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A Review Paper on Design Analysis of Connecting Rod

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Abstract - This topic deals with the past literature survey which shows that, In an internal combustion engines and compressors, connecting rod is a high volume production, critical component which is periodically subjected to high tensile, compressive and bending loads caused by the thrust and pull on the piston and by the centrifugal force of the rotating crankshaft. The connecting rods can be manufactured by various methods and variety of materials but it depends on application, which technology and material to use. Existing connecting rods are mostly manufactured by using carbon steel. Aluminium and titanium alloys are strong and light weight alloys known. Titanium finds its application in high performance automotives where light weight but strength of components is also needed. ANSYS is the analysis tool to calculate Von mises stress, Von mises strain and deformation etc.

Index Terms *- Connecting rod,composite material, design optimization.*

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I. INTRODUCTION

Connecting rod is integral part of an internal combustion engine, it acts as a linkage between piston and crankshaft. Connecting rod has three main zones. The piston pin end, the central shank and the big end. The piston pin end is the small end,the central shank is of I-cross section andthe crank end is the big end. Connecting rod is a pin jointed strut in which more weight is concentrated towards the crank endend. Hence the location of the CG point of connecting rod lies more towards the big end.This connecting rod are mostly made of steel for production engines, but can be made of Aluminium (for lightness and the ability to absorb high impact at the expense of durability) or titanium (for combination of strength and lightness at the expense of affordability) for high performance engines, or of cast iron. They can be produced either by casting, powder metallurgy or forging. However, connecting rods produced by castingusually have blow holes which are adverse from durability and fatigue points of view. The fact that forgings produce better rods which are free from blow holes gives them an advantage over cast rods. Powder metal manufactured blanks have the advantage ofreducing material waste and being near net shape. However, the cost of the blank is high due to sophisticated manufacturing techniques and the high material cost.

Automotive should be light in weight so as to consume less fuel and at the same time they should provide comfort and safety to passengers, which unfortunately leads to increase in weight of the vehicle. This tendency in vehicle construction leads to 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. Application of composite material enables high strength to weight ratio and advances that leads to effective use of fuel and to obtain high engine power.

Automobile industry always require cost efficient and high quality product. This gives us an opportunity to study design methodology so as to improve and provide industrial requirement. The time spend in trial and error analysis in the design process need to be eliminated in order to sustain in this fast moving market. Therefore, computational method has been used in early stage of the design. Finite element method is applied for modal analysis and structural analysis of connecting rod. Modal analysis gives the inherent dynamic characteristics of a system in form of natural frequencies, damping factors and mode shapes.Whereas structural analysis gives an idea about stress distribution at loading condition. Mesh determination is too critical in order to ensure that the best mesh size is to be use in carry out the analysis for other parameter involves. As stability and convergence of various mesh processing applications depend on mesh quality, there is frequently a need to improve the quality of the mesh.

II. LITERATURE REVIEW

VenuGopalVegi and Leela Krishna Vegi [3] in their paper describe designing and analysis of a connecting rod. Currently existing connecting rods are made of carbon steel. The model of connecting rod is modelled using CATIA software and analysis is carried out on ANSYS

software. Finite element analysis is carried out on a connecting rod made of forged steel. The parameters like Von mises stress, strain, deformation, factor of safety etc were calculated and found that forged steel have more factor of safety, reduced weight, greater stiffness than carbon steel.

Vikas Gupta [4] in his research work altered the dimensions of already existing design of a connecting rod of a tractor engine. This analysis was done under static and fatigue loading. Optimization was done under same boundary and loading conditions for validation in few stress and fatigue parameters. The critical regions under both static and fatigue analysis are identified and improved. The connecting rod was modelled and optimized for the reduced weight, improved life and manufacturability. The material was kept same and a significant change was observed in Von mises stress. 9.4% less stress was observed at critical point under static load conditions. Only 5 gm of weight was reduced which is very low. From this we can conclude that not only materials but also design parameters can be considered for optimization.

The comparison of fatigue behaviour of forged steel and powder metal connecting rods was discussed by A. Afzal et al. [5]. The experiments included strain controlled specimen testing with specimen obtained from the connecting rods as well as strain controlled connecting rod bench testing. Monotonic and cyclic deformation behaviour and strain controlled fatigue properties of two materials are evaluated and compared. The stress concentration factors were obtained from FEA, and modified Goodman equation was used to account for the mean stress effect.

The connecting rod is a most stressed part in internal combustion engine. During its operation various stresses are acting on it. The effect of compressive stress is more due to gas pressure and whipping stress. Fanil Desai and all [6] compared two samples of connecting rod made of forged steel. Static analysis was done using ANSYS software and experimental analysis with Universal Testing Machine (UTM). Experimental results were verified with the numerical results.

To reduce weight and cost of forged steel connecting rod, AmbrishTiwari et al. [2] extremely used the numerical tools during the development phase. Therefore, to complete understand the mechanisms involved as well as the reliability of the numerical methodology are extremely important to take technological advantages, such as, to reduce project lead time and prototypes cost reduction. The work shows complete FEA methodology to explore weight and cost reduction opportunities for production of forged steel connecting rod. Considering the modified Goodman diagram, fatigue study based on stress life theory was also performed.

Kuldeep B. replaced the conventional materials of connecting rod by aluminium based composite materials reinforced with silicon carbide and fly ash. The comparative study between conventional materials and new materials found that new materials have less weight and better stiffness. It resulted in reduction of 43.48% of weight with 75%reduction in displacement [1].

Ramanpreet Singh in his study used isotropic and orthotropic composite materials. The modelling of connecting rod was done using CATIA v5 and stress analysed in MSC. PATRAN. Linear static analysis was carried out for both materials with tetrahedron with element size of 4mm to obtain stress results. Comparison of both materials was done keeping the boundary conditions same. Author concluded that there was a reduction of 33.99% of stresses when isotropic material (i.e. steel) is replaced with orthotropic material (i.e. E-glass/Epoxy). Also there was reduction in displacement of about 0.026% [7].

G.M. Sayeed Ahmed [8] et al. In their work, a broken connecting rod made of forged steel is replaced with aluminium alloys and carbon fiber. By doing so, the authors found that weight of connecting rods was reduced and all performed to the level of expectation. The carbon fibers have good strength and are light in weight. The rods were tested in ideal condition and also by applying variable loads. The rods tested to their extreme capacities and they performed well. The analysis also carried out on the crankshaft of aluminium which gave good results and pressure induced on connecting rod was less.

Existing connecting rod is manufactured using ferrous alloys. Authors S. Vijaya Kumar et al. Replaced material of connecting rod with chrome steel and titanium. Modelling is done using Creo Parametric 2.0 software and analyzed over ANSYS. Composites used for manufacturing helped optimizing weight and cost and improved its life span than the original design. The maximum stress was within the allowable stress limit for chrome steel and titanium [9].

III. CONCLUSION

Connecting rods are being manufactured by conventional method of forging. Steel can be replaced by aluminium and titanium alloys on a cost of affordability. Weight optimization is possible using composite materials without varying the allowable stresses and boundary conditions.

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