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Review Study for Performance Enhancement of Crankshaft Through Weight Reduction via Static Structural Analysis on ANSYS

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Abstract:

Crankshafts are one of the important components in any IC engine. Current research paper reviews various previous researches & the advancements in the field of crankshafts. Current paper reviews the researches related to performance enhancement of the crankshaft by using several ne materials so that weight reduction in the crankshaft is achieved.

Keywords-Crankshaft, IC engine, performance enhancement, weight reduction

Introduction

An engine or motor is a machine designed to convert one or more forms of energy into mechanical energy. Available energy sources include potential energy, heat energy, chemical energy, electric potential and nuclear energy. Mechanical energy is of particular importance in transportation, but also plays a role in many industrial processes such as cutting, grinding, crushing, and mixing.

Mechanical heat engines convert heat into work via various thermodynamic processes. The internal combustion engine is perhaps the most common example of a chemical heat engine, in which heat from the combustion of a fuel causes rapid pressurization of the gaseous combustion products in the combustion chamber, causing them to expand and drive a piston, which turns a crankshaft.

An internal combustion engine (ICE or IC engine) is a heat engine in which the combustion of a fuel occurs with an oxidizer (usually air) in a combustion chamber that is an integral part of the working fluid flow circuit. In an internal combustion engine, the expansion of the high-temperature and high-pressure gases produced by combustion applies direct force to some component of the engine. The force is applied typically to pistons, turbine blades, a rotor, or a nozzle. This force moves the component over a distance, transforming chemical energy into useful kinetic energy and is used to propel, move or power whatever the engine is attached to. This replaced the external combustion engine for applications where weight or size of the engine is important.

Fig. 1 Components of a Crankshaft

A crankshaft is a shaft driven by a crank mechanism consisting of a series of cranks and crankpins to which the connecting rods of an engine is attached. It is a mechanical part able to perform a conversion between 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.

Structural analysis is the determination of the effects of loads on physical structures and their components. Structures subject to this type of analysis include all that must withstand loads, such as buildings, bridges, aircraft and ships. Structural analysis employs the fields of applied mechanics, materials science and applied mathematics to compute a structure's deformations, internal forces, stresses, support reactions, accelerations, and stability. The results of the analysis are used to verify a structure's fitness for use, often precluding physical tests. Structural analysis is thus a key part of the engineering design of structures.

Literature Review

Ajazul Haque et al. (2015) Present research paper "Study of Fillet Stresses on Crankshaft and Modal Analysis" is a complete Finite Element Analysis of Crankshaft and validate results are theoretical analysed for 4-cylinder, 4-stroke, turbocharged diesel engine with in-line through crankshaft that used the most of automobile companies for the model analysis. In this study the Crankshaft torsional vibrations are analyzed by using the numerical simulation methods and causes of failures of Crankshaft. For this research Holzer method is used to determine the natural frequency and mode shape of multi-rotor torsional vibration system. Various Pressures at different crank angles are also taken in the account of analysis. This study is an important effort to develop the scientific and technical understanding for the failure Crankshaft of any Engine under the line of laws of mechanics.

Amit Patil et al. (2014) This paper focuses on the failure of crankshaft due to fatigue which are put into service in several applications. Crankshaft is important part in all types of engines employed in applications like aircraft, reciprocating compressor, marine engine, vehicle engine as well as diesel generator. The failure of crankshaft is due to fatigue resulting into cracks on the surface of crankshaft and effect of residual stresses due to fillet rolling process. The motivation behind this paper is to study how fatigue phenomenon leads to the failure of the crankshaft.

Amit Solanki et al. (2011) The performance of any automobile largely depends on its size and working in dynamic conditions. The design of the crankshaft considers the dynamic loading and the optimization can lead to a shaft diameter satisfying the requirements of automobile specifications with cost and size effectiveness. The review of existing literature on crankshaft design and optimization is presented. The materials, manufacturing process, failure analysis, design consideration etc. of the crankshaft are reviewed here.

Anand, S et al. (2014) Crankshaft is most important and a critical component in an Internal Combustion Engine. In this study plays a dual role of multi cylinder petrol engine crankshaft was made up of EN- 19 steel and Nitriding coated EN-19 steel. It has been shaped by using modelling software (PRO-E) and analysed by using analysis software (ANSYS). Finite element Analysis (FEA) is a method was used to conduct the dynamic Analysis on crank shafts, which are applied Load spectrum on crank pin bearings. The various Analyses on crank shaft also conducted such as Von misses stress, Yield, Tensile, hardness and thermal expansion. The analysis is done for finding critical location in crank shaft. Stress variation over the engine cycle and the effect of torsional and bending load in the analysis are investigated.

