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"THERMO MECHANICAL TRANSIENT ANALYSIS OF ANIC ENGINE PISTON WITH DIFFERENT THERMAL MATERIAL BY USING ANSYS SOFTWARE"

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ABSTRACT

Piston is the part of engine which converts heat and pressure energy liberated by fuel combustion into mechanical works. Engine piston is the most complex component among the automotives. In this thesis, we will be illustrate design procedure for a piston for diesel engine for water pump and its analysis by its comparison with original piston dimensions used in water pump. In this thesis the combined effect of mechanical and load will be taken into consideration while determining various dimensions. we will be used modeling through CATIA and simulation through ANSYS software. I give as the input to the piston model are fixed support, Gas pressure (6 MPa), Heat flow rate (1400 W) and Temperature (120,190,220 & 300 °C). Then find the value of Thermal stress , Deformation , Thermal results and Heat flux . I obtained value of Thermal stesses, Deformations, Temperature and Heat flux of **Carbon fiber are 224.53 MPa, 0.0439 mm, 269.45°C and 6.42 w/mm² repectively which are the best result among three materials.**

Key Words: *Piston, AL 6060, Carbon Fiber, AL Si 398, CATIA and ANSYS*

I. INTRODUCTION

Piston is considered to be one of the most important parts in a reciprocating Engine, reciprocating Pumps, among other similar mechanisms in which it helps to convert the chemical energy obtained by the combustion of fuel into useful (work) mechanical power.

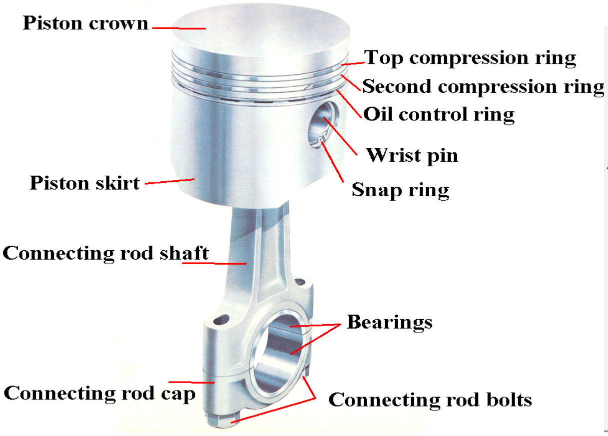

Fig 1.1 Piston with connecting Rod

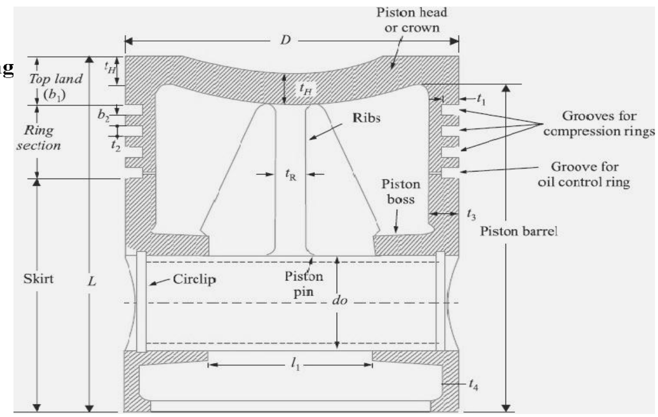

Fig 1.2 Piston elements

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II. MATERIALS

We have selected three materials

- AL –Si 398
- AL-6060 Alloy
- Carbon Fiber

III. MODELING & SIMULATION

Table 3.1 Diesel engine specifications

Sl. No	Description	Specification
1	Engine make	Kirloskar diesel engine
2	Bore	80 mm
3	Stroke	110mm
4	Engine speed taken for study	1500 rpm
5	Compression ratio	16.5:1
6	Test condition/Type	Water cooled direct injection diesel single cylinder engine
7	Max pressure at study rpm	6MPa

