Review on Design and Analysis of Connecting Rod Using Different Materials

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Abstract— A connecting rod, also called a con rod, is the part of a piston engine which connects the piston to the crankshaft. Together with the crank, the connecting rod converts the reciprocating motion of the piston into the rotation of the crankshaft. The connecting rod is required to transmit the compressive and tensile forces from the piston, and rotate at both ends .The predecessor to the connecting rod is a mechanic linkage used by water mills to convert rotating motion of the water wheel into reciprocating motion .The most common usage of connecting rods is in internal combustion engines and steam engines. Use of composite material would help to reduce weight and improve fuel consumption without sacrificing the safety of the vehicle. In this current work, connecting rod has been designed by using computer aided design (CAD) software CATIA and was analysed using a finite element analysis (FEA) software ANSYS to understand the exact behaviour of the connecting rod under different material properties.

Keywords: Connecting Rod, Finite element, ANSYS, Connecting rod, optimal design

I. INTRODUCTION

Connecting rods are generally used in all varieties of automobile engines. Connecting rod acting as an intermediate link between the piston and the crankshaft of the engine, by converting the reciprocating motion of the piston to the rotary motion of crankshaft. Generally connecting rods are manufactured using carbon steel and in recent days Aluminium alloys are used for manufactured the connecting rods.

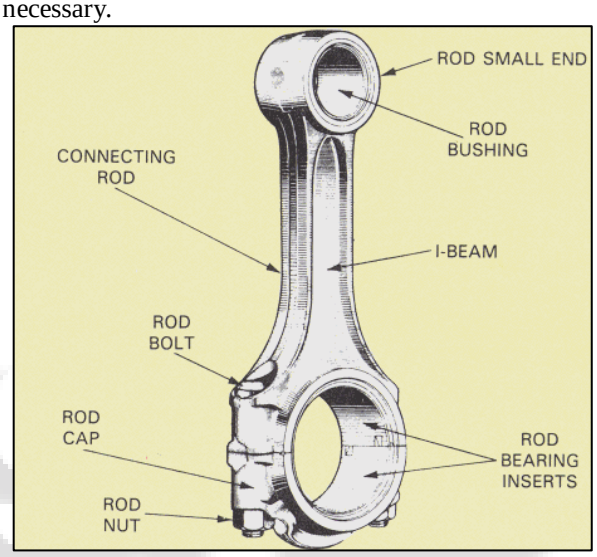
The Connecting rod is a major link inside a combustion engine. It connects the piston to the crankshaft and is responsible for transferring power from the piston to the crankshaft and sending it to the transmission.

There are different type of materials and production methods used in the creation of connecting rods. The most common type of connecting rods are steel and aluminium. The most common types of manufacturing processes are casting forging and powdered metallurgy.

Connecting rods are widely used in variety of engines such as, line engines, V engine, opposed cylinder engines, radial engines and opposed piston engines. Its work is to transmit the thrust of piston to the transmission.

Connecting rods, automotive should be lighter and lighter, should consume less fuel and at the same time they should provide comfort and safety to passengers. In ancient time connecting rods are made by high density materials so that weight of the connecting rod increases so that large inertia force acting. Due to this reason engine speed slows down and other factors stress, strain, factor of safety may also affect the design of connecting rods.

This tendency in vehicle construction led to the invention and implementation of quite new materials which are light meet design requirements. Lighter connecting rods help to decrease load caused by force of inertia in engine as it does not require big balancing weight on crankshaft. So a connecting rod should be designed in such a way that it can withstand high stresses that are imposed on it. So its analysis is necessary.



II. OBJECTIVE

1) Designing of the connecting rod based on the input parameters and then modeling of the connecting rod.
2) FEM tool software is given model and material input based on the parameters obtained.
3) To determine the stresses, Strain Intensity, Total Deformation and to optimize in the existing Connecting rod design.
4) To calculate stresses in critical areas and to identify the spots in the connecting rod where there are more chances of failure.
5) To reduce weight of the existing connecting rod based on the magnitude of the output of analysis.
6) Fabrication of connecting rods and performance of various tests on them for validating the results.
7) The main Objective of this work is to explore weight reduction opportunities in the connecting rod of an I.C. engine by examining various materials. This was entailed by performing a detailed load analysis. Therefore, this study has dealt with two subjects, first, static load and stress analysis of the connecting rod and second, Design Optimization for suitable material to minimize the deflection.

III. RESEARCH PROBLEM DEFINITION:

The present work provides an insight of bending stress acting along the body of connecting rod due to inertia forces acting on the connecting rod which are known by name of whipping stress. The bending moment is dependent on material selected for connecting rod and is used to evaluate the bending stress. The comparative study of bending stress parameter provides the best material to be selected for connecting rod of engine.

IV. LITERATURE SURVEY:

The following research papers are consulted for obtaining an in-depth understanding of various aspects of the project:-

