IOSR Journal of Engineering (IOSRJEN) **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
Vol. 08, Issue 01 (January. 2018), ||V1|| PP 38-42

Design And Stress Analysis of Crankshaft For Single Cylinder 4-Stroke Diesel Engine

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Abstract: Crankshaft is one of the critical components for the effective and precise working of the internal combustion engine. In this paper a static simulation is conducted on a crankshaft from a single cylinder 4- stroke diesel engine. A three-dimension model of diesel engine crankshaft is created using solids work software. Finite element analysis (FEA) is performed to obtain the variation of stress magnitude at critical locations of crankshaft. Simulation inputs are taken from the engine specification chart. The static analysis is done using FEA Software ANSYS which resulted in the load spectrum applied to crank pin bearing. This load is applied to the FEA model in ANSYS, and boundary conditions are applied according to the engine mounting conditions. The analysis is done for finding critical location in crankshaft. Stress variation over the engine cycle and the effect of torsion and bending load in the analysis are investigated. Von-meshes stress is calculated using theoretically and FEA software ANSYS. The relationship between the frequency and the vibration modal is explained by the modal and harmonic analysis of crankshaft using FEA software ANSYS.

Keywords: Diesel Engine, Crankshaft, Solid Works Software, Finite Element Analysis, Stress Analysis.

Date of Submission: 27-12-2017 Date of acceptance:12-01-2018

I. INTRODUCTION

A **crankshaft** related to crankis a mechanical part able to perform a conversionbetween reciprocating motion and rotational motion. In a reciprocating engine, it translates reciprocating motion of the piston into rotational motion; whereas in a reciprocating compressor, it converts the rotational motion into reciprocating motion. In order to do the conversion between two motions, the crankshaft has "crank throws" or "crankpins", additional bearing surfaces whose axis is offset from that of the crank, to which the "big ends" of the connecting rods from each cylinder attach.It is typically connected to a flywheel to reduce the pulsation characteristic of the four-stroke cycle, and sometimes a torsional or vibrational damper at the opposite end, to reduce the torsional vibrations often caused along the length of the crankshaft by the cylinders farthest from the output end acting on the torsional elasticity of the metal.Large engines are usually multi cylinder to reduce pulsations from individual firing strokes, with more than one piston attached to a complex crankshaft. Many small engines, such as those found in mopeds or garden machinery, are single cylinder and use only a single piston, simplifying crankshaft design.A crankshaft is subjected to enormous stresses, potentially equivalent of several tonnes of force. The crankshaft is connected to the fly-wheel (used to smooth out shock and convert energy to torque), the engine block, using bearings on the main journals, and to the pistons via their respective con-rods. An engine loses up to 75% of its generated energy in the form of friction, noise and vibration in the crankcase and piston area. remaining losses occur in the valve train (timing chains, belts, pulleys, camshafts, lobes, valves, seals etc.) heat and blow by.

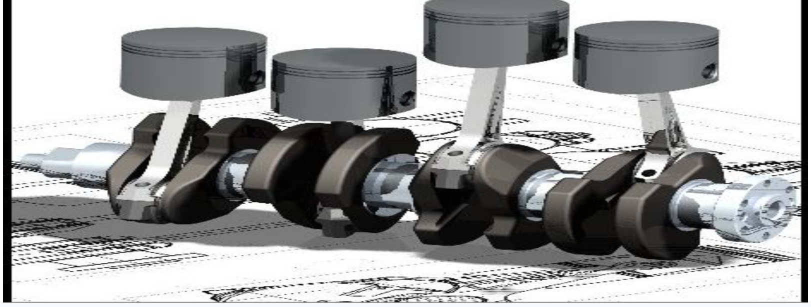


Fig: Crankshaft, pistons and connecting rods for a typical internal combustion engine.

The crankshaft is the engine component. It is used to transmit the power from the engine. Crankshaft is a sharp consisting of the following major parts.

1. Main journal
2. Crank pins
3. Crank webs
4. Counter weights

1. **Main journal:**These are supported in main bearings in the crankcase. This form the axis for the rotation of the crankshaft. Their number is always one more (or) one less than the number of cylinders.
2. **Crank pin:** The crankpin are the journals for the connecting rod big end bearings and are supported by the crank webs.
3. **Crank webs:** The crank webs should be suitable strong to against the twisting and the bending loads. However, increases the inertia. Which would tend to wind and unwind the crankshaft, when the engine is running.
4. **Counter weights:** These are either formed as internal part of the crank web (or) attached separately, on the side opposite to the crankpin. As the separate weights can be made to overlap (one part of the load cover and another part) the crank webs.

