Design and Analysis of Gudgeon Pin: A Review

Abstract-— **Gudgeon pin connects the piston and the small end of the connecting rod of engines. This paper deals with the detailed design and analysis of existing Gudgeon pin to find stress concentration of the pin, and then minimize stress concentration by making suitable changes in gudgeon pin design and changes in materials. Hence, The materials with high temperature conductivity & low weight ratio to withstanding propensity and structural potency will make a alternate for the commercial pin used, by analyzing the gudgeon pin we can see the results of shear stress, bending stress, contact stress, displacement and deformation due to the load distribution over the whole pin. Finite Element Method is established using ANSYS software to analyze the stresses on gudgeon pin.**

Keywords—Gudgeon pin, Stress concentration, ANSYS, FEM

I.   INTRODUCTION

The piston pin is used to connect the piston and the connecting rods in the internal combustion engine, and the piston pin transfers gas pressure to the connecting rods. The rubbing pair is constituted by the piston pin and piston pin boss; the gas pressure will be delivered to the rubbing pair through the piston pin and piston pin boss, and then the piston pin may occur bending. So the piston and the piston pin should have enough stiffness which can endure the pressure and the friction between contacting surfaces [1].
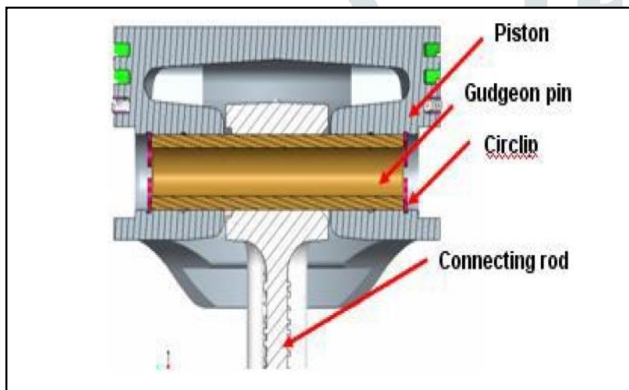

Fig 1 Cross section of piston assembly [4]

The stress distribution on the piston pin seat mainly depends on the deformation of piston pin. Therefore, in order to reduce the stress concentration, the piston pin should have enough stiffness to reduce the deformation[1].As an important part in an engine piston pin endures the cyclic gas pressure and inertia forces at work and this working condition may cause the fatigue damage of the pin. Generally the piston pin is hollow cylinder, but according to the different working conditions and requirements, the selection of the piston pin material can be various. Damage mechanisms have different origins and are mainly wear, temperature, and fatigue related. But more than wear and fatigue, damage of the piston pin is mainly due to stress development – shear stress, bending stress, contact stress & combined stress [2].

Fig 2 New piston pin [2]

Fig 3 Damaged piston pin [2]

Now a day mechanics have a problem in remove the "piston pin" from the piston. During the disassemble of pin piston from connecting rod mechanic usually use the hammer and screwdriver by ordinary method. By using the ordinary method, the chances/probability of damages for the pin piston, piston surface and the bearing is high because of the impact of load on the piston increase when the mechanic hits the pin piston to remove it. So when the piston, piston pin, connecting rod and bearing damage the engine will vibrating because of misalignment. So the accuracy of the rotation and alignment is lower [3].

II.   LITERATURE REVIEW

Due to the fatigue failure and the fracture injury occurs under the alternative mechanical loads, the optimal design of the piston pin and the piston pin boss is presented depending on the FEA static analysis. The optimization is carried out using the Genetic Algorithm (GA), and the piston noncircular pin hole is used to further reduce the stress concentration on the upper end of the piston pin seat. The FEA is carried out for the initial piston model and the optimal one respectively. The results of analysis indicate that the maximum stress has changed from 171MPa to 145MPa, and the biggest deformation has been reduced from 0.359mm to 0.301mm [1].

The objectives of this project are to design the jig and fixture to remove pin in the piston using pro engineer software (Pro/E), second is to fabricate the jig and fixture using machining process and finally is to improve the method when assembly and removing the pin piston by using the jig compare to conventional method by analyze the effect on the piston parts, the piston pin, connecting rod and piston block. The result shows that the application of jig and fixture have the reduced damage on piston pin, connecting rod and piston head surfaces. These jigs and fixture are used at main

assembly line to assemble the engine components. The experiments also conducted on the locator pins (custom made jig) between mild steel and aluminium. It is found that the wear progressively generate on aluminium pin locater compare to mild steel. The result is obtained from experiment conducted [3].

