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"THERMAL TRANSIENT ANALYSIS ON CONNECTING ROD USING FINITE ELEMENT ANALYSIS"

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ABSTRACT

In this Project the stress distribution is evaluated on the four stroke engine connecting rod by using FEA. The finite element analysis is performed by using FEA software. The couple field analysis is carried out to calculate stresses and deflection due to thermal loads and gas pressure. These stresses will be calculated for three different materials. The results are compared for all the two materials and the best one is proposed. In this paper, a connecting rod for two wheeler is designed by analytical method and computational method . On the basis of that design a physical model is created in CATIAV5. Structural system of connecting rod has been analyzed using FEA. With the use of FEA various thermal stresses are calculated for a particular loading conditions using FEA software ANSYS WORKBENCH 19.2 The same work is carried out for different material. Also the thermal analysis of the connecting rod is performed. The obtained results are compared on the basis of various performances with considerable reduction in weight.

Key Words: *Connecting rod, Materials, Finite Element Analysis (FEA), thermal behaviour, ANSYS, CATIA*

I. INTRODUCTION

The internal combustion engine is basically a crank-slider mechanism, where the slider is the piston in this case. The piston is moved up and down by the rotary motion of crankshaft. The piston is encapsulated within a combustion chamber. The combustion of a fuel occurs with an oxidizer in a combustion chamber which 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 applies direct force to piston. This force moves the component over a distance, named as connecting rod, crankshaft, which transforms chemical energy into useful mechanical energy.

The valves on top represent suction and exhaust valves necessary for the intake of an air-fuel mixture and exhaust of chamber residuals. In a petrol engines, a spark plug is required to transfer an electrical discharge to ignite the mixture. Some of the important components of the internal combustion engine are Cylinder, piston, piston rings, Connecting rod, crankshaft etc.

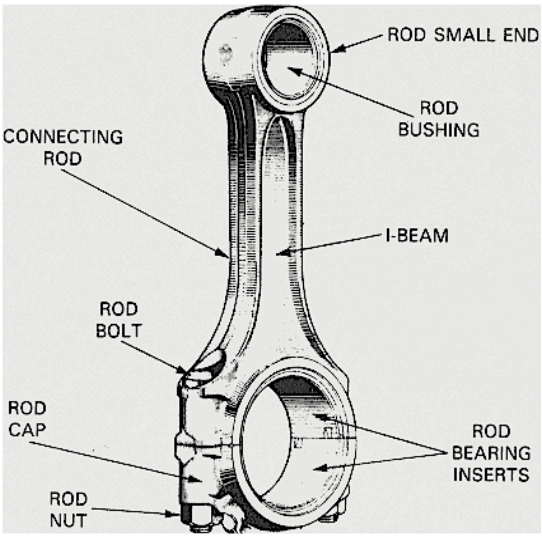

Fig.1 Connecting Rod Parts

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The connecting rod forms an integral part of an internal combustion engine. It acts as a linkage between piston and crank shaft. The small end of connecting rod attaches to the piston pin, gudgeon pin (the usual British term) or wrist pin, which is currently most often press fit into the connecting rod but can swivel in the piston. The other end, the bigger end being connected to the crankshaft.
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.[6]

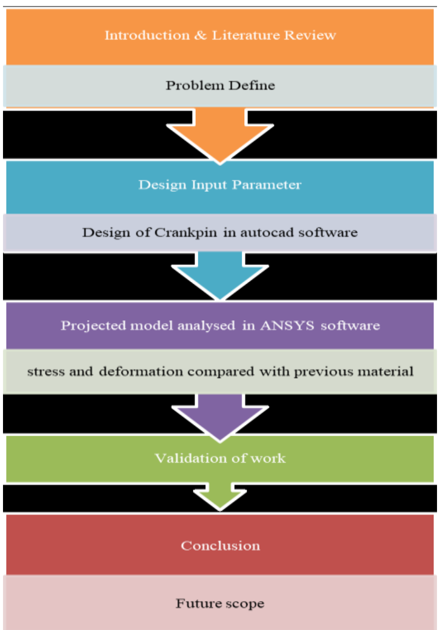
II. FEM TECHNIQUE FOR OPTIMIZATION

In optimization of different internal combustion components, material and cost are to be taken according to their respective densities and market price. The best material according to the required need is taken as suitable. FEM is numerical methods for solving the problems of stress and thermal analysis which give optimize result to suitable materials. Typical problems areas of interest include structural analysis, heat transfer and fluid flow analysis. The analytical solution of these problems are generally requires the solutions for boundary value problems for partial differential equations. The finite element method is formulation of the problems which results in a system of methods yields approximate values of the unknowns at discrete numbers of points over the domain. To solve the problems, it subdivides a large problem into smaller parts, simpler or smaller parts which is called finite elements. FEM are uses variational methods for the calculation of variations to approximate a solution by minimizing its associated error function.

