International Journal of Multidisciplinary Engineering in Current Research
ISSN: 2456-4265, Volume 6, Issue 2, February 2021, http://ijmec.com/

ENHANCING THE QUALITY OF BAJAJ PULSAR 150CC IC ENGINE CONNECTING ROD THROUGH THE STUDY OF STRAIGHT LINES AND CURVES

Dr. CH. MALLI KARJUNA[*1], K. L. N. MURTHY[*2], B. NARASIMHA RAO[*3]
[*1] Professor, Dept. of Mechanical Engineering,
[*2, 3]Assistant Professor, Dept. of Mechanical Engineering.
A.M Reddy Memorial College of Engineering and Technology, Andhra Pradesh.

Abstract: This project mainly deals with the design and analysis of I.C engine connecting rod. Connecting Rod is a component of reciprocating engines, reciprocating pumps, gas compressors and pneumatic cylinders among other similar mechanisms. In an engine, its purpose is to transfer force from expanding gas in the cylinder to the crankshaft via a piston rod. For this project, there are two basic requirements. The first requirement is to design of a model of I.C engine connecting rod as per the standard mathematical calculations. The second requirement is to analyze of I.C engine connecting rod by the method, such as following a track, which consists of straight lines and curves. These systems are done by modeling software's like CatiaV5, and analysis is done by Ansys software. Specifications of a product are detailed in terms of the product size, speed range, weight and power consumption. Here the Connecting rod is designed; analyzed and has been studied. Connecting Rod temperature has considerable influence on efficiency, emission, performance of the engine. Purpose of the investigation is measurement of connecting rod transient temperature at several points on the connecting rod, from cold start to steady condition and comparison with the results of finite element analysis. Even though the program worked well, there were some errors that were identified after testing, resulting in increased performance. In this project work has been taken up on the different aspects of Materials like Magnesium Alloy, Beryllium 25 Alloy and Forged Steel Materials to cover the research gaps to present the results based on the systematic studies through the connecting rod of the engine, FEA analysis of is to measure temperature at the points where it is not possible to find out practically and to observe the heat flow inside the Connecting Rod.

I- INTRODUCTION

Automobile components are in great demand these days because of increased use of automobiles. The increased demand is due to improved performance and reduced cost of these components. R&D and testing engineers should develop critical components in shortest possible time to minimize launch time for new products. This necessitates understanding of new technologies and quick absorption in the development of new products**.** A piston is a component of reciprocating IC-engines. It is the moving component that is contained by a cylinder and is made gas-tight by piston rings. In an engine, its purpose is to transfer force from expanding gas in the cylinder to the crankshaft via a piston rod and/or connecting rod.

International Journal of Multidisciplinary Engineering in Current Research
ISSN: 2456-4265, Volume 6, Issue 2, February 2021, http://ijmec.com/

As an important part in an engine, piston endures the cyclic gas pressure and the inertial forces at work, and this working condition may cause the fatigue damage of piston, such as piston side wear, piston head/crown cracks and so on. The investigations indicate that the greatest stress appears on the upper end of the piston and stress concentration is one of the mainly reason for fatigue failure. On the other hand piston overheating-seizure can only occur when something burns or scrapes away the oil film that exists between the piston and the cylinder wall.

Understanding this, it's not hard to see why oils with exceptionally high film strengths are very desirable. Good quality oils can provide a film that stands up to the most intense heat and the pressure loads of a modern high output engine. Structural analysis is a branch of materials science where the properties of materials are studied as they change with temperature. FEM method is commonly used for Analysis. Considered a problem of optimum coating thickness Compared to thick coatings, thin coatings offer the advantage of longer durability and the moderate increase in surface temperature.

Connecting rod

In a reciprocating piston engine, the connecting rod connects the piston to the crank or crankshaft. Together with the crank, they form a simple mechanism that converts reciprocating motion into rotating motion.

Connecting rods may also convert rotating motion into reciprocating motion. Historically, before the development of engines, they were first used in this way.

As a connecting rod is rigid, it may transmit either a push or a pull and so the rod may rotate the crank through both halves of a revolution, i.e. piston pushing and piston pulling. Earlier mechanisms, such as chains, could only pull. In a few two-stroke engines the connecting rod is only required to push.

