Evaluation of Optimum Design Parameters for Connecting Rod using FEA

Nikhil P. Patil[1], Suhas M. Shinde[2]

[1]PG Scholar, Jayawantrao Sawant College of Engineering, SPPU Pune-028, India
[2]Professor, Jayawantrao Sawant College of Engineering, SPPU Pune-028, India

---

Abstract - *The connecting rod connects the pistons to the crankshaft. It converts the linear motion of the pistons to the rotary motion of the crankshaft. On every stroke, the connecting rod is stretched and compressed. This force and additional loading may cause the connecting rod to break. The broken rod can go through the engine block completely, ruining the engine, this condition is known as "throwing a rod". The current work includes design of connecting rod with given conditions and CAD modelling of the connecting rod is done. The connecting rod is compared with four different materials 20CrMo steel alloy, AA7010, AA7068, AA6010 aluminum alloys. The best combination of parameters like Von-Misses Stress and Strain, deformations, Factor of safety were done in ANSYS programming. In this different materials are compared and AA7068 possess less weight and deformations. Aluminum Alloys are lesser in weight, corrosion resistance, non-toxic, flexible in design and stiffer than other material like Steel. ANSYS software was employed to analyze and examine the effect of stress in different parts of the connecting rod. For the analysis we have started with the existing design parameters and then incrementally changed the fillet radius at big end with keeping the small end dimensions constant and then changing the fillet radius of the small end with keeping the fillet radius of the big end intact. Finally optimum parameters were selected for the modified design for the minimum stress conditions.*

Key Words: *Connecting Rod, Aluminum Alloy, Fillet radius, Pistons, Crankshaft, CAD modeling*

1. INTRODUCTION

Connecting rod is an integral component of internal combustion engine and it is classified under functional component. It acts as a linkage between piston and crank shaft. The main function of connecting rod is to transmit the translational motion of piston to rotational motion of crank shaft. The function of the connecting rod also involves transmitting the thrust of the piston to the connecting rod. Connecting rod has three main zones. The piston pin end, the center shank and the big end. The piston pin end is the small end, the crank end is the big end and the center shank is of I-cross section. Connecting rod is a pin jointed strut in which more weight is concentrated towards the big end.

The connecting rod is subjected to a complex state of loading. It undergoes high cyclic loads of the order of 10^8 to 10^9 cycles, which range from high compressive loads due to combustion, to high tensile loads due to inertia. Therefore, durability of this component is of critical importance. Due to these factors, the connecting rod has been the topic of our project for different aspects such as life cycle, materials cost, fatigue, etc… For the current manufacturing condition, it was necessary to investigate finite element modelling techniques, optimization techniques, and developments in new materials, fatigue modelling, and material cost analysis for different mechanical components such as automobile, plastic, home appliances etc…, which are made by large volume production. Due to its large volume production, it is only logical that optimization of the connecting rod for its material cost will result in large-scale savings. Below is a picture of the fundamental parts of an engine. Surface "L" is where combustion occurs, air enters through "M", and "H" is the shaft through which power is accumulated and delivered out of the engine. The combustion occurs against the top surface of the piston (F) and pushes the connecting rod (G) downward, causing the shaft to move in a circular motion. So, it is easy to see that the connecting rod harnesses all of the power produced in combustion and converts it into something useful, in this case a spinning shaft.

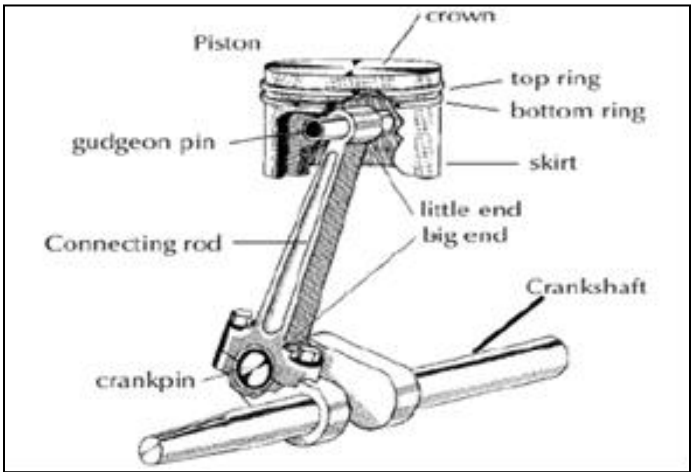


Fig. 1: Connecting rod with piston and crankshaft assembly

2. LITERATURE SURVEY

Tony George Thomas et. al. [1] selected heavy duty application's connecting rod for the study. The analytically calculated loads acting on the small end of connecting rod were used to carry out the static analysis using ANSYS. A stress concentration was observed near the transition between small end and shank. A piston-crank-connecting rod assembly was simulated for one complete cycle (0.02 seconds) using ADAMS to obtain the loads acting on small end of connecting rod. This force vs. time graph was converted into an equivalent stress vs. time graph. This stress vs. time graph was used as loading graph for fe-safe. The fatigue life calculated using fe-safe is 6.94×106 cycles and these results are validated with the help of Palmgren-Miner linear damage rule. The fatigue life of connecting rod can be further enhanced by incorporating manufacturing process effects in the analysis stage. Fatigue life was estimated by incorporating the shot peening process effects. An in-plane residual stress for the selected surface elements were applied for obtaining the beneficial effect of shot peening. There was an increment of 72% in fatigue life cycles). He concludes that shot peening can significantly increase the fatigue life of a connecting rod Component.

