

## DESIGN AND ANALYSIS OF ENGINE BLOCK

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**ABSTRACT:** The engine block is the linchpin of vehicles that run on internal combustion, providing the powerhouse for the vehicle. It is called a "block" because it is usually a solid cast car part, housing the cylinders and their components inside a cooled and lubricated crankcase. This part is designed to be extremely strong and sturdy, because its failure results in failure of the car, which will not function until the engine block is replaced or repaired. Most engine blocks are made of cast iron, although in the late 1990s, some made from plastic and other experimental materials were being used in prototype cars with the hope of developing more lightweight, efficient vehicles. Cylinders blocks are under goes high thermal and structural loads. The main objective of the project is to study the thermal and structural load determination in engine blocks. The engine block design is done in solid works simulation and analysis of structural and thermal analysis carried out in solid works simulation.

converts the chemical energy into mechanical energy. The fuel inside the combustion chamber ignites and the force is exerted on the piston, the piston moves down and up thus rotating the crankshaft of the engine. Thus the chemical energy of the engine is converted into mechanical energy. The engine consists of several components. Internal combustion engines convert potential chemical energy in the form of heat derived from a fuel into mechanical energy. Approximately 30% of the energy released in an internal combustion engine is converted into work. The remaining energy is lost in the form of heat and friction in the engine. Engine components are designed to convert energy in an internal combustion engine for maximum efficiency. Material used for engine components must withstand heat and stress generated inside the engine during operation, and meet size and weight requirements. Engine components commonly required in reciprocating engines include the engine block, cylinder head, crank shaft, piston and piston rings, connecting rod, bearings, flywheel, and valve train

### Introduction

An internal combustion engine requires different engine components depending on the number of strokes and the type of fuel used. Four- stroke cycle engines are the most common type of internal combustion engine. Two- stroke cycle engines are light in weight and have few moving parts. Diesel engines are internal combustion engines that ignite fuel by compression. Engine output is measured in torque and horse power. The internal combustion engine

### CLASSIFICATION

The internal combustion engine takes many forms, and many efforts have been made to optimize the performance of every component from oil-pan to air-cleaner. The engine block itself is no exception, and of all the different designs experimented with over the years, the following are the most popular and prolific.

### The V Engine

This is probably the most popular engine block on the market and comes in several iterations. From massive Cadillac V16s, to classic V8s to the tiny V4s used on



Figure: Engine Block.

motorcycles; the V engine has a long history and time-tested record of reliability.



Figure: V-Type Engine.

### Inline Engine

Inline-block engines use a series of cylinders that run in a single line from the back of the engine to the front. Because these engines typically run smoothly, they are often used in applications that require high-rpm power, which makes the configuration ideally suited to the small-displacement engines used in most passenger cars. It is for this reason that almost all four-cylinder engines use an inline-block configuration.



### Boxer Engines

Boxer engines are used primarily by Porsche and Subaru and are some of the most highly developed engines around. The easiest way to understand the boxer engine is to think of it as a V engine that has been pressed flat, so that the cylinder heads are directly opposite each other.



### Materials

Grey iron is a form of cast iron. There are many different kinds of cast iron, depending on the particular materials they contain. Grey iron is a cast iron that contains carbon in the form of graphite, plus silicon, manganese and phosphorus. The fractured surface of a cast iron with graphite appears grey, hence the name. It is brittle and cannot absorb shocks. It resists heat and corrosion, and can be cast into many different shapes. It is used for many components

### LITERATURE REVIEW

Heat engines generate mechanical power by extracting energy from heat flows, much as a water wheel extracts mechanical power from a flow of mass falling through a distance. Engines are inefficient, so more heat energy enters the engine than comes out as mechanical power; the difference is waste heat which must be removed. Internal

combustion engines remove waste heat through cool intake air, hot exhaust gases, and explicit engine cooling. Engines with higher efficiency have more energy leave as mechanical motion and less as waste heat. Some waste heat is essential: it guides heat through the engine, much as a water wheel works only if there is some exit velocity (energy) in the waste water to carry it away and make room for more water. Thus, all heat engines need cooling to operate. Cooling is also needed because high temperatures damage engine materials and lubricants. Internal combustion engines burn fuel hotter than the melting temperature of engine materials, and hot enough to set fire to lubricants. Engine cooling removes energy fast enough to keep temperatures low so the engine can survive.