II - LITERATURE SURVEY

There is a vast amount of literature related to Finite Element Analysis of shape optimization of connecting rod. The literature review presented here considers the major development in implementation of FEA. The main objective of this study was to explore opportunities for an I.C engine connecting rod.

Nagaraju K L (2016) In his thesis, a connecting rod is demonstrated utilizing Catia v5, discretization utilizing Hyper Mesh and analysis utilizing Nastran. The outcome predicts the most extreme buckling load and basic locale on the interfacing pole. It is imperative to find the basic territory of concentrated stress for fitting adjustments. He discovered the stresses created in interfacing pole under static loading with various stacking states of compression and tension at crank end and pin end of connecting rod. The displacement plot shows a very small value which does not affect the performance of the connecting rod. The linear static analysis of the connecting rod shows that the stress generated in the model is within the acceptable limits or maximum allowable stress. The buckling mode analysis gives the buckling factor greater than 1 and hence it can be concluded that the connecting rod can withstand the load applied.

Akbar H Khan. (2017) studied existing connecting rod is manufactured by using steel 16MnCr5. His paper describes Design, modeling and analysis of connecting rod. In his work connecting rod is replaced by steel alloy SAE 8620 and Aluminum alloy 360 for Discover 100cc motorbike. A 2D drawing is drafted from the calculations. A parametric model of connecting rod is modeled using Creo 2.0 software. Analysis is carried out by using Ansys 15.0 software. By comparing the von mises stresses in the materials of connecting rod he concluded that stresses occurs in the aluminum alloy 360 connecting rod are very less as compared to the steel 16mnCr5 and steel alloy SAE 8620. Instead of using the material Steel 16mnCr5 we can use the either aluminum alloy 360 or steel alloy SAE 8620 to reduce the weight and cost of the material and for better stiffness.

Mohammed Mohsin Ali Ha (2015) modeled Connecting rod using CATIA software and FE analysis is carried out using ANSYS Software. Load distribution plays important role in fatigue life of the structure. Bush failure changes the loading direction and distribution. His study is concentrated around the fatigue life due to concentrated load and cosine type load distribution on the bigger end. The connecting rod analysis is carried out to check the fatigue life and alternating stress development due to service and assembly loads with variation in load distribution. The results are summarized as follows; initially the connecting rod is built to the actual dimensions using Catia software. Axis-symmetric analysis is carried out to find interference effect on the stress behavior in the joint. 8 noded plane82 elements with quadratic displacement variation are used for accurate results. The contact pair is created with Target69 and Contact72 elements. Interference is created through geometric built up. The result shows contact pressure development at the interface and higher compressive stress in the bush and tensile stress development in the small end. The results are plotted for radial, hoop and Vonmises stresses. Also a three dimensional views are obtained through Ansys ax symmetric options.

III - PRINCIPLE OF I.C ENGINE CONNECTING ROD

An Internal Combustion Engine (ICE) is a heat engine where the combustion of a fuel occurs with an oxidizer (usually air) in a combustion that is an integral part of the working fluid flow circuit. In an internal combustion engine the expansion of the high-temperature and high-pressure gases produced by combustion apply direct force to some component of the engine. The force is applied typically to pistons, turbine blades, rotor or a nozzle. This force moves the component over a distance, transforming chemical energy into useful mechanical energy.

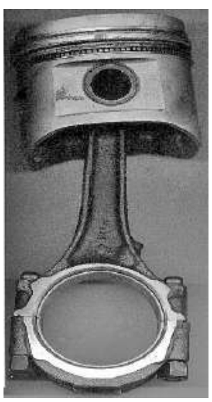
The first commercially successful internal combustion engine was created by Étienne Lenoir around 1859 and the first modern

International Journal of Multidisciplinary Engineering in Current Research
ISSN: 2456-4265, Volume 6, Issue 2, February 2021, http://ijmec.com/

internal combustion engine was created in 1876 by Nicolaus Otto (see Otto engine).

The term internal combustion engine usually refers to an engine in which combustion is intermittent, such as the more familiar four-stroke and two-stroke piston engines, along with variants, such as the six-stroke piston engine and the Wankel rotary engine. A second class of internal combustion engines use continuous combustion: gas turbines, jet engines and most rocket engines, each of which are internal combustion engines on the same principle as previously described. Firearms are also a form of internal combustion engine.