1) Suraj Pal et al. in their paper entitled "Design Evaluation and Optimization of Connecting Rod Parameters Using FEM" concludes that Finite element analysis of single cylinder four stroke petrol engines is taken for the study; Structural systems of Connecting rod can be easily analyzed using Finite Element techniques. So firstly a proper Finite Element Model is developed using Cad software Pro/E Wildfire 4.0.Then static analysis is done to determine the von Misses stress, shear stress, elastic strain, total deformation in the present design connecting rod for the given loading conditions using Finite Element Analysis Software ANSYS .In the first part of the study, the static loads acting on the connecting rod, After that the work is carried out for safe design. [1]
2) Naga Malleshwara Rao et al. in their paper entitled "Design Optimization and Analysis of a Connecting Rod using ANSYS" put the main Objective of this work to explore weight reduction opportunities in the connecting rod of an I.C. engine by examining various materials such as Genetic Steel, Aluminium, Titanium and Cast Iron. This was entailed by performing a detailed load analysis. [2]
3) Sudershan Kumar et al. in their paper entitled "Modelling and Analysis of Two Wheeler Connecting Rod" describes modelling and analysis of connecting rod. In this project connecting rod is replaced by Aluminium reinforced with Boron carbide for SuzukiGS150R motorbike. A 2D drawing is drafted from the calculations. A parametric model of connecting rod is modelled using PRO-E 4.0 software. Analysis is carried out by using ANSYS software.[3]
4) Anusha, C. Vijaya Bhaskar Reddy et al.in their paper entitled "Modelling and Analysis of Two-wheeler Connecting Rod by Using Ansys" concludes that a static analysis is conducted on a connecting rod of a single cylinder 4-stroke petrol engine. The model is developed using Solid modelling software i.e. PRO/E (creo-parametric). Further finite element analysis is done to determine the von-misses stresses shear stress and strains for the given loading conditions. [4]
5) Anusha, Dr. C. Vijaya Bhaskar Reddy et al. in their paper entitled "Comparison Of Materials For Two- Wheeler Connecting Rod Using Ansys" concludes that the modelled connecting rod imported to the analysis software i.e. ANSYS. Static analysis is done to determine von-misses stresses, strain, shear stress and total deformation for the given loading conditions using analysis software i.e. ANSYS. In this analysis two materials are selected and analyzed. The software results of two materials are compared and utilized for designing the connecting rod. [5]
6) Mr. H. B. Ramani, Mr. Neeraj Kumar, Mr. P. M. Kasundr et al. in their paper entitled "Analysis of Connecting Rod under Different Loading Condition Using Ansys Software" study, detailed load analysis was performed on connecting rod, followed by finite element method in Ansys-13 medium. In this regard, In order to calculate stress in Different part of connecting rod, the total forces exerted connecting rod were calculated and then it was modelled, meshed and loaded in Ansys software. The maximum stresses in different parts of connecting rod were determined by Analysis. The maximum pressure stress was between pin end and rod linkages and between bearing cup and connecting rod linkage. The maximum tensile stress was obtained in lower half of pin end and between pin end and rod linkage. It is suggested that the results obtained can be useful to bring about modification in Design of connecting rod. [6]
7) Leela Krishna Vegi et al. in their paper entitled "Design and Analysis of Connecting Rod Using Forged steel," had carried out a study in which the present material of the connecting rod is replaced by forged steel material. By comparing both the material on ANSYS the result indicates the factor of safety and stiffness increases comparable to carbon steel connecting rod. Also, there is a reduction in weight and an increase in life cycle of connecting rod having forged steel material. [7]
8) Akbar H Khan et al. in their paper entitled "Static structural and experimental stress analysis of connecting rod using FEA and Photoelasticity" studied existing connecting rod is manufactured by using steel 16MnCr5. His paper describes Design, modeling and analysis of connecting rod. In his work connecting rod is replaced by steel alloy SAE 8620 and Aluminum alloy 360 for Discover 100cc motorbike. A 2D drawing is drafted from the calculations. A parametric model of connecting rod is modeled using Creo 2.0 software. Analysis is carried out by using Ansys 15.0 software. By comparing the von mises stresses in the materials of connecting rod he concluded that stresses occurs in the aluminium alloy 360 connecting rod are very less as compared to the steel 16mnCr5 and steel alloy SAE 8620. Instead of using the material Steel 16mnCr5 we can use the either aluminium alloy 360 or steel alloy SAE 8620 to reduce the weight and cost of the material and for better stiffness. [8]
9) Kuldeep B et al. in their paper entitled "Analysis and optimization of connecting rod using ALFASiC composites", analyzed the connecting rod by replacing Al360 material by aluminium based composite material reinforced with silicon carbide and fly ash. He also described the modeling and analysis of connecting rod. FEA analysis was carried out by considering two materials. The parameters like von misses stress, von misses strain and displacements were 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. [9]

10) Digvijay, Mohd.Ahmad, Ajay Mishra, Karunakar Mishra,AlokPanday, ShyamBihary Lal al et al. in their paper entitled "Stress Analysis Of Connecting Rod Using Finite Element Method", Connecting rod is an intermediate link between piston & crank. It's responsible to transmit the push & pull motion from the piston pin & crank pin. They also converting reciprocating motion of the piston to rotary motion of the crank. The main objective of this work is to weight reduction opportunities in the connecting rod of an I. C. engine by examining various materials such as steel alloy, cost Iron, Structural steel. The objective of the present work is to design & analyses of connecting rod made of structural steel. In this project the material of connecting rod as a steel alloy replaced with structural steel & after analysis in ANSYS. [10]

V. METHODOLOGY

- Literature survey.
- Design of connecting rod of different material.
- Fabrication of connecting rod of different material.
- Testing of rods.
- Validation of results.
- Discussion and conclusion based on testing and validation.
- References

VI. PLAN OF WORK

First of all I will study the load acting on the connecting rod. It can be concluded from this study that the connecting rod can be designed and optimized. Then I will go to fabricate the connecting rod of different material. Further test can be performed on the new connecting rod to investigate weight reduction and suitable/better material for minimizing deflections in connecting rod.

VII. CONCLUSIONS

Performance of connecting rod can be improved by changing the material composition. Different materials have different properties and by alloying materials the desired properties can be achieve. Thus in this paper a literature review is done to formulate the methodology for further work.

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