

# International Journal of Innovative Research in Science, Engineering and Technology

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## Design and Material Optimization of Flywheel

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**ABSTRACT:** In this project we are doing the material optimization of flywheel in an internal combustion engine. This project we are designed the 3D model of the flywheel by using pro-e software and the analysis taken by different materials of the flywheel and the analysis taken by the ansys software.

This project we are analyzed the rotational velocity and moment acting on the flywheel by the five materials. Presently the flywheels are made by the material of gray cast iron, this project we are testing the same load under the three materials. The materials are aluminium alloy (Duralumin), carbon fiber, E glass epoxy.

### I. INTRODUCTION

A flywheel is a mechanical device with a significant moment of inertia used as a storage device for rotational energy. Flywheels resist changes in their rotational speed, which helps steady the rotation of the shaft when a fluctuating torque is exerted on it by its power source such as a piston-based (reciprocating) engine, or when an intermittent load, such as a piston pump, is placed on it. Flywheels can be used to produce very high power pulses for experiments, where drawing the power from the public network would produce unacceptable spikes.

The phenomenon of precession has to be considered when using flywheels in moving vehicles. However in one modern application, a momentum wheel is a type of flywheel useful in satellite pointing operations, in which the flywheels are used to point the satellite's instruments in the correct direction without the use of thrusters rockets.

Flywheels are used in punching machines and riveting machines. For internal combustion engine applications, the flywheel is a heavy wheel mounted on the crankshaft. The main function of a flywheel is to maintain a near constant angular velocity of the crankshaft.

### II. PRO-E MODELLING

Pro/ENGINEER, PTC's parametric, integrated 3D CAD/CAM/CAE solution, is used by discrete manufacturers for mechanical engineering, design and manufacturing. Created by Dr. Samuel P. Geisberg in the mid-1980s, Pro/ENGINEER was the industry's first successful parametric, 3D CAD modeling system. The parametric modeling approach uses parameters, dimensions, features, and relationships to capture intended product behavior and create a recipe which enables design automation and the optimization of design and product development processes. This powerful and rich design approach is used by companies whose product strategy is family-based or platform-driven, where a prescriptive design strategy is critical to the success of the design process by embedding engineering constraints and relationships to quickly optimize the design, or where the resulting geometry may be complex or based upon equations. Pro/ENGINEER provides a complete set of design, analysis and manufacturing capabilities on one, integral, scalable platform. These capabilities, include Solid Modeling, Surfacing, Rendering, Data Interoperability, Routed Systems Design, Simulation, Tolerance Analysis, and NC and Tooling Design.

#### BASIC MODES IN PRO E

Sketcher - Define the 2D cross-section (or section) of an object model for sweeping.

Part - Create the solid model of a part.

Assembly - Form the solid model of an assembly of multiple components.

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Drawing - Produce engineering drawings of parts and assemblies created in Pro/ENGINEER. These drawings are fully associative with the 3D solid model. When a dimension in the drawing is changed the dimension of the associated 3D model(s) will be automatically updated, and vice versa.