1.1 About the project:

Crankshaft is one of the critical component for the effective and precise working of the internal combustion engine. Many of the industries are using the ductile material for the manufacturing the crankshaft. Crankshafts materials should be readily shaped, machined and heat-treated, and have adequate strength, toughness, hardness, and high fatigue strength. the crankshaft are manufactured from steel either by forging or casting. the main bearing and connecting rod bearing liners are made of Babbitt, a tin and lead alloy. forged crankshafts are stronger than the cast crankshafts, but are more expensive. forged crankshafts are made from SAE 1045 or similar type steel. forging makes a very dense, tough shaft with a grain running parallel to the principal stress direction. crankshafts are cast in steel, modular iron or malleable iron. Generally automobile crankshafts were forged in past to have all the desirable properties. However, with the evolution of the nodular cast irons and improvements in foundry techniques, cast crankshafts are now preferred for moderate loads. Only for heavy duty applications forged shafts are favored. The crankshaft made by the **3%-Chromium-molybdenum or 1.5%-Chromium-aluminum-molybdenum Steel** These forged steels are used for diesel-engine crankshafts suitable for bearing of hard high fatigue-strength materials. The alloying compositions are 0.15% carbon, 3% chromium, and 0.5% molybdenum or 0.3% carbon, 1.5% chromium, 1.1% aluminum, and 0.2% molybdenum. Initial heat treatment for both steels is oil quenching and tempering at 1193 K and 883 K or 1163 K and 963 K respectively for the two steels. The shafts are case-hardened by nitriding, so that nitrogen is absorbed into their surface layers. If the nitriding is carried out well in the journal fillets, the fatigue strength of these shafts is increased by at least 30% compared to induction and flame-surface-hardened shafts. The 3%-chromium steel has a relatively tough surface and hardness of 800 to 900 DPN. On the other hand the 1.5%-chromium steel casing tends to be slightly more brittle but has an increased hardness, of the order of 1050 to 1100 DPN. Then different types of stress is added to the crankshaft then the shaft is subjected to various forces but generally needs to be analyzed in two positions. Firstly, failure may occur at the position of maximum bending; this may be at the Centre of the crank or at either end. In such a condition the failure is due to bending and the pressure in the cylinder is maximal. Second, the crank may fail due to twisting, so the conrod needs to be checked for shear at the position of maximal twisting. The pressure at this position is the maximal pressure, but only a fraction of maximal pressure.

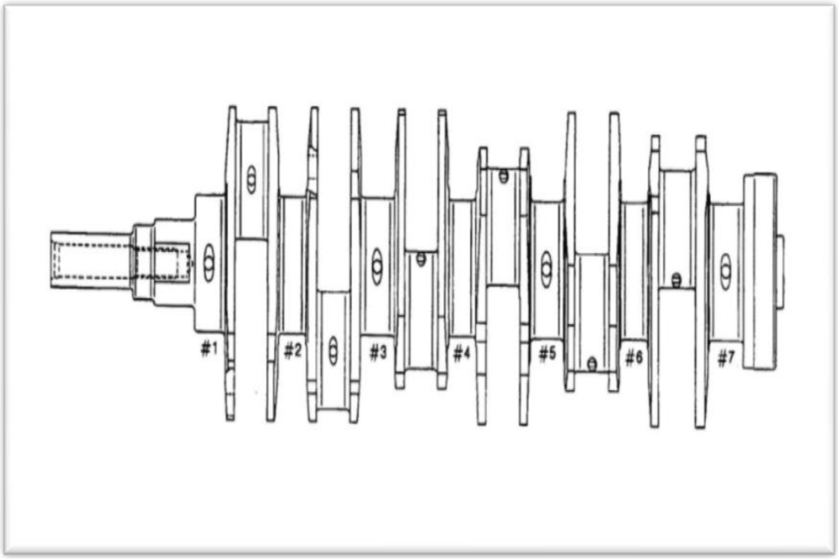
Fig: Forged crank shaft

II. OBJECTIVE

The main objective is to Design and Stress Analysis of Crankshaft for Single Cylinder 4-Stroke Diesel Engine.

