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# Design and Static Structural Analysis on Four Cylinder Engine Block Using FEA

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**ABSTRACT:** In the present study case we have considered the An Four Cylinder Engine Block is an integrated and stiff structure that contains cylinders and the other components like pistons, crankshaft, cams etc. Cylinder block undergoes tremendous amount of pressure executed during the combustion process where the spark occurs the peak cylinder pressure ranges from 300 to 1000psi. The Design of the Turbine Blade was carried out in the CAD Design Software i.e CATIA (Computer Aided Three-Dimensional Interactive Application) And Simulation on turbine blade was performed using ANSYS Software (Analysis of Systems). In this project Strength of materials, Design of Machine Members, and various physical and material properties.

**KEYWORDS:** Four Cylinder Engine Block, CATIA, ANSYS, FEA

## I. INTRODUCTION

An IC engine is one during which the combustion of fuel takes place inside the engine cylinder; multiple combustion chamber arrangement is named as cylinder block. IC engine uses fuel either petrol or diesel as their fuel. In engines which uses fuel as petrol (S.I engines) the correct proportion of air and petrol is mixed in the carburettor and fed to engine cylinder where it's ignited by means of a sparking plug. The steps involved during a 4 stroke IC engine are suction stroke, compression stroke, and expansion stroke and exhaust stroke. One of the most components in an IC engine is that the combustion chamber. The design of a combustion chamber has a crucial influence upon the engine performance and its knock properties. Design of a combustion chamber with the associated cylinders involves the form of the combustion chamber, location of the sparking plug and therefore the position of the inlet and exhaust valves.

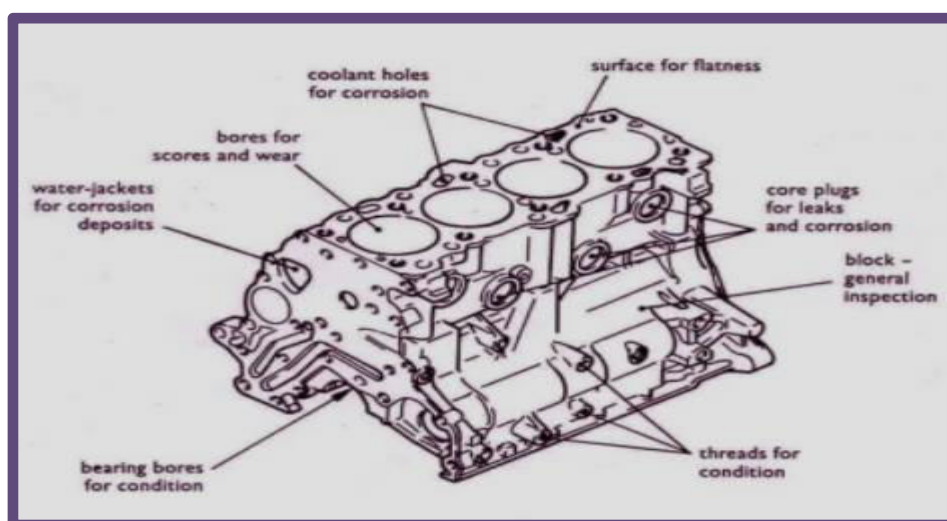


Fig.1 represents the schematic diagram of four cylinder engine block



The engine blocks are the most loaded components of a internal combustion engine. They must satisfy the requirements concerning durability and functionality. Therefore, a new type of material with high strength properties at high temperature is required. The use of aluminium material based alloys is because of fabrication of spark ignition engine blocks in automotive has grown rapidly in recent years due to weight reduction which helps to increases the performance of the engine. Engine blocks are usually made up of forged iron or in modern engine blocks, aluminium and magnesium are used. The loads that are working on the cylinder block are thermal load, mechanical load etc. In the light of shortcomings in experimentation, researchers have turned their attention.

## II. MATERIAL AND MANUFACTURING PROCESSES

Material selection of specified components plays a major role. Basically the material Selection for a component was selected based upon the various mechanical experienced forces and we need to distinguish all the mechanical failures. The Engine block is a component that undergoes up to a peak pressure of 800 to 1500psi to the super racing cars The Selected material must possess good strength and Life and it should be resistance to damage when it experienced the loads Secondly Cost Effective is the concern of choosing the material according the usage and it should be readily available in the market for various manufacturing sites

GrayCast iron , a kind of forged iron most generally used for production of commercial components, has superior machinability thereto of other sorts of cast irons and requires lower levels of lubrication from the metalworking fluid used. The graphite in gray forged iron features a flake-like structure which is essentially liable for the high machinability of this metal. The flake-like graphite structure gives rise to discontinuities within the metal matrix and subsequent reduced cutting forces. The graphite in gray forged iron also provides lubrication during machining. Which reduces the level of demand and level of lubrication required from the metalworking fluid used. In addition to the consequences of the graphite structure on gray forged iron machinability, the metal also contains compositional elements which contribute to enhanced machinability.