High temperature distribution over the internal combustion cylinder leads to the infringement of the contact with the piston to the connecting rod, in this project we have scrutinized the recital of the gudgeon pin to resist from the shear and wear along the bending deformation during the loading of the engine, here we were using diverse materials to improve the performance of the cotter pin hence the materials with high temperature conductivity & low weight ratio to withstanding propensity and structural potency will make a alternate for the commercial pin used now a days, by analyzing the gudgeon pin we can see the results of shear stress, bending stress, contact stress, displacement and deformation due to the load distribution over the whole pin. The concept design were going to done in modeling software Solid works and analysis of stress and load will be done in ANSYS, this project mainly deals with stress, shear, load, contact, bending stress and Von Mises Hencky theory of failure analysis of the gudgeon pin by exploiting dissimilar materials. The analysis is carried out for three different material such as Ti-6Al-4V, Titanium Ti-17 and Al alloy 4032. From the result, titanium alloy (Ti6Al4V) is suitable for manufacturing piston pin [2].

This paper deals with the detailed design and analysis of existing gudgeon pin to find stress concentration of the pin, and then minimize stress concentration by making suitable changes in gudgeon pin design and mounting. Present work consists of design of gudgeon pin and then the Finite Element Method is established using ANSYS software to analyze the stresses on gudgeon pin and minimizing it [4].

Gudgeon pin connects the piston and the small end of the connecting rod of engines. The wear of the gudgeon pin and connecting rod concern for the company. In this Way frictional stress and Von-mises stresses are produced on Pin and they are determined by finite element analysis tool ANSYS .Fatigue life of pin is determined using fatigue analysis tool. Analysis is carried out for both materials such as aluminium and steel. As we considered both the material compared with each other. The aluminium having better strength as compared to steel [5].

III. FORCE ANALYSIS OF GUDGEON PIN
The Gudgeon pin assembly is subjected to uniform intensity of pressure in the region of the connecting rod due to air compressed on the top flat face of the piston. Besides it is prevented from moving axially by the circlips. The deformation of the Gudgeon pin is to be within elastic limits under the action of the force along the width of the connecting rod for various angular positions. The bending deformation of the Gudgeon pin is to be assessed to
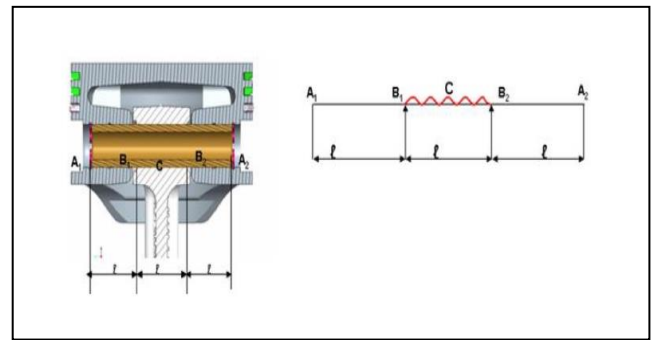

Fig 4 Close up view of Gudgeon pin and its salient locations. [6]

address the adequacy of clearance between the pin and the small end of the connecting rod and also between the Gudgeon pin and piston bore. The Gudgeon pin, in reality, is a cylinder of roughly length 5 times its diameter, supported by lubricating oil present in the clearance on the piston bore for roughly two thirds its length with the middle one third subjected to lubricating oil pressure on the annular space of the small end of connecting rod. The load that gets communicated to the Gudgeon pin from the connecting rod acts on the outer circumference along the middle one third of its length which is shown in fig 4 [6].

IV. CONCLUSION
In this paper, review carried out on design and analysis of gudgeon pin. Gudgeon pin most of time fails due to high stress concentration so that stress concentration could be reduced by changing of design and changing of material and high stress occur at the mid span of gudgeon pin. Most of the researchers used the ANSYS software for analysis. This review study deals that the more efficient and useful material which is to be analyzed according to their market price and respective densities of them by FEA technique.

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