Pravardhan S. Shenoy et. al. [2] in his work, optimization study was performed on a steel forged connecting rod with a consideration for improvement in weight and production cost. Since the weight of the connecting rod has little influence on its total production cost, the cost and the weight were dealt with separately. Reduction in machining operations, achieved by change in material, was a significant factor in manufacturing cost reduction. Weight reduction was achieved by using an iterative procedure. Literature survey suggests cyclic loads comprised of static tensile and compressive loads are often used for design and optimization of connecting rods. However, in this study weight optimization is performed under a cyclic load comprising dynamic tensile load and static compressive load as the two extreme loads. Constraints of fatigue strength, static strength, buckling resistance and manufacturability were also imposed. The fatigue strength was the most significant factor in the optimization of the connecting rod. An estimate of the cost savings is also made. The study results in an optimized connecting rod that is 10% lighter and 25% less expensive, as compared to the existing connecting rod.

The paper of Gaba Peeyush et. al. [3] deals with the stress analysis of connecting rod and guidelines for its finite element simulation. The definitions of critical load cases and the High Cycle Fatigue (HCF) have been explained. Finally it has been concluded that the connecting rod design can be optimized using Finite Element Methods (FEM) for high cycle fatigue. From the work carried out during this research it is concluded that complicated mechanisms can be simulated. The results obtained are logical and can be used to improve or modify the parts, shapes and performance of the whole system.

Amit Telang et. al. [4] work on the effect on the quality improvements of cutting fluid and the standard practices of usage during the machining operation mainly attributed on reduction in cutting zone temperature and minimize its adverse effects on human health and environment. Now-a-days the Connecting rod is made up of aluminium silicon alloy, C-70 steel, Carbon epoxy Material which expands enormously due to generation of heat in the piston. This will affect clearance volume and insufficient clearance can cause the piston size in the cylinder. The ultimate aim is to reduce the expansion and increasing service factor by material and design modification and to analyze the various characteristics of Connecting rod like stress, deformation, density, Young's modules and poisons ratio.

3. OBJECTIVES

1. Design of connecting rod.
2. Study of different materials used for connecting rod.
3. Comparative analysis study for different materials of connecting rod using ANSYS.
4. Optimization of connecting rod using Fillet radius.

4. DESIGN OF CONNECTING ROD

A. Problem Specification :-

Design Specifications of Engine for which Connecting rod is to be designed-
Engine type - 4-stroke Petrol Engine (Stationary Engine)

Bore × Stroke (mm) = 0.1 × 0.15 m
Speed = 1500 rpm
Possible over speed = 2500 rpm
Crank Radius = 0.075 m
Explosion Pressure = 5 N/ mm^2
Compression Ratio = 9/1

Additional Data,

- Density of petrol at 288.855 K - 737.22*10-9 kg/mm^3
- Molecular weight M - 114.228 g/mole
- Ideal gas constant R – 8.3143 J/ mol.k

Weight of reciprocating parts = Piston Weight + 0.33*Weight of connecting rod

B. 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 Rankine 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.

1. Nomenclature

A = Cross sectional area of the connecting rod.
L = Length of the connecting rod.
C = Compressive yield stress.
W_{cr} = Crippling or buckling load.
I_{xx} = Moment of inertia of the section about x-axis

I_{yy} = Moment of inertia of the section about y-axis respectively.
K_{xx} = Radius of gyration of the section about x-axis
K_{yy} = Radius of gyration of the section about y- axis respectively.
D = Diameter of piston
r = Radius of crank
FOS=Factor of safety

According to Rankine formulae,
In order to have a connecting rod equally strong in buckling about both the axis, the buckling loads must be equal. i.e.
$I_{xx} = 4I_{yy}$ ------- ($I = A \times K^2$)

This shows that the connecting rod is four times strong in buckling about y-axis than about X-axis.

If $I_{xx} > 4I_{yy}$, Then buckling will occur about y-axis and if $I_{xx} < 4I_{yy}$ then buckling will occur about x-axis .In Actual practice I_{xx} is kept slightly less than 4 I_{yy}. It is usually taken between 3 and 3.5 and the Connecting rod is designed for buckling about x-axis. The design will always be satisfactory for buckling about y-axis. The most suitable section for the connecting rod is I-section with the proportions shown in fig. The standard dimension of I – SECTION

