Journal of Engineering Sciences

Vol 10, Issue 11, Nov /2019
ISSN NO:0377-9254

DESIGN & ANALYSIS OF A CONNECTING ROD WITH DIFFERENT MATERIALS

[1]MOMIN ATHARUDDIN, [2]J.A.SANDEEP KUMAR,[3]P.HUSSAIN,
[4]Dr.P.MALLIKARJUNA REDDY
[1]M.Tech Student, [2]Assistant Professor, [3]Associate Professor, [4]Professor
DEPARTMENT OF MECHANICAL ENGINEERING
SVR Engineering College, Nandyal

ABSTRACT:

Connecting rods are practically generally used in all varieties of automobile engines connecting rod acting as a converting intermediate link between the piston and the crankshaft of the engine, by the reciprocating motion of the piston to the rotary motion of crankshaft. Thus, this study aims to carry out for the load strain, stress, total deformation and analysis of factor of safety of pin end of the connecting rod of different materials. Generally connecting rods are manufactured using aluminium alloys are used for manufactured the connecting rods. In this work existing connecting rod material are replaced by aluminium alloy the connecting rod is the intermediate member between the piston and the Crankshaft. Its primary function is to transmit the push and pull from the piston pin to the crank pin, thus converting the reciprocating motion of the piston into rotary motion of the crank. A parametric model of Connecting rod is modeled fabricated using cnc machine

Keywords: connecting Rod, four stroke engine connecting rod, aluminium connecting rod,

I. INTRODUCTION

Internal Combustion engine has many parts like cylinder, piston, connecting rod, crank and crank shaft. The connecting rod is very important part of an engine. Working of the connecting rod is to transmit power of piston to crank pin. Connecting rod has two ends one is pin end and other is crank end. Pin end is attached with piston. The big end (crank end) is attached to the crank pin by a crank shaft. The function of crank shaft is to transmit the reciprocating motion of piston into rotary motion. The connecting rod should be such that it can sustain the maximum load without any failure during high cycle fatigue. The connecting rod has generally three parts pin end, crank end, and long shank. Design of shank can be different type like rectangular, tubular, circular, I-section and Hsection. Circular section is generally used for low speed engines. I-section is used for high speed engines. Generally connecting rods are being made up of stainless steel and aluminium alloy through the forging process, as this method provides high productivity and that too with a lower production cost. Forces generated on the connected rod are generally by weight and combustion of fuel inside cylinder acts upon piston and then on the connecting rod, which results in both the bending and axial stresses.

Therefore it order to study the strain intensity, stress concentration and deformation in the crank end of the connection rod, firstly based on the working parameter and the vehicle chosen the design parameter or dimensions of the connecting rod is calculated, then the model of the connecting rod parts is prepared and finally it is analysed using Finite Element Method and results thus achieved will provide us the required outcome of the work done here .Also further study can also be carried out later on for the dynamic loading working conditions of the connecting rod and also improvement in design can also be made for operation condition and longer life cycle against failure.

In a reciprocating piston engine, the connecting rod connects the piston to the crank or crankshaft. 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 lightness and the ability to absorb high impact at the expense of durability) or titanium (for a combination of strength and lightness at the expense of affordability) for high performance engines, or of cast iron for applications such as motor scooters. The small end attaches to the piston pin, gudgeon pin (the usual British term) or wrist pin, which is currently most often press fit into the con rod but can swivel in the piston, a "floating wrist pin" design. The connecting rod is under tremendous stress from the reciprocating load represented by the piston, actually stretching and being compressed with every rotation, and the load increases to the third power with increasing engine speed. Failure of a connecting rod, usually called "throwing a rod" is one of the most common causes of catastrophic engine failure in cars, frequently putting the broken rod through the side of the crankcase and thereby

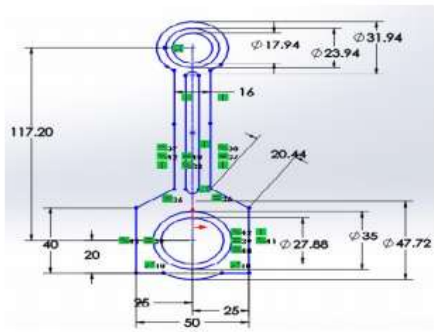
Journal of Engineering Sciences
Vol 10, Issue 11, Nov /2019
ISSN NO:0377-9254

rendering the engine irreparable; it can result from fatigue near a physical defect in the rod, lubrication failure in a bearing due to faulty maintenance or from failure of the rod bolts from a defect, improper tightening, or re-use of already used (stressed) bolts where not recommended. Despite their frequent occurrence on televised competitive automobile events, such failures are quite rare on production cars during normal daily driving. This is because production auto parts have a much larger factor of safety, and often more systematic quality control. When building a high performance engine, great attention is paid to the connecting rods, eliminating stress risers by such techniques as grinding the edges of the rod to a smooth radius, shot peening to induce compressive surface stresses (to prevent crack initiation), balancing all connecting rod/piston assemblies to the same weight and Magnafluxings to reveal otherwise invisible small cracks which would cause the rod to fail under stress. In addition, great care is taken to torque the con rod bolts to the exact value specified; often these bolts must be replaced rather than reused. The big end of the rod is fabricated as a unit and cut or cracked in two to establish precision fit around the big end bearing shell. Recent engines such as the Ford 4.6 liter engine and the Chrysler 2.0 liter engine have connecting rods made using powder metallurgy, which allows more precise control of size and weight with less machining and less excess mass to be machined off for balancing. The cap is then separated from the rod by a fracturing process, which results in an uneven mating surface due to the grain of the powdered metal. This ensures that upon reassembly, the cap will be perfectly positioned with respect to the rod, compared to the minor misalignments, which can occur if the mating surfaces are both flat. A major source of engine wear is the sideways force exerted on the piston through the con rod by the crankshaft, which typically wears the cylinder into an oval cross-section rather than circular, making it impossible for piston rings to correctly seal against the cylinder walls. Geometrically, it can be seen that longer connecting rods will reduce the amount of this sideways force, and therefore lead to longer engine life. However, for a given engine block, the sum of the length of the con rod plus the piston stroke is a fixed number, determined by the fixed distance between the crankshaft axis and the top of the cylinder block where the cylinder head fastens; thus, for a given cylinder block longer stroke, giving greater engine displacement and power, requires a shorter connecting rod (or a piston with smaller compression height), resulting in accelerated cylinder wear.

