# Design And Analysis Of Connecting Rod Using CAD Softwares

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**Abstract : As the purpose of the connecting rod is to transfer the reciprocating motion of the piston into rotary motion of the crankshaft. Connecting rods for automotive applications are typically manufactured by forging from either wrought steel or powdered metal. The fact that forgings produce blow-hole-free and better rods gives them an advantage over cast rods. In this paper single cylinder petrol engines connecting rod CAD model is generated and designed a Static structural analysis is performed and finally an optimal design selected , Using CREO software. The safe design model is then printed in a RIO 3-D printer machine using raw material as ABS (Acrylonitrile-Butadiene-Styrene) wire. Various results were analyzed and compared with the existing results. The study presented here has came up with better results as well as safe design of connecting rod under permissible limits of various parameters and stresses.**

**Keywords : Connecting rod , Creo , Ansys , 3D printing.**

## I. INTRODUCTION

Every vehicle that uses an internal combustion engine requires at least one connecting rod depending upon the number of cylinders in the engine. The automobile engine connecting rod is a high volume production, critical component. It connects reciprocating piston to rotating crankshaft, transmitting the thrust of the piston to the crankshaft. This type of connecting rod is most widely used in multi cylinder engine.

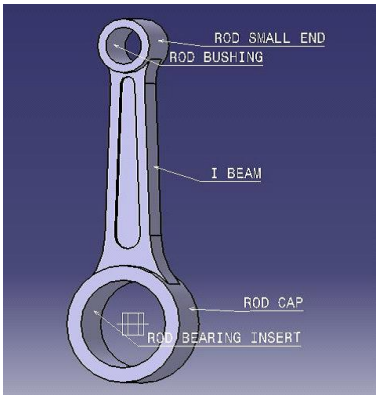


Fig.1 : Different parts of a Connecting Rod

The working model of connecting rod is shown in fig.1, small end of connecting rod is in contact with the piston with the help of gudgeon pin. And the larger end is in contact with the crankshaft.

### 1.1 Types of connecting rod

There are many types of connecting rod with different I section and H section. But there are basically two

types of connecting rod.
i) Connecting rod with nut and bolt- The connecting rod with cap at the larger end is joined by means of bolt and nut . This type of connecting rod is most widely used in multi cylinder engines. For example trucks,tractor etc.
ii) Connecting rod without nut and bolt – This type of connecting rod consist of single parts itself. And mostly used in single cylinder engine. For example bikes, scooter etc.

## II. LITERATUR REVIEW

There is a vast amount of literature related to Finite Element Analysis. Many research publications, journals, reference manuals, newspaper articles, handbooks; books are available of national and international editions dealing with basic concepts of FEA. Many other publications indicate the success story of implementation of FEA on various components.

The literature review presented here considers the major development in implementation of FEA. Pravardhan S. Shenoy, the University of Toledo [1] carried out the dynamic load analysis and optimization of connecting rod. The main objective of this study was to explore weight and cost reduction opportunities for a production forged steel connecting rod.

This has entailed performing a detailed load analysis. James R. Dale (2005) [2] presented a paper which gave the idea of Connecting Rod Evaluation in which he summarized up with Most forging grade alloy powders use nickel and molybdenum and small amounts of manganese to enhance iron harden-ability without developing stable oxide formation.

A. Mirehei, M. Hedayati Zadeh, A. Jafari, M. Omid (2008) [3] carried out the fatigue analysis of connecting rod .The connecting rod fatigue of universal tractor (U650) was investigated through the ANSYS software application and its lifespan were estimated. The reason for performing this research showed the connecting rod behaviour affected by fatigue phenomenon due to the cyclic loadings and to consider the results for more savings in time and costs, as two very significant parameters relevant to manufacturing.

The results indicate that with fully reverse loading, one can estimate longevity of a connecting rod and also find the critical points that more possibly the crack growth initiate from. Xianjun Hou, Cuicui Tian,Dan Fang, et.al (2009) [4] carried out the Sensitivity Analysis and Optimization for Connecting rod of LJ276M Electronic Gasoline Engine. Sensitivity analysis and optimization based on the combination of Pro/MECHANICAL and ANSYS are applied to designing of the connecting rod of LJ276M electronic gasoline engine. The maximum stress of connecting rod on the largest compression condition is reduced by 4.9% after the optimization is applied, static intension safety coefficient is increased by 5.4% and mass of connecting rod is also reduced.