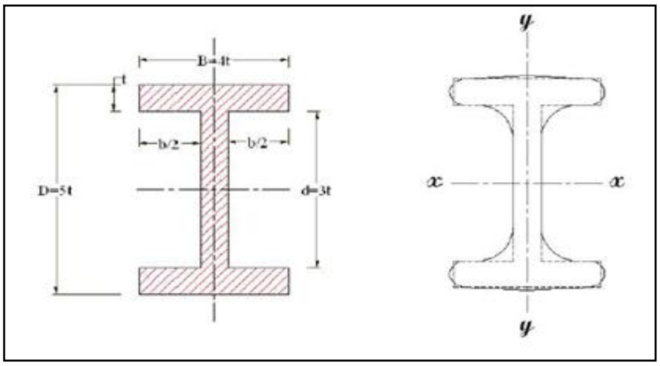


Fig. 2: Connecting Rod I- section

Area of the cross section = $2[4t \times t] + 3t \times t = 11t^2$
Moment of inertia about x-axis $I_{xx} = 1/12\ [4t \times 5t^3 - 3t \times 3t^3] = 419/12\ [t^4]$
And moment of inertia about y-axis $I_{yy} = 2 \times (1/12) \times t \times 4t^3 + (1/12)\ 3t\ (t^3) = 131/12\ [t^4]$

$I_{xx} / I_{yy} = [419/12] \times [12/131] = 3.2$
Since the value of I_{xx} / I_{yy} lies between 3 and 3.5 m therefore I-section chosen is quite satisfactory.

2. Design Calculations for Connecting Rod

Bore × Stroke (mm) = 0.1 × 0.15 m
Speed = 1500 rpm
Possible over speed = 2500 rpm
Crank Radius = 0.075 m
Explosion Pressure p = 5 N/ mm^2
Compression Ratio = 9/1
FOS: 6

Thickness of flange & web of the section = t
Width of section B= 4t
Height of section H = 5t,
Area of section Area of the cross section = $2[4t \times t] + 3t \times t = 11t^2$
MOI about x-axis $I_{xx} = 1/12\ [4t \times 5t^3 - 3t \times 3t^3] = 419/12\ [t^4]$
MOI about y-axis $I_{yy} = 2 \times (1/12) \times t \times 4t^3 + (1/12)\ 3t\ (t^3) = 131/12\ [t^4]$
$I_{xx} / I_{yy} = [419/12] \times [12/131] = 3.2$

Length of connecting rod (L) = 2 times the stroke,
$\therefore L = 300\ mm$
Buckling load W_B =
Maximum gas force on Con Rod (Fg) × F.O.S

$F_g = \pi/4\ (d^2) \times p = \pi/4\ (100^2) \times 5$
= 39270 N
Now,
Buckling load W_B= 39270 x 6 = 235620 N

Length of connecting rod L = 300 mm, So for both end hinged, L = l = 300 mm
Rankines Formula,

$$W_B = \frac{A\,\sigma_c}{1+\alpha\left(\frac{L}{K_{xx}}\right)^2}$$

$$235620 = \frac{11t^2 \times 415}{1+\left(\frac{1}{7500}\right)\left(\frac{300}{1.78t}\right)^2}$$

$t^4 - 51.61\ t^2 - 195.46 = 0$
$t^2 = 55.15$
t = 7.5 mm

3. Dimensions of Connecting Rod

Width of section B = 4t = 4×7.5 = 30 mm
Height of section H = 5t = 5×7.5 = 37.5 mm
Area A = $11t^2 = 11 \times 7.5^2 = 618.75$ mm^2
Height at the big end (crank end) = H_2 = 1.1H to 1.25H
= 1.1×37.5
H_2 = 41.25 mm
Height at the small end (piston end) = 0.9H to 0.75H
= 0.9×37.5
H_1 = 33.75 mm

Stroke length = 150 mm
Diameter of piston (D) = 100 mm
P = 5 N/ mm^2
Radius of crank(r) = stroke length/2
= 150/2 = 75 mm

Maximum force on the piston due to pressure,
$F_g = \pi/4\ (d^2) \times p = \pi/4\ (100^2) \times 5$
= 39270 N
Maximum angular speed $W_{max} = 2\pi N_{max}/60$ =261.80 rad/sec
Ratio of the length of connecting rod to the radius of crank
N= l/r =300/ 75 = 4

Maximum Inertia force of reciprocating parts:

$F_{imax} = M_r W_{max}^2 r (1+\frac{1}{N})$

----------M_r – Mass of reciprocating parts. = 1.2 kg

$F_{imax} = 1.2 \times 261.80^2 \times 0.075 (1+\frac{1}{4})$

= 7710.66 N -- (i)

4. Small/Big End Dimensions

Inner diameter of the small end d_1,

$F_g = d_{p1} P_{b1} \times l_1$

$39270 = d_{p1} \times 12.5 \times 1.5\, d_{p1}$

$d_{p1} = 45.80$ mm

Where,

Design bearing pressure for small end: P_{b1} = 12.5 to 15.4 N/mm²

Length of the piston pin l_1 = (1.5 to 2) d_{p1}

l_1 = 1.5x45.80 = 68.7 mm

Outer diameter of the small end = $d_1 + 2t_b + 2t_m$

= 45.80 + [2×2] + [2×5]