Internal combustion engines are quite different from external combustion engines, such as steam or Sterling engines, in which the energy is delivered to a working fluid not consisting of, mixed with, or contaminated by combustion products. Working fluids can be air, hot water, pressurized or even liquid sodium, heated in a boiler. ICEs are usually powered by energy-dense fuels such as gasoline or diesel, liquids derived from fossil fuels. While there are many stationary applications, most ICEs are used in mobile applications and are the dominant power supply for vehicles such as cars, aircraft, and boats.



The pistons are short cylindrical parts which seal one end of the cylinder from the high pressure of the compressed air and combustion products and slide continuously within it while the engine is in operation. The top wall of the piston is termed its crown and is typically flat or concave. Some two-stroke engines use pistons with a deflector head. Pistons are open at the bottom and hollow except for an integral reinforcement structure (the piston web). When an engine is working the gas pressure in the combustion chamber exerts a force on the piston crown which is transferred through its web to a gudgeon pin. Each piston has rings fitted around its circumference that mostly prevent the gases from leaking into the crankcase or the oil into the combustion chamber. A ventilation system drives the small amount of gas that escape past the pistons during normal operation (the blow-by gases) out of the crankcase so that it does not accumulate contaminating the oil and creating corrosion. In two-stroke gasoline engines the crankcase is part of the air–fuel path and due to the continuous flow of it they do not need a separate crankcase ventilation system.

IV - MATHEMATICAL CALCULATIONS OF CONNECTING ROD FOR PULSAR 150CC

CONFIGURATION OF ENGINE MODEL

Engine Type = Air Cooled
Stroke = 4-Stroke
Bore × Stroke (mm) = 58 × 56.4
Displacement = 149.01 CC
Maximum Power = 15.1 ps at 9000 rpm
Maximum Torque = 12.45 Nm at 6500rpm
Compression Ratio = 9.5 ± 0.5:1

ISSN: 2456-4265, Volume 6, Issue 2, February 2021, http://ijmec.com/

Density of Petrol (C_8H_{18}) = 737.22 kg/m^3 = 737.22E^{-9} kg/mm^3

Temperature (T) = 60 ºF = 288.855 ºK

Mass (m) = Density × Volume

= 737.22E^{-9} x 149.01E^3

= 0.11 kg

Molecular Weight of Petrol (M) = 114.228 g/mole = 0.114228 kg/mole

From Gas Equation,

$$PV = M R_{specific} T$$

Where;

P = Maximum Pressure (MPa)

V = Volume

m = Mass (kg)

R specific = Specific Gas Constant

T = Temperature °k

$$R_{specific} = R/M$$

= 8.3143 / 0.114228

= 72.76 Nm/kg K

$$PV = m R_{specific} T$$

P × 149.5 = (0.11 × 72.76 × 288.85)

P = 8.3143/114228

P = 15.46 MPa

A = cross sectional area of the connecting rod

L = length of the connecting rod

σ_c = compressive yield stress

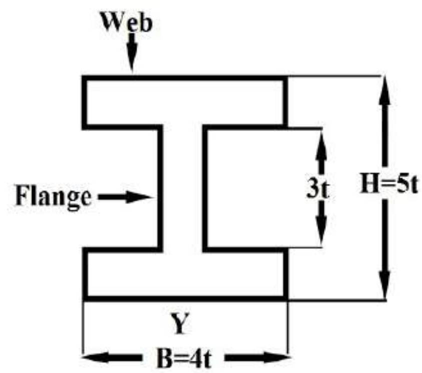
W_B = crippling or buckling load

Ixx and Iyy = moment of inertia of the section about x- axis and y-axis respectively

Kxx and Kyy = radius of gyration of the section about x-axis and y- axis respectively

The standard dimension of I section:

The standard dimensions are calculated using standard formulas and it is reported



Dimensions of connecting rod

S.No	Parameters	Values
01	Outer diameter of Big end	60.93 mm
02	Inner diameter of big end	46.16 mm
03	Outer diameter of small end	45.29 mm
04	Inner diameter of small end	37.64 mm
05	Length of Connecting Rod	112.8 mm

MATERIALS PROPERTIES USED FOR CONNECTING ROD IN PULSAR 150CC

1- Magnesium Alloy

Mechanical Properties

Material	Magnesium
Alloy	AZ91D
Tensile Strength (Mpa)	230
Yield Strength (Mpa)	160
Impact Strength (J)	3
Shear Strength (Mpa)	140
Hardness (Brinell)	63
Elongation (% in 50 mm)	3