III. PROBLEM STATEMENT

For the analysis of I.C. Engine connecting rod, the most critical area is considered. The objective of the present work is to determine the stresses in critical areas, the spots in the connecting rod where there are more chances of failure. The different dimensions of the connecting rod for Structural Steel is calculated through analytical method. Calculated loads are applied at one end and the other end kept fixed. Same process is carried out for Aluminium alloy. Finally both results are compared for performance, various stresses, weight, life cycles, fatigue life, heat flux etc. and best alternative is defined.

IV. RESEARCH METHODOLOGY



Methodology

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V. ENGINE SPECIFICATIONS

Engine	4 stroke Single cylinder air cooled with oil cooler
Displacement	220 cc
Bore & stroke	67 x 62.4
Compression Ratio	9.5:1
Max Power	20.06 PS(14.75 KW)@ 8500 rpm
Max Torque	19.12 N-M @ 6500 rpm
Transmission	5 speed, constant mesh, 1 down – 4up
Clutch	Mutilate wet
Ignition	CDI
Fuel Supply	Fuel injection

VI. DESIGN & ANALYSIS

A. Connecting rod Model in CATIA

This chapter design and analysis of connecting rod of dissertation includes design and analysis of existing crankpin of Hero splendor engine. Dimensions of the existing crankpin assembly have been extracted from the available data and CAD model has been prepared in CATIA as shown in figure. The finite element analysis is carried out by using ANSYS. In this project the connecting rod which is of Bajaj pulsur 150cc is taken. CAD model then is made by the commands in CATIA of Pad, pocket, fillet, and geometrical selections in part design module. Parametric generation of drawings will help to get the dimensions useful in forces calculations in static loading conditions on a component.

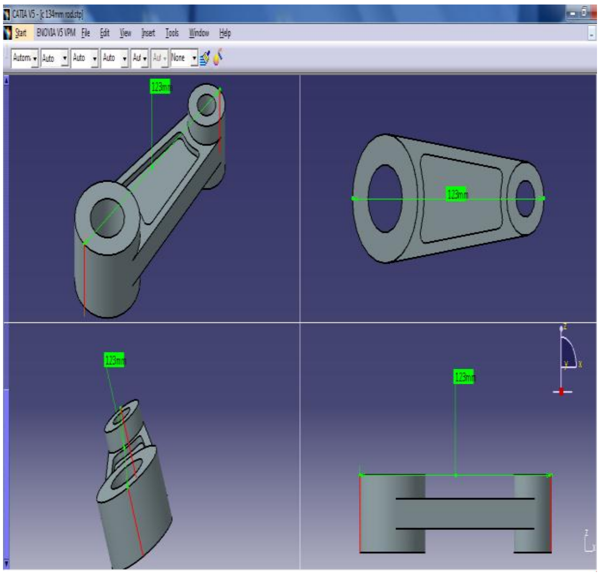

Fig.6.1 CAD model on CATIA

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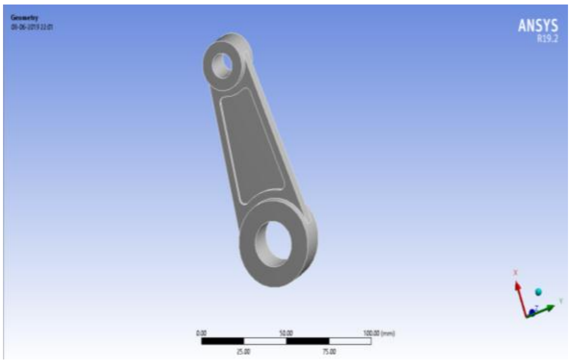