Aniket Dindore et al. (2020) Crankshaft is an important component of the internal combustion engine. Due to huge loading and high number of fatigue cycles, crankshaft is prone to early damage and hence reducing the engine life. In this research paper, static structural analysis is performed on crankshaft for a 4- cylinder inline SI engine. A three-dimensional model of crankshaft is designed using SIEMENS NX 12.0 software. In order to study the effect of loading, Finite Element Analysis (FEA) is performed on ANSYS 18.1 software by applying load and constraints to the shaft according to engine working conditions. The analysis is performed for locating critical failure in crankshaft. The optimization includes the modification in the geometry of crankshaft which results in safe and efficient design of the crankshaft. The review of work on the crankshaft optimization and design is demonstrated. The materials, failure analysis, design parameters of the crankshaft analyzed here.

B. Mounika et al. (2017) Crankshaft is one of the vital components for the effective and precise working of Internal Combustion engine with the complex geometry; which converts the reciprocating displacement of the piston to a rotary motion. In this paper an attempt is made to study the Static structural analysis on crankshaft from single cylinder 4-stroke I.C Engine. The 3-Dimensional Modeling of crankshaft is done using Catia V5R20 software and Finite element Analysis is performed by using ANSYS Software by applying boundary conditions as the sides fixed and pressure spectrum is applied in the middle of crankpin. Bending moment causes the tensile and compressive stresses; Twisting moment causes Shear stresses. Thus, Analysis was conducted on the crankshaft with three different materials cast iron, High carbon steel and Alloy steel (42CrMn) to obtain variation of stress magnitude at critical locations. Analysis results are compared with Theoretical results of von-misses and shear stress which are in the limits to validate the model.

Chetan Kahate et al. (2016) The fatigue phenomenon occurs due to repetitive loading on components like crankshaft of IC engine. Fatigue due to combined bending and torsion is most common reason of failure of crankshaft. The objective of this work is to evaluate fatigue life of alloy steel made crankshaft. The crankshaft under study was investigated for failure zone in pin web fillet region. The process wise investigation was made to find out the root cause of fracture occurred in failure zone. The root cause was found to be low surface finish in the pin web fillet region. It caused the undesired stresses in the failure zone. It is observed that due to bad surface finish the fatigue life of existing crankshaft was drastically reduced. The crankshaft is modelled and stresses are analyzed using finite element software. The fatigue life of crankshaft subjected to pure bending and pure torsion loading is obtained during actual testing. The possibility of using fatigue test data from pure bending and pure torsion loading is explored in present work to estimate the fatigue life due to combined loading. In the present study the attempt has been made to improve the surface finish of crank shaft. It is observed that the surface finish is improved 35/% by changing the guide shoe material of crank shaft assembly. The results obtained from simulations are then correlated with experimental results of loading[8].

Dhokale Shubham B et al. (2016) The main objective of this study was to investigate weight and cost reduction opportunities for a crankshaft. The need of load history in the FEM analysis necessitates performing a detailed analysis. Therefore, this study consists of two major sections: FEM and stress analysis and optimization for weight and cost reduction. In this study a simulation was conducted on crankshaft. Finite element analysis was performed to obtain the variation of stress magnitude at critical locations. The dynamic analysis was done analytically and was verified by simulations in ANSYS. The analysis was done and as a result, critical region on the crankshafts were obtained. Geometry, material, and manufacturing processes were optimized considering different constraints, manufacturing feasibility, and cost.

Haruyoshi KUBO et al. (2005) Diesel engines are required to have higher out-puts with smaller sizes. Semi-built-up and solid crankshafts, which are main parts of diesel engines, are subject to severer service conditions to meet such requirements. As a result, crankshaft manufacturers are driven to improve fatigue strength, quality and reliability of the crankshafts. This article describes technical developments and recent trends in crankshaft manufacturing, including steel-making processes, new materials with higher strength, and new fillet hardening processes.

Himanshu Bist et al. (2021) Crankshaft is an important component of the engine that is used for converting the reciprocating motion of the piston to rotary motion. It is necessary to ensure that the crankshaft doesn’t fail under load for the smooth functioning of the engine. In this paper, we performed the structural analysis of a single-cylinder crankshaft using ANSYS for 4 different materials to see which is the most suitable for it. We used Solidworks for creating the 3-d model of the crankshaft, which was then imported to ANSYS, where mesh was created, and forces were applied. Then the deformation and stresses were analyzed and compared to find the regions of high-stress concentration and to see the most compatible material.