Fig-1 Schematic diagram of connecting rod

DESIGN OF CONNECTING ROD:

A connecting rod is a machine member which is subjected to alternating direct compressive and tensile forces. Since the compressive forces are much higher than the tensile force, therefore the cross- section of the connecting rod is designed as a strut and the ranking formula is used. A connecting rod subjected to an axial load W may buckle with x-axis as neutral axis in the plane of motion of the connecting rod,{or} y-axis is a neutral axis. The connecting rod is considered like both ends hinged for buckling about x-axis and both ends fixed for buckling about y-axis. A connecting rod should be equally strong in buckling about either axis. According to ranking formula



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. Connecting rod with nut and bolt - The connecting rod with cap at the larger end is joined by means of bolt. This type of connecting rod is most widely used in multi cylinder engines. For example trucks, tractor etc. 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. [4].

Journal of Engineering Sciences
Vol 10, Issue 11, Nov /2019
ISSN NO:0377-9254

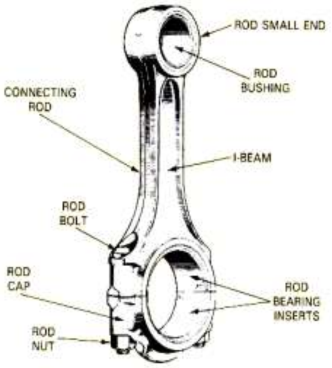


Fig. 1 Connecting Rod[9]

The earliest evidence for a connecting rod appears in the late 3rd century AD Roman Hierapolis sawmills. It also appears in two 6th century Eastern Roman saw mills excavated at Ephesus and Gerasa. The crank and connecting rod mechanism of these Roman watermills converted the rotary motion of the waterwheel into the linear movement of the saw blades. Sometime between 1174 and 1206, the Arab inventor and engineer Al-Jazari described a machine which incorporated the connecting rod with a crankshaft to pump water as part of a waterraising machine, but the device was unnecessarily complex indicating that he still did not fully understand the concept of power conversion. In Renaissance Italy, the earliest evidence of albeit mechanically misunderstood compound crank and connecting-rod is found in the sketch books of Taccola. A sound understanding of the motion involved is displayed by the painter Pisanello who showed a piston-pump driven by a water-wheel and operated by two simple cranks and two connecting rods. By the 16th century, evidence of cranks and connecting rods in the technological treatises and artwork of Renaissance Europe becomes abundant.

The piston, rings, and wrist pin:

The piston makes the crankshaft to turn by utilizing the energy supplied to it by the combustion of the fuel. It is cylindrical in shape and reciprocates inside the cylinder. Pistons are provided with groves near the top and provide an air tight fit. The pistons do not allow the high pressure mixture from the combustion chambers into the crankcase. The piston has four strokes in total, two upside and two down. During the intake stroke, the piston moves down and the cylinder is filled with air fuel mixture. The upward stroke

Compresses the mixture and as it reaches near the top position, the ignition of the fuel causes the piston to move downwards, the third stroke. During the fourth stroke, the piston moves upward and pushes the burnt gases to the exhaust system. The piston operates under high pressure and high temperature. The top portion of the piston is called as Crown. It's bottom is called as skirt. The diameter of the piston crown is less than the skirt. There are groves at the top for oil ring and compression rings. The oil groove is wider and deep than the compression ring. The oil ring scraps the excess oil and returns back and prevents the oil reaching the combustion chamber. Lands are the spaces between the grooves. In the design of pistons, the weight of the piston is an important factor. The top surface of the piston called as "Crown" is provided many shapes viz. convex, concave, and flat to control the combustion. Some pistons are provided with a narrow groove above the top ring to reduce the heat reaching the top ring. The wrist pin connects the connecting rod at the bottom of the piston, wherein the pin connects by passing through the side of the piston.

Piston stroke: The piston stroke displacement is determined by the axis of the crank throws from the axis of the crankshaft. Increasing the stroke increases the low-speed torque of the engine. This increases the reciprocating vibration and limits the high speed capability of the engine. If the stroke is longer than the cylinder bore diameter is called as "Under square" or long-stroke.

Materials for the Piston:

Cast Iron, Aluminium Alloy and Cast Steel etc. are the common materials used for piston. These pistons have greater strength and resistance to wear. In Aluminium Alloy pistons piston slap results due to insufficient piston clearance. A vertical slot is cut to overcome the defect. To increase the life of grooves and to reduce the wear, a ferrous metal rings are inserted in the grooves of high speed engines.

Connecting rod:

The connecting rod links the piston and the crankshaft. It has a hole at the upper end (small end) and is connected to the piston by the wrist pin. The lower end, also called as Big end, is attached to the crankshaft. The small end is press fit and can swivel in the piston. The Connecting rods are usually made of alloy steel, Titanium and sometimes with aluminum. They are not rigidly fixed at either end, so that the angle between the connecting rod and the piston can change as the rod moves up and down and rotates around the crankshaft. The big end is connected to the bearing journal on the crank throw. The connecting rod is under a lot of stress with every rotation. High factor of safety is provided as the failure of the connecting rod is very likely under such heavy stresses. Attention has to be paid to eliminate the stress risers in the connecting rod during production. Also, the bolts should be tightened with

Vol 10, Issue 11, Nov /2019
ISSN NO:0377-9254

proper torque. Wearing of engine is due to the sideward force exerted on the piston which results into wearing of the cylinder into an oval cross section. For a given engine block, the sum of the length of the connecting rod plus the piston stroke is a fixed number. This is determined by the fixed distance between the crankshaft axis and the top of the cylinder block where the cylinder head fastens. Thus, for a given cylinder block longer stroke, giving greater engine displacement and power, requires a shorter connecting rod (or a piston with smaller compression height), resulting in accelerated cylinder wear

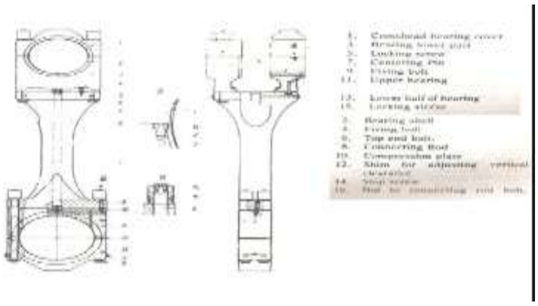


Figure:2 Schematic diagram of connecting rod

The type of rod material you want, or are available to fit the engine you are building (4340 or 300M forged or billet steel, aluminum, powder metal or titanium).

