DESIGN AND ANALYSIS OF TWO WHEELER CONNECTING ROD USING DIFFERENT MATERIALS

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ABSTRACT

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.

Keywords: Ansys 10.0, FE Analysis, Connecting Rod, Pro-E 4.0, Von Mises Stress And Strain.

I. INTRODUCTION

Every Internal Combustion (I.C.) engine consists of mainly cylinder, piston, connecting rod, crank and crank shaft. The Connecting Rod is one of the important parts of an engine. Its work is to transmit the thrust of piston from piston pin generated by the burnt gas's pressure to the other part of engine called Crank via crank pin. It has two ends one is called small or piston end and other one is big or crank end. The big end make a joint with crank or crank shaft by crank pin and small end make a joint with piston by piston pin. It gives the rotating motion to the crank shaft by converting the reciprocating motion of piston into rotating motion. The connecting rod should be such that which can be withstand the maximum load without any failure during high cycle fatigue in operation. The fracture toughness also should be such that it does not go below a certain minimum limit. A further need is that the connecting rod should not buckle during operation. These requirements are used to select an appropriate cross section and material for manufacture [3]. The connecting rod generally has a long shank, a small end and a big end. According to the requirements, the cross-section of the shank may be rectangular, circular, tubular, I-section or H-section. It has been observe that circular section is used for low speed engines and I-section is used for high speed engines [6]. In a long research span it has been noted that during reciprocating motion of the piston a wear of cylinder wall occurs, Which is caused by sideways force of piston acting on cylinder wall and results in an oval cross-section rather than being circular. Due to which piston rings lose their closeness to the cylinder wall and are failed to seal the cylinder. Geometrically, it can be seen that longer connecting rods will reduce the amount of this sideways force, and therefore may increase the engine life

[5]. A connecting rod is one of the most mechanically stressed components in internal combustion engines. There are different types of stresses induced in connecting rod. One of which is axial stress induced by cylinder gas pressure (compressive only) and second one is bending stress caused by centrifugal action and third one is inertial force generated by reciprocation of piston [11]. The connecting rod has a tremendous field of research. In addition to this, vehicle construction led the invention and implementation of quite new materials which are light and meet design requirements. And the optimization of connecting rod had already started as early year 1983 by Webster and his team. There are many materials which can be used in connecting rod for optimization. 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 reducing the weight and the ability of absorbing high impact at the expense of durability) or titanium (for a high performance engines) or of cast iron for applications such as motor scooters. In this study three materials Al360, Beryllium alloy 25 and Magnesium alloy have considered for analysis. Tukaram S. Sarkate et al [3], (2013) carried out an analysis to find out an optimum material for connecting rod. The results obtain by FEA for both Aluminum 7068 alloy and AISI 4340 alloy steel are satisfactory for all possible loading conditions. Kuldeep B. et al [4], (2013) described in the study that Weight can be reduced by changing the material of the current Al360 connecting rod to hybrid alfasic composite. Leela Krishna Vegi, Venu Gopal Vegi [5], (2013), demonstrated that the factor of safety (from Soderberg's), stiffness of forged steel is more than the existing carbon steel found and The weight of the forged steel material is less than the existing carbon steel and reported that by using fatigue analysis life time of the connecting rod can be determined. B. Anusha et al [6] (2013), clarified in the paper and concluded that the stress induced in the structural steel is less than the cast iron for the present investigation. Pushpendra kumar Sharma et al [9] (2012), performed the static FEA of the connecting rod using the software and took the advantages of using crackable forged steel (C70) in place of current forging steel for reducing weight of connecting rod. And the software gives a view of stress distribution in the whole connecting rod which gives the information that which parts are to be hardened or given attention during manufacturing stage. Ram bansal [8] et al, in the paper a dynamic analysis was performed on a connecting rod made of aluminium alloy using FEA. The analysis was performed under dynamic to determine the in service loading of the connecting rod and FEA was conducted to find the stress at critical points.

II. PROBLEM FORMULATION

The objective of the present study is to design and analysis of two wheeler connecting rod and to find the best alternative material of connecting rod**.** In the present study beryllium alloys and magnesium alloys have taken in place of currently using materials like aluminum 360 for CAE analysis and a meaningful comparison made among AL360, Beryllium alloy and Magnesium alloy for choosing the alternative of existing material using for manufacture the connecting rod of single cylinder 4 stroke combustion engines. In this work, an analysis is done for aluminium alloy, magnesium alloy and beryllium alloy. Beryllium alloys feature high fatigue strength and resistance to wear, corrosion, galling, and stress relaxation.

