A STUDY OF THE STRUCTURAL AND THERMAL ANALYSIS OF A PISTON USING THE DESIGN PROGRAMME SOLID WORKS 2011

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Abstract :
A piston is an engine component that transfers heat energy into mechanical energy by reciprocating. It is the moving component housed within a cylinder and sealed by piston rings. The piston that transfers the power of the combustible gases to the connecting rod. Pistons, which are commonly constructed of alloy steels, demonstrate the grate's resistance to thermal and structural loads. Fatigue failure occurs as a result of cyclic thermal and mechanical loads. So, in order to extend the piston's life, more study has been conducted into changing the piston's design, altering the material, and modifying the production procedure. In this project, we created a piston using Solid Works 2011 design software and used ANSYS workbench software to perform structural load analysis and thermal analysis on the piston by using various materials such as composites.

I. INTRODUCTION

Piston was a mechanical device that was invented in 1866 by a German scientist named Nicholas August Otto. The piston would be a revolving component of the engine that is subjected to heat and mechanical stress. When fuel is burned in an engine, a large amount of energy is released, causing the temperature to increase and a large enormous pressure to be generated, which descends on the piston. The piston's heat may vary from 300 to 600 degrees Celsius, and the force may rise to 15 MPa.

The purpose of a piston rod and/or linking line in a motor is to transmit force from rising gas in the chamber to the shaft. As a crucial component of an engine, the piston is subjected to cyclic gas pressure and gravity force during work, which can result in fatigue failure to the piston, like piston lateral wear, piston cap or head fractures, and so on.

According to the findings, the largest stress occurs at the piston's upper end, and maximum stress is one of the primary causes of fatigue damage. A piston heating seizures, on either hand, can only happen if anything burns or scratches off the oil slick that lies between the cylinder wall.

II. LITERATURE SURVEY

All basic casting procedures can be used to cast metals and alloys (Budinski 2001). Diffusion of reactive species via the intermetallic barrier, not the interface chemical interaction, limits the rate of expansion of the inter - metallic layer . However, the light alloy's poor hardness and greater service heat during piston operations pose some challenges .

As per , pistons made of aluminum-based alloy are used in internal combustion engines, especially diesel engine engines, to improve heat radiation and reduce weight. Casting the metal alloy all around insert core can solve this problem. The dipping duration of the insert was changed from 3 to 10 mins for

III. DESIGN OF PISTON

The technique for designing piston assemblies begins with one of these common designs. The piston is developed using the procedure and specifications found in mechanical systems and data guidebooks. SI Units are used to compute the dimensions. Pressure on the piston skirt, temperatures in various parts of the piston, flow of heat, tensions, strains, height, diameter of the nozzle and hole, depth, and other characteristics are all taken into account.

Engine construction companies may create test rings to demonstrate different aspects of the pistons' achievement before integrating them in an engine, especially when they involve any new design details. Pistons for bigger engines seek to integrate more conceptual design by the motor builders, and they could in some cases build test circles to prove different aspects of the pistons' achievement before integrating them in a motor..

IV. MATERIALS USED

Pure iron, cast aluminium, generated aluminium, steel plate, and forging steel are the most frequent materials for pistons in I.C. engines. Due to strengthening the strength properties of the piston, we used several materials to evaluate aluminium alloy.

• Aluminium alloys are among the materials used.

• Alsic-10 (grey cast iron) • Alsic-12 (grey cast iron)

4.1. Material Properties

Table 1: Aluminium alloys Material properties

Properties	Young's modulus	Poisons ratio	Density	Thermal conductivity
Value	0.71e5 Mpa	0.33	2270 kg/m3	144 W/m degree celsius

Table 2: Grey cast iron Material properties

Properties	Young's modulus	Poisons ratio	Density	Thermal conductivity
Value	1.1e5 Mpa	0.28	7200 kg/m3	52 W/m degree celsius

Table 3: Alsic-10 Material properties

Properties	Young's modulus	Poisons ratio	Density	Thermal conductivity	Specific heat
Value	1.67e5 Mpa	0.251	2960 kg/m3	190 W/m degree Celsius	786 J/kg degree degree Celsius

