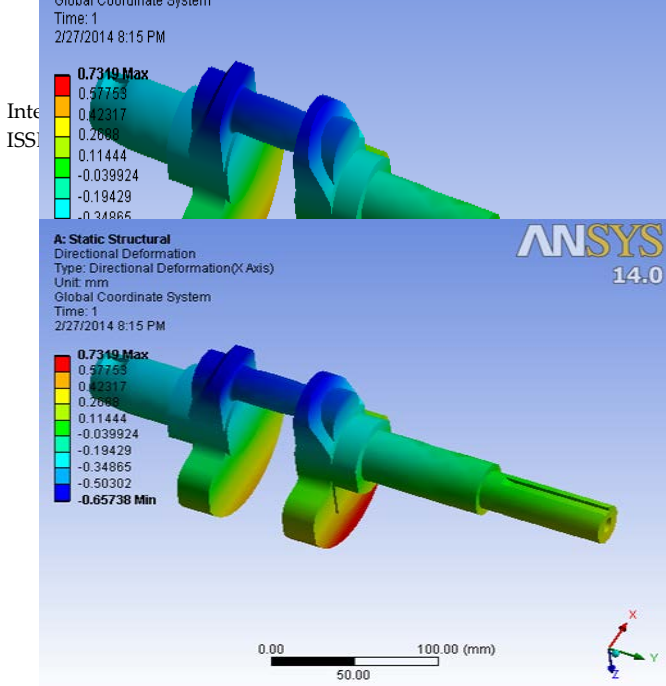


Fig. No. 5: Directional deformation of the crankshaft

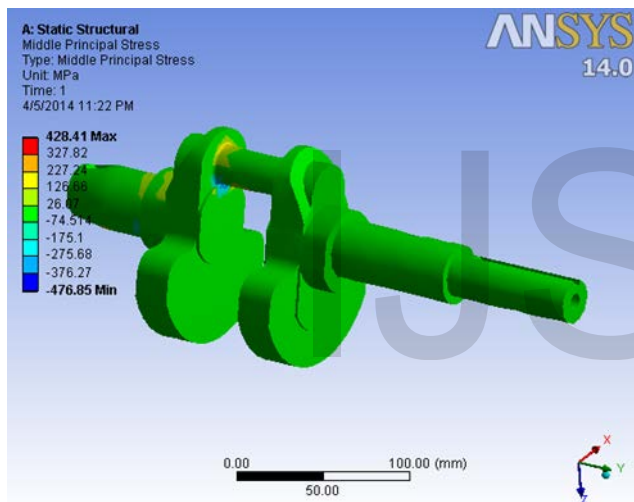


Fig. no. 6: Middle principal stress of the crankshaft.

