"DESIGN AND ANALYSIS OF IC ENGINE PISTON USING COMPOSITE MATERIALS"

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In partial fulfillment for the award of the Degree

Of

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IN

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UNDER THE GUIDANCE

Of

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ANJUMAN-I-ISLAM

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ANJUMAN-I-ISLAM KALSEKAR

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This is to certify that the project titled

"Design & Analysis Of IC Engine Piston Using Composite Material"

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of the Kalsekar Technical Campus, New Panvel is a record of bonafide work carried out by him under our supervision and guidance, for partial fulfillment of the requirements for the award of the Degree of Bachelor of Engineering in Mechanical Engineering as prescribed by University Of Mumbai, is approved.

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	NAME:
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APPROVAL OF DISSERTATION

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(Project Guide) **(External Examiner)**

(Prof. Mohd Sirazuddin Khan) ________________________

DATE:________________

ACKNOWLEDGEMENT

It is our great pleasure to present this report, a written testimonial of a fruitful experience. It would be unethical on my art to claim complete credit for the project. We therefore take this opportunity to express acknowledgement to all those individuals who helped in making our project a success. First and foremost, we would like to thank **Prof. Zakir Ansari (HOD- Department of Mechanical Engineering)** working with whom is a delightful and wholesome learning experience. Highly indebted to **Prof. Mohd Sirazuddin Khan** for guidance and constant supervision as well as for providing necessary information regarding the project.

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ABSTRACT

The study of this paper is to show how carbon-carbon, AlSiC, & Hyper-eutectic materials can be used as piston material rather than commonly used Aluminum Alloys, Cast Iron, etc. We have carried out Static Structural and Steady State Thermal Analysis using ANSYS WORKBENCH to examine the above mentioned materials under high stresses and dynamic loads. The main aim of our work is to increase the pressure and temperature tolerance of IC Engine piston

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1.4 Motivation

1.5 Aim and Objectives

CHAPTER 1

INTRODUCTION

1.1 Background:

In an automobile engines, when the air-fuel mixture burn in combustion chamber, the gas exerts pressure on the piston crown and the piston transmits this force to the crankshaft converting reciprocating action into rotory motion. A piston is a moving disk enclosed in a cylinder which is made gas-tight by piston rings. We have a tight fit between the cylinder and piston because during combustion we have high pressure and if it is not tightly fit we might loose some energy which will affect the performance of the engine .The disk moves inside the cylinder as a liquid or gas inside the cylinder expands and contracts. A piston aids in the transformation of heat energy into mechanical work and vice versa. Because of this, pistons are a key component of heat engines. Piston is connected to the connecting rod with the help of gudgeon pin/piston pin this connecting rod connects piston to the crankshaft where it is attached to the crankpin and thus piston is connected to crankshaft. The main function of the piston of an internal combustion engine is to receive the impulse from the expanding gas and to transmit the energy to the crankshaft through the connecting rod. The piston must also disperse a large amount of heat from the combustion chamber to the cylinder walls. The engine where the conversion of thermal energy to mechanical energy takes place due to reciprocating piston is called as reciprocating engine.

Fig. 1 Connecting Rod

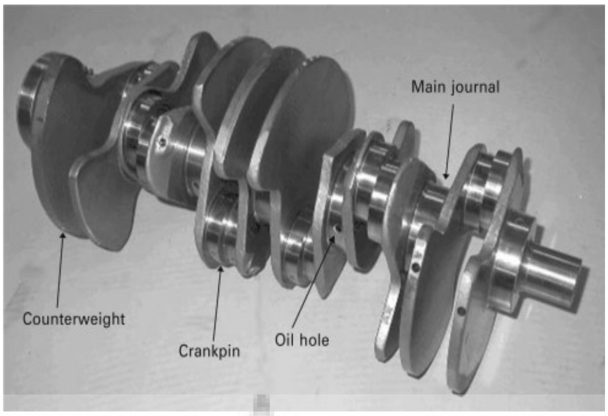

Fig. 2 Crank shaft

1.2 Nomenclature Of Piston

The piston of internal combustion engines consists of the following parts:

Piston Head/Crown: The piston head or crown may be flat, convex or concave depending upon the design of combustion chamber. It withstands the pressure of gas in the cylinder.

Piston Rings: The piston rings are used to seal the cylinder in order to prevent leakage of the gas past the piston.

Piston Skirt: The skirt acts as a bearing for the side thrust of the connecting rod on the walls of the cylinder.

Piston Pin: It is called a gudgeon pin or wrist pin. It is used to connect piston to the connecting rod

1.3 Forces Acting On Piston:

1. Thermal Load
2. Loads due to explosion of fuel
3. Loads due to compression of fuel
4. Inertia force due to reciprocating of piston

1.4 Motivation:

As an important part of the engine, piston endures the cyclic gas pressures and inertial forces at work, and this working condition may cause the fatigue damage of the piston, such as piston side wear, piston head/crown cracks and so on. The investigation suggests that the greatest stress appear on the upper end of the piston and stress concentration are one of the mainly reasons of fatigue failure

The modification of the piston is necessary to increase the surface resistance of piston against thermal and mechanical stress. At present researchers are attracted in downsizing of engine which will reduce emission of pollutants and consumption of less fuel.

The average temperature of piston crown during normal operation is about 300°C.

Aluminum expand more than iron at this temperature range. So for piston to fit the cylinder properly when at normal temperatures, the piston must have a loose fit when cold.

Due to high temperature and pressure in combustion chambers normal elements used for pistons results in fatigue failure ,cracks on piston head.

1.5 AIM/OBJECTIVE/PURPOSE OF THE STUDY:

The purpose of the study is to carryout how carbon-carbon, AlSiC and hyper-eutectic alloys can be used as a piston material rather than commonly used alloys of aluminium, cast iron, etc.

The objective of the process is to design a piston which exhibits high performance durability, and can be used in high performing engines.

CHAPTER 2

Literature Review

CHAPTER 2

LITERATURE REVIEW :

In 1950's compact automotive v-8 engines made of cast iron were introduced with aluminium alloy pistons as standard production parts.

Aluminium alloy pistons had significant advantage as compared to cast iron, steel pistons and could dissipate heat more quickly.

Today, most pistons are made of aluminium which is relatively light weight easy to manufacture and low in cost.

Piston experiences cyclic gas pressure, inertial forces, high temperature due to combustion during work as a result piston expands, when piston expands to the diameter of the cylinder it leads to piston seizure as it leads to metal to metal contact between cylinder and piston.

Due to high temperature and pressure in combustion chambers normal elements used for pistons results in fatigue failure ,cracks on piston head.

Carbon-carbon piston program was started in 1986 involving NASA and U.S army, The first objective was to develop and test for all carbon-carbon piston technology for use in two stroke engine. The second objective was to transfer the carbon-carbon piston technology to engines used in light aircraft, automobiles and other types of transport vehicles, i.e four stroke cycle engines.

When carbon-carbon piston was tested in the engine it did not seize , or produce any audible or visual abnormalities.

The development and testing that has taken place under advanced carbon-carbon piston programs shows that pistons can be manufactured from carbon-carbon composite material and can be successfully operated in an internal combustion engine.

Researchers have been conducting various experiments with different materials to design a piston with light weight, high strength, low thermal deformation, etc.

According to these researches we have found that traditional/commonly used aluminium pistons can be replaced with other composite materials (carbon-carbon, AlSiC, hyper-eutectic aluminium)

[Sundaram.K , Palanikumar.N] in their research concluded that AlSiC with 10% SiC material having better temperature distribution in both steady state thermal analysis as well as transient state thermal analysis

[Joel C , Anand S] in their research stated that “The aluminium alloy piston can be replaced by a carbon-carbon material piston. Since it provides minimum thermal stress in same working condition as that of aluminium alloy”

they also suggested that with the significant physical properties of carbon-carbon refractory-composite material, pistons can be made much lighter weight

[Shubham Jog, Kevin Anthony] in their research stated that hyper-eutectic material has increased hardness, strength, wear resistance properties and optimisation in weight.

[Vinod Junju] carried out an attempt to reduce the intensity of thermo-structural stress by having silicon coating on the top of eutectic aluminum alloy piston crown where ceramic reinforcement was used to reduce the failure of the ceramic crown.

[Abino John] demonstrated how aluminum silicon carbide AlSiC, Aluminium composite can be used as an alternate to aluminium because of their abrasion resistance ,creep resistance, strength to weight ratio and better high temperature performance.

As these materials pose a strong possibility of replacing currently using aluminium alloys

we can use these materials for piston.

CHAPTER 3

Methodology

3.1 Design Consideration

3.2 Material Selection

3.3 3D Modelling And Analysis Of Piston

CHAPTER 3

METHODOLOGY

3.1 Design Consideration:

In designing a piston for IC Engine, following points should be taken into consideration

1. It should have enormous strength to withstand high gas pressure and inertia forces
2. It should have minimum mass to minimize inertia forces.
3. It should desperse the heat of combustion quickly to the cylinder wall
4. It should have high speed reciprocation without any noise
5. It should be of sufficient rigid construction to withstand thermal and mechanical distortions
6. It should have sufficient support for piston pin.