Shahrukh shamim [5] studied finite element analysis of connecting rod used in single cylinder four stroke petrol engines. Static stress analysis is conducted on connecting rod made up of two different materials viz. E-glass/Epoxy and Aluminium composite reinforced with Carbon nano tubes. Modeling and comparative analysis of connecting rod is carried out in commercially used FEM software ANSYS 14.0. Static structural analysis was done by fixing the piston end and applying load at the crank end of the connecting rod. Output parameters in static stress analysis are Von-Mises stress, Shear stress, total deformation and equivalent elastic strain for the given loading conditions.
The objective of this work is to develop solid model of connecting rod of single cylinder-four stroke diesel engine using ANSYS Design 14.0 software. Static structural analysis is performed using FEA software ANSYS 14.0. The materials used in this study are E-glass/Epoxy and Aluminium Nano composite reinforced with Carbon nanotubes. Output parameters of static structural analysis are Von-Mises stress, total deformation, shear stress and equivalent elastic strain.

G. Naga Malleshwara Rao [6] worked on Design Optimization and Analysis of a Connecting Rod. The main

Objective of this work is to explore weight reduction opportunities in the connecting rod of an I.C. engine by examining various materials such as Genetic Steel, Aluminum, Titanium and Cast Iron. This was entailed by performing a detailed load analysis. Therefore, this study has dealt with two subjects, first, static load and stress analysis of the connecting rod and second, Design Optimization for suitable material to minimize the deflection. In the first of the study the loads acting on the connecting rod as a function of time are obtained. The relations for obtaining the loads for the connecting rod at a given constant speed of crank shaft are also determined. It can be concluded from this study that the connecting rod can be designed and optimized under a comprising tensile load corresponding to 360° crank angle at the maximum engine speed as one extreme load, and the crank pressure as the other extreme load. Furthermore, the existing connecting rod can be replaced with a new connecting rod made of Genetic Steel.

T Chandra Sekhar, CH Joseph Sundar, MP Manmohanan [7] investigated and compares fatigue behavior of forged steel and powder metal connecting rods. At the same time comparing cost analysis of both the materials like forged steel and powder material are compared. They must be capable of transmitting axial tension and compression loads. For applying tension and compression loads we are using latest solver technology called Altair Hyper works software. In which used Altair Hyper mesh for preprocessing, Altair Radios for solving tension and compression analysis at the same time fatigue analysis for checking the life of two different materials based on tension and compression condition are solved. Final conclusion is based on the result of which material is having more life. Based on cost of the two different materials, which will be low cost so that which material connecting rod can be more applicable.

## III . THE PROBLEMS RELATED TO CONNECTING ROD

 Proper oil level or lubrication prevents friction and engine overheating. Overheating leads to rod failure due to metal on metal friction, warped valves or warped pistons. Carbon build up also leads to rod failure due to overheating. This problem shows as dark or black-colored oil. Maintaining the proper oil level and using the proper grade of motor oil minimizes these types of rod breaks.

 Over-revving the engine can lead to rod breaks. The revving causes rod failure due to a valve's spring failing or being sucked into the engine.

 Faulty bearings cause too much play in a crankshaft and stresses the rod. Continued stress causes metal fatigue and eventual rod failure. Engine knock is the usual symptom. Knocking may also mean worn pistons or worn piston valves. In these instances, auto repair sites recommend replacing the piston valve, rod and crankshaft as a unit.

 Good auto maintenance extends an auto's life. However, a vehicle's age or high mileage may lead to a rod failure. A thrown rod pierces the engine block or causes the piston valve and cylinder unit to jam. In either instance, the event is a costly engine rebuild or replacement.

Fig.2 : Failure of a Connecting Rod

## IV.THE DESIGN PROCESS

The basic five-step process usually used in a problem-solving works for design problems as well. Since design problems are usually defined more vaguely and have a multitude of correct answers, the process may require backtracking and iteration. Solving a design problem is a contingent process and the solution is subject to unforeseen complications and changes as it develops.
The five steps used for solving design problems are:
1. Define the problem
2. Gather pertinent information
3. Generate multiple solutions
4. Analyze and select a solution
5. Test and implement the solution

## V. MATERIALS USED FOR CONNECTING ROD

**Iron**

Iron is a ductile, gray, relatively soft metal and is a moderately good conductor of heat and electricity. It is attracted by magnets and can be readily magnetized. The pure metal is chemically very reactive and rusts readily in moist air, forming red-brown oxides. Alpha iron, also known as ferrite, is the stable form of iron at normal temperatures.

**Chrome steel**

Chromium is a lustrous, brittle, hard metal. Its colour is silver-gray and it can be highly polished. It does not tarnish in air, when heated it burns and forms the green chromic oxide. Chromium is unstable in oxygen, it immediately produces a thin oxide layer that is impermeable to oxygen and protects the metal below.

