ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Design & Optimization of a Flywheel for the 4 Cylinder Diesel Engine by Using FEM

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ABSTRACT:
A flywheel is a rotating mechanical device that is used to store rotational energy. Flywheels have an inertia called the moment of inertia and thus resist changes in rotational speed. The amount of energy stored in a flywheel is proportional to the square of its rotational speed. Energy is transferred to a flywheel by the application of a torque to it, thereby increasing its rotational speed, and hence its stored energy. Conversely, a flywheel releases stored energy by applying torque to a mechanical load, thereby decreasing the flywheel's rotational speed. In this project, flywheel of 4 cylinder diesel engine is design and optimization by varying material. By taking light material and test for better result. Appling angular velocity and dead weight. Study is done by varying angular velocity. Analytical calculation done for design of flywheel and Simulation by varying material is done in Ansys. Results are compared

1. INTRODUCTION

1.1 Flywheel:
A flywheel is a machine component which is used in machines serves as a reservoir which stores energy during the period when the supply of energy is more than the requirement and releases it during the period when the requirement of energy is more than supply.
For example, in I.C. engines, the energy is developed only in the power stroke which is much more than engine load, and no energy is being developed during the suction, compression and exhaust strokes in case of four stroke engines.

The excess energy is developed during power stroke is absorbed by the flywheel and releases it's to the crank shaft during the other strokes in which no energy is developed, thus rotating the crankshaft at a uniform speed. The flywheel is located on one end of the crankshaft and serves two purposes. First, through its inertia, it reduces vibrations by smoothing out the power stroke as each cylinder fires. Second, it is the mounting surface used to bolt the engine up to its load.

1.2 Function of a Flywheel:
The main function of a fly wheel is to smoothen out variations in the speed of a shaft caused by torque fluctuations. If the source of the driving torque or load torque is fluctuating in nature, then a flywheel is usually called for. Many machines have load patterns that cause the torque time function to vary over the cycle. Internal combustion engines with one or two cylinders are a typical example. Piston compressors, punch presses, rock crushers etc. are the other systems that have fly wheel. Flywheel absorbs mechanical energy by increasing its angular velocity and delivers the stored energy by decreasing its velocity.

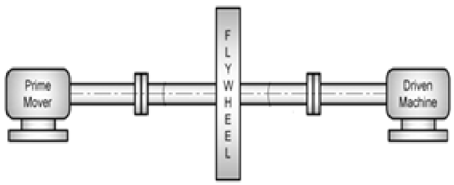

Fig. flywheel function

Cite this article as: B. Aruna Kumar Subudhi & Dr.Prabhu Prasad Mishra, "Design & Optimization of a Flywheel for the 4 Cylinder Diesel Engine by Using FEM", International Journal & Magazine of Engineering, Technology, Management and Research, Volume 5, Issue 6, 2018, Page 82-92.

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2. LITERATURE REVIEW

Sushama G.Bawane et al. [1], proposed flywheel design .They study different types of flywheel & use different types of material for the analysis purpose. By using FEA analysis suggested the best material for the flywheel. S. M. Dhengle et al. [2] shows the comparison between analytical stresses and FE stresses in Rim by varying no. of arms& comparison between FE stresses on arm and analytical calculated bending stresses in arms. They also had seen that as a number of arms increases from 4 to 8, the stresses in the arms go on reducing. This may be due to sharing of load by larger no. of arms shows the comparison of FE stresses and analytical bending stresses near the hub end of arm for 4, 6 and 8 arms flywheel under the influence of tangential forces on rim.