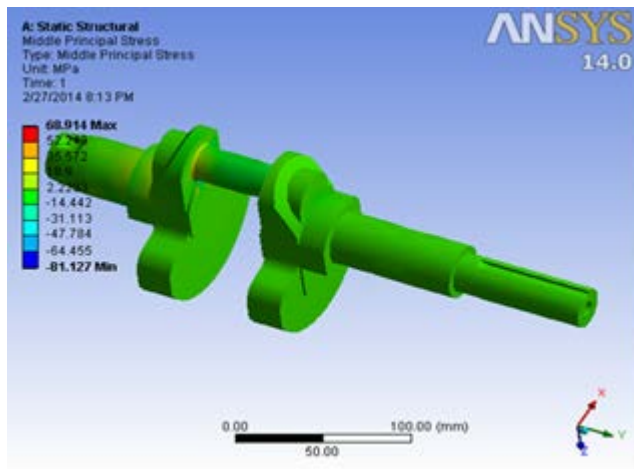


Fig. No.7: Middle principal stress of the crankshaft

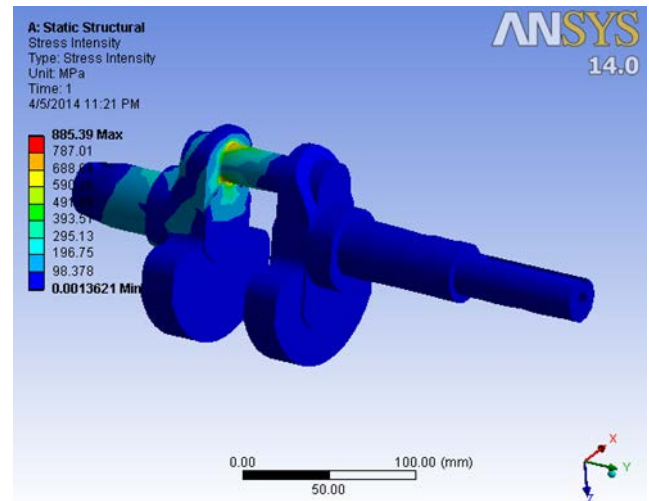
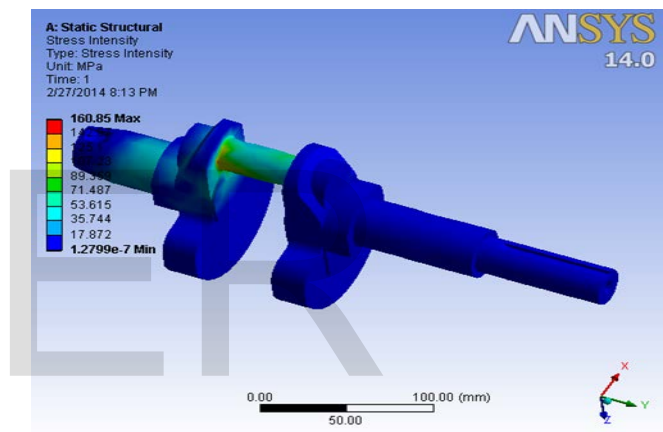


Fig. No.8: Middle principal stress of the crankshaft



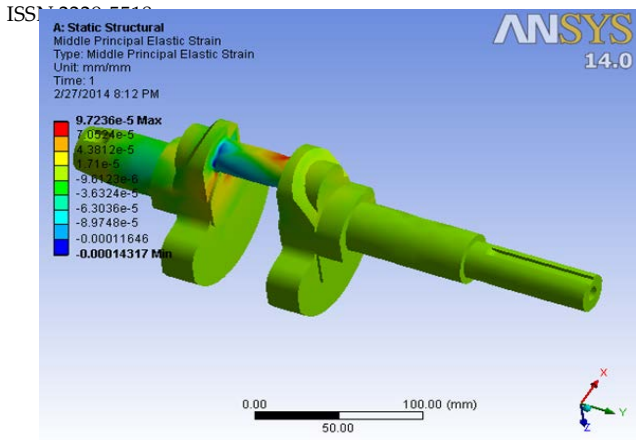


Fig. no.11: Middle principal elastic strain of the crankshaft

Table 1: Type stress and FEA analysis

Type of stress	FEA analysis
Shear stresses	59.89 (reference paper)
Shear stresses	59.964 (our calculation)
Directional deformation	0.7319 (mm)
Middle principal stress	68.914 (MPa)
Stress intensity	160.86 (MPa)
Middle principal elastic strain	$9.7236 \times 10^{-5}$ (mm/mm)

Table 2: Compression between nickel chrome and structural steel

S.N.	Analysis	Nickel Chrome steel	structural steel
1	Equivalent stress	805.65	59.964
2	Total Deformation	$1.1894e^5$	0.7319
3	Middle principle stress	428.41	68.914
4	Stress Intensity	885.39	160.85
5	Middle principle stress	428.41	$9.7236e^5$

#### 4. Results and Conclusions:

In this paper, the crankshaft model was created by pro/E 5 software. After that the model was created by pro/E is imported to Ansys workbench.

Above Result shows that FEA results conformal matches with the software calculation so we can say that FEA is a good tool to reduce time consuming Ansys workbench. The maximum deformation appears at the center of crankpin neck surface. The maximum stress appears at the fillets between the crankshaft journal and crank cheeks and near the central point journal. The edge of main journal is high stresses area.

The value of the von-Misses stresses that comes out from the analysis is for less than material yield stress so our design is safe and we should go for optimization to reduce the material and cost.

After performing static analysis we performed dynamic analysis of the crankshaft which result shows more realistic whereas static analysis provides an overestimate results. Accurate stresses and deformation are critical input to fatigue analysis and optimization of the crankshaft.

Analysis results, so we can say that Dynamic FEA is a good tool reduce costly experimental work. By observing the static analysis results shows that stress assesses using nickel chrome steel and structural steel crank shafts from a single cylinder four stroke engine are within the permissible stress value. So using nickel chrome steel and structural steel is good for crank shafts but as compared between nickel chrome and structural steel, nickel chrome is best suited material over the structural steel.

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