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DESIGN AND ANALYZE THE TEMPERATURE IN FINNED TUBE BY CONVECTION PROCESS USING THE TRANSIENT THERMAL ANALYSIS

Ms. G. Lavanya Lakshmi [1], Ms. M V Lakshmi, Ms. K Deep Rani

Abstract

The thermal efficiency of an internal combustion engine is affected by many factors, including the combustion process, fuel properties, and engine design. However, heat transfer is a crucial phenomenon that directly affects the thermal efficiency of an engine. In this case, we had regarded air cooled IC Engine. Four different fin structures are selected and analysis is done by using them, to select the best material. Fins are the important component in an IC engine cylinder block which is responsible for heat removal during the combustion process via convection process. The efficient removal of heat transfer can always maintain the consistent efficiency of an IC engine. The modeling of cylinder block with fins is done by using Space claim direct modeler software. The design specifications of the IC engine Cylinder block with fins are is taken from Honda CB Shine 125CC. The FEA analysis is done by using ANSYS Workbench 18. FEA analysis is done through Transient Thermal which used to find out the total heat flux distribution and temperature distribution.

Keywords: fins, heat removal, Honda block, space claim, transient analysis, thermal analysis.

Introduction

Fins are an important component of air-cooled heat exchangers as they increase the surface area available for heat transfer between the hot fluid inside the tubes and the cool air outside. Nowadays, Air cooled heat exchanger (ACHEs) are common sight in chemical, petro-chemical and refinery compared to past. This is due to water scarcity and increased cost of water, while air is freely available in abundance. There are various advantages of ACHEs, such as environment friendly, low maintenance and easy to install as no water piping and pump involved. Disadvantages of ACHEs are high initial cost, high plot area required, fan noise, low approach temperature (in the range of 10- 12°C compared to 3-4°C for water cooled heat exchangers), etc

The main concern in using the air as cooling medium is extremely low heat transfer coefficient of Air, which lead low thermal conductivity. To increase the thermal conductivity on air side, we need to use extended surface on air side by mean of finned tubes. In this article, I will be discussing about the type of Fins and its selection.

Statement of the Problem

Fins are commonly used in engines to increase their surface area, which helps to dissipate heat more efficiently. They are typically found on air-cooled engines, such as those used in motorcycles, lawnmowers, and other small engines. But there are some drawbacks in the applications of the existing engines. Overheating, uneven wear etc, decreases the efficiency of the engine, which can reduce their effectiveness in dissipating heat. Bent fins can impede the flow of air over the engine and cause hot spots, which can lead to engine damage or even failure.

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The cross-section of the fin structure also considered to get even temperature distribution. The cross-section of a fin determines its surface area and volume, larger surface area results in increased heat transfer, while a larger volume can store more heat. Therefore, the selection of an appropriate cross-sectional shape for a fin is crucial for achieving efficient heat transfer and even temperature distribution. Some commonly
used cross-sectional shapes for fins include rectangular, triangular, circular etc. Apart from that by changing the shape the rate of heat transfer changes that may lead to increase in engine efficiency.

Objectives of the study

- To evaluate the temperature distribution of finned tube susing Convection by Transient Thermal process
- To optimise the geometry and operating conditions of the finned tubes for maximum efficiency and performance.
- To investigate the effect of load by the piston on engine cylinder.
- To identify and compare the temperature distribution on different cross-sections in fins of cylinder blocks.