Fatigue design requirement Connecting rod is acted upon by gas loads and inertial loads during its operation. The forces include gas forces due to combustion and inertia forces due to its own weight. In that point of view fatigue is an important parameter to be considered for estimating the life of the component. The magnitudes of inertia forces are constant but gas forces are varying in nature. Due to fluctuating nature of these forces the chances of component failure due to fatigue is very high. Thus fatigue is one of the significant factors to be taken into account while optimizing an existing design. Fatigue in a component arises due to the following reasons

- Material defect
- Manufacturing defects
- Poor detailing of dimensions while designing
- Error in load calculation

The possible zones of stress concentrations are the change in cross-section from center shank to small end, change in cross-section from big end to center shank and the center shank itself. The connecting rod is subjected to higher duty cycles and the forces acting on the connecting rod is also tremendously high.

The connecting rod is the link that transmits forces between the piston and the crankshaft. Connecting rods must be strong enough to remain rigid under load and yet be light enough to reduce the inertia forces that are produced when the rod and piston stop, change direction, and start again at the end of each stroke.

Figure:3.A connecting rod between the piston and crankshaft

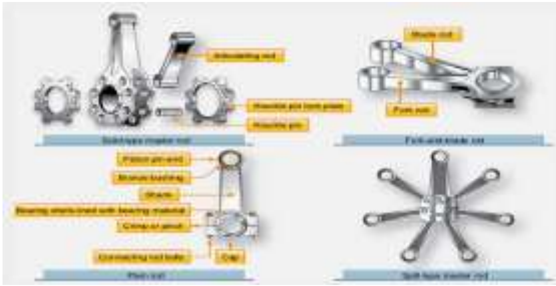


Figure:4.Connecting rod assembly

Master-and-Articulated Rod Assembly

The master-and-articulated rod assembly is commonly used in radial engines. In a radial engine, the piston in one cylinder in each row is connected to the crankshaft by a master rod. All other pistons in the row are connected to the master rod by articulated rods. In an 18-cylinder engine, which has two rows of cylinders, there are two master rods and 16 articulated rods. The articulated rods are constructed of forged steel alloy in either the I- or H-shape, denoting the cross-sectional shape. Bronze bushings are pressed into the bores in each end of the articulated rod to provide knuckle pin and piston-pin bearings.

The master rod serves as the connecting link between the piston pin and the crankpin. The crankpin end, or the big end, contains the crankpin or master rod bearing. Flanges around the big end provide for the attachment of the articulated rods. The articulated rods are attached to the master rod by knuckle pins, which are pressed into holes in the master rod flanges during assembly. A plain bearing, usually called a piston-pin bushing, is installed in the piston end of the master rod to receive the piston pin.

Figure:5. Elliptical travel path of knuckle pins in an articulated rod assembly.

When a crankshaft of the split-spline or split-clamp type is employed, a one-piece master rod is used. The master and articulated rods are assembled and then installed on the crankpin; the crankshaft sections are then joined together. In engines that use the one-piece type of crankshaft, the big end of the master rod is split, as is the master rod bearing. The main part of the master rod is installed on the crankpin; then the bearing cap is set in place and bolted to the master rod. The centers of the knuckle pins do not coincide with the center of the crankpin. Thus, while the crankpin center describes a true circle for each revolution of the crankshaft, the centers of the knuckle pins describe an elliptical path. The elliptical paths are symmetrical about a center line through the master rod cylinder. It can be seen that the major diameters of the ellipses are not the same. Thus, the link rods have varying degrees of angularity relative to the center of the crank throw.

II.LITERATURE REVIEW

Pushpendra kumar Sharma et al. (2012) performed the static FEA of the connecting rod using the software and said optimization was performed to reduce weight. Weight can be reduced by changing the material of the current forged steel connecting rod to crack able forged steel (C70). 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.

III.DESIGN SPECIFICATIONS AND METHODOLOGY

- The base feature is created on three orthogonal datum planes.
- Creating two circular entities on either sides of rod crank and piston pin end (with the help of sketcher Option).
- Filling the material between the crank and piston pin End (With the help of EXTRUDE Option).
- The second feature is also created on datum planes.
- Using the EXTRUDE option the second feature is generated in between the two ends of the connecting rod.
- Using the Protrude CUT option, the cut feature is generated on the second feature inorder to get the I section.
- Then the CATIA file is converted into .iges file for exporting it into the ansys software for further processing.

Cnc machine working :

The first five operations were carried out in a single set- up, which required fixture set-up time of 1hr. And another operation, the big end boring was carried out in another set –up, which required fixture set-up time of 1hr. With this new fixture design and programming capability, the time taken by the MAG HMC1000 CNC Machine for the operations is reduced. The time taken by respective machining centers to carry out these six operations is 113min per component, whereas the time taken by this new fixture design is about 24min for a single component. This new fixture design can perform machining operations for 12 components at a time. It takes around 290min to complete the machining operations for 12 components in this fixture design, whereas it takes 3 shifts by employees to complete these machining operations in respective convention machines.

In the same fixture, slots are made to accommodate three different positions of the component. More than one operation can be carried out or two components can be accommodated in a single operation.

Figure:6. CNC milling machine

The MAG HMC 1000 adopts an impressionable casting with scrapping skill, high rigidity structure, and precision axial feed rates to assure high precision machining capacity. It uses a box way mechanism with a worktable of dimension 1500x1000mm and the X, Y, Z axes travel 2700x1100x1100mm.