Table 4: Alsic-12 Material properties

Properties	Young's modulus	Poisons ratio	Density	Thermal conductivity	Specific heat
Value	1.67e5 Mpa	0.21	2890 kg/m3	170 W/m degree Celsius	808 J/kg degree Celsius

V MODELLING OF PISTON

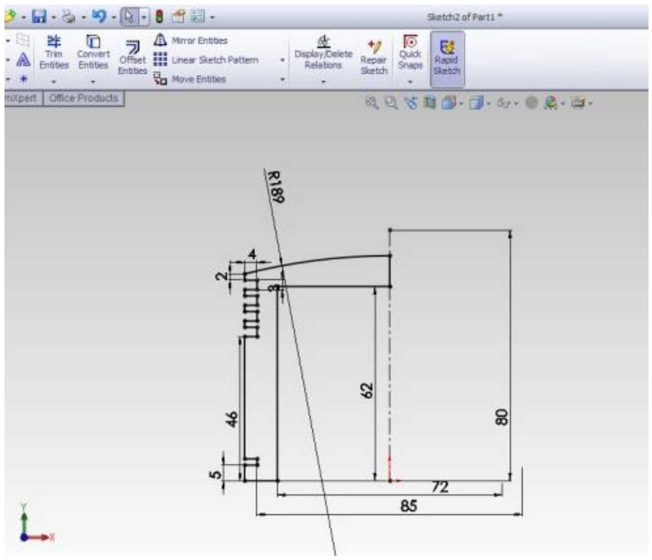


Figure 1: Piston

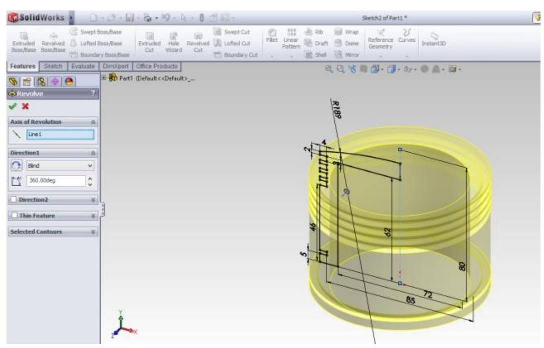


Figure 2: After the piston model, make a sketch.

