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Parameter modifications for technological advancements and implied domain efficiency of connecting rods

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ABSTRACT

In this paper discussed about various design of connecting rod with different approach. The design and optimization of connecting rod reduce the weight and it will leads to better fatigue performance for the heavy duty applications. Different design approach leads to find out effective design of particular area. Topology optimization approaches have an ability to reduce the weight of connecting rod. Use of different material for connecting rod shows the different results through finite element analysis. Based on the finite element analysis we can find suitable material and it will increase the life of connecting rod. Generally for analyzing purpose ANSYS/NASTRAN software can be used. According to various research papers studied it will be clearly indicate that the new design much lighter and has more strength than initial design of connecting rod.

INTRODUCTION

The connecting rod is a major link inside a combustion engine. It connects the piston to the crankshaft and is responsible for transferring power from the piston to the crankshaft and sending it to the transmission. There are different types of materials and production methods used in the creation of connecting rods. The most common types of Connecting rods are steel and aluminum. The most common types of manufacturing processes are casting, forging and powdered metallurgy. Connecting rods are widely used in variety of engines such as, in-line engines, V-engine, opposed cylinder engines, radial engines and opposed-piston engines. A connecting rod consists of a pin-end, a shank section, and a crank-end. Pin-end and crank-end pinholes at the upper and lower ends are machined to permit accurate fitting of bearings. These holes must be parallel. The upper end of the connecting rod is connected to the piston by the piston pin. If the piston pin is locked in the piston pin bosses or if it floats in the piston and the connecting rod, the upper hole of the connecting rod will have a solid bearing (bushing) of Bronze or a similar material. The lower hole in the connecting rod is split to permit it to be clamped around the crankshaft. The bottom part, or cap, is made of the same material as the rod and is attached by two bolts. The surface that bears on the crankshaft is generally a bearing material in the form of a separate split shell. The two parts of the bearing are positioned in the rod and cap by dowel pins, projections, or short brass screws. From the viewpoint of functionality, connecting rods must have the highest possible rigidity at the lowest weight. The function of connecting rod is to transmit the thrust of the piston to the crankshaft. Being one of the most integral parts in an engine's design, the connecting rod must be able to withstand tremendous loads and transmit a great deal of power. It is no surprise that a failure in a connecting rod can be one of the most costly and damaging failures in an engine. Forged steel has more factor of safety, reduce the weight, increase the stiffness and reduce the stress and stiffer than other material like carbon steel. With Fatigue analysis we can determine the lifetime of the connecting rod [1].

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VARIOUS PARAMETERS STUDY OF CONNECTING ROD

Design of Connecting Rod for Heavy Duty Applications Produced By Different Processes for Enhanced Fatigue Life

The authors Tony George Thomas, S.Srikari , M. L. J Suman presented a paper, "Design of Connecting Rod for Heavy Duty Applications Produced By Different Processes for Enhanced Fatigue Life". The connecting rod forms an integral part of an internal combustion engine. The connecting rod is acted upon by different types of loads while undergoing its operation. One of the main reasons contributing to its failure is fatigue. The aim of this study is to redesign the connecting rod by incorporating the manufacturing process effects into the analysis and obtain a better fatigue performance. The redesign is aimed at reducing the weight of the component. Heavy duty application's connecting rod was selected for the study. The analytically calculated loads acting on the small end of connecting rod were used to carry out the static analysis using ANSYS. A stress concentration was observed near the transition between small end and shank [3]. A piston-crank-connecting rod assembly was simulated for one complete cycle (0.02 seconds) using ADAMS to obtain the loads acting on small end of connecting rod. This force vs. time graph was converted into an equivalent stress vs. time graph. This stress vs. time graph was used as loading graph for fe-safe. The fatigue life calculated using fe-safe is 6.94×106 cycles and these results are validated with the help of Palmgren-Miner linear damage rule. The fatigue life of connecting rod can be further enhanced by incorporating manufacturing process effects in the analysis stage. Fatigue life was estimated by incorporating the shot peening process effects. An in-plane residual stress for the selected surface elements were applied for obtaining the beneficial effect of shot peening. There was an increment of 72% in fatigue life cycles. We conclude that shot peening can significantly increase the fatigue life of a connecting rod component [2].

