DESIGN AND ANALYSIS OF FLYWHEEL IN PETROL ENGINE

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ABSTRACT

A flywheel used in machines which serves as a reservoir which stores energy all along the period when the supply of energy is more than the required energy and releases it during the period when the requirement of source is less than supply.

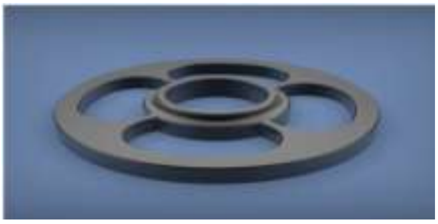
For example, in Internal. Combustion (I.C). engines, the required energy is developed only in the power stroke which is lot more than engine load, and no energy is being produced during the suction process, compression and exhaust strokes in case of four stroke engines. The excess energy which is developed during power stroke is consumed by the flywheel and discharges it to the crank shaft at the time of other strokes in which no energy is produced, thus rotating the crank shaft at a constant speed.The flywheel is placed at one end of the crankshaft and delivers two objectives. First, through its inertia, it compensate vibration by smoothing out the power stroke as each cylinder fires. And the Second, one is the mounting surface used to nut the engine up to its load.The aim of the system is to model a flywheel for a multi cylinder petrol engine flywheel using the empirical formulas. A parametric model of the flywheel is designed using 3D modeling programable software called Creo.

The forces assisting on the flywheel are also considered and calculated. The capacity of the flywheel is validated by applying forces on the flywheel in analysis software ANSYS.

Structural study, model studys and fatigue study are done on the flywheel. Structural study is used to test whether flywheel withstands under working conditions are not. Fatigue study is done for knowing the life of the component.Model analysis is done to explain the number of mode shapes for flywheel.Analysis study is done for two materials Gray Cast Iron and S Glass Epoxy to compare the results.

I. INTRODUCTION

A flywheel is a heavy disk or wheel. Which is attached to a rotating shaft. Flywheels are used for storage of kinetic energy. The drive of the flywheel causes it not to change its rotating speed easily. Because of this reason, the flywheels help to keep the shaft rotating at the constant speed. This helps when the torque enforced to the shaft changes often. Irregular torque can vary the speed of rotation. Because the flywheel opposes the changes in speed, it decreases the effects of irregular torque. Engines which use pistons to produce power usually have uneven torque and use flywheels to fix this issue.



II. RESULTS & DISCUSSION STRUCTURAL ANALYSIS OF FLYWHEEL CAST IRON

Imported Model from Pro/Engineer

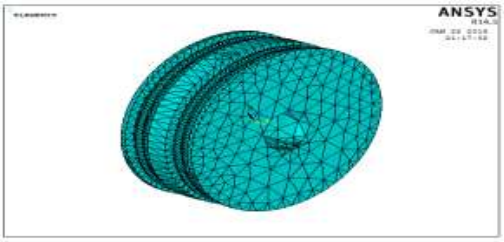
Element Type: solid 20 nodes 186

Material Properties: Youngs Modulus (EX) : 103000N/mm^2

Poissons Ratio (PRXY): 0.211

Density : 0.0000071 kg/mm^3

Meshed Model



Loads

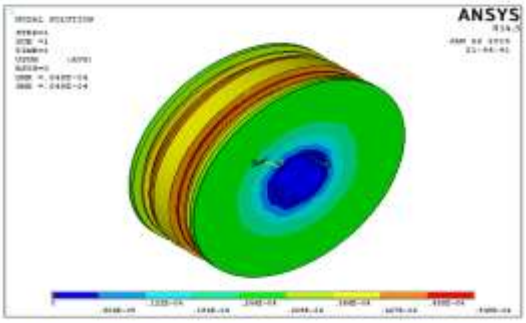
Pressure values – 0.64398e-01, 0.86604e-01,0.19221,0.25849,0.51714e-01,0.618646e-01.

