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Study of mesh refinement on thermal analysis of engine cylinder block

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ABSTRACT

The Engine Cylinder block is the structure that contains the cylinders, and connecting rods of pistons of an internal combustion engine. The engine block consisted of just the cylinder block, to which a separate crankcase was attached. Engine blocks often also include elements such as coolant passages and oil galleries. Many names such as "cylinder block" or simply "Engine Block" are also known by the engine block. Any modern engine block (which has multiple cylinders in a single component block) would be classified as a monobloc. A cylinder block contains the cylinder, cylinder sleeves, coolant passages and some space. At the starting of internal combustion engine development, cylinders were cast individually, so cylinder blocks were produced individually for each cylinder. With an increase in mass-production and technology, engine manufacturers combined two or three cylinders into a single-cylinder block, with an engine combining several of these cylinder blocks. The cylinder block being the heart of the engine receives too much heat. This paper aims to evaluate the performed static thermal analysis of the block under severe thermal conditions. The block model and analysis are performed using SOLIDWORKS and ANSYS Workbench. Thermal analysis is performed on the Cylinder block with structural steel to validate thermal properties and working.

Keyword: *ANSYS, Thermal Analysis, Cylinder Blocks, Solidworks*

1. INTRODUCTION

Basic knowledge about the component is absolutely necessary before working and performing analysis on the component. Cylinder block is a one-piece design of rigid structure with crankshaft, cast-in charge air manifold and large crankcase doors. The main bearing bolts are hydraulically tightened. A Cylinder liner is centrifugally cast design with a running surface treated to improve wear resistance; a carbon-cutting ring is incorporated at the top of the liner.[1] Crankshaft: continuous grain flow forged; large diameter journals and pins; hydraulically tightened counterweight bolts. The Connecting rods are made up of alloy steel, obliquely split and serrated big end; hydraulically tightened big end bolts with pistons on top of them. Bearings are necessary for smooth friction free working. They are steel backed with Sn/Al bearing material. Pistons are improved oil-cooled two-piece design; two compression rings and one oil scraper ring.[1] Fig 1 shows a diagram of a typical Engine cylinder block.

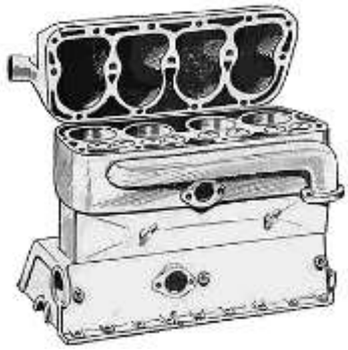


Fig 1

1.1 Material Properties

Though commonly cast iron was used for manufacturing of Cylinder blocks, with development in vehicles and needs changing from bulk to fast and smooth; Aluminum and Steel are becoming more and more popular. Properties of Structural steel, Grey cast iron and Aluminum alloy are listed below.[2]

Material	Tensile strength (M pa)	Young's Mod (G pa)	Density (Kg/m^3)	Specific Heat j/Kgk	Thermal Conductivity (W/K m)
Aluminum Alloy 6061	310	73	2700	1256	167
Grey Cast Iron	255	54	7200	45	46
Structural Steel	250	207	7850	466	45

2. MODELLING

The cylinder block was modeled by using the SOLIDWORKS software by considering the dimensions of a typical Engine cylinder block. Heat transfer simulation and Thermal analysis was carried out by using ANSYS software. This Analysis is used to find out the distribution of temperature through the material of cylinder engine block. The rate of heat transfer that will distribute depends on engine block model, number of fins, wind velocity and mainly depends on the material of block; hence in this paper thermal analysis of cylinder block has been carried out.[3]

This model was generated with the help of SOLIDWORKS modeling and meshing package as shown below Fig.2 and Fig 3a and 3b tetrahedral mesh with fine size element has been considered for the better convergence of solution.