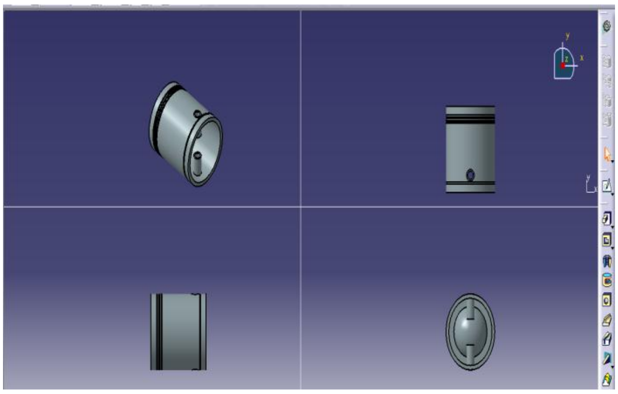

Fig.3.1 3D Drafting

Fig.3.2 CATIA Model

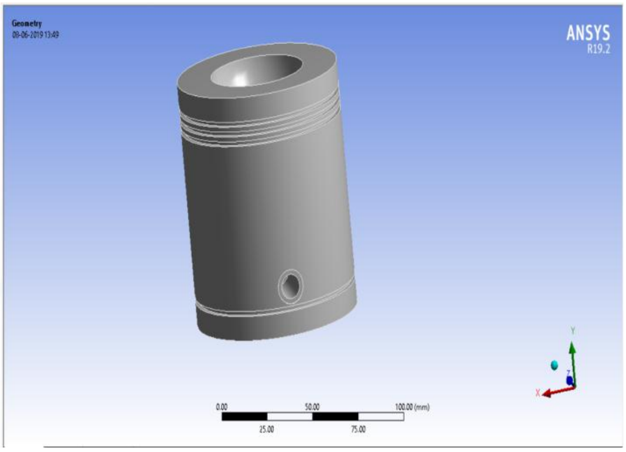

Fig.3.3 Import Geometry ANSYS

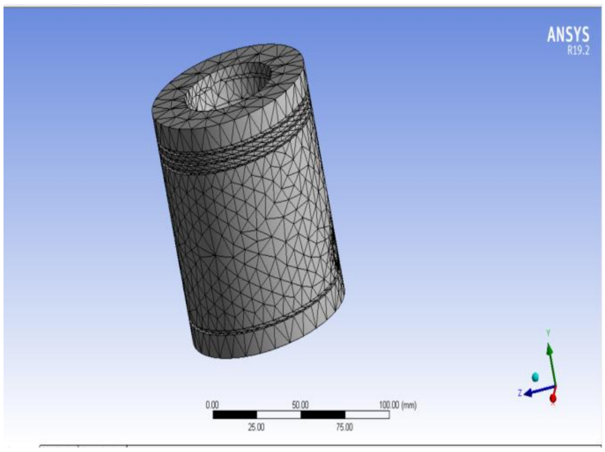

Fig.3.4 Meshing

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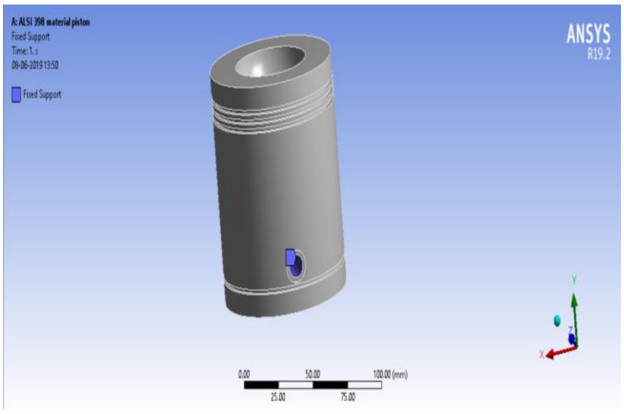

