A Comparative Study of Different Materials of Connecting Rod: A Review

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INTRODUCTION
A connecting rod acts as a link between the piston assembly and crankshaft thereby converting the reciprocating motion of piston into the rotary motion of crankshaft. Around the globe connecting rod is produced in large quantity and furthermore it works under high tensile and compressive loads. Connecting rod is one of the important components of the whole engine assembly as it acts as a mediator between piston assembly and crankshaft. Also it faces a lot of tensile and compressive loads during its life time. The main objective of this paper is to proposed different properties of different material used for the production of connecting rod. We are taking different types of connecting rod made of cast steel, forged steel, aluminium-360, AlFASiC (Aluminium based composite material reinforced with silicon carbide), magnesium alloy & Beryllium alloy, & compare their mechanical properties. In recent time it is very necessary to reduce weight, Stress, Strain, Displacement while increasing or maintaining strength of Connecting rod. This has entailed performing a detailed load, deformation, fatigue, stress and strain analysis. The connecting rod is a high volume production from automobile side. Every vehicle that uses an internal combustion engine requires at least one connecting rod. Connecting rod is subjected to more stress than other engine components. Failure and damage are also more in connecting rod, so identification and comparison of different materials for connecting rod is very important.

Keywords: Connecting Rod, Aluminium based composite (AlFASiC), carbon steel, forged steel, Al-360, magnesium & beryllium alloy.

ABSTRACT
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Connecting rod, automotives should be lighter and lighter, should consume less fuel and at the same time they should provide comfort and safety to passengers, that unfortunately leads to increase in weight of the vehicle. This tendency in vehicle construction led the invention and implementation of quite new materials which are light and meet design requirements. Lighter connecting rods help to decrease lead caused by forces 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. It has mainly three parts namely- a pin end, a shank region and a crank end. Pin end is connected to the piston assembly and crank end is connected to crankshaft. However the stress analysis can be performed easily by modeling it in any CAD software and analyzing it by using FEA. Discovering new techniques and methods for weight and Stress and strain reduction can definitely increase the engine performance and economy.

Fig. 1: Connecting Rod nomenclature [1]
LITERATURE REVIEW

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 materials compared are Carbon Steel, Forged Steel, Aluminium 360, AlFASiC, Magnesium Alloy, Beryllium Alloy.

K. Sudershankumar [2] et al, (2012) described modeling and analysis of Connecting rod. In his project carbon steel connecting rod is replaced by aluminium boron carbide connecting rod. Aluminium boron carbide is found to have working factory of safety is nearer to theoretical factory of safety, to increase the stiffness by 48.55% and to reduce stress by 10.35%.

Leela Krishna Vegi, Venu Gopal Vegi [3], (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.

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 AlFASi Ccomposite. He described that the aluminium composite connecting rod is 43.48% lighter than the Al360 connecting rod and much stiffer.

A. Gupta et. al. [5], (2014) compared three materials used for manufacturing of connecting rod these are Al360, magnesium alloy, beryllium alloy using. The modeling and analysis of connecting rod was done. FEM analysis was carried out by considering three materials AL360, beryllium alloy and magnesium alloy. In his study he found out that out of above three material beryllium alloys is the best suitable material for connecting rod of two wheeler. Comparing the different results obtained from the analysis, it is concluded that the stress induced in the beryllium alloy is less than the aluminium and magnesium alloy.

Mr. H. B. Ramani, et. al. (2012) investigates the stress developed at different parts of connecting rod using CAE software. It is evident from the result shown by the authors that the maximum stress developed was between pin end and rod linkages and between bearing cup and connecting rod linkage. The maximum tensile stress developed 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.

The properties of different material are show in the below mentioned chart through which the analysis of the material was done.
We are taking different types of connecting rod made of cast steel, forged steel, aluminium-360, AlFASiC (Aluminium based composite material reinforced with silicon carbide), magnesium alloy and Beryllium alloy, and compare their density, young modulus, stiffness, weight. Know the review is focused on three materials which are light in weight & having stiffness. Stress, strain and displacement comparison for Al360, beryllium alloy and magnesium alloy is taking into consideration.

CONCLUSION
A connecting rod forms a basic element of an internal combustion (IC) engine, which performs the function of converting the reciprocating motion of the piston into angular effort of the crank. The prime concern of this study is to compare the different materials for connecting rod manufacturing. It is noted that the economic aspect is not considered in the study. For the above discussion following conclusion can be made.

A. Carbon steel as a connecting rod material is less stiff and having more weight than forged steel and other material taking in consideration.

B. Forged steel connecting rod is having more weight than Aluminium, magnesium and beryllium alloys connecting rod.

C. Aluminium alloy connecting rod is having more weight and displacement than magnesium and beryllium alloys. So, aluminium connecting rod show more shaky behaviour.

D. Maximum von mises stress, Maximum von mises strain and Maximum displacement are minimum in connecting rod of Beryllium alloy.

E. Comparing the different data it is observed that stress, strain and displacement is minimum in beryllium alloy connecting rod. So, beryllium alloy can be used for production of connecting rod for longer life.

REFERENCES


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