ANALYSIS OF ENGINE FIN USING DIFERENT MATERIALS

A PROJECT REPORT

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BONAFIDE CERTIFICATE

Certificate that this project report **"ANALYSIS OF ENGINE FIN USING DIFERENT MATERIALS"** is the bonafide work of

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Submitted for the Anna University Viva- Voce Examination held on___________________

INTERNAL EXAMINER EXTERNAL EXAMINER

ACKNOWLEDGEMENT

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ABSTRACT

The engine cylinder is the heart of the automobile component which is Subjected to high temperature variation and thermal stresses. In order to cool the cylinder , fins are provided on the surface of the cylinder to increase the rate of heat transfer. By executing the thermal analysis of the engine fins , it is helpful to know t heat dissipation and temperature distribution inside the cylinder. The main aim of the present project is to analyze the thermal properties like Directional heat flux, Total heat flux and Temperature distribution of a modified conical design along with the existing model (Harley Davidson model fin) with three different material Aluminum and Aluminum alloy (silicon carbide). The design for the fins model will be prepare in CATIA V5R20 and analyzed using ANSYS WORKBENCH with an Average Internal Temperature and Stagnant Air-simplified cases as cooling medium on outer surface with reasonable Flim Transfer Coefficient as boundary condition.

CHAPTER 1
INTRODUCTION

We know that in case of internal combustion engine, combustion of air and fuel takes place inside the engine cylinder and hot gases are generated. The temperature of gases will be arounded 2300-2500^{o}C. this is a very high temperature and may resukt into burning of oil flim between the moving parts and may result in seizing welding of same that is chance of piston seizure, change of piston ring, compression ring, oil ring etc can be affected. Excess temperature can also damage the cylinder material. So this temperature must be reduced to about 150-200^{o}c at which the engine will work most efficiency. So the object of cooling system is to keep the engine running at its most efficient. Too much cooling is also not desirable since it reduce the thermal efficiency. So the object of cooling system is to keep the engine is running as its most efficient operating remperature. It is to be noted that the engine is quite inefficient when it is cooled when the engine is warning up and till it attains to maximum efficient operating temperature, then it starts cooling.

To avoid overheating and the consequent ill effect, the heat transfer to an engine component (after a certain level) must be removed a quickly as possible conveyed to the atmosphere. It will be proper to say the cooling system as a temperature regulation system. It should be remembered that abstraction of heat from the working medium by way of cooling the engine components is a direct thermodynamics loss. The rate of heat transfer depends upon the wind velocity, geometry of engine surface, area and the ambient temperature. In this work of analysis is done on engine block fins considering temperature inside my means of

Conduction and convection, air velocity is not consider in this work. Motor bike engine are normally designed for operating at a particular atmosphere temperature, however cooling beyond optimum limited is also not considered because it can reduce overall efficiency. This is it may be observe that only surface end cooling is desirable.

Air cool engine generally use individual cases for the cylinder to facilitate cooling. In line motor cycle engines are an expectation , having two-three-four or even six-cylinder air cooled unit in a common block. Water cooled engine with only a few cylinder may also use individual cylinder cases, though this makes the cooling system more complex. The ducati motor cycle company which for year used air cooled motors with individual cylinder cases, retained the basic design of there v-twine engine while adopting it to water-cooling.

1.1 FINS

Fins are provided any where primarily for increasing the rate of heat transfer to the cooling media fins basically increase the rate of heat transfer by increasing the area available for convection. Taking the example of a motor bike engine the heat from the cylinder block gets transferred to the fins via conduction.

1.2 FIN USED

Fins are they extended surface protruding from a surface or body and they are meant for increasing they heat transfer rate between the surface and the surrounding fluid by increasing heat transfer area.

1.3 TYPES OF FINS

Infinitely long fin

Short fin-end is insulated

Short fin-end is not insulated

1.4 APPLICATION OF FINS

Cooling of electronics components

Cooling of motor cycle engine

Cooling of small capacity compressors

Cooling of transformer

Cooling of radiators

1.5 ENGINE FIN DIMENSION

The cylinder diameter of 50mm and height of 53mm have be for the present analysis. The fin thickness is 2.5mm and gap between fins is 7.5mm the engine cylinder is designed with different fin geometrics.

1.6 FINS

A fins is a surface that extents from on object to increase the rate of heat transfer to or from the environment by increasing convection. The amount of conduction, convection , radiation of an object determine the amount of heat it transfers. An increasing the temperature difference between the object and the environment ,increasing the convection heat transfer coefficient or increasing the surface area of the object increases the heat transfer. Sometimes it is not economical or it is not feasible to change the first two options.

1.1 figure of fin

1.6.1 Fins terminology and type

Fin base

Fin tip

Straight fin

Variable cross section area fin

Pin fin

1.6.2 Thermal analysis

Thermal analysis is a branch of material science where the properties of materials are studied as they change with temperature several method are commonly used- these are distiguneshed from one another properties which is measured.

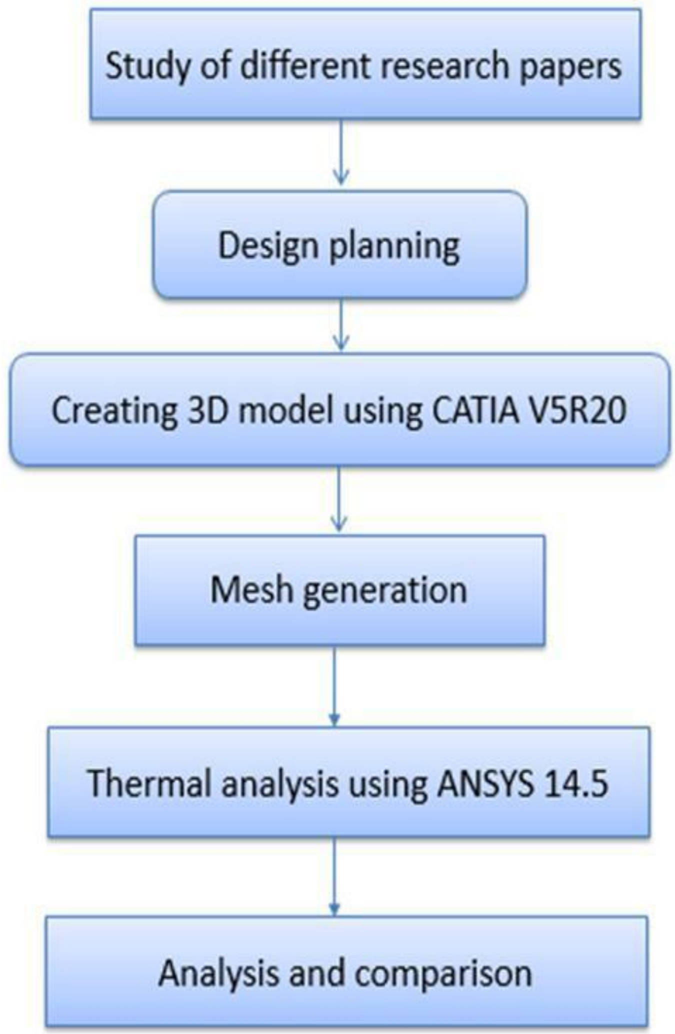
Dielectric thermal analysis(DEA)

Thermal analysis (DTA)

Thermo gravimetric analysis (TGA).

CHAPTER 2

METHODOLOGY



2.1 EXISTING SYSTEM

In exixting engine fin we are having a cylinder like structure for temperature reduction. This may result in increase in weight as well as occupying a higher space

.

2.2 PROPOSED SYSTEM

In the current project we are going to modify the current design by convection cylindrical in to conical structure this may result in higher weight reduction which result in increased few efficiency and also reduction in temperature distribution, total heat flux and directional heat flux.

CHAPTER 3

LITERATURE REVIEW

TITLE: Thermal Analysis of Engine Cylinder with Fins by using ANSYS Workbench

AUTHOR: Mulukuntla Vidya Sagar, Nalla Suresh

ABSTRACT: The Engine cylinder is one of the major automobile component, which is subjected to high temperature variations and thermal stresses. In order to cool the cylinder, fins are provided on the surface of the cylinder to increase the rate of Heat transfer. By doing thermal analysis on the engine cylinder and fins around it, It is helpful to know the heat dissipation rate and Temperature Distribution inside the cylinder. We know that, by increasing the surface area we can increase the heat dissipation rate, so designing such a large complex engine is very difficult. The main aim of the present project is to analyse the thermal properties like Directional Heat Flux, Total Heat Flux and Temperature Distribution by varying Geometry(Circular, Rectangular),material (Aluminium Alloy, Magnesium Alloy) and thickness of Fin (3mm,2mm) of an approximately square cylinder model prepared in SOLIDWORKS-2013 which is imported into ANSYS WORKBENCH-2016 for Transient Thermal analysis with an Average Internal Temperature and Stagnant Air-Simplified case as Cooling medium on Outer surface with reasonable Film Transfer Coefficient as Boundary Conditions.

TITLE: Design Modification And Thermal Analysis of IC Engine Fin

AUTHOR: Deepak Tekhre, Jagdeesh Saini

ABSTRACT: Cooling fins in IC engines remove excess heat from it to protect its components from thermal damages. These fins work on the principle of convection heat transfer. The cooling efficiency of the engine fins can be improvised by changing geometry, thermal conductivity and the material of the cooling fins. Computational fluid dynamics is the technique used to determine thermal stresses and temperature distribution through the fins. CFD analysis gives accurate and realistic results in comparison with physical analysis processes. This project is based on designing more efficient cooling fins for a 150 cc (Honda Unicorn) bike engine by improvising the design and the material of the fin. Where the modelling of the fin is performed on Creo modelling software and the CFD analysis is performed on ANSYS 15.0 Workbench software.