**Titanium**

Chemical element, Ti, atomic number 22 and atomic weight 47.90. Its chemical behavior shows many similarities with that or silica and zirconium, as an element belonging to the first transition group. Its chemistry in aqueous solution, especially in the lower oxidation states, has some similarities with that of chrome and vanadium. Titanium is a transition metal light with a white-silvery-metallic colour. It is stung, lustrous, and corrosion-resistant. Pure titanium is not soluble in water but is soluble in concentrated acids. This metal forms a passive but protective oxide coating (leading to corrosion-resistance) when exposed to elevated temperatures in air but at room temperatures it resists tarnishing.

## VI . DESIGN SPECIFICATION

Following are the specification of the connecting rod being modeled and analysed :

| S.NO. | Parameters | Values |
|---|---|---|
| 1. | Length of connecting rod | 124.27 mm |
| 2. | Outer diameter of big end | 20.00 mm |
| 3. | Inner diameter of big end | 15.00 mm |
| 4. | Outer diameter of small end | 9.25 mm |
| 5. | Inner diameter of small end | 6.35 mm |

## VII : DESIGNING STEPS

Connecting Rod has been modelled with the help of CREO PARAMETRIC 2.0 Software. The Orthographic & final Solid Model of connecting rod is shown in figures below.

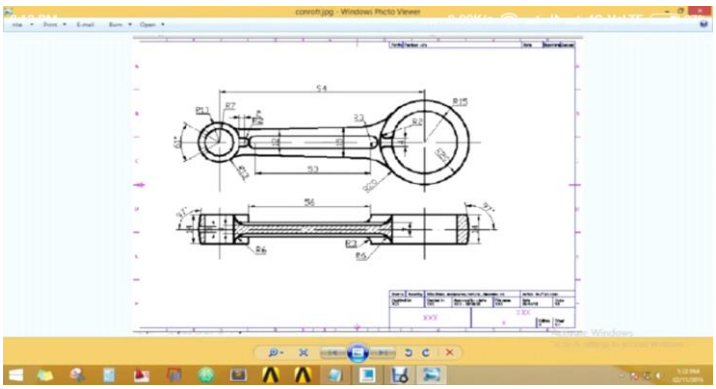

Fig.3 : A drafted CAD model in CREO Software

The following is the list of steps that are use to create the required model.

1) The base feature is created on three orthogonal datum planes.
2) Creating two circular entities on either sides of rod crank and piston pin end (with the help of sketcher Option).
3) Filling the material between the crank and piston pin End (With the help of EXTRUDE Option).
4) The second feature is also created on datum planes.
5) Using the EXTRUDE option the second feature is generated in between the two ends of the connecting rod.
6) Using the Protrude CUT option, the cut feature is generated on the second feature in order to get the I section.
7) Then the creo file is converted into IGES file for exporting it to analysis software for further processing.

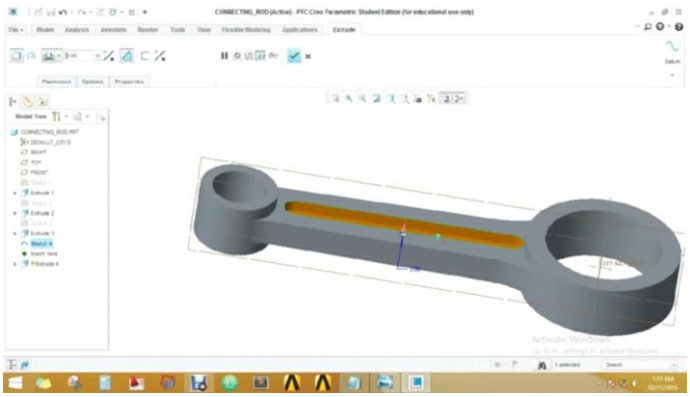

Fig.4 : A cad model of connecting rod

## VIII : DESIGN ANALYSIS

### 8.1 **Steps Involved In Analysing The Connecting Rod Using Ansys:**

The analysis is also done by using ANSYS software by importing the .iges file from creo parametric. The procedure followed is given below

1) First the .iges file is imported into the ansys, File>Import>IGES>filename.
2) In the Ansys main menu, the Structural analysis is set in the pre-processor section.
3) The appropriate element type is given. Solid>Tet 10 node187
4) The material properties are given.
5) Meshing of model was done.
6) One end of the connecting rod is fixed and the load is applied on the other end(big).

7) The solution was generated for current LS.
8) The result for von- mises stress and deformed & undeformed shape was taken.