Fig.6.2 CAD model import on ANSYS

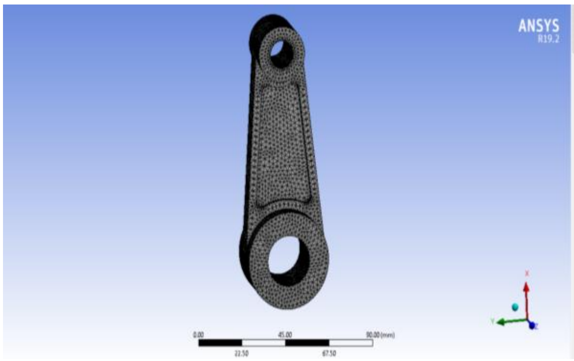

Fig.6.3 connecting rod meshing

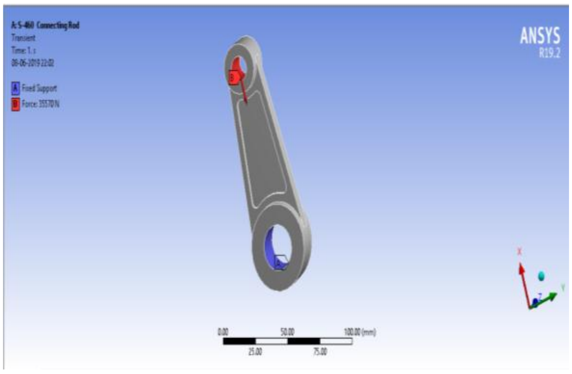

Fig.6.4 connecting rod S-460 material boundary conditions

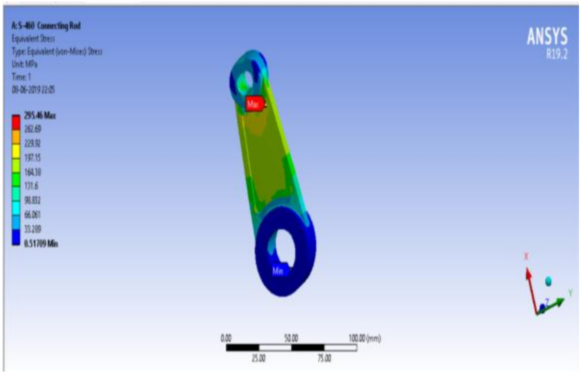

Fig.6.5 connecting rod S-460 material Thermal Stress result

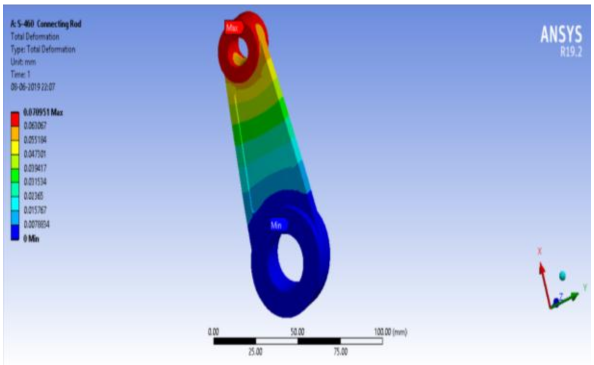

Fig.6.6 connecting rod S-460 material deformation result

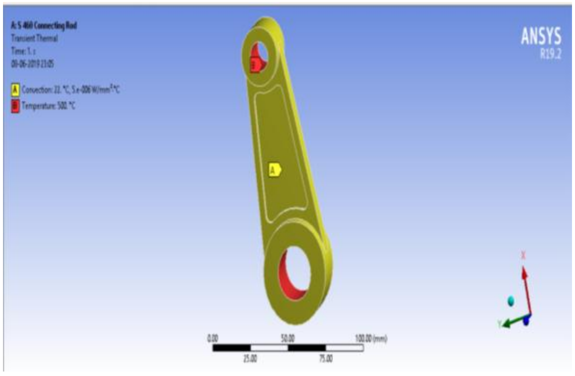

Fig.6.7 connecting rod S-460 material thermal boundary conditions

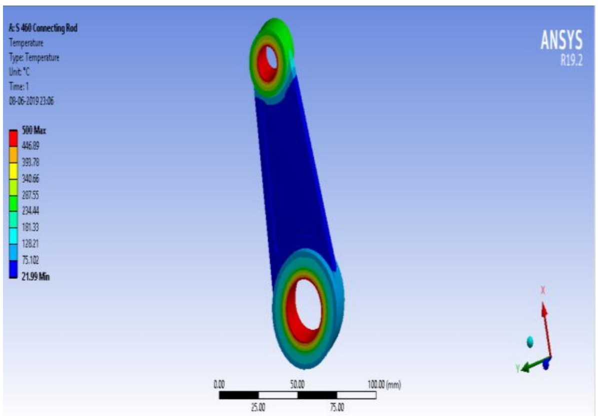

Fig.6.8 connecting rod S-460 material temperature results

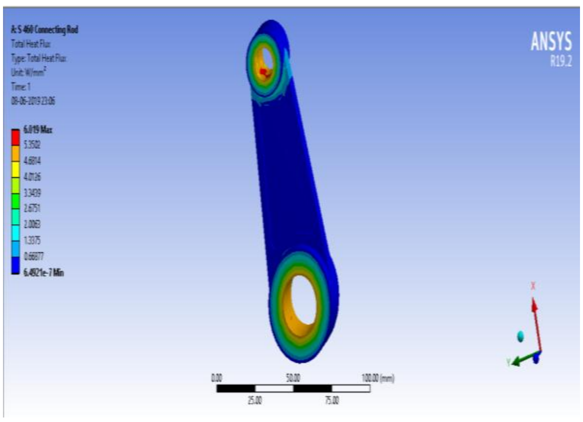

Fig.6.9 connecting rod S-460 material heat flux results

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Connecting Rod applied boundary conditions AL SI 398 materials

