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A COMPARATIVE ANALYSIS OF VON-MISSES STRESS DISTRIBUTION IN ENGINE SHAFTS

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Abstract:-
In the present work, dynamic analysis is carried out on an engine shaft for a single cylinder four stroke engine. The shafts are modeled using finite element analysis and the intensity of stress magnitude is determined. It is shown in the paper that the stress variation is high at some critical points. The dynamic analysis is carried out analytically at different engine speeds and is verified by simulation software. As a result, the critical engine speed and critical region on the shafts are obtained.

Keywords: - *Dynamic analysis, Von-Misses stress, critical speed, Finite element model*

I. INTRODUCTION

Today's automotive industries are faced with a number of issues, which require them to be responsive in order to be competitive. To be competitive, one has to produce components with low cost and high quality. The advent of high performance computers, CAD tools and Optimization techniques has helped realize the demand of global market. With the help of Optimization techniques and numerical methods, one can design a component, create a solid model using CAD tools, simulate the operating conditions and find out if the component meets the expectations and feasibility before starting the actual production, thereby saving time and resources. 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.

Rinkle garg and Sunil Baghl. [1] have been analyzed crankshaft model and crank throw were created by Pro/E Software and then imported to ANSYS software. The result shows that the improvement in the strength of the crankshaft as the maximum limits of stress, total deformation, and the strain is reduced. Gu Yingkui, Zhou Zhibo. [2] have been discussed a three-Dimensional model of a diesel engine crankshaft were established by using PRO/E software and analytical ANSYS Software tool, it shows that the high stress region mainly concentrates in the knuckles of the crank arm & the main journal and the crank arm & connecting rod journal ,which is the area most easily broken. R. J. Deshbhratar, and Y.R Suple.[3] have been analyzed 4- cylinder crankshaft and model of the crankshaft were created by Pro/E Software and then imported to ANSYS software The maximum deformation appears at the centre of crankshaft surface. The maximum stress appears at the fillets between the crankshaft journal and crank cheeks, and near the central point.

II. Design issues

In the world of component design, there are competing criteria, which require the engineers to achieve a perceived optimal compromise to satisfy the requirements of their particular efforts. In contemporary racing crankshaft design, the requirements for bending and torsional stiffness compete with the need for low mass moment of inertia (MMOI). Several crankshaft experts emphasized the fact that exotic metallurgy is no substitute for proper design, and there's little point in switching to exotics if there is no fatigue problem to be solved.

High stiffness is a benefit because it increases the torsional resonant frequency of the crankshaft, and because it reduces bending deflection of the bearing journals. Journal deflection can cause increased friction by disturbing the hydrodynamic film at critical points, and can cause loss of lubrication because of increased leakage through the greater radial clearances that occur when a journal's axis is not parallel to the bearing axis.

Metal parts are not rigid. When a load is applied to a metal part, the part deflects in response to the load. The deflection can be very small Crankshaft, or it can be quite large (valve springs, etc). But to one degree or another, all parts behave like springs in response to a load. The ultimate strength of a material is a measure of the stress level which can be applied to a lab sample of the material before it fractures. If you apply an increasing load to each component, both will deflect the same amount for each load value, until the component with the lower strength permanently deforms (and breaks if it is loaded and constrained in a certain way) at a relatively low stress level. The component with the higher strength will continue to deform with increasing load until its yield stress is reached, at which point it too will permanently deform.
Since the current crankshaft materials are alloy steels, the Young's Modulus is fairly constant. That means that altering the section properties of the highly-stressed portions of the crankshaft is the only way to increase stiffness.

III.METHODOLOGY

- Determine the magnitudes of the various loads acting on the crankshaft.
- Determine the distance between supports. The distances will depend upon the lengths of the bearing. The lengths & diameters of the bearings are determined on the basis of maximum permissible bearing pressures, l/d ratios and the acting loads. (TABLE 1 and Table 3.6/49)
- For the sake of simplicity and safety, the shaft is considered to be supported at the centers of the bearings.
- The thickness of the crank webs is assumed, about 0.5d to 0.6d, where d is the shaft diameter, or from 0.22D to 0.32D, where D is the cylinder bore.
- Now calculate the distance between supports.
- Assume allowable bending and shearing stresses.
- Compute the necessary dimensions of the crankshaft.

IV.NUMERICAL PROBLEM:

The crank shaft for a power transmitting IC engine is shown in the figure 4.1

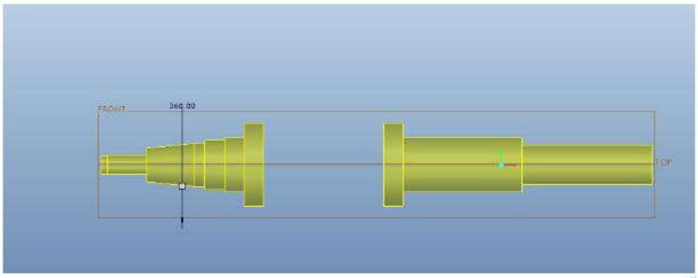

Fig.4.1 Crankshaft of an engine

The shaft is modeled considering its degrees of freedom and the finite element model is developed as shown in the figure 4.2.

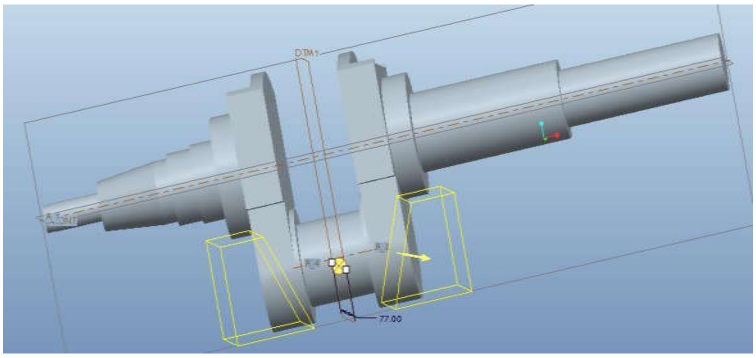

Fig.4.2 Finite element model of the engine shaft

Results and discussion

Static structural analysis: Analysis was done to calculate the strengths of the materials applied for the crankshaft.
The load was applied for the crank shaft which of carbon steel as material.

S.No	Load N.mm	Deformation in mm	Strain in mm/mm	Von-mises Stress in MPa
1	1000	5.3724e-003	8.5912e-005	12.87
2	2000	1.0745e-002	1.7182e-004	25.74
3	3000	1.6117e-002	2.5774e-004	38.611
4	4000	2.1489e-002	3.4365e-004	51.481
5	5000	2.6862e-002	4.2956e-004	64.351

V. Conclusion

Dynamic analysis of a crank shaft at different speeds has been carried out for a four stroke engine. The results are compared using simulation software and obtained the deviation in the Von-misses stress and strain values.

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