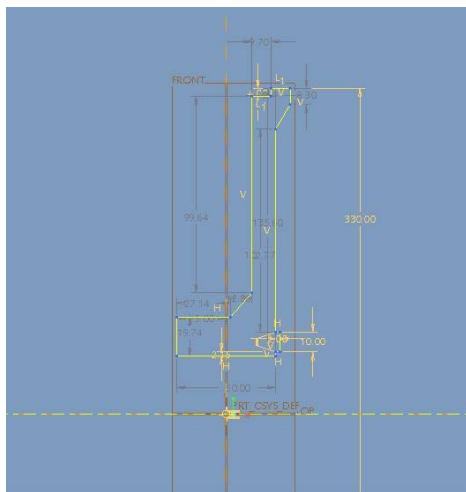


Fig 1: PRO-E MODELLING

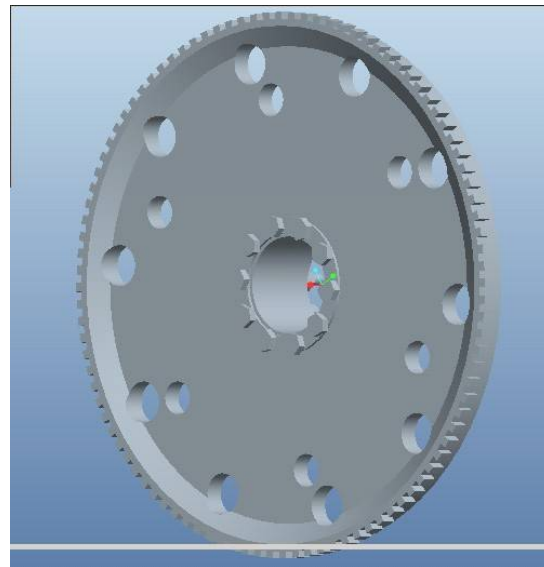


Fig 2: FULL ASSEMBLY VIEW

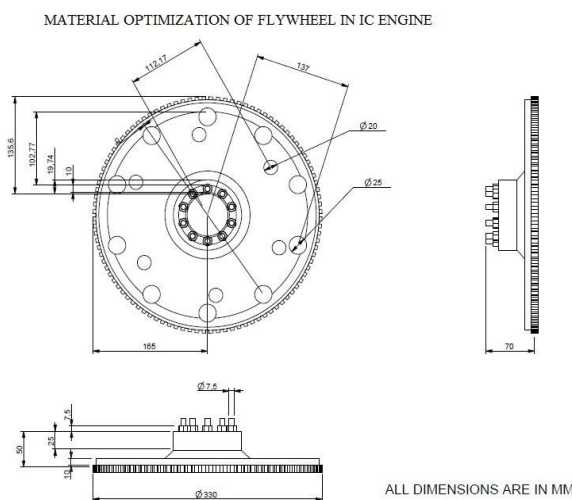


Fig 3: LAYOUT OF FLYWHEEL

## ANSYS

ANSYS is an engineering simulation software provider founded by software engineer John Swanson. It develops general-purpose finite element analysis and computational fluid dynamics software. While ANSYS has developed a

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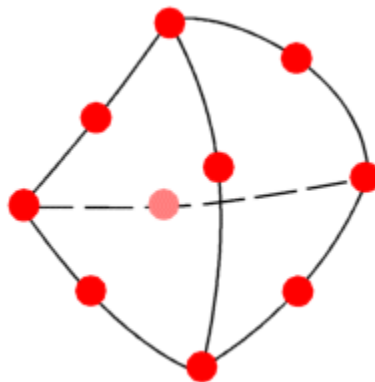
range of computer-aided engineering (CAE) products, it is perhaps best known for its ANSYS Mechanical and ANSYS Multiphysics products.

ANSYS Mechanical and ANSYS Multiphysics software are non exportable analysis tools incorporating pre-processing (geometry creation, meshing), solver and post-processing modules in a graphical user interface. These are general-purpose finite element modeling packages for numerically solving mechanical problems, including static/dynamic structural analysis (both linear and non-linear), heat transfer and fluid problems, as well as acoustic and electro-magnetic problems.

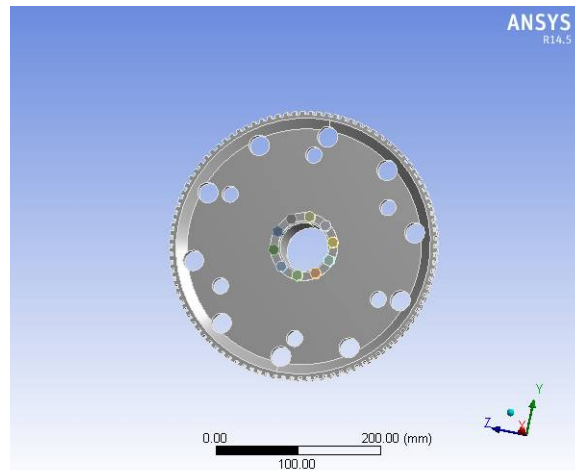
ANSYS Mechanical technology incorporates both structural and material non-linearities. ANSYS Multiphysics software includes solvers for thermal, structural, CFD, electromagnetic, and acoustics and can sometimes couple these separate physics together in order to address multidisciplinary applications. ANSYS software can also be used in civil engineering, electrical engineering, physics and chemistry.