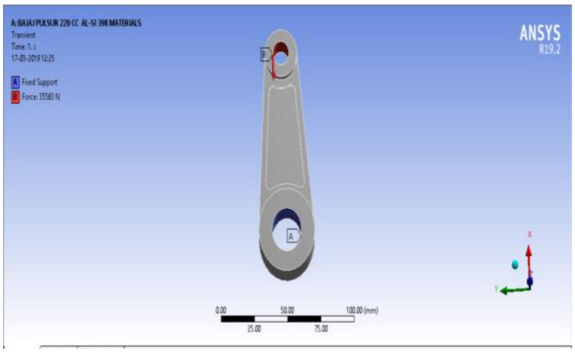

Fig.6.10 connecting rod AL SI 398 material boundary conditions

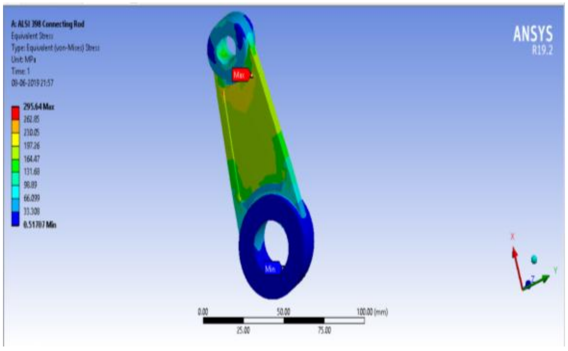

Fig.6.11 connecting rod AL SI 398 material thermal stresses results

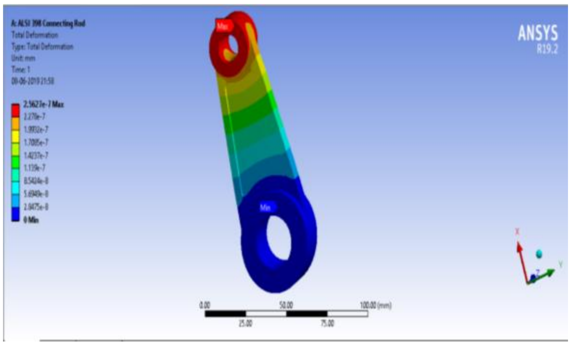

Fig.6.12 connecting rod AL SI 398 material deformation results

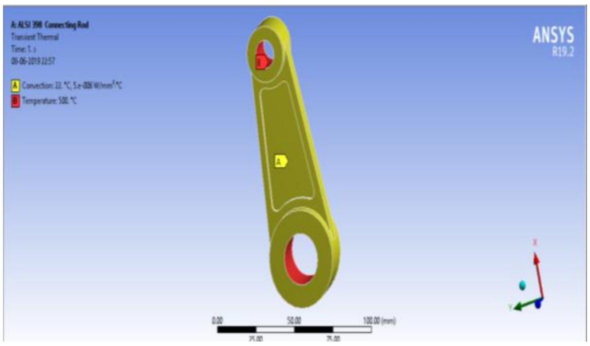

Fig.6.13 connecting rod AL SI 398 material thermal boundary condition

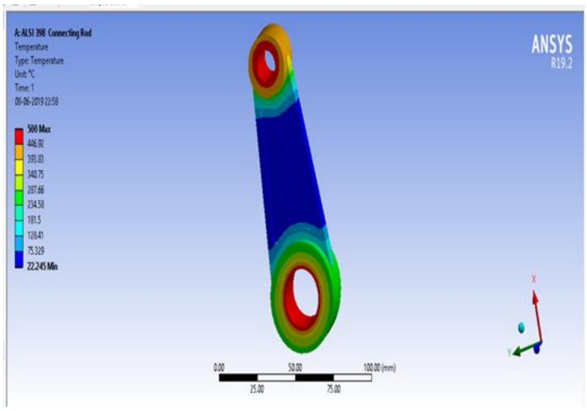

