ANALYSIS OF DESIGN AND OPTIMIZATION OF CONNECTING ROD

ASHISH KUMAR

P.G student mechanical engineering dept. Rayat Bahra University, Kharar, India

Asst. Professor. Er. SHUBHAM PARMAR

MECHANICAL ENGINEERING DEPT.

ABSTRACT

This paper demonstrates the performance of an automobile basically depend on its size optimization, material selection for the connecting rod and manufacturing process. The design of the connecting rod basically depends on the dynamic weight. In this paper, there is an analysis of the connecting rod design and optimization. Special attention is been paid to the design of connecting rod and how a failure of design occurs. Optimization of the connecting rod is by reducing the cost.

Key Words: *Connecting Rod Design, Design Optimization, and Failur*

1. INTRODUCTION:

Internal Combustion(IC) engine has consisted of many parts like cylinder, piston, connecting rod, crank, and crankshaft. The connecting rod is one of the important parts of an engine. The main function of connecting rod is to transmit power of piston to crank pin. Connecting rod has two ends one is piston end and second is the crank end. Piston end is attached with the piston. The crank end (big end) is attached to the crank pin by a crankshaft. The main motto of connecting rod is to transmit the reciprocating motion of the piston into rotary motion of the crankshaft. The connecting rod should such a way that it can withstand the maximum load without any failure during high cycle fatigue. The main parts of connecting rod are piston end, crank end, and long shank. There are different types of shanks of the connecting rod like rectangular, tubular, circular, I-section and H-section.

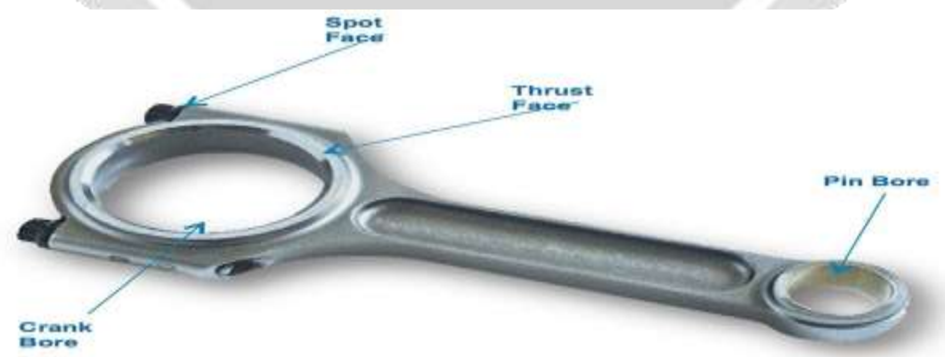

Fig.1.1: Connecting Rod

1.1 Types of manufacturing processes of connecting rods:

- Casting
- Forging
- Powdered metal

1.2 Applications of connecting rod:

- Most commonly used in engines in automobiles.
- Used in all types of vehicles such as cars, trucks, bikes etc. where combustion engine is used.

2. LITERATURE SURVEY:

Manoj et al. [1] investigated the connecting rod of Mahindra Jeep CJ340 and changes its material from AL360 to PEEK. The model of the connecting rod is designed in Pro-E wildfire 4.0 and analysis is done on ANSYS 11.0 software. The parameters like von miss stress and strain, deformation is obtained from ANSYS software and reduction in the weight of connecting rod (approx. 46.7%) and improves the strength of connecting rod (approx. 23.76%).

G. Naga et al. [2] explains weight optimization in the connecting rod of the IC engine by various materials like Genetic steel, aluminum, titanium and cast iron. The model is designed in Pro-E and analysis is done on ANSYS. They perform the various load analysis in static load and stress analysis of the connecting rod. Design optimization for suitable material to minimize the deflection. The load acting on the connecting rod as a function of time are obtained. The relation for obtaining the load for the connecting rod at the given constant speed of crankshaft is also determined. They concluded that the connecting rod can be designed and optimized under a compressing tensile load corresponding to 360^0 crank angles at the maximum engine speed as one extreme load and the crank pressure as the other extreme load which results to cost reduction and weight reduction. The bending stresses are accounted for tensile bending stresses about 266.86333 N/mm^2 and also found that connecting rod made up of genetic steel shows less deformation and stress then titanium, cast iron, and Aluminium.

G.Sailaja, and S. Irfan Sadaq [3] investigated the static and model analysis carried out to determine the dynamic behavior of the connecting rod. The parameters consider such as deformation, strain, and stress which made up with the Beryllium Alloy. An analysis is carried out with Ansys software. These parameters help in identifying the section of failure due to stresses acting on connecting rod.

Sujata et al. [4] demonstrate the analysis is performed on the connecting rod using various composite materials. They mainly focused on the material used for the connecting rod and structural analysis in static loading. The model is prepared by using SOLIDWORKS workbench and CATIA and analysis are done by using FEA software which shows the weight reduction, increase in von-misses stress, decrease in von- misses strain and reduction on deformation.

Nikhil et al. [5] in their study the material of connecting rod is replaced by aluminum-based composite material reinforced with silicon carbide and fly ash and they also describe the model and analysis of connecting rod. FEA analysis was performed by considering two different materials of connecting rod for the 180cc engine. They consider the parameters like von misses stress and displacement result were obtained from ANSYS software. Compared to the existing material and the replaced material found to have less weight and better stiffness. It results in the reduction of 39.48% of weight, with 64.23% reduction in displacement.

Puran Singh et al. [6] said that the computation of the strength and distortion characteristics of a connecting rod. FEM is used to analyze the connecting rod stress and deformation using Ansys. Fatigue and structural analysis were performed. The compressive load is greater than the tensile load. Therefore, the design is only analyzed for the axial compressive loads which result in the reduction of yield compressive strength by 118.68 MPa.

