

STRUCTURAL AND MODAL ANALYSIS OF FLYWHEEL USED IN PETROL ENGINE

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ABSTRACT

The flywheel is serves as a reservoir which stores energy in the machines through the period when the supply of energy is more than the necessity and discharges it during the period when the requirement of energy is more than supply. For instance, in I.C. engines, the energy is created just in the power stroke which is great deal more than an engine load, and no energy is being produced within the suction, compression and exhaust strokes if there should be an occurrence of four stroke engines. The additional energy is produced during power stroke is consumed by the flywheel and discharges it's to the crank shaft amid the further strokes in which no energy is created, in this way pivoting the crankshaft at a uniform speed.

The flywheel is fixed at one side of the crankshaft and fills two needs. The second, it is the mounting surface used to fasten the engine up to its heap. The point of the undertaken is to design a flywheel for a multi cylinder petrol engine flywheel using the exact equations. A parametric model of the flywheel is designed utilizing 3D modeling software CATIA V5 R18. The strengths following up on the flywheel are likewise computed. The strength of the flywheel is approved by applying the forces on the flywheel in analysis software ANSYS14.5.

I. INTRODUCTION

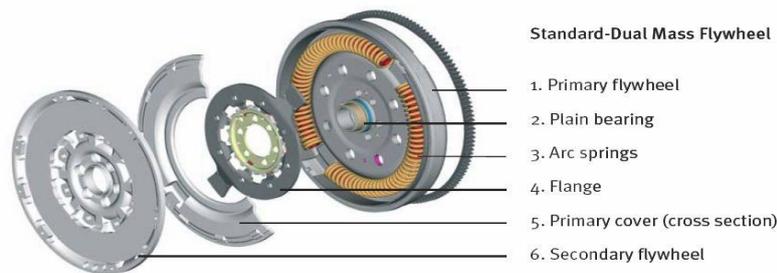
A flywheel is a heavy disk or wheel that is connected to a pivoting shaft. These are used for storage of K.E. The force of the flywheel makes it to not change its rotational speed effectively. Due to this, flywheels keep the shaft turning at the same rate of speed. This aids when the torque connected to the shaft changes frequently. Uneven torque can change the speed of turning speed. Since the flywheel opposes changes in speed, it shrinkages the impact of uneven torque. Engines which use pistons to give control more often than not have uneven torque and use flywheels to fix this issue.

It takes vitality to get a wheel (any wheel) to turn. On the off chance that there is little friction then it will continue rotating quite a while. At the point when energy is required, it can be taken from the wheel once more. So it is a straightforward mechanical method for putting storing energy. The total energy stored is an element of the weight and the speed of rotation - making a heavier wheel pivot quicker takes more energy. Another variable is the span (dimension) on the grounds that the more remote from the pivot a part of the wheel is, the more energy it takes to make is rotate. These three elements can be signified by M (mass), ω (angular velocity) and R (radius). Joining the two mathematical statements below gives $\omega^2 MR^2/4$. A fly-wheel is any wheel, as well as particularly intended to store energy. So it ought to be overwhelming and/or pivot quickly. For example, a few transports have a fly-wheel that is utilized for halting and beginning. At the point when the transport stops (ex. Traffic signal), the fly-wheel is associated with the wheels, so the rotational energy is exchanged to it, so the



vehicle will back off while the fly-wheel speeds up. At that point, when the vehicle needs to begin driving once more, it is associated again and the energy is exchanged back. Obviously, you wouldn't have any desire to drag a substantial wheel around on a vehicle, so it is made of a lighter material that can withstand extremely quick rotation.

II. FLYWHEEL



The kinetic energy of a rotating flywheel is

$$E = \frac{1}{2} I \omega^2$$

Where the moment of inertia of center mass is equal to

$$I = \frac{1}{2} MR^2$$

where I is the moment of inertia of the mass about the center of rotation and ω (omega) is the angular velocity in radian units.