Fig.6.14 connecting rod AL SI 398 material temperature results

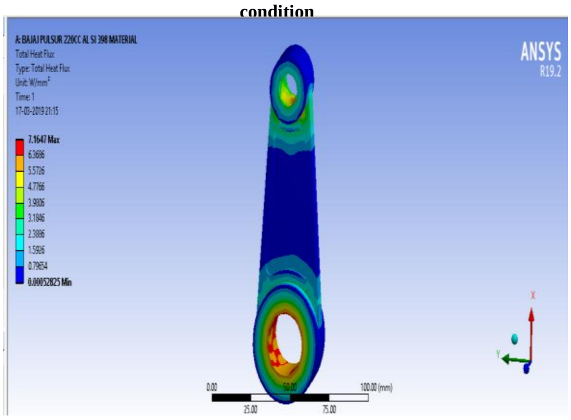

Fig.6.15 connecting rod AL 6060 material heat flux results

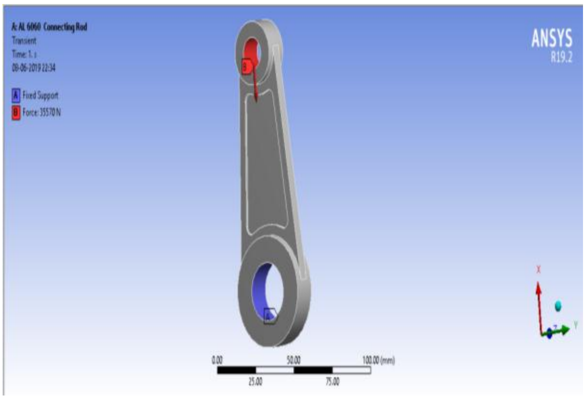

Fig.6.16 connecting rod AL6060 material boundary conditions

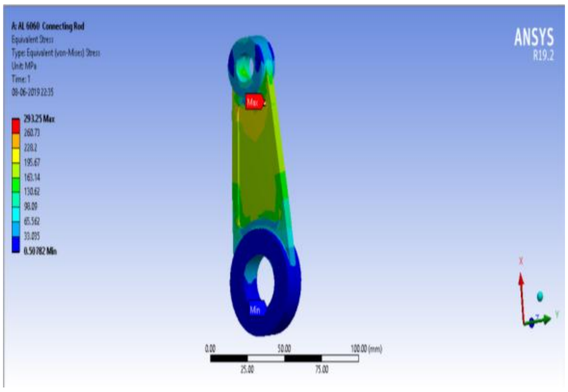

Fig.6.17 connecting rod AL6060 material thermal stresses

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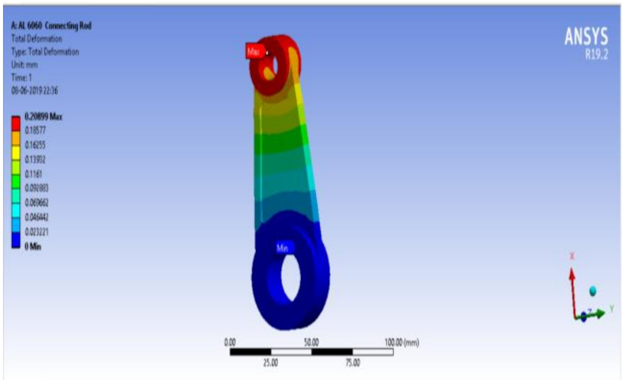


