A STUDY AND APPROACH ON CONNECTING ROD WITH DIFFERENT MATERIALS

Sangamesh B Herakal
Research Scholar
Shri JJT University
Rajasthan

Dr. S.Chakradhara Goud
Prof. & Principal
Moghal College of Engineering & Technology, Hyderabad

ABSTRACT

Connecting Rods are used practically generally used in all varieties of automobile engines acting as an intermediate link between the piston and the crankshaft of an engine of an automobile. It is responsible for transmission the up and down motion of the piston to the crankshaft of the engine, by converting the reciprocating motion of the piston to the rotary motion of crankshaft. While the one end, small end the connecting rod is connecting to the piston of the engine by the means of piston pin, the other end, the bigger end being connected to the crankshaft with lower end big end bearing by generally two bolts. Generally connecting rods are being made up of stainless steel and aluminium alloy through the forging process, as this method provides high productivity and that too with a lower production cost. Forces generated on the connected rod are generally by weight and combustion of fuel inside cylinder acts upon piston and then on the connecting rod, which results in both the bending and axial stresses. The present paper attempts to design and analyze the connecting rod used in a diesel engine in context of the lateral bending forces acting along its length during cycle of it The lateral bending stress are commonly called as whipping stress and this whipping stress forms the base of evaluation of performance of various materials that can be used for manufacturing of connecting rod. The conventional material used is steel which is designe using CAD tool which is CATIA V5 and subsequently analysed for bending stress acting on it in the arena of finite element analysis using ANSYS workbench 14.5 and this procedure is followed for different material which are aluminium 7075 , aluminium 6061 and High Strength Carbon.

SCOPE OF WORK

Connecting Rods are practically generally used in all varieties of automobile engines. Acting as an intermediate link between the piston and the crankshaft of an engine. It is responsible for transmission of the up and down motion of the piston to the crankshaft of the engine, by converting the reciprocating motion of the piston to the rotary motion of crankshaft. Thus, this study aims to carry out for the load, strain and stress analysis of the crank end of the connecting rod of different materials. Based on which the High Strength Carbon Fiber connecting rod will be compared with connecting rod made up of Stainless Steel and Aluminum Alloy. The results can be used for optimization for weight reduction and for design modification of the connecting rod. Pro-E software is used for modeling and analyses are carried out in ANSYS software. The results archived can also help us identify the spot or section where chances of failure are high due to stress induced. Also the results obtained can be used to modify the existing designs so that better performance and longer life cycle can be archived.

Connecting rod is an intermediate link which connects the piston and the crankshaft in an internal combustion engine, the main work of connecting rod is to convert the linear motion of the piston (thrust force) into rotary motion of the crankshaft. In this study, an attempt has been made to analyze and understand the connecting rod structure using Finite Element Analysis method. An invariable model of connecting rod is modelled using NX 6.0 and on this model static structural analysis is carried out by using ANSYS14.5 simulation tool. Further analysis was carried out by considering different materials to understand the variations of equivalent von-mises stress, strain, total deformation and factor of safety.

Selection of connecting rod for good performance of engine is very difficult. The material used in the connecting rod should be chosen wisely because during manufacturing process it has to undergo various production processes and subsequent heat treatment process, which is very much important for strength and stiffness. Based on which the High Strength Carbon Fiber connecting rod will be compared with connecting rod made up of Stainless Steel and Aluminum Alloy. The results can be used for optimization for weight reduction and for design modification of the connecting rod. Analyses are carried out in ANSYS software.

OBJECTIVES OF THE STUDY

1. To review on design and analysis of connecting rod using different material
2. To design and analysis of two wheeler connecting rod using different materials
3. To study fem analysis of connecting rod of different materials using ansys
4. To design and comparative analysis of connecting rod using finite element analysis

LITERATURE REVIEW

Kuldeep B, Arun L.R, Mohammed Faheem (2013) Thus it can be inferred that this paper projects a work to determine the best material that can be used for manufacturing of connecting rods. The geometric model generated with the aid of specification of design procedure is consequently analysed for bending stress which is caused by bending moment due to ineria of connecting rod . The FEA approach helps to evaluate the approximate values of bending stress acting on different material such as Al 7075, Al6061 and High strength carbon fiber which are used to compare with the conventional material employed which is steel. The connecting rod of high strength carbon fiber suffers lesser in context of bending due to inertia and thus can be best suited for connecting rod of diesel engine.