As talk over above, the flywheel does not keep up consistent speed. It essentially decreases the change of speed. At the end of the day a flywheel controls the speed variations created by the fluctuation of the engine turning moment amid every cycle of operation. It does not control the speed variations brought on by the changing load.

Coefficient of fluctuation of speed:

The difference between the maximum and minimum speeds during a cycle is called the maximum fluctuation of speed. The ratio of the maximum fluctuation of speed to the mean speed is called coefficient of fluctuation of speed.

Coefficient of steadiness:

The equal of coefficient of fluctuation of pace is called coefficient of steadiness and it is represented by letter 'm'.

III. FINITE ELEMENT ANALYSIS (FEA)

The fundamental idea in FEA is that the body or structure may be separated into little components of finite measurements called "Finite Elements". The original body or the structure is then considered as an array of these components associated at a limited number of joints called "hubs". Straightforward capacities are approximated the removals over each limited component. Such accepted capacities are called "shape capacities". This will signify the movement within the components as far as the relocation at the hubs of the components.

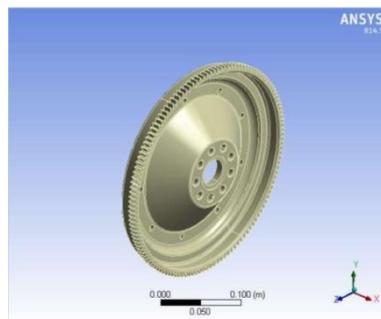
The Finite Element method is a scientific tool for resolving ordinary and partial differential comparison in light of the fact it is a numerical tool, it can take care of the complex issue that can be signified in differential mathematical statement from. The use of FEM is limitless as respects the arrangement of down to earth design issues. Because of high cost of processing power of years passed by, FEM has a history of being utilized to take care of complex and expensive critical difficulties.

MATERIAL PROPERTIES OF FLYWHEEL

Material Name & Properties	Cast Iron	CFRP	Beta Ti Alloy
Young's Modulus (E)	103000 N/mm ²	80000N/mm ²	72000N/mm ²
Poisson's Ratio	0.211	0.33	0.21
Density	0.0000071 Kg/mm ³	0.00000268Kg/mm ³	0.00000255Kg/mm ³

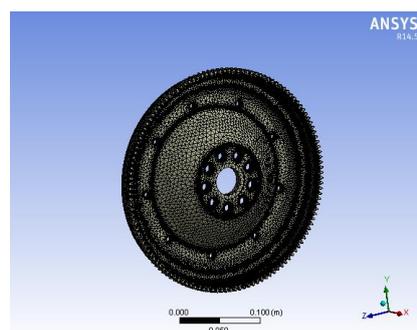
IV. STATIC AND MODAL ANALYSIS OF FLYWHEEL

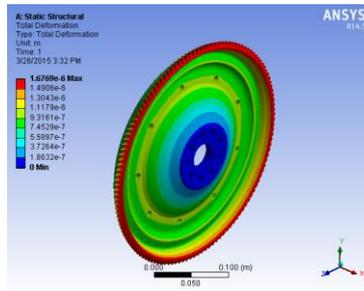
Flywheel Imported Model from Catia V5 R18