Iyasu Tafese Jiregna et al. (2020) The crankshaft is an essential component of in internal combustion engines, which is widely used in an automobile. The most common modes of crankshaft failure are fatigue failure. During its operation, the crankshaft is always subjected to a cyclical load. Besides, the bending and shear load are also typical loads on the crankshaft. Due to the effect of these loads, the crankshaft fails and causes a substantial economic and loss of life. Therefore, predicting the more accurate fatigue life of the crankshaft is essential to save the economic and life losses. This paper discusses several existing approaches to predicting crankshaft fatigue life. Various analytical and experimental approaches used to predict fatigue life discussed. The most common analytical approaches used to predict life are total life approaches, crack initiation life prediction approaches, and crack growth. The review shows that most crankshaft failures are the result of fatigue. The crack initiation can occur due to high-stress concentration or as a defect during manufacture and can eventually propagate under cyclic loads.

Jaimin Brahmbhatt et al. (2012) Crankshaft is one of the critical components for the effective and precise working of the internal combustion engine. In this paper a dynamic 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 SOLID WORKS 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 dynamic analysis is done using FEA Software ANSYS which resulted in the load spectrum applied to crank pin bearing. This load is applied to the FE 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-mises 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.

Jinglong Fan et al. (2017) Engine crankshaft of macro and micro cracks were analyzed by morphological characteristics and quench cracks organization identified as the quenching crack, but further study showed that the cause of this quenching cracks generated was not due to the heat treatment process or other causes, but to poor uniformity of the hot iron casting and elements gathered along the grain boundary segregation.

K. Satyanarayana et al. (2018) The objective of the present work is to investigate the induced stress and deformation of a crank shaft. For this purpose, Variable Compression Ratio (VCR) engine is tested at 16.5 compression ratio. Peak pressures were recorded at various crank angles. A MATLAB code is generated for dynamic analysis. For structural analysis and factor of safety, a three-dimensional model crank shaft was developed using solid works. Finite element analysis of AISI E4340 Forged steel and Aluminium alloy 7076-T6 materials are carried by using analysis software ANSYS. The obtained results are equivalent Von-Mises stress, total deformation and factor of safety at different crank angles for the two materials are analyzed. It is concluded that Aluminium alloy exhibits better results than forged steel.

Ketan V. Karandikar et al. (2017) A crankshaft can be called as the heart of any I.C. engine since it is the first recipient of the power generated by the engine. Its main function is to convert the oscillating motion of the connecting rod into rotary motion of the flywheel. The main function of a camshaft is to convert rotary motion of the crankshaft into vertically reciprocating motion of the valves required to open and close the intake and exhaust valves of engine cylinders, with the assistance of cams located on it and an intermediate mechanism. The crankshaft is subjected to bending stress and torsional shear stress, whereas the camshaft is mainly subjected to compressive stress due to contact pressure, galling and wear and tear. This project aims at designing of I.C. engine multi crankshaft and camshaft using standard design procedures. Further, Creo software is used to create 3-D models of crankshaft and camshaft. After creating the models, static structural analysis is performed for both of these using different materials and boundary conditions using ANSYS software. A static load testing is performed on the crankshaft and camshaft of a TATA Vista Quadra jet car using UTM and experimental stresses are compared with analytical stresses for validation purpose. Finally, the results of total deformation and equivalent (von-Mises) stresses obtained for different crankshaft materials like ASTM 100-70-03, GS-70, AISI 1045 and Inconel X-750, different camshaft materials like ASTM A532 and ASTM A536 are evaluated and compared with each other to select the best suitable material for manufacturing of crankshaft and camshaft.

Khaeroman et al. (2017) This paper discusses the failure of a diesel engine crankshaft of a four stroke 6 cylinders, used in a marine diesel generator. A correct analysis and evaluation of the dimension of the crankshaft are very essential to prevent failure of the crankshaft fracture and cracks. The crankshaft is liable to deformation due to misalignment of the main journal bearings. This article presents the result of crankshaft failure analysis by measuring the mean diameter of the rod journal and the main journal, on the wear, out of roundness, taper, etc. The measurement results must be compared with the acceptable value in the engine specification and manual service and also should follow the American Bureau of Shipping (ABS) guidance notes on propulsion shafting alignment. The measurement results of this study show that the main journal diameter of the third cylinder exhibits an excessive wear, 1.35 % above the permissible lowest rate. It also has a taper for 0.23 mm and out of roundness of 0.13 mm. The diameter of the rod journal indicates excessive wear, 1.06 % higher than the permissible lowest rate, the taper of 0.41 mm and out of roundness of 0.65 mm. The crankshaft warpage or run-out journal, the analysis of the crank web deflection is also evaluated and presented in this paper.

