DESIGN AND ANALYSIS OF CRANKSHAFT FOR 4-STROKE DEISEL ENGINE

M. Srihari*, Shaik Himam Saheb** & S. Vijaya Nirmala***
Assistant Professor, Guru Nanak Institute of Technology,
Hyderabad, Telangana

Abstract:
Crankshaft is large volume production component with a complex geometry in the Internal Combustion (I.C) Engine. This converts the reciprocating displacement of the piston in to a rotary motion of the crank. We are study selection of best material by comparing the Static analysis on a crankshaft from a multi cylinder (4-cylinder) 4-stroke I.C Engine*. The modeling of the crankshaft is created using CATIA-V5 Software. This model will be converted to Initial Graphic Exchange Specification (IGS). Finite element analysis (FEA) is performed to obtain the variation of stress at critical locations of the crank shaft using the ANSYS software and applying the boundary conditions. Then the results are drawn Von-misses stress induced in the crankshaft is 15.83Mpa and shear stress is induced in the crankshaft is 8.271Mpa. The Theoretical results are obtained von-misses stress is 19.6Mpa, shear stress is 9.28Mpa. The validation of model is compared with the Theoretical and FEA results of Von-misses stress and shear stress are within the limits.*

Introduction:
Crank shaft is a large component with a complex geometry in the I.C engine, which converts the reciprocating displacement of the piston to a rotary motion with a four bar link mechanism. Crankshaft consisting of shaft parts, two journal bearings and one crankpin bearing.

The Shaft parts which revolve in the main bearings, the crank pins to which the big end of the connecting rod are connected, the crank arms or webs which connect the crank pins and shaft parts. In addition, the linear displacement of an engine is not smooth; as the displacement is caused by the combustion chamber therefore the displacement has sudden shocks.

The concept of using crankshaft is to change these sudden displacements to as smooth rotary output, which is the input to many devices such as generators, pumps and compressors. It should also be stated that the use of a flywheel helps in smoothing the shocks. Crankshaft experiences large forces from gas combustion. This force is applied to the top of the piston and since the connecting rod connects the piston to the crank shaft, the force will be transmitted to the crankshaft.

The magnitude of the forces depends on many factors which consist of crank radius, connecting rod dimensions, and weight of the connecting rod, piston, piston rings, and pin. Combustion and inertia forces acting on the crankshaft

- ✓ Torsional Load
- ✓ Bending Load

Crankshaft must be strong enough to take the downward force of the power stroke without excessive bending so the reliability and life of the internal combustion engine depend on the strength of the crankshaft largely.
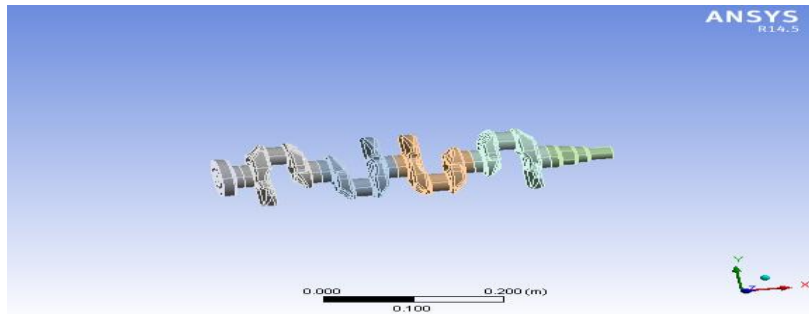
The crank pin is like a built in beam with a distributed load along its length that varies with crank positions. Each web is like a cantilever beam subjected to bending and twisting.

