International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 04 , April - 2026

Simulation of Piston Used in Bike Engine Using Silicon Based Materials under Thermal Load

Mr. Sagar N.Oguwar
Department of Mechanical Engineering
Tulsiramji Gaikwad Patil College of
Engineering and Technology, Nagpur, India.

Prof. Gaurav Nagdeve
Department of Mechanical Engineering
Tulsiramji Gaikwad Patil College of
Engineering and Technology, Nagpur, India.

***Abstract* - Piston is base component of bike engine. In this paper use 2D and 3D software such as AUTOCAD, SOLIDWORKS creating Piston of this project. Basically simulation of piston to be done in this paper by using ANSYS Software. Materials are AISI5, AISI12, A390, AISI20 and AISI25 used for simulation of piston under thermal load. In this thermal load Equivalent Stress, Equivalent elastic stain, Heat Flux and Total deformation carried out by simulation of piston. The results indicate that higher silicon content improves thermal stability and reduces deformation, thanks to superior wear resistance and a lower coefficient of thermal expansion. Among the materials studied, AISI20 demonstrates superior performance under high thermal stress, making it an ideal candidate for applications in high-temperature engines. Out of all materials only one material to be selected for the piston design, which is better among all materials. This silicon mix with aluminum and one composite material which give piston life increase, reduced cracks and fatigue. Simulation of piston helps to find these defects and protect piston.**

***Keywords* - Silicon material, ANSYS, Thermal load, Simulation, Piston.**

I. INTRODUCTION

The piston is an essential component of an internal combustion engine, responsible for converting the energy generated by fuel combustion into mechanical work. In motorcycle engines, pistons operate under extreme conditions characterized by high temperatures, pressure fluctuations, and cyclic mechanical stresses. These harsh operating environments often lead to wear, thermal deformation, and a decline in efficiency over time.

Traditionally, materials used for pistons such as aluminum alloys have been widely favored for their lightweight properties and good thermal conductivity. However, in light of the growing demand for enhanced performance, energy efficiency, and durability, there is an increasing urgency to explore advanced materials possessing superior thermal and mechanical properties. This project focuses on the simulation of a motorcycle engine piston manufactured from silicon-based materials and subjected to thermal stresses. Silicon-based materials exhibit promising characteristics, including high thermal stability, improved resistance to high temperatures, and excellent resistance to thermal expansion. Utilizing simulation techniques, this study aims to analyze the temperature distribution, thermal stresses, and deformation behavior of the piston under typical engine operating conditions.

The objective of this work is to evaluate the feasibility and performance benefits offered by silicon-based materials compared to conventional materials. The simulation results will help clarify how these materials can enhance engine efficiency, reliability, and service life, while simultaneously reducing maintenance costs and the risk of failure.

Methodology - The software based methodology used to identify the defect or protection of piston by using all the literature review first thing to find out the materials which are used for piston design, the material selected are AISI5, AISI12, A390, AISI20, AISI25. Then to find the these materials properties such as density, young's modulus, modulus of elasticity, poisons ratio, thermal conductivity, coefficient of thermal expansion and ultimate tensile strength to solve the simulation of piston.

Aim of this paper is to Simulation of piston using silicon percentage under thermal load.

Objectives of this paper are to simulate the piston and carried out results such as Equivalent Stress, Equivalent stain, Heat Flux and Total deformation and compare them simultaneously and select one better material from silicon based material for piston design for bike engine.

Application of this silicon based piston is light weight, low wear resistance, so low friction and good lubrication, increased life of piston. It is special piston for bikes only.

II. LITERATURE REVIEW

Yash Dhamecha, Vaibhav Saptarshi, Tejasve Parnami and Shubham Parikh (2020) represent the paper in which they were used A2618, AI-GHS 1300 and Ti 6A14V materials to analyze the piston. They identify the Ti 6A14V material is suitable for supercar piston and AI-GHS 1300 material is suitable for 220 cc bike.

Durkaieswarn, Kanagaraj, Ravikumar, Muthiah and Sivakasi (2020) examined that the aluminum and cast iron materials are suitable for car piston.

