Heat Transfer Analysis of Engine Cylinder Fins Having Triangular Shape

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Indian two-wheeler market is the world's second biggest market. Among the three segments (motorcycles, scooters and mopeds) of the Indian two wheeler market, major growth trends have been seen in the motorcycle segment over the last four to five years due to its resistance and balance even on bad road conditions. In Indian motorcycles, Air-cooling is used due to reduced weight and simple in construction of engine cylinder block. As the air-cooled engine builds heat, the cooling fins allow the wind and air to move the heat away from the engine. Low rate of heat transfer through cooling fins is the main problem in this type of cooling. 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 of cylinder fins.

There are three basic mechanisms of heat transfer which are often referred as modes of heat transfer. These are conduction, convection and radiation. All the energy transfer that takes place in the form of heat is either any one or a combination of these.

1. Conduction
2. Convection
3. Radiation

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Extended Surfaces

It is most common approach to enhance the Heat transfer by using the extended surfaces. A plain fin may increases the surface area but a special shape extended surface may increase heat transfer coefficient in addition to the heat exchanger. The extended surfaces for liquids typically use much smaller fin heights than that used for gases because of the higher heat transfer coefficient for liquids. Use of high fins with liquids would result in low fin efficiency and result in poor material utilization. Externally finned tube and internally finned tube are tha examples of extended surfaces for liquids.

The temperature distribution, rate of heat transfer and fin effectiveness for six common profiles of longitudinal fins are given below. The analytical expressions given for these profiles are based on the following assumptions:

1. The heat conduction in the fin is steady and one dimensional.
2. The fin material is homogeneous and isotropic.
3. There is no energy generation in the fin.
4. The convective environment is characterized by a uniform and constant heat transfer coefficient and temperatures.
5. The fin has a constant thermal conductivity.
6. The contact between the base of the fin and the primary surface is perfect.
7. The fin has a constant base temperature.

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Application

1. Fins are commonly used as heat management in electrical appliances.
2. Condensers in Refrigeration and Air Conditioning.
3. Engine Cooling.
4. Thin plate of fins of Car Radiator
5. Heat exchanger in power plant
6. Most effective in application where heat transfer coefficient (h) is low.
7. Nature has also taken advantage of the phenomena of fins. The ears of jackrabbits and fennec foxes act as fins to release heat from the blood that flows through them.
8. In old times say Dinosaur time, Fins are on the backside of the Dinosaur.
9. Fins are also used in automobiles like engine cylinder with fins.

10. Fins are employed range from small electronic components to large power and process heat exchangers.

The following are the methodologies of the **thesis work**:

1. To design cylinder with fins for a 150 cc engine by varying the geometry such as rectangular, circular and triangular shaped fins.
2. To determine transient thermal properties of the proposed fin models
3. To identify suitable material for the engine cylinder fins.

Sr. No.	Parameter	Forms
1	Type of fins	1. Rectangular 2. Circular 3. Triangular
2	Thickness of the fin	3 mm
3	Material of the fin	1. Aluminum Alloy 2. Magnesium Alloy