Most internal combustion engines are fluid cooled using either air (a gaseous fluid) or a liquid coolant run through a heat exchanger (radiator) cooled by air. Marine engines and some stationary engines have ready access to a large volume of water at a suitable temperature. The water may be used directly to cool the engine, but often has sediment, which can clog coolant passages, or chemicals, such as salt, that can chemically damage the engine. Thus, engine coolant may be run through a heat exchanger that is cooled by the body of water.

### Modeling of the engine block in CATIA Software

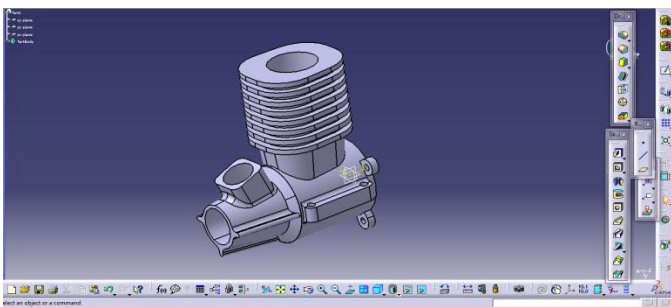
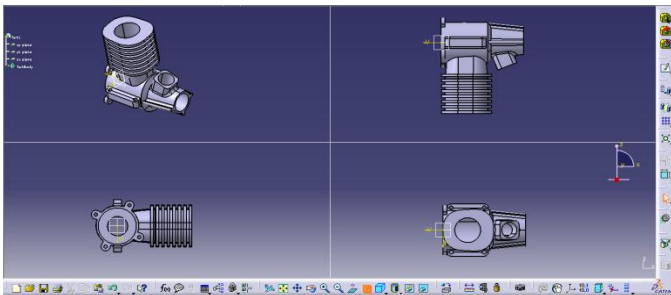
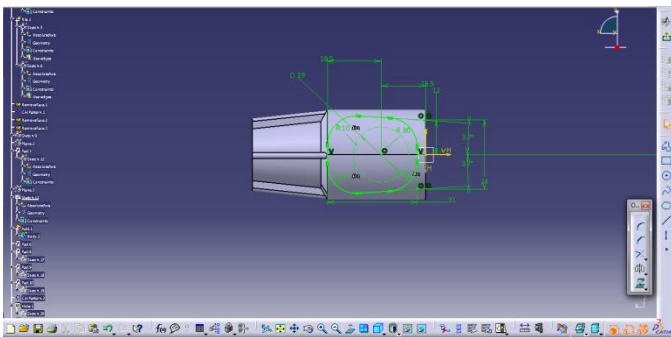
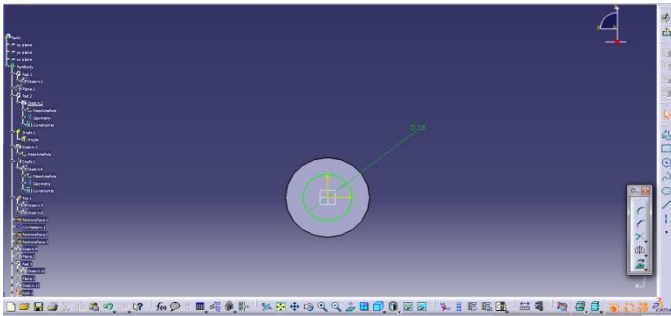
#### Introduction

CATIA Software is an acronym of computer -aided three dimensional interactive application is multi-platform software suit for CAD, CAM, CAE, PLM, and 3D, developed by the French company Dassault system.



The modeling of all the component was concluded in CATIA Software.