= 59.80 mm

Where,

Thickness of the bush (t_b) = 2 to 5 mm

Marginal thickness (t_m) = 5 to 15 mm,

Inner diameter of the big end d_2,

$F_g = d_{p2} P_{b2} \times l_2$

$39270 = d_{p2} \times 10.8 \times 1.0\, d_{p2}$

$d_{p2} = 60.30$ mm

Where,

Design bearing pressure for big end: P_{b2}= 10.8 to 12.6 N/mm²

Length of the crank pin l_2 = (1.0 to 1.25) d_{p2},

= 1.0 x 60.30 = 60.30 mm

Outer diameter of the big end = $d_2 + 2t_b + 2t_m$

= 60.30 + 2×2 + 2×5

= 74.30 mm

5. Final Parameters-Connecting Rod

TABLE I Final Parameters-Connecting Rod

Sr. No.	Parameters (mm)
1	Thickness of the connecting rod (t) = 7.5
2	Width of the section (B = 4t) = 30
3	Height of the section(H = 5t) = 37.5
4	Height at the big end = (1.1 to 1.125)H = 41.25
5	Height at the small end = 0.9H to 0.75H = 33.75
6	Inner diameter of the small end = 45.80
7	Outer diameter of the small end = 59.80
8	Inner diameter of the big end = 60.30
9	Outer diameter of the big end = 74.30

C. Modeling of Connecting Rod:

CATIA V5 provides three basic platforms: P1, P2 and P3. P1 is for small and medium sized process oriented companies that wish to grow toward the large scale digitized product Definition. P2 is for the advanced design engineering companies that require product, process and resource modelling. P3 is for the high-end design application and is basically for Aerospace Industry, where high quality surfacing or class-A surfacing is used for designing. A good feature is that any change made to the external data is notified to user and the model can be updated quickly. A workbench is defined as a specified environment consisting of a set of tool, which allows the user to specific design tasks in a particular area.

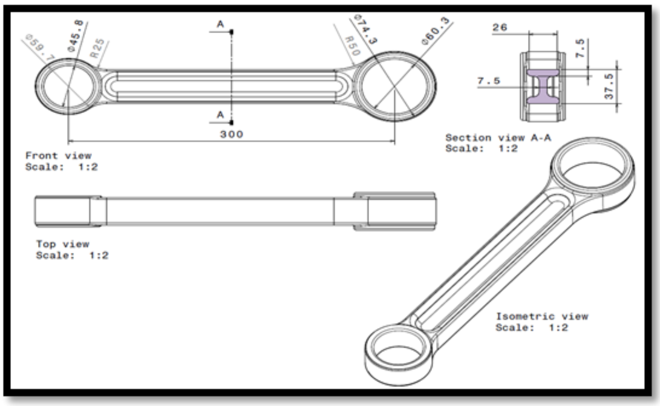


Fig. 3: Connecting Rod Drawing

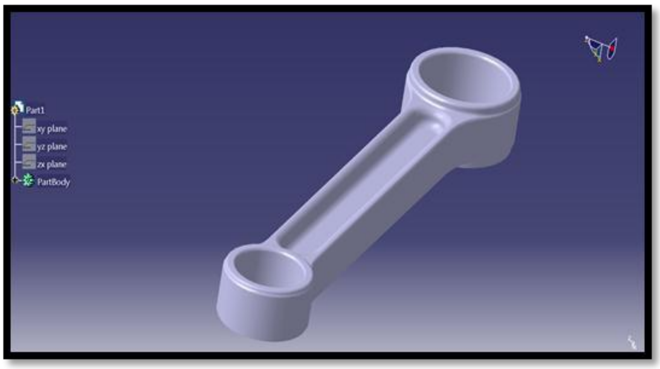


Fig. 4: Connecting Rod CAD model

5. COMPARATIVE ANALYSIS OF CONNECTING ROD FOR DIFFERENT MATERIALS USING ANSYS

The connecting rod is the transitional part between the piston and the Crankshaft. Its essential capacity is to transmit the push and pull from the piston stick to the crank, hence changing over the responding movement of the piston into rotating movement of the crank. Right now existing associating bar is fabricated by utilizing structural steel the connecting rod is compared with four different materials 20CrMo steel alloy, AA7010, AA7068, AA6010 aluminum alloys. In this illustration is drafted from the computations. A parametric model of Connecting rod is designed utilizing CATIA V5 programming and to that model, investigation is completed by utilizing ANSYS Workbench Software. Limited component investigation of associating rod is finished by thinking about the materials, viz., Aluminum Alloys. The best combination of parameters like Von-Misses Stress and Strain, deformations, Factor of safety and weight decrease for bike cylinder were done in ANSYS programming. In this different materials are compared and AA7068 possess less weight and deformations. Aluminum Alloys are lesser in weight, corrosion resistance, non-toxic, flexible in design and stiffer than other material like Steel.

The objective of the present work is to design and analyze the connecting rod made of Aluminum Alloy. Steel materials are used to design the connecting rod. In this project the material Structural Steel of connecting rod is compared with Aluminum Alloys. Connecting rod was designed in CATIA V5. Model is imported in ANSYS workbench for analysis. After computational analysis a comparison is made between existing Steel and Aluminum Alloys connecting rods in terms of weight, factor of safety, stiffens, deformation and stress.

