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MATERIAL OPTIMIZATION OF FLYWHEEL IN IC ENGINE

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ABSTRACT

The material optimization of flywheel in an internal combustion engine is performed. 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 has done. The rotational velocity and moment acting on the flywheel by the 3 materials are analyzed. Presently the flywheels are made by the material of gray cast iron, same load under the three materials have been tested. The materials taken are Aluminum alloy (Duralumin), Carbon Fiber, E glass epoxy.

KEYWORDS: Rotational velocity, Flywheel, Optimization

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 thruster's rockets. 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.

PRO-E MODELING

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.

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

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.

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.

APPLICATIONS

Typical applications of gray iron include automotive engine blocks, gears, flywheels, brake discs and drums, and machine bases. Gray iron serves well in machinery applications because of its good fatigue resistance.

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.

APPLICATIONS

Aircraft structures, rivets, hardware, truck wheels, screw machine products, and other miscellaneous structural applications. Forgings, aircraft and diesel engine pistons, aircraft engine cylinder heads, jet engine impellers, flywheels and compressor rings.

CARBON FIBRE COMPOSITE

Carbon fiber, alternatively graphite fiber or CF, is a material consisting of fibers about 5–10 µm in diameter and composed mostly of carbon atoms. Carbon fiber (also known as carbon fibre) is the super hero of the materials world – it's one of the strongest and most lightweight materials available on the market today. To make a carbon fiber sheet (also known as a composite), carbon fiber fabric is saturated or infused with epoxy resins and heated at high temperatures. Shaped pieces are made by layering several pieces of fabric over a mold, saturating them with resin and heating it until the resin has infused through all layers.

ADVANTAGES OF CARBON FIBER

- Lightweight – carbon fiber is a low density material with a very high strength to weight ratio
- High tensile strength – one of the strongest of all commercial reinforcing fibers when it comes to tension, carbon fiber is very difficult to stretch or bend
- Low thermal expansion – carbon fiber will expand or contract much less in hot or cold conditions than materials like steel and aluminum
- Exceptional durability – carbon fiber has superior fatigue properties compared to

metal, meaning components made of carbon fiber won't wear out as quickly under the stress of constant use

- Corrosion-resistance – when made with the appropriate resins, carbon fiber is one of the most corrosion-resistant materials available
- Radiolucence – carbon fiber is transparent to radiation and invisible in x-rays, making it valuable for usage in medical equipment and facilities
- Electrical conductivity – carbon fiber composites are an excellent conductor of electricity

APPLICATIONS

Energy-related applications include pressure vessels and windmills for wind turbine generator. Transport machinery applications include drive shafts and rear spoilers for automobiles. In civil engineering and construction-related area, Toray carbon fiber is applied to repair and reinforce bridge piers and decks. In general industrial machineries, major applications are medical equipments, chassis, machine parts, etc.

E-GLASS EPOXY

The E-glass /Epoxy based composites filled with varying concentrations (0, 10 and 15 Vol %) of aluminum oxide (Al₂O₃), magnesium

hydroxide (Mg (OH)₂), silicon carbide (SiC), and hematite powder were prepared. The volume fraction of fiber, epoxy and filler materials are determined by considering the density, specific gravity and mass. Fabrication of the composites was done at room temperature by hand lay-up techniques.

ADVANTAGES

- Low cost
- High production rates
- High strength,
- High stiffness
- Relatively low density
- Non-flammable
- Resistant to heat
- Good chemical resistance
- Relatively insensitive to moisture
- Able to maintain strength properties over a wide range of conditions
- Good electrical insulation

APPLICATIONS

Applications of fiberglass include aircraft, boats, automobiles, bath tubs and enclosures, hot tubs, septic tanks, water tanks, roofing, pipes, cladding, casts, surfboards, and external door skins.