M. GuruBramhananda Reddy et al. (2017) Crankshaft is a standout amongst the most imperative moving parts in internal combustion engine. Crankshaft is an extensive segment with a perplexing (complex) geometry in the engine, which changes over the reciprocating displacement of the piston into a rotating movement. In this paper a static simulation is led on a crankshaft from a single cylinder 4-stroke diesel engine. A three-dimensional model of diesel engine crankshaft is made utilizing Pro-E. Finite element analysis (FEA) is performed to get the variety of stress magnitude at basic areas of crankshaft. Reproduction sources of info are taken from the engine specification chart. The static analysis is done utilizing FEA Software ANSYS which brought about the heap range connected to crank pin bearing. This load is applied to the FE model in ANSYS, and boundary conditions are applied by the engine mounting conditions. The analysis is accomplished 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-Mises stress is calculated using FEA software ANSYS. The composite materials have high quality and solidness so that these are utilized as a part of different Engineering applications. Every one of the exhibitions will complete with the assistance of Ansys software.

M. Senthil Kumar et al. (2014) A detailed study was carried out on crankshafts used in two-wheeler made from C45 (EN 8/AISI 1042) steel. Undesirable noise was heard in crankshaft when the engine is in running. This was stated as failure of crankshaft. Material has been peeled off and seemed to be scraped at the central portion of the crankpin. It was the bearing seating place where oil hole also provided. Under analysis the crankpin was identified as tempered. Chemical composition, micro-hardness and microstructure were studied and compared with the specified properties of the crankpin material. Reason for failure is identified as wear due to lower hardness, improper lubrication and high operating oil temperature.

M. Srihari et al. (2016) 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.

Md. Hameed et al. (2019) In this project design and analysis of the crankshaft for the combustion engine. These components have a large volume component with complex geometry and need huge investment. These will be converts reciprocating or linear motion of the piston into a rotary motion. In this project the product is modelled in a 3D model with all available constraint by using advanced cad software CATIA-V5. this model will be converted to initial graphics exchange specification (IGES) format and imported to ANSYS workbench to perform static analysis. Finite element analysis (FEA) is performed to obtain the various stress and critical location of crankshaft under loads by using ANSYS software. This project helps to many researchers to select best material to production of crankshaft.

Miloud Souiyah (2021) Finite Element Method (FEM) of failure analysis was developed on automobile crankshaft, to determine the stress distribution and the fatigue life, by using ANSYS software. Further, an analytical analysis is applied, Measure the crankshaft stress life. A study was performed on some of the Honda CR-V engine components, specifically are crankshaft, the connecting rod, and the piston. Upon the finite element analysis, it was found that the fillet areas of the crankshaft are the most critical locations where high stresses were generated in these areas. Moreover, with/without considering torsional force acting on the crankshaft does not appear to have any major effects on the stress experience by the crankshaft. In addition, the location where the crack initiated, and fatigue failure starts is located at one of the crankpin journal fillet areas. Indeed, the crankshaft critical areas are mostly affected by uniaxial stress. Moreover, the prediction of the crankshaft fatigue life by using the strain-life theory gives the overall most conservative fatigue life results.

Mr. Jayesh Ramani et al. (2013) Crankshaft is a large volume of production for automobile industries. Day by day demand of highly efficient and optimized parts increasing with high rate. This paper presents a study of design work by upgrading 1.8 L four stroke inline cylinder engines. To upgrade engine capacity and to make powerful engine as 2.6 L four stroke engine diameter of crankshaft to be varied & to sustain high dynamic load coming from 2.6 L petrol engine, it needs to be cross checked against bending and torsional by FEA. FEA is performed by applying dynamic loads to crankshaft.

FEA over crankshaft conducting stress calculations over both, entire crank & single throw. Boundary conditions apply to check maximum loading conditions for crankshaft. In FEA constraints are applied at Face and Bearing area over the crankshaft. The IC engine for the intended application is upgraded from 1.8 L to 2.6 L to leverage its objective for dispensing better performance as regards the power generated for its application in four wheelers.

Mr. V. C. Shahane et al. (2016) Crankshaft is a mechanical component with a complex geometry which transforms reciprocating motion into rotary motion; hence crankshaft plays a key role in its functioning. The crankshaft is connected to the piston through the connecting rod. The journals of the crankshaft are supported on main bearings, housed in the crankcase. The design of the crankshaft and analysis study is the most important process for an effective engine design and engine performance improvement in the internal combustion engine. The crankshaft is subjected to different pressure load with respect to crank angle and therefore the study the crankshaft subjected to different performance conditions is the most significant for an effective design in the internal combustion engines.