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Model of the proposed fin

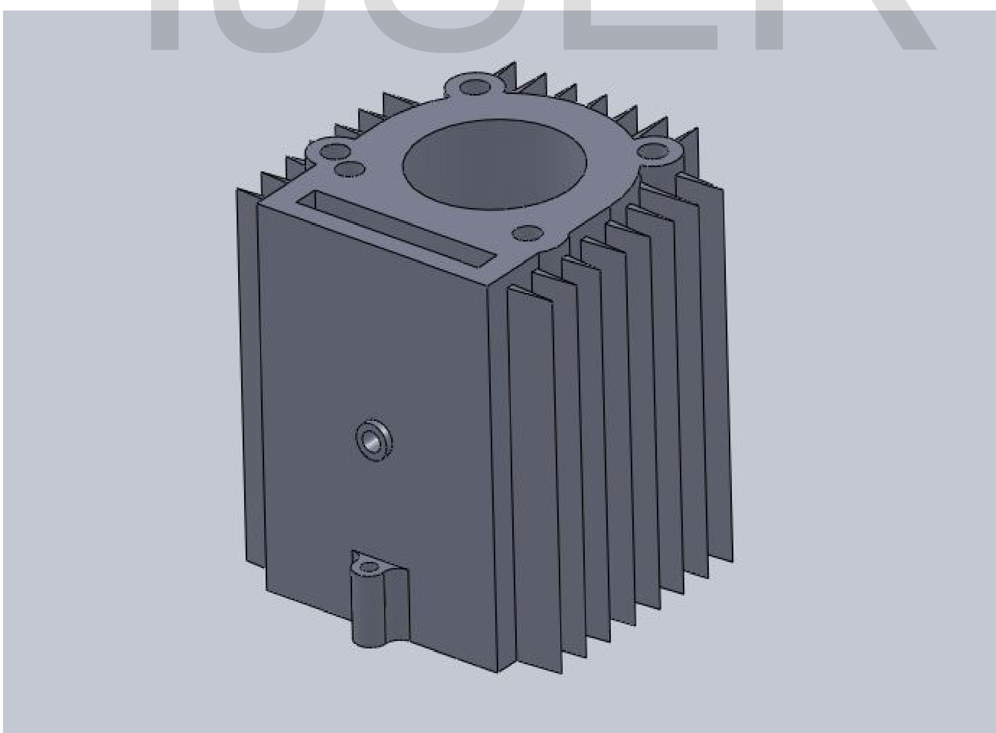

Fig: - ENGINE CYLINDER WITH TRIANGULAR FIN

Triangular fin of Al alloy

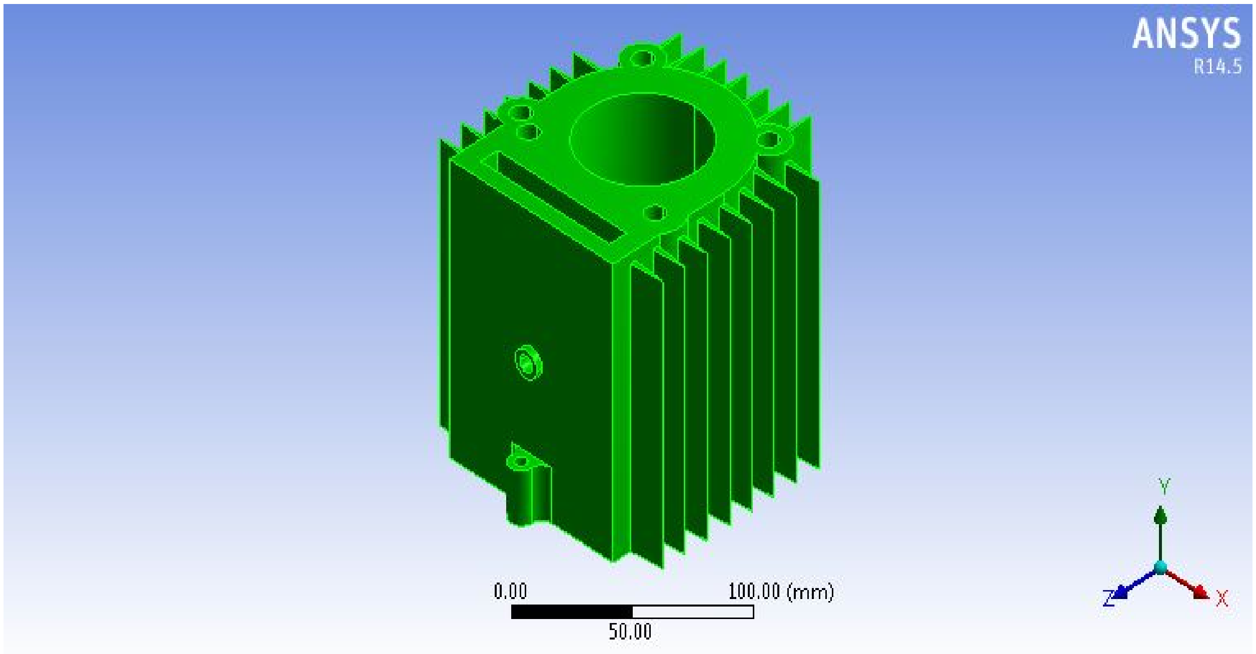

Fig-Triangular fin of Al alloy