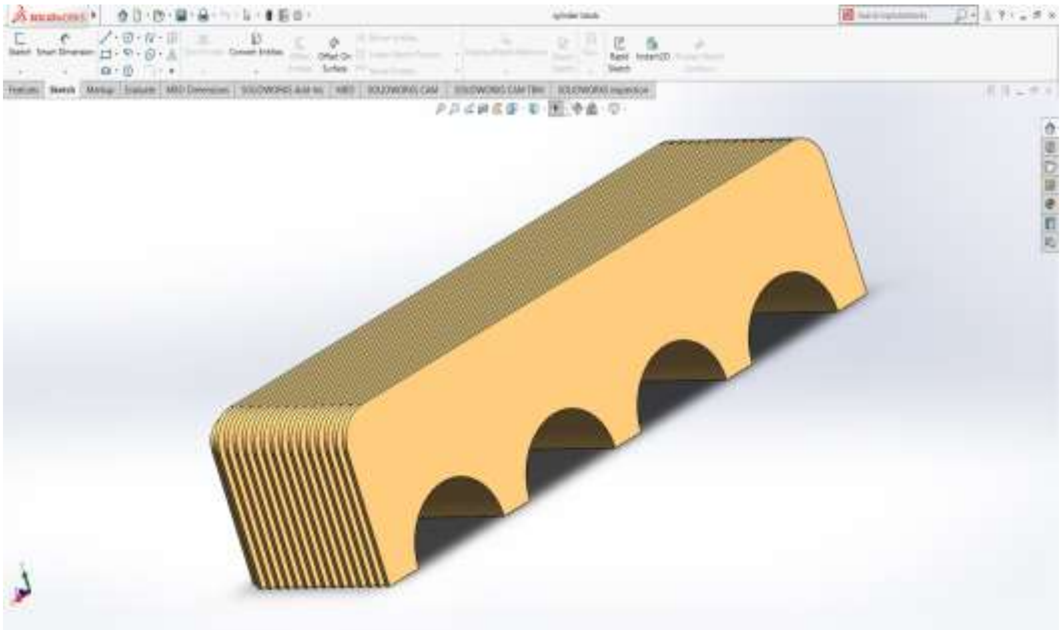
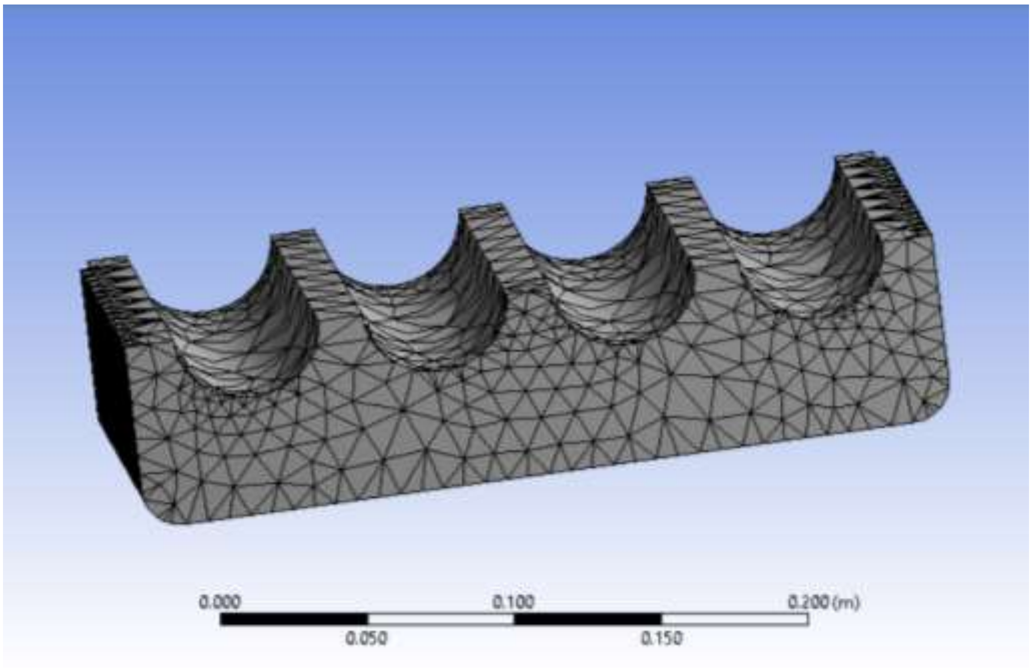