CONNECTING RODS WITH AND WITHOUT OPENING

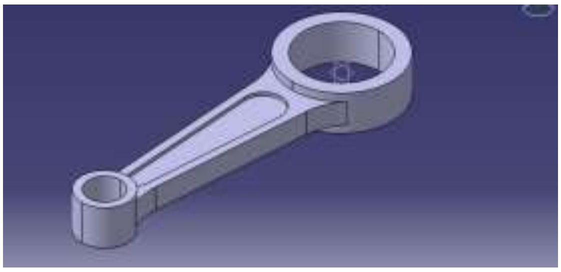


Figure.7. shows the connecting rod model

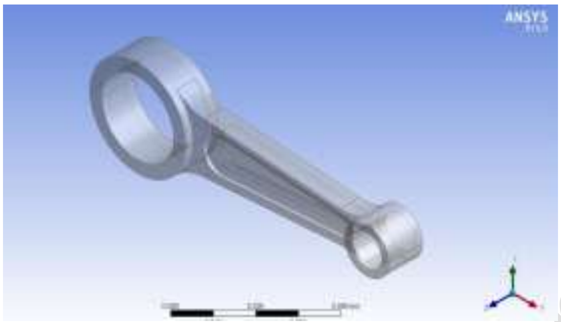


Figure.8.shows the connecting rod model with slot end

IV.RESULTS AND DISCUSSIONS

The materials were chosen and the connecting rod was manufactured by the two processes respectively. The ingot of the specified material where purchased from the dealers of the required materials The ingots where machined using the CNC machine by the model modelled on Pro-Engineer and it was transferred to the machine. The work piece on the table was clamped with bench wise again fixed to the table in the T slots. The cutter was aligned properly by once setting the co-ordinates. The bores are precision honed. All corners where blended to eliminate stress at corners

Figure:9.CNC machining of aluminium block

Figure: 10.Mold preparation of connecting rod

The aluminium connecting rod was produced using hand layup method First the half Mold was made by making a wooden pattern around the half periphery of the rod. The holes were also covered with the wooden pattern and screws were fit into them to pull them out after the half Mold is built. The releasing agent was then applied so that when the Mold is ready after drying it is easily removed from the pattern and doesn't stick to it. The realizing has to be applied properly otherwise the Mold may break while separating. The half Mold was prepared by using the aluminium material which was placed by hand layer after layer and applying the general purpose resin mixed with the accelerator copal and then the catalyst methyl-ethyl copal is added while layers are added and left for drying

The connecting rods of the aluminium alloy where solution heat treated to increase their strength and mechanical properties at temperatures of around 480c and was held in water for 30 minutes. The rods after solution heat treatment and stress revealing operation. The aluminium connecting rods where then fit in the engine step by step as shown in the following figures

Figure:11.Connecting using module

Figure:12.Solution Heat Treated Rod

Due to its central role in every combustion piston engine, mechanical reliability of every Connecting rod is of upmost importance. Connecting rod mechanical properties depend on used material and applied manufacturing technology. Current paper elaborates three most frequently employed manufacturing processes to fabricate Connecting rod classical forging, casting and powder forging. Hot forging is still the most used technology, especially for high performance engines as it enables production of mechanically high reliable Connecting rod Powder forging alternative is somewhat more costly than classical forging, but it requires reduced additional machining operations and therefore has a strong growing market

Materials and properties:

The connecting rod is under tremendous stress from the reciprocating load represented by the piston, actually stretching and being compressed with every rotation, and the load increases to the third power with increasing engine speed. Steel is normally used for construction of automobile connecting rods because of its strength, durability, and lower cost. However, steel with its high mass density exerts excessive stresses on the crankshaft of a high speed engine. This in turn requires a heavier crankshaft for carrying the loads and, therefore, the maximum RPM of the engine is limited. Additionally, higher inertia loads, such as those caused by steel connecting rods and heavier crankshafts reduces the acceleration or declaration rates of engine speed. 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. Every vehicle that uses an internal combustion engine requires at least one connecting rod depending upon the number of cylinders in the engine. With steel forging, the material is inexpensive and the rough part manufacturing process is cost effective. Bringing the part to final dimensions under tight tolerance results in high expenditure for machining, as the blank usually contains more excess material The first aspect was to investigate and compare fatigue strength of steel forged connecting rods with that of the powder forged connecting rods. Due to its large volume production, it is only logical that optimization of the connecting rod for its weight or volume will result in large-scale savings. It can also achieve the objective of reducing the weight of the engine component, thus reducing inertia loads, reducing engine weight and improving engine performance and fuel economy A composite is a material that is formed by combining two or more materials to achieve some superior properties. Almost all the materials which we see around us are composites. Some of them like woods, bones, stones, etc. are natural composites, as they are either grown in nature or developed by natural processes..

Table:1. Chemical composition of aluminum 7068 alloy

Element	Content %
Zinc, Zn	8.3
Magnesium, Mg	3
Copper, Cu	2.4
Iron, Fe	0.15
Zirconium, Zr	0.15
Silicon, Si	0.12
Manganese, Mn	0.1
Titanium, Ti	0.1
Chromium, Cr	0.05
Other (total)	0.15

Table:2.Physical properties of aluminum 7068 alloy

Properties	Metric	Imperial
Density	2.85 mg/cm³	0.103 lb/in³
Melting point	476-635 °C	890-1175 °F

Table: 3.Mechanical Properties of aluminum 7068 alloy

Properties	Metric	Imperial
Tensile strength	641 MPa	93 ksi
Yield strength	590 MPa	85.7 ksi
Elongation	8%	8%

Silicon Carbide Properties:

Properties:

Properties	Metric
Flexural Strength	550 MPa
Elastic Modulus	410 GPa
Compressive Strength	3900 MPa
Hardness	2800 Kg
Thermal Conductivity	120 W/m•°K
Specific Heat	750 J/Kg•°K

Table: 4.Forged Steel Properties:

Properties	Metric
Tensile Strength	845 MPa
Yield strength	540 GPa
Young's modulus	210 Mpa
Elongation	15%
Poisson's ratio	0.3
Density	7.85 g/cm^3
Melting point	1416°C

Modeling of connecting rod:

To calculate existing factor of safety of the connecting rod the flowing considerations are being taken the connecting rod is designed using CATIA V5 6R 2018 according to the specifications given below

Parameter	Value
Length of connecting rod	150
Outer diameter of big end	56
Inner diameter of big end	48
Outer diameter of small end	32
Inner diameter of small end	24