TITLE: Thermal Analysis Of Engine Cylinder Fins By Varying Its Geometry And Material

AUTHOR: N. Phani Raja Rao, Mr. T. Vishnu Vardhan

ABSTRACT: The Engine cylinder is one of the major automobile components, which is subjected to high temperature variations and thermal stresses. In order to cool the cylinder, fins are provided on the surface of the cylinder to increase the rate of heat transfer. By doing thermal analysis on the engine cylinder fins, it is helpful to know the heat dissipation inside the cylinder. The principle implemented in the project is to increase the heat dissipation rate by using the invisible working fluid, nothing but air. We know that, by increasing the surface area we can increase the heat dissipation rate, so designing such a large complex engine is very difficult. The main purpose of using these cooling fins is to cool the engine cylinder by air. The main aim of the project is to analyze the thermal properties by varying geometry, material and thickness of cylinder fins. Transient thermal analysis determines temperatures and other thermal quantities that vary over time. The variation of temperature distribution over time is of interest in many applications such as in cooling. The accurate thermal simulation could permit critical design parameters to be identified for improved life.

TITLE: Design and Analysis of Engine Cylinder Fins of Varying Geometry and Materials

AUTHOR: Manir Alam, Assoc.Prof. Mrs. M. Durga Sushmitha

ABSTRACT: The Engine cylinder is one of the major automobile components, which is subjected to high temperature variations and thermal stresses. In order to cool the cylinder, fins are provided on the cylinder to increase the rate of heat transfer. By doing thermal analysis on the engine cylinder fins, it is helpful to know the heat dissipation inside the cylinder. The principle implemented in this project is to increase the heat dissipation rate by using the invisible working fluid, nothing but air. We know that, by increasing the surface area we can increase the heat dissipation rate, so designing such a large complex engine is very difficult. The main purpose of using these cooling fins is to cool the engine cylinder by air. Presently Material used for manufacturing cylinder fin body is Cast Iron. In this thesis, using materials Copper and Aluminium alloy 6082 are also analyzed. Thermal analysis is done using all the three materials by changing geometries, distance between the fins and thickness of the fins for the actual model of the cylinder fin body.

CHAPTER 4

INTRODUCTION TO CAD/CAM/CAE

The Modern world of design, development, manufacturing so on, in which we have stepped can't be imagined without interference of computer. The usage of computer is such that, they have become an integral part of these fields. In the world market now the competition in not only cost factor but also quality, consistency, availability, packing, stocking, delivery etc. So are the requirements forcing industries to adopt modern technique rather than local forcing the industries to adapt better techniques like CAD / CAM / CAE, etc.

The Possible basic way to industries is to have high quality products at low costs is by using the computer Aided Engineering (CAE), Computer Aided Design (CAD) And Computer Aided Manufacturing (CAM) set up. Further many tools is been introduced to simplify & serve the requirement CATIA, PRO-E, UG are some among many.

This penetration of technique concern has helped the manufacturers to

a) Increase productivity

b) Shortening the lead-time

c) Minimizing the protype expense

d) Improving quality

CAD: Computer Aided Designing (Technology to create, Modify, Analyze or Optimize the design using computer.

CAE: Computer Aided Engineering (Technology to analyze, Simulate or Study behavior of the cad model generated using computer.

CAM: Computer Aided Manufacturing (Technology to Plan, manage or control the operation in manufacturing using computer.

4.1 NEED FOR CAD, CAE, CAM

Usage of CAD CAE & CAM have changed the overlook of the industries and developed healthy and standard competition, as could achieve target in lean time and ultimately the product reaches market in estimated time with better quality and consistency. In general view ,it as lead to fast approach and creative thinking,

4.2 ADVANTAGES

Cut off of the designing time

Cut off of the editing time

Cut off of the manufacturing time

High and control quality

Reduction of process cost

4.3 DISADVANTAGES

Require skilled operators

Applicable if production is high

Time setting cost is more

4.4 INTRODUCTION OF CATIA

CATIA is a robust application that enables you to create rich and complex designs. The goals of the CATIA course are to teach you how to build parts and assemblies in CATIA, and how to make simple drawings of those parts and assemblies. This course focuses on the fundamental skills and concepts that enable you to create a solid foundation for your designs.

4.5 SOLID MODELLING

A solid model is the most complete type of geometric model used in CAD systems. It contains all the wireframe and surface geometry necessary to fully describe the edges and faces of the model. In addition to geometric information, solid models also convey their ―topology‖, which relates the geometry together. For example, topology might include identifying which faces (surfaces) meet at which edges (curves). This intelligence makes adding features easier.

4.6 FULLY ASSOCIATIVE

A CATIA model is fully associative with the drawings and parts or assemblies that reference it. Changes to the model are automatically reflected in the associated drawings, parts, and/or assemblies. Likewise, changes in the context of the drawing or assembly are reflected back in the model.

4.7 CONSTRAINTS

Geometric constraints (such as parallel, perpendicular, horizontal, vertical, concentric, and coincident) establish relationships between features in your model by fixing their positions with respect to one another. In addition, equations can be used to establish mathematical relationships between parameters. By using constraints and equations, you can guarantee that design concepts such as through holes and equal radii are captured and maintained.

4.8 CATIA USER-INTERFACE

Below is the layout of the elements of the standard CATIA application.

Menu Commands

Specification Tree

Window of Active document File name and extension of current document

Icons to maximize/minimize and close window

Icon of the active workbench

Toolbars specific to the active workbench

Standard toolbar

Compass

Different types of engineering drawings, construction of solid models, assemblies of solid parts can be done using inventor.

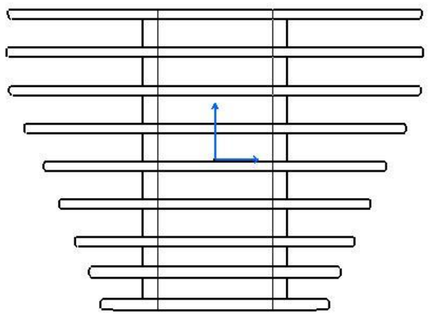
Different types of files used are:

1. Part files: .CAT Part
2. Assembly files: .CAT Product

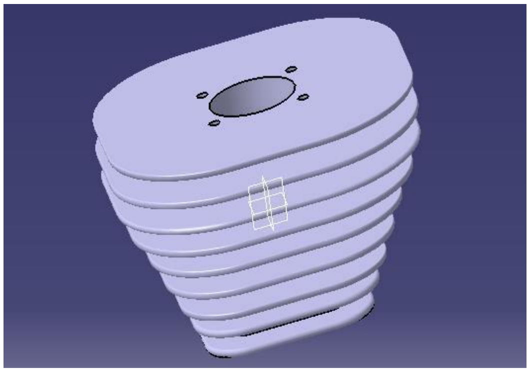
4.9 WORKBENCHES

Workbenches contain various tools that you may need to access during your part creation. You can switch between any primary workbenches using the following two ways.

4.10 DESIGN IMAGE



4.10.1 2D design engine fin



4.10.2 3D design engine fin catia

4.11 DESIGN DETAIL

4.11.1 Modelling of Cylinder Fin:

Cylinder along with fin was modelled in SOLIDWORKS-2013. The dimensions of the cylinder along with fin were taken for a square engine whose stroke ratio is unity. Fins with different geometries (circular and rectangular) were modelled using SOLIDWORKS-2013.

4.11.2 Procedure

- Observe and understand the given models top and front view clearly and there dimension
- Adjust the unit system in solid works as SI system
- Go to sketch select the front view from the given views
- First draw the center line assumed distance by using line command
- Then draw one side of front view with assume dimension
- By using the smart dimension command adjust the fin length , groove length , upward projection of cylinder and projection distance from center line which is the diameter of the fin flank in case of circular fins and for the rectangular fins take it as the diagonal length of the fin flank

- in case of circular fins, the fin model is ready but in case of rectangular fins we need to perform extrude cut in downward direction by using the extrude cut option film cut need to perform to remove the excess projection of rectangular shape.