Solution

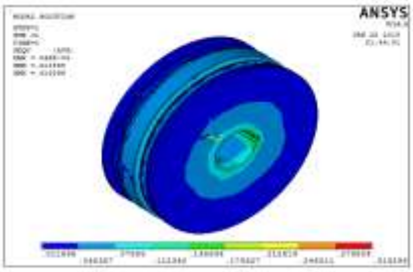
Solution – Solve – Current LS – ok

Post Processor

General Post Processor – Plot Results – Contour Plot - Nodal Solution – DOF Solution – Displacement Vector Sum



General Post Processor – Plot Results – Contour Plot – Nodal Solution – Stress – Von Mises Stress



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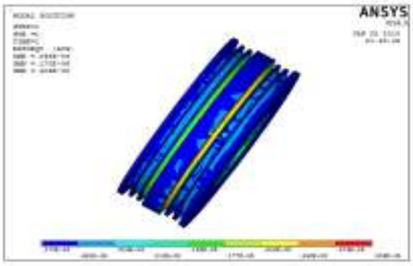


III. STRUCTURAL ANALYSIS OF FLYWHEEL ALUMINIUM-A360

Imported Model from Pro/Engineer

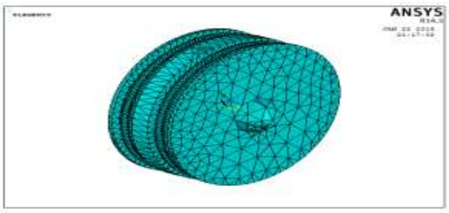
Element Type: solid 20 nodes 186

Material Properties: Youngs Modulus (EX) : 80000N/mm^2

Poissons Ratio (PRXY): 0.33

Density : 0.00000268 kg/mm^3

Meshed Model



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Pressure values – 0.64398e-01,0.86604e-01,0.19221,0.25849,0.51714e-01,0.618646e-01.

Solution

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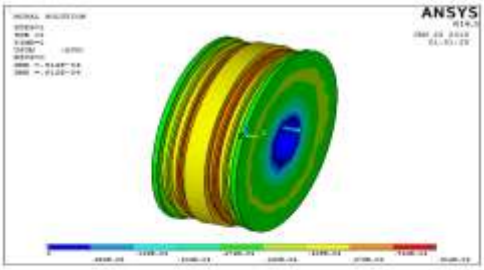
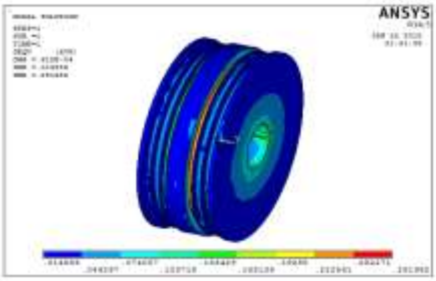
Post Processor

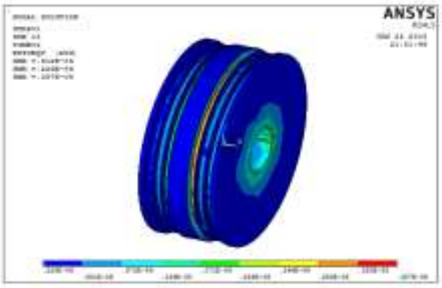
General Post Processor – Plot Results – Contour Plot - Nodal Solution – DOF Solution – Displacement Vector Sum



General Post Processor – Plot Results – Contour Plot – Nodal Solution – Stress – Von Mises Stress



General Post Processor – Plot Results – Contour Plot – Nodal Solution – Strain – Total mechanical Strain