Koli and Subodhkumar (2018) used the materials AI4032 and AI2618 for the piston analysis used for car, and A2618 material is selected for design car piston.

Muneendra, Mayandi, jaya Harshavardhan and Anandbabu (2021) has materials used such as C26000, AI7068 and Ti 10V2FE 3AI for car piston,. Out of these materials C26000 material is selected for design.

Shahanwaz Havale and Santosh Wankhede (2017) works on piston by using Eutectic alloy, hyper eutectic alloy and special eutectic alloy materials. out of these materials AISI18 CuMgNi material is suggested for car piston.

Pagadala Sidddiraju and Koppula Venkateswarareddy (2021) determined the material which is better for bike piston by using five materials are AI graphite, A7075, A4032, AL ghy 1250 and A6082. All these materials used to determined only for 220cc bike engine.

Vishwanath, Ajay, Deepika, Bharathraja and Ramnath (2021) used the materials are Ti6AI4V, AI4032 and AI202.

Jitendra Kumar (2021) carried out the piston analysis by using SOLIDWORKS and ANSYS Software. Ti6AI4V, AI4032, Copper and AI2024 materials are used for piston static and thermal analysis.

Omezhilan, Stephan John and Praveen (2020) has examined the AISIC and AISIMg materials by using ANSYS RA16 Software to simulating the static and structural analysis.

Ayush and Kamlesh Gangrade (2022) has analyzed the piston by using AI4032, AL6061 and Gray iron materials. In this paper Catia V5 and ANSYS Softwares used for piston design.

III. LITERATURE SURVEY

After studying all the above literatures it is conclude that the silicon percentages based materials AISI5, AISI12, A390, AISI20 and AISI25 not used for piston analysis which is used for bike engine. This is the gap which we conclude and try to bridge this gap in this paper.

IV. METHODOLOGY

A. LITERATURE REVIEW

Studied many literatures which mentioned in literature part.

Find out the gap of the literature and try to bridge the gap.

B. SELECTION OF MATERIAL

After finding the gap, materials to be selection for the piston design, which is not taken previous research. Materials are AISI5, AISI12, A390, AISI20, AISI25.

C. GEOMETRIC MODELING OF PISTON

Use Autocad and Solidworks softwares for 3D design of piston.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 04 , April - 2026

D. SIMULATION OF PISTON

Use ANSYS Software for simulation and increase piston life by detecting the problems.

E. SIMULATION OF PISTON

Apply loads and boundary condition to the piston and carried out results under thermal load.

F. COMPARISION OF RESULT

After results, need to select the material for the piston which perform better for 150cc bike engine.

V. SELECTION OF MATERIALS

1. AISI5 – 5% of silicon mix with aluminum and make composite material.
2. AISI12 - 12% of silicon mix with aluminum and make composite material.
3. A390 - 17% of silicon mix with aluminum and make composite material.
4. AISI20 - 20% of silicon mix with aluminum and make composite material.
5. AISI25 - 25% of silicon mix with aluminum and make composite material.

VI. RESULT

UNDER THERMAL LOAD

1. **3D PISTON MODEL –**
With the use of AUTOCAD and SOLIDWORKS Software create 3D piston model

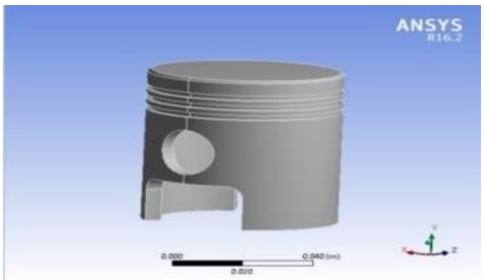

Fig.1 3D piston model

2. **MESHING OF PISTON –**
For accurate result it is need to mesh, results piston divide into small pieces.