Density (kg/m^3)	**1810**

2- Beryllium 25 Alloy
Mechanical Properties

Ultimate Tensile Strength (MPa)	**1280 - 1480**
Yield Strength (MPa)	**965 - 120**
Young Modulus (GPa)	**125 - 130**
Poisson's ratio	**0.33**
Modulus of rigidity (GPa)	**50**
Density (g/cm^3)	**8.36**

3- Forged Steel
Mechanical Properties

Density (g/cc)	**7700**
Average Hardness (HRB)	**101**
Yield Strength (Mpa)	**625**
Ultimate Strength (MPa)	**625**
Percent Reduction in Area	**58**
Modulus of Elasticity (GPa)	**221**
Possions Ratio	**0.21**

V - DESIGN METHODLOGY OF I.C ENGINE CONNECTING ROD

Introduction to CATIA

CATIA (Computer Aided Three-dimensional Interactive Application) is a multi-platform CAD/CAM/CAE commercial software suite developed by the French company Dassault Systems. Written in the C++ programming language, CATIA is the cornerstone of the Dassault Systems product lifecycle management software suite. CATIA competes in the high-end CAD/CAM/CAE market with Cero Elements/Pro and NX (Unigraphics).

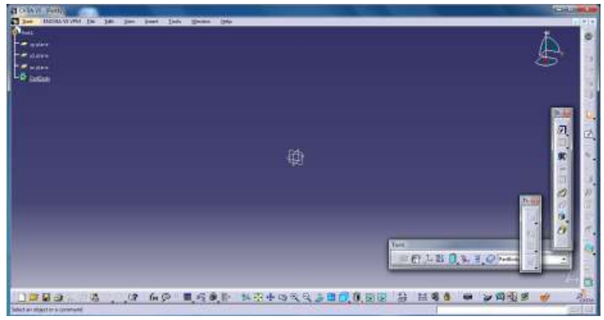


Fig: 5.1: Home Page of CatiaV5

Modeling of I.C engine connecting rod in CATIA V5

This **I.C engine connecting rod** is designed using CATIA V5 software. This software used in automobile, aerospace, consumer goods, heavy engineering etc. it is very powerful software for designing complicated 3d models, applications of CATIA Version 5 like part design, assembly design.

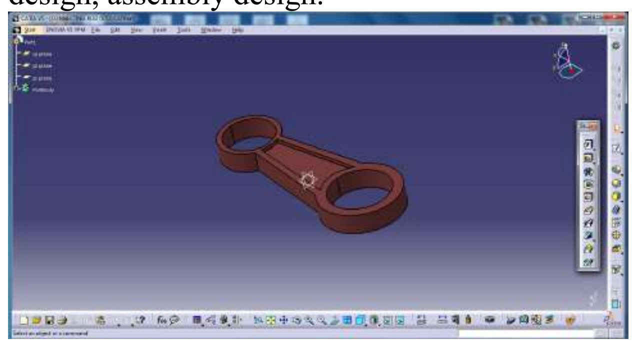


Fig: 5.2: Model design of I.C engine connecting rod in CATIA-V5

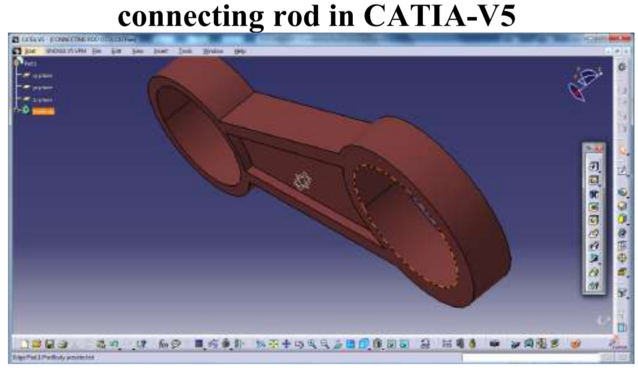


Fig: 5.3: Model arrangement in CATIA-V5

International Journal of Multidisciplinary Engineering in Current Research
ISSN: 2456-4265, Volume 6, Issue 2, February 2021, http://ijmec.com/

VI - ANALYSIS OF I.C ENGINE CONNECTING ROD

6.1 Procedure for FE Analysis Using ANSYS:

The analysis of the Connecting Rod is done using ANSYS. For compete assembly is not required, is to carried out by applying moments at the rotation location along which axis we need to mention. Fixing location is bottom legs of rod assembly machine.

