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Design Thermal and Structural Analysis of Piston with Different Material using Fea

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ABSTRACT

The rising gas pressure is converted into mechanical energy by the piston. The piston is moved inside the cylinder's sleeve during operation. Pistons are typically constructed of heat-treated aluminium or iron alloys. The goal of this project is to create a piston petrol engine for a motorcycle. The goal of the research on stress fluctuations on the piston's top face is to maximise performance. The thermal behaviour of the piston, as well as its pressure on the surface, are investigated. The working gas pressure, temperature, and material functions of the piston were all considered for this investigation. Because scratched or broken parts are so expensive to replace and are frequently unavailable, an investigation was conducted to determine whether the top face of the piston was scratched or broken as a result of the working conditions. In addition to curved and straight Solid Works 2016 was used to create the piston geometry, and ANSYS 14.0 was used for FEM analysis to optimise the piston's thermal behaviour. Aluminum alloy and grey cast iron were used to create the piston. By applying pressure to the piston, structural analysis examines its stress and displacement. The study results can tell us whether our piston design is safe under actual load levels. Heating the piston surface allows for analysis of thermal flux and temperature distribution.

Key Words: Piston, Piston crown, finite element analysis (FEA), steady state thermal analysis, Structural analysis.

1. INTRODUCTION

Pistons were among the first mechanical components discovered by Otto in 1866. One of the most important components of a reciprocating engine is the piston. To convert the chemical energy produced by burning fuel into usable mechanical power, engines, reciprocating pumps, gas compressors, and pneumatic cylinders can all be used. The pass of gas into the connecting rod and piston, which then supply it to the crankshaft for final combustion, increases as the combustion chamber is increased. The cylindrical stopper of the cylinder rises and falls. Piston rings are included to ensure a secure seal. Pistons move in an oscillating motion using metal rods to exert pressure on fluids inside the chamber. A ring that separates piston oil from combustion chamber oil may keep fuel and air from entering the oil. Almost every piston in a cylinder comes with piston rings. To form a seal between the piston and the cylinder wall, two spring compression rings and an oil control ring are frequently used. Piston heads come in a variety of shapes and sizes. There are both cast and forgeable pistons available. The piston is spherical in its most common form, but it can also take on a variety of other shapes.

2. PROBLEM IDENTIFICATION

The fuel is converted into kinetic energy by the vehicle. It is a dynamic component that transmits cylinder power to the crankshaft. Pistons are widely accepted as the engine components that compress the most, thereby transferring the most heat. It is critical to determine the temperature distribution in the piston in order to regulate the thermal pressure and deformation in the work situation. If we can accurately predict the temperature profile on the piston surface, we can optimise thermal characteristics for a low-cost design. Temperature distribution, heat transfer, and mechanical load are all factors to consider. The radiation from the piston layer is also considered in the convectional heat load. The piston is damaged as a result of heat radiation. The chemical reaction of excessive gas combustion forces the piston into thermal compression and thermal fluctuation. It is necessary to investigate the pressure distribution, temperature distribution, heat transfer, and mechanical load in order to minimise the pressure beneath the piston of a different load.

3. OBJECTIVES

The following are the four primary goals that must be met:

- To develop the geometry of the piston using CATIA V5 software.
- To select deferent material of piston.
- To investigate the maximum thermal stress using Stress analysis by ANSYS software.
- To investigate the maximum temperature using thermal analysis by ANSYS software