VI **Results and Discussions**

VI.1 Thermal Analysis of Piston on ANSYS

Aluminium Alloy

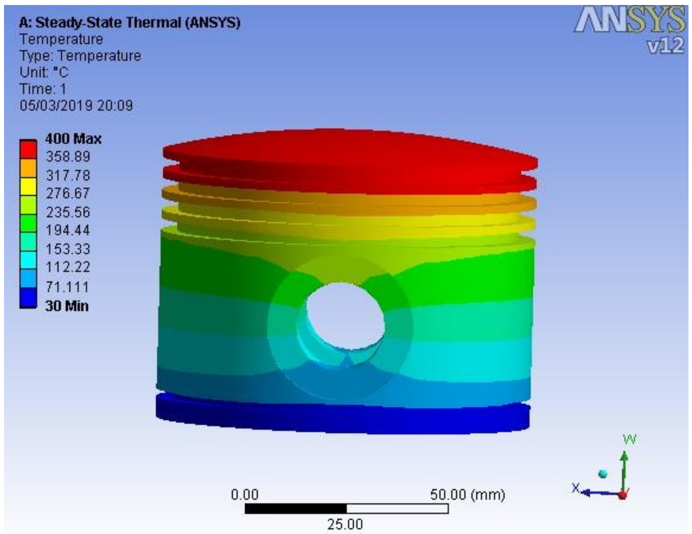


Figure 3: Temperature Distribution in Al Piston Alloy

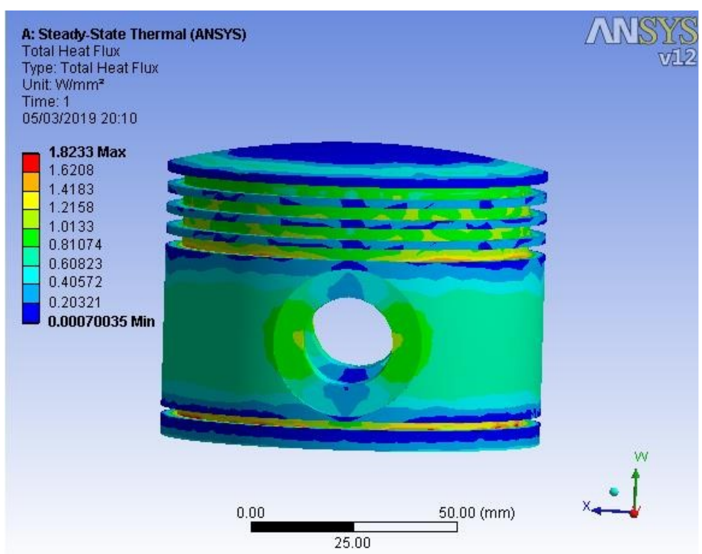


Figure 4: Total Heat Flux for Al Piston Alloy

Cast Iron, Grey