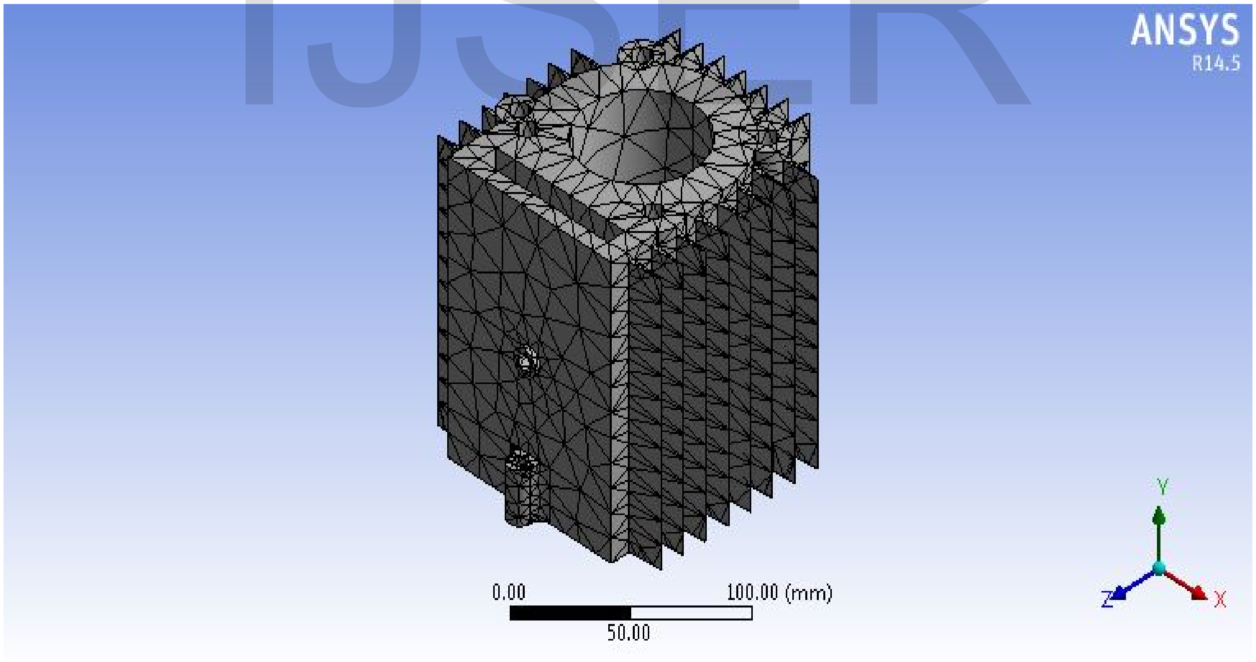

Fig- Mesh generated body of triangular fin of Al alloy

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With the help of Mesh generation tool, after meshing there are 17953 nodes and 9450 elements are made.