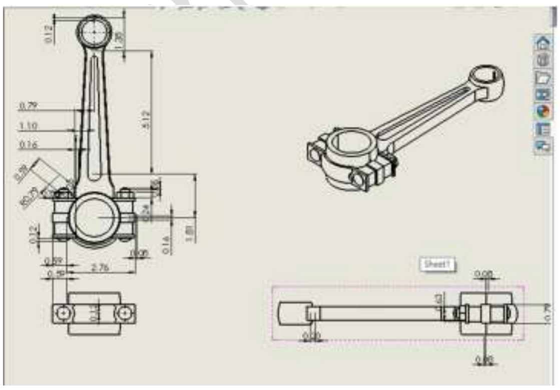


Figure: 13.Geometric view

ANALYSIS ON ANSYS WORKBENCH 16.2:

A. Introduction to Ansys Ansys is analysis software. It is used to check design feasibility of the design almost in all aspect. Ansys as a software is made to be user-friendly and simplified as much as possible with lots of interface options to keep the user as much as possible from the hectic side of programming and debugging process. A glimpse of Ansys workbench is shown in figure

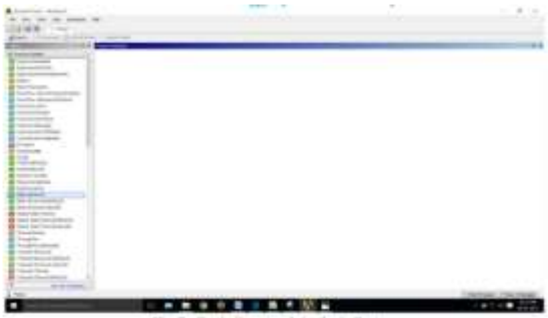


Figure:14.Static Structural Analysis System

In this project we took static structural as analysis system for the analysis of connecting rod. To analyzing connecting rod using different material at Ansys workbench 16.2 following step have been followed:-

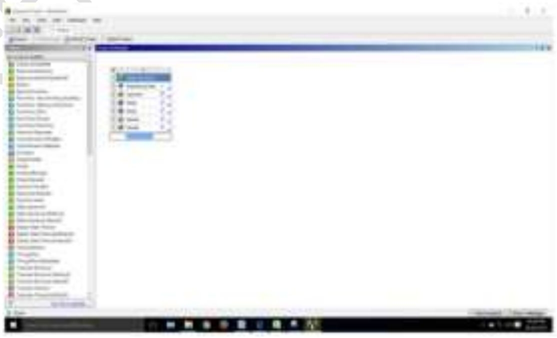


Figure: 15.First view of static structure

Meshing After importing the external geometry further function is meshing. Meshing is done for better accuracy in result. It is many typesa)

a) Triangular meshing

b) Rectangular meshing

c) Tetrahedron meshing ....et

Vol 10, Issue 11, Nov /2019
ISSN NO:0377-9254

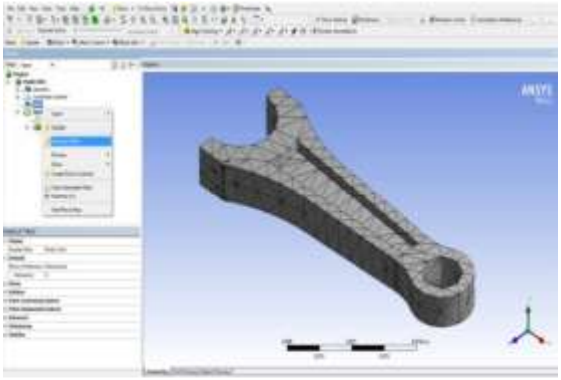


Figure:16. Generate meshing

Working on Model:

a) After meshing we go to SET UP we click on CONNECTING and see like this

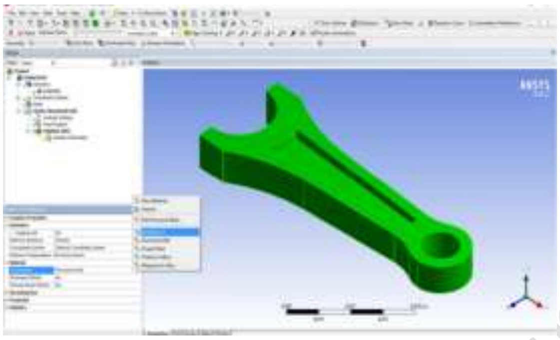


Figure: 17.Giving new material to connecting rod

In Details of CONNECTING click on assignment we see there are importing materials.

Then we selecting one of them for further implementation.

Static Structural Setting: In static structure Analysis we have to fixed one part then right click on static structure then go to insert and further click on fixed support and apply on one part of the connecting rod

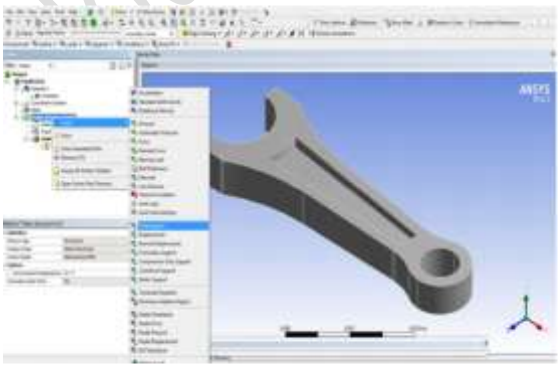


Figure:18.Giving fixed support

To define stress various theories have been already assigned in the ansys like Von-Mises, Maximum principal etc. In this project Von- Mises used as stress theory.