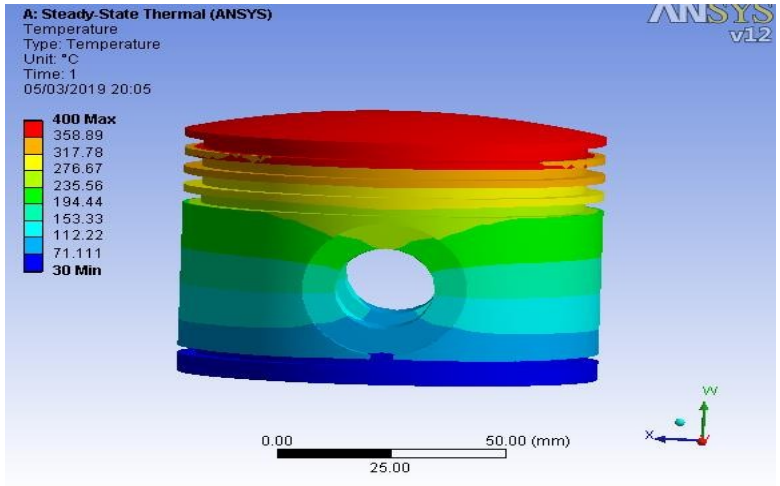


Figure 5: Thermodynamic Distribution of Grey Cast Iron Pistons

Alsic-10

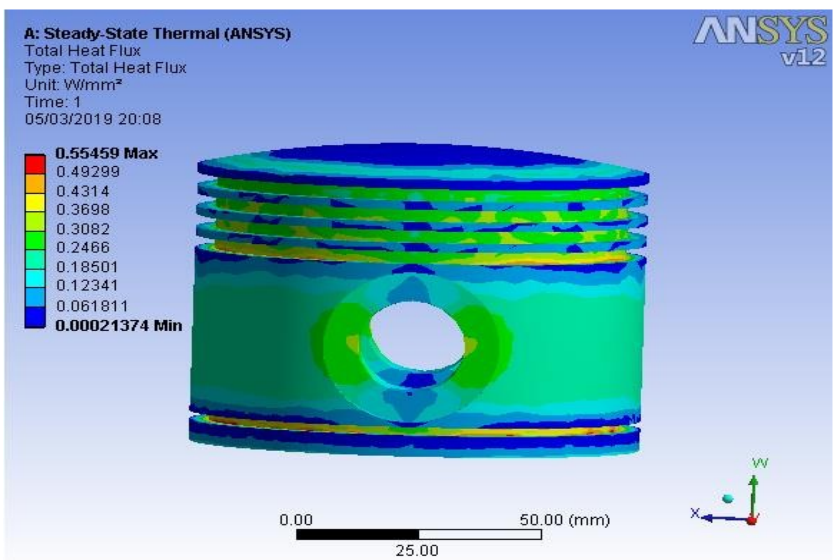


Figure 6: Total Heat Flux for Piston Grey Cast Iron

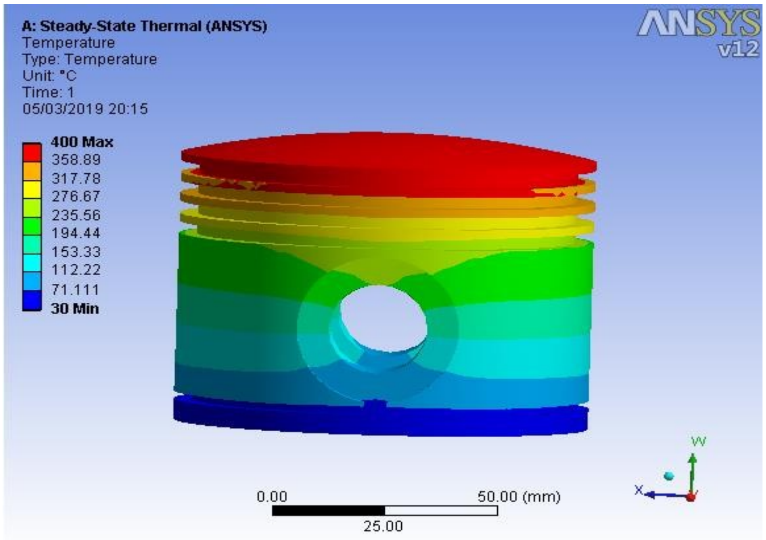


Figure 7: Piston temperature distribution for Alsic-10