Fig.3.5 AL-Si 398 fixed support boundary condition

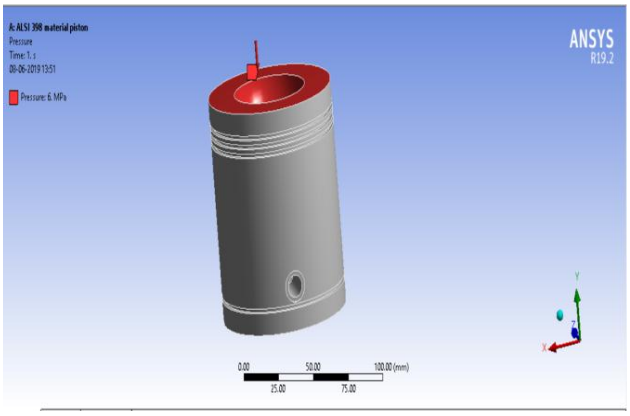

Fig. 3.6 AL-Si 398 pressure applied boundary

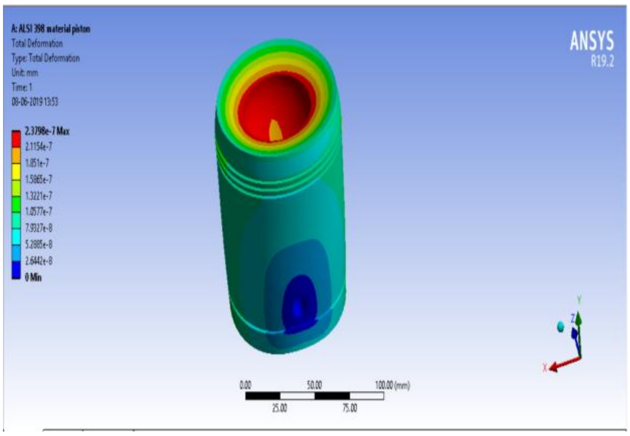

Fig. 3.7 AL-Si 398 Total deformation

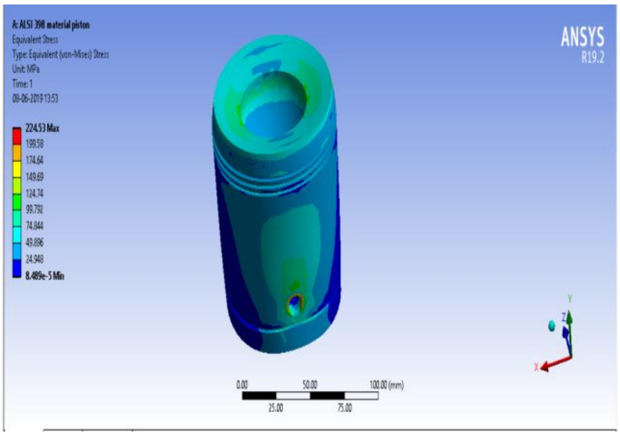

Fig.3.8 AL-Si 398 thermal stresses

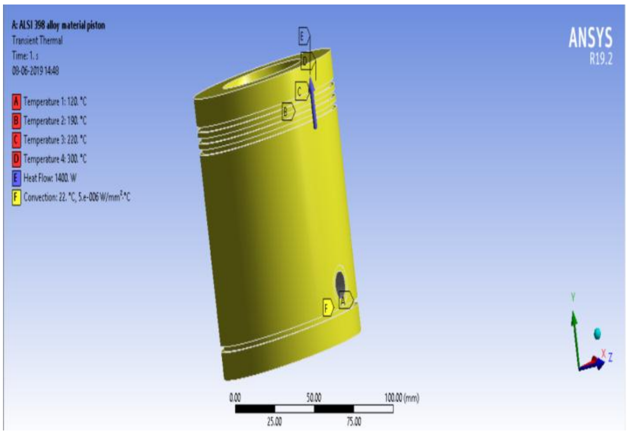

Fig.3.9 TransientThermal Boundary conditions AL-Si 398

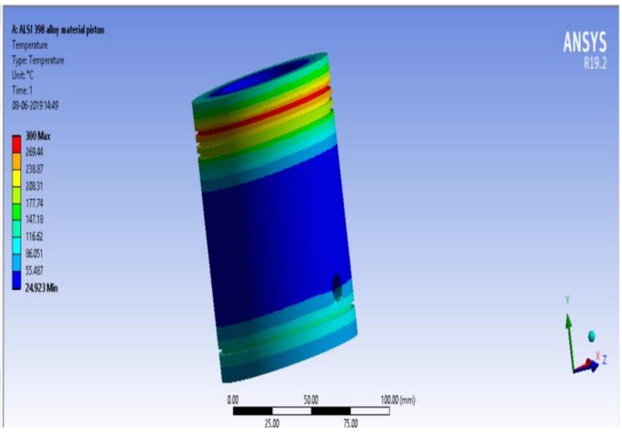

Fig.3.10 AL-Si 398 temperature result

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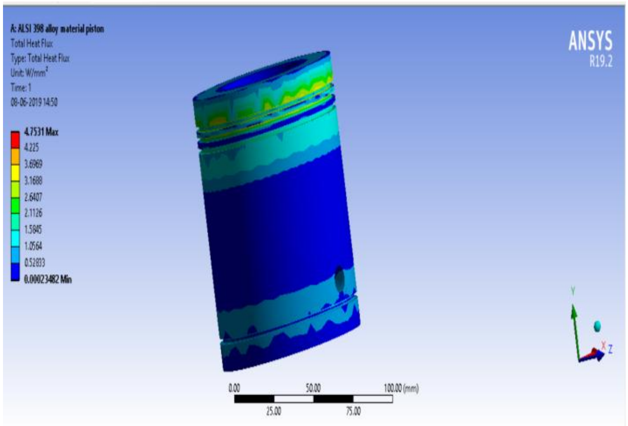