Literature Review

M.R. Jafari Nasr and A.T. Zoghi [1], From the study described that using low finned tubes instead of plain tubes can improve the performance of the heat exchanged. N. Nagarani[2], The paper showed the heat transfer rate and efficiency of the circular and elliptical annular fins under different experimental conditions. Sikindar Baba et al. [3], The paper described experimental, theoretical and finite element analysis of the inter-cooler and compare the results obtained from these different methods. Shiv Kumar Rathore and Ajeet Bergaley [4], The objective of this paper is to highlight the benefits of using low-finned tube heat exchangers compared to plain tube (bare tube) units and the results of the analysis demonstrate that finned tube heat exchangers are more economical than conventional bare tube exchangers, as they have a higher heat transfer coefficient per meter of tubing. Sujan Shrestha et al. [5], This paper is able to use ANSYS to analyze the heat transfer through the engine fins, and to observe temperature distribution and heat flux through the walls. Shubham Shrivastava and Shikar Upadhyay [6] The paper shows the thermal analysis of the engine block with fins to determine the heat dissipation inside the cylinder with different materials properties. Rajesh Ranjan and Vijaykant Pandey [7], This paper investigated the thermal performance of an engine block with fins which is exposed to high temperatures and thermal stresses to determine the heat dissipation inside the cylinder. A. N. Mohan Das et al. [8], From the study investigated that the effect of rectangular and circular fins, with and without slots, on temperature distribution and heat flux in the engine piston chamber and to improve engine performance bycooling the cylinder with fins.

Research Methodology

The fins are responsible for dissipating heat from the engine cylinder to the surrounding air, preventing the engine from overheating. The main focus is to optimize the design of an air cooled engine cylinder block of a 125cc IC engine to increase the heat distribution across the cylinder. A study says that the temperature inside an IC engine cylinder ranges from 600^{o}c to 1500^{o}c and from outside the cylinder due to heat distribution at normal conditions, ranges from 80^{o}c to 150^{o}c. Most of the engines are built up with grey cast iron which is very efficient in damping absorption, good wear and thermal resistance, available at low cost when compared with other metals. Aluminium Alloy also advances with the same requirements as grey cast iron and also less in weight. Aluminium Alloy is used as base material.

Model

From figure 1 to figure 4 shows the geometry of the different finned cross-sections for varying in the analysis.

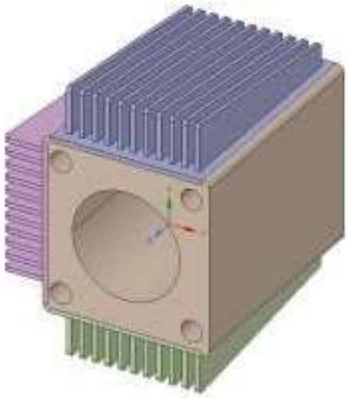

Fig 1. Vertical finned Cylinder

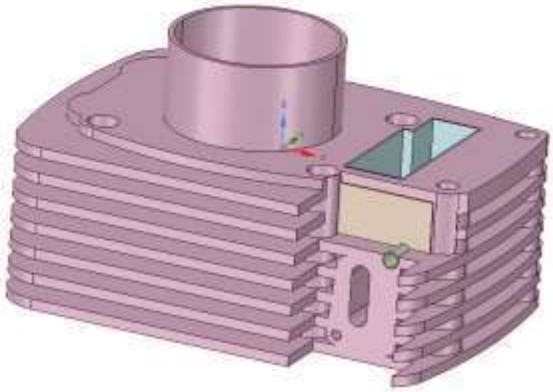

Fig 2. Horizontal Finned Cylinder

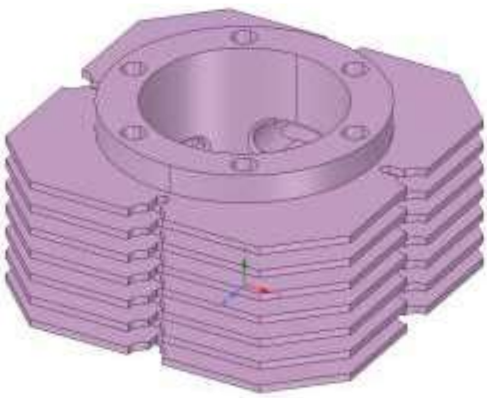

Fig 3. Hexagonal Finned Cylinder (Sharp Edges)