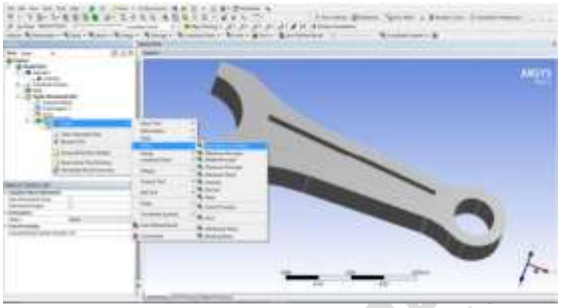


Figure:19.Applied stress in model

Deformation: Two type of deformation is given in Ansys a) Total Deformation It is the volumetric deformation in geometry. b) Directional Deformation: In directional deformation, deformation is in a particular direction i.e. in x, y and z-direction

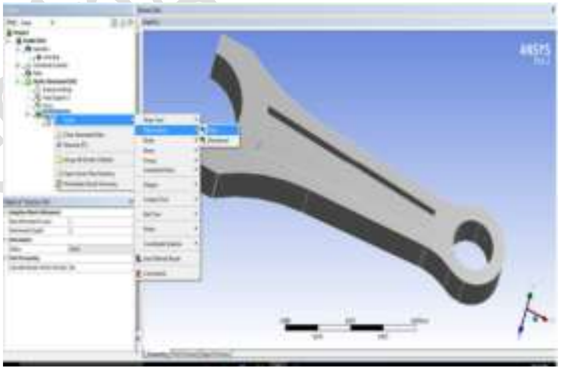


Figure: 20.Total deformations in connecting rod

Strain: There are many type of strain in ansys as von-mises, maximum principle strain, and maximum shear strain. In this project we discuss only von-mises strain.

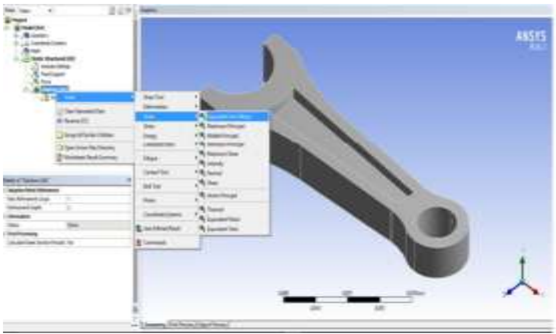


Figure:21.Strain in model

Vol 10, Issue 11, Nov /2019
ISSN NO:0377-9254

Analysis of Connecting Rod of Forged Steel:

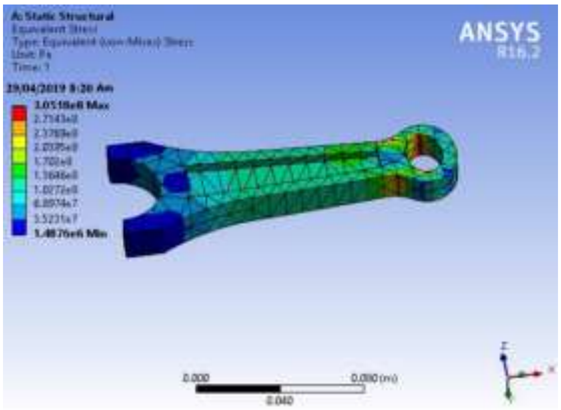


Figure:21. Equivalent Stress Analysis

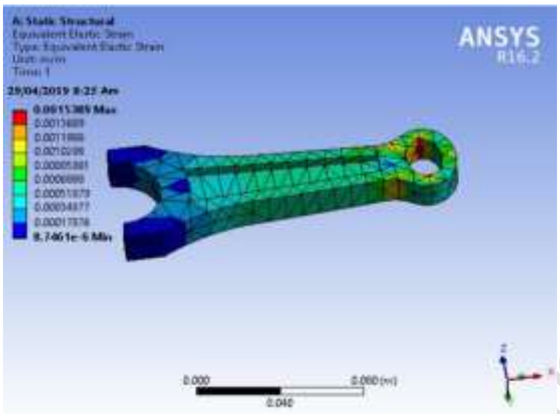


Figure:22.Equivalent Strain Analysis

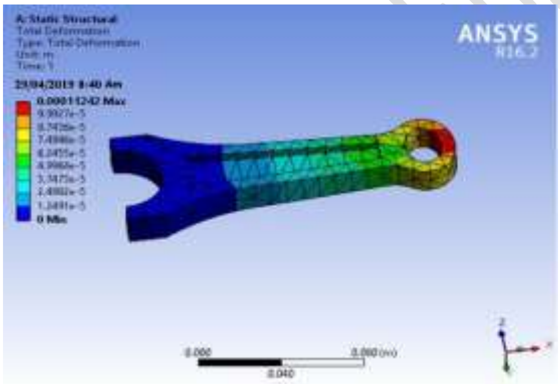


Figure:23. Equivalent Deformation Analysis

Table: Result and Analysis of Forged Steel Connecting Rod

Parameters	Minimum	Maximum
Stress	$1.4876x10^6$	$3.0518x10^8$
Strain	$8.7461x10^{-6}$	0 .0015389
Deformation	0.0	0.00011242

Analysis of Connecting Rod of Silicon Carbide:

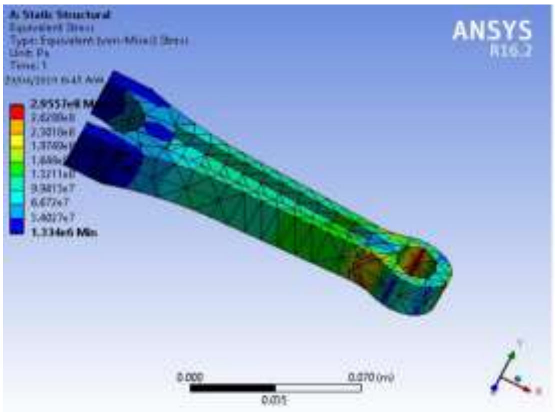


Figure:24.Equivalent Stress Analysis

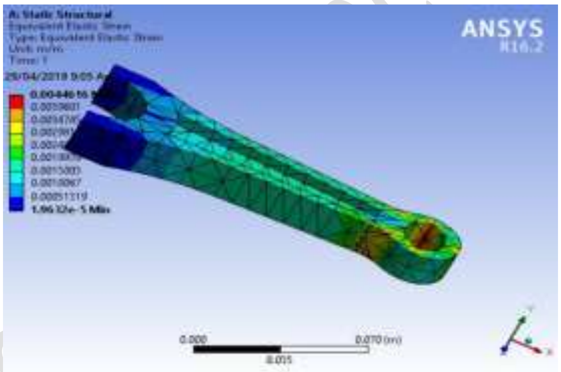


Figure:25.Equivalent Strain Analysis

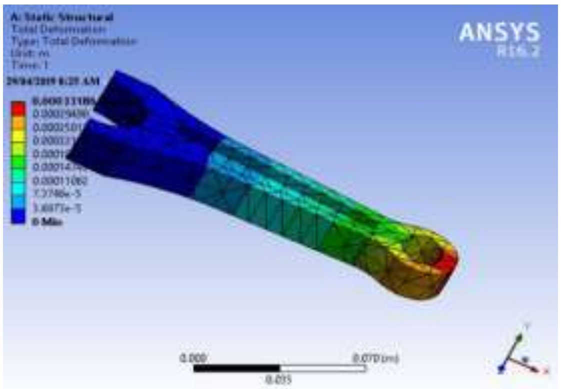


Figure:26. Equivalent Deformation Analysis

Table: Result and Analysis of silicon carbide Connecting Rod

Parameters	Minimum	Maximum
Stress	$1.334x10^6$	$2.9557x10^8$
Strain	$1.9632x10^{-5}$	0 .0044616
Deformation	0.0	0.00033186