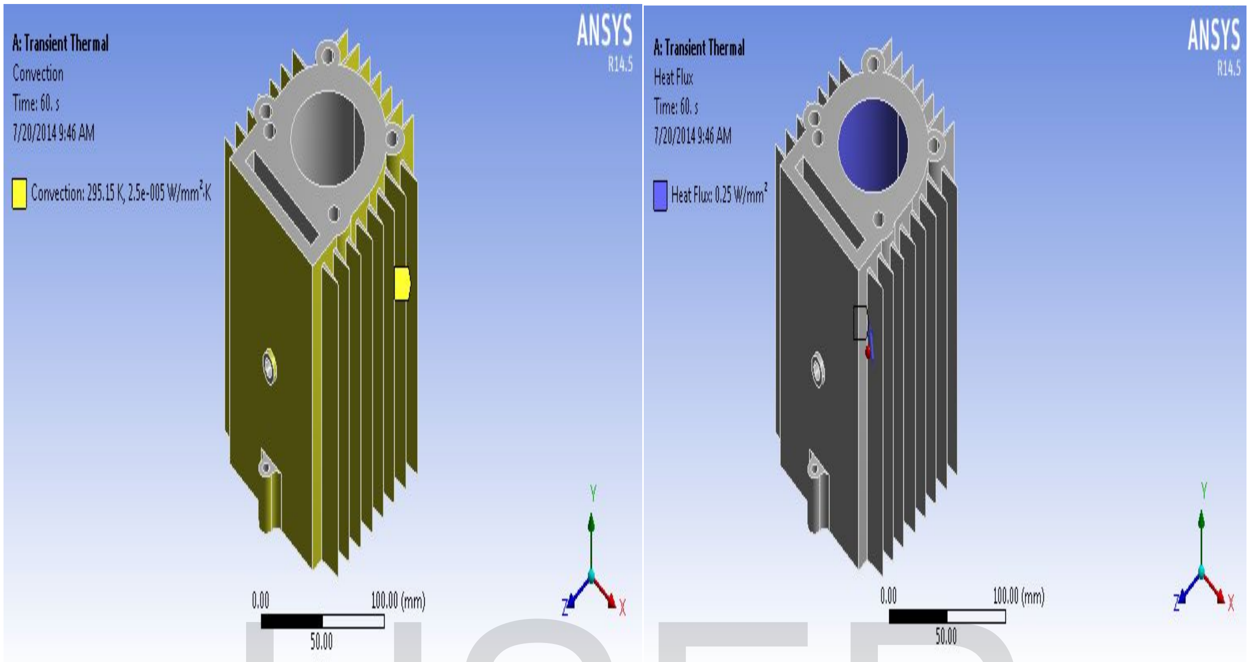

Fig- given load on triangular fin of Al alloy

After meshing we need to give some initial values like we give the initial values are convection coefficient h=0.000025 (W/mm^2×K), heat flux 0.25 (W/mm^2) and ambient temperature is 295.15 (K).

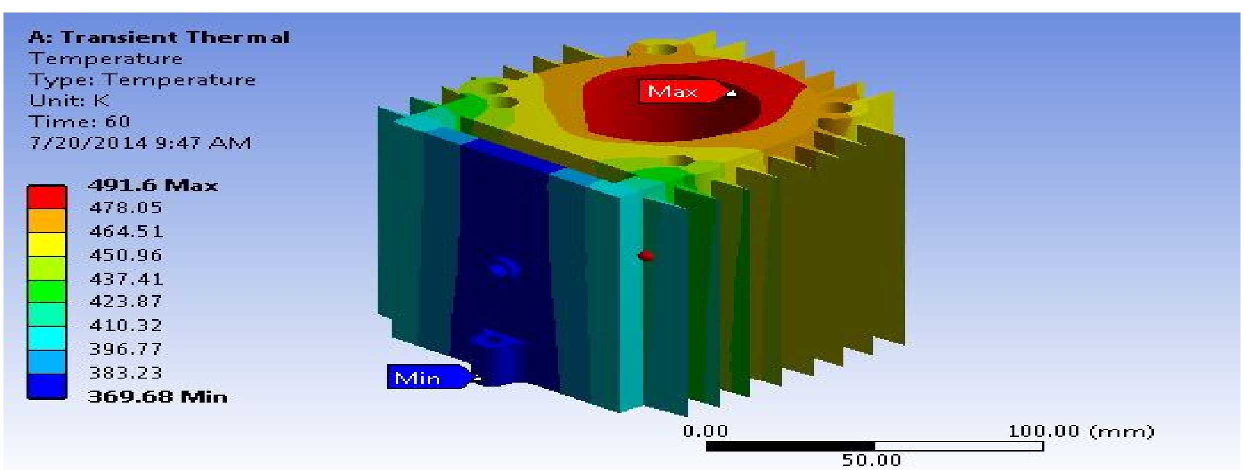

Fig- Temperature distribution of Triangular fin of Al alloy

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Temperature distribution of Circular fin of Mg alloy shows that maximum value of temperature is 491.6 K and minimum temperature is 369.68 K.