IV. STRUCTURAL ANALYSIS OF FLYWHEEL E-GLASS FLIBER

Imported Model from Pro/Engineer

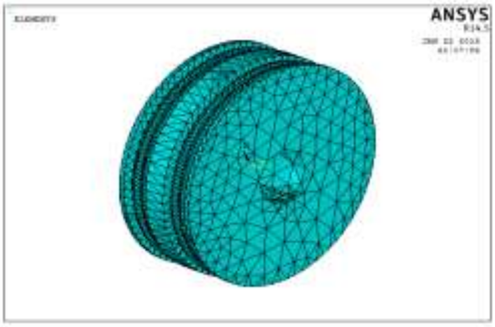
Element Type: Solid 20 node 186

Material Properties: Youngs Modulus (EX) : 72000N/mm^2

Poissons Ratio (PRXY) : 0.21

Density : 0.00000255 kg/mm^3

Meshed Model



Loads

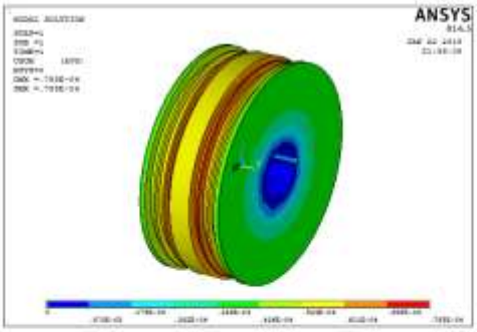
Pressure values – 0.64398e-01,0.86604e-01,0.19221,0.25849,0.51714e-01,0.618646e-01.

Solution

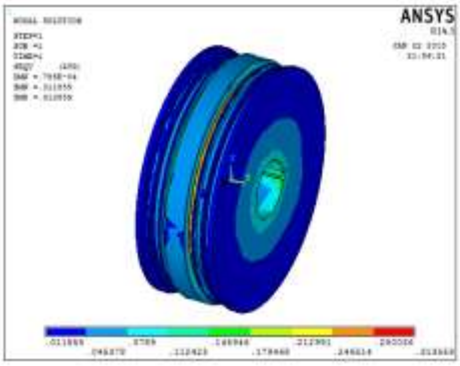
Solution – Solve – Current LS – ok

Post Processor

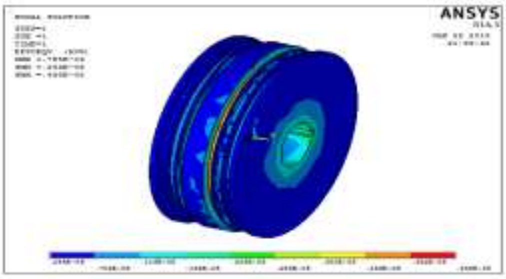
General Post Processor – Plot Results – Contour Plot - Nodal Solution – DOF Solution – Displacement Vector Sum



General Post Processor – Plot Results – Contour Plot – Nodal Solution – Stress – Von Mises Stress



General Post Processor – Plot Results – Contour Plot – Nodal Solution – Strain – Total mechanical Strain



V. FLYWHEEL MODAL ANALYSIS FOR CAST IRON

Import Model

Material Properties

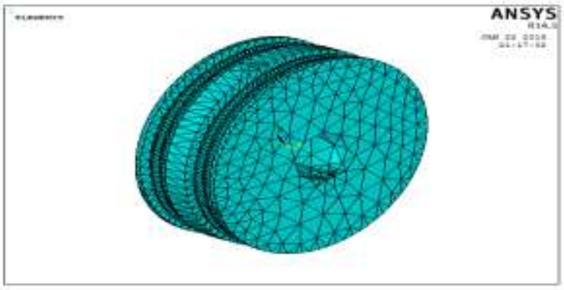
Cast Iron

Young's Modulus – 103000Mpa

Poisson's ratio – 0.211

Density – 0.0000071Kg/mm^3

MESH mode



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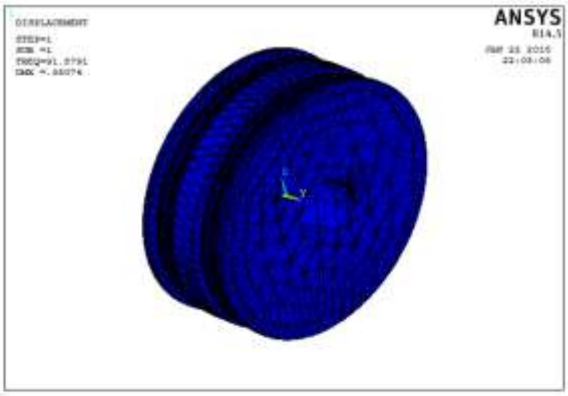
Analysis options>no of modes to extract>5