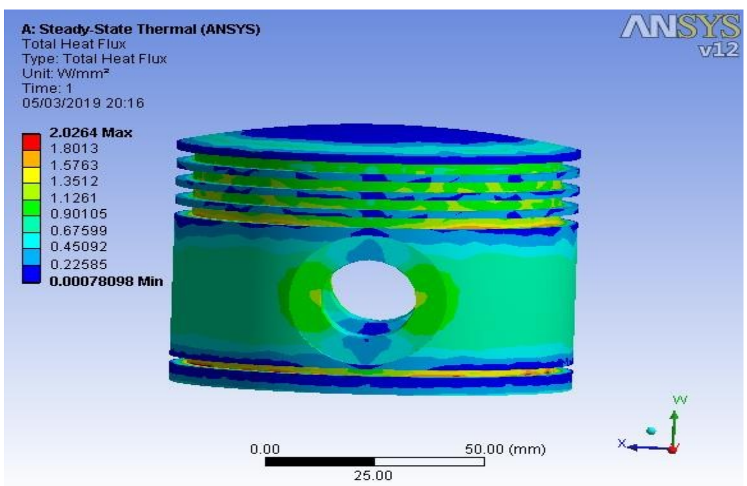


Figure 8: Total Heat Flux for Alsic-10 of piston

Alsic-12

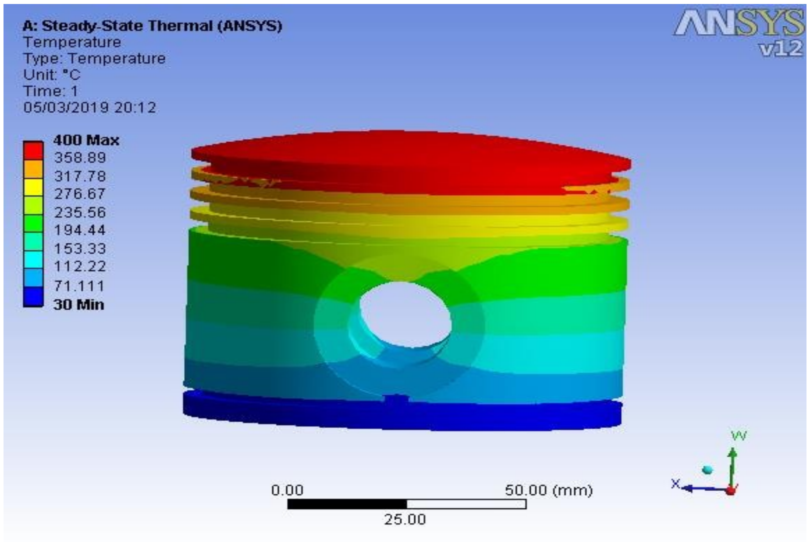


Figure 9: Temperature Distribution for Alsic-12 of piston

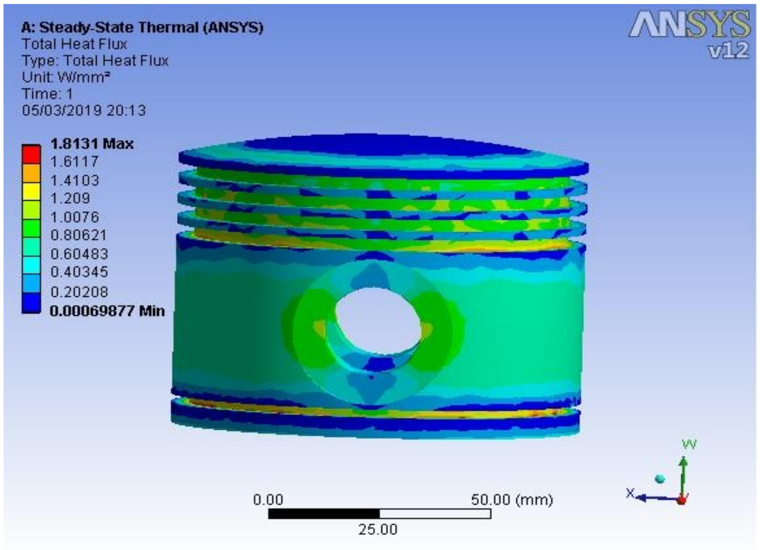


Figure 10: Total Heat Flux for Alsic-12 of piston