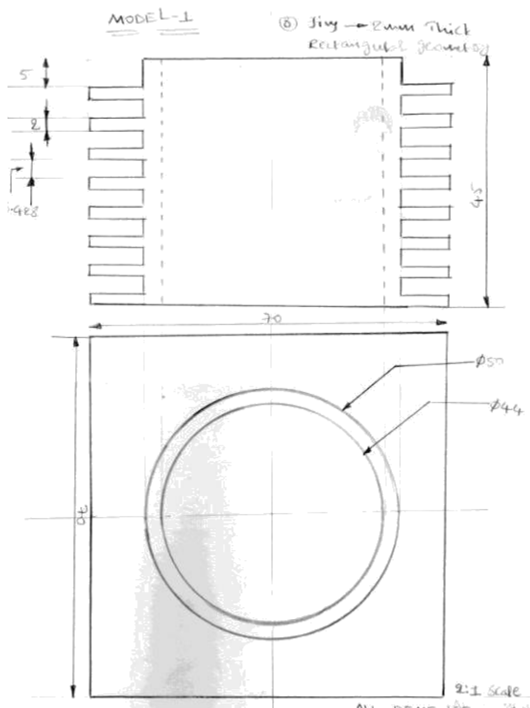


Fig 4.11.1 model - 1

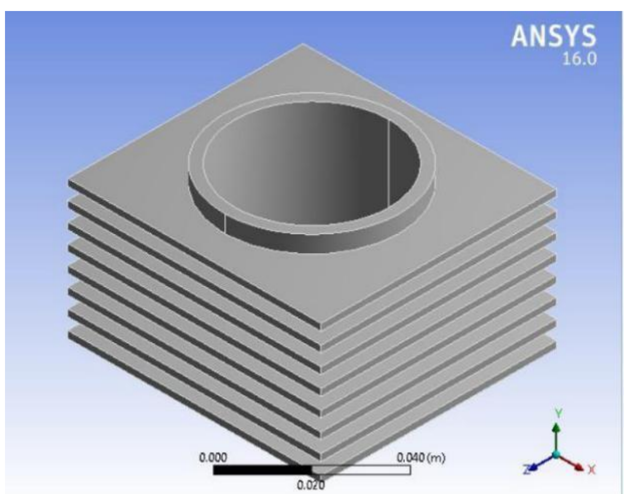


Fig 4.11.2 rectangular fin of 2mm thickness

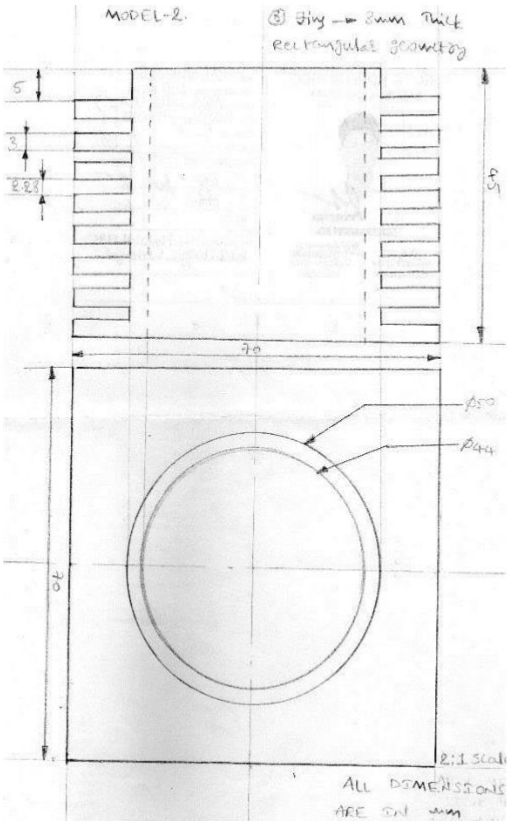


fig 4.11.3 model-2

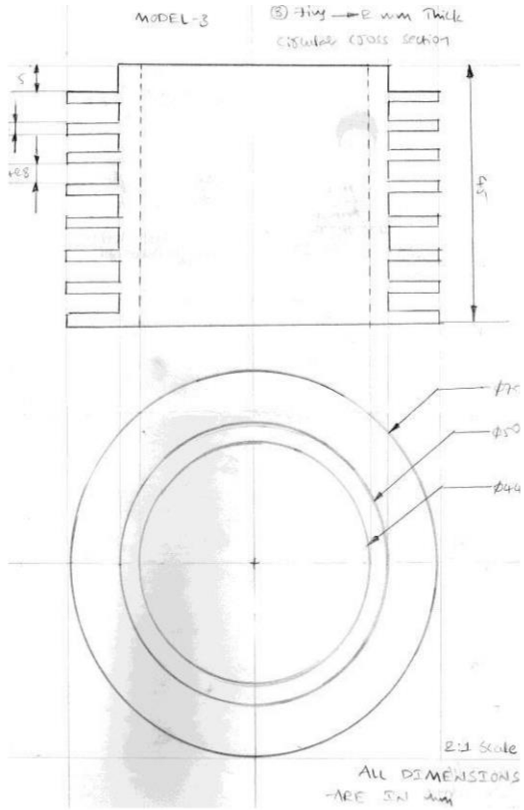


fig 4.11.4 model-3

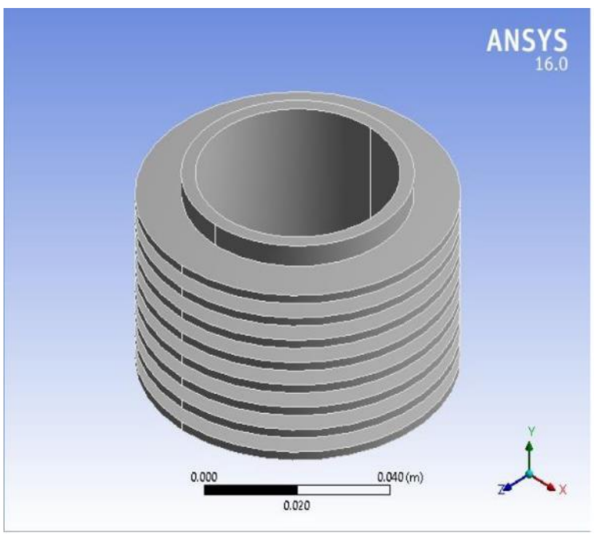


Fig 4.11.5 circular fin

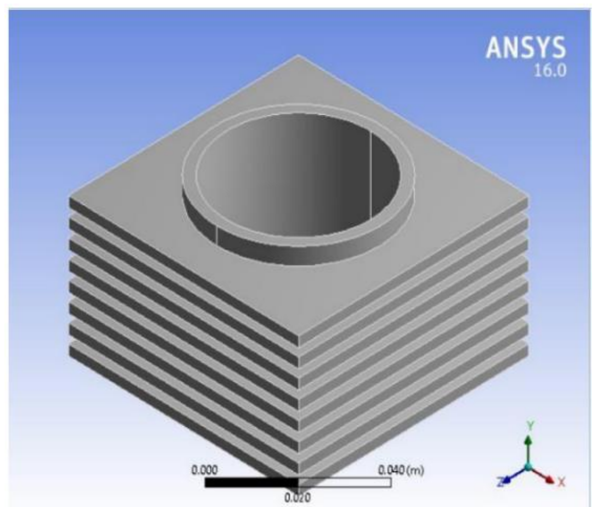


Fig 4.11.6 rectangular fin

CHAPTER 5
SELECTION OF MATERIAL

5.1 EXPERIMENTAL DETAIL

5.1.1 The boundary condtion

Sl. No.	Loads	Units	Value
1	Inlet temperature	K	1073
2	Film coefficient	$W/m^2 K$	5
3	Ambient temperature	K	303
4	Material		Aluminium Alloy, Magnesium Alloy

Table 5.1.1 input parameter

5.1.2 Material data

Aluminium Alloy

Density	**2770 kg m^-3**
Coefficient of Thermal Expansion	**2.3e-005 C^-1**
Specific Heat	**875 J kg^-1 C^-1**

Table 5.1.2 aluminium alloy constants

Magnesium alloy

Density	**1800 kg m^-3**
Coefficient of Thermal Expansion	**2.6e-005 C^-1**
	1024 J kg^-1 C^-1
Thermal Conductivity	**156 W m^-1 C^-1**
Resistivity	**7.7e-007 ohm m**

Table 5.1.3 magnesium alloy constant

5.2 MATERIAL PROPERTIES

5.2.1 Aluminum alloy

Light weight and structural material.

Resistance to corrosion .

Maintain strength at high temperature.

5.2.2 Magnesium alloy

Light weight and structural material.

Lightest of the commonly used alloy.

High tensile yield strength.

5.2.3 Cast Iron

High compressive strength.

Good machine ability.

Good thermal conductivity.

Good resistance to thermal fatigue.

5.3 ADVANTAGE

Heat transfer rate will be higher.

Increase engine efficiency.

Reduce weight of the fin thus increase the fuel efficiency.

5.4 DISADVANTAGE

The length of fins is directly proportional to the heat transfer rate.

The larger is may be case of pending in the fins and also increase the weight of engine.

The overall efficiency will goes to decrease.