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SomnathChattopadhyay (2010) Connecting rod is the mediator between the piston and the crank. And its function is to transmit the thrust 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 aluminum alloys are used for manufacture the connecting rods. In this work existing connecting rod material is replaced by beryllium alloy and magnesium alloy. And this also described the modeling and analysis of connecting rod. FEA analysis was carried out by considering three materials Al360, beryllium alloy and magnesium alloy. In this study a solid 3D model of Connecting rod was developed using PRO-E 4.0 software and an analysis was carried out by using ANSYS 10.0 Software and useful factors like von mises stress, von mises strain and displacement were obtained.

Sarkate T S, Washimkar S P, Dhulekar S S (2013) Connecting Rods are practically generally used in all varieties of automobile engines. Acting as an intermediate link between the piston and the crankshaft of an engine. It is responsible for transmission of the up and down motion of the piston to the crankshaft of the engine, by converting the reciprocating motion of the piston to the rotary motion of crankshaft. Thus, this study aims to carry out for the load, strain and stress analysis of the crank end of the connecting rod of different materials. Based on which the High Strength Carbon Fiber connecting rod will be compared with connecting rod made up of Stainless Steel and Aluminum Alloy. The results can be used for optimization for weight reduction and for design modification of the connecting rod. Pro-E software is used for modeling and analyses are carried out in ANSYS software. The results archived can also help us identify the spot or section where chances of failure are high due to stress induced. Also the results obtained can be used to modify the existing designs so that better performance and longer life cycle can be archived.

Ashby, M. F (2005) Connecting Rods are used practically generally used in all varieties of automobile engines acting as an intermediate link between the piston and the crankshaft of an engine of an automobile. It is responsible for transmission the up and down motion of the piston to the crankshaft of the engine, by converting the reciprocating motion of the piston to the rotary motion of crankshaft. While the one end, small end the connecting rod is connecting to the piston of the engine by the means of piston pin, the other end, the bigger end being connected to the crankshaft with lower end big end bearing by generally two bolts. Generally connecting rods are being made up of stainless steel and aluminium alloy through the forging process, as this method provides high productivity and that too with a lower production cost. Forces generated on the connected rod are generally by weight and combustion of fuel inside cylinder acts upon piston and then on the connecting rod, which results in both the bending and axial stresses. The present paper attempts to design and analyze the connecting rod used in a diesel engine in context of the lateral bending forces acting along its length during cycle of it The lateral bending stress are commonly called as whipping stress and this whipping stress forms the base of evaluation of performance of various materials that can be used for manufacturing of connecting rod. The conventional material used is steel which is designe using CAD tool which is CATIA V5 and subsequently analysed for bending stress acting on it in the arena of finite element analysis using ANSYS workbench 14.5 and this procedure is followed for different material which are aluminium 7075 , aluminium 6061 and High Strength Carbon

METHODOLOGY

The most common type of production methods is casting, forging, and powdered metallurgy. Connecting rod must withstand a complex state of loading. It need to undergo high cyclic loads of the order of 10^8 to 10^9 cycles, which range from high compressive loads due to combustion, to high tensile loads due to inertia. Therefore, durability of this component is vital. Due to these factors, automotive connecting rods have been the topic of research for different aspects such as production technology materials, performance, simulation, fatigue, etc. In modern automotive cylinder engines, the connecting rods are most usually made of forged steel for production engines. Connecting rods for automotive applications are typically manufactured by forging from either forged. They could also be cast.