3.2 Material Selection :

Depending upon the various properties of the materials like thermal conductivity , co-efficient of expansion, Young Modulus, etc we chose the materials as follows:

3.2.1)ALUMINIUM SILICON CARBIDE:

- Aluminium-(Silicon Carbide) is a metal ceramic composite material consisting of silicon carbide particles dispersed in a matrix of aluminum alloy. It combines the benefits of high thermal conductivity of metal and low CTE (coefficient of thermal expansion) of ceramic.
- It has High thermal conductivity (conducts heat almost like aluminium).
- Light weight and strong almost as light as aluminium but stronger.
- Cost effective production.

3.2.2)CARBON-CARBON MATERIAL:

- Carbon-carbon is a composite material consisting of carbon fibre reinforcement in a matrix of graphite. Carbon–carbon is well-suited to structural applications at high temperatures.
- Carbon-Carbon has High stiffness, high tensile strength, low weight, high chemical resistance, high temperature tolerance and low thermal expansion.

3.2.3)HYPER EUTECTIC ALUMINIUM:

- Hyper eutectic aluminium has a lower coefficient of thermal expansion, which allows engine designers to specify much tighter tolerances. ... When significantly more silicon is added to the aluminium than 12%, the properties of the aluminium change in a way that is useful for the purposes of pistons for combustion engines.
- Low Thermal Expansion
- Slightly Lighter
- The tendency to expand less means that the piston can have a tighter piston to bore clearance.

3.3) 3D Modelling And Analysis Of Piston :

3D Model of the piston is created using Fusion 360 As the 3-D model has been designed and material has been selected, the design has to be exported in the ANSYS Workbench and the analysis will be done on piston taking different materials for static structural and steady thermal. After the completion of analysis , the results of the materials will be compared to know which material is better for piston as per the requirement.

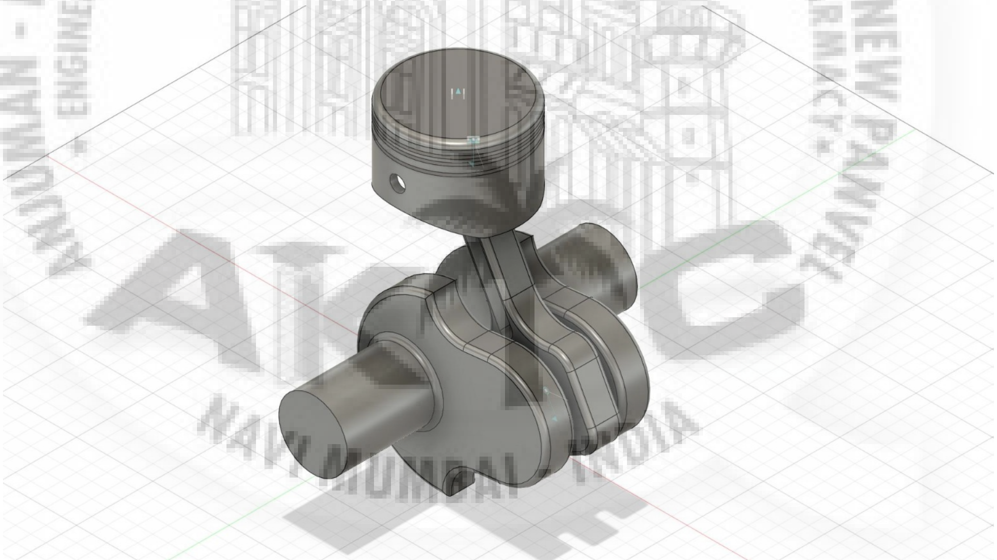

Fig.3 Piston Assembly

Analysis Of Piston

We will be analyzing piston with all three materials for Total Deformation, Equivalent Stress, Equivalent Strain, Temperature Distribution, Heat Flux, and compare with traditionally used aluminium for the same

Static structural

These are the loading conditions that we have applied on all three materials for static structural

Object Name	*Pressure*	*Fixed Support*
State	Fully Defined	
Scope		
Scoping Method	Geometry Selection	
Geometry	1 Face	2 Faces
Definition		
Type	Pressure	Fixed Support
Define By	Normal To	
Applied By	Surface Effect	
Loaded Area	Deformed	
Magnitude	1.5e-002 MPa (ramped)	
Suppressed	No	

Table1. Loads

1) AlSiC

Total Deformation

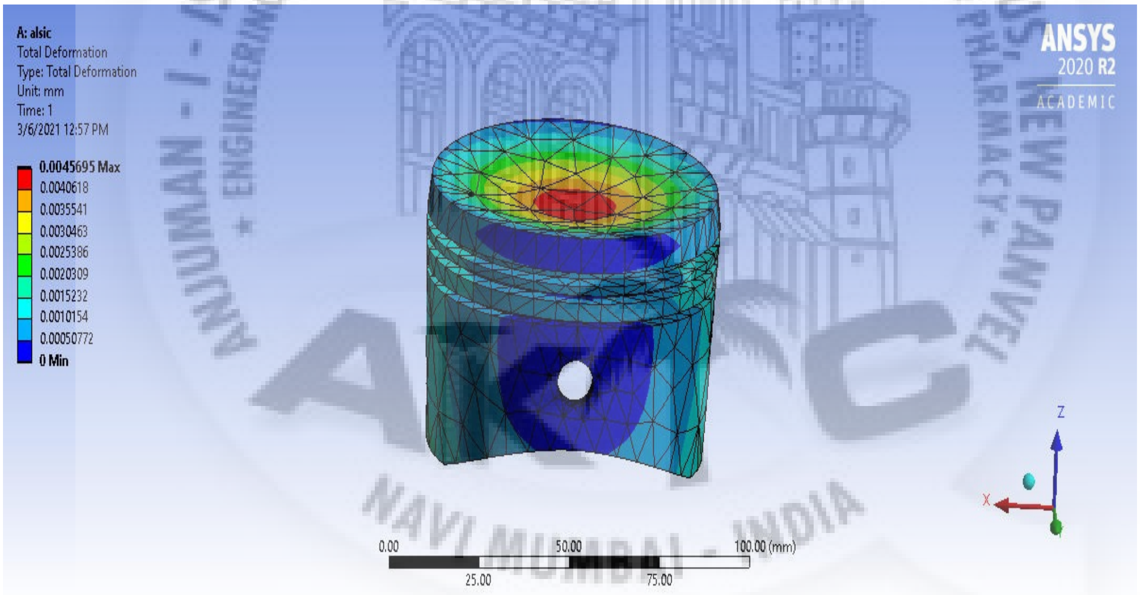

Fig. 4 Total Deformation (AlSiC)

Time [s]	Minimum [mm]	Maximum [mm]	Average [mm]
1.	0.	4.5695e-004	7.2668e-005

Table 2. Total Deformation (AlSiC)

Equivalent Stress

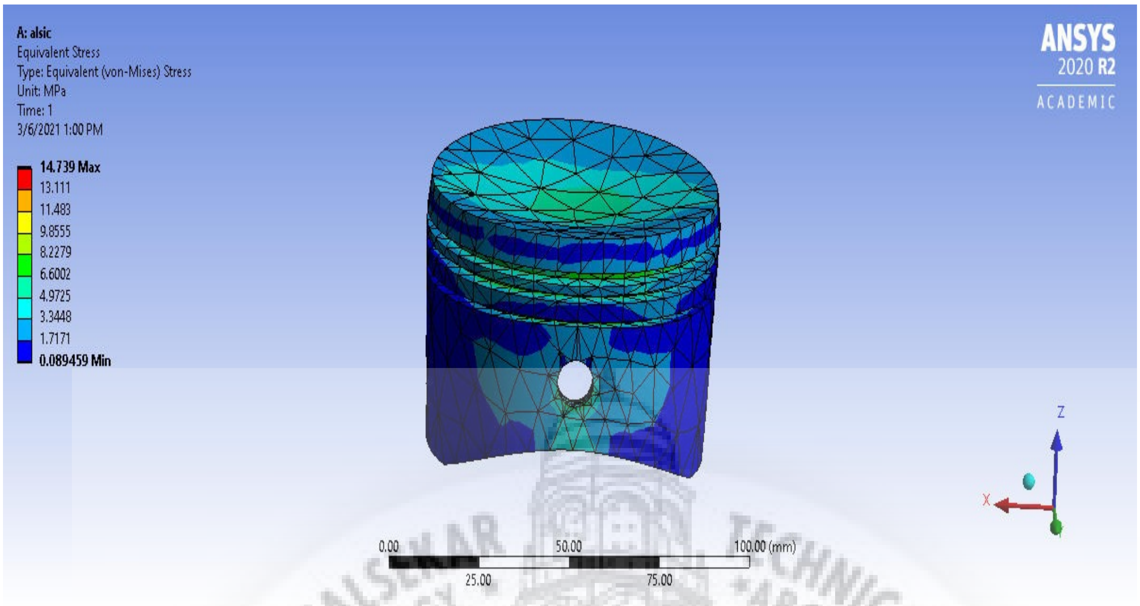

Fig. 5 Equivalent Stress (AlSiC)