5.5 COMPARISION OF ENGINE FIN

5.5.1 CONICAL ENGINE DESIGN FIN

Cast Iron

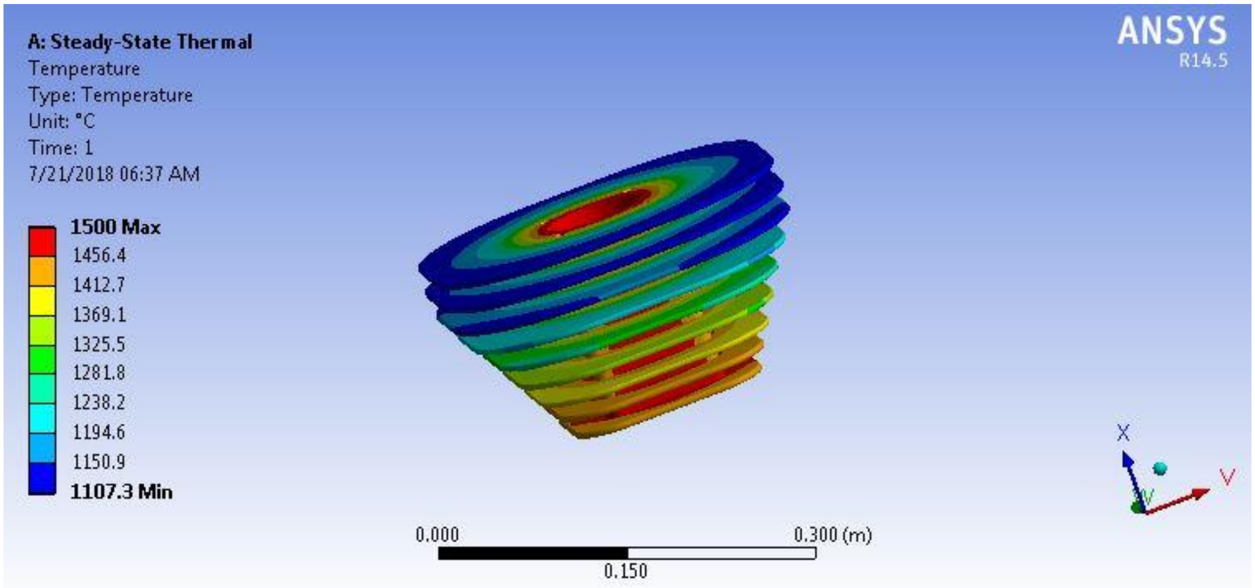


Fig 5.1 Temperature in conical

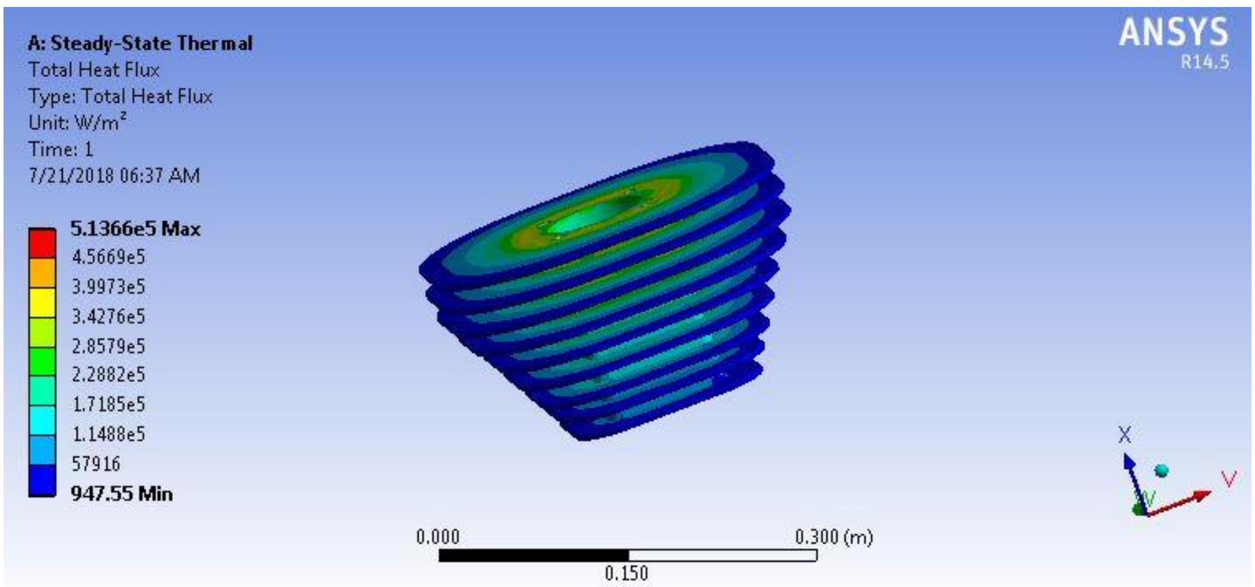


Fig 5.2 Total heat flux in conical

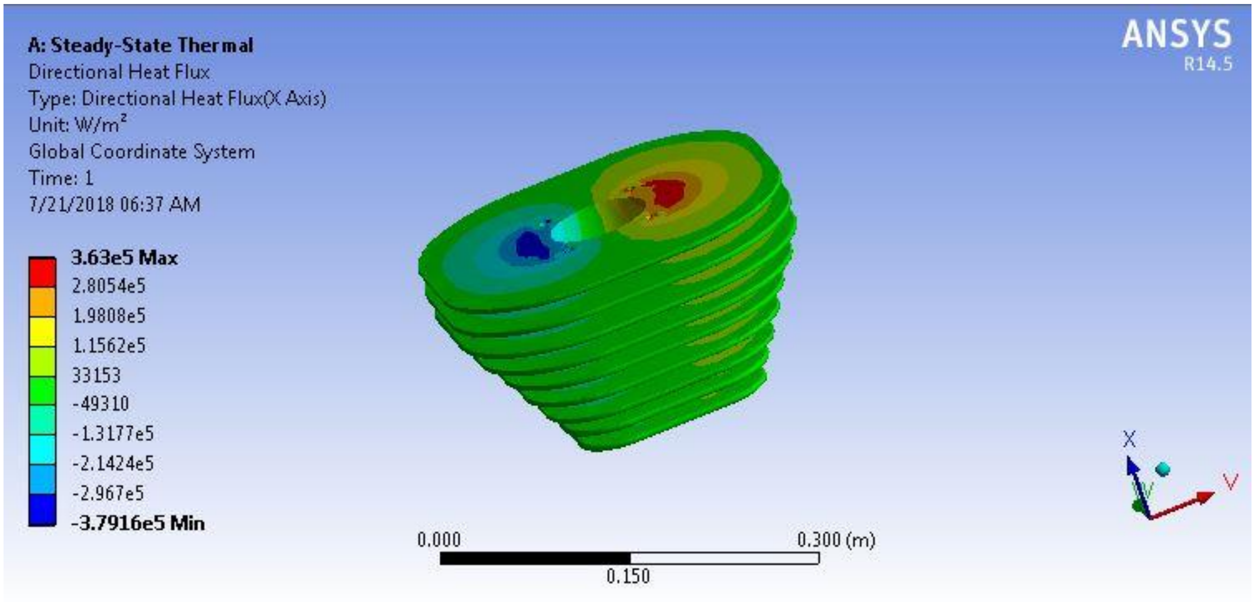


Fig 5.3 Directional heat flux in conical

Magnesium alloy

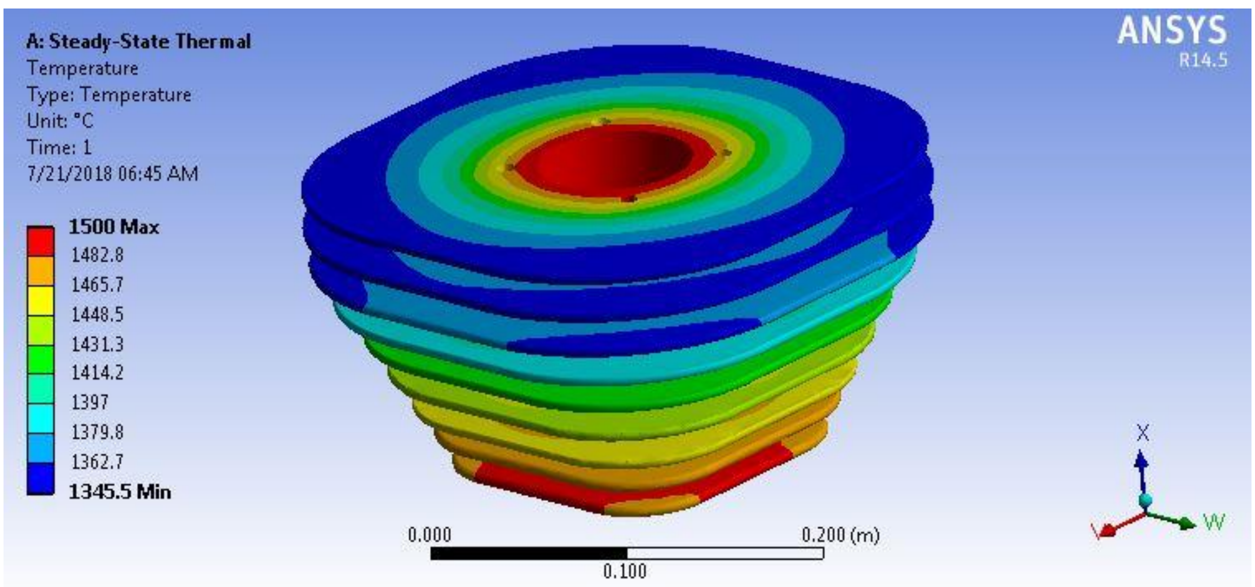


Fig 5.4 Temperature in conical

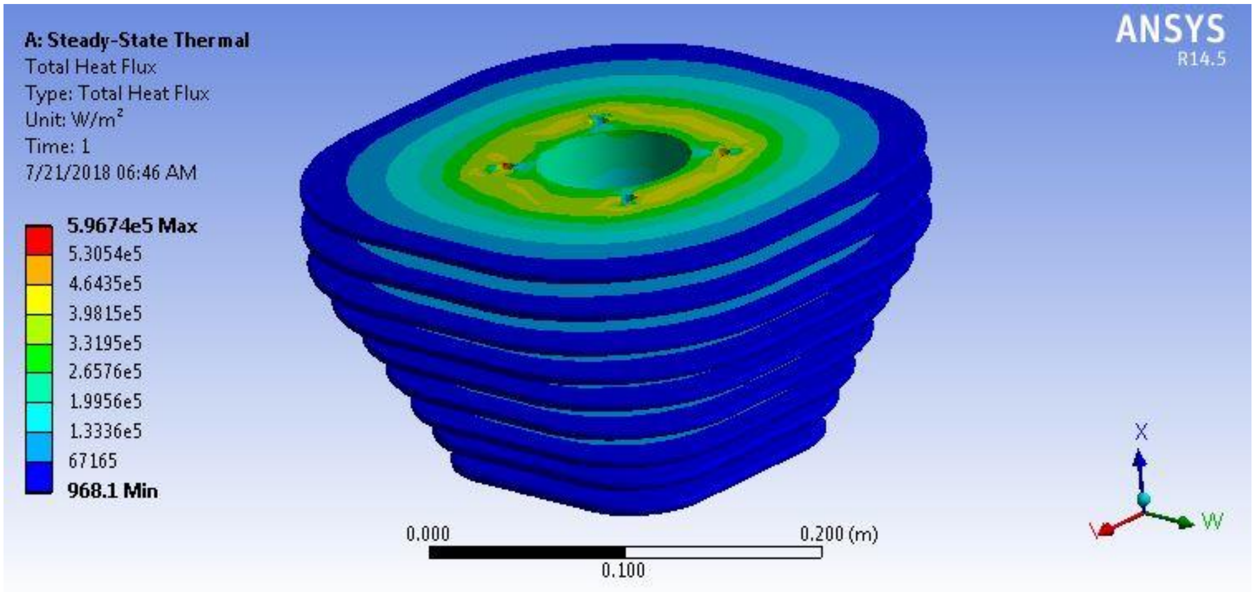


Fig 5.5 Total heat flux in conical

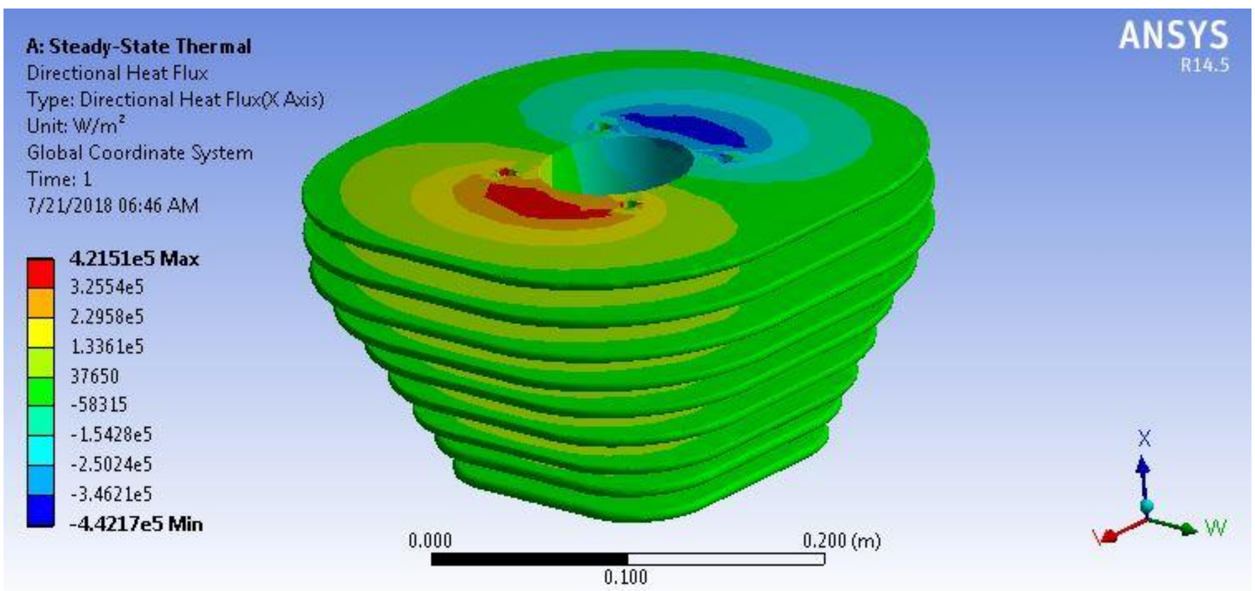


Fig 5.6 Directional heat flux in conical

Aluminium Alloy

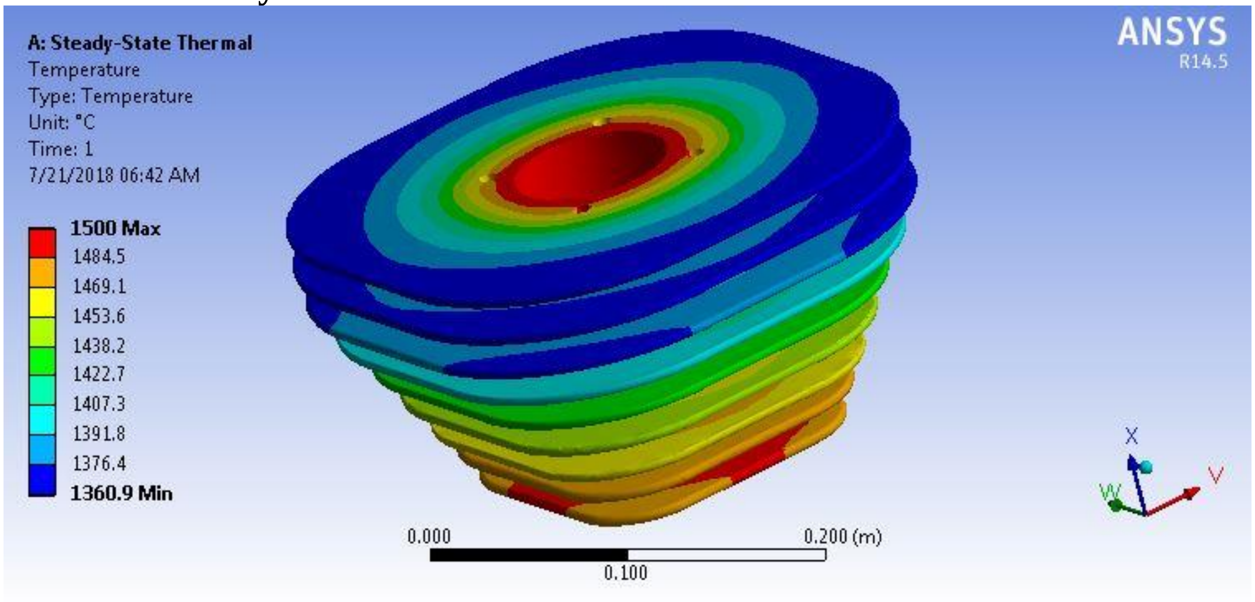


Fig 5.7 Temperature in conical

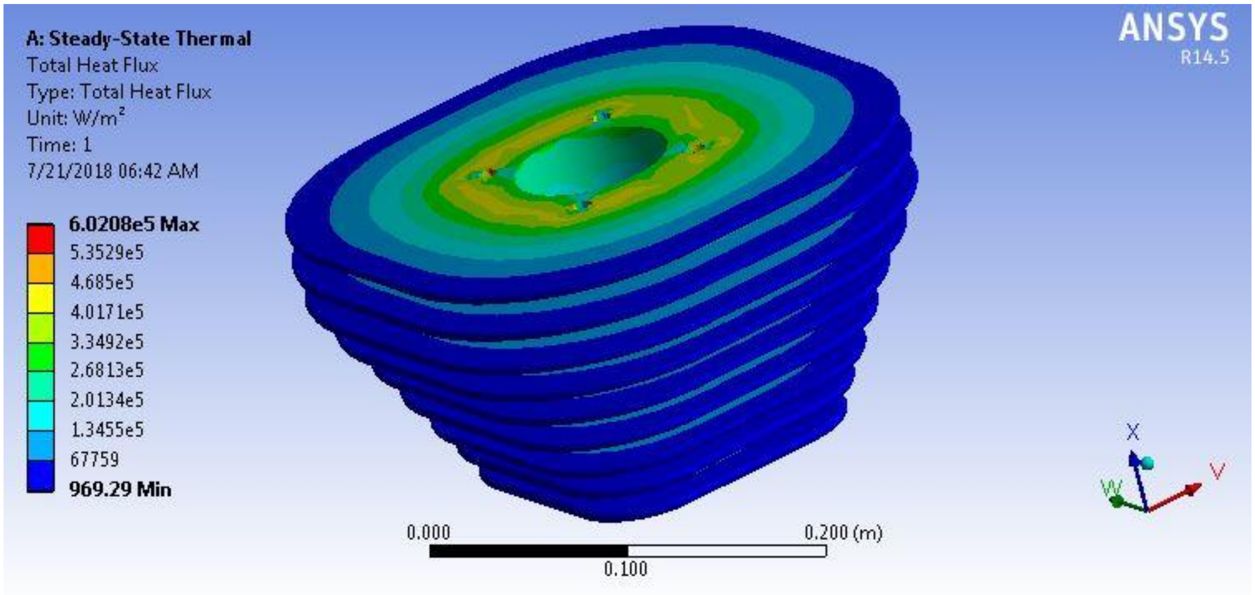


Fig 5.8 Total heat flux in conical

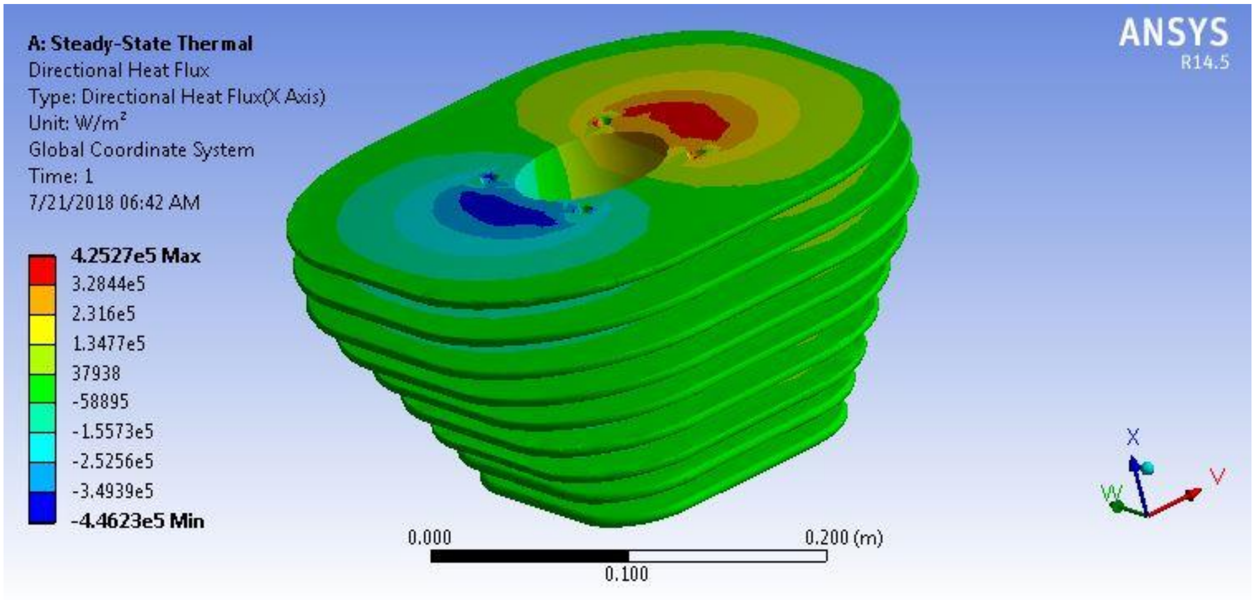


Fig 5.9 Directional heat flux in conical

5.5.2 RECTANGULAR DESIGN ENGINE FIN

Cast Iron

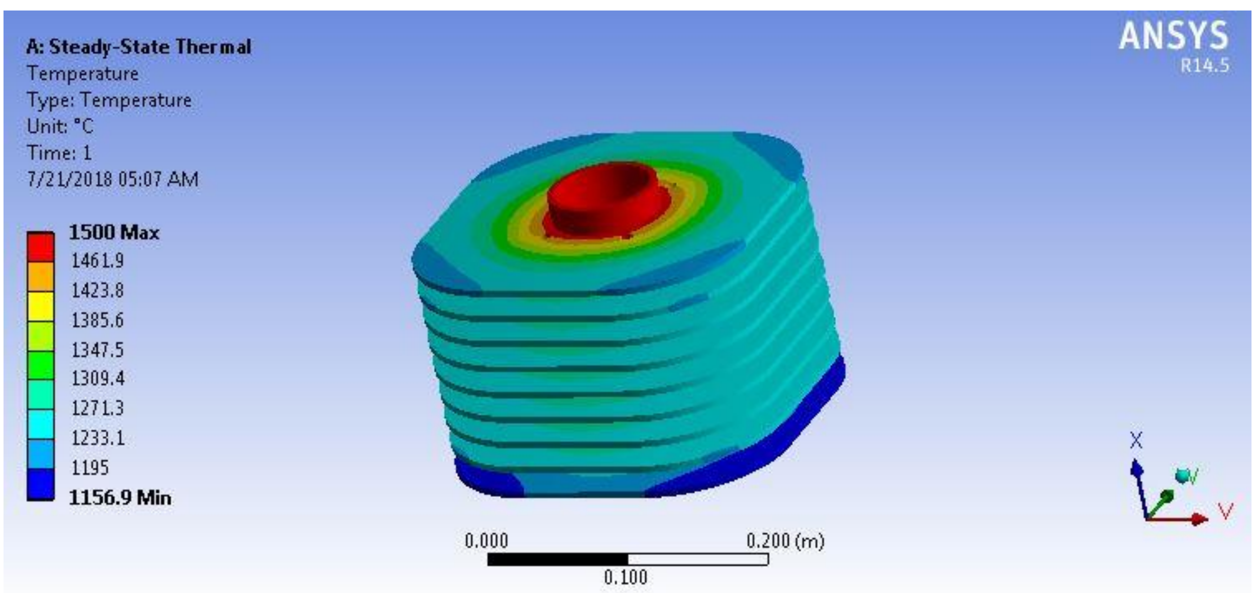


FIG 5.10 Temperature in rectangular

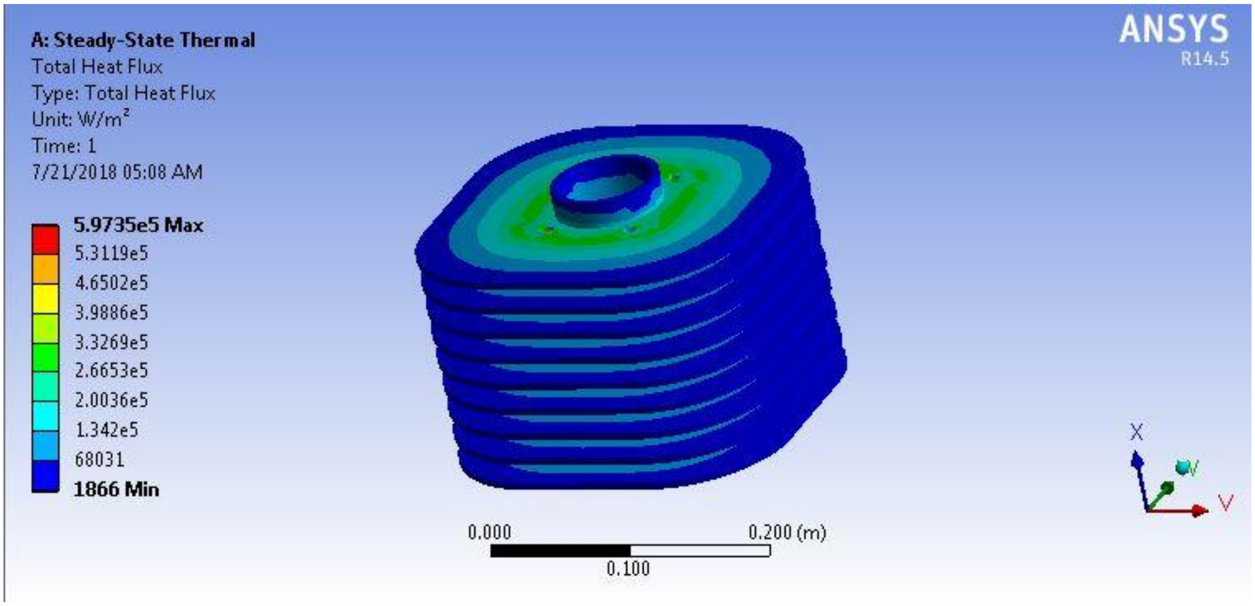


Fig 5.11 Total heat flux in rectangular

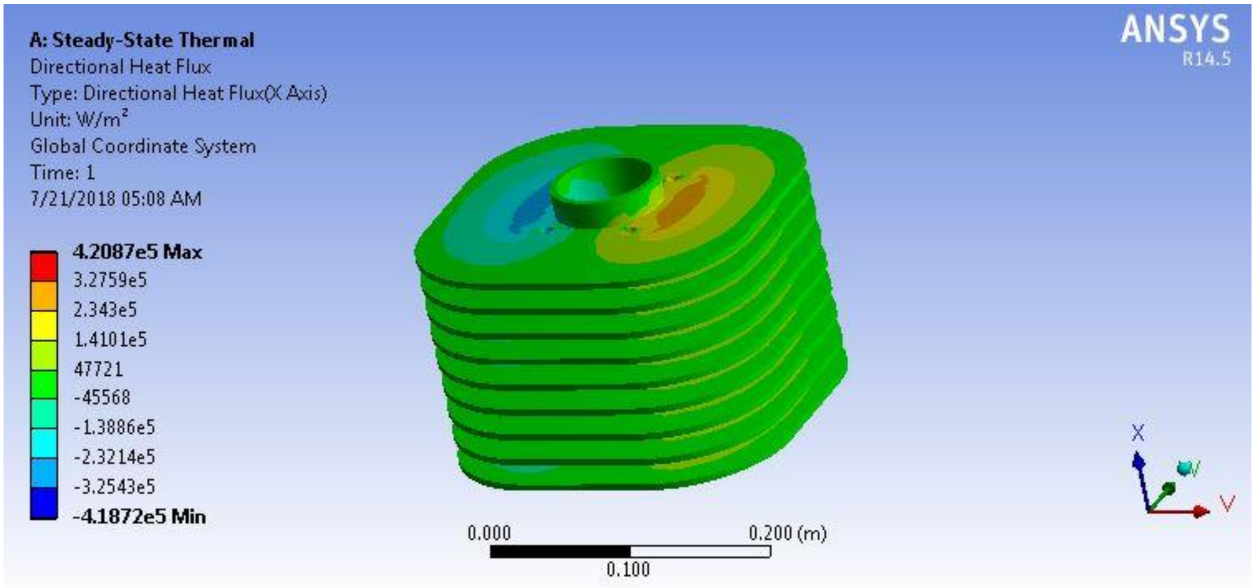


Fig 5.12 Directional heat flux in rectangular

Magnesium alloy