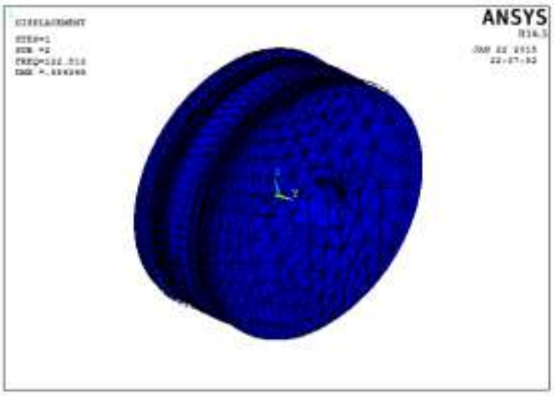
No of modes to expand 5>ok

Frequency range>0 to1000

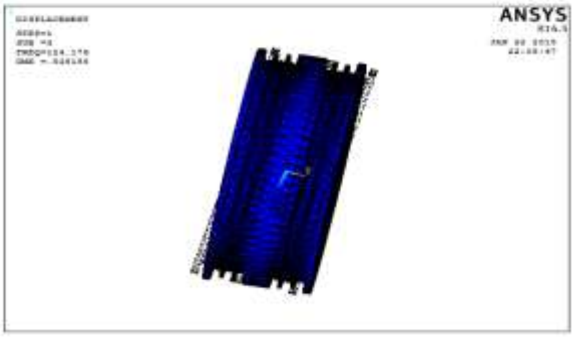
Modal Analysis 1



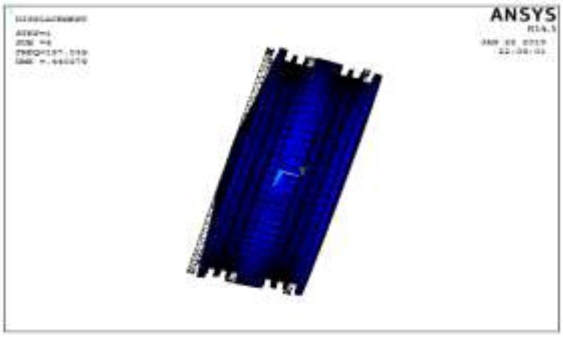
Modal analysis 2



Modal Analysis 3



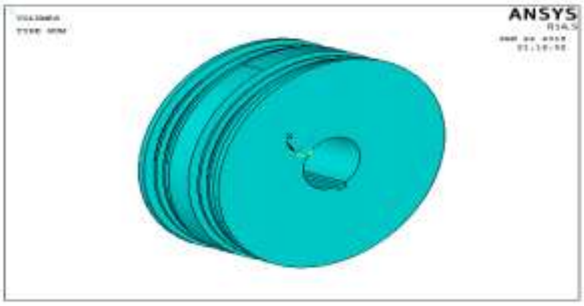
Modal Analysis 4



Modal Analysis 5

VI. FLYWHEEL MODAL ANALYSIS FOR AL-A360

Import Model



Material Properties

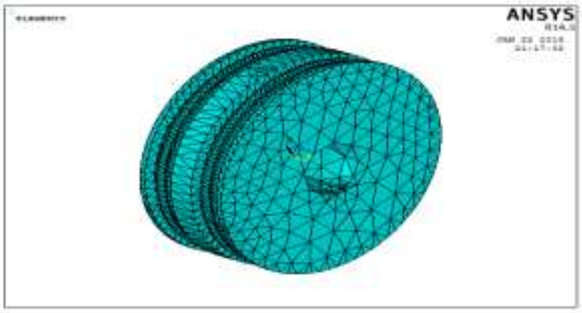
Cast Iron

Young's Modulus – 80000Mpa

Poisson's ratio – 0.33