Analysis of Connecting Rod of aluminum 7068:

Vol 10, Issue 11, Nov /2019
ISSN NO:0377-9254

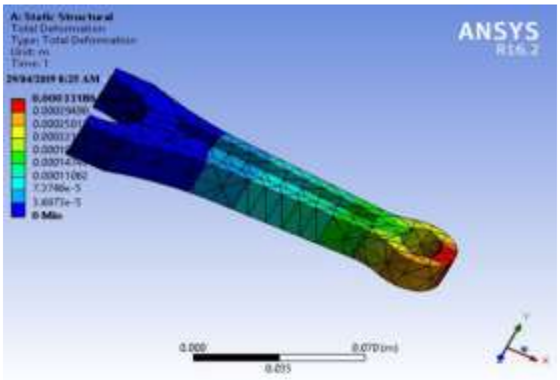


Figure: 27.Equivalent Stress Analysis

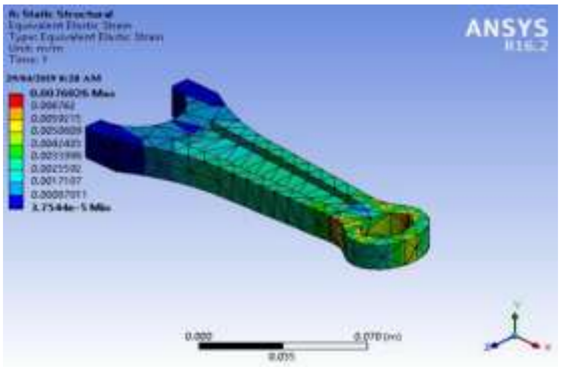


Figure: 28.Equivalent Strain Analysis

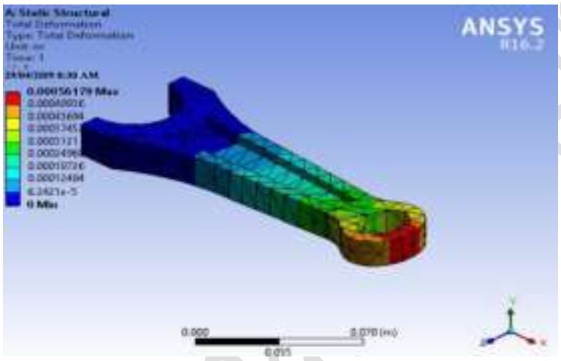


Figure: 29.Equivalent Deformation Analysis

Table: Analysis of Connecting Rod of aluminum 7068

Parameters	Minimum	Maximum
Stress	$1.5246x10^{6}$	$2.9968x10^{8}$
Strain	$3.7544x10^{-5}$	0 .0076026
Deformation	0.0	0.00056179

Analysis of Connecting Rod of SS304:

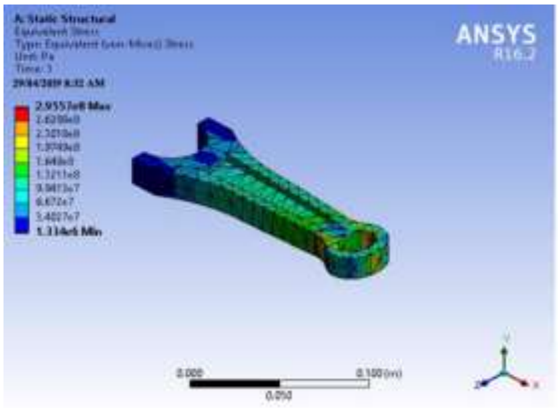


Figure :30.Equivalent Stress Analysis

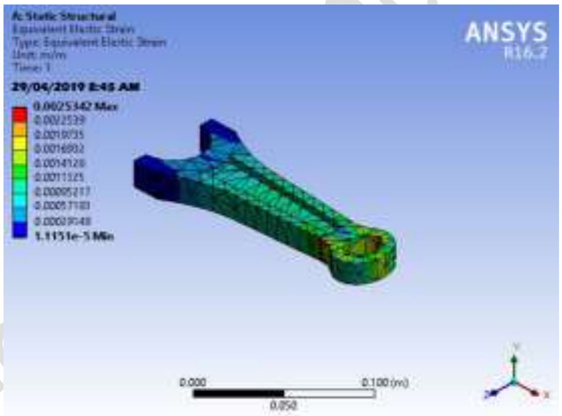


Figure: 31.Equivalent Strain Analysis

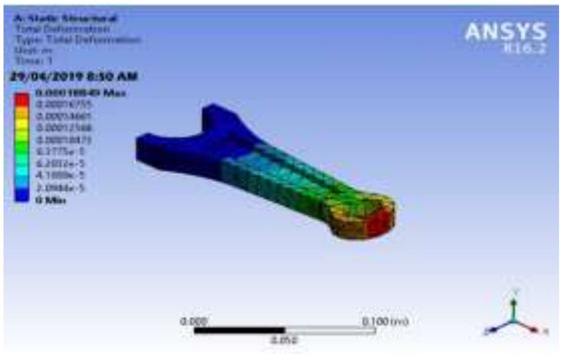


Figure:32.Equivalent Deformation Analysis

Analysis of Connecting Rod of SS304

Parameters	Minimum	Maximum
Stress	$1.334x10^{6}$	$2.95578x10^{8}$
Strain	$1.115x10^{-5}$	0 .0025342
Deformation	0.0	0.0001884