Design of Connecting Rod of Internal Combustion Engine: A Topology Optimization Approach

The authors M.S.Shaari, M.M. Rahman , M.M. Noor , K. Kadirgama and A.K.Amirruddin presented a paper, "Design connecting rod of internal combustion engine using the topology optimization" .The objectives of this paper are to develop structural modeling , finite element analyze and the optimization of the connecting rod for robust design . The structure of connecting rod was modeled utilized SOLIDWORKS software. Finite element modeling and analysis were performed using MSC/ PATRAN and MSC / NASTRAN software. Linear static analysis was carried out to obtain the stress/strain state results. The mesh convergence analysis was performed to select the best mesh for the analysis. The topology optimization technique is used to achieve the objectives of optimization which is to reduce the weight of the connecting rod. From the FEA analysis results, TET10 predicted higher maximum stress than TET4 and maximum principal stress captured the maximum stress. The crank end is suggested to be redesign based on the topology optimization results. The optimized connecting rod is 11.7% lighter and predicted low maximum stress compare to initial design. For future research, the optimization should cover on material optimization to increase the strength of the connecting rod [4].

Design and Analysis of Connecting Rod Using Forged Steel

The authors Leela Krishna Vegi, Venu Gopal Vegi presented a paper, "Design And Analysis Of Connecting Rod Using Forged Steel". The connecting rod is the intermediate member between the piston and the Crankshaft. Its primary function is to transmit the push and pull from the piston pin to the crank pin, thus converting the reciprocating motion of the piston into rotary motion of the crank. This thesis describes designing and Analysis of connecting rod. Currently existing connecting rod is manufactured by using Carbon steel. In this drawing is drafted from the calculations. A parametric model of Connecting rod is mode led using CATIA V5 R19 software and to that model, analysis is carried out by using ANSYS 13.0 Software. Finite element analysis of connecting rod is done by considering the materials, viz...Forged

steel. The best combination of parameters like Von misses Stress and strain, Deformation, Factor of safety and weight reduction for two wheeler piston were done in ANSYS software. Forged steel has more factor of safety, reduce the weight, increase the stiffness and reduce the stress and stiffer than other material like carbon steel. With Fatigue analysis we can determine the lifetime of the connecting rod [4].

Design, Fabrication and Analysis of a Connecting Rod with Aluminum Alloys and Carbon Fiber

The authors G.M Sayeed Ahmed, Sirajuddin Elyas Khany, Syed Hamza Shareef presented a paper, "Design, Fabrication and Analysis of a Connecting Rod with Aluminum Alloys and Carbon Fiber". In a reciprocating piston engine, the connecting rod connects the piston to the crank or crankshaft. In modern automotive internal combustion engines, the connecting rods are most usually made of steel for production engines, but can be made of aluminum (for lightness and the ability to absorb high impact at the expense of durability) or titanium (for a combination of strength and lightness at the expense of affordability) for high performance engines, or of cast iron for applications such as motor scooters. The present work has been undertaken to replace the existing connecting rod made of forged steel which is broken for LML Freedom with the aluminum connecting rod. The spare parts of the motorcycle are not available as the production has stopped. In this thesis, the connecting rod is modeled in Pro/Engineer, forces are calculated, analysis is done on the connecting rod using materials aluminum 6061, aluminum 7075, aluminum 2014carbon fiber 280 gsm bidirectional, and Analysis is also done for the assembly of piston, connecting rod and crankshaft. The prototype of the connecting rod is made using direct machining for aluminum alloy and hand layup method for carbon fiber connecting rod [5].

Analysis and Optimization of Connecting Rod Using Alfasic Composites

The authors Kuldeep B, Arun L.R, Mohammed Faheem presented a paper titled on "Analysis and Optimization of Connecting Rod Using Alfasic Composites". Connecting rod is the intermediate link between the piston and the crank. And is responsible to transmit the push and pull from the piston pin to crank pin, thus converting the reciprocating motion of the piston to rotary motion of the crank. Generally connecting rods are manufactured using carbon steel and in recent days aluminium alloys are finding its application in connecting rod. In this work connecting rod is replaced by aluminium based composite material reinforced with silicon carbide and fly ash. And it also describes the modeling and analysis of connecting rod.FEA analysis was carried out by considering two materials. The parameters like von miss stress, von misses strain and displacement was obtained from ANSYS software. Compared to the former material the new material found to have less weight and better stiffness. It resulted in reduction of 43.48% of weight, with 75% reduction in displacement [6].