Fig.3.11 AL-Si 398 heat flux result

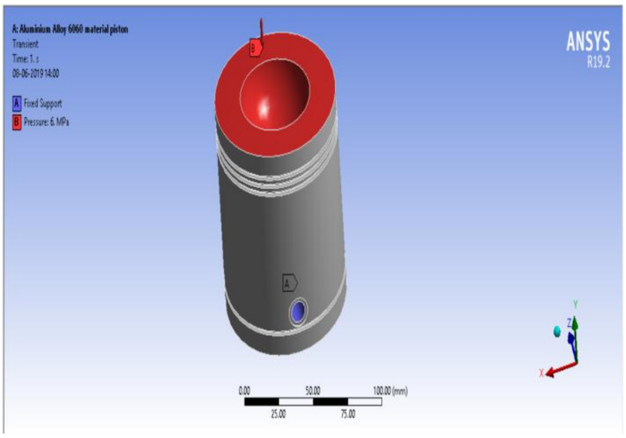

Fig.3.12 Pressure and fixed support boundary conditions AL-6060

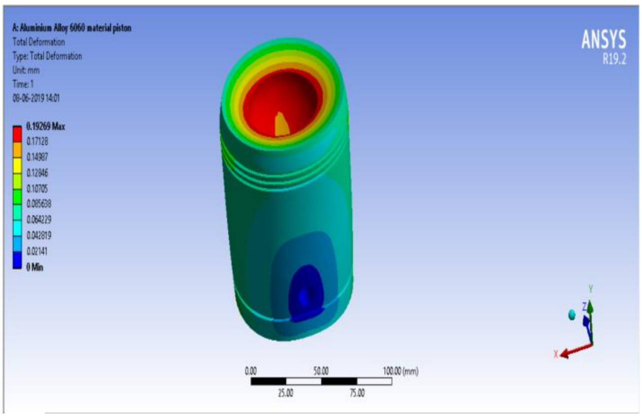

Fig.3.13 AL- 6060 total deformation result

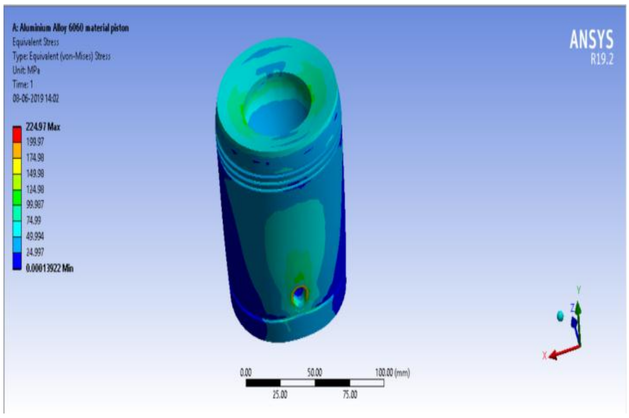

Fig.3.14AL- 6060Thermal Stress result conditions AL-6060

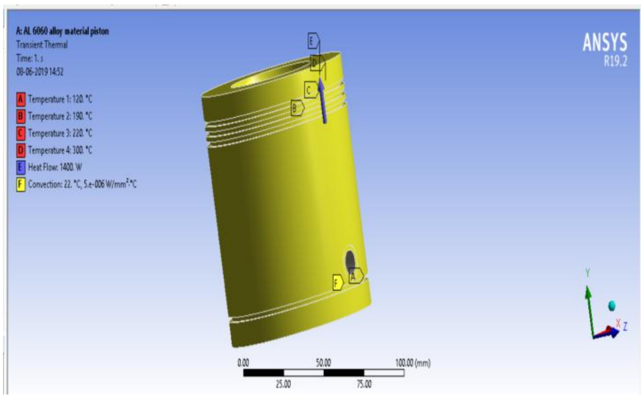

Fig.3.15AL- 6060 thermal boundary condition

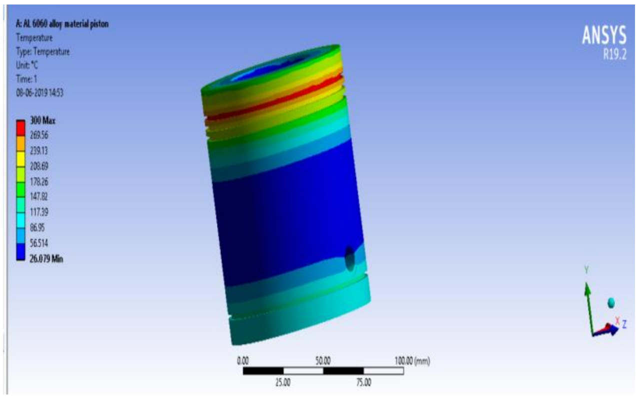

Fig.3.16AL- 6060 temperature result

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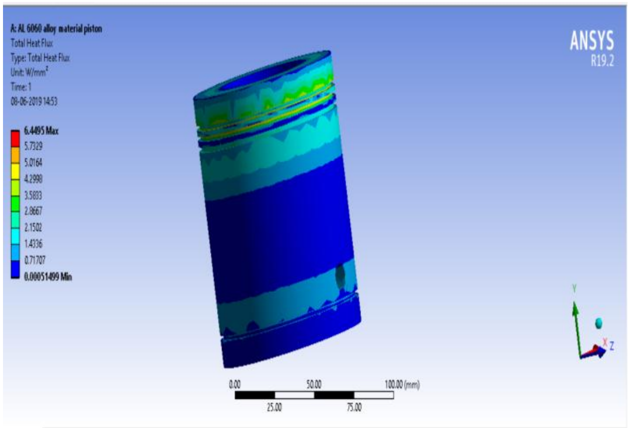