Fig.6.18 connecting rod AL 6060 material deformations results

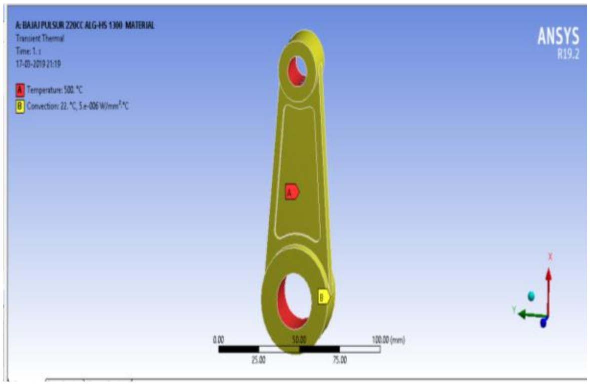


Fig.6.19 connecting rod AL6060material thermal boundary

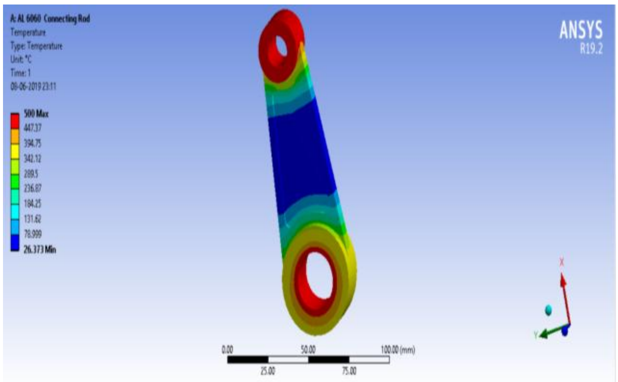


Fig.6.20 connecting rod AL6060 material temperature results

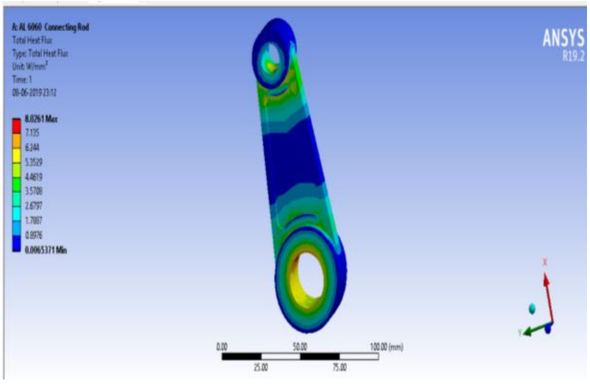


Fig.6.21 connecting rod AL6060 material heat flux results

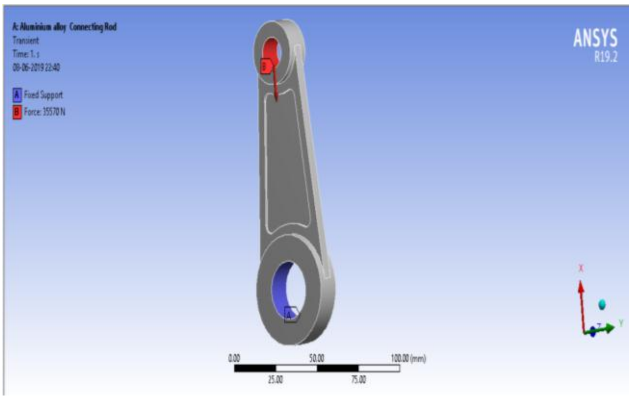


Fig6.22 Connecting Rod Aluminium alloy materials boundary condition applied

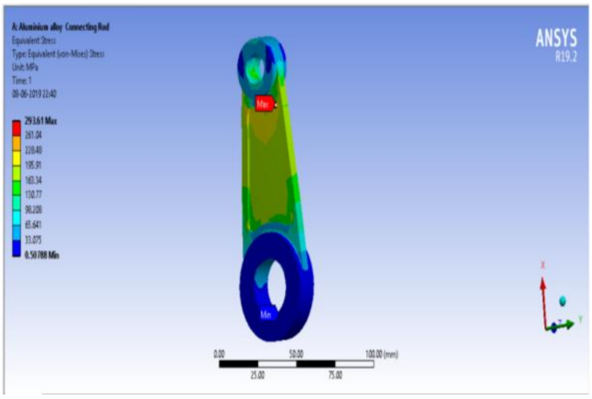
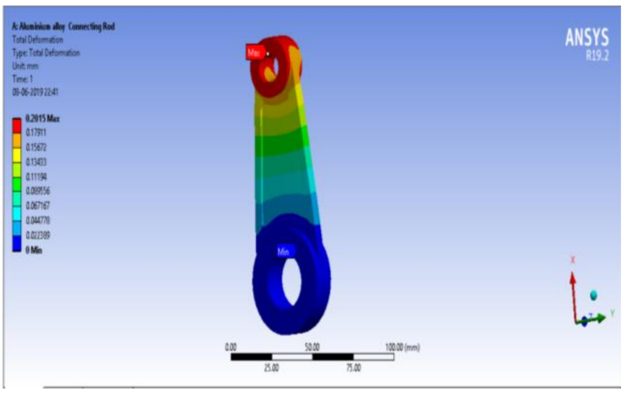
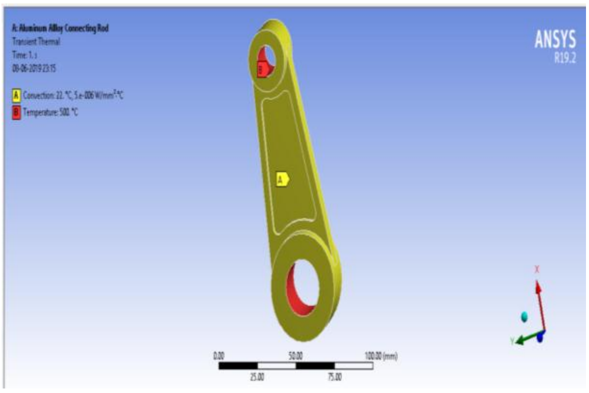