III. PROPERTIES OF MATERIALS

MATERIAL	DENSITY (Kg/m3)	YOUNG'S MODULUS(Gpa)	POISON RATIO

Aluminium 360	2700	69	0.33
Beryllium (Alloy 25)	8360	131	0.29
Magnesium alloy	1740	45	0.35

IV. ANALYSIS OF CONNECTING ROD

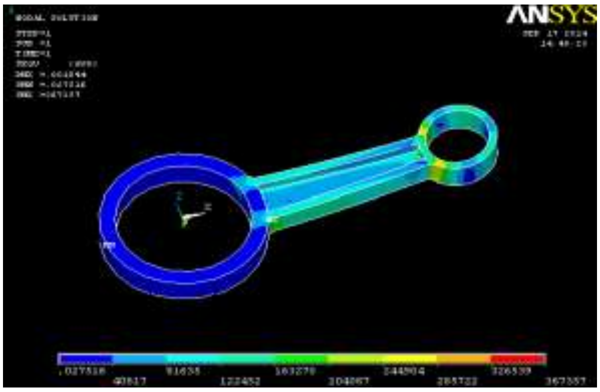

Figure 1: Von mises stress in connecting rod using al360

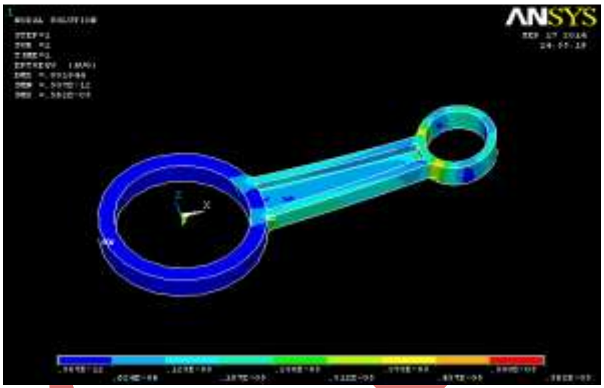

Figure 2: Von mises strain in connecting rod using al360

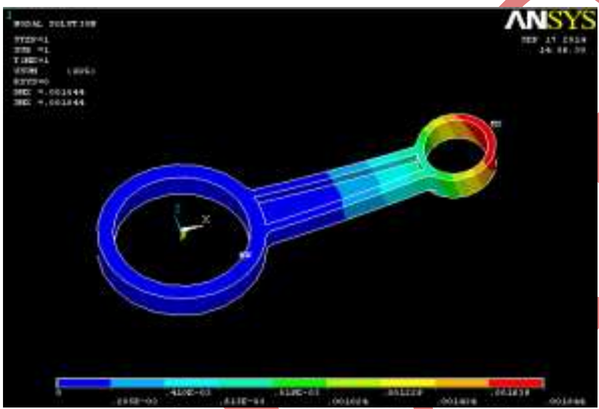

Figure 3: Displacement in connecting rod using al360

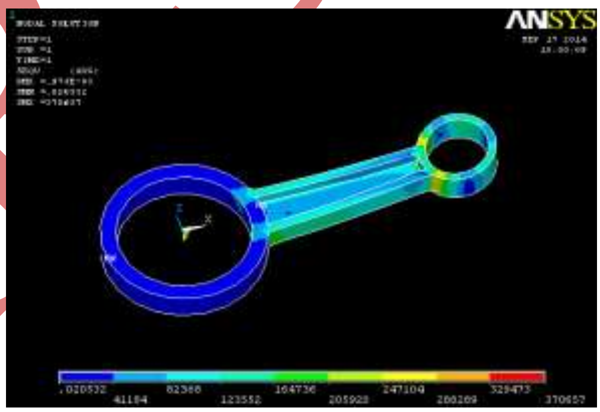

Figure 4: Von mises stress in connecting rod using beryllium alloy

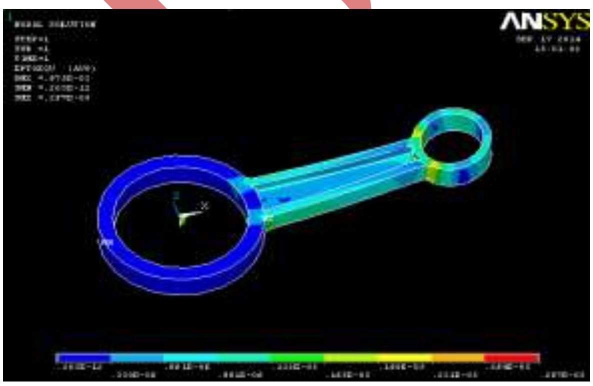

Figure 5: Von mises strain in connecting rod using beryllium alloy

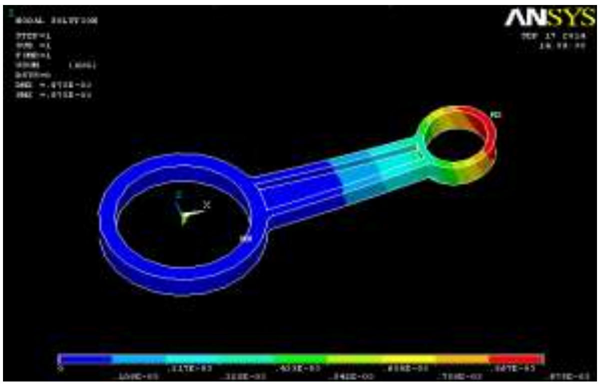

Figure 6: Displacement in connecting rod using beryllium alloy

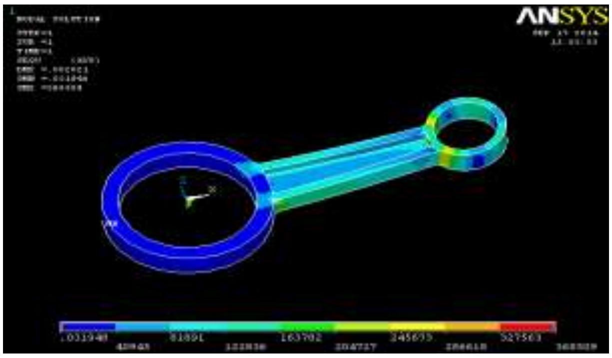

Figure 7: Von mises stress in connecting rod using magnesium alloy

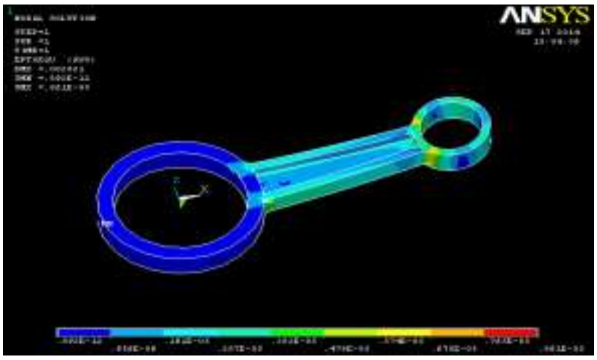

Figure 8: Von mises strain in connecting rod using magnesium alloy