Fig.3.17 AL- 6060 heat flux result

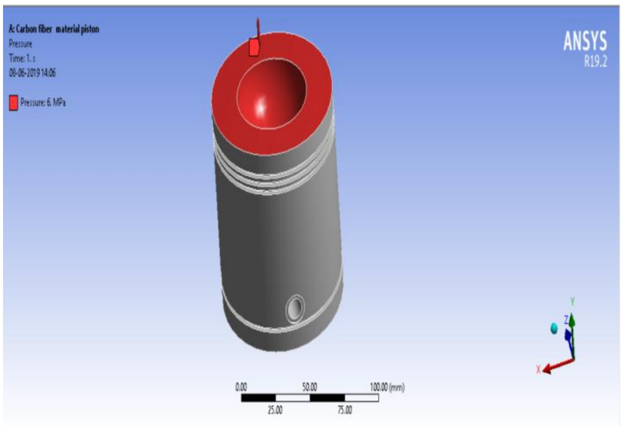

Fig.3.18Carbon fiber applied boundary conditions

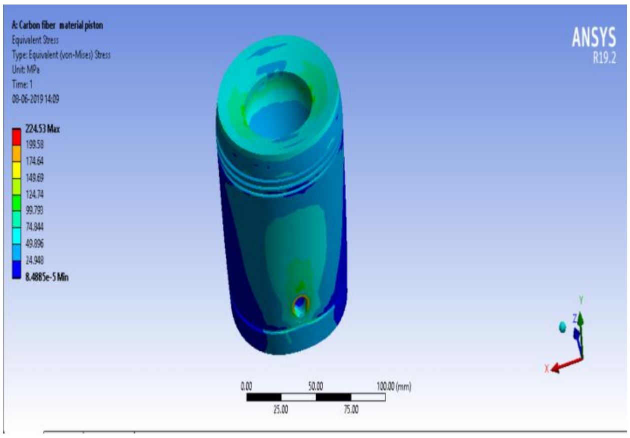

Fig.3.19Carbon fiberthermal stresses results

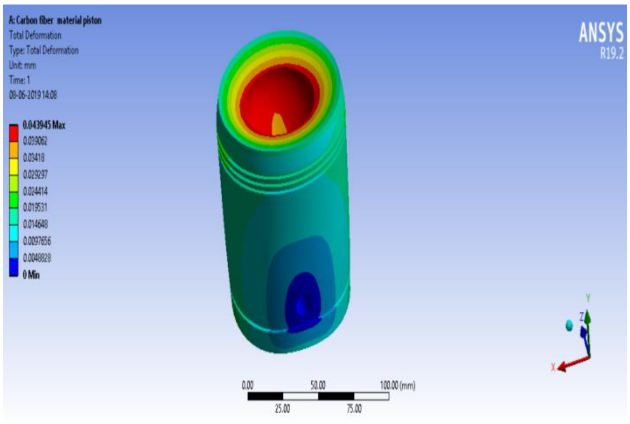

Fig.3.20Carbon fibertotal deformation results

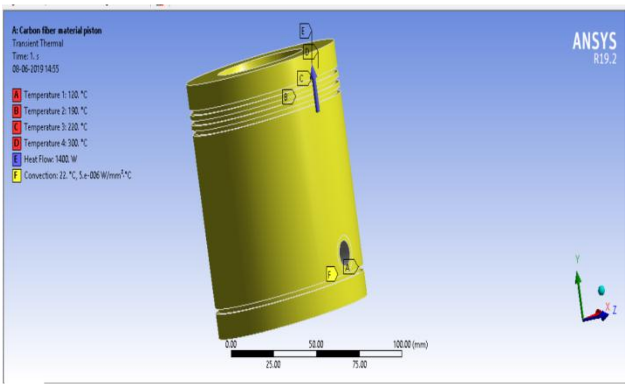

Fig.3.21Carbon fiberthermal boundary conditions

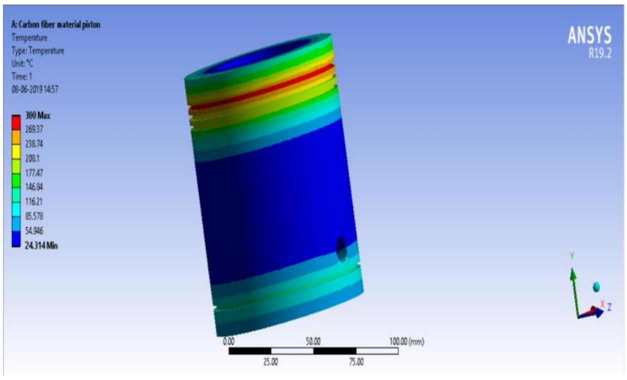

Fig3.22Carbon fibertemperature results

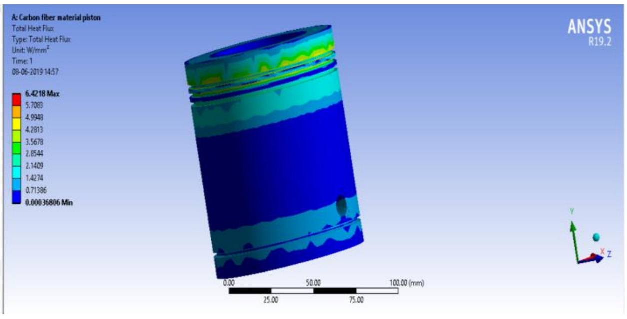

Fig. 3.23 Carbon fiberheat flux results

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IV. RESULT & DISCUSSION

I take three different materials 3D models of piston are created based on the dimensions obtained. CATIA V5R20 is used for creating the 3D model. These models are then imported into ANSYS WORKBENCH 19.2 for analysis. Static structural analysis of pistons is carried out.

Meshing is done with an automatic which gives a fine mesh. For static structural analysis, gas pressure is applied on the top of the piston and frictionless support is applied across the surface of piston and also on the piston pin holes. Then results are obtained for von-misses stress and maximum elastic strain. A comparison is made between these results and the best suited aluminium alloy is selected based on the parameters which shown in Fig 4.1. The static structural analysis of **AL6060 Aluminium, Carbon fiber, AL-Si 398 are** done and results are obtained for Equivalent (Von-Mises) thermal stress, Temperature, deformation and heat flux .