Time [s]	Minimum [MPa]	Maximum [MPa]	Average [MPa]
1.	8.9459e-003	1.4739	0.38322

Table 3. Equivalent Stress (AlSiC)

Equivalent Strain

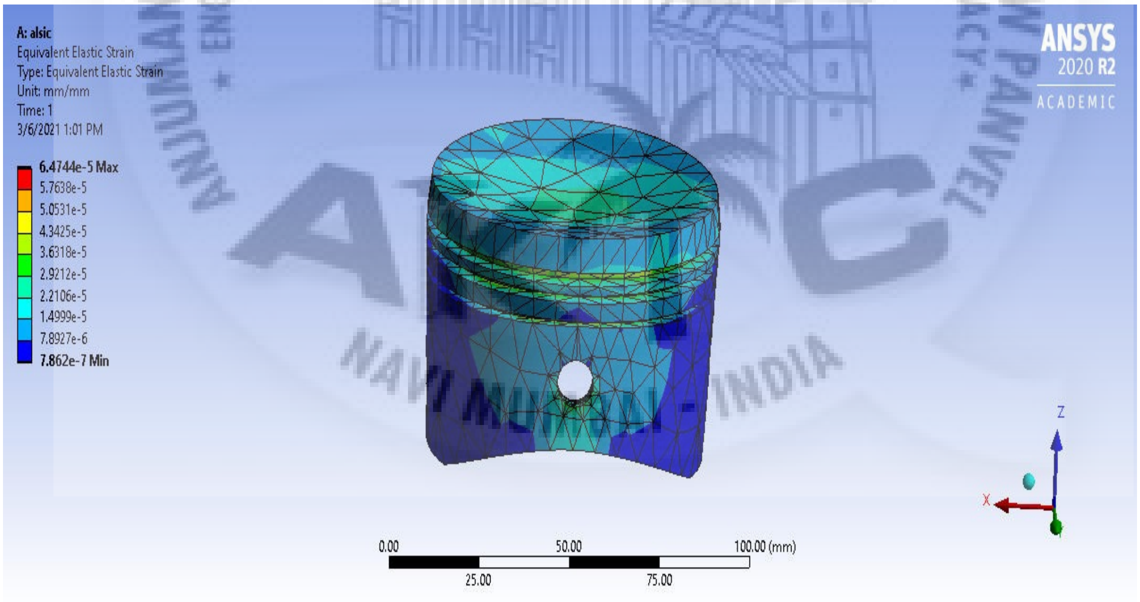

Fig.6 Equivalent Strain (AlSiC)

Time [s]	Minimum [mm/mm]	Maximum [mm/mm]	Average [mm/mm]
1.	7.862e-008	6.4744e-006	2.0011e-006

Table 4. Equivalent Strain (AlSiC)

Static Structural AlSiC Results

Object Name	*Total Deformation*	*Equivalent Elastic Strain*	*Equivalent Stress*
State	Solved		
Scope			
Scoping Method	Geometry Selection		
Geometry	All Bodies		
Definition			
Type	Total Deformation	Equivalent Elastic Strain	Equivalent (von-Mises) Stress
By	Time		
Display Time	Last		
Calculate Time History	Yes		
Identifier			
Suppressed	No		
Results			
Minimum	0. mm	7.862e-008 mm/mm	8.9459e-003 MPa
Maximum	4.5695e-004 mm	6.4744e-006 mm/mm	1.4739 MPa
Average	7.2668e-005 mm	2.0011e-006 mm/mm	0.38322 MPa
Minimum Occurs On	piston		
Maximum Occurs On	piston		
Information			
Time	1. s		
Load Step	1		
Substep	1		
Iteration Number	1		
Integration Point Results			
Display Option		Averaged	
Average Across Bodies		No	

Table 5. Static Structural AlSiC Results

AlSiC Material Data

Thermal Conductivity	0.17 W mm^-1 C^-1
Density	2.937e-006 kg mm^-3

Table 6. AlSiC constants

Young's Modulus MPa	Poisson's Ratio	Bulk Modulus MPa	Shear Modulus MPa	Temperature C
2.3e+005	0.24	1.4744e+005	92742	

Table 7. Isotropic Elasticity (AlSiC)

2) Carbon-carbon

Total Deformation

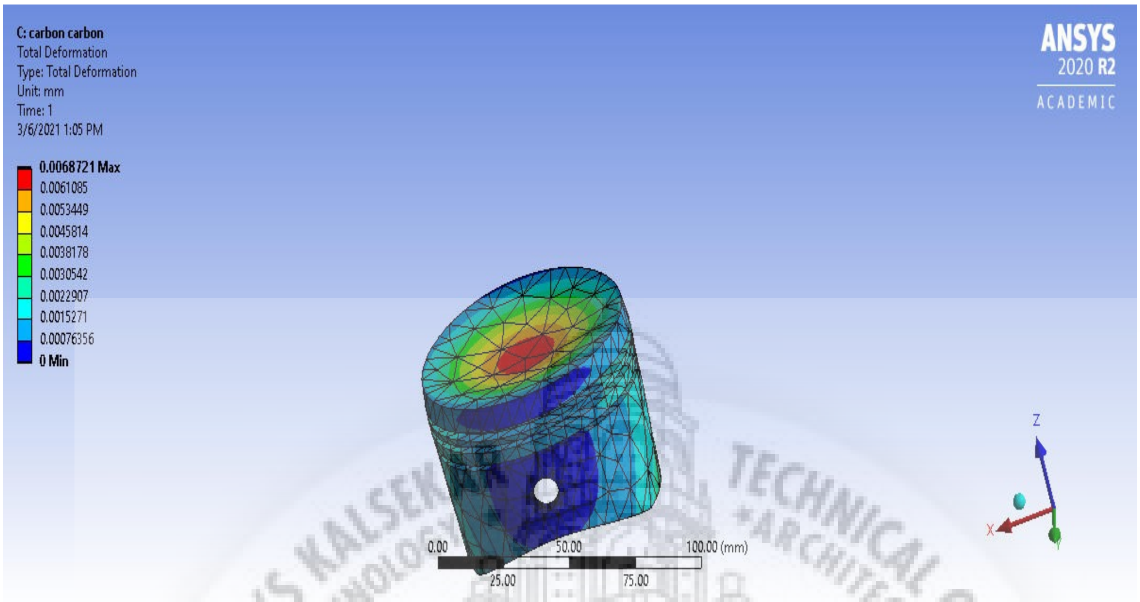

Fig 7. Total Deformation (carbon-carbon)

Time [s]	Minimum [mm]	Maximum [mm]	Average [mm]
1.	0.	6.8721e-004	1.122e-004

Table 8. Total Deformation (carbon-carbon)

Equivalent Stress

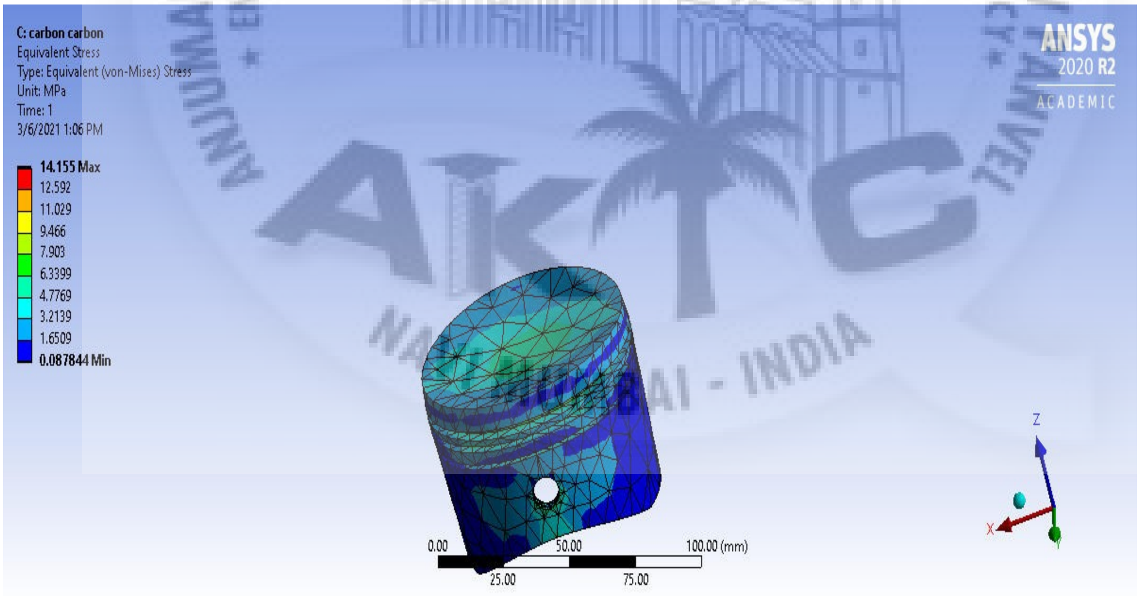

Fig 8. Equivalent Stress (carbon-carbon)