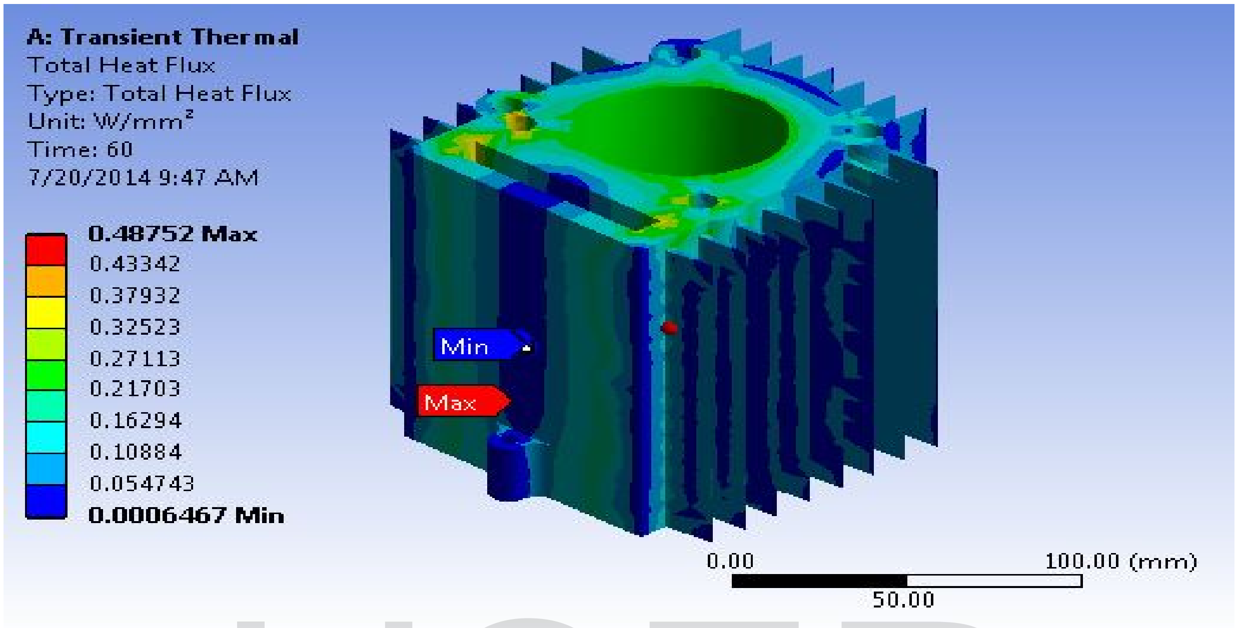

Fig- Total heat flux inside Triangular fin of Al alloy

Figure shows that the maximum heat flux value 0.48752 (W/mm^2) for triangular fin of Al alloy.

