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Dynamic Stress Analysis of Engine Shafts in Automobile Industries

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Abstract

In the present work, stress analysis of engine shafts in an Automobile industry has been carried out. The dynamic analysis is performed on the engine shaft to determine stress and deformation that developed across its length when subjected to variable loading conditions. The modal analysis has also been carried out to determine the dynamic features of the shaft. The results obtained by the stress analysis is found to be good agreement and the strains developed are presented are within the limit. Simulation software is used to analyze the data for various speeds of rotation of the engine shaft. The critical speed of the engine is predicted based on the experimental and simulation values.

***Keywords:** Dynamic analysis, Computer aided design, Dynamic stress, Critical speed, Finite element model*

INTRODUCTION

The design, development, manufacture, marketing, and sale of motor vehicles is majorly carried out in automobile industries. In India, automobile industries were developed with significant scope for expansion, both in the domestic market and international market. Due to these automobile industries, India stood among top in the world market [1]. For the past two decades, India was grown very fast in the automobile sector due to the revolutionary changes that has come in the management systems and manufacturing innovations of the world automotive industry. The growth of automobile sectors in India has become key driver for all other countries in the world. Several other sectors have also been linked up with automobile sectors and hence the contribution for growth has become much higher [2]. The automobile globalization has brought significant changes in the World economy providing good and better quality products at lower costs [3]. Global competition of India in world market was succeeded due to the changes in design and adaptation of international technologies [4]. With the introduction of Computer in design and manufacturing fields, tremendous changes have come in the industries and changed the lives of designers and engineers in the entire world [5]. Introduction of latest technologies in the fields provides more efficient and effective works [6]. With the emerge of 3D printing technology, earlier fabrication methods are made much simpler and encompasses prototyping of the models in a much effective way [7].

DESIGN ISSUES

The cooperative operation of each vehicle component is a necessary condition to ensure the security. It can be seen from the collision test data that the safety performance of the vehicle body is important as the main force structure. The efficient utilization of resources, reasonable design methods reduce the cost of manufacturing, fabricate components possessing good mechanical properties like strength, durability, stiffness. This could replace the traditional design methods which incur large amount of work, and also the unreasonable structural margin design due to larger calculation error. Traditional methods cannot

effectively improve the structure safety, as we'll as the incensement of production costs and structural weights. FEM have been widely used in the mechanical design of automobile parts, such as the lightweight design of automotive frame and the analysis of frame and body vibration characteristics, which can effectively solve the problem of the whole deformation and stress distribution of complex parts. Also Finite element formulation provides better support for strength and stiffness analysis of brake systems and wheel systems. FEM is an analytical tool used to analyze stresses and deformations under different loading conditions, through which efficiency in design is improved to a far extent and thus reducing the calculation error.

The safety of automobiles is based mainly on the engine, chassis and its body, which are the complicated parts to be designed. FEM is a powerful tool which can be employed through which manufacturing cost is reduced and manufacturing period is shortened.

METHODOLOGY

The Finite Element method is a numerical technique used to obtain solution to partial differential equations. They are termed as boundary value problems as they comprise of boundary conditions to solve differential equations. A set of algebraic equations could be arrived through these equations employing boundary conditions, which can be solved easily. The initial value problems containing parabolic equations could not be solved completely by FEM and other tool termed as Finite Difference method (FDM) is employed. This is an effective numerical technique used to solve parabolic and hyperbolic equations which contain time as one of the independent variable.

Considering the magnitudes of various loads acting on the shafts, determine the size of the bearings chosen for the application. Assuming the dimensions of the crank webs, the dynamic stresses developed in the shaft are determined. Thereafter the bending stresses and shearing stresses developed in the shaft are also determined

NUMERICAL PROBLEM

The crank shaft for a power transmitting IC engine is shown in the Figure 1.