I can observe that in case of **Thermal stress**, piston made of **AL 6060** is found to have maximum thermal stress of 224.97 MPa is observed. When piston made of **Carbon fiber** the thermal stress value maximum 224.53 MPa. When piston made of **AL-Si 398** alloy the maximum thermal stress on is found to be 224.53MPa .

I can observe that in case of **deformations** shown in Fig 4.2, piston made of **AL-Si 398** is found to have minimum deformation of 0.00000023 mm is observed. When piston made of **Carbon Fiber** then deformations value maximum 0.0439 mm. When piston made of **AL 6060** alloy then maximum deformation on is found to be 0.19269 mm.

We can observe that in case of **Temperature** shown in Fig 4.3 , piston made of **Carbon fiber** is found to have maximum temprature of 269.45 °C is observed. When piston made of **AL 6060** then temperature value maximum 269.49 °C. When piston made of **AL-Si 398** alloy then Maximum temperature on is found to be 269.45 °C

We can observe that in case of **heat flux (w/mm²)** shown in Fig 4.4, piston made of **Carbon Fiber** is found to have maximum heat flux of **6.42 (w/mm²)**, it is observed., minimum heat flux for AL Si 398 be **4.7531 (w/mm²)**, and maximum heat flux for AL 6060 that of is found to be **6.495 (w/mm²)**.

We can observe that in all case we take here for materials Carbon fiber is good thermal conductivy compared with other than materials its light weight and it has more value heat flux.