3. PROBLEM STATEMENT

Now-a-days cast iron is replaced by carbon fiber reinforced plastics due to the high tensile strength produced by the carbon fiber when compared to that with cast iron. Carbon fiber reinforced plastic (CFRP) Graphite-Fiber Reinforced Polymer (GFRP) is considered as an excellent choice for flywheels fitted on modern car engines due to rotating mass made of fiber glass resins or polymer materials with a high strength-to-weight ratio, a mass that operates in a vacuum to minimize aerodynamic drag, mass that rotates at high frequency, air or magnetic suppression bearing technology to accommodate high rotational speed 100000 rpm. But the drawback of carbon fibre reinforced plastics is that the cost of it comparatively more. Therefore the overall cost of the fabrication also increases. Research has begun in this field about the use of different materials which places a good substitute for the carbon fiber reinforced plastics. Taking a disc type flywheel of 4 strokes, 4 cylinder diesel engines, which is used to transmit the power of 2.25 kW at 2740 rpm. It has to be design and optimization by changing the materials. By identify the stress and deformations in flywheel from Theoretical and Numerical. As per given below inputs, Analysis which is best material for given design.

Validate results by comparing theoretical and Numerical and plot best material for use as given design data.

4.1 Design Approach:

There are two stages to the design of a flywheel.

First, the amount of energy required for the desired degree of smoothening must be found and the (mass) moment of inertia needed to absorb that energy determined. Then flywheel geometry must be defined that caters the required moment of inertia in a reasonably sized package and is safe against failure at the designed speeds of operation.

4.2 Design Parameters:

Flywheel inertia (size) needed directly depends upon the acceptable changes in the speed.

4.2.1 Speed fluctuation:

The change in the shaft speed during a cycle is called the speed fluctuation and is equal to ωmax- ωmin

Fl = ωmax – ωmin

We can normalize this to a dimensionless ratio by dividing it by the average or nominal shaft speed (ωave).

Cf= (ωmax - ωmin)/ω   Where

Cf=coefficient of speed fluctuation

ωave=Average or mean

ω= nominal angular velocity

The coefficient is a design parameter to chosen by the designer and it must be small.

4.2.2 Design equation:

The kinetic energy in rotating system is given by

$$K.E = \frac{1}{2} I\omega 2$$

The change in KE is given as $K.E = E2\text{-}E1 = \frac{1}{2} Im (\omega_{max} 2 - \omega_{min} 2)$

$$\omega_{avg} = \frac{(\omega_{max} + \omega_{min})}{2}$$

$$K.E = \frac{1}{2} I_S \,(2\omega_{avg})\,(C_f \omega_{min} 2) = E2\text{-}E1$$

Thus the mass moment of inertia I_m needed in the entire rotating system in order to obtain selected

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coefficient of speed fluctuation is determined using the relation

$K.E = \frac{1}{2} I_S\ (2\omega_{avg})\ (C_f \omega_{avg})$

I_S=K.E/ (C_f ωavg2)

For solid disc geometry with inside radius $r_i$and outside radius r_o, the mass moment of inertiaI_m is

$I_m = mk2 = \frac{m}{2}[(r_o)^2+(r_i)^2]$

The mass of a hollow circular disc of constant thickness t is

$m = W/g = \rho\pi\ [(r_o)^2+(r_i)^2]t$

From the above two equations

$Im= \frac{\pi\rho}{2}[(r_o)^4+(r_i)^4]t$

The above equation can be used to obtain appropriate flywheel inertia I_m corresponding to the known energy change K.E for a specific value coefficient of speed fluctuation C_f,

4.2.3Torque Variation and Energy:

The required change in kinetic energy K.E is obtained from the known torque time relation or curve by integrating it for one cycle.

$$K.E = \sum_{\theta@\omega min}^{\theta@\omega max} (T1 - Tavg)d\theta$$

4.2.4Torque Time Relation without Flywheel:

A typical torque time relation, for example of a mechanical punching press without a flywheel in shown in the figure. In the absence of fly wheel surplus or positive energy is available initially and intermedialty and energy absorption or negative energy during punching and stripping operations. A large magnitude of speed fluctuation can be noted.