1. MATERIAL USED :-

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. Therefore, light alloy metals such as aluminum and titanium are currently being used in high speed engine connecting rods to circumvent the abovementioned problems. Titanium has better mechanical properties than aluminum, at the expense of higher density and cost. This higher density and cost have made aluminium connecting rods more popular and attractive. However, they suffer from relatively low strength and fatigue life.

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. Connecting rods for automotive applications are typically manufactured by forging from either wrought steel or powdered metal. They could also be cast. However, castings could have blow-holes which are detrimental from durability and fatigue points of view. The fact that forgings produce blow-hole-free and better rods gives them an advantage over cast rods. Between the forging processes, powder forged or drop forged, each process has its own pros and cons. Powder metal manufactured blanks have the advantage of being near net shape, reducing material waste. However, the cost of the blank is high due to the high material cost and sophisticated manufacturing techniques.

With aluminum alloys, the material is inexpensive and the rough part manufacturing process is cost effective. The first aspect was to investigate and compare fatigue strength of 20CrMo steel alloy, AA7010, AA7068 and AA6010 aluminum alloys connecting rods with that of the structural steel connecting rods. The second aspect was to optimize the weight and manufacturing cost of the structural steel connecting rod. Due to its large volume production, it is logical that the optimization of the connecting rod for its weight or volume will result in large-scale savings of material & cost. Further achieving the objective reducing inertia loads, thus reducing engine weight and improving engine performance and fuel economy.

Stress analysis of connecting rod is done by finite element method using ANSYS workbench software and it is analyzed that the stress induced in the piston end of the connecting rod are greater than the stresses induced at the crank end. So, the piston end has more fractures as compare to crank end.

We have parameters of connecting rod as we design in chapter four, same procedure is followed for the four different materials summary is reported in the table no. 2

Material	Density (kg/m3)	Young modulus (GPa)	Compressive stress (MPa)	Poisons ratio
Structural steel	7850	200	250	0.3
20CrMo	7860	210	685	0.29
AA6061	2700	68.9	276	0.33
AA7010	3000	70	410	0.32
AA7068	2850	73.1	683	0.23

TABLE III Analytical data for I-section materials

a) Meshing and forces applied :-

By applying boundary condition we can apply the force over connecting rod in two way. In first condition we can fix the big end of the connecting rod and apply the force on small end. We can apply the compressive load of 39270 N.

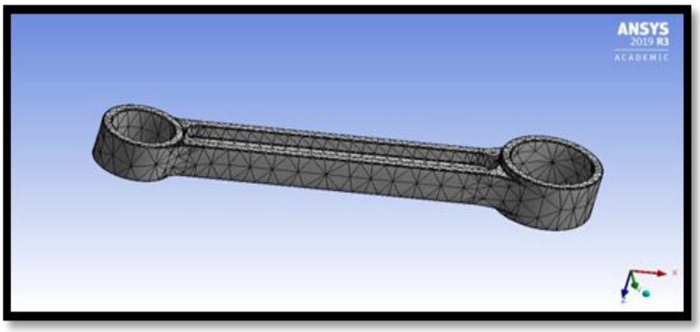


Fig. 5: Meshing and forces applied on a connecting rod

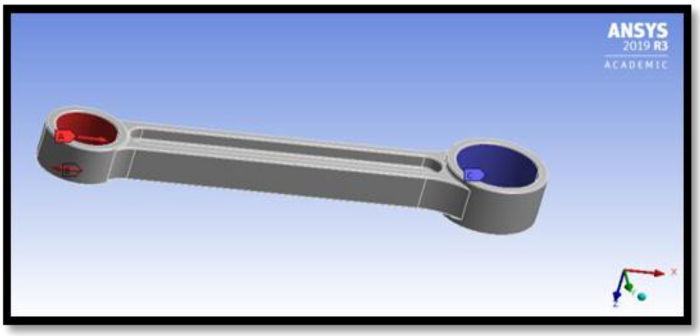


Fig. 6: Meshing and forces applied on a connecting rod

b) Total Deformation :-

For structural steel the Total deformation values are calculated here we get deformation which varies form 0 mm to 0.00013469 mm.

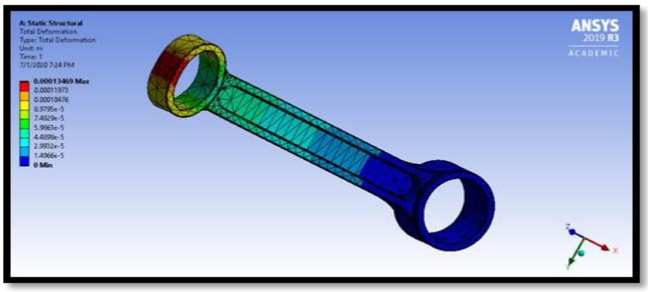


Fig. 7: Total Deformation

c) Equivalent Stress analysis :-

For structural steel the Equivalent Von-Mises Stress values are calculated here we get stresses which varies from 0.00013957 MPa to 189.1 MPa.