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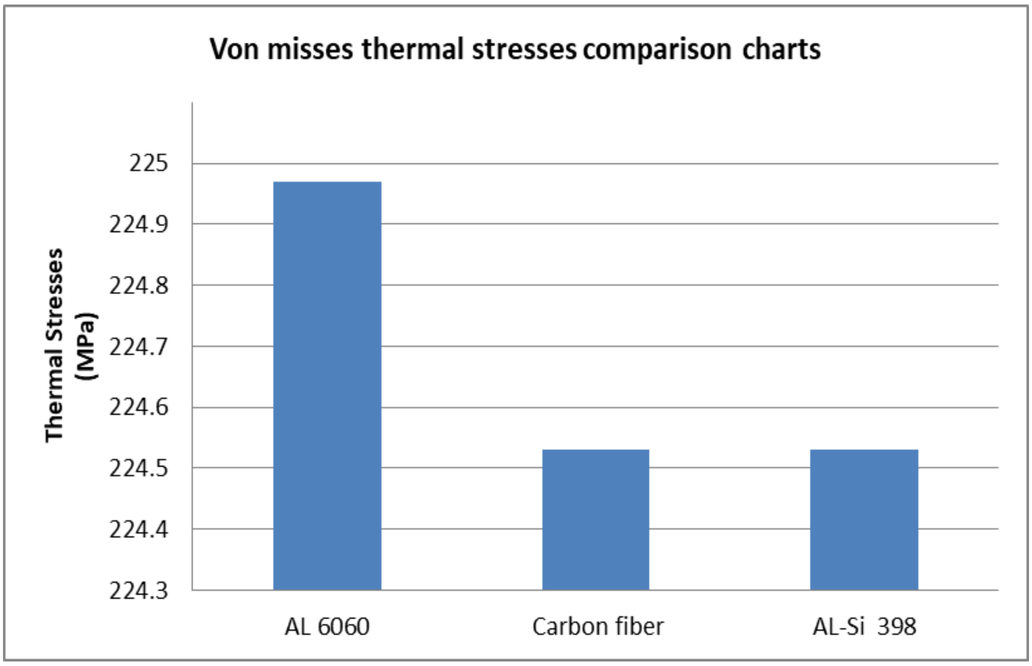