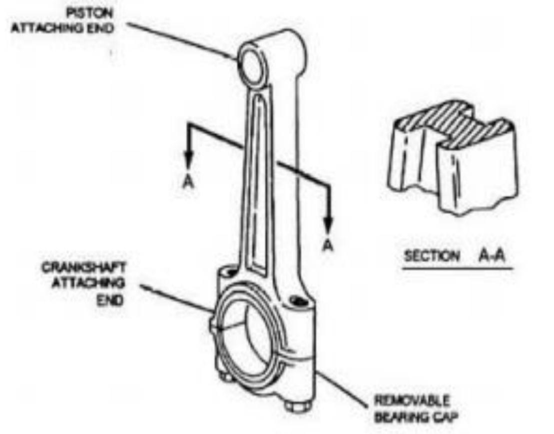

Figure Connecting rod assembly

Between the forging processes, powder forged or drop forged, each process has its own advantages and disadvantages. Powder metalmanufactured blanks have the advantage of near net shape and saving materials. However, the cost of the blank is high due to the high material cost and sophisticated manufacturing techniques. With steel forging, the material is cheap and the drop forging manufacturing process is cost effective..Due to its large volume production, it is only logical that optimization of the connecting rod for its weight or volume will result in largescale savings. It can also achieve the objective of reducing the weight of the engine component, thus reducing inertia loads, reducing engine weight and improving engine performance and fuel economy.

FINITE ELEMENT METHOD (FEM)

The finite element method (FEM) is a numerical technique for solving problems to find out approximate solution of a problem which are described by the partial differential equations or can also be formulated as functional minimization. A principle of interest is torepresented as an assembly of finite elements. Approximating functions in the finite elements are determined in the terms of the nodal values of a physical field which is sought. FEM subdivides a whole problem or entity into numbers of smaller simpler parts, called finite elements, and solve these parts for the problems. The main advantage of FEM is that it can handle complicated boundary and geometries with very ease. Steps for the Finite Element Method are:-

- Modelling the Model
- Import the model
- Defining element type
- Defining material properties
- Meshing of model
- Applying boundary constrains
- Applying load
- Results and Analysing it.

RESULTS

It is evident from the Fig.1 that the maximum von mises stress occurs at the piston end of the connecting rod is 32.64E4 Mpa and minimum stress occurs at the crank end of the connecting rod is 0.275 Mpa for Al360.It is also evident from the Fig.2 that the maximum von mises strain occurs at the piston end of the connecting rod is 0.49E-5 and minimum strain occurs at the crank end of the connecting rod is 0.50E-12 for Al360.It is noticeable from the Fig.3 that the maximum displacement occurs at the piston end of the connecting rod is 0.1629E-2 and minimum displacement occurs at the crank end of the connecting rod is 0 for Al360. It is cleared from the Fig.4 that the maximum von mises stress occurs at the piston end of the connecting rod is 32.44E4 Mpa and minimum stress occurs at the crank end of the connecting rod is 0.0205 Mpa for Beryllium (alloy 25).