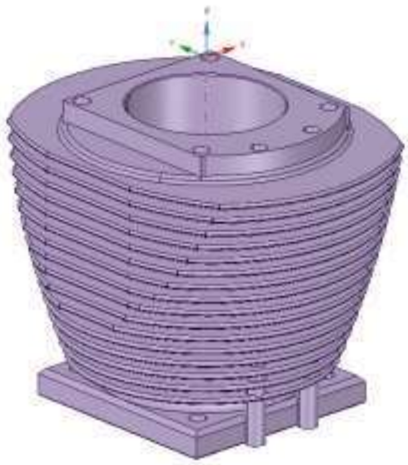

Fig 4. Hexagonal Finned Cylinder (Curved Edges)

Meshing

Figure 5 shows the Meshing of a Finned Model (Size: Fine) and Table 1 Shoes Nodes and Elements of the Mesh.

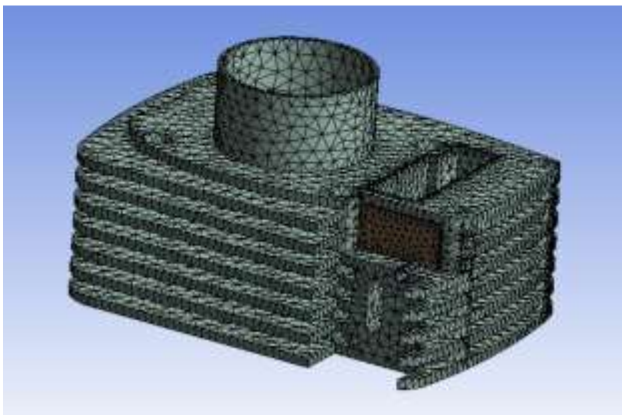

Fig 5. Mesh of the Model

Nodes	Elements
102507	53248

Table 1. Nodes And Elements

Boundary Conditions

The parameters that represents as the inputs are shown in Table 2.

S. No	Loads	Units	Value
1	Max Temperature	^{o}c	500
2	Pressure	Pa	4.9987e^{6}
3	Ambient Temperature	^{o}c	22
4	Material		Aluminium Alloy

Table 2. Input Parameters

Result and Discussions

Transient Thermal, Transient Structural and Modal are the three analyses that are performed in this study on finned structure.

Transient Thermal Analysis

- Temperature Distribution

Figure 6 to 9 shows the temperature distribution across the cylinder to the fins.