Time [s]	Minimum [MPa]	Maximum [MPa]	Average [MPa]
1.	8.7844e-003	1.4155	0.37602

Table 9. Equivalent Stress (carbon-carbon)

Equivalent Strain

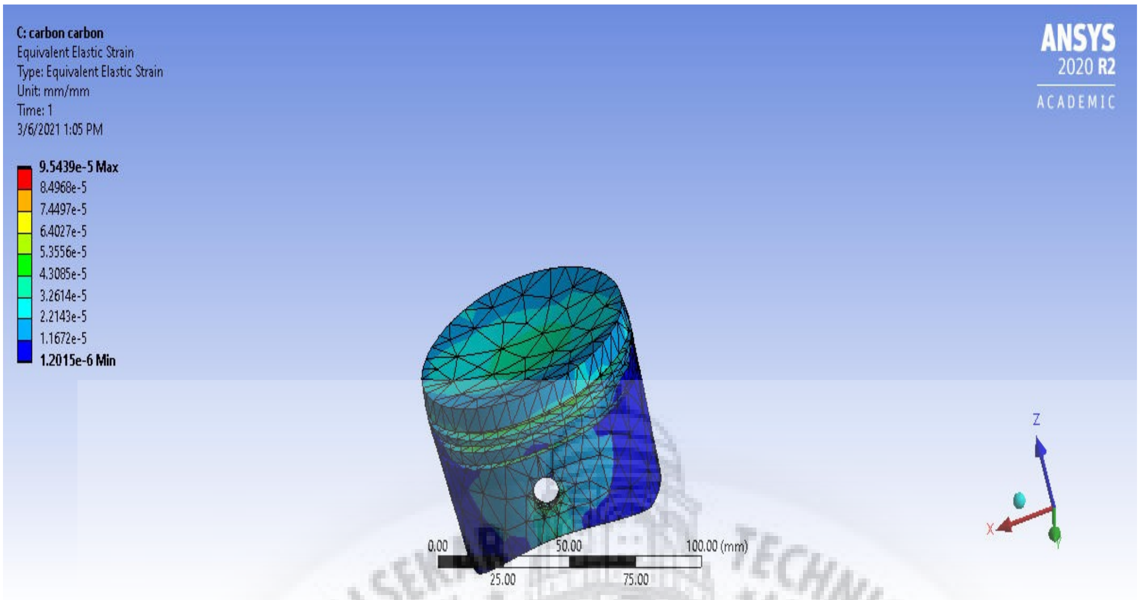

Fig 9. Equivalent Strain (carbon-carbon)

Time [s]	Minimum [mm/mm]	Maximum [mm/mm]	Average [mm/mm]
1.	1.2015e-007	9.5439e-006	2.997e-006

Table 10. Equivalent Strain (carbon-carbon)

Static Structural carbon-carbon Results

Object Name	*Total Deformation*	*Equivalent Elastic Strain*	*Equivalent Stress*
State	Solved		
Scope			
Scoping Method	Geometry Selection		
Geometry	All Bodies		
Definition			
Type	Total Deformation	Equivalent Elastic Strain	Equivalent (von-Mises) Stress
By	Time		
Display Time	Last		
Calculate Time History	Yes		
Identifier			
Suppressed	No		
Results			
Minimum	0. mm	1.2015e-007 mm/mm	8.7844e-003 MPa
Maximum	6.8721e-004 mm	9.5439e-006 mm/mm	1.4155 MPa
Average	1.122e-004 mm	2.997e-006 mm/mm	0.37602 MPa
Minimum Occurs On	piston		
Maximum Occurs On	piston		
Information			
Time	1. s		
Load Step	1		
Substep	1		

Table 11. Static Structural carbon-carbon Results

Carbon-carbon Material Data

Thermal Conductivity	3.14e-002 W mm^-1 C^-1
Density	2.2e-006 kg mm^-3

Table 12. carbon-carbon constants

Young's Modulus MPa	Poisson's Ratio	Bulk Modulus MPa	Shear Modulus MPa	Temperature C
1.5e+005	0.29	1.1905e+005	58140	

Table 13. isotropic elasticity (carbon-carbon)

3) Hyper-eutectic Aluminium

Total Deformation

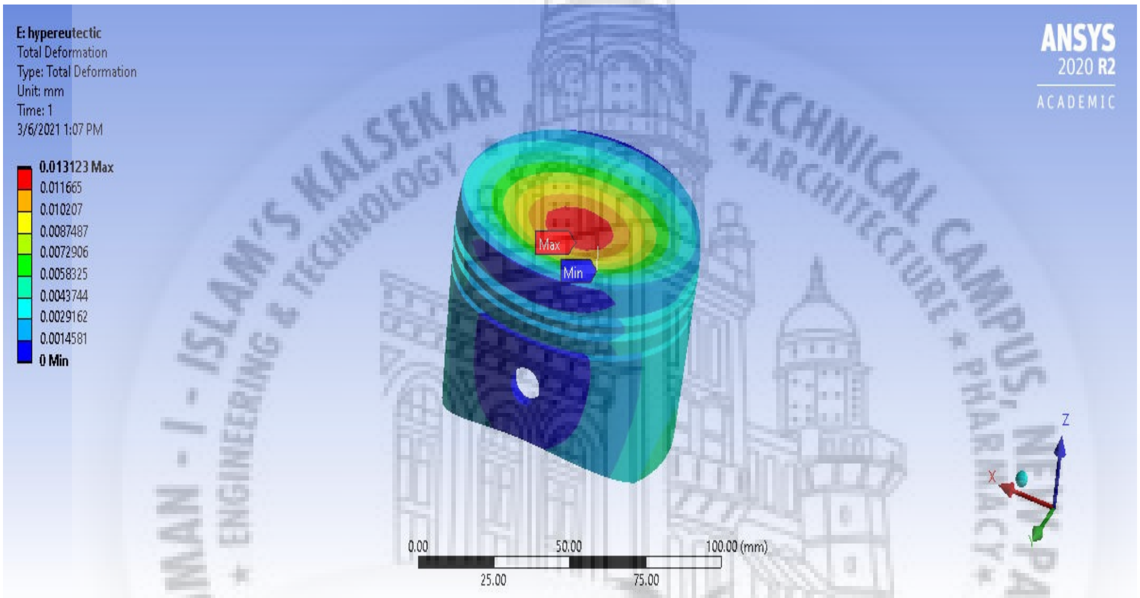

Fig 10. Total Deformation (Hyper-eutectic Aluminium)

Time [s]	Minimum [mm]	Maximum [mm]	Average [mm]
1.	0.	1.3123e-003	2.1924e-004

Table 14. Total Deformation (Hyper-eutectic Aluminium)

Equivalent stress

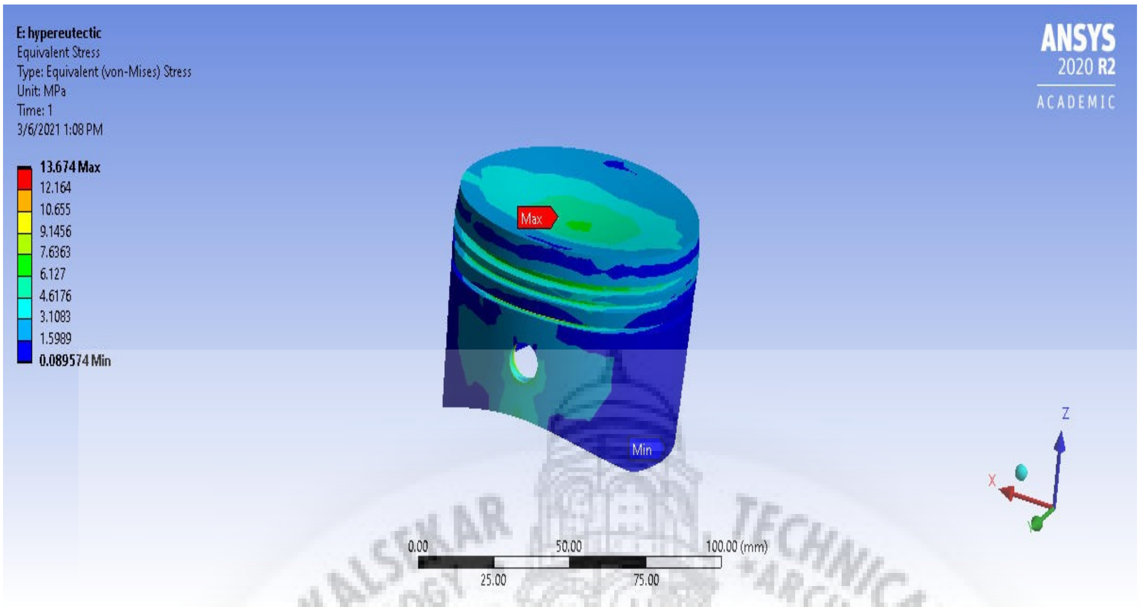

Fig 11. Equivalent stress(Hyper-eutectic Aluminium)

Time [s]	Minimum [MPa]	Maximum [MPa]	Average [MPa]
1.	8.9574e-003	1.3674	0.37009

Table 15. Equivalent stress(Hyper-eutectic Aluminium)