4.2.5 Stresses in Flywheel:

Flywheel being a rotating disc, centrifugal stresses acts upon its distributed mass and attempts to pull it apart. Its effect is similar to those caused by an internally pressurized cylinder

Radial stress $\sigma_r = \rho\omega^2 \left[\frac{3+\mu}{8}\right]\left[{r_o}^2 + {r_i}^2 - \frac{{r_o}^2{r_i}^2}{r^2} - r^2\right]$

Tangential stress $\sigma_\theta = \rho\omega^2 \left[\frac{3+\mu}{8}\right]\left[{r_o}^2 + {r_i}^2 - \frac{{r_o}^2{r_i}^2}{r^2} - \left[\frac{1+3\mu}{3+\mu}\right] r^2\right]$

The maximum tensile and radial stresses are

Equal and both occur at (r=0)

$(\sigma_r)max = (\sigma_t)max = \frac{\rho \times \omega^2}{10^6}\left[\frac{\mu+3}{8}\right][{r_o}^2 - {r_i}^2]$

Where ρ = Density of the material kg/m3

μ = Poissions ratio

R = Outer radius in m

4. CATIA MODEL

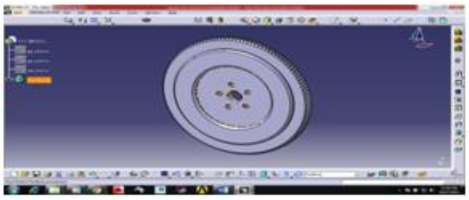

Fig. 4.5 Part model of Flywheel

Fig.5.18 Mesh of flywheel in Ansys

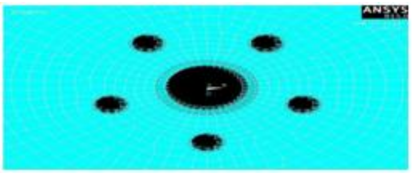

Fig.5.19 Boundary conditions of flywheel inAnsys

6. THEORETICAL CALCULATIONS

Theoretical calculations of Flywheel:

Model calculation for the material (CFRP)

Given:

Density ρ = 1600kg/m3

Power = 2.25 KW = 2.25 x 10^3 W

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International Journal & Magazine of Engineering, Technology, Management and Research
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Speed N = 2740 rpm.
Torque (T) = (P × 60) / 2πN
= $(2.25 \times 10^3 \times 60)/ 2\pi \times 2740$
= 8.41N-m.
Dimensions of the flywheel

Outer dia plate (D_o)	281mm
Inner dia plate (D_i)	25mm
Dia of the rim (D_{ri})	150mm
Outer dia of the rim (D_{ro})	230mm
Thickness of the plate (t_p)	20mm
Thickness of the rim (t_r)	7mm
Dia of the holes (D_h)	12mm

Mass of the flywheel (Mt):

Mt = Density × volume
= (Mass of the Disc + Mass of the Rim) – (Mass of the Holes)
= $\rho\frac{\pi}{4}(D_o^2 - D_i^2)t_p + \rho\frac{\pi}{4}(D_{ro}^2 - D_{ri}^2)t_p - \rho\frac{\pi}{4}(D_h^2)t_p \times$ 5holes
$M_t = 1600\frac{\pi}{4}(0.281^2 - 0.025^2)0.020 + 1600\frac{\pi}{4}(0.230^2 - 0.150^2)0.007 - 1600\frac{\pi}{4}(0.0122)0.020 \times 5$
= 2.22kg ≈ 2.25kg.

Mass Moment of inertia:

$I_m = \frac{1}{2}mR2$
R= Outer radius in mm
$I_m = \frac{1}{2}(2.25)\ 140.52 =$ 0.0222kg-m2

Kinetic Energy of the Flywheel is,

$K.E = \frac{1}{2} I_m \omega^2$
$\Delta E = \frac{1}{2}(0.0222 \times 287.6^2) = 918.122$ N-m.
Now,

Stresses in flywheel:

Let

r_o = Outer radius of the flywheel = 140.5mm
r_i = Inner radius of the flywheel = 12.5mm
r = mean radius of the flywheel = 38.4mm
(for calculation purpose)

ω = angular velocity of the flywheel = $\frac{2 \times 3.141 \times 2740}{60}$ = 287.6 rad/sec
μ =Poissons ratio (for CFRP) = 0.28
E = young's modulus of elasticity = 150000 N/mm2