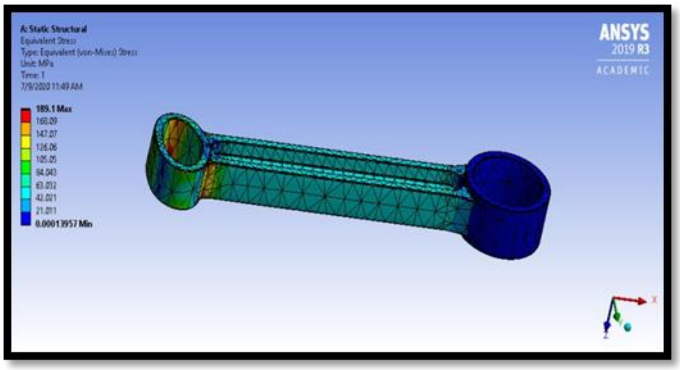


Fig. 8: Equivalent Stress analysis

d) Equivalent Elastic Strain analysis :-

For structural steel the Equivalent Elastic Strain value are calculated here we get strain which varies from 1.1272 × 10-9 to 0.00097387mm/mm.

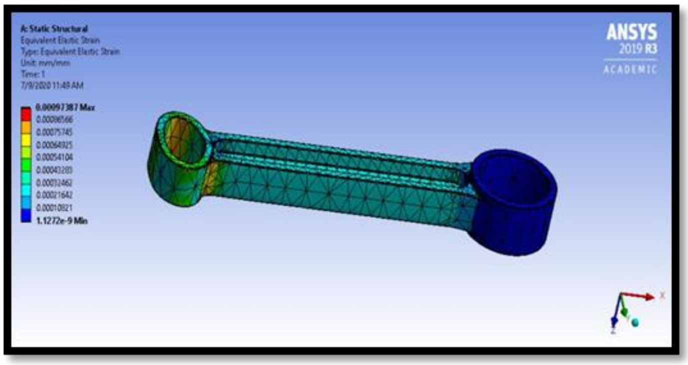


Fig. 9: Equivalent Elastic Strain analysis

e) Factor of Safety:-

For structural steel the Factor of Safety values are calculated here we get FOS which varies from 2.5197 to 15.

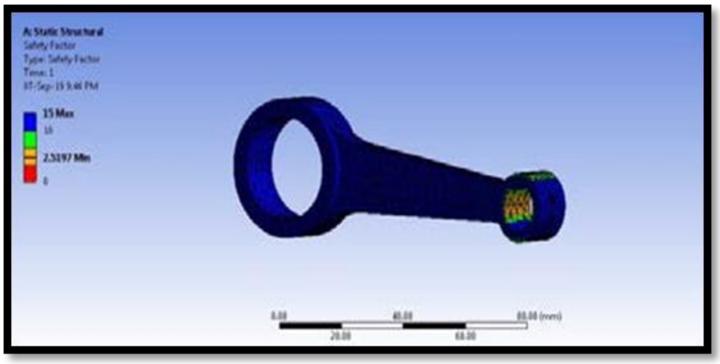


Fig 10: Factor of Safety Analysis

2. FEA RESULTS & DISCUSSION:-

TABLE IIIII Comparative static analysis of the four different materials

Material	Deformation (mm)	Equivalent Elastic Strain (mm/mm)	Equivalent Stress (MPa)
Structural steel	0.13469	0.001017	188.84
20CrMo	0.12828	0.0009738	189.1
AA6061	0.38989	0.0029039	188.04
AA7010	0.38414	0.0028745	188.31
AA7068	0.12913	0.0009841	144.133

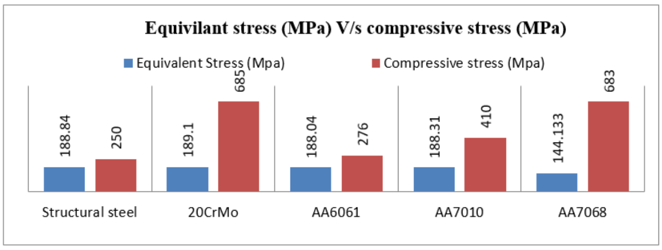


Fig. 11(A): Comparison between material and there property

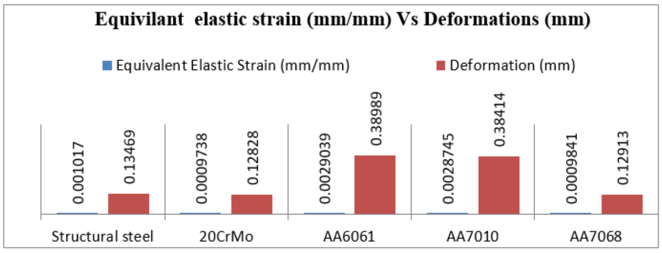


Fig. 11 (B): Comparison between material and there property

Finite Element Analysis of the connecting rod has been done using FEA tool in ANSYS Workbench and results are obtained. The deformation is 0.13469mm for Steel, 0.12828 mm for 20CrMo, 0.12913 mm for AA7068, 0.38414 mm for AA7071, and 0.38989 mm for AA6061. The Maximum Equivalent Stress found to be 188.84 MPa for the Steel, 189.1 MPa for 20CrMo, 144.133 MPa for AA7068, 188.31 MPa for AA7010, 188.04 MPa for AA6061.The material models presented here is safe and under the permissible limit of stresses and material AA7068 has least maximum stress i.e. 144.133 MPa as compared to the other three materials.