Fig 2 Solidworks CAD Model of Cylinder Block



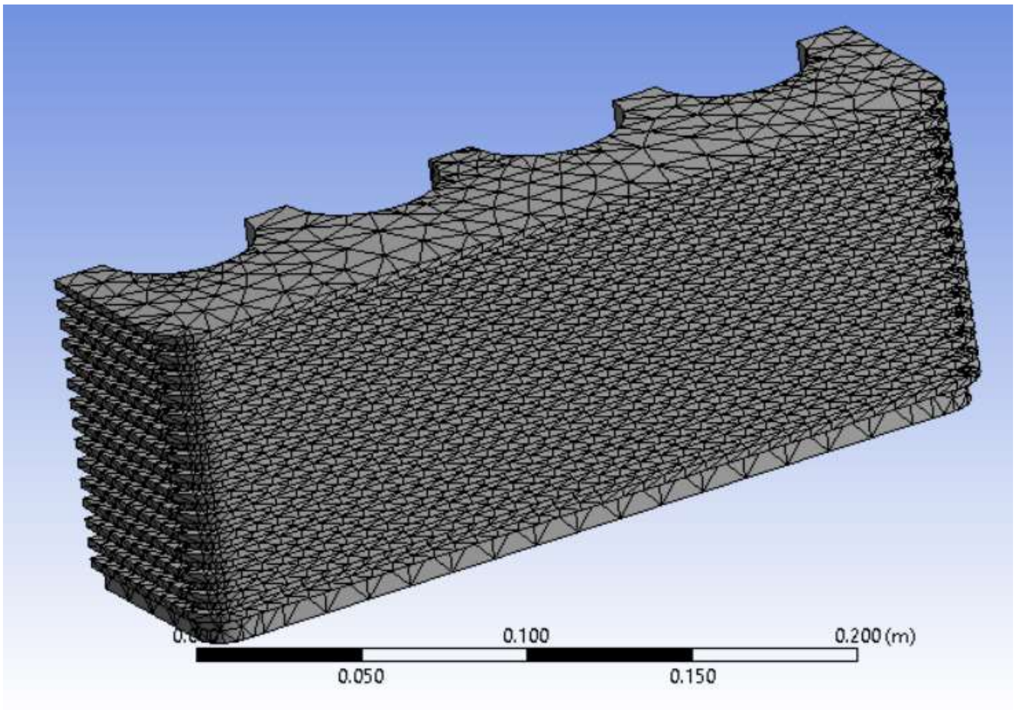


Fig 3a and 3b. Tetrahedral Linear Meshed Model in ANSYS (Isometric views)

2.1 Generating Meshing and Thermal Analysis

First the CAD model of Cylinder block was designed in Solidworks and saved in the format of IGES. Then it was imported into ANSYS. The first step after importing into ANSYS is to select the material which is structural steel in this case. To start meshing first change the global setting which can be found below in the form of Group. We have performed Thermal Analysis of Structural Steel in meshing- It is used to set the goal for curvature-based refinement. To perform this meshing change the span angle size accordingly to your choice as medium, coarse, fine. The above Cylinder block is meshed to the span angle size as FINE. To change the normal curvature angle set "advanced size function" and then specify the angle at which you want to do meshing. Then right click on meshing and select generate mesh then the mesh will generate. Fig 3. Illustrates the meshed Cylinder block.

After meshing we move ahead with the static Thermal analysis of the block. Then the initial boundary conditions are applied on the like Heat Flow, Convection, & Radiation. After the boundary conditions are set the model is solved by the software for the steady state thermal analysis. Thermal analysis is done by changing three parameters of Structural Steel. The Basic Comparison in Thermal Analysis [4] is done with these factors:

1. Total Heat Flux
2. Directional Heat Flux
3. Temperature

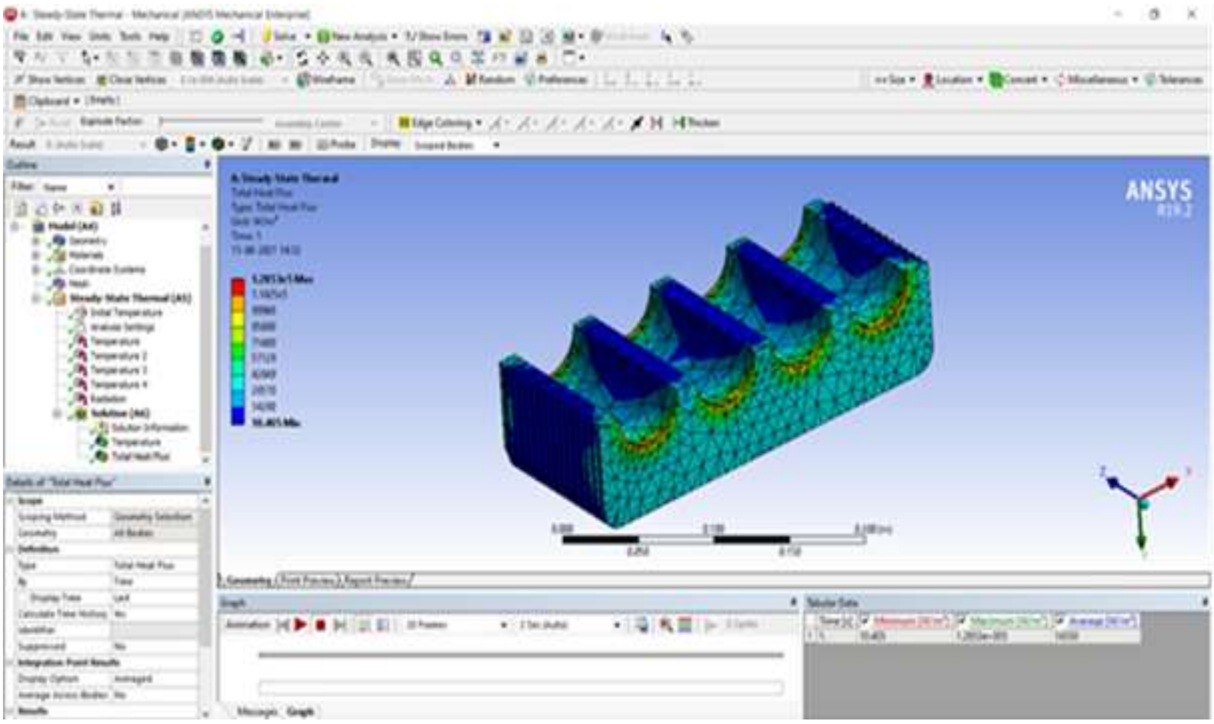


Fig 4. Steady State Thermal Analysis (Total Heat Flux)

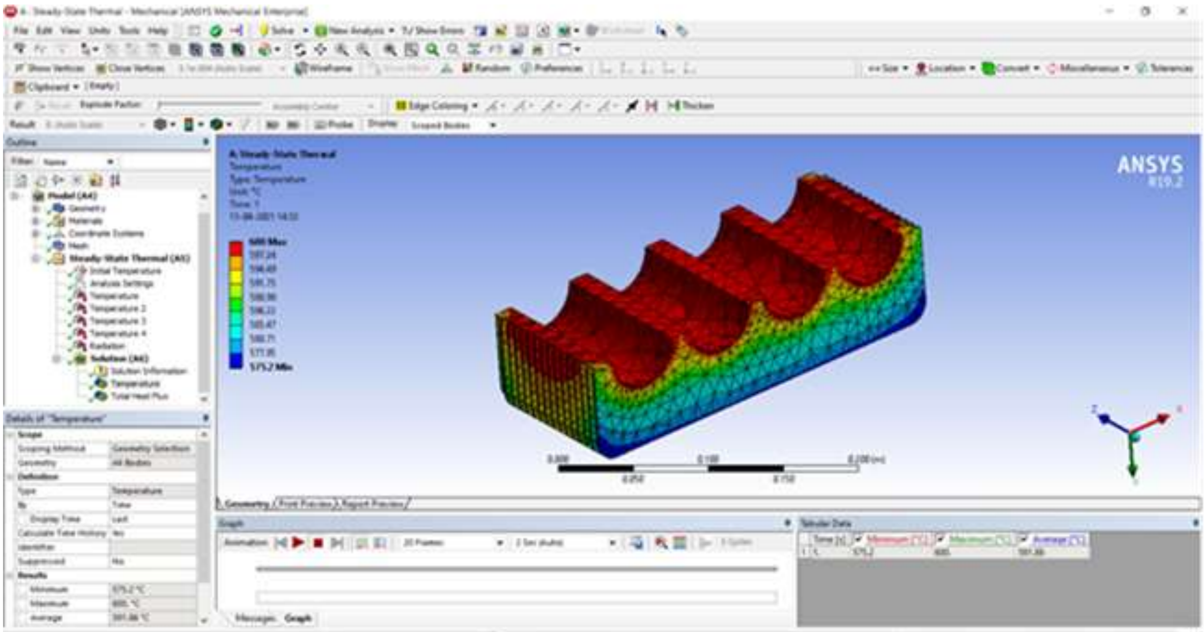


Fig 5. Steady State Thermal Analysis (Temperature)

2.2 Results

The Steady State Thermal analysis calculates the Thermal load (Total Heat Flux) and Temperature range of the applied conditions on the component with temperature changes in the component. Here are the final statistics of the thermal analysis of Engine Cylinder block.

Initial Temperature Value: 22'C (Uniform)

RESULTS		
	TEMPERATURE ('C)	TOTAL HEAT FLUX (W/m^2)
MINIMUM TEMPERATURE	**575.2**	**10.405**
MAXIMUM TEMPERATURE	**600**	**1.2853e+005**
AVERAGE	**591.86**	**14550**
MIN Occurs on	**Cylinder block free parts**	
MAX Occurs on	**Cylinder block free parts**	

3. CONCLUSION

The steady state thermal analysis of Engine Cylinder Block in real engine conditions has been per-formed. Comparison by defining different parameters have completed successfully. The key point to be noted is initial temperature of 22'C rose up to 600'C which was dissipated by the fins. The Cylinder block was considered and modelled using SOLIDWORKS software and thermal analyses were performed by using ANSYS software. From the above thermal analysis results it is to be identified that composite material Structural Steel has an adequate Heat Transfer rate. Coming to practical applications most of the heavy vehicles cylinder blocks are manufactured with this material along with grey cast iron. However, these materials are not that much suitable for light vehicles due to its more weight, hence there is a development of light Aluminium alloys.

4. REFERENCES

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BIOGRAPHY

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