- ✓ Bending moment which causes tensile and compressive stresses
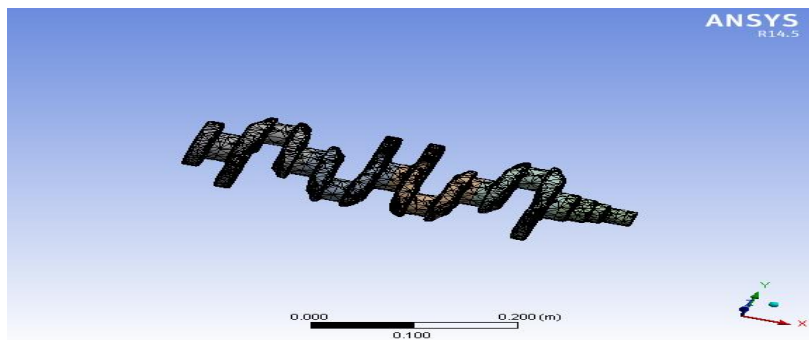- ✓ Twisting moment causes shear stress
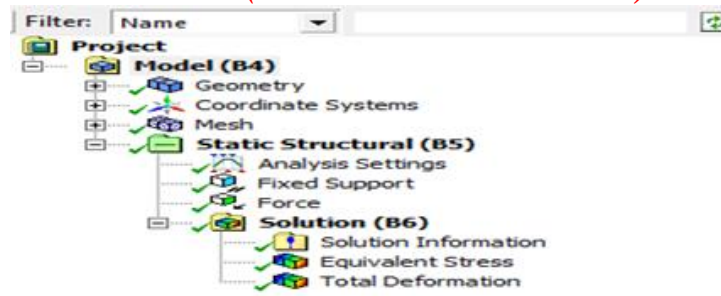
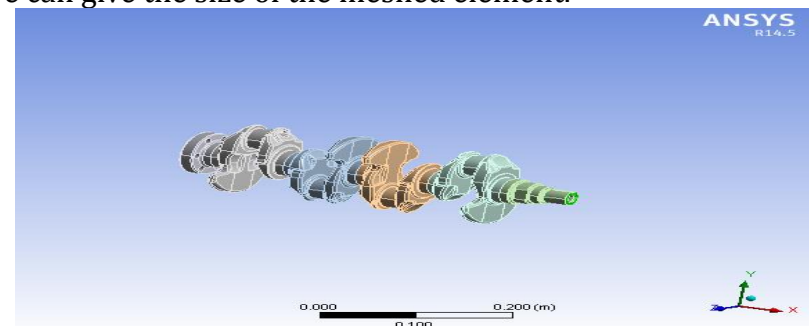Modal Tree

✓ This is the model tree which is on the left side.

Imported Crankshaft

✓ This is the imported multi cylinder crankshaft.
✓ When we go into the geometry firstly we give the units.

Meshing Operation

✓ Now right click on the mesh and click Generate Mesh.
✓ Then mesh is generated.
✓ Here we can give the size of the meshed element.

Fixed Support

✓ In static structural we give fixed supports.
✓ Here we have taken 2 fixed supports.
✓ One in X-axis and other in Y- axis.
   Here in our project we are considering two materials structural steel and gray

cast iron. Analysis when structural steel material is considered.
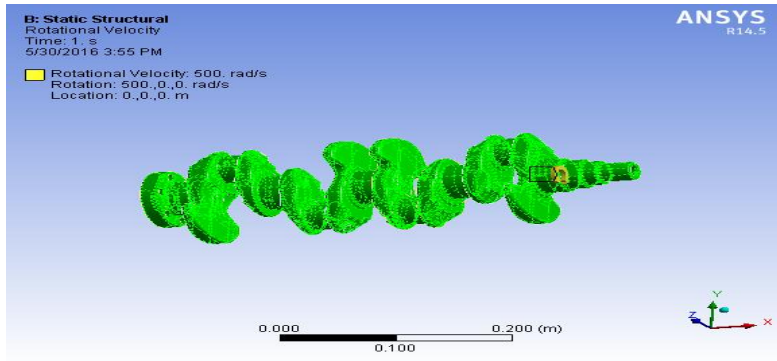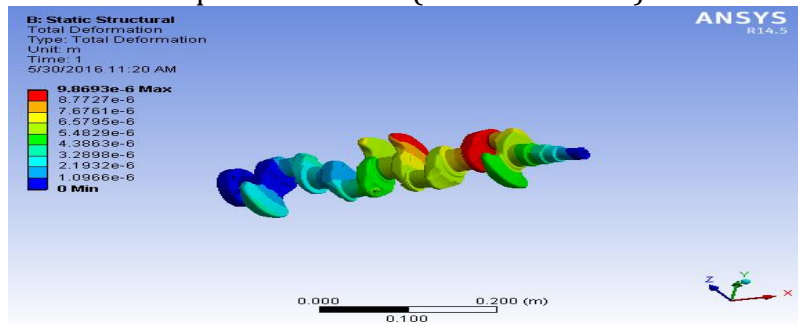