## Model of the engine block

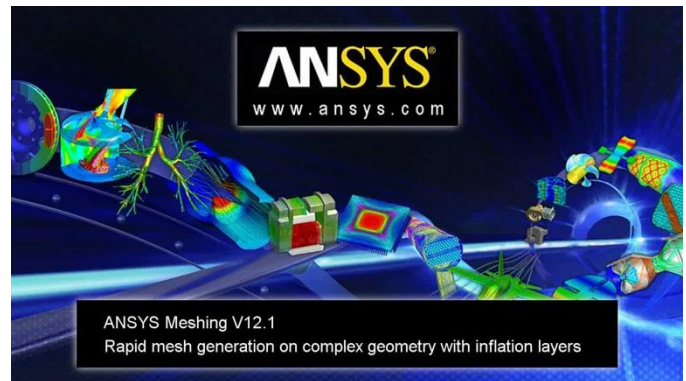


## Analysis of engine block in ANSYS Software

### Introduction

ANSYS delivers innovative, dramatic simulation technology advances in every major Physics discipline, along with improvements in computing speed and enhancements to enabling technologies such as geometry handling, meshing and post-processing. These

advancements alone represent a major step ahead on the path forward in Simulation Driven Product Development. But ANSYS has reached even further by delivering all this technology in an innovative simulation framework, ANSYS Workbench 16.0. The ANSYS Workbench environment is the glue that binds the simulation process; this has not changed with version 16.0. In the original ANSYS Workbench, the user interacted with the analysis as a whole using the platform's project page: launching the various applications and tracking the resulting files employed in the process of creating an analysis. Tight integration between the component applications yielded unprecedented ease of use for setup and solution of even complex multi physics simulations.



### Analysis Types :

The different type of analysis that can be performed in ANSYS

Structural static analysis:

1. Structural dynamic analysis
2. Structural buckling analysis
  - Linear buckling
  - Non linear buckling
3. Structural non linearity
4. Static and dynamic kinematics analysis
5. Thermal analysis
6. Electromagnetic field analysis
7. Electric field analysis
8. Fluid flow analysis
  - Computational fluid dynamics
  - Pipe flow Coupled-field analys.

### Structural analysis

Structural analysis is the most widely used application in Finite element Method.

Structural analysis is of seven types. They are:

1. Static Analysis
2. Modal Analysis
3. Harmonic Analysis
4. Transient Analysis
5. Spectrum Analysis
6. Buckling Analysis
7. Explicit Dynamic Analysis

Since this project involves only Static Structural Analysis a brief description is given below.

### Static analysis

A static analysis calculates a structure's steady loading conditions, ignoring damping effects and inertia. Static analysis analyzes the stresses, displacements, forces and strains under static loading conditions. Static analysis is either Linear or Non-linear. The types of nonlinearities include plasticity, stress stiffening, large deflection and deformations, contact or gap elements, creep and hyper elasticity. The procedure for implementing the structural static analysis involves the following main tasks:

1. Building the model
2. Setting the solution controls
3. Applying the loads
4. Solving the analysis and
5. Reviewing the results

### Thermal Analysis:

Changes in temperature can induce substantial deformations, strains, and stresses. Thermal analysis refers to analysis that includes the effect of temperature. In below figures we can see the process of design and analysis of radial engine components using solid works using simulation and analysis. Solid works simulation enables every designer and engineer to carry out thermal analysis at any stage of design to ensure that every component and assembly performs properly within expected temperature ranges, and spot safety issues before they arise

### Advantages of ANSYS

1. The ANSYS program is a flexible and cost effective tool which helps in the reduction of rework on prototype.
2. ANSYS program is a graphical user interface that facilitates the users with easy and intuitive path to program commands, documentation and functions.
3. In order to reduce the production costs, ANSYS enables to optimize the design in the development process itself.
4. ANSYS program helps in designing the computer models and study the physical responses such as stress levels, temperature distribution.