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Ms. Jagruti K. Chaudhari et al. (2016) In the project, 3-D finite element analysis was carried out on the modal analysis of crankshaft and the stress analysis of crankshaft to check the safety. The FEM software ANSYS workbench was used to simulate the analysis of crankshaft. The results of stress and deformation distributions and natural frequency of crankshaft were obtained by using ANSYS software. The experimental investigation also carried out for modal part and it validates with the FEM results.

Ms. Shweta Ambadas Naik (2015) The crankshaft is an important and large component of an engine. The function of crankshaft is to converts the reciprocating displacement of the piston into a rotary motion. In this paper, the stress analysis and modal analysis of a 4-cylinder crankshaft are discussed using finite element method. The 3D model of crankshaft was developed in PRO/E and imported to ANSYS for strength analysis. In this study, failure analysis of a crankshaft was carried out. Several causes are there to failed the crankshaft. All crankshafts were failed from the same region. Failures had occurred in the first crankpin, the nearest crankpin to the flywheel. Dynamic analysis and finite element modelling were carried out to determine the state of stress in the crankshaft. Finite element analysis was performed to obtain the variation of stress magnitude at critical locations. We know that, the performance of any automobile largely depends on its size and working in dynamic conditions. The design of the crankshaft considers the dynamic loading and the optimization can lead to a shaft diameter that satisfying the requirements of automobile specifications with cost and size effectiveness. The review of existing literature on crankshaft design and optimization is presented. The materials, manufacturing process, failure analysis, design consideration of the crankshaft is reviewed here.

Muse Degefe et al. (2017) Crankshaft is large volume production component with a complex geometry in internal combustion Engine (ICE), which converts the reciprocating displacement of the piston into a rotary motion of the crank. An effort was done in this paper to improve fatigue life for single cylinder engine crankshaft with geometric optimization. The modeling of the original and optimized crankshaft is created using SOLIDWORK Software and imported to ANSYS software for analysis. Finite element analysis (FEA) was performed to obtain maximum stress point or concentrated stress, to optimize the life of crank shaft by applying the boundary conditions. The maximum stress appears at the fillet areas between the crankshaft journal and crank web. The FE model of the crankshaft geometry is meshed with tetrahedral elements. Mesh refinement are done on the crank pin fillet and journal fillet, so that fine mesh is obtained on fillet areas, which are generally critical locations on crankshaft. The failure in the crankshaft initiated at the fillet region of the journal, and fatigue is the dominant mechanism of failure.

Geometry optimization resulted in 15% stress reduction and life is optimized 62.55% crankshaft which was achieved by changing crankpin fillet radius and 25.88% stress reduction and life is optimized 70.63% of crankpin diameter change. Then the results Von-misses stress, shear stress and life of crankshaft is done using ANSYS software results. It was concluded from that the result of geometric optimization parameter; like changing crankpin fillet radius and crankpin diameter were changes in model of crankshaft to improve fatigue life of crankshaft.

N. Tracy Jonafark et al. (2013) Crankshaft is one of the critical components for the effective and precise working of the internal combustion engine. In this paper a dynamic simulation is conducted on a crankshaft from a single cylinder 4- stroke diesel engine. A three-dimension model of diesel engine crankshaft is modelled using UNIGRAPHICS 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 dynamic analysis is done using FEA Software ANSYS which resulted in the load spectrum applied to crank pin bearing. This load is applied to the FE model in ANSYS, and boundary conditions are applied according to the engine mounting conditions. The analysis was done for different engine speeds and as a result critical engine speed and critical region on the crankshaft were obtained. Stress variation over the engine cycle and the effect of torsional load in the analysis were investigated.

Nileshkumar Lavand et al. (2019) Crankshaft basic purpose is to generate power in engine from rotary motion. But it may fail after particular life cycle this occurs to its geometry, weight distribution etc. Major parameter here is stress concentration that is present at weak section. This paper explains various ways in which these critical stress values can be reduced. For these analytical calculations been done and those were compared with ANSYS for normal or standard crankshaft. Optimization been applied to crankshaft i.e., drilling a hole near critical stress location. Again, results are obtained for optimized crankshaft. Furthermore, results are compared are percentage of difference and reduced weight are noted.