Magnesium alloy castings can be produced by nearly all of the conventional casting methods, namely, sand, permanent, and semi-permanent mould and shell, investment, and die-casting. The choice of a casting method for a particular part depends upon factors such as the configuration of the proposed design, the application, the properties required, the total number of castings required, and the properties of the alloy. Magnesium castings of all types have found use in many commercial applications, especially where their lightness and rigidity are a major advantage, such as for chain saw bodies, computer components, camera bodies, and certain portable tools and equipment. Magnesium alloy sand castings are used extensively in aerospace components.

Aluminium / aluminium may be a versatile, lightweight, and malleable metal. Aluminium alloys are manufactured to satisfy specific product needs. Aluminium / aluminium 5059 alloy may be a wrought alloy type with good corrosion resistance. This alloy can't be heat treated to realize strength but are often readily welded and retains most of its mechanical strength. Aluminium / aluminium 5059 alloy are often strengthened using strain hardening, or cold mechanical working processes if required.

Material	Young's Modulus Pa	Density Kg/m <sup>3</sup>	Poisson's Ratio	Bulk Modulus Pa	Shear Modulus Pa
Gray Cast Iron	1.1e+11	7200	0.28	8.333e+10	4.2969e+10
Sand Cast Magnesium Alloy	4.5e+10	1810	0.35	5e+10	1.667e+10
AA5059	6.9e+10	2660	0.33	6.7647e+10	2.594e+10

Table 1: shows the material properties of the ofGray Cast Iron, Sand Cast Magnesium Alloy, AA5059

### III. MODELLING AND ANALYSIS PROCEDURE

For the Modelling of Four cylinder block engine we have chosen the CATIAV5 R21 which is really a good user interactive and friendly software has different modulus like part, Surface and Assembly Design. The procedure of creating the blades is as follows initially take plane and positioned sketch here we have created an 2D Sketch as a Geometrical element which need to constrained and then converted into a part by inserting a body. The Major Tool bars used are pad, revolve, pattern, slot etc and