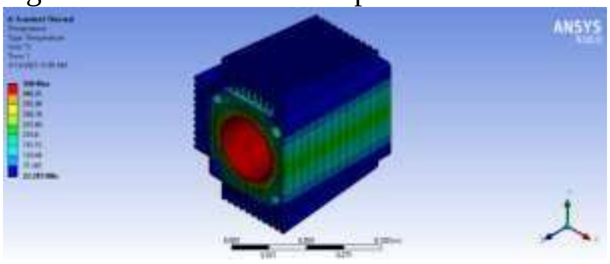

Fig 6. Vertical Finned Cylinder

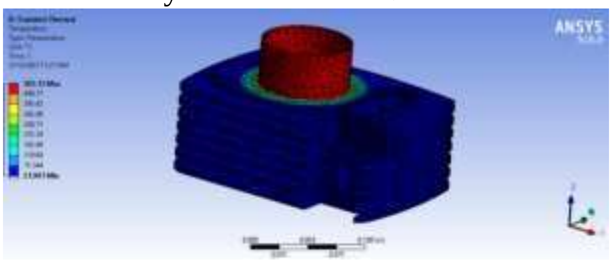

Fig 7. Horizontal Finned Cylinder

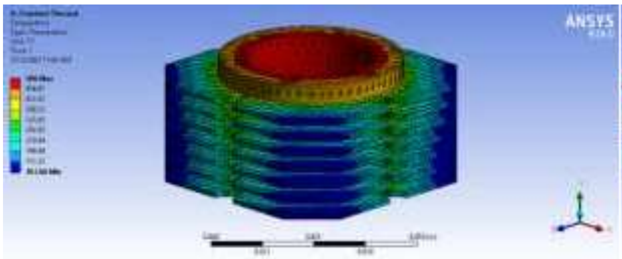

Fig 8. Hexagonal Finned Cylinder (Sharp Edges

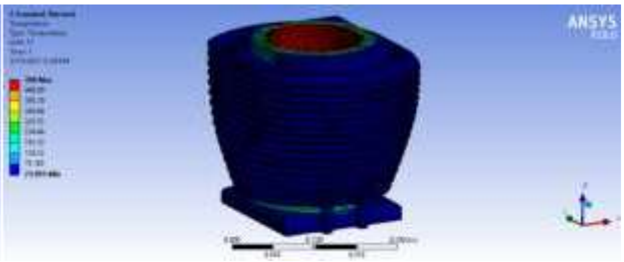

Fig 9. Hexagonal Finned Cylinder (Curved Edges)

- Heat Flux

Figure 10 to 13 shows the total heat flux generated across the cylinder.

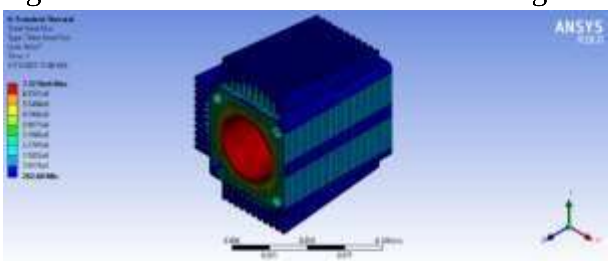

Fig 10. Vertical Finned Cylinder

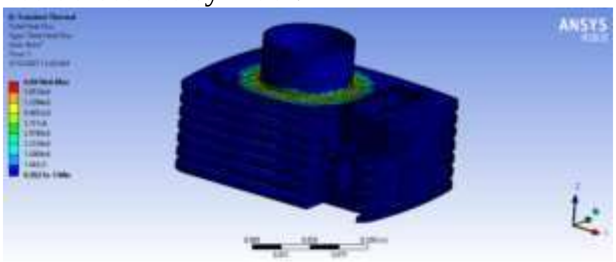

Fig 11. Horizontal Finned Cylinder

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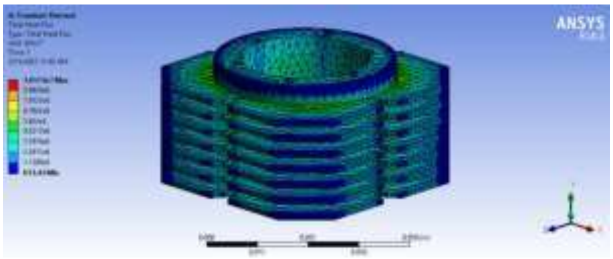
Vol 6, Issue.1 Jan 2018



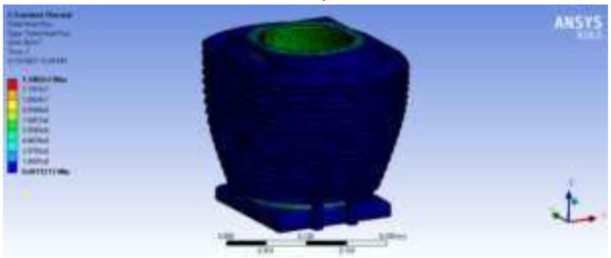
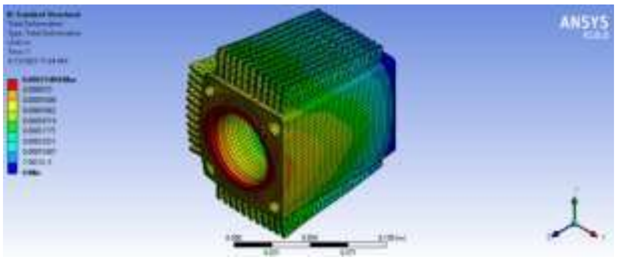


Fig 12. Hexagonal Finned Cylinder(Sharp Edges) Fig 13. Hexagonal Finned Cylinder(CurvedEdges)

Transient Structural

- Total Deformation

Figure 14 to 17 shows the total deformation (in meters, m) of the finned cylinder at certain load conditions.