RESULTS

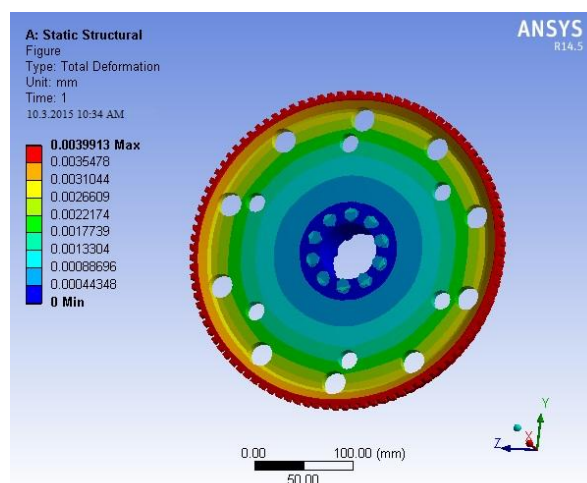


Fig: 4.1 Results for Carbon Fiber

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

Table 4.1: Result Comparison of Carbon fibre

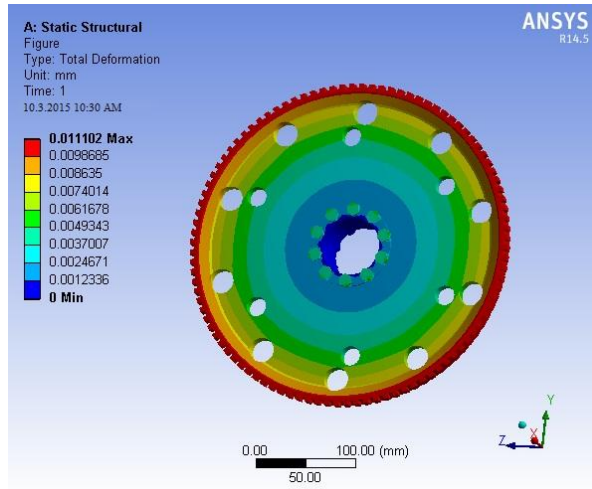


Fig: 4.2 Results DuroAluminium

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

Table 4.1: Result Comparison of Duro Aluminium

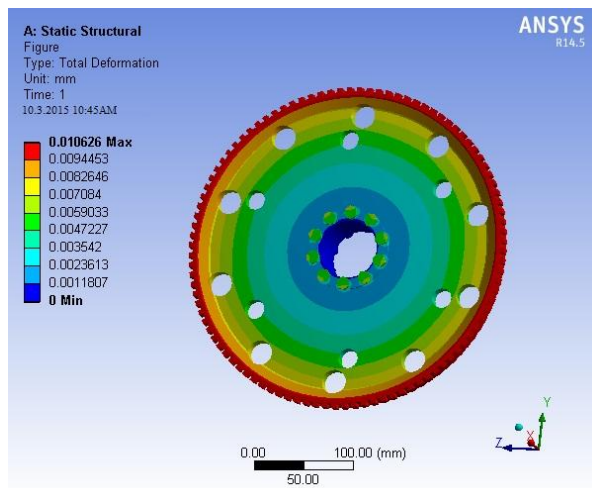


Fig: 4.3 Results for E-PROXY

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

Table 4.1: Result Comparison of E-Proxy

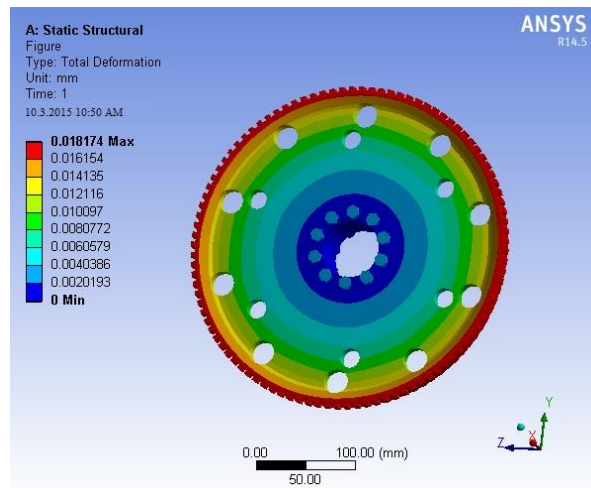


Fig: 4.4 Results for Gray Cast Iron

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

Table 4.1: Result Comparison of Gray Cast Iron

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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