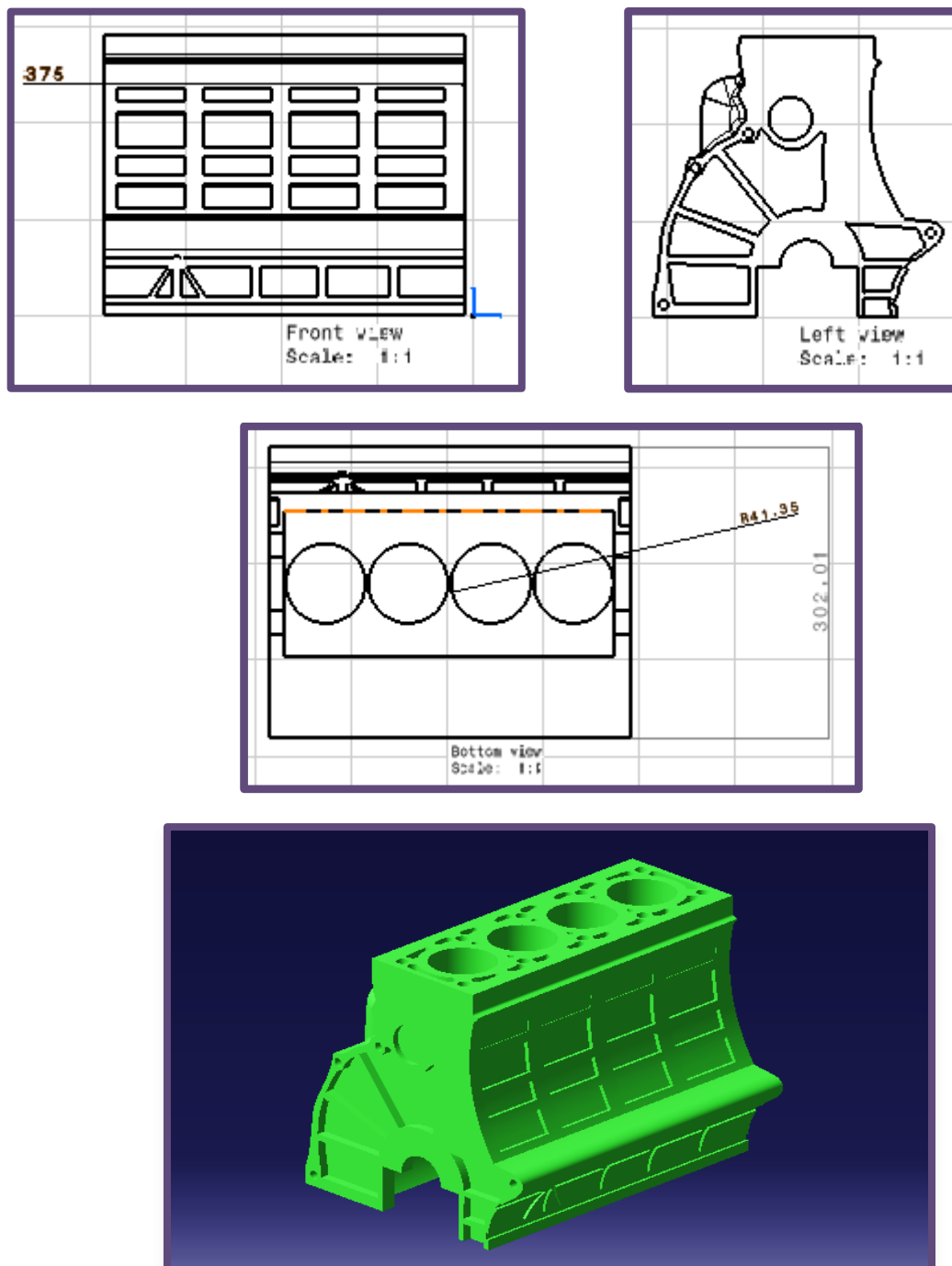


fig 1 .shows the engine block after modelling



After Designing the Turbine blade it was saved in an STP format (step File) which can be easily uploaded in ANSYS Workbench ANSYS is a Finite element Analysis Software package. Different types of analysis can be carried out using Ansys like Structural, Model, and Thermal etc. Ansys is performed with an internal sequence of steps i.e Pre-processing, Meshing, Loading Boundary Conditions Post processing , solve and finally the results.

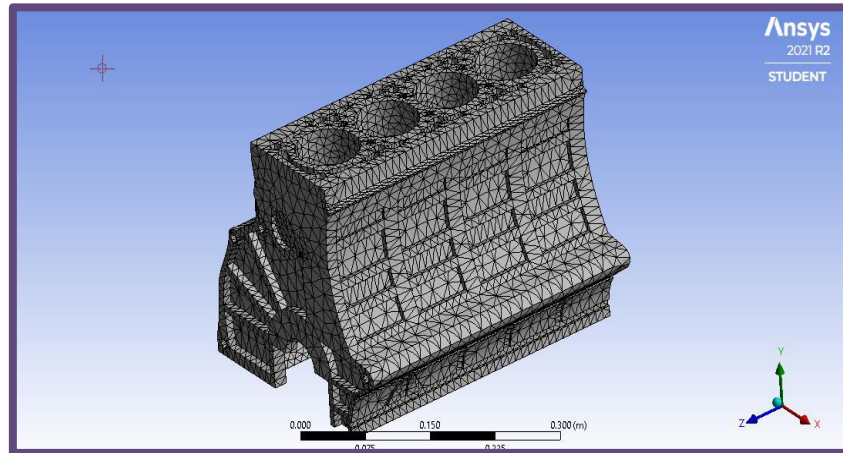


Fig2.shows the mesh presentation

Meshing is an internal most important Simulation process in ANSYS. What happens is it divides or segregates the solid into tiny number of elements to make the speedup of solution and mostly high accuracy. Here we have created meshing with Tetrahedrons element shape with program controlled type and 1mm at the corner and 5mm normal size

#### IV. LOADING AND BOUNDARY CONDITIONS

As per the Functioning point view the engine block experiences tremendous amounts of pressure up to 1500psi to super cars and normal to 300-900psi and we have carried out analysis at 750psi