Fig6.23 Connecting Rod Aluminium alloy materials thermal stress result





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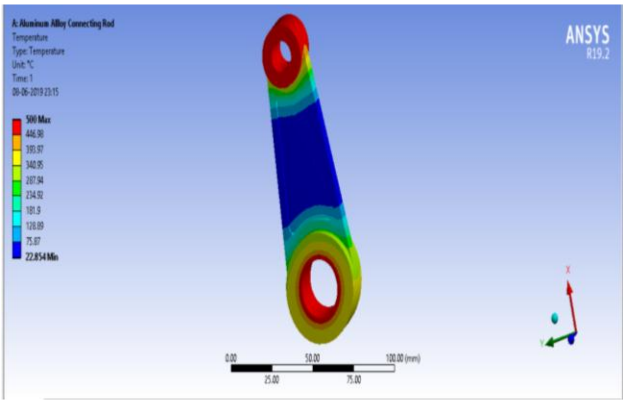

Fig6.26 Connecting Rod Aluminium alloy materials temperature results

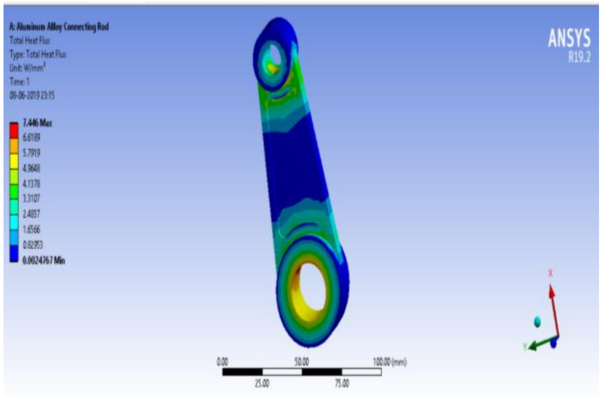

Fig.27 Connecting Rod Aluminium alloy materials heat flux results

VII. RESULTS & DISCUSSION

AL 6060 materials has more value of heat flux with different other materials. So it is ok for future plan on the basis of more value heat flux so here main objective this project finds out more value heat flux. So we can suggested AL 6060 materials for connecting rod in future. Because it is light weight and durable materials. This research project investigated weight and cost

reduction opportunities that steel forged connecting rods offer. This Project is concentrated on the calculation of the stresses developed in the connecting rod and to find region more susceptible to failure. The connecting rod chosen for the study is of 4 stroke single cylinder engine in which failure of the connecting rod results in the replacement of the whole connecting rod crankshaft assembly. FEA was performed using these results obtained from load analysis to gain an insight of the structural behaviour of connecting rod and to determine design loads for further study. First the CAD Modeling of connecting rod with the help of Cad software CATIA V5R20 and then Load analysis was performed with different cases consideration. The analysis was carried out with computer aided simulation. The tool used for analysis is ANSYS WORKBENCH 19.2

In below table its cleared that here take four materials for all material like S-460, AL SI 398, AL 6060 and Aluminium Alloy individually are 295.46MPa, 295.64MPa, 293.23MPa and 293.61. Here cleared that **AL 6060** materials has less value of thermal stresses with different materials and its considerable range.

In below table its cleared that here take four materials for all material like S-460, AL SI 398, AL 6060 and Aluminium Alloy individually are 0.0709 mm, 0.00000025mm, 0.208 mm and 0.0215mm. Here we can plainly saw that Here cleared that **AL 6060** materials have value of deformation with different materials and its considerable range.
In below table its cleared that here take four materials for all material like S-460, AL SI 398, AL 6060 and Aluminium Alloy individually are 150.4 MPa, 150.57MPa ,149.37MPa and 149.54. Here we can cleared saw that **AL 6060** materials has considerable range of shear stresses compare to different materials.

In below table its cleared that here take four materials for all material like S-460, AL SI 398, AL 6060 and Aluminium Alloy individually are 446.8 C, 446.92 C, 447.3C and 446.9 C. Here obviously saw that **AL6060** materials have value of temperature value with different materials its considerable range . So it is alright for future structure.
In below table its cleared that here take four materials for all material like S-460, AL SI 398, AL 6060 and Aluminium Alloy individually are 6.02 w/mm^2, 7.27w/mm^2, 8.02 w/mm^2 and 7.44 w/mm^2. Here cleared saw that **AL 6060** materials has more value of heat flux with different other materials. So it is ok for future plan on the basis of more value heat flux so here main objective this project finds out more value heat flux.