Density – 0.00000268Kg/mm^3

MESH Model



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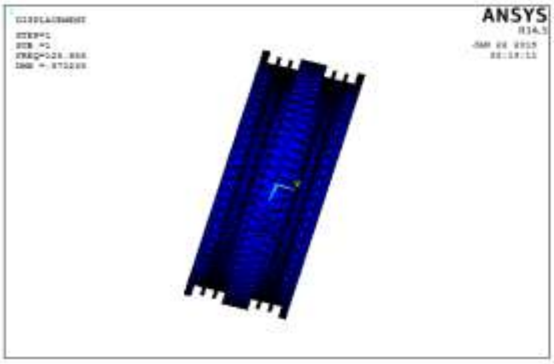
Analysis options>no of modes to extract>5

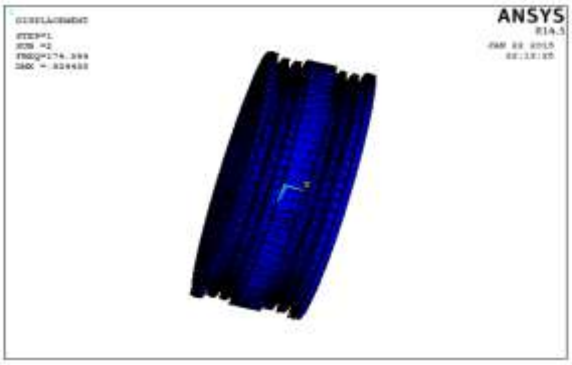
No of modes to expand 5>ok

Frequency range>0 to1000

Modal Analysis 1



Modal analysis 2



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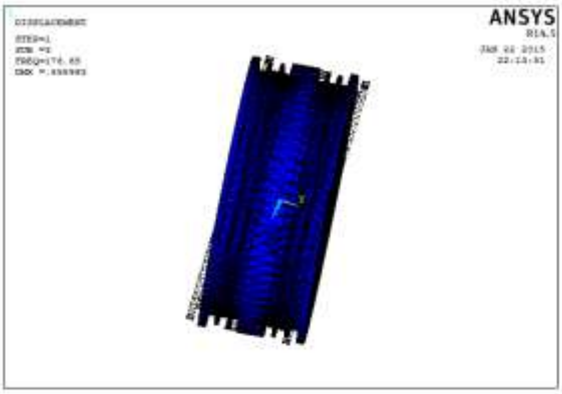
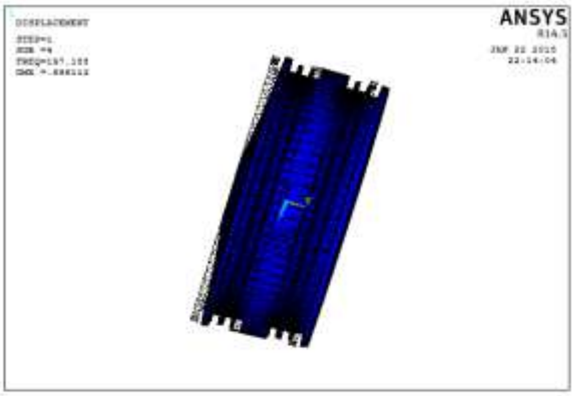
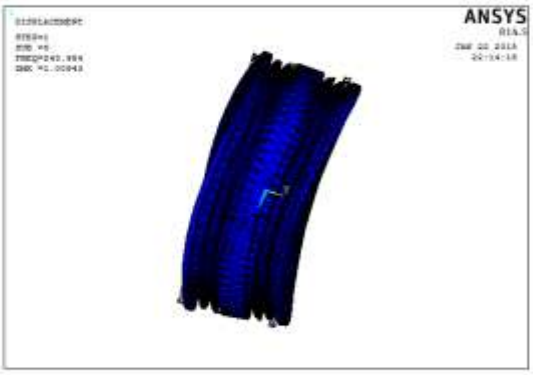