Equivalent Strain

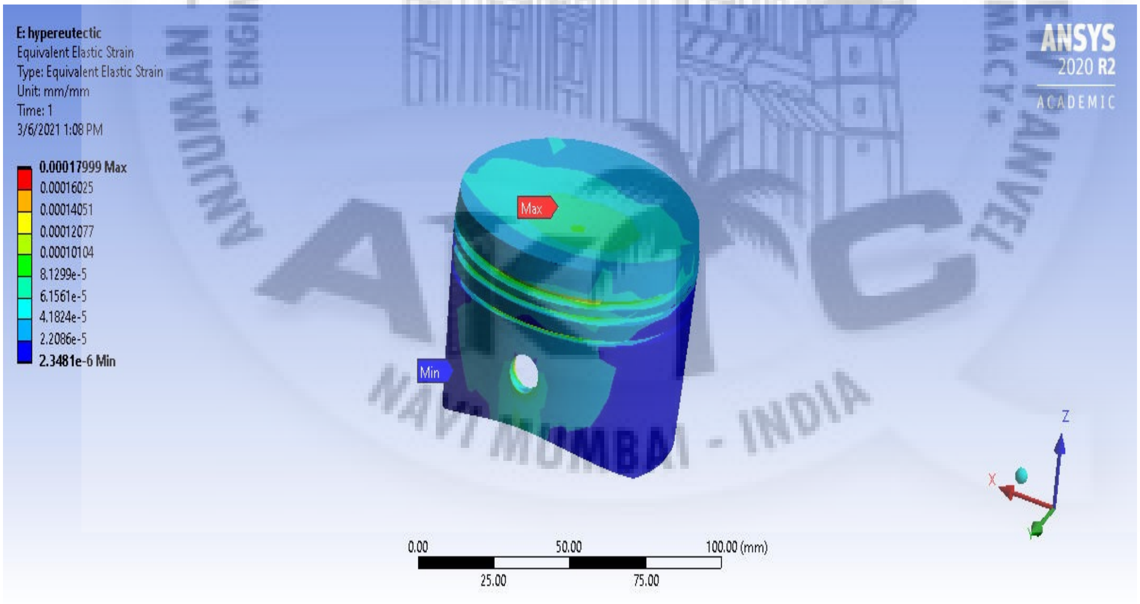

Fig 12. Equivalent strain (Hyper-eutectic Aluminium)

Time [s]	Minimum [mm/mm]	Maximum [mm/mm]	Average [mm/mm]
1.	2.3481e-007	1.7999e-005	5.7282e-006

Table 16. Equivalent strain (Hyper-eutectic Aluminium)

Static Structural Hyper-eutectic Aluminium Results

Object Name	*Total Deformation*	*Equivalent Elastic Strain*	*Equivalent Stress*
State	Solved		
Scope			
Scoping Method	Geometry Selection		
Geometry	All Bodies		
Definition			
Type	Total Deformation	Equivalent Elastic Strain	Equivalent (von-Mises) Stress
By	Time		
Display Time	Last		
Calculate Time History	Yes		
Identifier			
Suppressed	No		
Results			
Minimum	0. mm	2.3481e-007 mm/mm	8.9574e-003 MPa
Maximum	1.3123e-003 mm	1.7999e-005 mm/mm	1.3674 MPa
Average	2.1924e-004 mm	5.7282e-006 mm/mm	0.37009 MPa
Minimum Occurs On	piston		
Maximum Occurs On	piston		
Information			
Time	1. s		
Load Step	1		
Substep	1		

Table 17. Static Structural Hyper-eutectic Aluminium Results

Hyper-eutectic aluminium Material Data

Thermal Conductivity	6.05e-002 W mm^-1 C^-1
Density	2.7e-006 kg mm^-3

Table 18. Hyper-eutectic Aluminium Constants

Young's Modulus MPa	Poisson's Ratio	Bulk Modulus MPa	Shear Modulus MPa	Temperature C
77000	0.33	75490	28947	

Table 19. Isotropic Elasticity Hyper-eutectic Aluminium

Steady-State Thermal Analysis
Below are the loading conditions for steady-state thermal analysis that we have selected for piston. To test the capacity of the materials we will consider the maximum temperature as 720°C.

1) AlSiC

Temperature Distribution

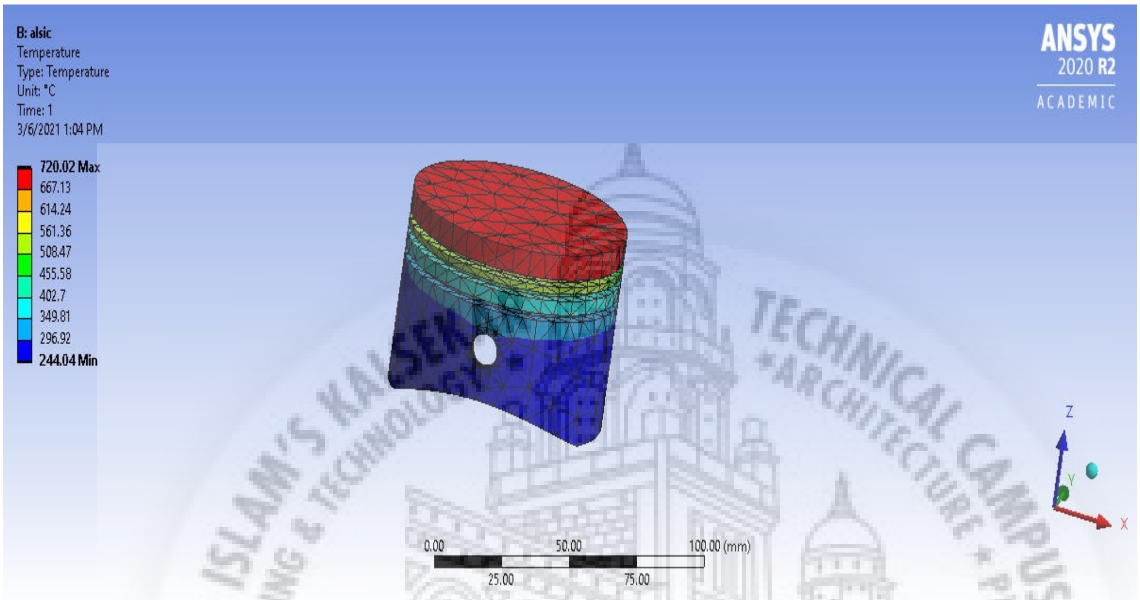

Fig 13. Temperature Distribution (AlSiC)

Time [s]	Minimum [°C]	Maximum [°C]	Average [°C]
1.	244.04	720.02	404.53

Table 20. Temperature Distribution (AlSiC)

Heat Flux

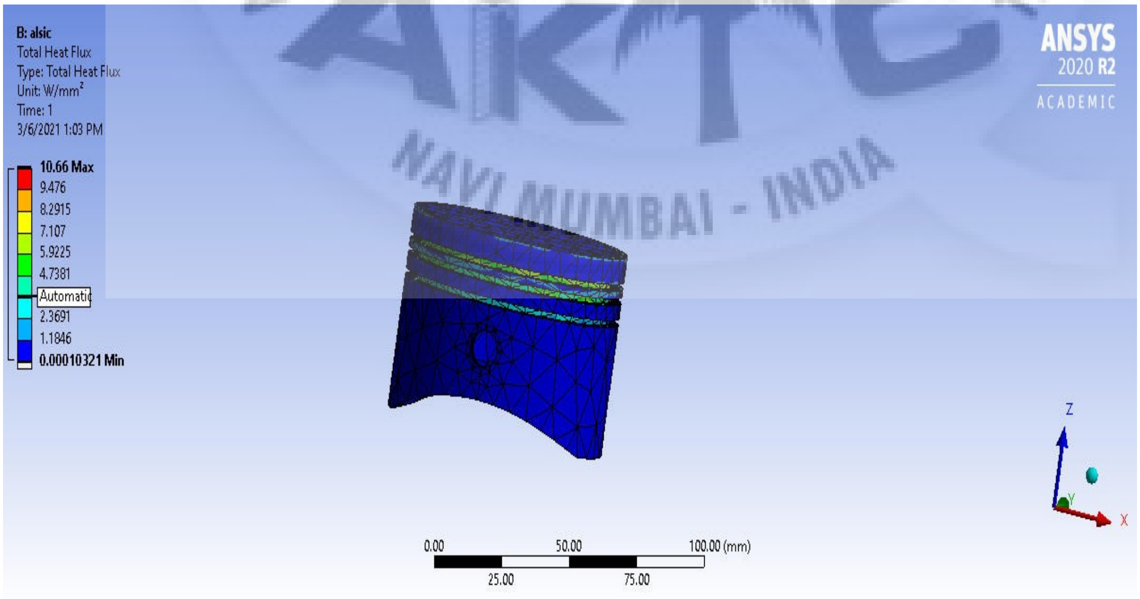

Fig 14. Heat Flux (AlSiC)

Time [s]	Minimum [W/mm²]	Maximum [W/mm²]	Average [W/mm²]
1.	1.0321e-004	10.66	1.5788

Table 21. Heat Flux (AlSiC)

AlSiC Steady-State Thermal Results

Object Name	*Temperature*	*Total Heat Flux*
State	Solved	
Scope		
Scoping Method	Geometry Selection	
Geometry	All Bodies	
Definition		
Type	Temperature	Total Heat Flux
By	Time	
Display Time	Last	
Calculate Time History	Yes	
Identifier		
Suppressed	No	
Results		
Minimum	244.04 °C	1.0321e-004 W/mm²
Maximum	720.02 °C	10.66 W/mm²
Average	404.53 °C	1.5788 W/mm²
Minimum Occurs On	piston	
Maximum Occurs On	piston	
Information		
Time	1. s	
Load Step	1	
Substep	1	
Iteration Number	1	
Integration Point Results		
Display Option		Averaged
Average Across Bodies		No

Table 22.AlSiC Steady-State Thermal Results.

