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A Review of Modeling and Thermal Analysis of IC Engine's Connecting Rod by using CATIA and ANSYS

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ABSTRACT-

The connecting rod is an integral part of the internal combustion engine. It acts as a link between the piston and the crankshaft. It is a staple attached to a pin in which more weight is concentrated towards the large end. From the point of view, the CG point location of the connecting rod is towards the big end. The material used to manufacture the conductive block is steel, but it can also be made of aluminum due to its lightness and high shock absorption capacity at the expense of durability, and titanium for a combination of strength and lightness at the expense of affordability for high performance. Connecting rods can be produced either by casting, powder metallurgy or forging. Forged bars are devoid of blow holes located above the casting bars. The stress concentration was observed using model analysis.

Keywords- Connecting Rod; Catia V5R20; Ansys 18.0.

1. INTRODUCTION

The connecting rod is an integral part of the internal combustion engine. It acts as a link between the piston and the crankshaft. The connecting rod has three main areas. Piston pin end, center stem and crank end. The end of the piston pin is the small end, the central leg of cross section I and the crank end are the large end. The connecting rod is a support attached to a pin in which more of the weight is concentrated towards the large end. Hence the location of the CG junction point is towards the big end. This connecting rod is mostly made of steel for production engines, but can be made of aluminum (for lightness and high shock absorption at the expense of durability) or titanium (for a combination of strength and lightness at the expense of affordability) for high-performance engines or cast iron.