ANSYS, Inc. acquired the CFX computational fluid dynamics code in 2003 and Fluent, Inc. in 2006. The CFD packages from ANSYS are used for engineering simulations. In 2008, ANSYS acquired Ansoft Corporation, a leading developer of high-performance electronic design automation (EDA) software, and added a suite of products designed to simulate high-performance electronics designs found in mobile communication and Internet devices, broadband networking components and systems, integrated circuits, printed circuit boards, and electromechanical systems. The acquisition allowed ANSYS to address the continuing convergence of the mechanical and electrical worlds across a whole range of industry sectors.

### III. UNDERSTANDING THE NODES AND ELEMENTS



- Red dots represent the element's nodes.
- Elements can have straight or curved edges.
- Each node has three unknowns, namely, the translations in the three global directions.
- The process of subdividing the part into small pieces (elements) is called meshing. In general, smaller elements give more accurate results but require more computer resources and time.
- Ansys suggests a global element size and tolerance for meshing. The size is only an average value, actual element sizes may vary from one location to another depending on geometry.
- It is recommended to use the default settings of meshing for the initial run. For a more accurate solution, use a smaller element size.



**Fig 4: GEOMETRY VIEW OF IC ENGINE FLYWHEEL**

#### IV. MATERIALS FOR FLYWHEEL

##### GRAY CAST IRON

Gray cast iron is a type of cast iron that has a graphitic microstructure. It is named after the gray color of the fracture it forms, which is due to the presence of graphite. It is the most common cast iron and the most widely used cast material based on weight. Gray Cast Iron is so called because of the colour of the fracture face. It contains 1.5-4.3% carbon and 0.3-5% silicon plus manganese, sulfur and phosphorus. It is brittle with low tensile strength, but is easy to cast.

##### ADVANTAGES

- Gray iron's high carbon content makes it easy to melt, weld, machine and cast using common metalworking processes.
- Gray iron contains graphite flakes that provide a high level of stability and minimize shrinking during the casting process.
- The metallurgy of gray iron also makes it resistant to corrosion.
- Gray iron's high conductivity makes it ideal for cookware.

##### DISADVANTAGES

- Gray cast iron's extremely low tensile strength makes it a poor shock resistor relative to newer, less rigid iron alloy varieties.
- Blasting gray iron can weaken castings by causing residual stress.
- Gray iron may be too brittle for some applications, including instances when a casting must be especially thin or flexible.

##### DURALUMIN

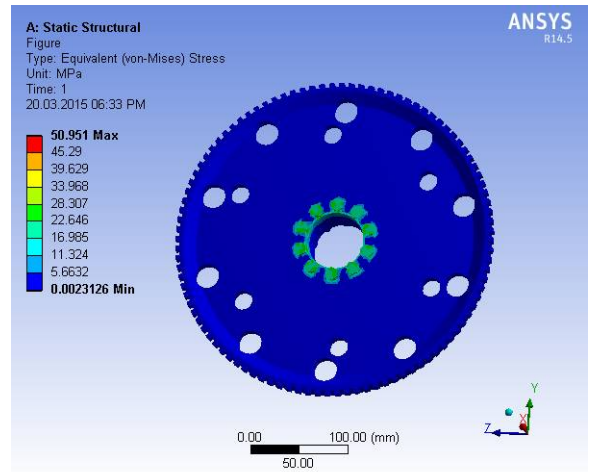
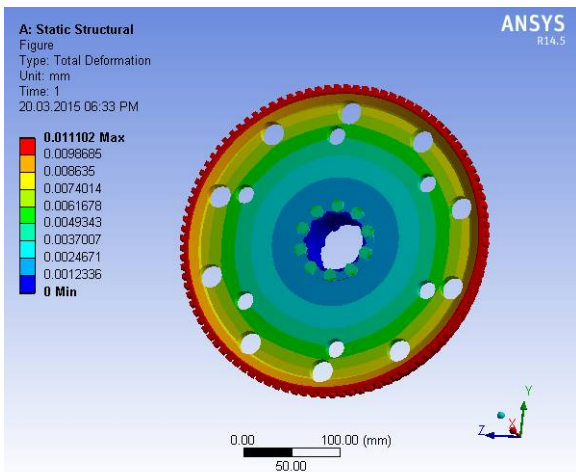
The main alloy of aluminium is duralumin. Duralumin (also called duraluminum, duralum, duraluminium, duralium or dural) is the trade name of one of the earliest types of age-hardenable aluminium alloys. Duralumin is an alloy of aluminium (94%), copper (4%) and magnesium (1%). Small quantities of manganese and silicon may also be present. Duralumin is a low density alloy. It has a higher strength to weight ratio than pure aluminium.