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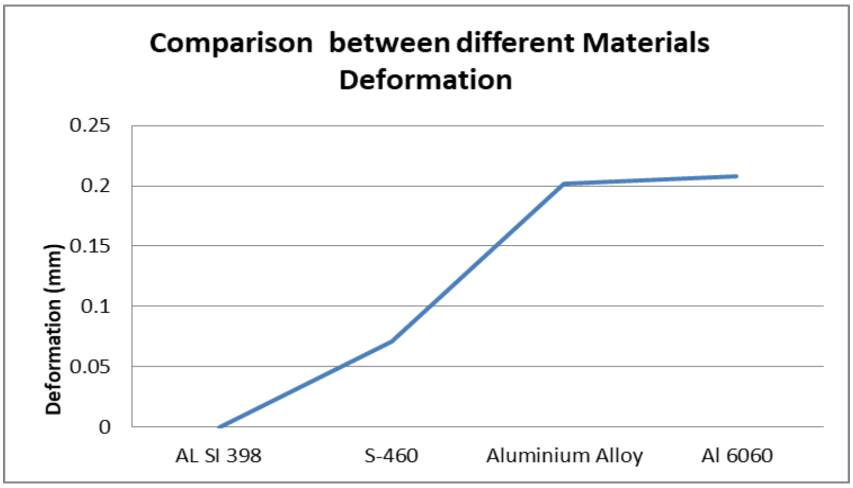

Fig. 7.1 Comparison between different Materials Deformation

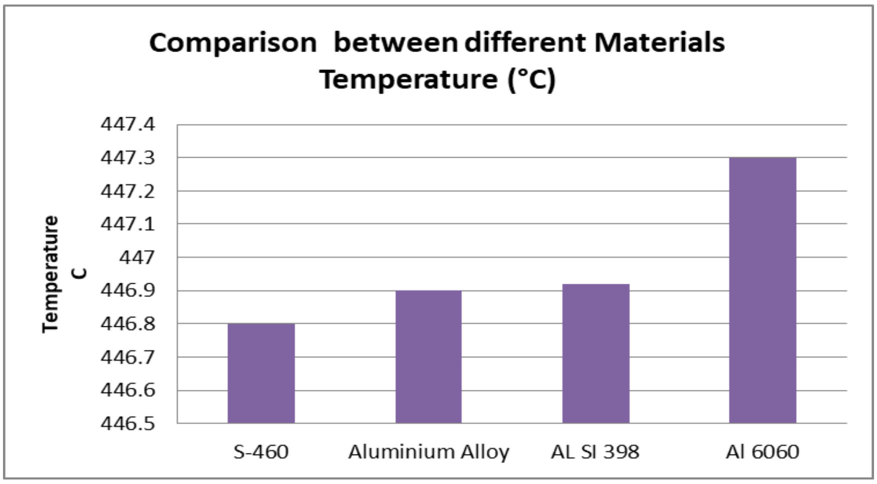

Fig 7.2 Comparison between different Materials temperature

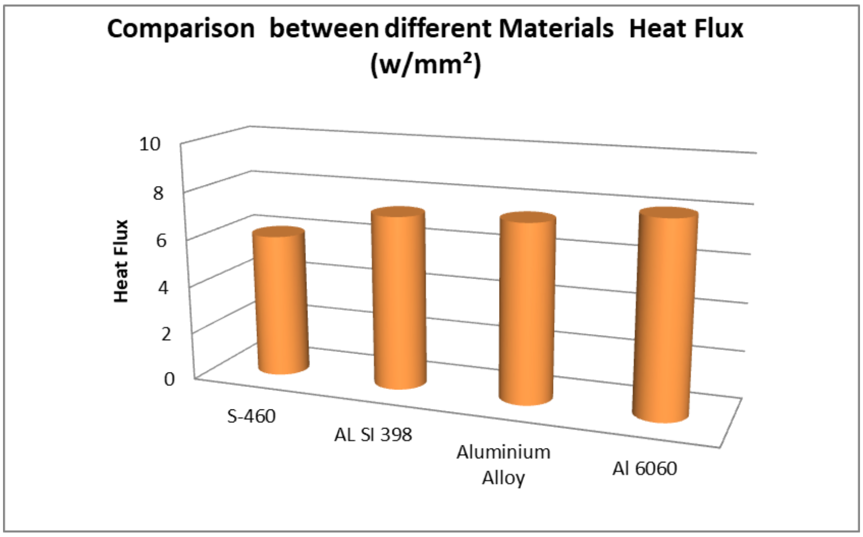

Fig 7.3 Comparison between different Materials heat flux

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VIII. CONCLUSION

Series of simulations were carried out to understand the effect of material selection in connecting rod design by considering different materials. Wide range of variations were observed in the magnitude of Equivalent von-mises stresses, Equivalent shear stress, Total deformation, Temperature and Heat flux for different materials.

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