2) Carbon-carbon

Temperature Distribution

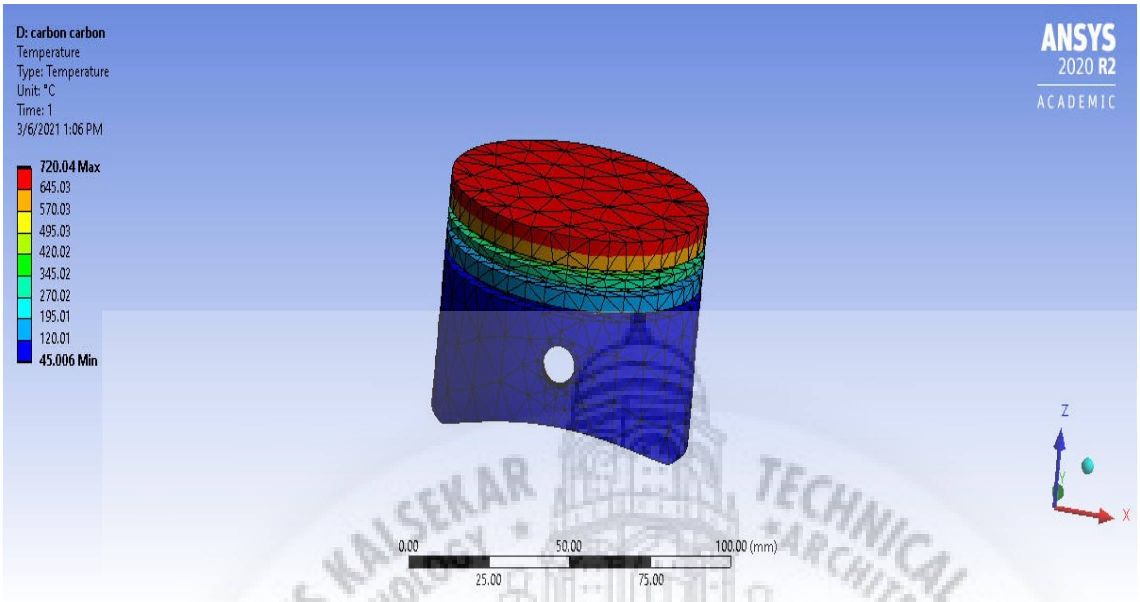

Fig 15. Temperature Distribution(Carbon-carbon)

Time [s]	Minimum [°C]	Maximum [°C]	Average [°C]
1.	45.006	720.04	222.57

Table 23. Temperature Distribution(Carbon-carbon)

Heat Flux

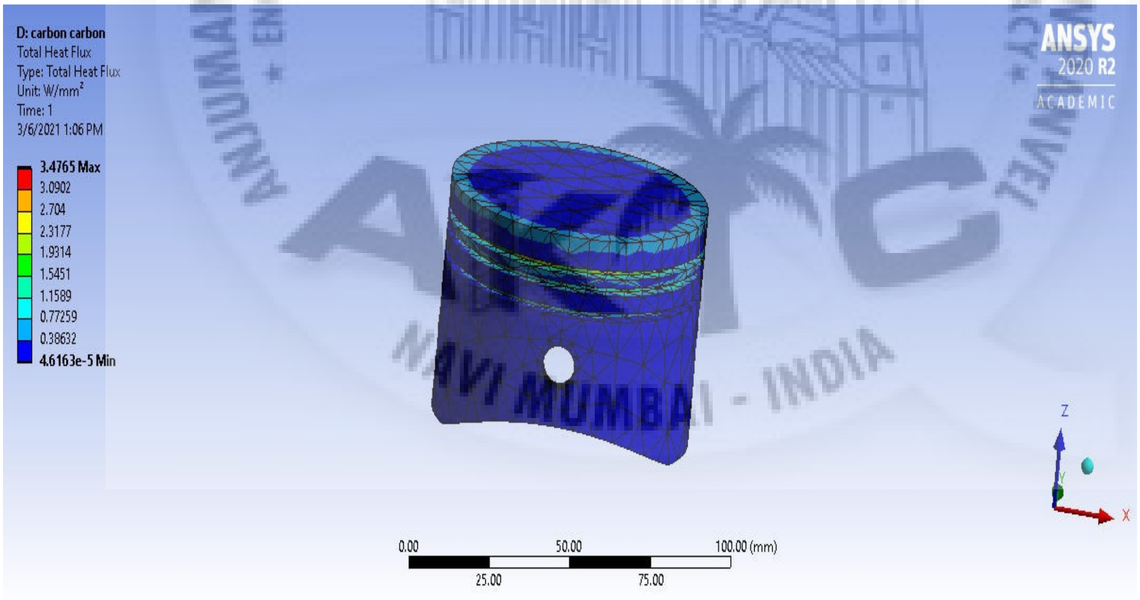

Fig 16. Heat Flux (carbon-carbon)

Time [s]	Minimum [W/mm²]	Maximum [W/mm²]	Average [W/mm²]
1.	4.6163e-005	3.4765	0.42284

Table 24. Heat Flux (carbon-carbon)

Carbon-carbon Steady-State Thermal Results

Object Name	*Temperature*	*Total Heat Flux*
State	Solved	
Scope		
Scoping Method	Geometry Selection	
Geometry	All Bodies	
Definition		
Type	Temperature	Total Heat Flux
By	Time	
Display Time	Last	
Calculate Time History	Yes	
Identifier		
Suppressed	No	
Results		
Minimum	45.006 °C	4.6163e-005 W/mm²
Maximum	720.04 °C	3.4765 W/mm²
Average	222.57 °C	0.42284 W/mm²
Minimum Occurs On	piston	
Maximum Occurs On	piston	
Information		
Time	1. s	
Load Step	1	
Substep	1	
Iteration Number	1	
Integration Point Results		
Display Option		Averaged
Average Across Bodies		No

Table 25. Carbon-carbon Steady-State Thermal Results.

3) Hyper-eutectic Aluminium
Temperature Deformation

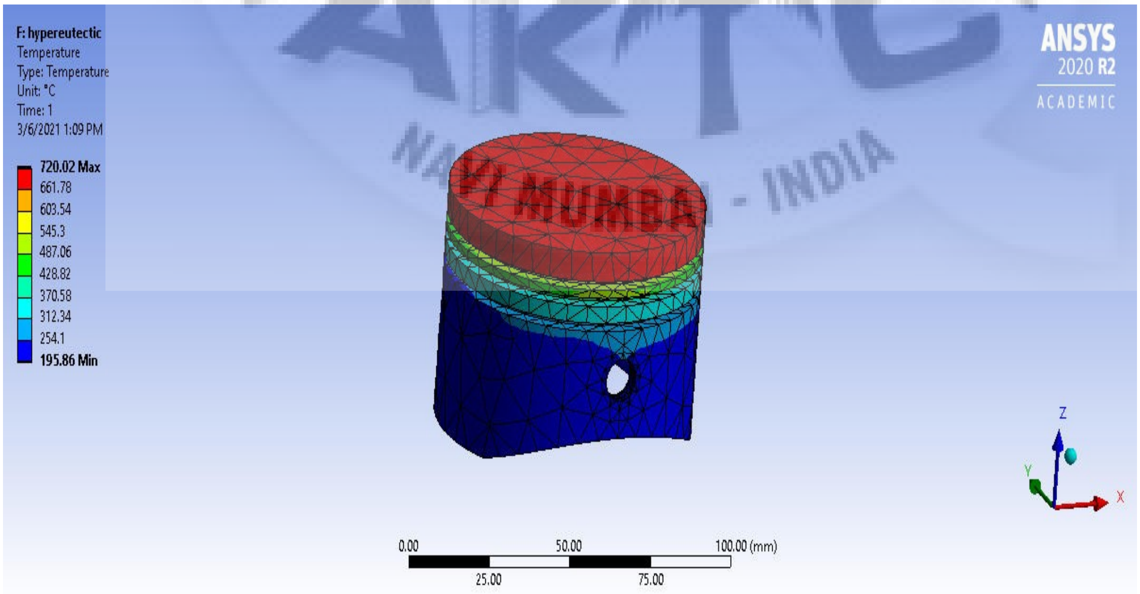

Fig 17. Temperature Distribution (Hyper-eutectic Aluminium).