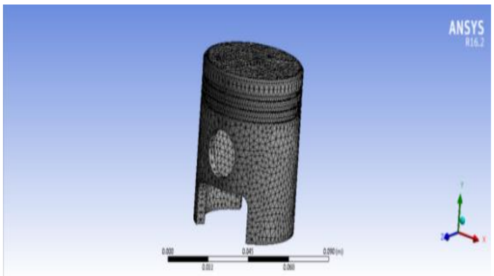

Fig.2 Meshing of piston

3. **APPLY BOUNDARY CONDITIONS -**
To apply boundary conditions to the piston

4. **EQUIVALENT STRESS –**

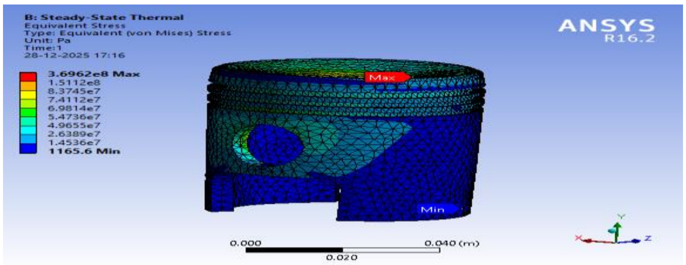

Fig.3 AISI5

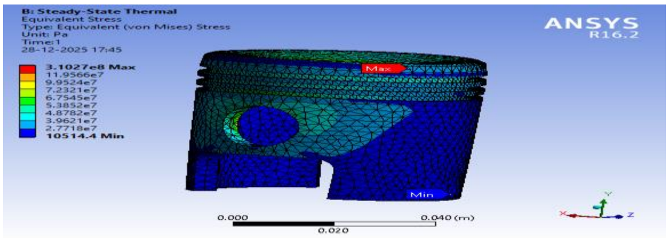

Fig.4 AISI12

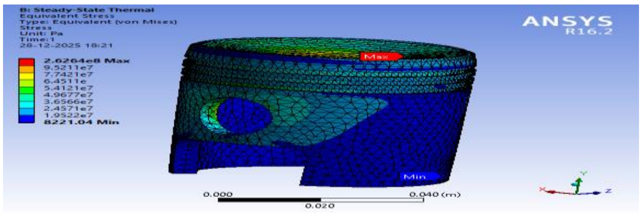

Fig.5 A390

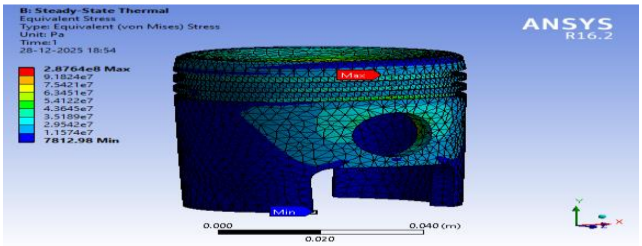

Fig.6 AISI20

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 04 , April - 2026

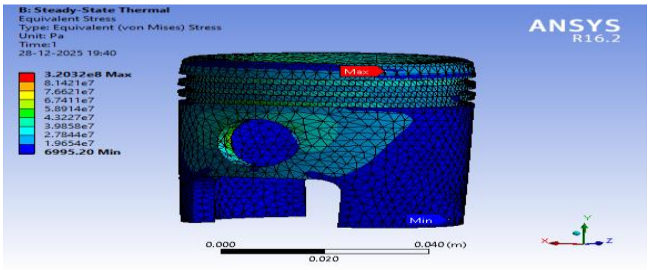

Fig.7 AISI25

5. EQUIVALENT ELASTIC STAIN –

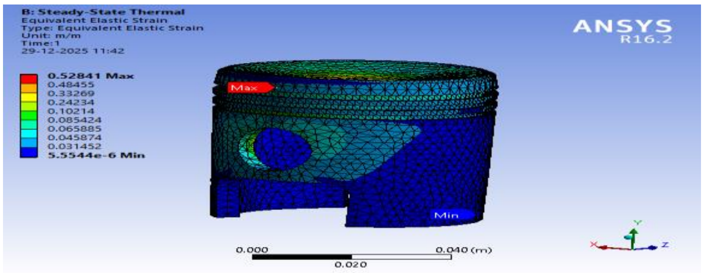

Fig.8 AISI5

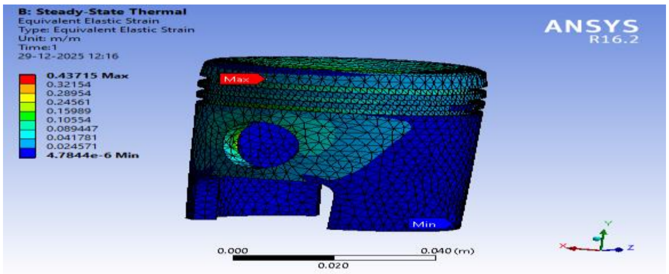

Fig.9 AISI12

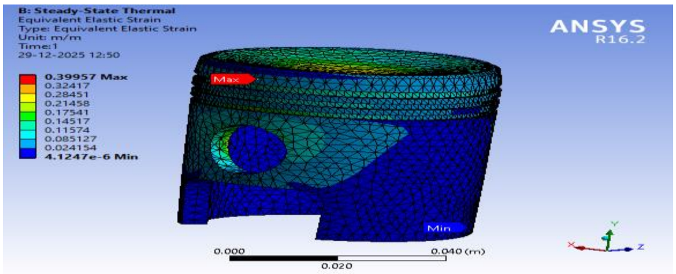

Fig.10 A390

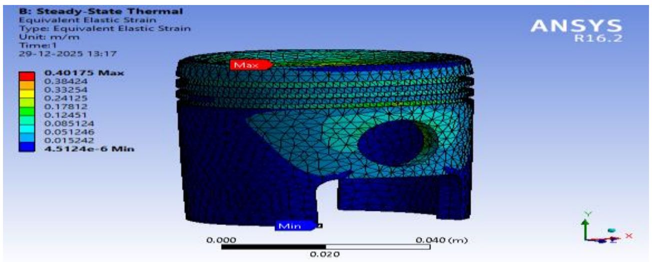

Fig.11 AISI20

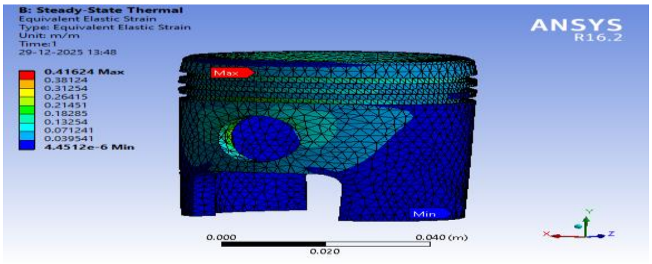

Fig.12 AISI25

6. HEAT FLUX -

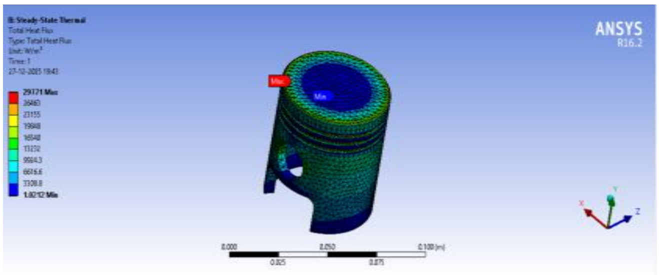

Fig.13 AISI5

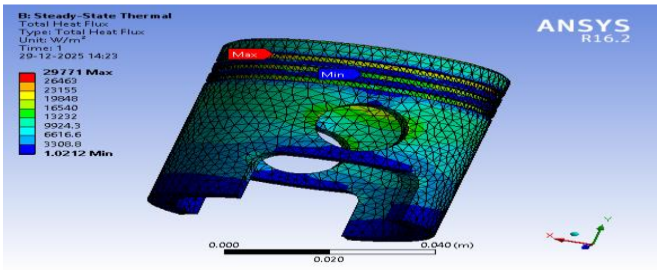

Fig.14 AISI12

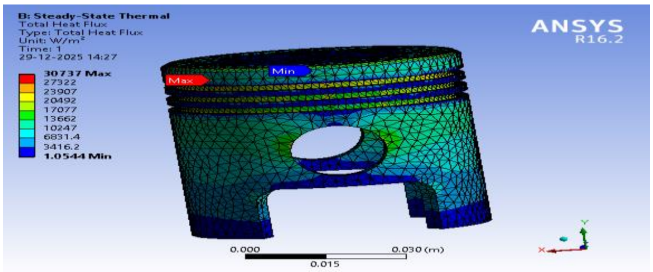

Fig.15 A390

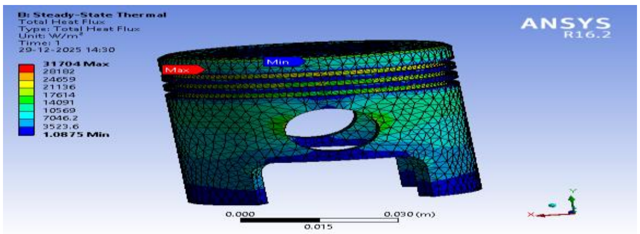

Fig.16 AISI20