### ANALYSIS OF ENGINE BLOCK

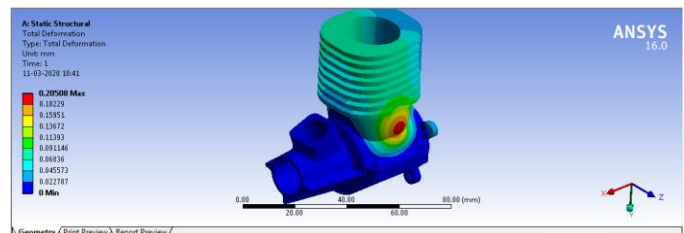
#### Properties

Material	Density (kg/m <sup>3</sup> )	Young's modulus (Gpa)	Poison's ratio
Stainless steel	7750	193000	0.31
Titanium alloy	4620	96000	0.36
Gray cast iron	7200	110000	0.28
Carbon epoxy	1451	59160	0.3

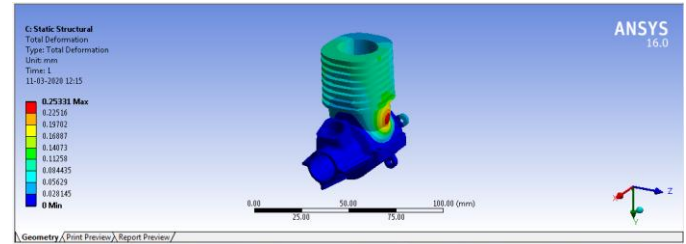
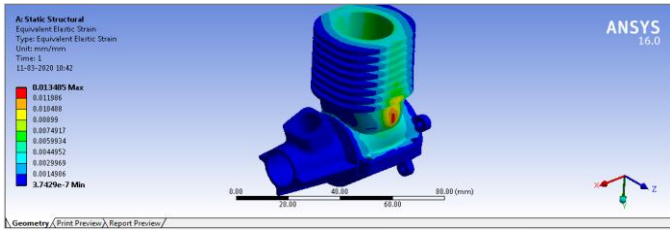
#### Static structural:

#### Stainless steel

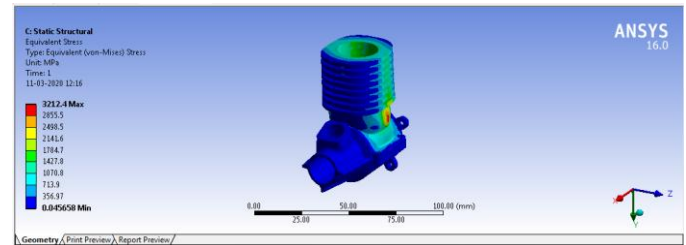
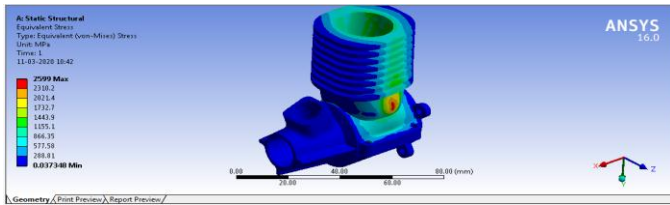
#### Total deformation