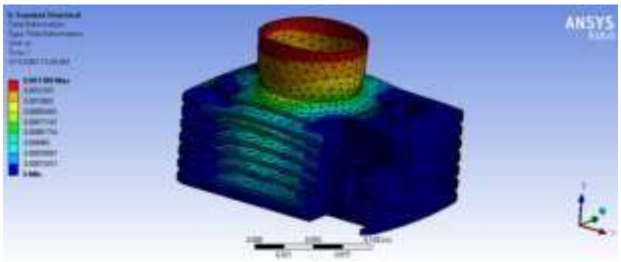
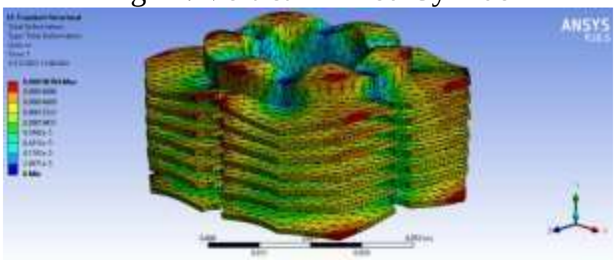


Fig 14. Vertical Finned Cylinder Fig 15. Horizontal Finned Cylinder



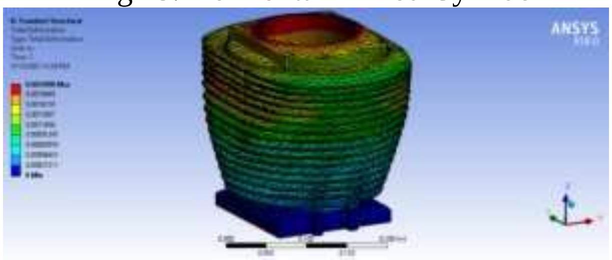
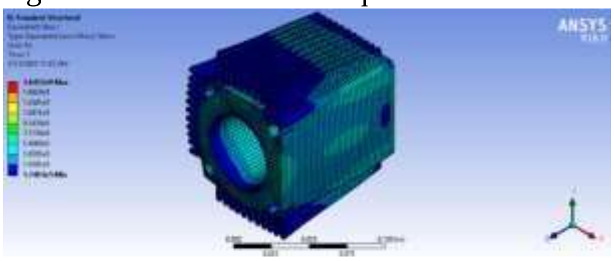


Fig 16.Hexagonal Finned Cylinder (Sharp Edges)Fig 17.Hexagonal Finned Cylinder(CurvedEdges)

- Equivalent Stress

Figure 18 to 21 shows the equivalent stresses developed in the cylinder at the load conditions.



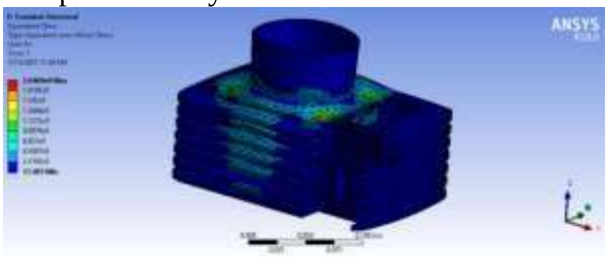
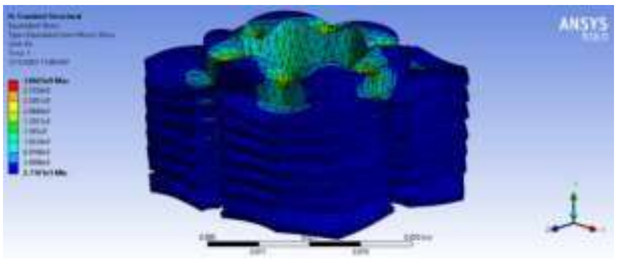