Triangular fin Mg alloy

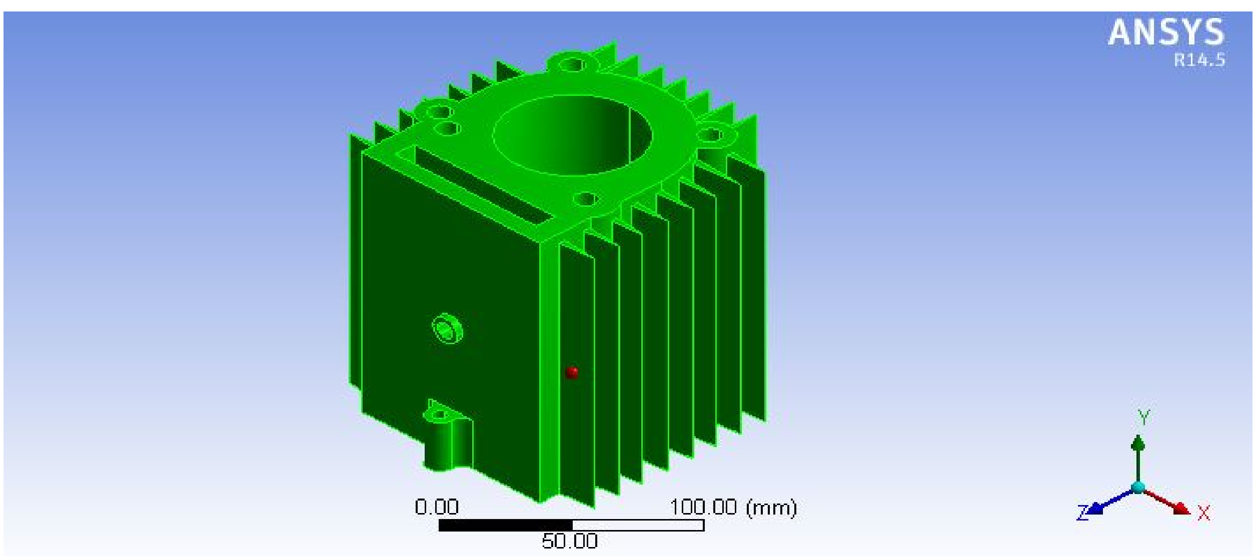

Fig- Triangular fin of Mg alloy

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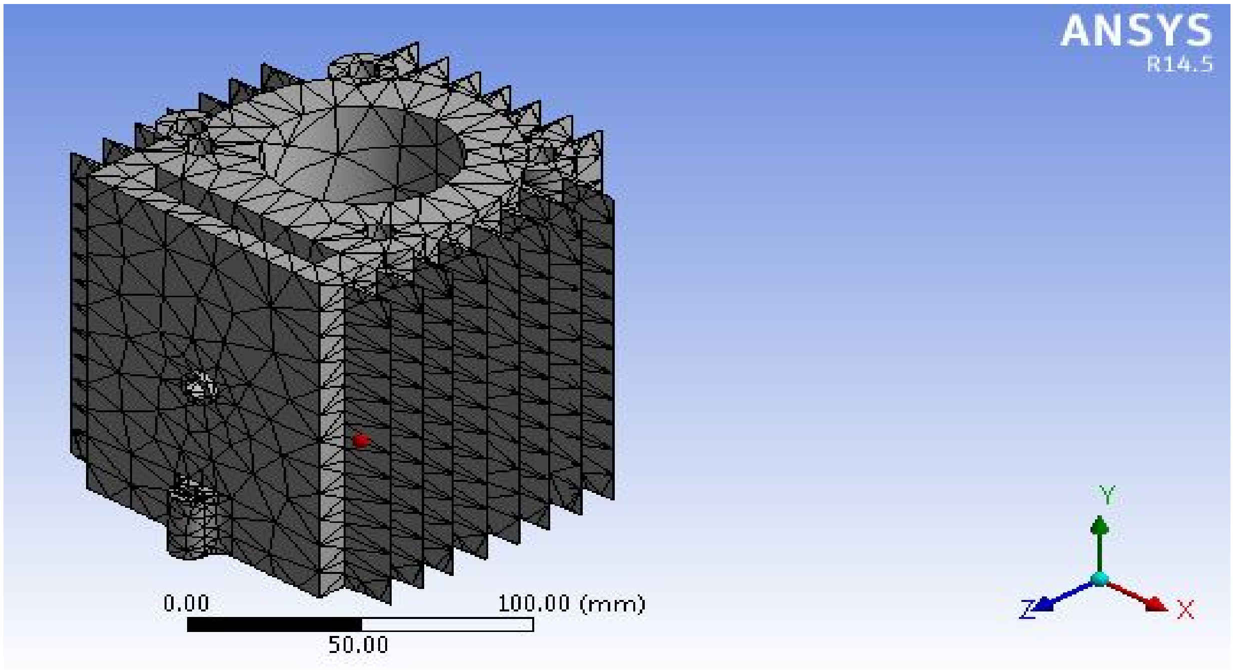

Fig- Mesh generated body of Triangular fin Mg alloy

With the help of Mesh generation tool, after meshing there are 17953 nodes and 9450 elements are made.