**Meshing of model :**

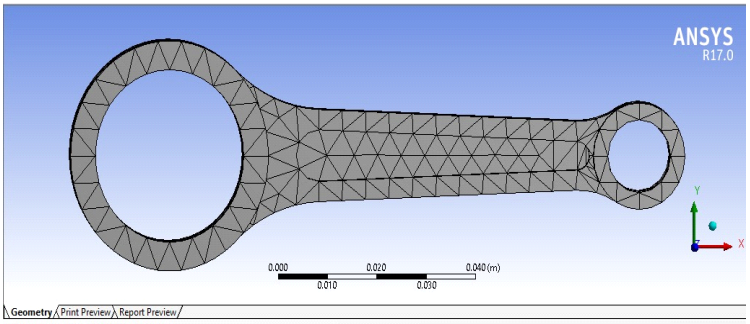


Fig. 5 : A meshed model of connecting rod

**Stress analysis :**

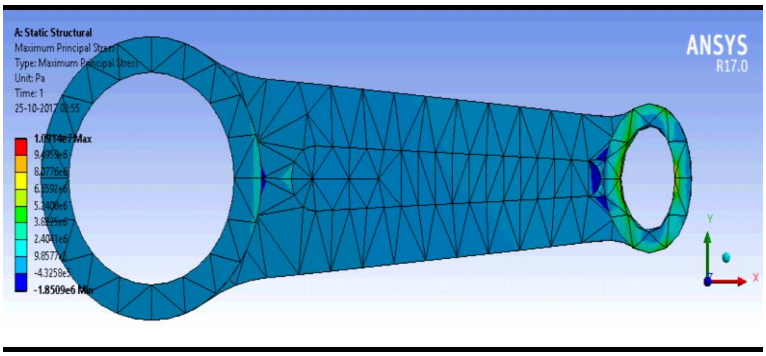


Fig.6 : Load Analysis For Maximium Principal Stress

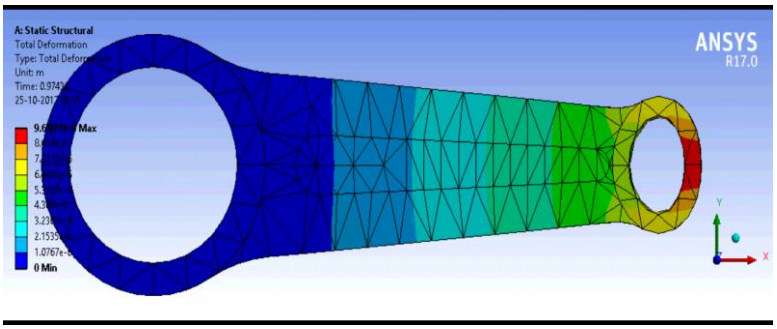


Fig.7 :Load Analysis For Total Deformation

**3 D printed model :**

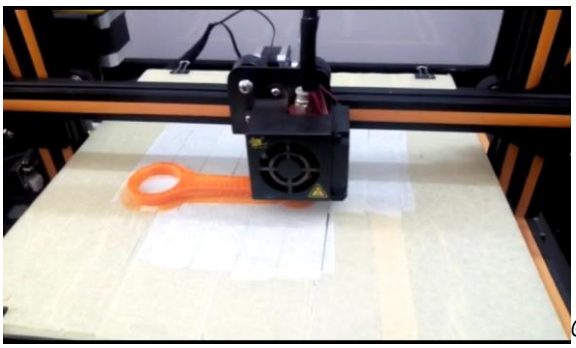

Fig. 8 : 3-D printing process and printed connecting rod

**Casting of connecting rod :**

3-D solid model of the connecting rod with specified dimensions for casting mold and the selected material i.e. aluminum is poured in molten state and allowed to solidified for the casting process to obtain the desired connecting rod and thus after machining the unfinished surface using CNC machining, the final product has been obtained with required dimensions and specified material.

Fig. 9: Image of casted connecting rod after machining operation

## IX : CONCLUSION

To study the deformation behavior of 3D model of connecting rod created in Creo software which is used in I.C engine .The design were optimized by Ansys as analysis software. The three materials aluminium, chromium and titanium were selected for analysis. In Ansys with same optimum dimensional parameters and load conditions the stress analysis was carried out. Out of these three materials the suitability of aluminium was justified due to its low cost and light weight. It is also having good tensile strength and toughness . A 3d piston rod made of material aluminium is casted to further use for real time physical testing and analysis in future . Also a 3d printed model of connecting rod is made in RIO 3 -D printer for converting the virtual 3d cad model to reality for better understanding the design parameters.

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