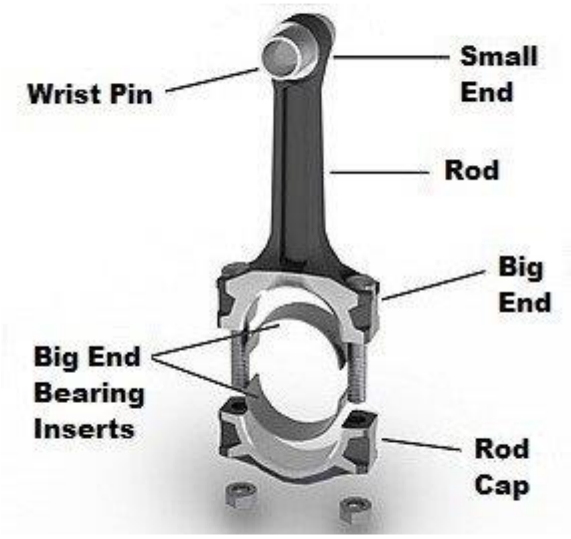

Figure 1 Connecting rod with nomenclature

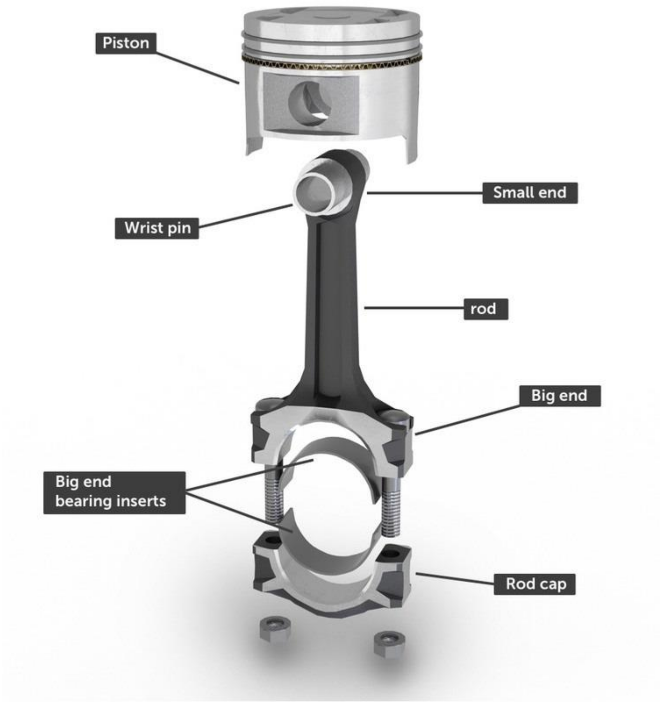

Figure 2 connecting rod with nomenclature and Piston

It can be produced either by casting, powder metallurgy or forging. However, connecting rods can be produced by casting, but due to the presence of blow holes in them which interfere with durability and fatigue. The fact that forgings produce hole-free rods gives them a better advantage over casting rods. Metal powder blanks have the advantage of reduced material waste and close to pure form. However, the cost of the vacuum is high due to the high cost of materials and advanced manufacturing techniques.

Cars must be lightweight so that they consume less fuel and at the same time provide comfort and safety for passengers, which unfortunately lead to an increase in the weight of the car. This trend in composite construction has led to the invention and implementation of entirely new materials that are lightweight and meet design requirements. Steel bar improvement also aims to work with different materials to obtain sufficient weight and strength.

Optimization begins with determining the correct load conditions and strength. Overestimating loads will simply increase safety factors. The idea behind the improvement is to maintain the same required force. The component is already part of the assembly, so by reverse engineering the same part is created but with enough load.

The weight and weight of the connecting rod affect the vehicle's performance. Therefore, it affects the credibility of the car's manufacture. The change in design and materials results in a significant difference in weight as well as in engine performance. Structural factors taken into account to reduce weight during optimization include diastolic load factor, stresses under loads, bending stiffness, and axial stiffness. Thus, the component can give higher strength, efficient design and lighter weight, which will bring great success in the automotive industry.

The connecting rod is a key link within a combustion engine. The piston is connected 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 to create connecting rods. The most common types of connecting rods are steel and aluminum. The most common types of manufacturing processes are casting, forging, and powder metallurgy. Connecting rods are widely used in a variety of engines such as linear engines, V-shaped engines, cylindrical engines, radial engines, and piston engines. The connecting rod consists of the pin end, the stem section and the crank end. Threaded slots and crank end holes are machined on the upper and lower ends to allow precise installation of bearings. The function of the connecting rod is to transfer the force of the piston to the crankshaft. The figure shows the role of the connecting rod in converting reciprocating motion into rotary motion. The four-stroke engine is the most common type. The four strokes are intake, compression, power and exhaust. Each stroke requires about 180 degrees of crankshaft rotation, so a full revolution would take 720 degrees. Each stroke plays a very important role in the combustion process. In the intake cycle, as the piston moves down, a valve opens. This creates a vacuum, and the air-fuel mixture is sucked into the chamber. During the second stroke, compression occurs.

Venu Gopal Vijay and Leela Krishna Vijay: In their paper, they describe the design and analysis of the connecting rod. The existing connecting rods are made of carbon steel. Finite element analysis is performed on a connecting rod made of forged steel. Parameters such as stress, strain, deformation, safety factor, etc. were calculated and found that forged steel has greater safety factor, lower weight and greater hardness than carbon steel. Pravardhan S. Shenoy and Ali Fatemi: They analyzed the dynamic load and optimized the connecting rod. The main objective of this study was to explore weight and cost reduction opportunities for the production of forged steel connecting rods. Change in materials, resulting in a significant reduction in manufacturing cost. Cost reduction is achieved by using C-70 steel. It eliminates rod sawing and manufacturing and is believed to reduce production cost by 25%.

The connecting rod is designed in CATIA. Plot the results of the bending stresses acting on structural steel, Al7075, Al6061 and high-strength carbon fibers and compare them to the bending stresses acting on the materials. The connecting rod made of high-strength carbon fiber suffers less, so it can be better suitable for connecting rod of diesel engine.