4. METHODOLOGY

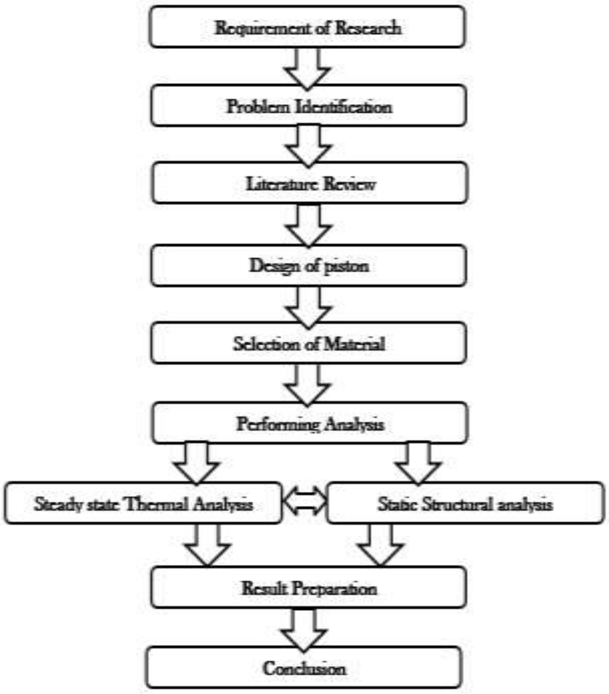

Figure: 4.1 METHODOLOGY ADOPTED

5. DESIGN AND ANALYSIS OF PISTON

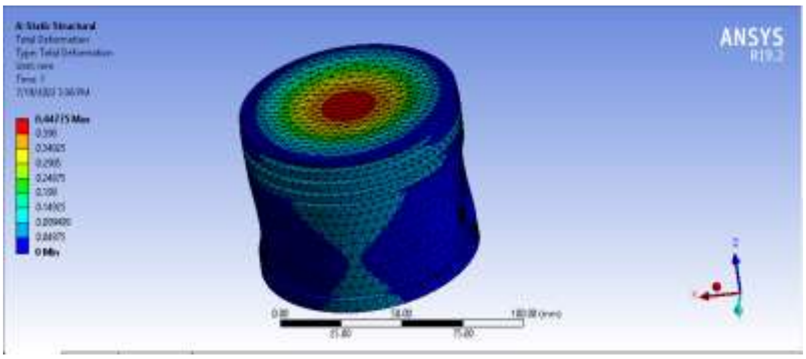

Figure 5.1 Total Deformation

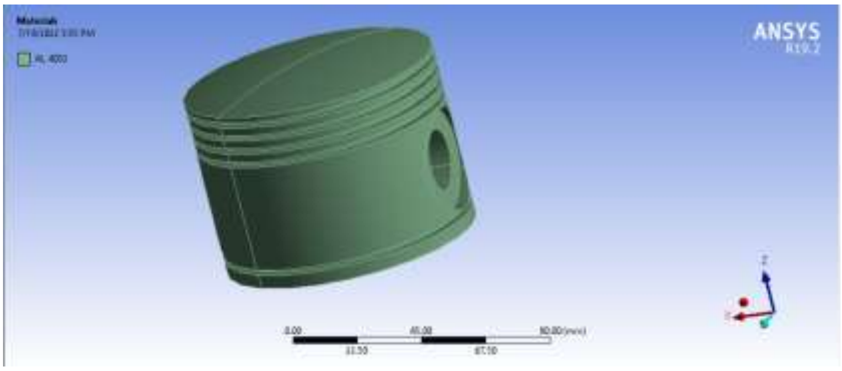

Figure 5.2 AL 4032 Material Applied into piston

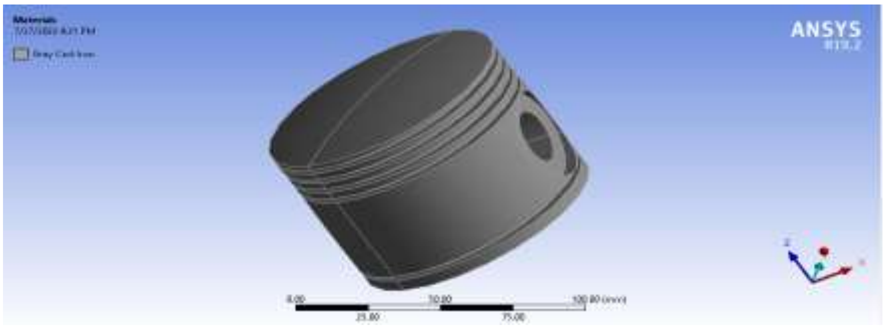

Figure 5.3 Gray Cast Iron Material Assignment into piston

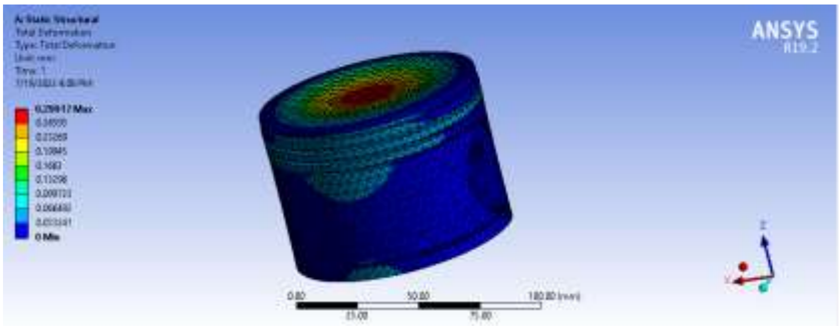

Figure 5.4 Temperature distribution

6. CONCLUSION

The material used to make the piston influences its strength, which is an important factor in engine performance. All materials experience the most stress on the piston crown's bottom surface, which is to be expected. Maximum displacement is absorbed by aluminium alloy and grey cast iron at the top of the piston. The highest value of the piston's maximum temperature is due to the materials' high thermal conductivity, and the greatest heat flow is absorbed by both piston materials. Further research could be conducted using advanced materials and various design and analytic techniques. Stresses and overall deformations are greater in concave shaped piston designs than in convex shaped piston designs. Concave or cup-shaped IC pistons are thus justified. Engines that run on diesel fuel and have a large displacement.

7. REFERENCES

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