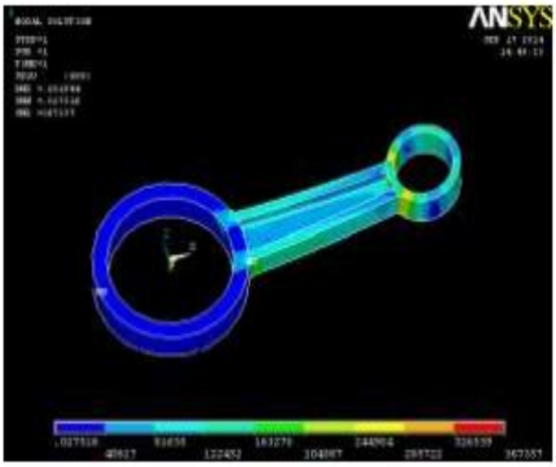

Figure Von mises stress in connecting rod using al360

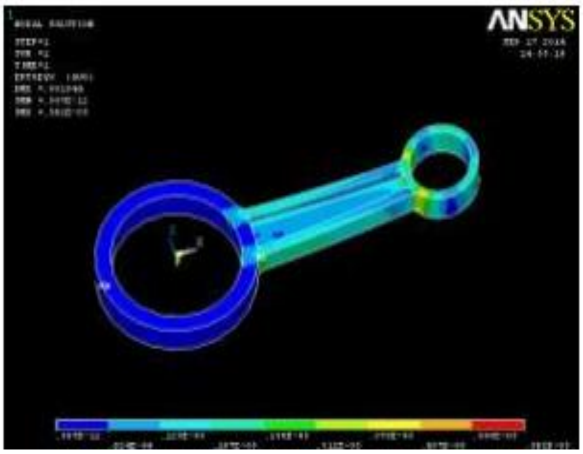

Figure Von mises strain in connecting rod using al360

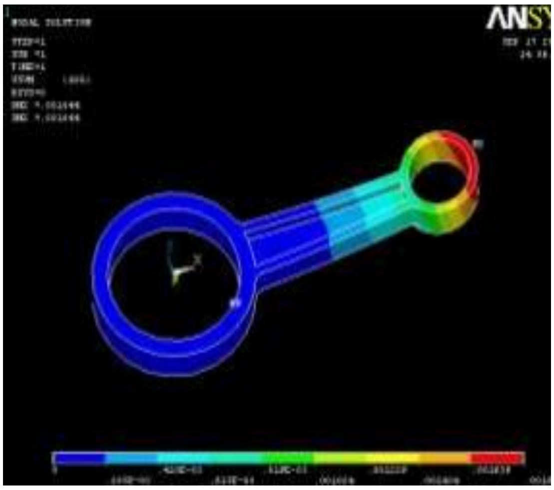

Figure Displacement in connecting rod using al360

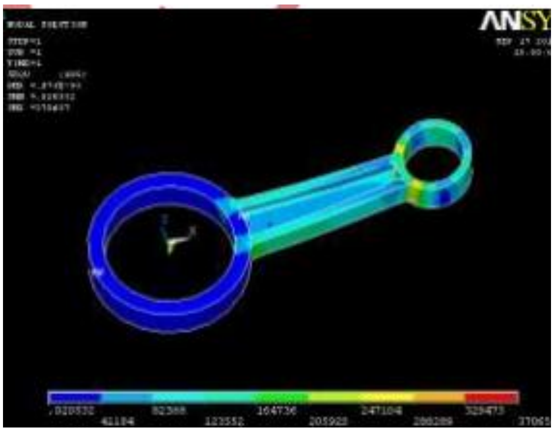

Figure Von mises stress in connecting rod using beryllium alloy

It is also cleared from the Fig. that the maximum von mises strain occurs at the piston end of the connecting rod is 0.23E-5 and minimum strain occurs at the crank end of the connecting rod is 0.20E-12 for Beryllium (alloy 25).It is mentioned from the Fig that the maximum displacement occurs at the piston end of the connecting rod is 0.86E-3 and minimum displacement occurs at the crank end of the connecting rod is 0 for Beryllium(alloy 25). It is well known from the Fig. that the maximum von mises stress occurs at the piston end of the connecting rod is 32.75E4 Mpa and minimum von mises stress occurs at the crank end of the connecting rod is 0.0319 Mpa for Magnesium alloy.

It is also known From the Fig that the maximum von mises strain occurs at the piston end of the connecting rod is 0.67E-5 and minimum strain occurs at the crank end of the connecting rod is 0.89E-12 for Magnesium alloy. It is evident from the Fig. that the maximum displacement occurs at the piston end of the connecting rod is 0.20E-5 and displacement occurs at the crank end of the connecting rod is 0.203E-12 for magnesium alloy.

CONCLUSION

By checking and comparing the above results it has been noticed that Beryllium alloy is the best suitable material for connecting rod of two wheeler vehicle. In the present study, the prime concern is to find the best suitable material for connecting rod. It is noteworthy that the economic aspect has not been incorporated in the present study. In the view of above discussion, following conclusion can be made.

(A) Maximum von mises stress, Maximum von mises strain and Maximum displacement are minimum in connecting rod of Beryllium alloy in comparison of rest of two materials.

(B) It has been prove that connecting rod should have minimum shaky behavior which causes the vibration, otherwise engine may fail. It can be noticed from the figure that maximum displacement is minimum only in beryllium alloy. Which represents that beryllium alloy has the minimum shacking behavior.

(C) Maximum stress, maximum strain and maximum displacement occur at the piston end of the connecting rod.

(D) Connecting rod design is safe for beryllium alloy based on the ultimate strength.

(E) Comparing the different results obtained from the analysis, it can be concluded that the stress induced in the Beryllium alloy is less than other for the present investigation. Here beryllium alloy can be used for production of connecting rod for long durability.

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