Ramakrishna et al. [8] said that connecting rod is manufactured from the 4340 Alloy steel connecting rod is replaced by ALSiC-9 and also described the model of connecting rod in ProE and analysis is done in the Ansys software. FEA analysis was considered with two materials. The von misses stress obtains from Ansys software. They compared with the formal material. It resulted in the reduction of 61.6560% of weight.

Balaji et al. [9] investigated that the model and analysis of connecting rod. Connecting rod is replaced by AlSiC for 125cc motorbike. A parametric model of connecting rod designed by using CREO software. The parameters like Von misses stress, strain, deformation and weight reduction is done by Ansys software. Due to which the optimization of connecting rod for weight, manufacturing cost reduction.

Fanil Desai et al. [10] investigates the compressive stress acting on connecting rod at different load condition. Two samples of connecting rods are taken for experimental an analysis. The static structural analysis is done using Ansys and experimental analysis is conducted on connecting rod made up of forged steel. The purpose of this study is that the performance of the connecting rod is shown under different load conditions. Experimental results are verified with the numerical results.

Kuldeep et al. [11] investigated that material of the connecting rod is replaced from carbon and aluminum alloy to Aluminum based composite material reinforced with Silicon carbide and fly ash. They designed a model and analyzed connecting rod. FEA analysis was carried out by using two materials. The obtained parameters like von miss stress, strain, and deformation from Ansys software. The replaced material results in 43.48% of weight, with a 75% reduction in displacement.

Mohamad Gani et al. [12] describes the model and analyze the connecting rod. Aluminium connecting rod is replaced by Boron Silicate for Suzuki GS 150R motorbike. The model of connecting rod is designed by using CATIA V5 software and analyzed in Ansys workbench software. Parameters included are von misses stress-strain, displacement and weight reduced for connecting rod by Ansys software and compared with Carbon Steel and Aluminum Boron Carbide.

Prof. Mane et al. [13] investigated design reduction of mass and cost for connecting rod made up of structural steel for 970cc four-stroke four-cylinder engines. The author mainly focused on FEA and optimization for design and mass. In this paper, I-section is designed using SOLIDWORKS and analyzed on ANSYS. It results in optimization of design and mass of connecting rod.

Sourabh et al. [14] said that various loads which are acting on different components on the main loading sections. The objective of this paper is to study cost and material optimization with the help of stress analysis by FEA technique. The designation material is steel alloy.

Amit Kumar et al. [15] describes the model of connecting rod is designed using CATIA software and then analyzed on Ansys 14.0. The weight of connecting rod in Bajaj Pulsar 150cc is reduced. The parameters included are von misses stress, strain, and deformation under loading conditions of compression at the crank end and pin of the connecting rod.

Dr. L.P. Singh et al. [16] investigate the stresses inducted in connecting rod that can be achieved by changing the geometric design parameters in the existing design of single cylinder 4-stroke petrol engine by using FEA.

Sathiamurthi et al. [17] investigate the weight and cost reduction of the connecting rod. That can be achieved by performing a detail load analysis. The study is performed on Steel the connecting rod by the reduction in the machining operations, achieved by the change in materials. They consider the weight reduction under two cyclic loads compare dynamic tensile and static compressive as the two extreme loads which result to reduction of weight and cost take place.

Prof. Shinde et al. [18] investigates that static and dynamic loading condition of connecting rod. They measure the dimensions of connecting rod. Design a model with Pro-E and ANSYS software is used for static analysis. They consider the parameters like material properties, static load, boundary condition, etc. The analysis is performed at the crank end of the connecting rod.

Ashutosh Sinha et al. [19] in their study they compare the existing connecting rod with the replaced C70 connecting rod. They determine the von misses stress, shear stress, elastic strain and total deformation. The model is designed in Pro-E wildfire 4.0 is used and ANSYS v14 is used for analysis which results in negligible changes in their properties.

Ashish et al. [20] in their study they replace existing material of connecting rod with aluminium fly ash silicon composite. The model is design in CATIA v5 and analysis is done with the help of ANSYS software. Compare the parameters like deformation and stress acting on connecting rod. And plot the deformation and stress contours which results in the reduction of weight and cost.

Tajmul et al. [21] in their study they study about the detailed load analysis under different loading condition. The model of the connecting rod is designed with the help of dimension taken from the standard machine drawing textbook. In the MATLAB the codes are written and Altair Hypermesh is used for the pre-processing of the model by FEA. Compare the stress results with the yield strength of the material. Optimize the connecting rod with 11.3% lighter than the original design.

3. Forces acting on the Connecting Rod

1. Force on the piston is due to the gas pressure and inertia of the reciprocating parts.
2. Force due to the inertia of the connecting rod or inertia bending forces.
3. Force due to the friction of the piston rings and of the piston.
4. Forces due to the friction of the piston pin bearing and crankpin bearing.

4. Causes of failure in connecting rod

1. Heat
2. Torque
3. Lubrication
4. Bolt Stretch
5. Bearing Spin

5. COST ANALYSIS:

Cost analysis is mostly based upon geometric changes, weight, and manufacturing process. The optimization required the redesign and remanufacture of forging dies. In which we add the residual stress by fillet rolling process which is a parameter of the manufacturing process which adds to cost of the finished component.

6. CONCLUSION:

1. Actual stresses are a critical input to fatigue analysis and optimization of the connecting rod.
2. The study is applied to the selection of material and manufacturing process so as to have cost-effectiveness.
3. Fatigue is the most dominant mechanism of failure of the crankshaft.
4. The maximum deformation occurs at the center of the connecting rod.

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