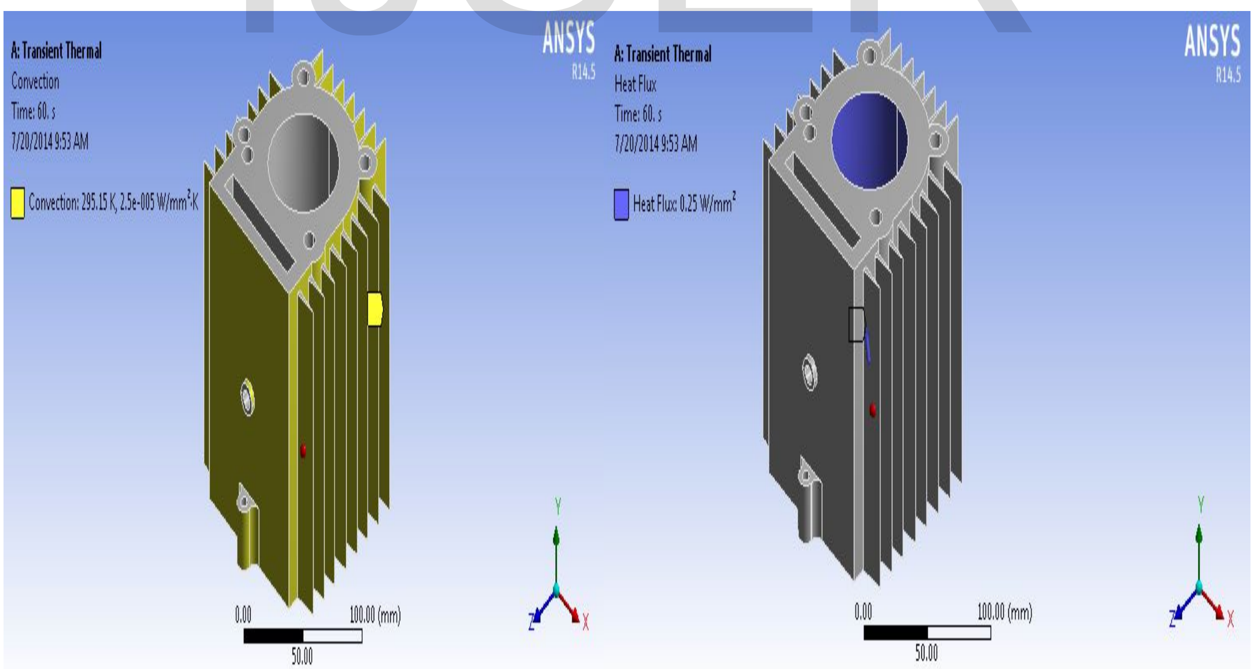

Fig- given load on triangular fin of Mg alloy

After meshing we need to give some initial values like we give the initial values are convection coefficient h=0.000025 (W/mm^2×K), heat flux 0.25 (W/mm^2) and ambient temperature is 295.15 (K).

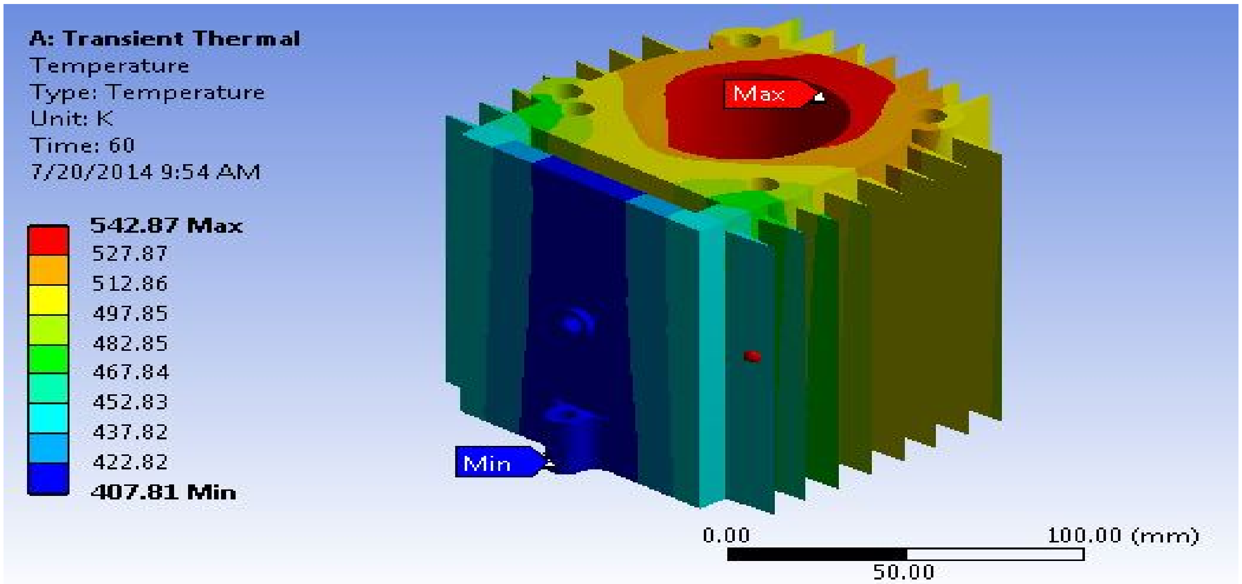

Fig- Temperature distribution of Triangular fin of Mg alloy

Temperature distribution of Circular fin of Mg alloy shows that maximum value of temperature is 542.87 K and minimum temperature is 407.81 K.