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 04 , April - 2026

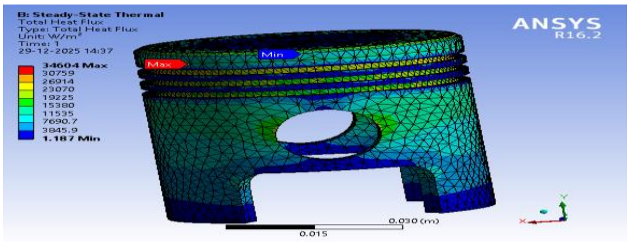

Fig.17 AISI25

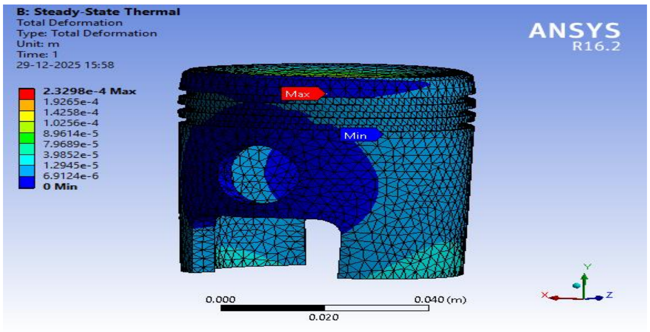

Fig.22 AISI25

7. TOTAL DEFORMATION –

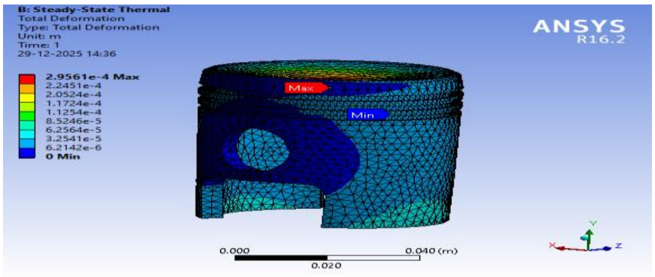

Fig.18 AISI5

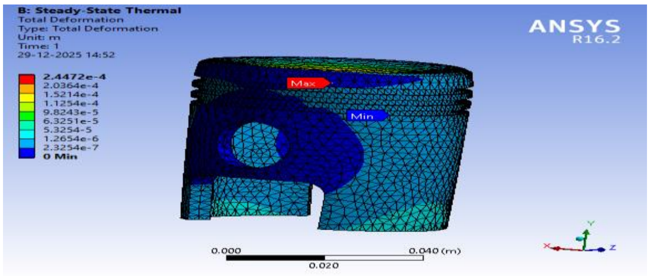

Fig.19 AISI12

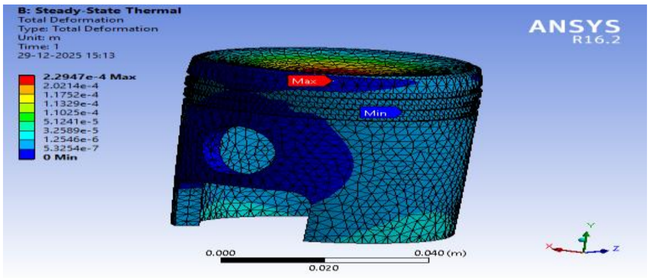

Fig.20 A390

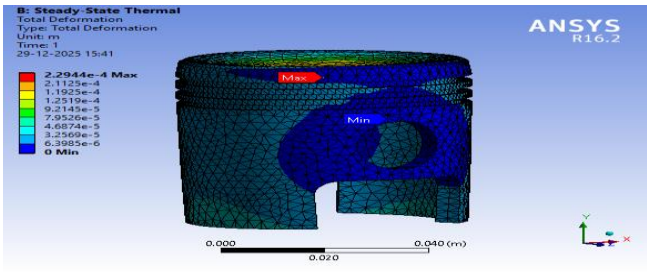

Fig.21 AISI20

VII. COMPARISION OF RESULTS UNDER THERMAL LOAD

Parameters	AISI 5	AISI12	A390	AISI 20	AISI25
Equivalent Stress (MPa)	369.62	310.27	**262.64**	287.64	320.32
Equivalent Elastic Strain (m/m)	0.52841	0.43715	**0.39957**	0.40175	0.41624
Heat Flux (W/m^2)	29771	29771	30737	31704	**34604**
Total Deformation (m) (10^{-4})	2.95	2.44	**2.29**	**2.29**	2.32

Table 1. All Parameters Results

VIII. CONCLUSION

According to the simulated results, A390 (17%SI) material performed better than any other materials. A390 material has lower Equivalent stress, Equivalent elastic strain, Total deformation which are important results for the design consideration. AISI20 is also better material followed by A390 material. So A390 materials is selected for piston design which is applicable for 150cc bike.