VI.2 Structural Analysis of Piston on ANSYS

Al Alloy

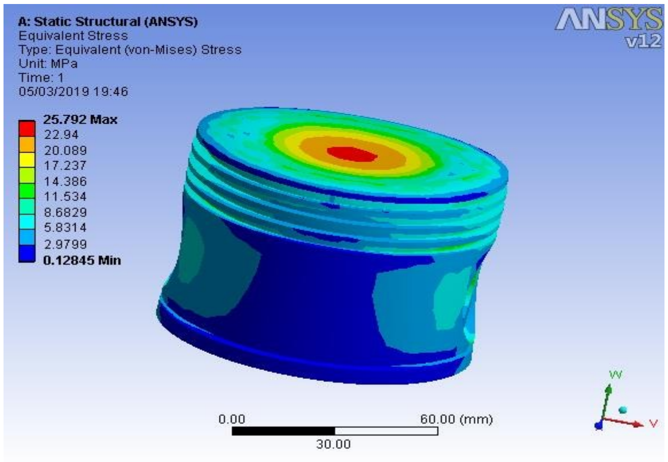


Figure 12: Maximum Stress of Piston

Grey Cast Iron

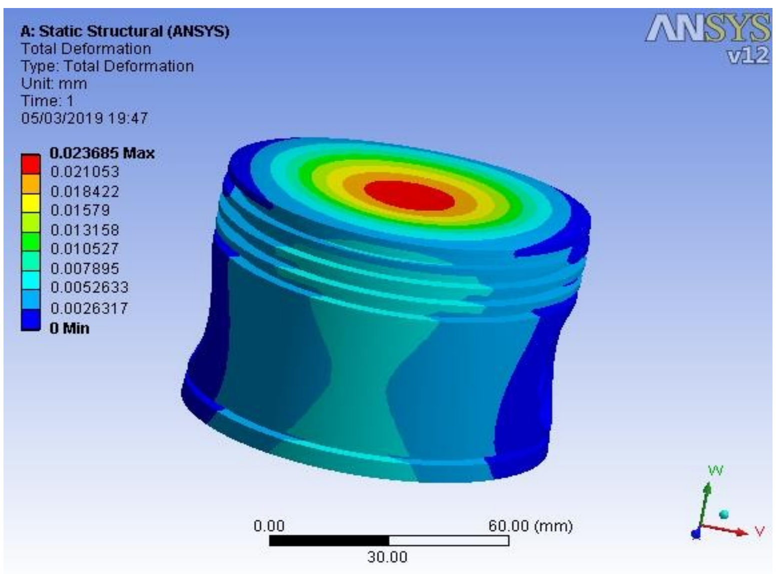


Figure 13: Total Deformation of Piston

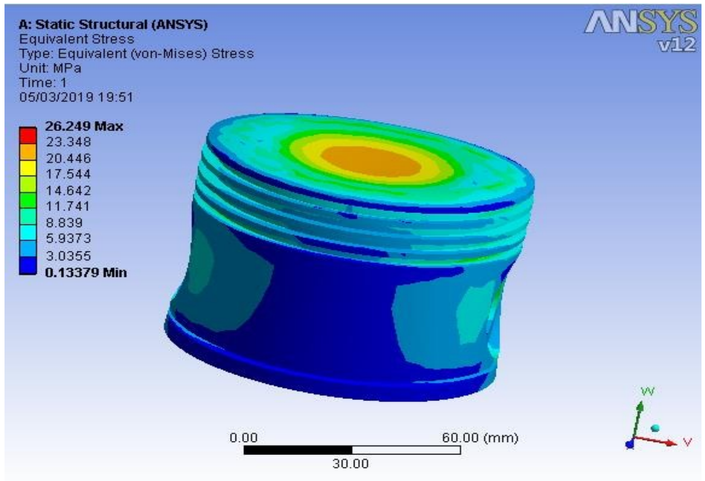
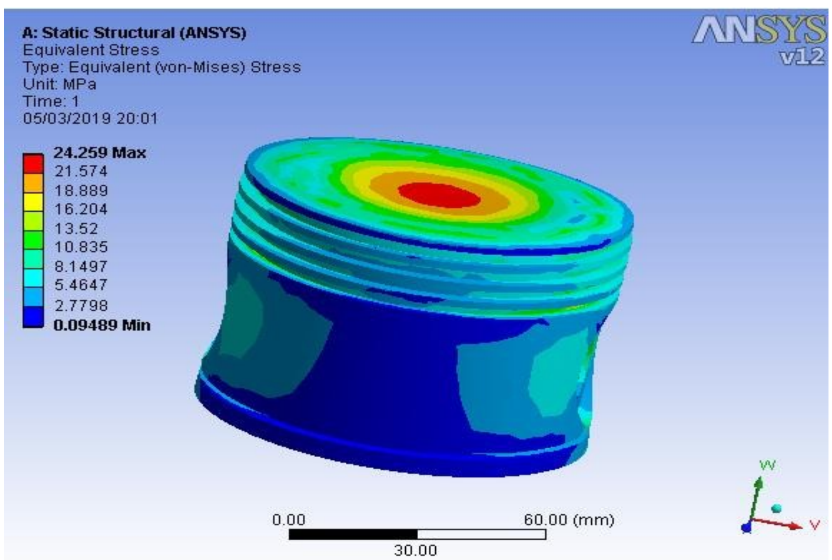