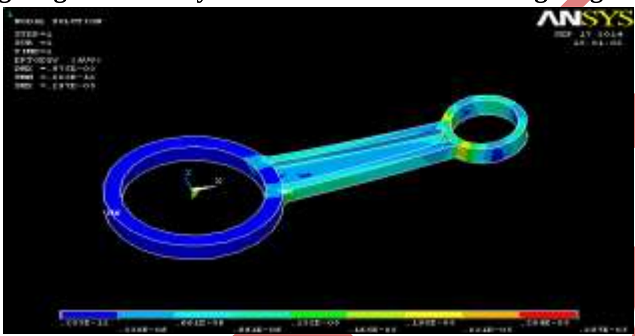

Figure 9: Displacement In Connecting Rod Using Magnesium Alloy

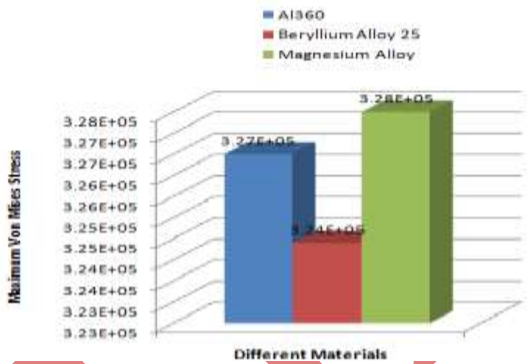

Figure 10: Max. von mises stress for different materials

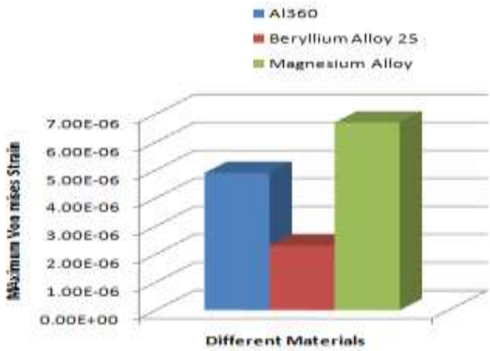

Figure 11: Max. von mises strain for different materials

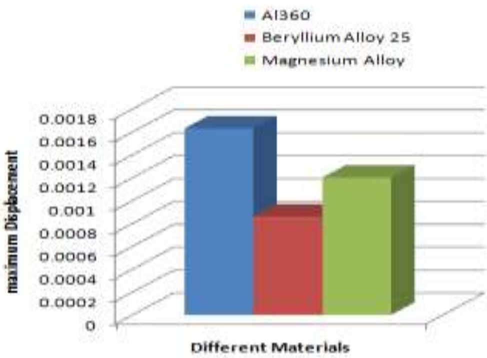

Figure 12: Max. Displacement For Different Materials

V. RESULT AND DISCUSSION

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).It is also cleared from the Fig.5 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.6 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.7 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.8 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.9 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.

VI. CONCLUSIONS

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 12 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.

VII. ACKNOWLEDGEMENT

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