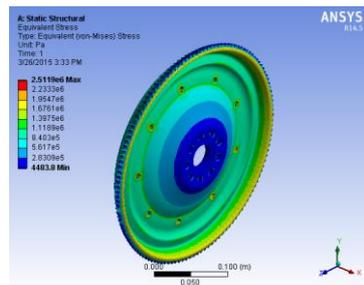
Structural Analysis Of Flywheel

Meshed Model

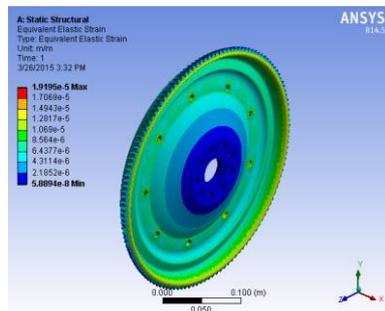




Equivalent Stress

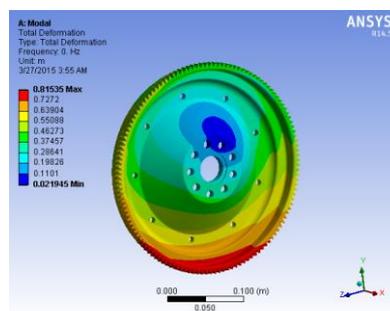


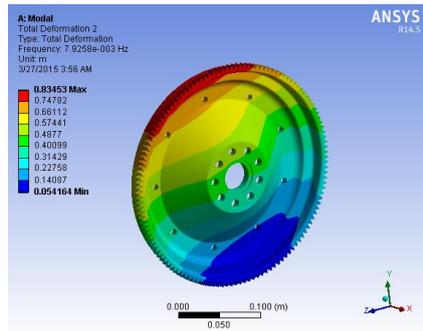
Equivalent Elastic Strain



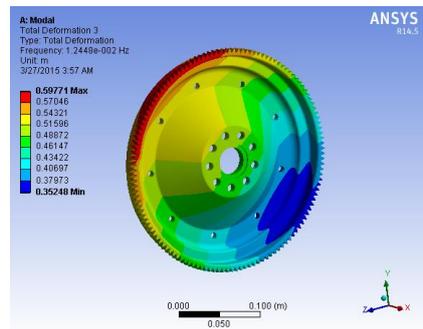
Modal Analysis For Cast Iron

Modal Analysis 1

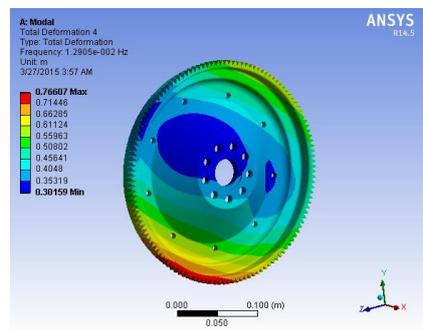




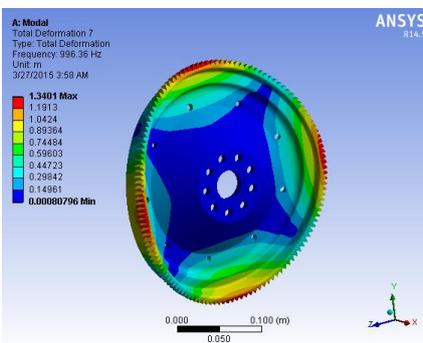
Modal Analysis 3



Modal Analysis 4

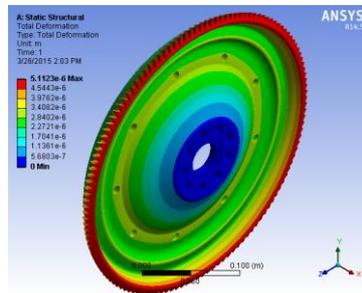


Modal Analysis 5

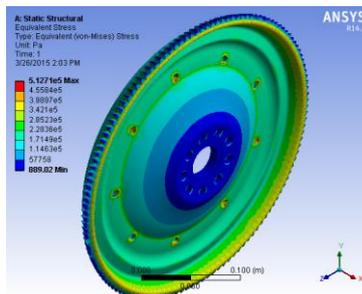


Carbon Fiber Reinforced Plastic

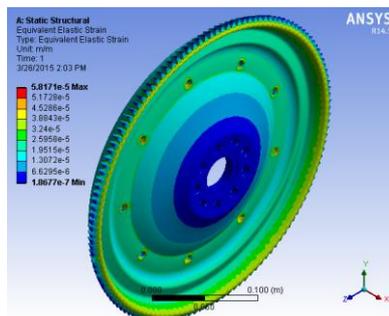
Total Deformation



Equivalent Stress

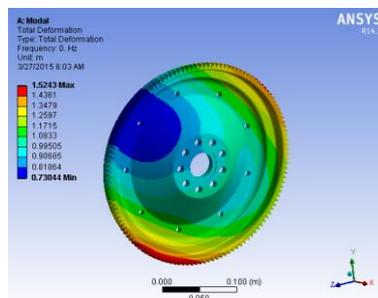


Equivalent Elastic Strain

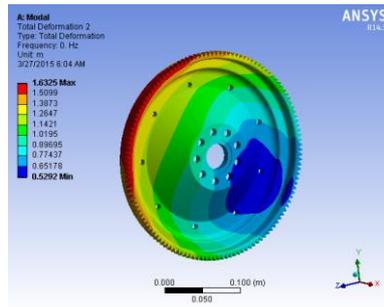


Modal analysis for Carbon Fiber

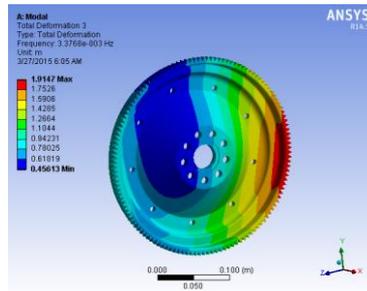
Modal analysis 1



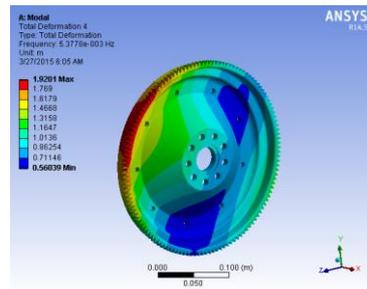
Modal Analysis 2



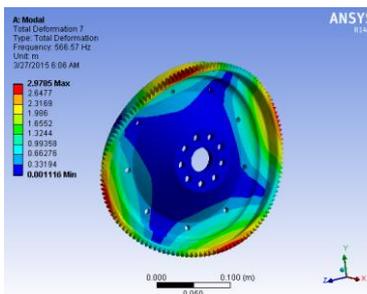
Modal Analysis 3



Modal Analysis 4



Modal Analysis 5