Time [s]	Minimum [°C]	Maximum [°C]	Average [°C]
1.	91.395	720.03	279.37

Table 26. Temperature Distribution (Hyper-eutectic Aluminium).

Heat Flux

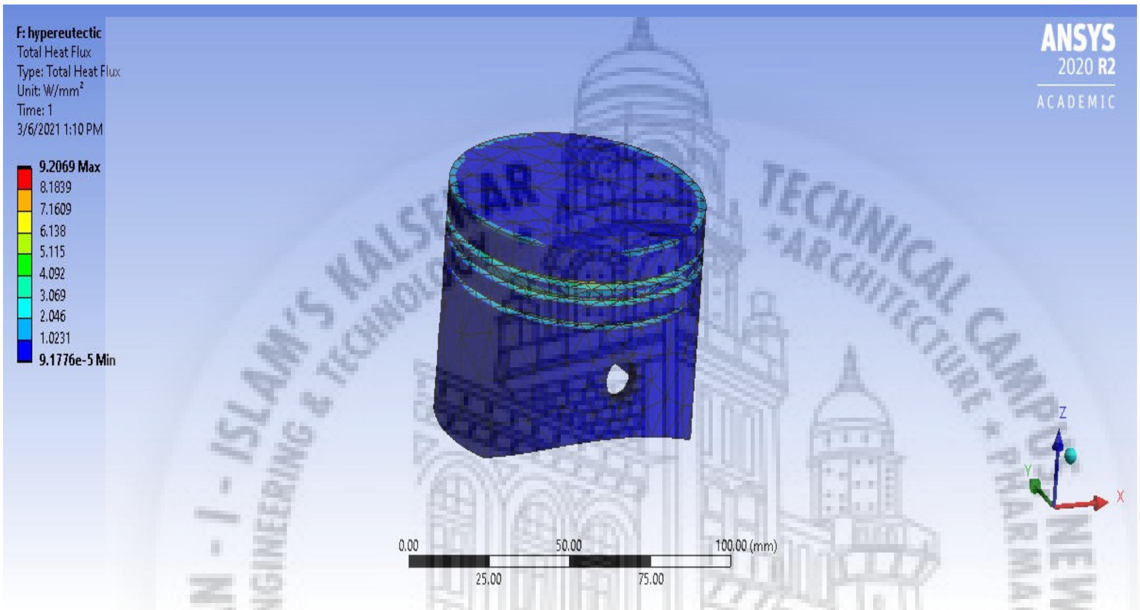

Fig 18. Heat Flux (Hyper-eutectic Aluminium).

Time [s]	Minimum [W/mm²]	Maximum [W/mm²]	Average [W/mm²]
1.	6.3722e-005	5.6551	0.75206

Table 27. Heat Flux (Hyper-eutectic Aluminium).

Aluminium Hyper-eutectic Steady-State Thermal Results

Object Name	*Temperature*	*Total Heat Flux*
State	Solved	
Scope		
Scoping Method	Geometry Selection	
Geometry	All Bodies	
Definition		
Type	Temperature	Total Heat Flux
By	Time	
Display Time	Last	
Calculate Time History	Yes	
Identifier		
Suppressed	No	
Results		
Minimum	91.395 °C	6.3722e-005 W/mm²
Maximum	720.03 °C	5.6551 W/mm²
Average	279.37 °C	0.75206 W/mm²
Minimum Occurs On	piston	
Maximum Occurs On	piston	
Information		
Time	1. s	
Load Step	1	
Substep	1	
Iteration Number	1	
Integration Point Results		
Display Option		Averaged
Average Across Bodies		No

Table 28. Hyper-eutectic Aluminium Steady-State Thermal Results.

Static structural for aluminium piston

1) Total Deformation

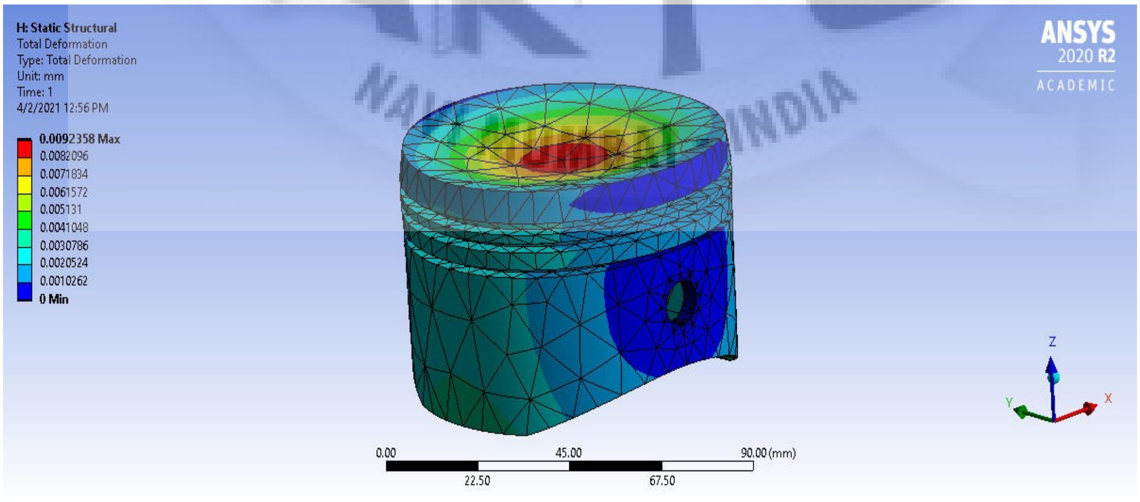

Fig 19. Total Deformation (aluminium).

Time [s]	Minimum [mm]	Maximum [mm]	Average [mm]
1.	0.	9.2358e-003	1.5339e-003

Table 29. Total Deformation (aluminium).

2) Equivalent stress

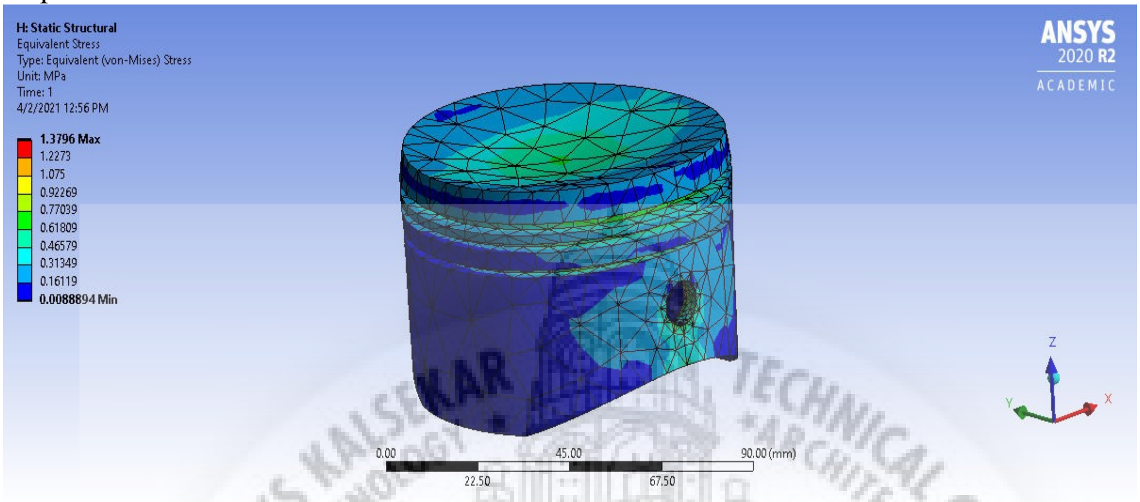

Fig 20. Equivalent stress (aluminium).

Time [s]	Minimum [MPa]	Maximum [MPa]	Average [MPa]
1.	8.8894e-003	1.3796	0.37159

Table 30. Equivalent Stress (aluminium).

3) Equivalent strain

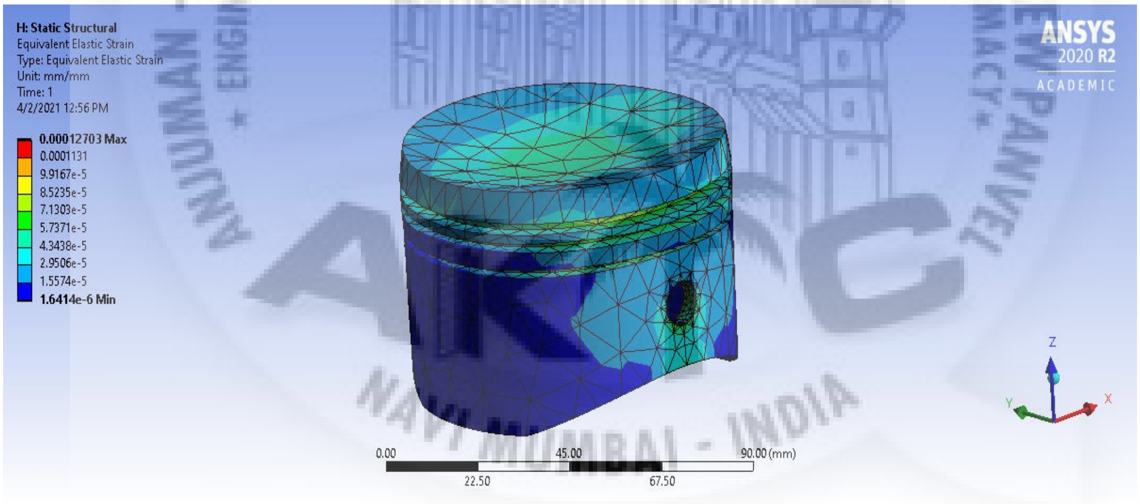

Fig 21. Equivalent strain (aluminium).