In general, study on the design along with the consideration of all aspect of industrial material used in connecting rod the main objective of this work is to optimize weight and make the component lighter without applicable change in size and manufacturing cost of connecting rod.

We have select material AA7068 Aluminium alloy because material AA7068 has least maximum stress i.e. 144.133 MPa as compared to the other four materials and it is fulfil our objective that is to optimize weight and make the component lighter without applicable change in size and manufacturing cost of connecting rod. From the static structural analysis it is observed that Equivalent von-Mises stresses, Equivalent Elastic Strain for Aluminium Alloy and Structural Steel was compared and it is observed that the stresses are high Aluminium Alloy so it has high strength compared with Structural Steel for a given loading conditions. AA7068 Aluminium alloy which required less material and less dimensions to sustain required pressure generated inside the cylinder compared to structural steel, 20CrMo steel alloy, AA7010, and AA6010 aluminium alloys material connecting rod. From four materials the optimized connecting rod is AA7068 Aluminium alloy and it is good in nature than other material used in this work.

6. OPTIMIZATION OF CONNECTING ROD USING FILLET RADIUS

A solid model of the same connecting rod was made using CATIA software. ANSYS software was employed to analyze and examine the effect of stress in different parts of the connecting rod. For the analysis we have started with the existing design parameters and then incrementally changed the fillet radius at big end with keeping the small end dimensions constant and then changing the fillet radius of the small end with keeping the fillet radius of the big end intact. Finally optimum parameters were selected for the modified design for the minimum stress conditions.

We have design of connecting rod as shown above in figure 2.

a) Changing the shapes and selection of design :-

By changing the shapes like fillet radius, thickness and other parameter to find out for which design the stress is minimum. I have changed the fillet radius in crank side (I section) dimensions by using CATIA V5 software.

When the modification of design is completed then we have choose the best dimension which satisfied all the constrained and reduces the stress

Effect of stress in connecting rod while changing the fillet radius in crank side (I section):-

The initial analysis using ANSYS was performed with distribution of loads at small end. There were fixed displacement boundary conditions at big end.

b) Finite Element Analysis with ANSYS :-

The initial analysis was performed by using ANSYS software with distribution of load at big end and fixed support at small end. Figure shows the modelling and analysis results of connecting rod used to determine the variation of stresses though change the fillet radius in crank side (I section).

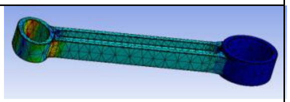
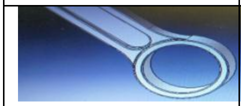
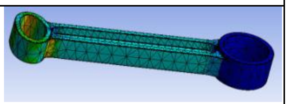
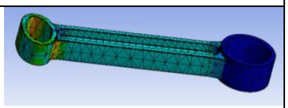
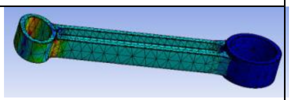
Modeling of connecting rod under different fillet radius in crank side in CATIA		Analysis result with ANSYS
	1.5 mm fillet radius	
	1.6 mm fillet radius	
	1.7 mm fillet radius	
	1.8 mm fillet radius	

Fig. 12 (A): Modeling and Analysis result with ANSYS

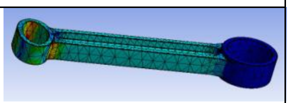
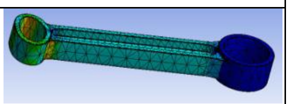
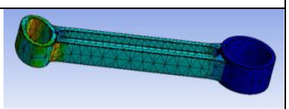
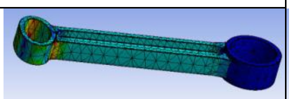
Modeling of connecting rod under different fillet radius in pin side in CATIA		Analysis result with ANSYS
	1.5 mm fillet radius	
	1.6 mm fillet radius	
	1.7 mm fillet radius	
	1.8 mm fillet radius	

Fig. 12 (B): Modeling and Analysis result with ANSYS

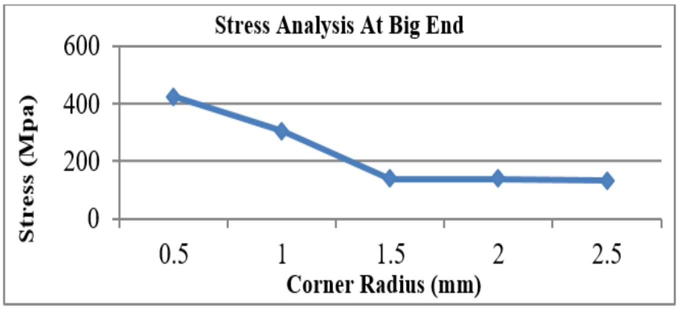


Fig. 13: Stress analysis result at big end

c) ANSYS result examination :-

After the running the simulation in the ANSYS workbench we have found that stress value peaks in the fillet area zone. Further analysis has shown that fillet radius of 1.7 mm has proven to be the minimum stress (130 MPa) at the big end. Further for similar investigation has shown that for the small end the minimum stress (126 MPa) occurs at the 1.6 mm.