##### ADVANTAGES

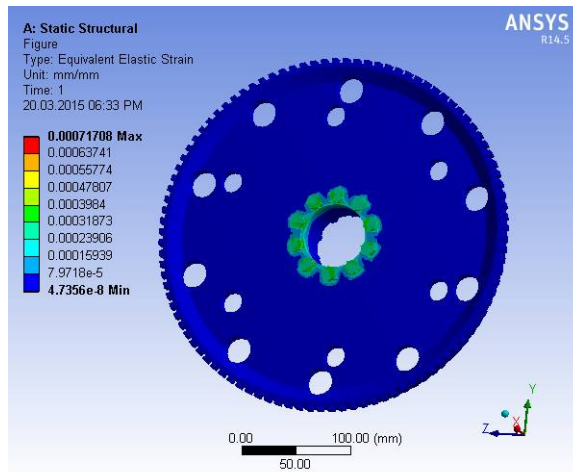
- It has an excellent strength to weight ratio, having a good strength while being lightweight; allowing applications of aircraft and vehicle structures.
- It is extremely tough and hard, with a high resistance to stress - corrosion and cracking.
- Furthermore duralumin machines and casts well with a high performance in extreme temperatures.

## V. RESULTS AND DISCUSSION

### TOTAL DEFORMATION



### EQUIVALENT ELASTIC STRAIN



### EQUIVALENT STRESS

#### RESULTS

#### RESULT COMPARISION FOR DURALUMIN

DURALUMIN	MINIMUM	MAXIMU M
Total deformation (mm)	0	0.0111
Equivalent elastic strain(mm/mm)	4.74e-8	7.17e-4
Equivalent stress (Mpa)	0.0023	50.951

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## RESULT COMPARISION OF GRAY CAST IRON

GRAY CAST IRON	MINIMUM	MAXIMUM
Total deformation (mm)	0	0.01817
Equivalent elastic strain(mm/mm)	7.964e-8	5.027e-4
Equivalent stress (Mpa)	0.00519	53.588

## RESULT COMPARISION OF CARBON FIBRE

CARBON FIBRE	MINIMUM	MAXIMUM
Total deformation (mm)	0	0.00399
Equivalent elastic strain(mm/mm)	1.87e-8	1.29e-4
Equivalent stress (Mpa)	0.00495	50.451

## RESULT COMPARISION OF E GLASS EPOXY

E GLASS EPOXY	MINIMUM	MAXIMUM
Total deformation (mm)	0	0.010626
Equivalent elastic strain(mm/mm)	4.16e-8	9.99e-4
Equivalent stress (Mpa)	0.001268	54.198

## VI. CONCLUSION

The analysis of flywheel we found that the carbon fiber material have a good physical properties and it have a less deformation under the moment and velocity, than the other four materials and finally the deformation, stress, strain of the carbon fiber is low compared to the materials.

The project carried out by us will make an impressing mark in the field of automobile. This project we are design and analyze the flywheel used in an IC engine.

Doing this project we are study about the 3Dmodelling software (PRO-E) and Study about the analyzing software (ansys) to develop our basic knowledge to know about the industrial design.

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