2.1Block diagram

Block diagram of the crankshaft



III. ADVANTAGES

1. Forging makes a very dense, tough shaft with a grain running parallel to the principal stress direction.
2. Good machinability, there is less need for expensive alloys to attain high strength components.
3. It can bear high temperatures.

4. Fatigue strength of these shafts is increased by at least 30% compared to induction and flame-surface-hardened shafts.
5. Forging offers uniformity of composition and structure.
6. While compare to casting crankshaft the forging crankshaft is less cost.

IV. Disadvantages

High brittleness.
Cold brittleness.

V. APPLICATIONS

Crankshafts are used in automobiles, cars , lorries , bus etc..,

VI. RESULT

The stress analysis of crank shaft model is carried out by using two methods. For the comparison of induced stresses in the model with these two methods are discussed in this chapter. The relevant results are plotted by the graphs. The methodologies used for the determination of stresses and analysis of the model are; Photo-elasticity analysis Numerical method (FEA) The results obtained from the above two methods with the crank shaft model is considered for the two extreme loading conditions are tabulated as follows;

TABLE 3: Comparison Of Results Of Experimental And Numerical Method
Sl. No. Load (W) N Computed values of stresses (N/mm2) for crank shaft model under central point load at the crank pin Computed values of stresses (N/mm2) for the crank shaft model under axial point load at the axis of the shaft Experimental method Numerical method Experimental method Numerical method Pt. 1 Pt. 2 Pt. 3 Pt. 4 Pt. 5 Pt. 1 Pt. 2 Pt. 3 Pt. 4 Pt. 5 Pt. 1 Pt. 2 Pt. 3 Pt. 4 Pt. 5 Pt. 1 Pt. 2 Pt. 3 Pt. 4 Pt. 5 1 25. 8 0.6 0. 3 0.3 0. 8 0. 8 0. 7 0. 5 0. 5 0. 7 0. 8 0. 8 0. 3 1. 1 1. 1 1. 1 1. 0 0. 5 1. 1 1. 2 1. 5 2 45. 5 0.8 1. 1 1.1 1. 3 1. 3 1. 3 1. 2 1. 3 1. 3 1. 3 1. 3 1. 8 1. 1 1. 3 1. 5 1. 8 0. 9 1. 3 1. 8 2. 0 3 65. 1 1.1 1. 3 1.3 1. 5 1. 5 2. 1 1. 4 1. 4 1. 8 1. 8 1. 1 1. 8 1. 3 1. 8 2. 8 2. 6 1. 3 1. 8 2. 2 2. 5 4 84. 7 1.5 1. 8 1.8 2. 8 2. 8 2. 4 2. 1 2. 2 2. 4 2. 4 1. 1 1. 5 2. 8 3. 0 3. 0 1. 7 1. 7 3. 1 3. 3 3. 6 5 104 2.6 2. 8 2.8 3. 0 3. 0 3. 0 2. 9 3. 0 3. 0 3. 0 1. 3 1. 1 3. 0 2. 8 4. 0 2. 1 2. 1 3. 3 3. 7 4. 1 6 123 3.0 3. 5 3.5 4. 0 4. 0 3. 5 3. 4 3. 4 3. 5 3. 6 2. 8 3. 0 3. 5 4. 0 4. 6 3. 7 2. 4 3. 8 4. 0 4. 5

VII. CONCLUSION

The conclusion stated as follows; The relevant literature review is made with respect to crank shaft design and stress analysis through Photo-elasticity and ANSY12. The photo-elastic models are fabricated and stress analysis is carried out through Research Polariscope in Design Laboratory. The model through ANSY 12 is built and analyzed for stress distribution at various points considered. The stress distribution by above methods shows that the values obtained are close. It is concluded that the designed model of crank shaft is safe to use for industrial purpose.

VIII. FUTURE SCOPE

The future scope for the project work carried out as followed; One may consider other parts for the similar study. Any intricate/complex design component may be analyzed using Photo-elasticity and ANSY software, one may take up the crank shaft design for other parameters like maximum twisting moment, for some other vehicle such as two stroke petrol or diesel or 4- stroke petrol or diesel engines.**:**

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Degala Rajendra."Design And Stress Analysis of Crankshaft For Single Cylinder 4-Stroke Diesel Engin.″ IOSR Journal of Engineering (IOSRJEN), vol. 08, no. 1, 2018, pp. 38-42.