Fig.4.1 Comparison Graph for thermal Stress with different materials

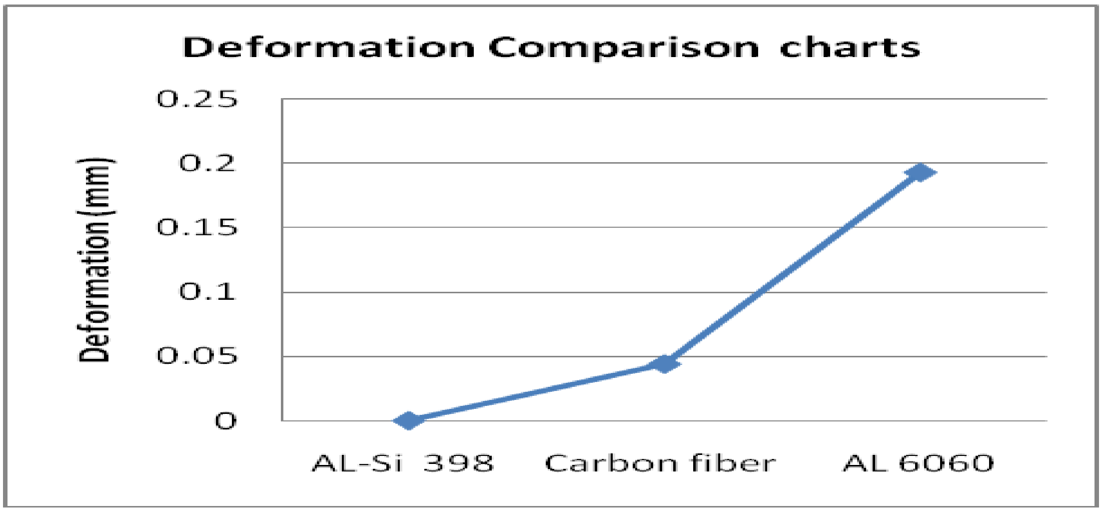

Fig.4.2Comparison Graph for Deformation with different materials

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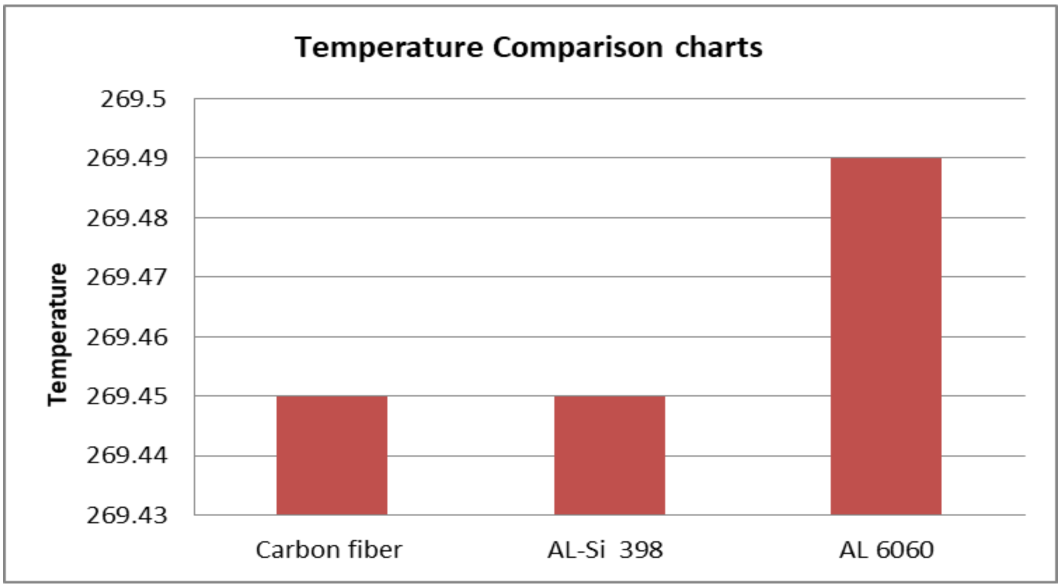

Fig.4.3 Temperature Comparison charts

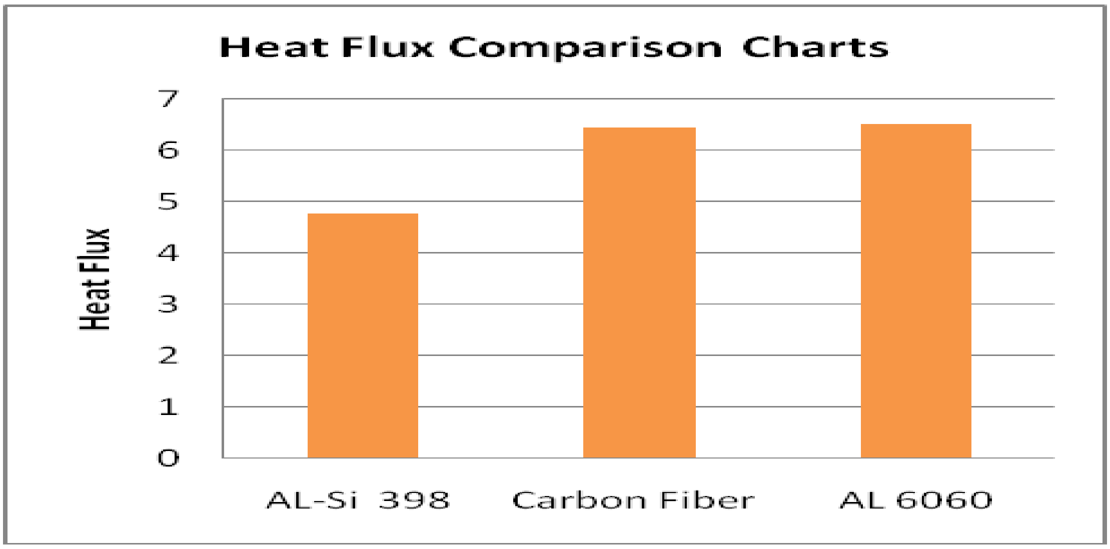

Fig.4.4 Heat Flux Comparison Charts

V. CONCLUSION

The fundamental concepts and design methods concerned with single cylinders Diesel engine have been studied in this project the thermal results found by the use of this Thermal transient and Thermal transient method are nearly equal to the actual dimensions used now a days. Hence it provides a fast procedure to design a piston which can be further improved by the use of various ANSYS thermal software and methods.The most critical part is that less time is required to outline the piston and just a couple of essential detail of the engine.

- Pistons made of various aluminum alloy like AL Si 398 , Carbon Fiber, Al 6060 were outlined and investigated effectively.
- We find Piston move even at minimum pressure carried out with help of thermal transient software.
- In static-auxiliary investigation, the pistons were examined to discover the proportional Thermal stress, comparable flexible strain, deformation and thermal heat flux
- I obtained value of Thermal stesses, Deformations, Temperature and Heat flux of Carbon fiber are 224.53 MPa, 0.0439 mm, 269.45°C and 6.42 w/mm² repectively which are the best result among three materials.

So I will be recommended this **Carbon Fiber** basic of thermal streses, thermal heat flux and turbulence for future work because all thermal parameter are in considerable range.

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