Fig 18. Vertical Finned Cylinder Fig 19. Horizontal Finned Cylinder



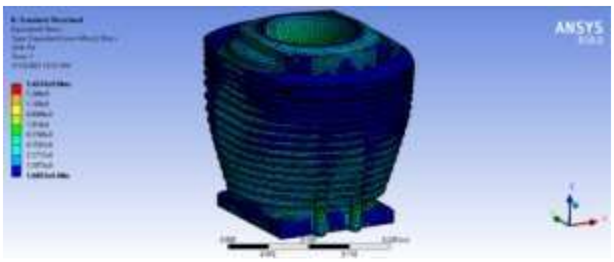


Fig 20. HexagonalFinned Cylinder(Sharp Edges) Fig 21.Hexagonal Finned Cylinder(CurvedEdges)

Modal

- Total Deformation

Figure 22 to 25 shows the total deformation due to external frequencies in model.

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Vol 6, Issue.1 Jan 2018

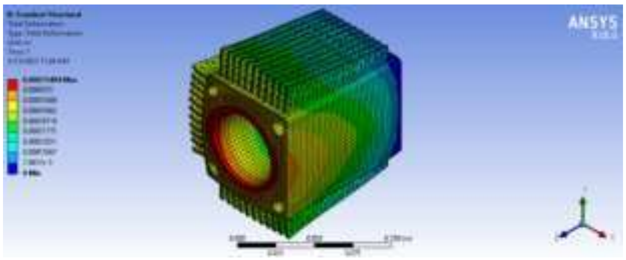


Fig 22. Vertical Finned Cylinder

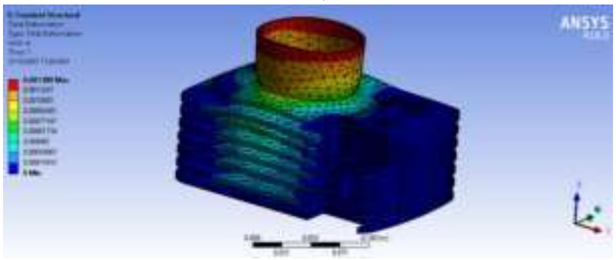


Fig 23. Horizontal Finned Cylinder

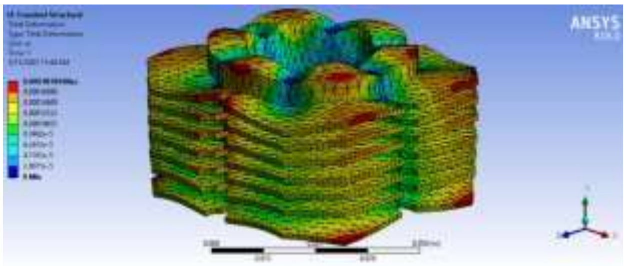


Fig 24. Hexagonal Finned Cylinder(SharpEdges)