The Engine is fixed at the bottom with respect functional point of view

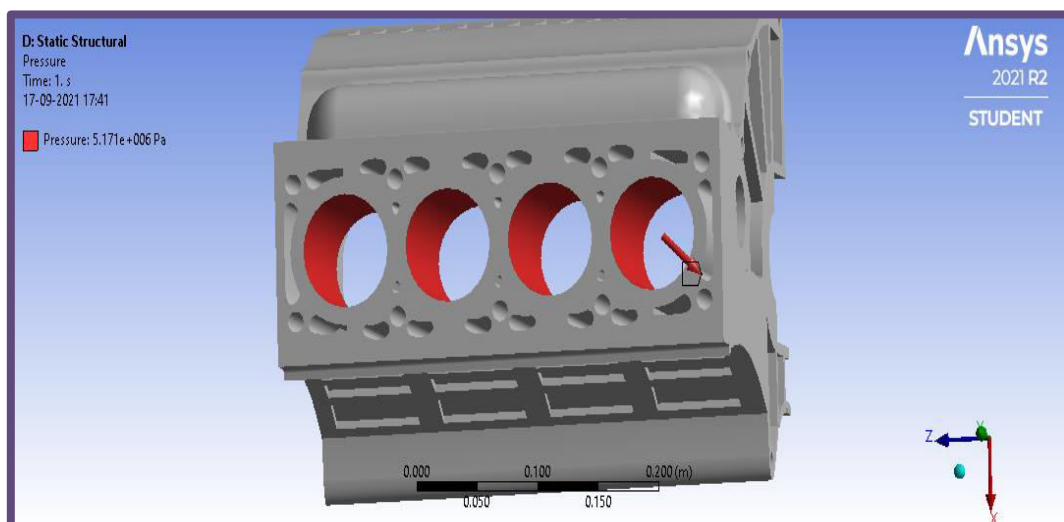


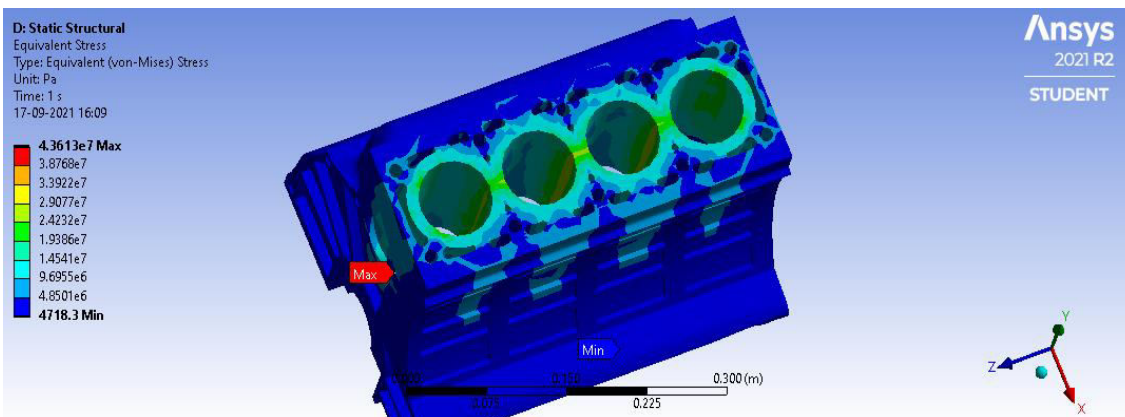