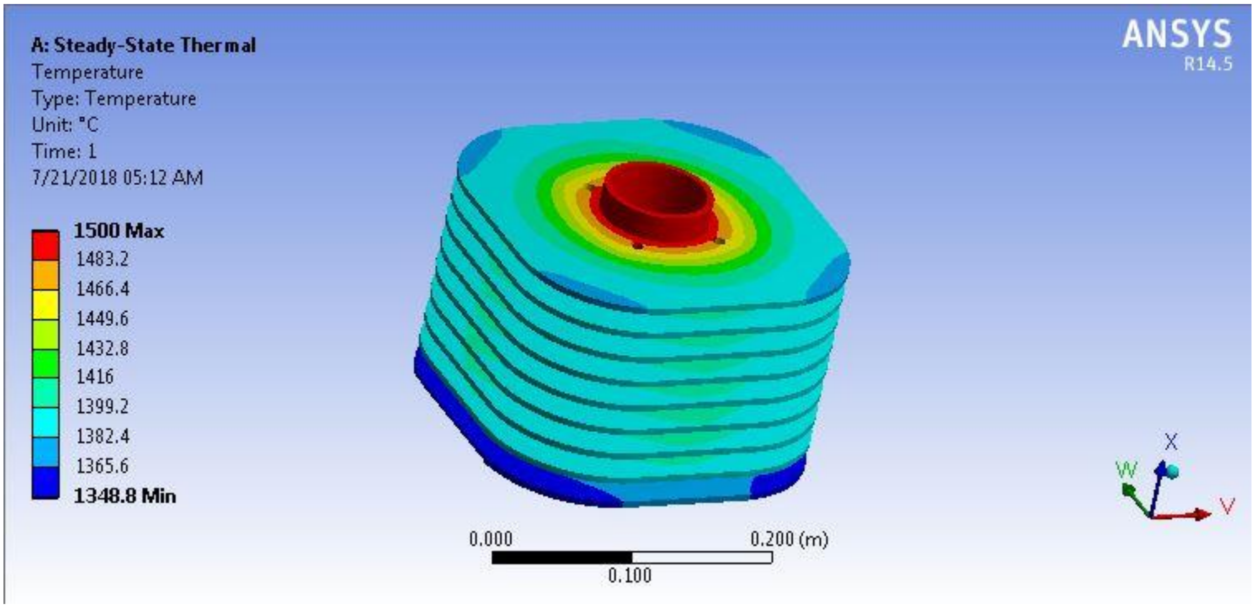


Fig 5.13 Temperature in rectangular

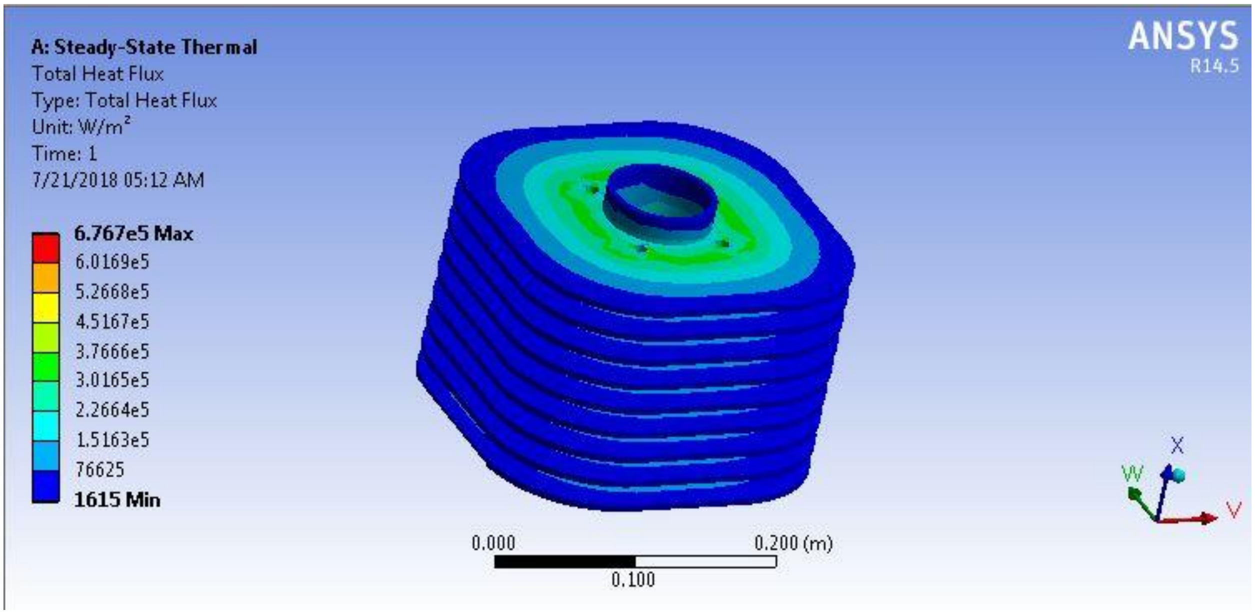


Fig 5.14 Total heat flux in rectangular

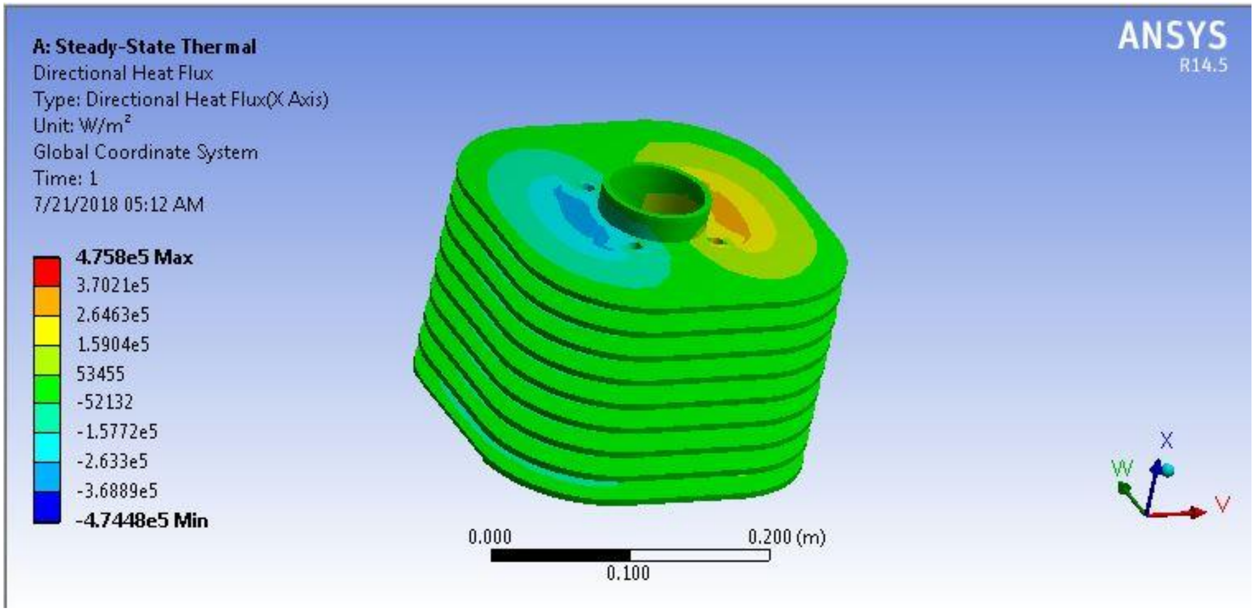


Fig 5.15 Directional heat flux in rectangular

Aluminum alloy

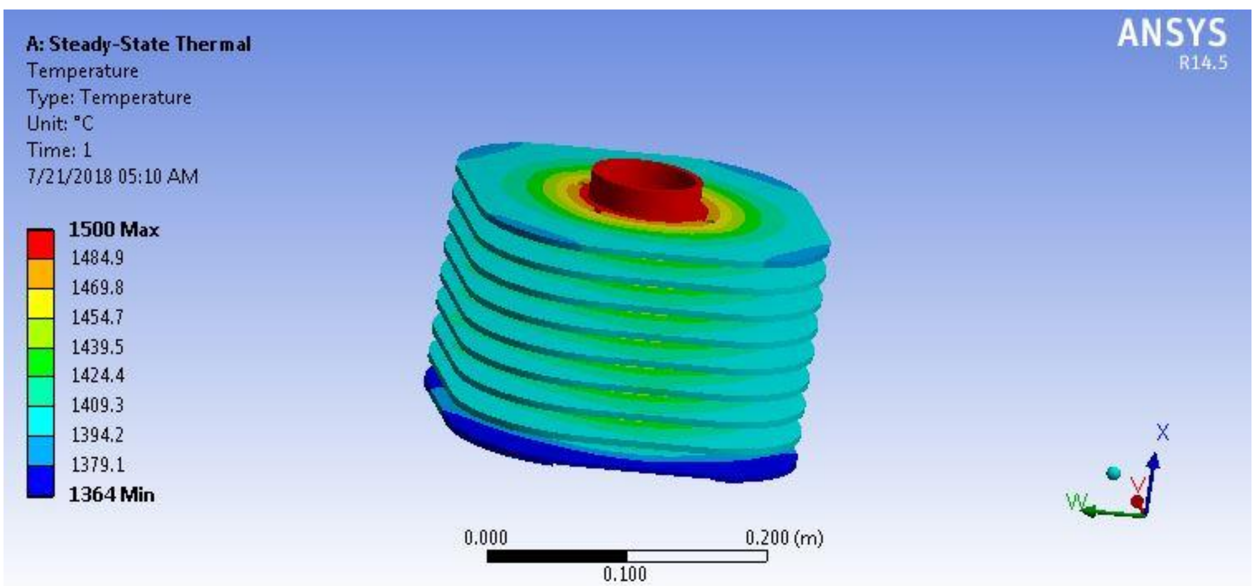


Fig 5.16 Temperature in rectangular

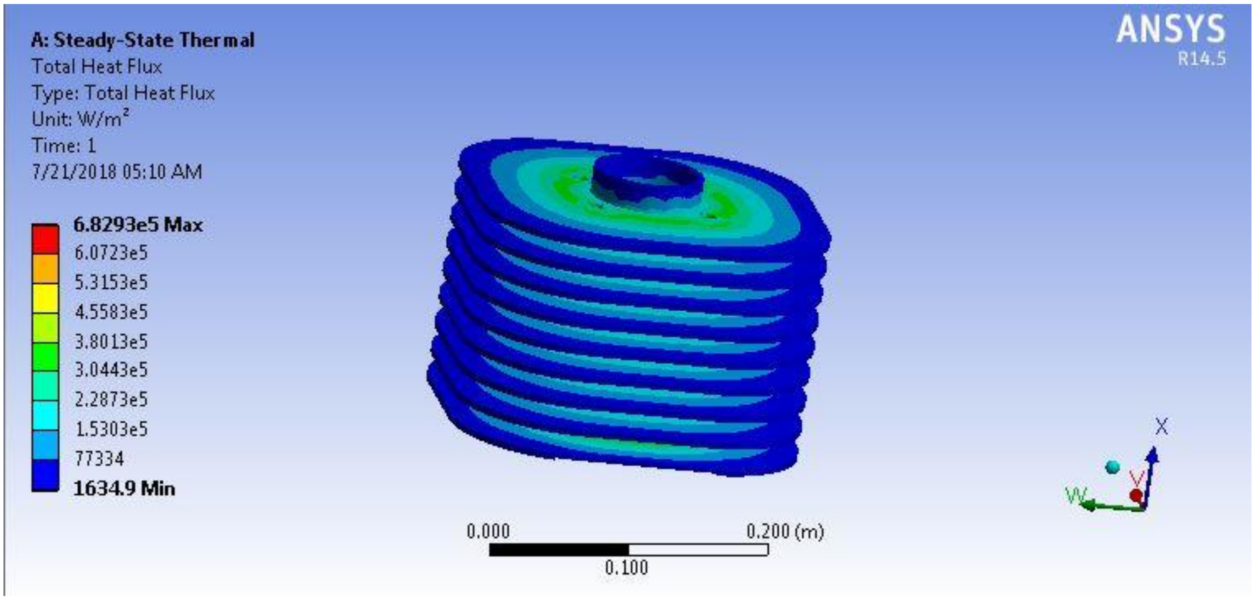


Fig 5.17 Total heat flux in rectangular

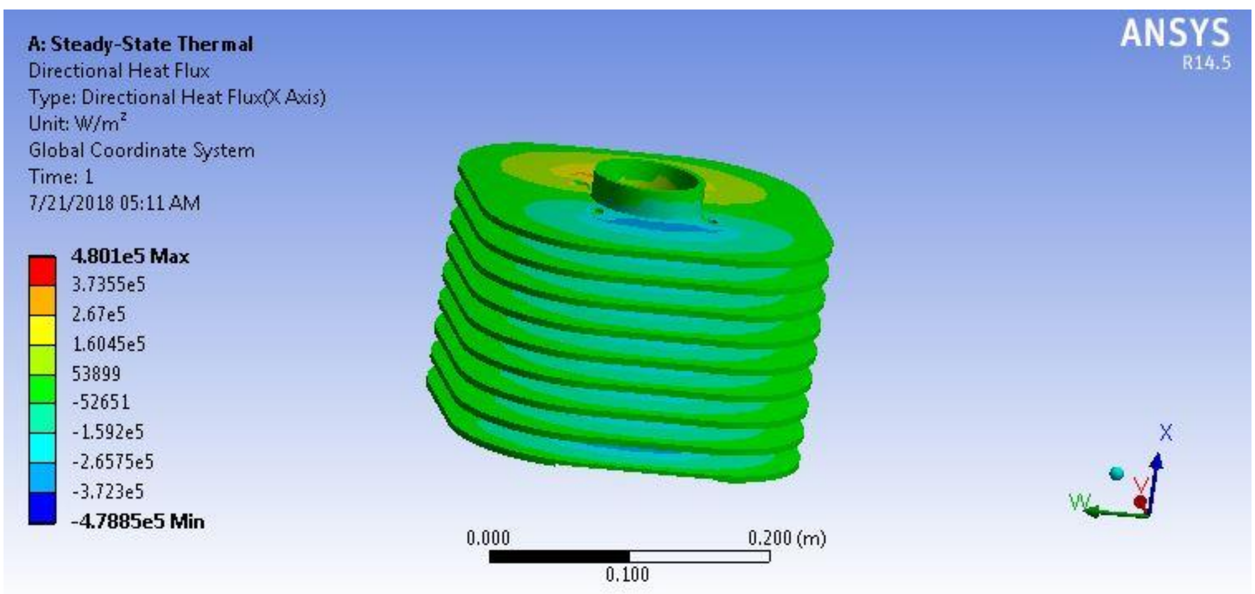


Fig 5.18 Directional heat flux in rectangular

CHAPTER 6

RESULT AND DISCUSSION

6.1 RESULTS OF CONICAL ENGINE FIN

S.No.	Content		Cast iron	Mg alloy	Al alloy
1	Temperature		1107.3	1345.5	1360.9
2	Total heat flux	Max	5.136e5	5.967e5	6.020e5
		Min	947.55	968.1	969.2
3	Directional heat flux	Max	3.63e5	4.215e5	4.252e5
		Min	-3.791e5	-4.421e5	-4.462e5

Table 6.1 Comparison of cast iron , Mg alloy, Al alloy (conical)

6.2 RESULT OF RECTANGULAR ENGINE FIN

S.No.	Content		Cast iron	Mg alloy	Al alloy
1	Temperature		1156.9	1348.8	1364
2	Total heat flux	Max	5.973e5	6.767e5	6.829e5
		Min	1866	1615	1634.9
3	Directional heat flux	Max	4.208e5	4.758e5	4.801e5
		Min	-4.187e5	-4.744e5	-4.788e5