Pandiyan, A et al. (2018) The aim of the study is to design and optimization of crankshaft for a single cylinder four stroke over head valve (OHV) spark ignition engine. This paper used reverse engineering techniques, in order to obtain of an existing physical model. A three-dimensional crankshaft has been created with the help of SOLIDWORKS and, it is imported to ANSYS environment for the coupled steady-state thermal structural analysis. The material used for crankshaft is AISI 1040, AISI 1045, AISI 4140 and AISI 4615. The objective of this paper focuses the light weight crankshaft design through coupled steady-state thermal structural analysis, and to optimize the crankshaft design within the design domain using parametric optimization. The results obtained from finite element analysis and parametric optimization concluded, the modified design is safe along the selected materials for AISI 1045 and shows the maximum von-mises stresses 184.21 MPa, factor of safety (n) is 2.4428 and it is reduced weight of the crankshaft was 63 grams which is 4.04 % less as compared to existing crankshaft model without compromising the strength to weight ratio.

Pawan Kumar Singh et al. (2016) Crankshaft is the complex geometry in the Internal Combustion Engine with large volume production component. This converts the reciprocating motion of the piston in to a rotary motion. An attempt is made in this paper to study the Static structure analysis on a crankshaft. The modelling of the crankshaft is created by using Solidworks 16 Software. Finite element analysis (FEA) is uses to analysis variation of stress at critical locations of the crankshaft to use the ANSYS software. The results of Von-misses stress on the crankshaft are 6.52Mpaand shear stress on the crankshaft is 3.367Mpa. The Theoretical results are obtained on von-misses stress is 10.99Mpa, shear stress is 2.9Mpa. Then approved of model is compared with the Theoretical and FEA results for Von-misses stress and shear stress are within the limits.

Pratik Kakade et al. (2015) The main objective of this paper is to critically review various papers related to analysis of crankshaft failure and identify different approaches in solving the problem. Design/methodology/approach: The paper critically examines 10 different papers related to analysis of crankshaft. The intention of the review is to find the different models used by various authors in solving the problem and study which method is suitable for various models. Findings: The review of various papers revealed which are the major factor for the fatigue failure and the means to check the cause of failure. Research limitations/implications: This research is just the comparison of different model used for analysis. It can specify which model is suitable for particular problem. Practical implications: The problem of crankshaft failure is very severe and cannot be eradicated. The review will help in choosing the method for solution.

Pratiksha M. Nargolkar (2017) Crankshaft is the most imperative, outsized and exposed component of an internal combustion engine. In this work a 4-cylinder diesel engine crankshaft is used for analysis. For analysis a crankshaft is modelled using software PRO-E and further analyzed by using software Ansys R15.0. FEA method is used to conduct static as well as dynamic analysis of the crankshaft in which the torque is applied on the drive end. Various analysis on the crankshaft is conducted, such as Equivalent principal elastic strain, Maximum shear stress, Equivalent Von misses stress. The analysis will be carried out to obtain the variation of stress magnitude at critical locations. Drive end, rear end and other critical locations of the connecting rod are targeted based upon the industrial practices and the literature review surveyed. Based upon the results obtained some critical conclusions will be derived. As a comparative stress analysis for both static as well as dynamic cases will be performed, stress distribution and response levels will be linked together with the help of the results obtained. These results will be additionally compared with theoretical results with the help of failure theories. Detailed insight will be provided for future research and developments in the field of crankshaft.

R. Raju et al. (2018) A crankshaft is a fundamental feature in a vehicle's engine. It is the prime mover which is responsible for the conversion of linear energy into rotational energy. The crankshaft changes the piston motion with the help of connecting rods which in turn enable the engine to run. Hence, crankshaft is the most critical part of any assembly and its life can be improved if maintained properly. This paper deals with the material composition and the manufacturing processes usually followed for crankshafts and also the possible causes of failure and their analysis. In this regard, a model of the crankshaft has been prepared using NX CAD 8.5 version and with the help of an analysis workbench, ANSYS (the premier CAE tool for forty years), we were able to analyze the stress distribution and deformation for two different materials. Finally, on the basis of the results acquired, suggestions with regard to the improvement in design have been made.

S. R. Deviyaprasanth (2016) The crankshaft is one of the critical components on the internal combustion engine. The dynamic analysis has been undergone in this paper under the condition of 4-stroke single cylinder diesel engine. The SOLIDWORKS software is used to create the 3D model of the single cylinder crankshaft. The Finite element analysis method had been carried out in this process to identify the various stress concentration and the critical point of the crankshaft. The pre-processing stage is done through the HYPERMESH software and analysing and post processing is done through ANSYS software. The dynamic analysis is done through the FEA method which results in the load iteration form applied on the crank pin bearing. The load is applied on the crankshaft based on the engine mounting condition and the stress concentration and the critical point has been found. The stress variation, Torsion and the bending load had been taken in consideration for this analysis. The relationship between the vibration and the frequency had been shown in the harmonic analysis of the crankshaft using this software.