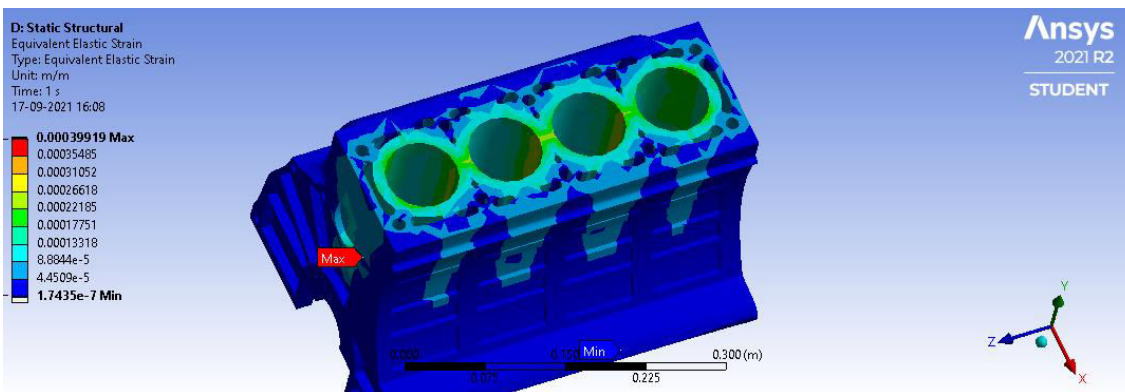
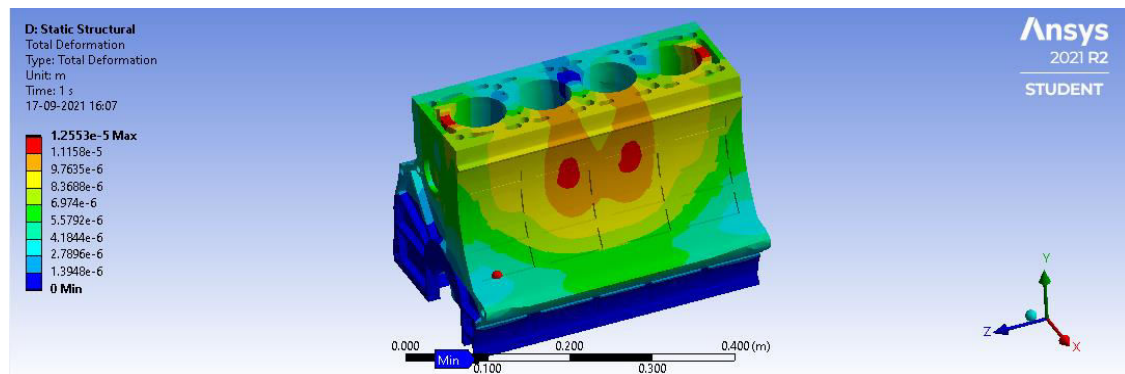
Fig.3.shows the boundary conditions