2. LITERATURE REVIEW

Rotational motion is generated by the rotation of the crankshaft piston using the connecting rod. The combustion gases in the engine and the movement of inertial components exert pressures that cause compressive and tensile stresses in the connecting rod respectively. Connecting rods fail due to overloading, bearing failure, irregular bolt adjustments, faulty assembly or fatigue [1]. It is important that the connecting rods are able to withstand the complex high tensile loads on which they act. As a result, different techniques for design, material selection, working and fatigue testing of connecting rod have been studied and presented [2]. The mechanical properties (such as hardness, tensile strength, toughness, and fatigue resistance) of materials used in the manufacture of connecting rod composites depend on the design of the connecting rod [3]. The failure of the rod connection is due to the large force required to bear the load. This can be overcome by extending the life cycle by increasing strength. Finite element analysis of the rod has been performed and presented by many researchers. In 2008, the theory and FEA of the connecting rod IC were developed. The analysis result obtained shows the causes of failure in segments of both ends due to induced stress. In FEA the continuous fatigue, deformation and weight optimization of the connecting rod is performed and displayed using the ANSYS workbench. From the proposed design changes obtained from the weight optimization result, the failure result is further updated to achieve a better result. In a paper by Bansal, dynamic stress analysis was performed on a single cylinder four-stroke diesel engine connecting an aluminum rod with FEA [4].

FEA is a computational tool commonly used to test and modify engineering structures within certain design limits. It involves diving into small units known as “elements” of static and dynamic analysis of a simple to complex model under various design constraints. Further research can also be done to optimize the design for optimal performance and service life with respect to design failure [5]. Much literature has worked on improving weight. Gaikwad in his paper modified the roller conveyor by performing a weight optimization procedure after performing a static analysis on the roller conveyor. Further structure optimization analysis is also performed to identify a new optimized structure with new deformation and stress values respectively. The analysis was performed using an ANSYS static structural mechanical analyzer with a tensile force of 100 N acting on its larger end.

3. FINITE ELEMENT ANALYSIS OF CONNECTING ROD

Finite element analysis is a numerical approach described by partial differential equations to investigate and solve problems to reach their exact approximate solution. Solving engineering problems involving complex structures is a good trait for Catia. ANSYS is a Catia software package that creates equations that solve and control the behavior of elements. The geometry is first defined depending on the nature of the analysis to be performed.

A 3D model can be rendered in ANSYS either by saving it in Initial Graphics Interchange Specification (IGES) format and then importing it into the ANSYS workbench, or by building the entire structure in the ANSYS workbench. In this paper, the analysis is done by importing geometric shapes from CATIA in IGES format into the software.

For static structural analysis, a load is applied at the piston end and a static support is provided at the crank end. The analysis is performed under axial loads. Here the applied axial load is 15,000 N (compression). Comparisons were made for the purpose of improvement.

4. OPTIMIZATION

Failure of all or part of the system will result in risk of death and financial loss. Just like in the human context, when the human body is doing too much work, it becomes tired, gets sick, and eventually a nervous breakdown may occur. Also, in an engineering structure, failure may occur when the structure is subjected to a large amount of stress. The amount of stress in an engineering model that occurs when subjected to an external force or load is called stress, which indicates that the applied load is a function of the amount of stress.

The designer uses Von-Mises stress analysis to confirm the failure of his design structure. Failure is inevitable when the strength of the material used is less than the maximum stress value. Calculation of the factor of safety includes yield strength; Therefore, it becomes necessary to declare this parameter before simulation in material properties.

5. CONCLUSION

According to this research, we change materials with different temperatures into the busbar, conduct analysis on the busbar, and compare the heat flow of the two materials at different temperatures. From the above result, it is concluded that carbon steel is better than aluminum alloy. The main objective of the analysis is to minimize mass and cost over the connecting rod loading range. The connecting rod weight is optimized with a target weight reduction of 20, 30, 40, 50 and 60% according to the mentioned constraints to determine which mass should be removed to reduce the cost. Furthermore, the deformation, stress, strain and safety factors were compared under the same loading conditions before and after the target weight reduction of 60%.

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