Time [s]	Minimum [mm/mm]	Maximum [mm/mm]	Average [mm/mm]
1.	1.6414e-006	1.2703e-004	4.0289e-005

Table 31. Equivalent Strain (aluminium).

Aluminium static structural results

Object Name	*Total Deformation*	*Equivalent Elastic Strain*	*Equivalent Stress*
State	Solved		
Scope			
Scoping Method	Geometry Selection		
Geometry	All Bodies		
Definition			
Type	Total Deformation	Equivalent Elastic Strain	Equivalent (von-Mises) Stress
By	Time		
Display Time	Last		
Calculate Time History	Yes		
Identifier			
Suppressed	No		
Results			
Minimum	0. mm	1.6414e-006 mm/mm	8.8894e-003 MPa
Maximum	9.2358e-003 mm	1.2703e-004 mm/mm	1.3796 MPa
Average	1.5339e-003 mm	4.0289e-005 mm/mm	0.37159 MPa
Minimum Occurs On	piston		
Maximum Occurs On	piston		
Information			
Time	1. s		
Load Step	1		
Substep	1		

Table 32. Aluminium static structural results.

Steady Thermal for Aluminium

1) Temperature Distribution.

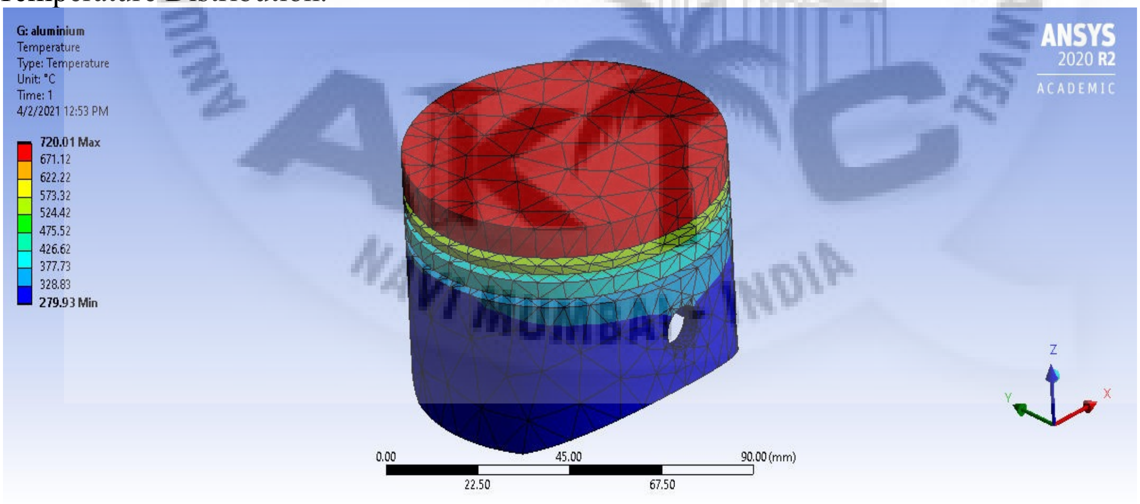

Fig 22. Temperature Distribution (aluminium).

Time [s]	Minimum [°C]	Maximum [°C]	Average [°C]
1.	279.93	720.01	430.3

Table 33. Temperature Distribution (aluminium).

2) Heat Flux

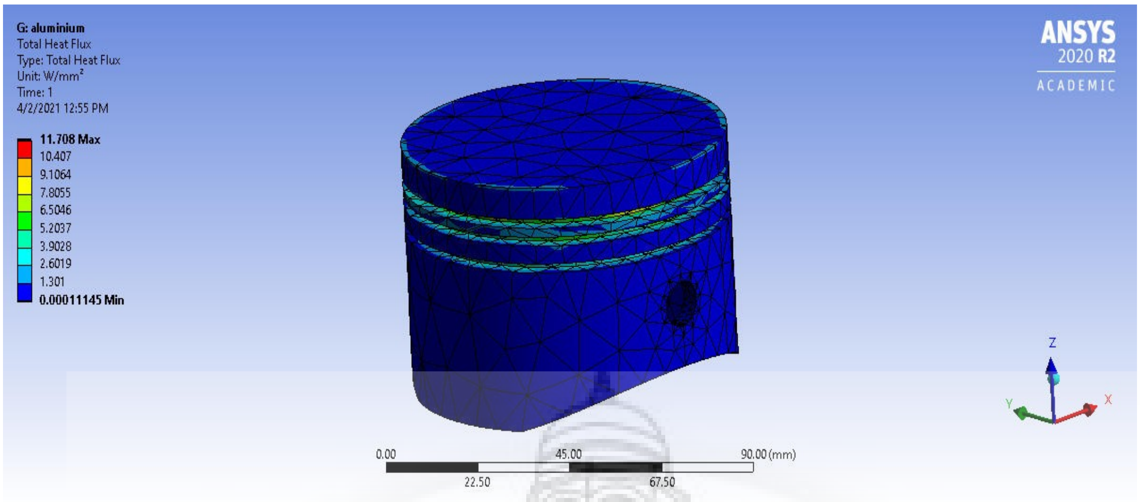

Fig 22. Heat flux (aluminium).

Time [s]	Minimum [W/mm²]	Maximum [W/mm²]	Average [W/mm²]
1.	1.1145e-004	11.708	1.7571

Table 34. Heat Flux (aluminium).

Aluminium Steady Thermal Results

Object Name	*Temperature*	*Total Heat Flux*
State	Solved	
Scope		
Scoping Method	Geometry Selection	
Geometry	All Bodies	
Definition		
Type	Temperature	Total Heat Flux
By	Time	
Display Time	Last	
Calculate Time History	Yes	
Identifier		
Suppressed	No	
Results		
Minimum	279.93 °C	1.1145e-004 W/mm²
Maximum	720.01 °C	11.708 W/mm²
Average	430.3 °C	1.7571 W/mm²
Minimum Occurs On	piston	
Maximum Occurs On	piston	
Information		
Time	1. s	
Load Step	1	
Substep	1	
Iteration Number	1	
Integration Point Results		
Display Option		Averaged
Average Across Bodies		No

Table 35. Steady Thermal Results (aluminium)

Results

Static Structural :-

Materials	Total Deformation		Equivalent Stress		Equivalent Strain	
	Min.	Max.	Min.	Max.	Min.	Max.
Aluminium alloy	0. mm	9.2358e-003 mm	8.8894e-003 MPa	1.3796 MPa	1.6414e-006	1.2703e-004
AlSiC	0. mm	4.5695e-004 mm	8.9459e-003 MPa	1.4739 MPa	7.862e-008	6.4744e-006
carbon-carbon	0. mm	6.8721e-004 mm	8.7844e-003 MPa	1.4155 MPa	1.2015e-007	9.5439e-006
Hyper-eutectic aluminium	0. mm	1.3123e-003 mm	8.9574e-003 MPa	1.3674 MPa	2.3481e-007	1.7999e-005

Steady-state Thermal :-

Materials	Temperature Distribution		Heat Flux	
	Min.	Max.	Min.	Max.
Aluminium alloy	279.93 °C	720.01 °C	1.1145e-004 W/mm²	11.708 W/mm²
AlSiC	244.04 °C	720.01 °C	1.0321e-004 W/mm²	10.66 W/mm²
carbon-carbon	45.006 °C	720.01 °C	4.6163e-005 W/mm²	3.4765 W/mm²
Hyper-eutectic aluminium	91.395 °C	720.01 °C	6.3722e-005 W/mm²	5.6551 W/mm²

Conclusion

The design of the piston that we have made is in such a way that the flat design that we have chosen is the most efficient way for the combustion process in IC engine. The review of different research paper shows that piston can be manufactured using composite materials like AlSiC, Carbon-carbon, Hyper-eutectic aluminium. In our research we tested all these three materials for deformation, heat flux, Temperature distribution, equivalent stress and equivalent strain. We found out that the Carbon-carbon material is the best suitable material for piston, as it shows less deformation, high temperature distribution, low coefficient of thermal expansion. Carbon-carbon pistons can hold its strength and stiffness at high temperatures. Carbon-carbon Pistons can be manufactured but its only drawback is that it is costly and not readily available, we hope that in the future with new technologies its manufacturing cost will be lowered and will be available cheaper as compared to now.

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