Modal Analysis 4



Modal Analysis 5



VII. FLYWHEEL MODAL ANALYSIS FOR E-GLASS FLIBER

Import Model

Material Properties

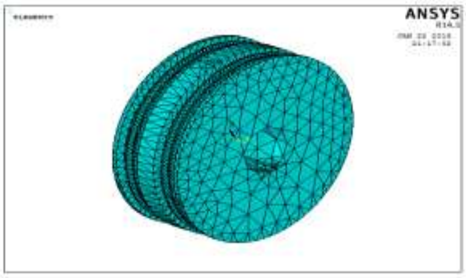
Cast Iron

Young's Modulus – 72000Mpa

Poisson's ratio – 0.21

Density – 0.00000255Kg/mm^3

MESH model



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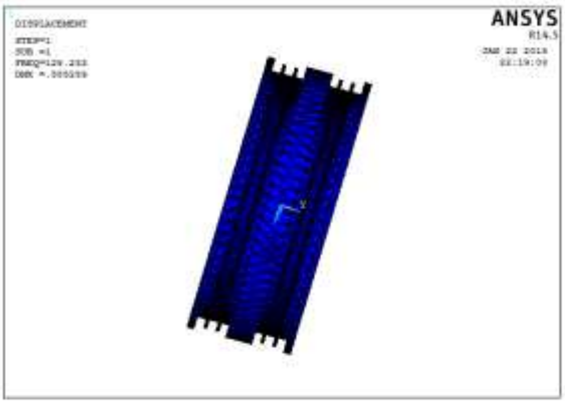
Analysis options>no of modes to extract>5

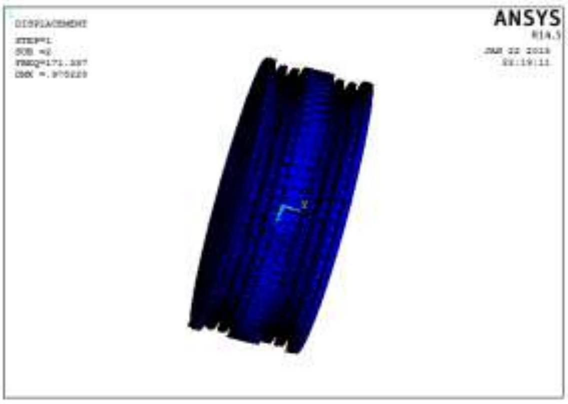
No of modes to expand 5>ok

Frequency range>0 to1000

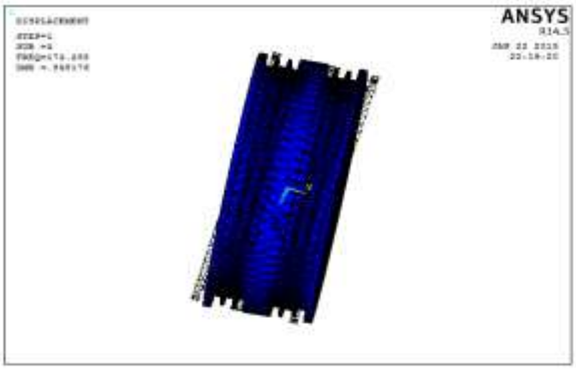
Modal Analysis 1



Modal analysis 2



Modal Analysis 3



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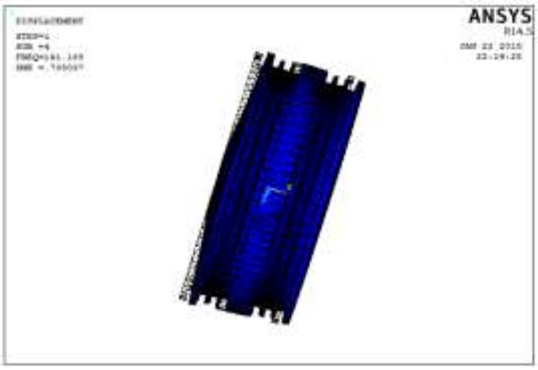