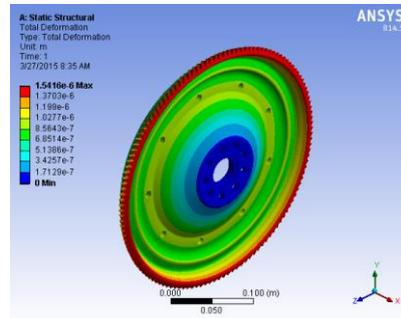




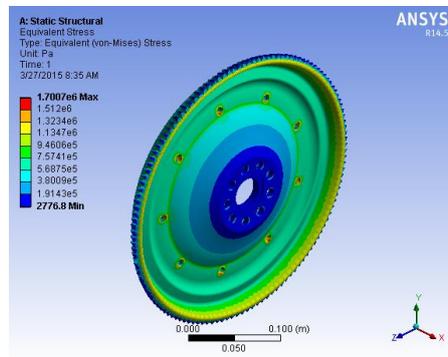
Structural Analysis of Flywheel

Beta Titanium alloy

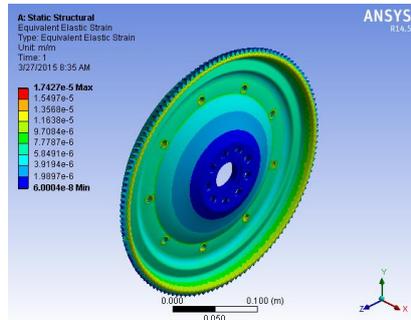
Total Deformation



Equivalent Stress

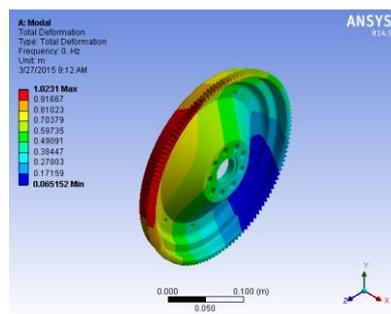


Equivalent Elastic Strain



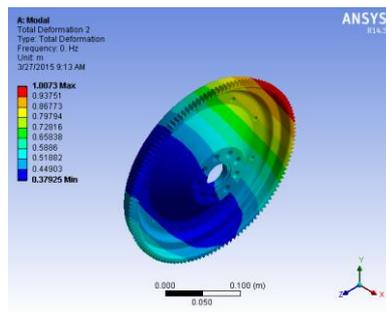
Modal Analysis for Beta Titanium Alloy

Modal Analysis 1

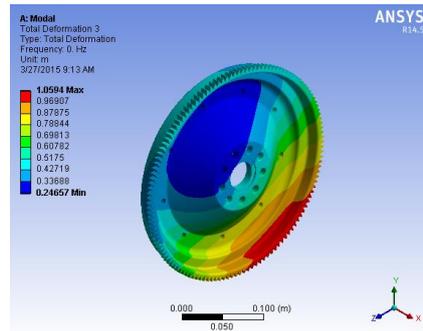




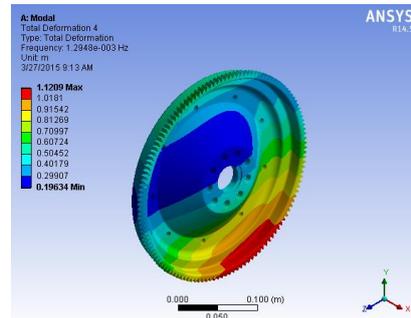
Modal Analysis 2



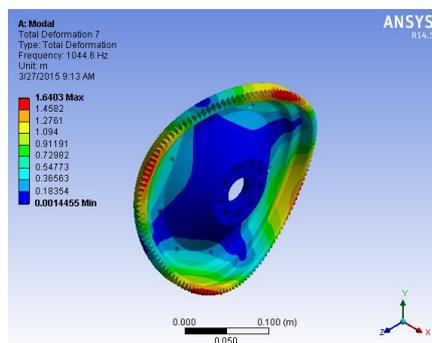
Modal Analysis 3



Modal Analysis 4



Modal Analysis 5



V. RESULTS AND DISCUSSION

Numerical values obtained during analysis:

si.no	material	Displacement		von-mises stress		Strain	
		min	Max	Min	Max	min	max
1	CAST IRON	0	1.678E-6	4483.8	2.5119E6	5.8894E-8	1.919E-5
2	CARBON FIBER	0	5.1123E-6	889.02	5.127E5	1.8677E-7	5.817E-5
3	BETA TITANIUM	0	1.5416E-6	2776.8	1.7007E6	6.0004E-8	1.74E-5

Table 1

si.no	material	mode	mode 2	mode 3	mode 4	mode 5
		1				
1	CAST IRON	0.81	0.83	0.59	0.76	0.97
2	CARBON FIBER	1.5	1.63	1.91	1.9201	1.63
3	BETA TITANIUM	1.0231	1.0073	1.059	1.1209	1.0361

Table 2

VI. CONCLUSION

In this project we have designed a flywheel used in a multi cylinder petrol engine using theoretical calculations. 2d drawing is created and modeling of flywheel is done using CATIA V5 R18. We have done structural and modal analysis on flywheel using three materials Gray Cast Iron, Carbon fiber and Titanium alloy to validate our design.

By seeing the results, for every one of the materials the strength values are less than their individual yield strength values. So our design is safe. We have additionally done modal analysis for number of modes to see the displacement of flywheel for number of frequencies. By comparing the results for three materials, the strength value for Carbon fiber and Titanium alloy is less than that of Cast Iron.

So we conclude that for our design, Gray Cast Iron is better material for flywheel. The nodes are selected at constrained area, pressure area and open area. In this project mainly we did material optimization.

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