Table 6.2 comparison of Cast iron , Mg ally, Al alloy (rectangular)

A model of the cylinder with fins mounted on its used for analysis in the present project. This is imported into ANSYS workbench environment and boundary condition were applied as mentioned above. Analysis is carried out for different geometry of fin (conical and rectangular) with various thickness and materials.

6.3 TEMPERATURE DISTRIBUTION

From the above results , we can observe that the 5th model which is made of aluminum alloy with 2mm thick conical shape circumferences fins can attained maximum temperature of 797.84^{o}c. which is also maximum amongst all the other model value of maximum temperature and the temperature and the time taken to attain this steady state is 14.8sec.

6.4 TOTAL HEAT FLUX

Which it is matter of total heat flux conductor by the cylinder the variations observed is as follows:

A model-1 which is made of aluminum alloy with 2mm rectangular circumference conduct more the total heat flux when compared with all the other model.

When material is point of interest , aluminum alloy conducts more total heat flux because model-2 which is made of magnesium alloy with some features as model -1expect material change conducting less total heat flux.

6.5 DIRECTIONAL HEAT FLUX

In case of Directional Heat flux all the results are similar to Total Heat flux The Directional heat flux conducted by the material increases with increase in amount of material but decreases with increase in fin thickness and it is high in rectangular geometry when compared with circular geometry. Aluminum alloy fin conducts more directional heat than that of magnesium alloy fin with the same geometry and fin thickness.

CHAPTER 7
CONCLUSION

In present work, a cylinder fin body is modelled by using CATIA V5R20 and Transient thermal analysis is done by using ANSYS WORKBENCH-2016. These fins are used for air cooling systems for two wheelers. In present study, Aluminium alloy is compared with Magnesium alloy. The various parameters (i.e., geometry and thickness of the fin) are considered, by reducing the thickness and also by changing the shape of the fin to circular shape from the conventional geometry i.e. rectangular, the weight of the fin body reduces there by increasing the heat transfer rate and efficiency of the fin. The results shows, By using rectangular fin with material Aluminium Alloy is better since heat transfer rate of the fin is more. By using circular fins the weight of the fin body reduces compared to existing rectangular engine cylinder fin.

CHAPTER 8
REFERENCE

Biermann, A. E. and B. Pinkel (1934). Heat Transfer from finned metal cylinders in an air stream, NACA Report.

Denpong Soodphakdee, et al. (2001). "A Comparison of Fin Geometries for Heatsinks in Laminar Forced Convection Part 1 -Round, Elliptical, and Plate Fins in Staggered and In-Line Configurations." The International Journal of Microcircuits and Electronic Packaging

Fernando Illan and M. Alarcon (2002). "Optimization of Annular Cylindrical and Spherical Fins in an Internal Combustion Engine under Realistic Conditions." Journal of Thermal Science and Engineering Applications.

D.G.Kumbhar, et al. (2009). Finite Element Analysis and Experimental Study of Convective Heat Transfer Augmentation from Horizontal Rectangular Fin by Triangular Perforations. Proc. of the International Conference on Advances in Mechanical Engineering.