6.2 Preprocessor

In this stage the following steps were executed:

- **Import file in ANSYS window**

File Menu > Import> STEP > Click ok for the popped up dialog box > Click

Browse" and choose the file saved from CATIAV5R20 > Click ok to import the file

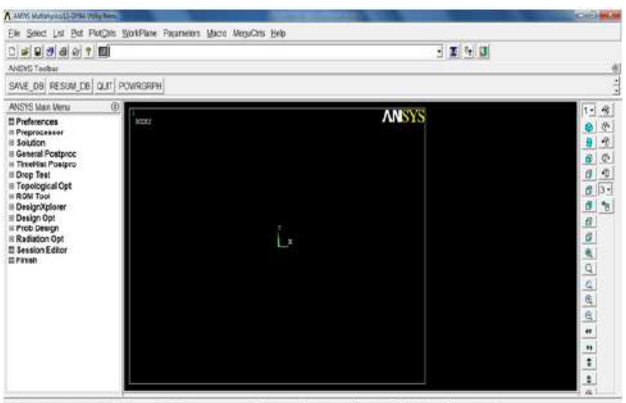


Fig.6.1: Import panel in Ansys.

Rod is modeled with 1d element and shown as above and assembled with adjacent components. Few components are solved using Thermal Analysis for checking the stress and displacements while flowing the fluid.

After completing the meshing of each assembly components next is to do analysis based on the OEM (Original Equipment of Manufacturer) application. So all the models which are analyzed, we need to mention in the Ansys software to get accurate results as per the original component. Some of the components are needed to be solved using thermal analysis.

VII - DISCUSSION ON ANALYSYS RESULT

7.1 Results of Displacement Results:

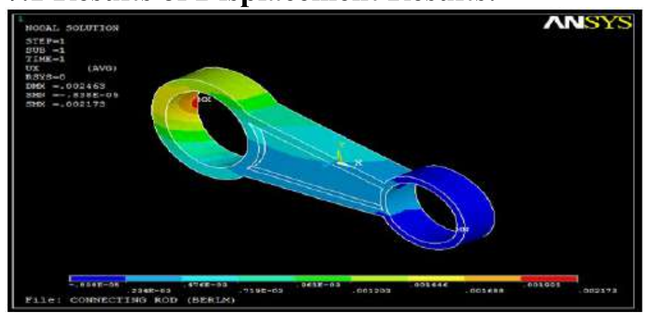


Fig: 7.1: Displacement of Connecting Rod (Beryllium 25 Alloy)

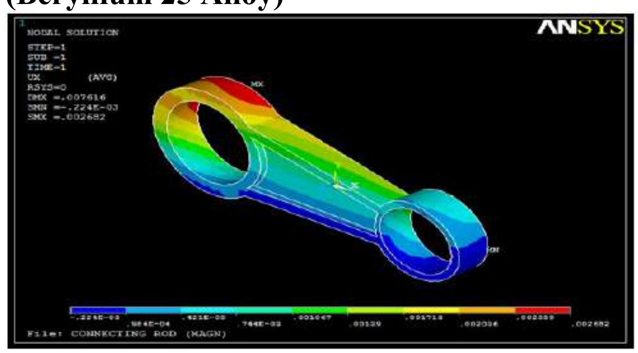


Fig: 7.2: Displacement of Connecting Rod (Magnesium Alloy)

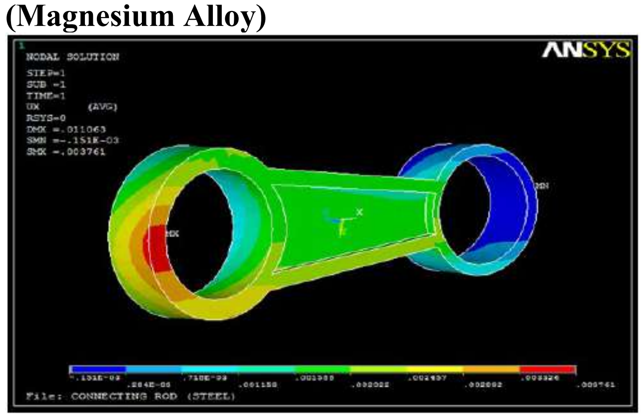


Fig: 7.3: Displacement of Connecting Rod (Forged Steel)