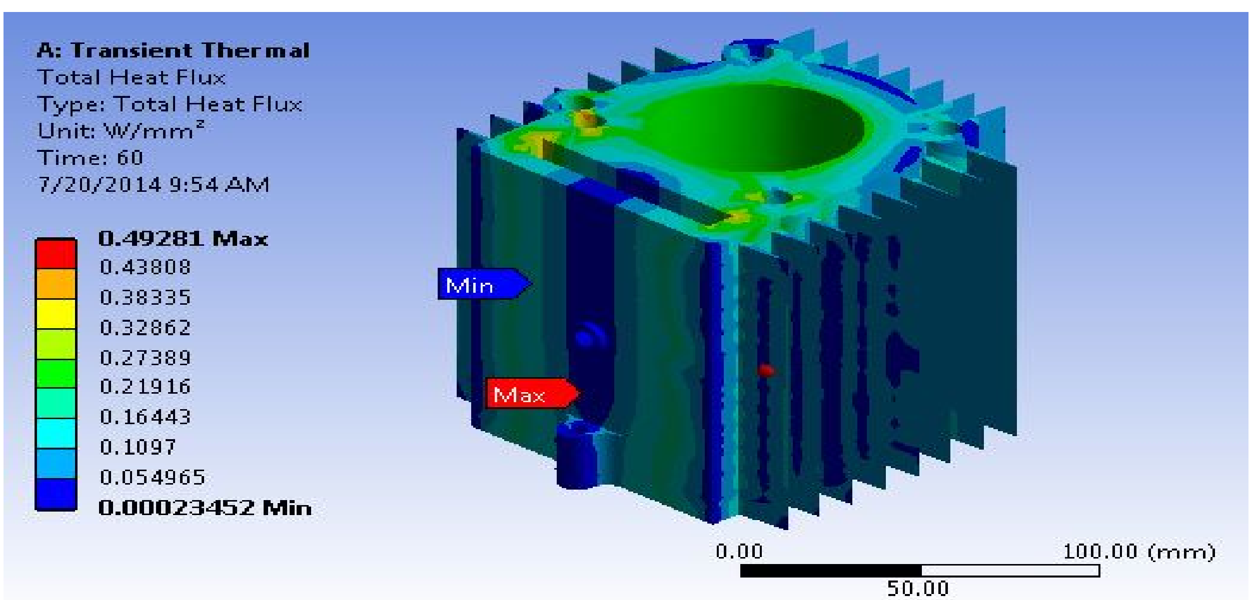

Fig- Total Heat flux inside Triangular fin of Mg alloy

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Figure shows that the maximum value of heat flux is 0.49281 (W/mm^2) inside the triangular fin of Mg alloy.

Results Comparison

Value of thermal flux

Thermal flux(W/mm^2)		**G.Babu and LavaKumar**		**Result by Present Work**	
	Al alloy 2024	Al alloy 6061	Mg alloy	Al alloy	Mg Alloy
Rectangular fin	0.529666	0.571051	0.463962	0.47422	0.47987
Circular fin	0.723258	0.738145	0.716357	0.69099	0.69565
Triangular fin				0.48752	0.49281

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Mass of Cylinder fin

Mass of cylinder fin(Kg)		**G.Babu and LavaKumar**		**Result by Present Work**	
	Al alloy 2024	Al alloy 6061	Mg alloy	Al alloy	Mg Alloy
Rectangular fin	1.0100279	0.97395552	0.89459618	1.245	1.0487
Circular fin	1.1846582	1.1423490	1.0492687	1.3286	1.1532
Triangular fin				1.027	0.9071

Conclusion

In present work, a cylinder fin body is modeled with the help of Solid Works 2010 software and transient thermal analysis is done by using ANSYS 14.5. These fins are used for air cooling systems for two wheelers. In present study, Aluminum alloy and Magnesium alloy are used and compared with G. Babu and M. LavaKumar results. The various parameters (i.e., shape and geometry of the fin) are considered in the study, shape (Rectangular, Circular and Triangular), and thickness (3 mm) by changing the shape of the fin to triangular shaped, the weight of the fin body reduces thereby increasing the heat transfer rate and efficiency of the fin. The weight of the fin body is also reduced when Magnesium alloy is used. By using triangular fins the weight of the fin body reduces compare to existing engine cylinder fins.

Future scope

In this thesis, we concluded that using triangular fins is better, but circular fins are mostly used in vertical engines than horizontal engines and also by using that, the weight of the fin body is also increases. By using triangular fins, the fin body weight is less, so more experiments are to be done to use triangular fins for the fin body in future.

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