**Equivalent elastic strain**



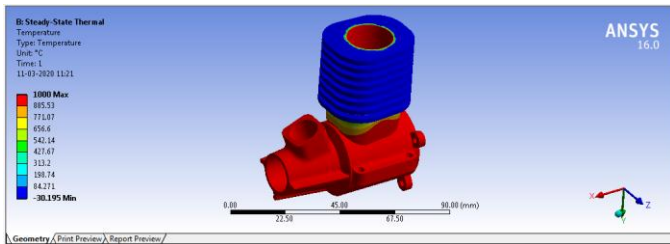
**Equivalent stress**



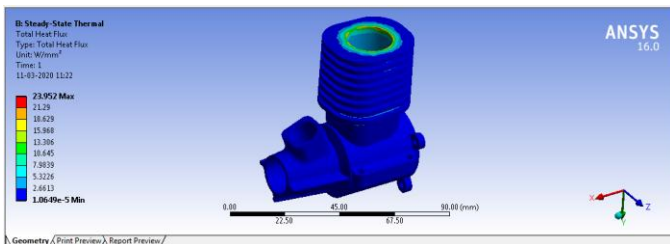
**Steady state Thermal analysis:**

**Stainless steel**

**Temperature**



**Total heat flux**



**Dynamic analysis:**

**Stainless steel**

**Total deformation**

**Equivalent stress**

**Results:**

**Static structural**

Material	Total deformation	Equivalent strain	Equivalent stress
Gray cast iron	0.3550	0.02339	2573.2
Stainless steel	0.20508	0.01340	2599
Titanium alloy	0.4075	0.0269	2573
Carbon epoxy	3.0351	0.2578	3356.3

**Steady state thermal:**

Material	Temperature	Total heat flux
Stainless steel	1000	23.92
Gray cast iron	25330	592.73
Titanium alloy	1000	34.71
Carbon epoxy	1000	1.432e <sup>6</sup>

**Dynamic analysis:**

Material	Total deformation	Equivalent stress
Gray cast iron	0.4437	3216.4

<b>Stainless steel</b>	0.2533	3212.4
<b>Titanium alloy</b>	0.5094	3216.6
<b>Carbon epoxy</b>	3.7938	4196.4

**Conclusions**

1. Modeling and analysis of engine block is done
2. Modeling of engine block is done in catia v5 design software by using various commands and save as IGES file.
3. Analysis on engine block is carried out by using ansys work bench software.
4. First Static structural analysis is carried out on engine block at 400 MPa pressure with four different materials, such as grey cast iron, stainless steel, titanium alloy and carbon epoxy.
5. Maximum stress, deformation and maximum strain are noted and tabulated
6. Then steady state thermal analysis is carried out at maximum temperature of 1000deg Celsius and convection is done by using fins from ambient temperature 27 deg Celsius.
7. Temperature distribution are noted for all four different materials and tabulated.
8. Then dynamic analysis is carried out on engine block at 500 mpa pressure with four different materials.
9. From the static analysis result tables it is concluded that magnesium alloy show least stress and aluminum metal matrix shows least deformation & strain value on same static load condition.
10. From the thermal analysis result tables it is concluded that grey cast iron shows highest temperature distribution i.e., minimum temperature and maximum heat flux on same thermal load condition followed by aluminum metal matrix.
11. Aluminum metal matrix can withstand more stresses and grey cast iron can withstand the temperatures. Hence aluminum metal matrix is preferable and can withstand high temperatures and stresses if high load and thermal condition both concern.

**REFERENCES**

1. "ASME Landmark: Additional Information on Marcus car," [Online], 20 March 2005-last update, Available: <http://www.asme.org/history/attachments/marcus1.html>.
2. Keay, Sue: "Diet of Australian metal lightens cars and pollution," Media release, 14 October 2002.
3. Anyalebechi, P.N., Private Communication.
4. "Anatomy of an Engine – the New North star V8," [Online], 7 April 2005-last visited, Available: [http://www.autospeed.com/cms/A\\_1569/article.html](http://www.autospeed.com/cms/A_1569/article.html).
5. "In Search of Light-Weight Components," [Online], <http://www.moderncasting.com/archive/WebOnly/1102/AL1102.asp>.
6. R.S. Khurmi, J.K. Gupta: A Text Book of Machine Design 2005 Edition Chapter 12 Internal Combustion Engine parts.
7. Dynamic Load and Stress Analysis of a Crankshaft. Paper no. 2007-01-0258.F.H. Montazersadgh and Ali Fatemi, University of Tornado.
8. Calculating and Displaying Fatigue Results By Raymond Browell, Product Manager New Technologies, Ansys, Inc.
9. G.F. Mauer, Modelling and experimental validation of torsional crankshaft speed fluctuation: a model for dynamics of IC engine, SAE Technical Paper No. 940630, 1994.

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