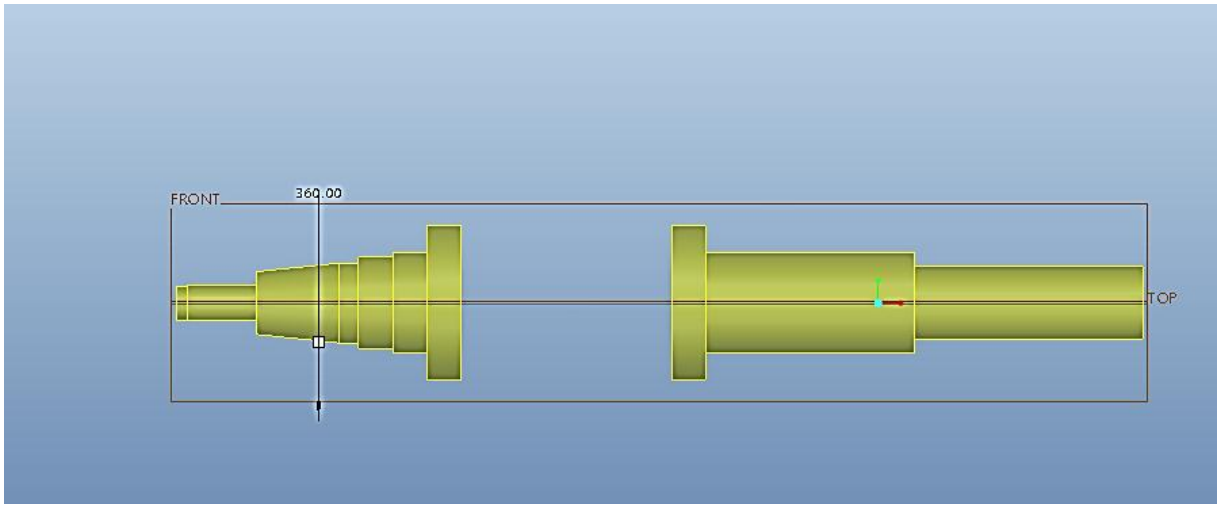

Figure 1: *Crankshaft of an Engine.*

The shaft is modeled considering its degrees of freedom and the finite element model is developed as shown in the Figure 2.

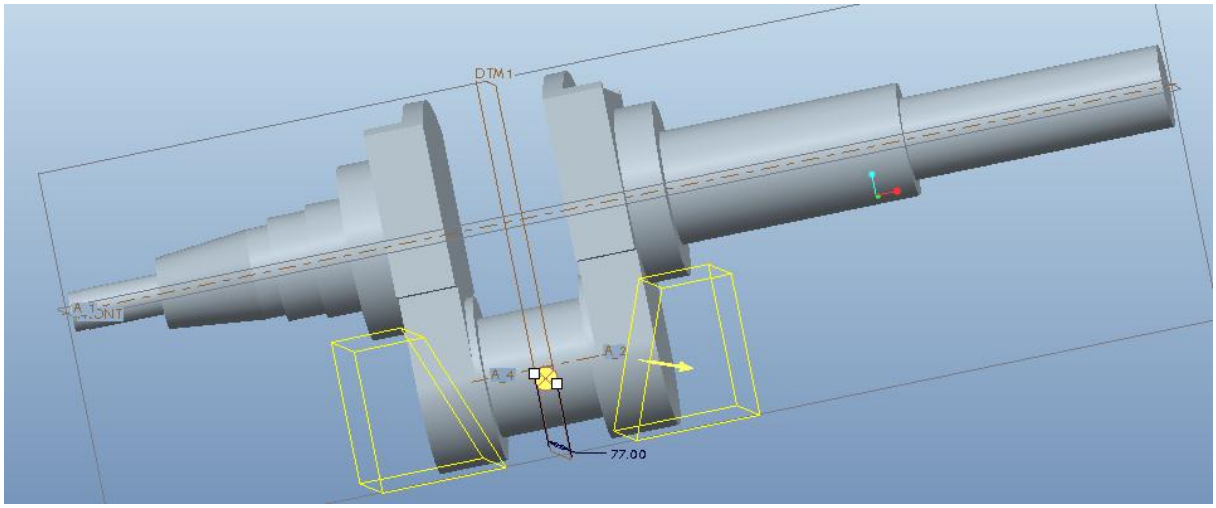

Figure 2: *Finite Element Model of the Engine Shaft.*

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.

Table 1: *Static Structural Analysis.*

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

CONCLUSIONS

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 train values. The results show that there is a reduction in stress at the peak points of the shaft and there is also reduction in the accumulation of stress at the joints and corners of the shaft. Besides the strain and deformation are also observed to get decreased at these specific regions. Incorporating Finite element analysis in the present work, modeling and analyzing of the shaft is done in a more effective way and results are validated with the traditional method. It is observed that the results are obtained with good accuracy applying the present method.

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