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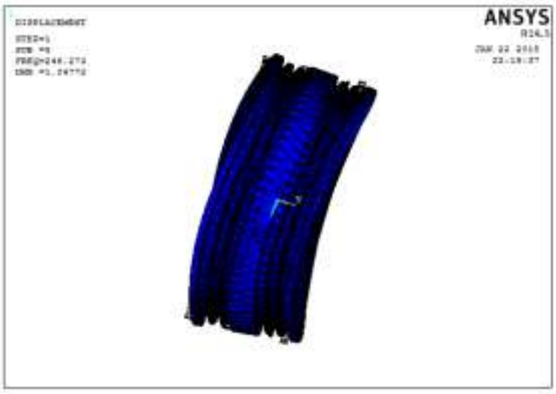

7.1 Numerical Values Obtained During Analysis

si.no	material	displacement		von-mises stress		strain	
		min	max	min	max	min	max
1	CAST IRON	0	5.48E-05	0.011865	0.313296	1.70E-07	3.06E-06
2	A360	0	6.12E-05	0.014586	0.281982	2.29E-07	3.57E-06
3	E-GLASS	0	7.85E-05	0.011855	3.14E-01	2.44E-07	4.38E-06

Table 1

si.no	material	mod 1	mode 2	mode 3	mode 4	mode 5
1	CAST IRON	9.19E+01	122.813	1.24E+02	137.039	1.76E+02
2	A360	125.955	174.594	1.77E+02	197.188	243.984
3	E-GLASS	128.233	171.357	1.73E+02	191.185	246.273

Table 2

VIII. CONCLUSION

In our 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 Pro/Engineer. We have done structural and modal analysis on flywheel using two materials Gray Cast Iron, Aluminum A360 and S Glass Epoxy to validate our design.

By observing the results, for all the materials the strength values are less than their respective yield strength values. So our design is safe. We have also 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 Aluminum A360 and S Glass Epoxy is less than that of Cast Iron.

So we conclude that for our design, Gray Cast Iron is better material for flywheel. Fatigue analysis is also done on flywheel to verify the strength values at the selected nodes. The nodes are selected at constrained area, pressure area and open area. In this project mainly we did material optimization.

REFERENCES

[1] "Flywheels move from steam age technology to Formula 1"; Jon Stewart | 1 July 2012, retrieved 2012-07-03

[2] **Jump up**^ [2], "Breakthrough in Ricardo Kinergy 'second generation' high-speed flywheel technology"; Press release date: 22 August 2011. retrieved 2012-07-03

[3] Janse van Rensburg, P.J. "Energy storage in composite flywheel rotors". University of Stellenbosch.

[4] **Jump up**^ rosseta Technik GmbH, Flywheel Energy Storage, German, retrieved February 4, 2010.

[5] Zhang Da-lun, Mechanics of Materials, Tongji University Press, Shjanghai, 1993

[6] Huang Xi-kai, Machine Design, Higher Education Press, Beijing, 1995

[7] Robert L. Norton, Design of Machinery, McGraw-Hill Inc, New York, 1992

[8] K. Lingaiah, Machine Design Data Handbook, McGraw-Hill Inc, New York, 1994

[9] R. S. Khurmi, J. K. Gupta, Machine Design, Eurasia Publishing House, NewDelhi, 1993

[10] ANSYS User's Manual, Swanson Analysis Systems, Inc., Houston

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