IX. ACKNOWLEDGMENT

We thanks to Mr. Sagar N. Oguwar and guide Prof. Gaurav Nagdeve for their contribution to this work. Special thanks to

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 04 , April - 2026

HOD Dr. A. Muthuraja and other faculty of Mechanical Department.

X. REFERANCES

[1] Yash Dhamecha, Vaibhav Saptarshi, Tejasve Parnami and Shubham Parikh, "Design and Analysis of piston using Different Materials, IRJET, Volume 7, Issue 12, Dec 2020.

[2] Durkaieswarn, Kanagaraj, Ravikumar, Muthiah and Sivakasi, "Stress Analysis of piston Using Pressure load and Thermal load", IJSTE, Volume 7, Issue 11, May 2021.

[3] Koli and Subodhkumar, "Stress Analysis of piston Using Pressure load and Thermal load", IJSART, Volume 4, Issue 2, Feb 2018.

[4] Muneendra, Mayandi, jaya Harshavardhan and Anandbabu, "Static and thermal analysis of piston using Ansys with various maerials",IRJMRTS, Volume 03, Issue 05, May 2021.

[5] Shahanwaz Havale and Santosh Wankhede, "Design, thermal analysis and optimization of a piston using Ansys", IRJET, Volume 4, Issue 12, Dec 2017.

[6] Pagadala Sidddiraju and Koppula Venkateswarareddy, "Design and analysis of a piston by using five different materials", Advance Scientific Research and Engineering Trends, Volume 6, Issue 2, Feb 2021.

[7] Vishwanath, Ajay, Deepika, Bharathraja and Ramnath, "Design and analysis of piston on different materials using CAE tools", IJERT, Volume 9, Issue 10, 2021.

[8] Jitendra Kumar, "Design and analysis of piston with different material subjected to thermal analysis", International Journal of Research and Analytical Review, Volume 8, Issue 4, Dec 2021.

[9] Omezhilan, Stephan John and Praveen, "Design and thermal analysis of piston", IJRESM, Volume 3, Issue 5, May 2020.

[10] Ayush and Kamlesh Gangrade, "Design thermal and structural analysis of piston with different material using finite element analysis, International Journal of Research Publicaion and Review, Volume 3, Issue 7, July 2022.