## V. EXPERIMENTAL RESULTS

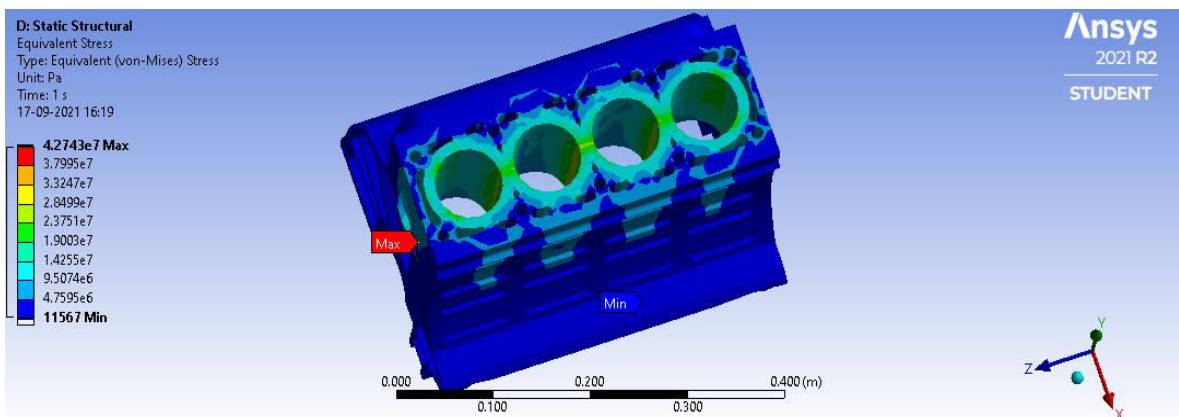
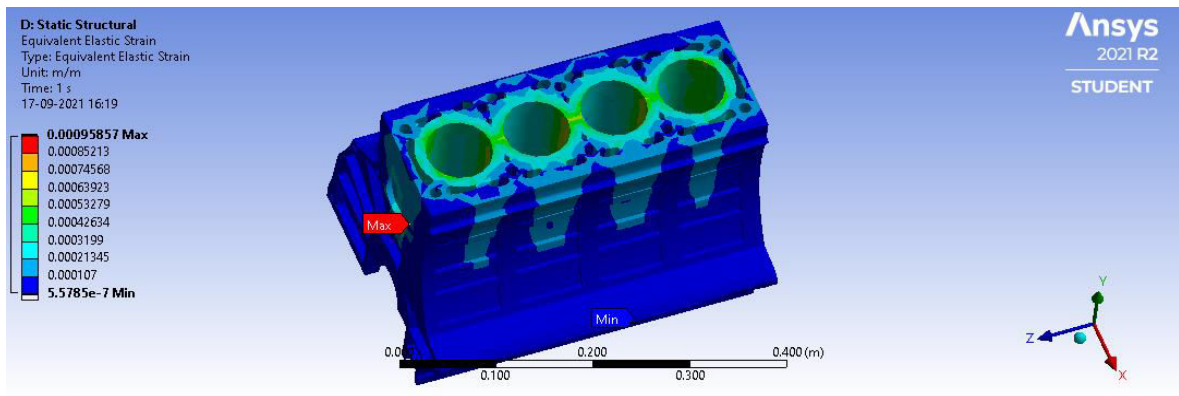
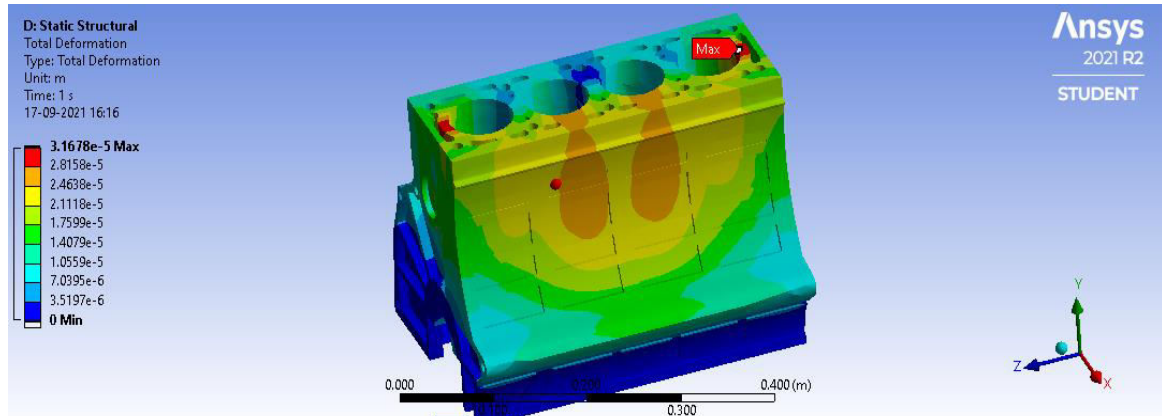
The structural analysis carried out at 750psi with three different thicknesses of engine cylinder thickness that is 5mm, 8mm, 11mm and with three different materials