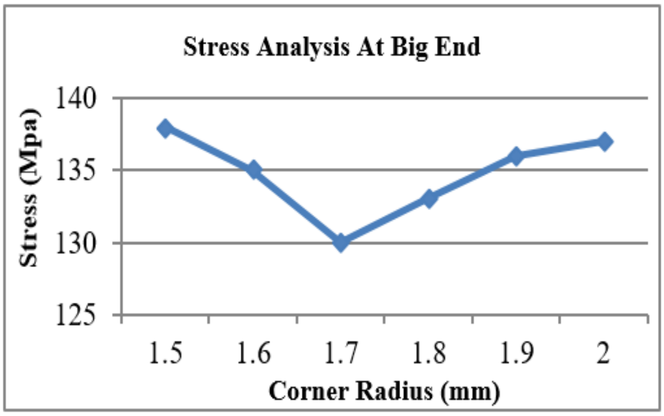


Fig. 14 (A): Analysis results

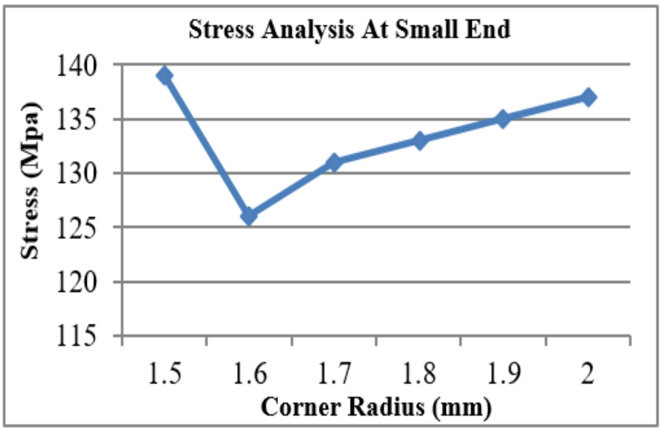


Fig. 14 (B): Analysis results

7. CONCLUSION

From the static structural analysis it is observed that Equivalent von-Mises stresses, Equivalent Elastic Strain for Aluminium Alloy and Structural Steel was compared and it is observed that the stresses are high Aluminium Alloy so it has high strength compared with Structural Steel for a given loading conditions. AA7068 Aluminium alloy which required less material and less dimensions to sustain required pressure generated inside the cylinder compared to structural steel, 20CrMo steel alloy, AA7010, and AA6010 aluminium alloys material connecting rod. From four materials the optimized connecting rod is AA7068 Aluminium alloy and it is good in nature than other material used in this work.

The following conclusions can be obtained from the study of Optimization of connecting rod using fillet radius,

- Change in the fillet radius greatly affects the maximum stress value inside the connecting rod.
- Change in the Design parameters of the big end in the connecting rod affects more than the small end.

REFERENCES

1. Tony George Thomas, S. Srikari, M. L. J Suman "Design of Connecting Rod for Heavy Duty Applications Produced by Different Processes for Enhanced Fatigue Life" at SASTECH Journal Volume 10, Issue 1, May 2011.
2. Pravardhan S. Shenoy and Ali Fatemi "Connecting Rod Optimization for Weight and Cost Reduction" 2005 SAE International, 2005-01-0987.
3. Gaba Peeyus, Sethi APS "Design Evaluation of Connecting Rod using FEM for High Cycle Fatigue Strength" International Journal of Research in Advent Technology, Vol.2, No.5, May 2014 E-ISSN: 2321-963.
4. Franklinemmanuel.T, R.Natarajan "Increasing the service factor of Connecting rod by material and design modification of 85bhp Tractor" at IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684, p-ISSN: 2320-334X PP 34-38.
5. DR. B.K.Roy "Design Analysis and Optimization of Various Parameters of Connecting Rod using CAE Softwares" at International Journal of New Innovations in Engineering and Technology (IJNIET) ISSN: 2319-6319 Vol. 1 Issue 1 October 2012.
6. M.S. Shaari, M.M. Rahman, M.M. Noor, K. Kadirgama and A.K. Amirruddin "Design of Connecting Rod of Internal Combustion Engine: A Topology Optimization Approach" at National Conference in Mechanical Engineering Research and Postgraduate Studies (2nd NCMER 2010) 3-4 December 2010, Faculty of Mechanical Engineering, UMP Pekan, Kuantan, Pahang, Malaysia; ISBN: 978-967-0120-04-1, pp. 155-166.
7. S.B. Chikalthankar, V.M. Nandedkar, Surendra Prasad Baratam "Fatigue Numerical Analysis for Connecting Rod" at International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 Vol. 2, Issue 6, November- December 2012, pp.628-632