From analysis it is observed that the minimum stresses among all loading conditions, were found at crank end cap as well as at piston end. So the material can be reduced from those portions, thereby reducing material cost. For further optimization of material dynamic analysis of connecting rod is needed. After considering dynamic load conditions once again finite element analysis will have to be performed. It will give more accurate results than existing. It is the conclusion of this study that the connecting rod can be designed and optimized under a load range comprising compressive load as one extreme load and tensile load. Furthermore, the existing connecting rod can be replaced by optimization with a new connecting rod made of lighter in weight From the above analysis we can conclude that stresses of all the materials are almost comparable and also in safe limit, i.e., well below the yield stress. The section modulus of the connecting rod should be high enough to prevent high bending stresses due to inertia forces. F. Weight of connecting rod is reduced, Thereby reduces the inertia force by comparing the results of three different materials used for connecting rod analysis it is found that equivalent von mises stress for all the materials is approximately same. From the static analysis the stress is found maximum at the small end of the connecting rod. H. Carbon steel as a connecting rod material is less stiff and having more weight than forged steel and other material taking in consideration

V.CONCLUSIONS

In this thesis, a broken connecting rod made of forged steel is replaced with Aluminium alloys and The materials are changed so that the weight of the connecting rod is less when aluminium alloys used The connecting rod is fabricated forces are calculated. Analysis is done on the connecting rod using materials aluminium 6061, the forces were applied on the piston head and the effect of it on the connecting rod was studied in this analysis. Demand of industry for components produced with high techno-economical performances is permanently growing. Such trends are exceedingly noticeable in automotive industry. One of the main components in every automobile is connecting rod. It converts linear motion of the piston into the rotating motion of the crankshaft and it is highly stressed by cyclic pushing and pulling loads.

Above project gives the idea about designing of the connecting rod. It explains about the various stresses to be considered while designing the connecting rod and different materials used and comparing the result of all material. These can be used for designing any connecting rod in Automobile. Connecting rod can be designed for weight and cost reduction also to increase the life time of connecting rod. Up to some level of extent the weight of the connecting rod is lighter and having more strength as compared to the original design.

Future scope:

1. Designing a connecting rod for a specific two wheeler IC Engine, by numerical method.

2. The connecting rod can be further modified with suitable alternate material for weight optimization.

REFERENCES

[1] A. Prem kumar "Design & Analysis of Connecting Rod by Composite Material" ISSN: 3855-0154, IJRD, Vol. 2, Issue 7, July 2015.

[2] Ambrish Tiwari, Jeetendra Kumar Tiwari, Sharad Kumar Chandrakar "Fatigue Analysis of Connecting Rod Using Finite Element Analysis to Explore Weight and Cost Reduction Opportunities for a Production of Forged Steel Connecting Rod" ISSN 2250-3234, Vol. 4, Number 7, 2014.

[3] B. Anusha, C.Vijaya Bhaskar Reddy "Modeling and Analysis of Two Wheeler Connecting Rod by Using Ansys" ISSN: 2320-334X, Vol. 6, Issue 5, May. - Jun. 2013

[4] Dr. B.K.Roy. "Design Analysis and Optimization of Various Parameters of Connecting Rod using CAE Softwares" ISSN: 2319-6319, IJNIET, Vol. 1, Issue 1, October 2012.

[5] Fanil Desai, Kiran kumar Jagtap, Abhijeet Deshpande "Numerical and Experimental Analysis of Connecting Rod" ISSN 2349-4395, IJEERT, Vol. 2, Issue 4, July 2014.

[6] G. Naga Malleshwara Rao "Design Optimization and Analysis of a Connecting Rod using ANSYS" ISSN: 2319-7064, IJSR, Vol. 2 Issue 7, July 2013.

[7] K. Sudershn Kumar, Dr. K. Tirupathi Reddy, Syed Altaf Hussain "Modeling and Analysis of Two Wheeler Connecting Rod" ISSN: 2249-6645, IJMER, Vol 2, Issue 5, Sep-Oct. 2012.

[8] Kuldeep B, Arun L.R, Mohammed Faheem "Analysis And Optimization Of Connecting Rod Using Alfasic Composites" ISSN: 2319-8753, IJIRSET, Vol. 2, Issue 6, June 2013.

[9] Mr. J.D. Ramani, Prof. Sunil Shukla, Dr. Pushpendra Kumar Sharma. "FE-Analysis of Connecting Rod of I.C.Engine by Using Ansys for Material Optimization" ISSN: 2248-9622, IJERA, Vol. 4, Issue 3, Version 1, March 2014.

[10] P.S. Shenoy and A Fatemi "Dynamic analysis of loads and stresses in Connecting Rods" JMES105, Vol. 220 Part C, 2006.

[11] Prateek Joshi, Mohammad Umair Zaki "FEM Analysis of Connecting Rod of different materials using ANSYS" ISSN: 2395-1303, IJET, Vol. 1, Issue 3, May - June 2015.

[12] Pushpendra Kumar Sharma, Borse Rajendra R "Fatigue Analysis And Optimiation Of Connecting Rod Using Finite Element Analysis" ISSN-2319-8354, IJARSE, Vol. No.1, Issue No. I, September 2012.

[13] R.A. Savanoor, Abhishek Patil, Rakesh Patil, Amit Rodagi "Finite Element Analysis Of IC Engine Connecting Rod By Ansys" ISSN: 2278 – 0149, IJMERR, Vol. 3, No. 3, July 2014.

[14] Sushant, Victor Gambhir "Design and Comparative Performance Analysis of Two Wheeler Connecting Rod Using Two Different Materials Namely Carbon 70 Steel and Aluminum 7068 by Finite Element Analysis" ISSN: 2321-3051, IJRAME, Vol. 2, Issue. 6, June 2014.

[15] Shenoy, P. S. and Fatemi, A. Connecting rod optimiz- ation for weight and cost reduction. SAE Technical Paper 2005-01-0987, 2005.

[16] Ferguson, C. R. Internal combustion engines, applied thermo sciences, 1986 (John Wiley & Sons, Shrewsbury).

[17] Socie, D. F. and Marquis, G. B. Multiaxial fatigue, 2000 (Society of Automotive Engineers, Warrendale, PA).