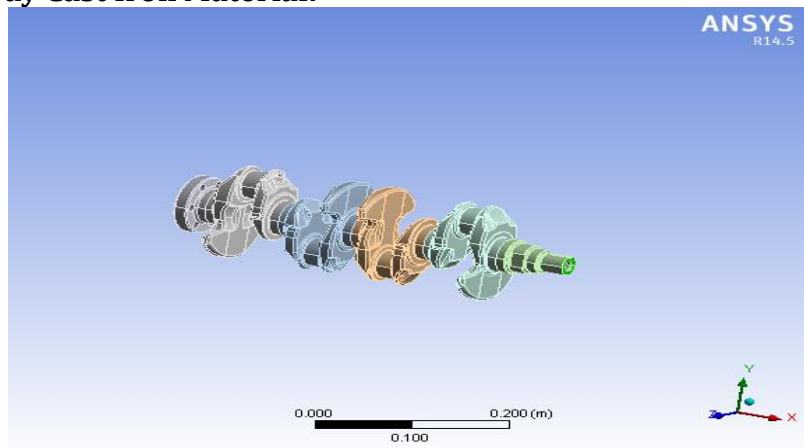Force Application

✓ Rotational velocity of 500 m/s is applied.
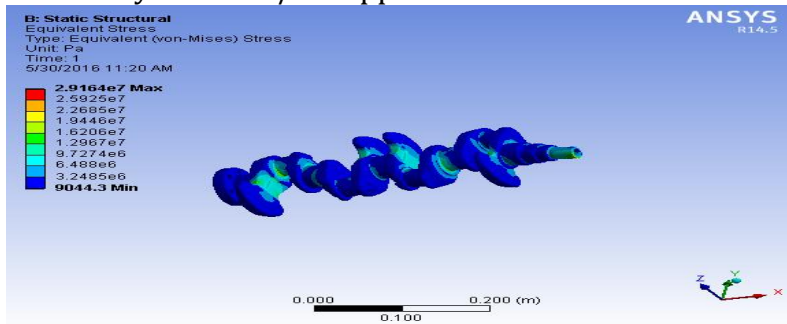
Equivalent Stress (Structural Steel)
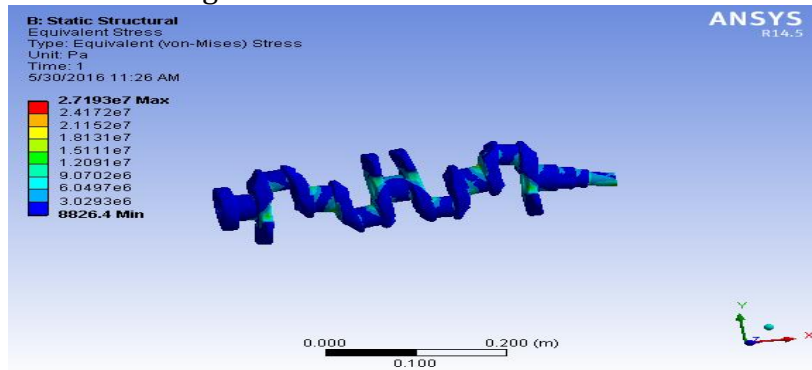

Total Deformation (Structural Steel)

✓ Deformation is shown in the figure.
✓ Here max deformation is shown in red color.
✓ Minimum deformation is shown in blue color.
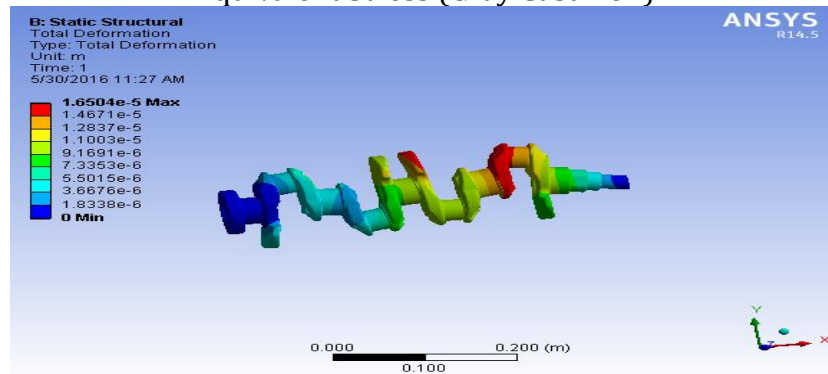
Analysis of Gray Cast Iron Material:

Fixed Support

International Journal of Scientific Research and Modern Education (IJSRME)
ISSN (Online): 2455 – 5630
(www.rdmodernresearch.com) Volume I, Issue II, 2016

✓ Same ends are fixed again.

Equivalent Stress (Gray Cast Iron)

Total Deformation (Gray Cast Iron)

✓ Deformation is shown in the figure.
✓ Here max deformation is shown in red color.
✓ Minimum deformation is shown in blue color.

Results:

S.No	Material	Rotational Velocity (Rad/Sec)	Equivalent Stress (pa)		Total Deformation (M)	
			Min	Max	Min	Max
1	Structural steel	500	9044.3	$2.9*e^7$	$1.09*e^{-6}$	$9.8*e^{-6}$
2	Gray cast iron	500	8826.3	$2.7*e^7$	$1.8*e^{-6}$	$1.6*e^{-5}$

Conclusion:

From the above structural analysis of crank shaft made of two different materials i.e., structural steel and gray cast iron by using ANSYS software it is observed that the equivalent stress and total deformation varies for every material. From the table it is seen that under same load conditions gray cast iron has minimum equivalent stress than gray cast iron as compared to their material properties. So it is more preferred to structural steel. Crank shafts average life depends upon the material properties. So proper material should be selected.

Above Results Shows that FEA Results Conformal matches with the theoretical calculation so we can say that FEA is a good tool to reduce time consuming theoretical Work. 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 stress area. The Value of Von-Misses Stresses that comes out from the analysis is far less than material yield stress so our design is safe and we should go for optimization to reduce the material and cost.

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