Sagar Khatri et al. (2016) This Study Demonstrates Crankshaft Counterweight Profile Optimization to Achieve Better Dynamic Balancing. Balancing Simulation Was Carried to Predict Initial Unbalance. During Balancing of Actual Crankshaft, The Position of Unbalance is Sometime Shifted Due to Machining Stock Distribution Towards Non-Favourable Direction Resulting in a greater Number of Balancing Holes, Thus Productivity Loss. To Reduce This, Counterweight Profile Optimized. After Balancing, Bending Fatigue Test Carried Out. Crankshaft Exhibited Pre-Mature Failure at Unusual Location. To Determine the Reason of Failure, Stress Analysis Was Performed Using FEA. Design Enhancement Solution Proposed to Reduce the Stresses and Subsequently Enhance Bending Fatigue Strength.

Shuzhan Bai et al. (2012) A failure analysis has been conducted on a diesel engine crankshaft used in a commercial vehicle, which is made from 42CrMo forging steel, and the crankshaft was after induction hardening process. The fracture occurred between the 4th journal and the 4th crankpin; fracture section indicates that fatigue is the dominant mechanism of failure for this crankshaft. In order to find the failure causes, the dimension of journal boss fillet, material chemical compositions, surface hardness and depth of hardness layer were evaluated. Chemical compositions of crankshaft material, surface hardness and the depth of hardness layer are within the specified range, however the dimension of journal boss fillet is less than specified, and the transition zone of hardness layer was found on the journal boss fillet. Heavy segregation and many non-metallic inclusions aggregate zones were found from metallographic; these would lead to the reduction of endurance bending strength. FEA analysis results suggest that the dimension of journal boss fillet have an important effect on the stress and stress amplitude of the crankshaft. So, the disqualification machining and material property are the main causes for the crankshaft fatigue fracture.

Siddharth Boon et al. (2020) Crankshaft is enormous volume creation segment with a mind-boggling geometry in the Internal Combustion (I.C) Engine. This proselytes the responding relocation of the cylinder in to a rotational movement of the wrench. An endeavour is made in this paper to examine the Static investigation on a crankshaft from a solitary chamber 4-stroke I.C Engine. The displaying of the crankshaft is made utilizing CATIA-V5 Software. Limited component examination is performed to acquire the variety of stress at basic areas of the driving rod utilizing the ANSYS programming and applying the limit conditions. At that point the outcomes are drawn Von-misses stress prompted in the crankshaft is 15.83Mpa and shear stress is actuated in the crankshaft is 8.271Mpa. The Theoretical outcomes are acquired von-misses stress is 19.6Mpa, shear stress is 9.28Mpa. The approval of model is contrasted and the Theoretical and FEA aftereffects of Von-misses stress and shear stress are inside the cut-off points. Further it very well may be stretched out for the various materials and dynamic examination, advancement of driving rod.

V. C. Shahane et al. (2017) Crankshaft is one of the most critical components for effective and precise working of the internal combustion engine. In this paper, a static structural and dynamic analysis was conducted on a single cylinder four-stroke diesel engine crankshaft. A solid model of the crankshaft was created using higher-end computer-aided design software, i.e., Pro/Engineer software according to the dimensional details drawing of the existing crankshaft. Finite element analysis was performed using ANSYS software under the static and dynamic condition to obtain the variation of stresses at different critical locations of the crankshaft. Boundary conditions were applied on finite element model in accordance with engine specification chart and engine mounting conditions. Optimization of the crankshaft was studied in the area of geometry and shape on the existing crankshaft; however especially working on geometry and shape optimization, the optimized crankshaft design should be replaced with existing crankshaft, without changes in the engine block and cylinder head. The optimized crankshaft helps to improve the performance of the engine and causes reduction in weight. This optimization study of the crankshaft helps to reduce 4.37% of the weight in the original crankshaft.

V. Sowjanya et al. (2016) 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 Pro-E 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 ap lied to crank pin bearing. This load is applied to the FE 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-mises stress is calculated using theoretical y and FEA software ANSYS. The relationship between n the frequency and the vibration modal are explained by the modal and harmonic analysis of crankshaft using FEA software ANSYS.