Figure 14: Maximum Stress of Piston

Alsic-10



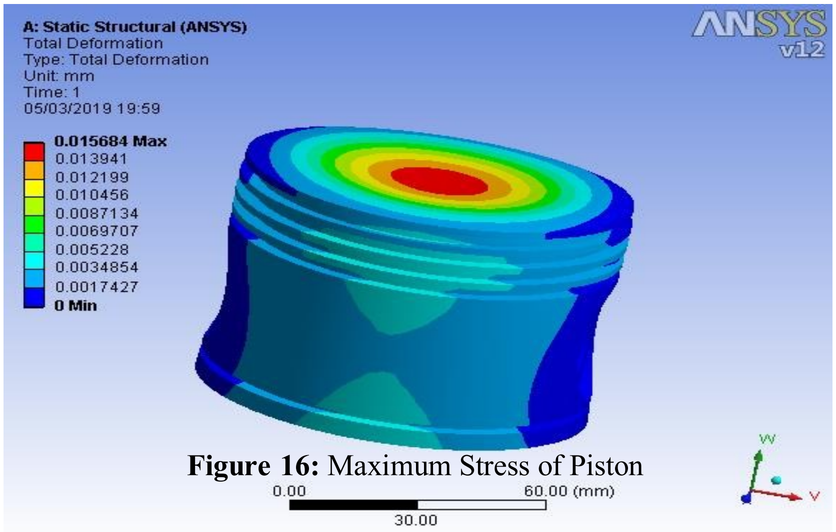


Figure 16: Maximum Stress of Piston

Alsic-12

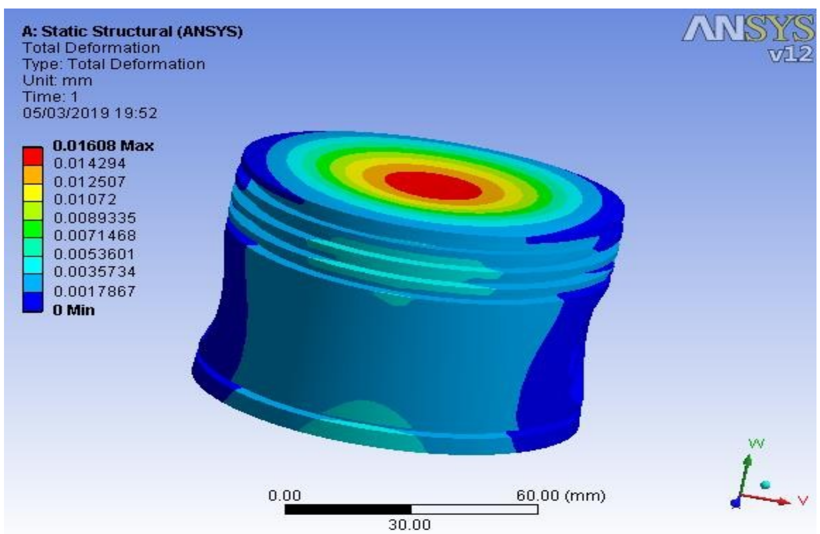


Figure 17: Total Deformation of Piston

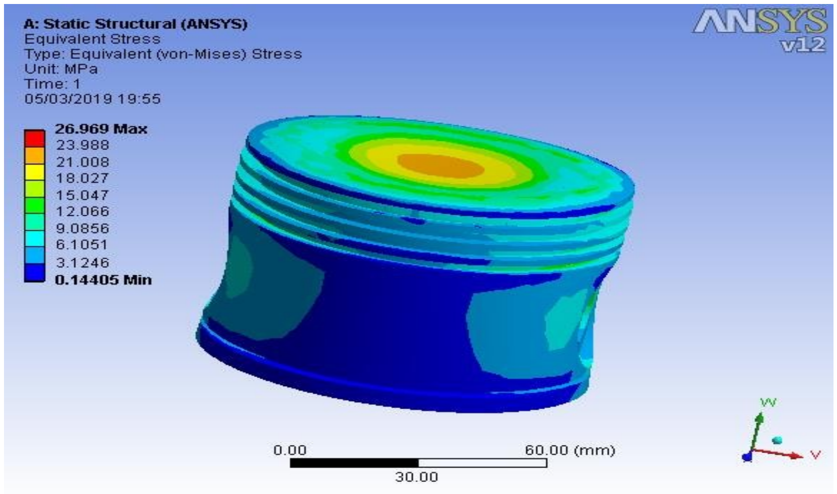


Figure 18: Maximum Stress of Piston

VII Results Tables

Table 5: Thermal Analysis of Piston Results

Material	Total Heat Flux(Degree Celsius)
Aluminium Alloy	1.82330
Grey Cast Iron	0.55459
Alsic-10	2.02640
Alsic-12	1.81310

Table 6: Structural Analysis of Piston Results

Material	Stress(Mpa)		Total Deformation(mm)
	Max	Min	
Aluminium	25.792	0.12845	0.035725
Grey Cast Iron	26.249	0.13379	0.023685
Alsic-10	24.259	0.09489	0.015684
Alsic-12	26.969	0.14405	0.016080

VIII Conclusion

As a result, the piston design and analysis are completed. Various instructions are used to design the piston in the Solid Works 2011 design software. The part file from Solidworks is converted to an IGS file and loaded into ANSYS Workbench. When using the ANSYS workbench to apply loads to various materials such as Aluminum Alloy, Grey Cast Iron, Alsic-10, and Alsic-12. The piston's highest and minimum stress, total deformation, and total heat flow are all observed and tabulated during the analysis. According to the table, the Alsic-10 produces more efficient outcomes when compared to other materials. As a result, Alsic-10 is the best of the four materials used.

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