Fatigue Numerical Analysis For Connecting Rod

The authors S B Chikalthankar,V M Nandedkar, Surendra Prasad Baratam presented a paper titled on "Fatigue Numerical Analysis For Connecting Rod". The connecting rod is a structural component cyclic loaded during the Internal Combustion Engines (ICE) operation, it means that fatigue phenomena should be taken into account during the development, in order to guarantee the connecting rod required lifetime. Numerical tools have been extremely used during the connecting rod development phase, therefore, the complete understand of the mechanisms involved as well as the reliability of the numerical methodology are extremely important to take technological advantages, such as, to reduce project lead time and prototypes cost reduction. The present work shows the complete connecting rod Finite Element Analysis (FEA) methodology. It was also performed a fatigue study based on Stress Life (SxN) theory, considering the Modified Goodman diagram [7].

Dynamic Analysis of Loads and Stresses in Connecting Rods

The authors P S Shenoy and A Fatemi presented a paper titled on "Dynamic Analysis of Loads and Stresses in Connecting Rods". Automobile internal combustion engine connecting rod is a high volume

production component subjected to complex loading. Proper optimization of this component, which is critical to the engine fuel efficiency and more vigorously pursued by the automotive industry in recent years, necessitates a detailed understanding of the applied loads and resulting stresses under in-service conditions. In this study, detailed load analysis under service loading conditions was performed for a typical connecting rod, followed by quasi-dynamic finite element analysis (FEA) to capture stress variations over a cycle of operation. On the basis of the resulting stress-time histories, variation of stress ratio, presence of mean and bending stresses, and multi-axiality of stress states in various locations of the connecting rod under service operating conditions were investigated. It was found that even though connecting rods are typically tested and analyzed under axial loading and stress state, bending stresses are significant and a multiaxial stress state exists at the critical regions of connecting rod. A comparison is also made between stresses obtained using static FEA which is commonly performed and stresses using quasi-dynamic FEA. It is shown that considerable differences in obtained stresses exist between the two sets of analyses [7].

Analysis of Connecting Rod Using Analytical and Finite Element Method

The authors Prof. N.P.Doshi, Prof .N.K.Ingole presented a paper titled on "Analysis of Connecting Rod Using Analytical and Finite Element Method". The connecting rod is a major link inside of a combustion engine. It connects the piston to the crankshaft and is responsible for transferring power from the piston to the crankshaft and sending it to the transmission. There are different types of materials and production methods used in the creation of connecting rods. The most common types of materials used for connecting rods are steel and aluminum. Connecting rods are widely used in variety of engines such as, in-line engines, V-engine, opposed cylinder engines, radial engines and oppose-piston engines. For the project work we have selected connecting rod used in light commercial vehicle of Tata motors had recently been launched in the market. We used PRO-E wildfire 4.0 software for modeling of connecting rod and ANSYS 11 software for analysis. ANSYS Workbench module had been used for analysis of connecting rod. We found out the stresses developed in connecting rod under static loading with different loading conditions of compression and tension at crank end and pin end of connecting rod. We have also designed the connecting rod by machine design approach. Design of connecting rod which is designed by machine design approach is compared with actual production drawing of connecting rod. We found that there is possibility of further reduction in mass of connecting rod [8].

CONCLUSION

Most of the paper discussed about design and finite element analysis of connecting rod with various material in which material and design optimization performed. Some of the research improves the fatigue life of the connecting rod. . The structural factors considered for weight reduction during the optimization process included fatigue strength, static strength, buckling resistance, bending stiffness, and axial stiffness. Furthermore, the existing connecting rod can be replaced by optimization with a new connecting rod made of lighter in weight. Generally for analyzing purpose ANSYS/NASTRAN software can be used. According to various research papers studied it will be clearly indicate that the new design much lighter and has more strength than initial design of connecting rod.

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