For Block 1,2,3

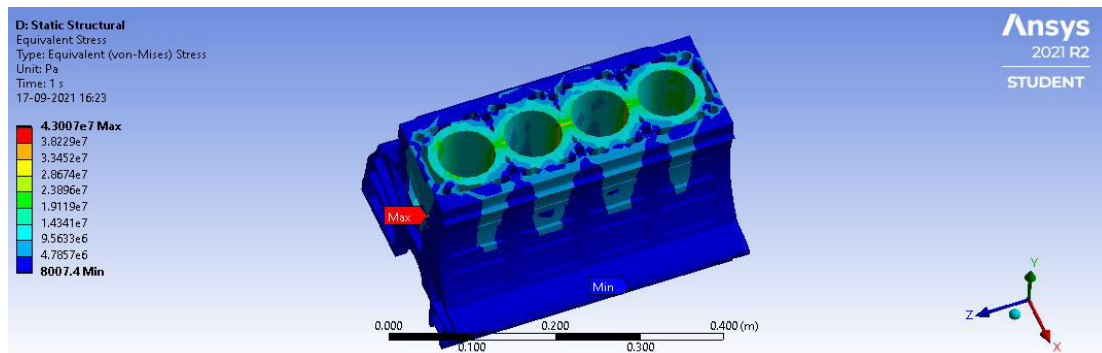
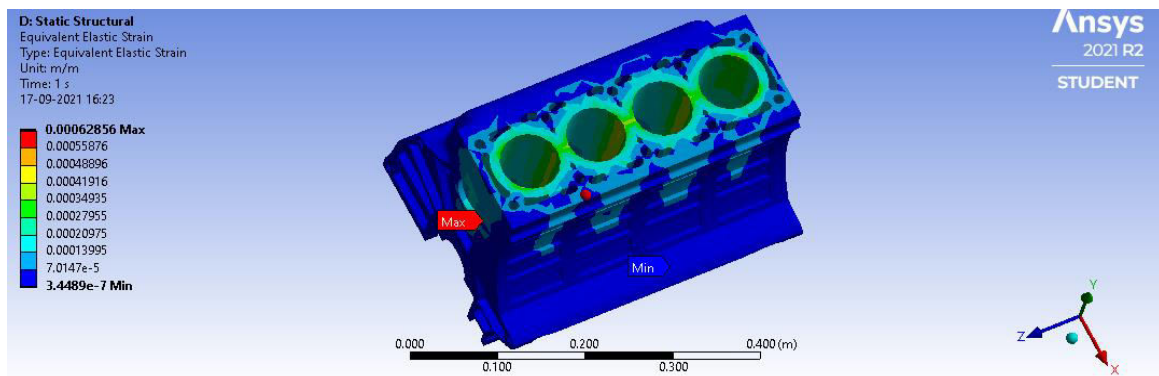
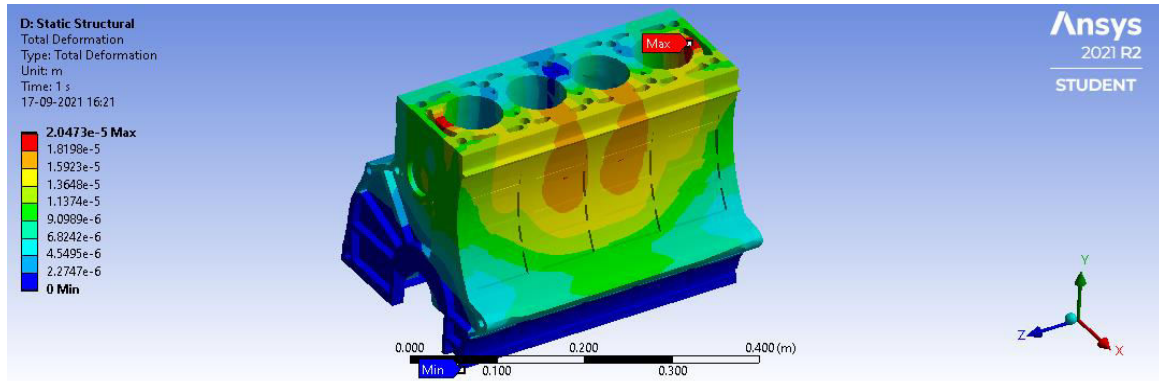
Gray Cast Iron



For Sand Cast Magnesium Alloy



For AA5059



For Block 1

Material	Total Deformation	Equivalent Elastic Strain	Equivalent Stress
Gray cast iron	3.7341e-5	0.0012541	1.3765e8
Sand Cast magnesium alloy	9.0541e-5	0.0030347	1.3627e8
AA5059	5.922e-5	0.0019848	1.3666e8



For Block2

Material	Total Deformation	Equivalent Elastic Strain	Equivalent Stress
Gray cast iron	1.9775e-5	0.00047425	5.1631e7
Sand Cast magnesium alloy	4.9842e-5	0.0011544	5.139e7
AA5059	1.2225e-5	0.0007538	5.1459e7

For Block 3

Material	Total Deformation	Equivalent Elastic Strain	Equivalent Stress
Gray cast iron	1.2553e-5	0.00039919	4.3613e7
Sand Cast magnesium alloy	3.1678e-5	0.00095857	4.2743e7
AA5059	2.0473e-5	0.00062856	4.3007e7

## VI. CONCLUSION

The Analysis has been carried on engine block by varying the cylinder wall thickness 5mm, 8mm, 11mm The Applied maximum pressure is 750Psi i.e 5.171e+6pa The Total Deformation was found mostly at the front side of the engine block that to for the 1st block The Total deformation was found comparatively less in block 3 because of increase in thickness Directional Deformations along x,y,z Axis as been mentioned and showed clearly. The Equivalent Elastic Strain was found very less in Block 3 with Sand Cast magnesium Alloy and found safe The Equivalent Stress mostly found on the engine cylinder for block 1 and 2 whereas in block 2 stress has seen less at the side wall of an engine block The value of von-misses stresses that comes out from the analysis is far less than material yield stress so our all three design is safe. Gray Cast Iron is comparatively high in weight among the three materials. According to the Strength to weight ratio Sand Cast Magnesium Alloy, AA5059 are best suited materials for the Engine Block.

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