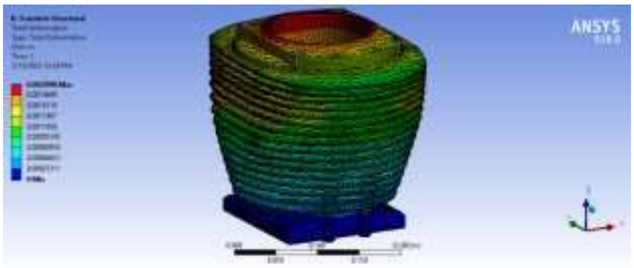
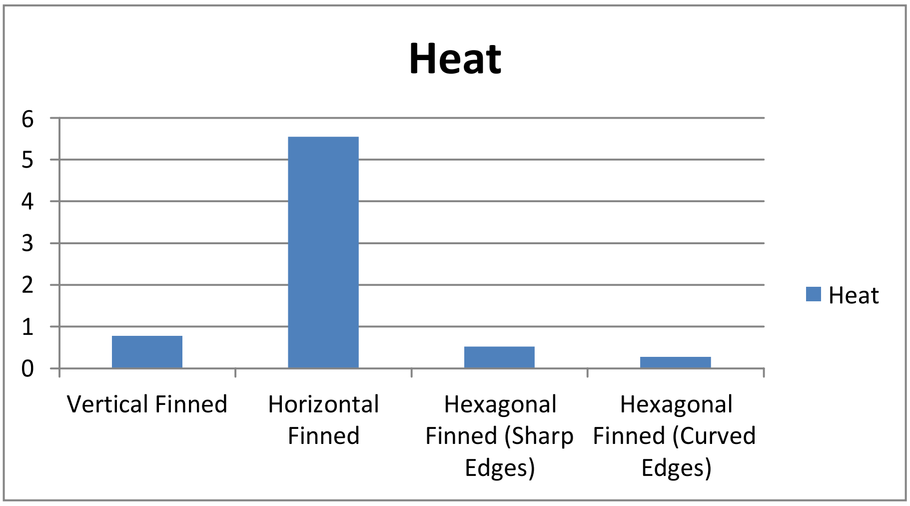


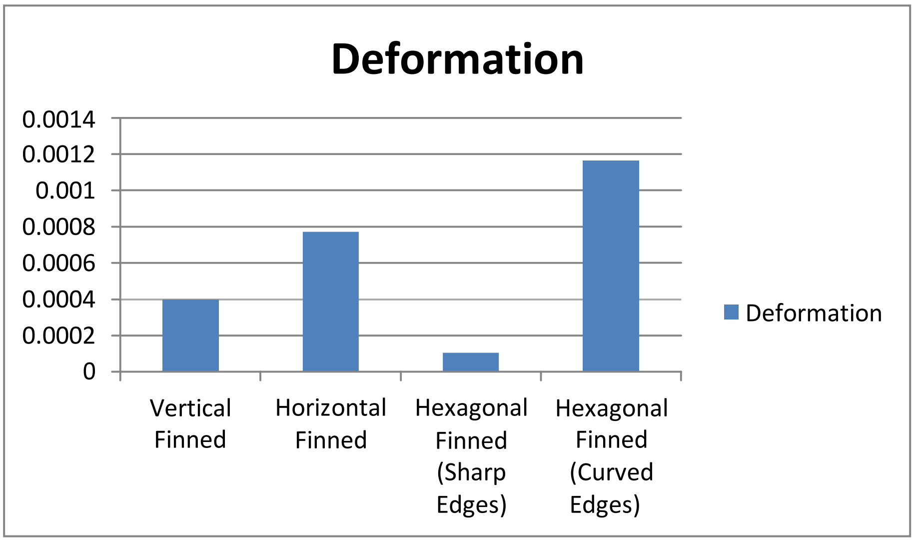
Fig 25. Hexagonal Finned Cylinder(CurvedEdges)

Results

Graph 1 shows the heat distribution at the outside of the cylinder within the contact of fins and Graph 2 shows the Deformation of the cylinder when load is applied on it.



Graph 1. Heat at outer surface of the fins



Graph 2. Deformation of the cylinder

Conclusion

The conclusion to the project is of three different materials under engine block design are analysed for heat exchanging process by structural fins .The three designs makes the difference in temperature distribution and making major factor of heat exchange by materials. In this project we are having aluminium alloy as the material. For all these conditions we done the analysis and the temperature distribution also determined under use a function load to apply this temperature. After observing the results, the Hexagonal Finned Cylinder Block (Curved Edges) model makes the high thermal resistance by Aluminium Alloy material.

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