7.2 Results of Stress Results:

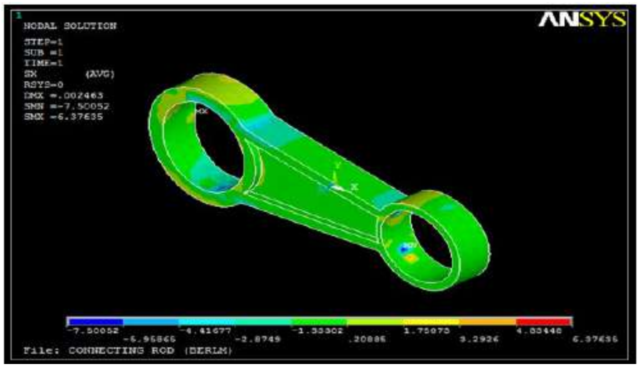


Fig: 7.4: Stress Analysis of Connecting Rod (Beryllium 25 Alloy)

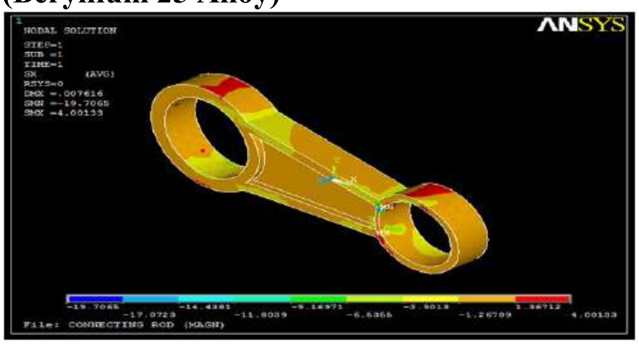


Fig: 7.5: Stress Analysis of Connecting Rod (Magnesium Alloy)

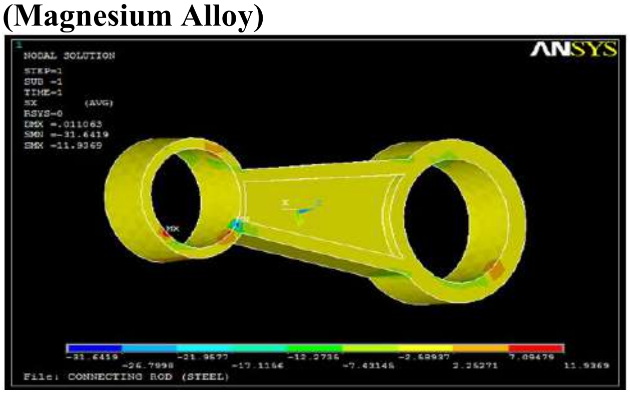


Fig: 7.6: Stress Analysis of Connecting Rod (Forged Steel)

7.3 Results of Strain Results:

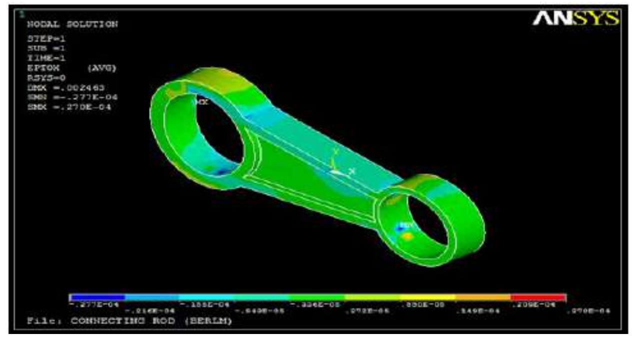


Fig: 7.7: Strain Analysis of Connecting Rod (Beryllium 25 Alloy)

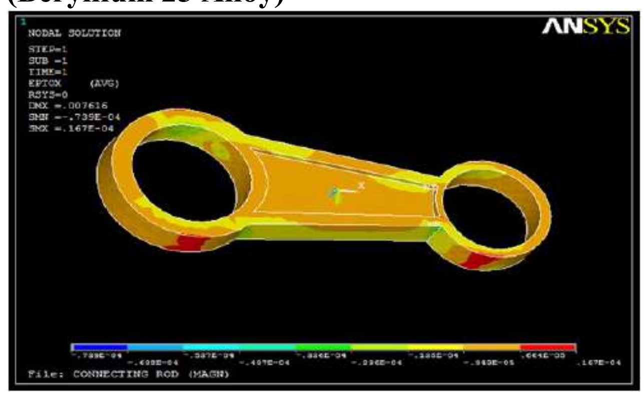


Fig: 7.8: Strain Analysis of Connecting Rod (Magnesium Alloy)