Venkata Swamy Marpudi et al. (2014) Crankshafts in automotive engines experience a significant number of cyclic loads during its service. Mechanical fatigue failures are the most common cause of crankshaft failures. Crankshafts fail at the fillet regions of main journal and crankpin. The project highlights how to predict & improve the fatigue life of crankshaft using FEA technique. I will take the data for crank shaft such as dimensions and loads and torque for maximum and minimum rpm. Then create a CAD model of crankshaft by using Uni-Graphis. Then the fatigue failure analysis will be carried out by using ANSYS software. The crankshaft will be modified by using sufficient radius to the fillets regions where the stress concentration occurs. Then the structural analysis is to be carried out for the finite element model for Modified crankshaft. Then, the fatigue failure analysis is carried out by using ANSYS software. Then the results are compared for the existing and modified crank shaft all speeds and torques. Fatigue life, Total deformation and Factor of safety are the outcome of the Fatigue failure analysis. Project establishes the procedure for predicting and improvement the fatigue life of any component.

Witek, L. et al. (2017) In this work the failure, stress and modal analysis of the crankshaft of diesel engine was performed. Visual examination of damaged part showed that the fatigue beach marks were observed on the fracture. Results of additional investigation using the scanning electron microscope revealed the presence of micro-cracks in crack origin area. In next part of experimental investigations, the specimens were cut from damaged shaft. Results of tension test showed that mechanical properties of the steel used for the crankshaft manufacturing is in the range defined by the standard. In order to explain the reason of premature crankshaft damage, the finite element method was utilized. In first step the numerical model of crankshaft with the connecting rods was prepared. The boundary conditions were next defined on bearing journal surfaces. The complex load cases were also defined in order to model the real engine loadings. Results of nonlinear stress analysis performed for the crankshaft model showed that during work of engine with a maximum power the high stress area was located in another zone than the crack origin. This result was a reason for extension of investigation on the dynamic problems. In last part of the study the numerical modal analysis was performed for the crankshaft. In this analysis both the frequencies and modes of free vibration were obtained. Results of modal analysis showed that during second mode of free vibration the high stress area was located in the crack origin zone. Based on results of performed investigations it was concluded that the main reasons of premature failure are resonant vibrations of the crankshaft.

Yashraj Dewangan et al. (2018) The aim of the study is to design and optimization of crankshaft for a single cylinder four stroke over head valve (OHV) spark ignition engine. This paper used reverse engineering techniques, in order to obtain of an existing physical model. A three-dimensional crankshaft has been created with the help of SOLIDWORKS and, it is imported to ANSYS environment for the coupled steady-state thermal structural analysis. The material used for crankshaft is AISI 1040, AISI 1045, AISI 4140 and AISI 4615. The objective of this paper focuses the light weight crankshaft design through coupled steady- state thermal structural analysis, and to optimize the crankshaft design within the design domain using parametric optimization. The results obtained from finite element analysis and parametric optimization concluded, the modified design is safe along the selected materials for AISI 1045 and shows the maximum von-mises stresses 184.21 MPa, factor of safety (n) is 2.4428 and it is reduced weight of the crankshaft was 63 grams which is 4.04 % less as compared to existing crankshaft model without compromising the strength to weight ratio.

Yoon Zuan Ang et al. (2020) Crankshaft is one of the crucial parts for the internal combustion engine which required effective and precise working. In this study, the aim of the study is to identify the stress state in the crankshaft and to explain the failure in automotive crankshaft and fatigue life of crankshaft by using finite element analysis. The 3D solid modelling of the crankshaft model was designed and developed using SolidWorks. A static structural and dynamic analysis on an L-twin cylinder crankshaft were used to determine the maximum equivalent stress and total deformation at critical locations of the crankshaft. The model was tested under dynamic loading conditions to determine fatigue life, safety factor, equivalent alternating stress and damage using the fatigue tool. The results obtained from this study indicated that the crankshaft has obvious fatigue crack which was belongs to fatigue fracture. The fatigue fracture developed was only attributed to the propagating and initiate cracks on the edges of the lubrication hole under cyclic bending and torsion. Overall, the crankshaft is safe for both static and fatigue loadings. In dynamic analysis, the critical frequency obtained in the frequency response curve should be avoided which it may cause failure of the crankshaft.

Conclusions

Looking at the above literature available in the field of crankshafts, following conclusions can be drawn-

- Crankshaft is one of the crucial parts for the internal combustion engine which required effective and precise working
- Several researches have been performed in order to enhance the performance of the crankshafts across the world.
- Most of the researches have focused on lowering the weight of crankshaft and hence need of a new lighter material has always been prominent.

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