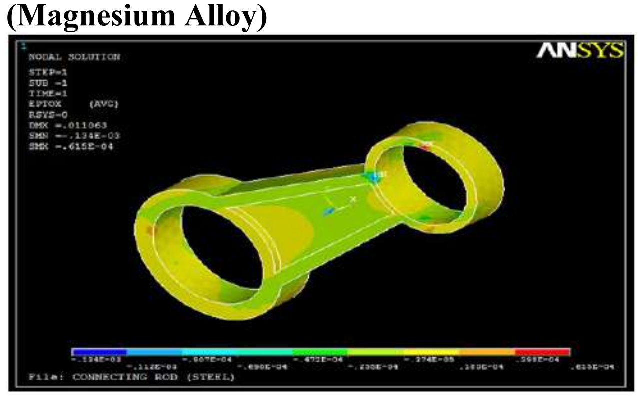


Fig: 7.9: Strain Analysis of Connecting Rod (Forged Steel)

VIII - CONCLUSION

A highly nonlinear model for the dynamic behavior is considered. A parametric study to investigate the influence of the control parameters on the dynamic response is conducted.

The control parameters that influence the transient response are found to be dimensioning equation is developed to predict the settling time of the response. Based on the developed equation, the Optimum values of the control parameters are obtained.

As shown above figures the displacement of the design is meshed and solved using Ansys and displacement are given below. This is showing us that clearly each component in assembly.

The maximum stress is coming, this solution solving with the help of Ansys software so that the maximum Stress are given below.

The maximum Strain is coming, this solution solving with the help of Ansys software so that the maximum Strain are given below. So we can conclude our design parameters are approximately correct.

Magnesium Alloy is used in high performance engines. It is light and strong, but comes at a higher cost. And now a day's, all the IC engine Connecting Rods are being made up of Steel.

Therefore, according to the above analysis, Beryllium alloy have obtained less deflection among the above materials be used for these as an alternative. It has exceptional stiffness and has brittle at room temperature and a reasonably high melting point. The modulus of elasticity of beryllium is approximately 50% greater than that of steel.

The design of the Connecting Rod mechanism worked flawlessly in analysis as well, all these facts point to the completion of our objective in high esteem.

REFERENCES

1. Isam Jasim Jaber and Ajeet Kumar Rai, Design and Analysis of IC Engine Using CATIA and ANSYS Software, IJMET.
2. DESIGN AND OPTIMIZATION OF CONNECTING ROD FOR 4 – STROKE PETROL ENGINE BY USING FINITE ELEMENT ANALYSIS By S. Aishwarya and E. V. V. Ramanamurthy
3. Design and Analysis of Connecting Rod for Different Material Using Ansys Workbench 16.2, Volume 5 Issue V, May 2017
4. Ch. Venkata Rajan ,P.V.K. Murthy, M.V.S. Muraly Krishna, G.M. Prasada Rao, Design Analysis and Optimization using CATIA and ANSYS, International Journal of Innovative Research in Engineering & Science Vol.1 , January 2013.
5. Kesarapu Sandeep Reddy, K.R. Senthil Kumar, P R Jeyakrishnam , Study on Stability of Honeycomb Structured Connecting Rod, IJERA.
6. Al-Beiruti, Dr.Basim M. Al Quraishi & Isam Ezzulddinyousif, Thermal effects on Diesel Engine Connecting Rod, Eng. & Tech Journal Vol. 27, 2009.
7. Ekeren Buyukkaya, Thermal analysis of functionally graded coating AlSi alloy and steel Connecting Rod, Surface & Coatings Technology 202 (2008).
8. THERMAL AND STRUCTURAL ANALYSIS OF CONNECTING ROD OF AN IC ENGINE, Mr. Shubham Chougale, June 2017, Volume 4, Issue 06 JETIR
9. Design And Analysis of Connecting Rod Using Forged steel, International Journal of Scientific & Engineering Research, Volume 4, Issue 6, June-2013