Radial Stress induced in the Flywheel

$\sigma_r = \rho\omega^2\left[\frac{3+\mu}{8}\right]\left[r_o^2 + r_i^2 - \frac{r_o^2 r_i^2}{r^2} - r^2\right]$
$= 1600 \times 287.6^2\left[\frac{3+0.28}{8}\right]\left[0.1405^2 + 0.0125^2 - \frac{(0.1405)^2 \times (0.0125)^2}{0.0384^2} - 0.0384^2\right] =$ 4.42 N/mm2

Tangential stress:

$\sigma_\theta = \rho\omega^2\left[\frac{3+\mu}{8}\right]\left[r_o^2 + r_i^2 - \frac{r_o^2 r_i^2}{r^2} - \left[\frac{1+3\mu}{3+\mu}\right]r^2\right]$
=
$1600 \times 287.6^2\left[\frac{3+0.28}{8}\right]\left[0.1405^2 +\right.$
0.01252–(0.1405)2×(0.0125)20.03842 –1 +
3(0.28)3 +(0.28)0.03842=
5.72 N/mm2

Von Mises Stresses:

$\sigma_v = \sqrt{\sigma_r^2 - \sigma_r\sigma_\theta - \sigma_\theta^2}$
$= \sqrt{(4.42)^2 - (4.42) \times (5.72) - (5.72)^2} =$ 5.19 N/mm2

Radial strain (ε_r):

$\varepsilon_r = \frac{\sigma_r - \mu\,\sigma_\theta}{E} = \frac{4.42 - 0.28 \times 5.72}{150 \times 10^3} = 3.073 \times 10^{-5}$

Tangential strain (ε_θ):

$\varepsilon_\theta = \frac{\sigma_\theta - \mu\,\sigma_r}{E} = \frac{5.72 - 0.28 \times 4.42}{150 \times 10^3} = 4.656 \times 10^{-5}$

Total displacement (u):

$u = \left[\frac{(3+\mu)(1-\mu)}{8E}\right]\rho\omega^2 r\left[r_o^2 + r_i^2 - \left[\frac{1-\mu}{3+\mu}\right]r^2 -\right.$
1 + μ1− μro2ri2r2

$= \left[\frac{(3+0.28)(1-0.28)}{8(150 \times 10^3)}\right] 1600 \times 287.6^2 \times 0.0384$

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International Journal & Magazine of Engineering, Technology, Management and Research
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$$\left[0.1405^2 + 0.0125^2 - \left[\frac{1-\ 0.28}{3\ +\ 0.28}\right] 0.0384^2 - \left[\frac{1\ +\ 0.28}{1-\ 0.28}\right] \frac{(0.1405)^2 \times\ (0.}{0.0384^2}\right.$$

$= \quad 0.0015mm$

Maximum radial stress

$$\sigma_{r(max)} = \quad \rho\omega^2 \left[\frac{3+\mu}{8}\right] \left[{r_o}^2 - {r_i}^2\right]$$

$= \quad 1600 \times\ 287.6^2 \left[\frac{3+0.28}{8}\right] [0.1405^2 - 0.125^2]$

$= \quad$ 1.14 N/mm2

Maximum Tangential stress

$$\sigma_{\theta(max)} = \quad \rho\omega^2 \left[\frac{3+\mu}{8}\right] \left[{r_o}^2 + \left[\frac{1-\mu}{3+\mu}\right] {r_i}^2\right]$$

$= \quad 1600 \times\ 287.6^2 \left[\frac{3+0.28}{8}\right] \left[0.1405^2 + \right.$

$1- 0.283 + 0.280.1252$=2.30N/mm2

S.No	Material	Total Mass Kg	Mass Moment of Inertia kg-mm²	KE N-mm	Efficiency of the flywheel (K.E/Mass) J/Kg
1	High Strength Steel 4340	10.8113	0.10671	4413.14	408.1976
2	Gray Cast Iron	10.4093	0.10274	4249.06	408.1976
3	Titanium Alloy (6Al4V)	6.23727	0.06156	2546.04	408.1976
4	Beryllium alloy	4.01958	0.03967	1640.78	408.1976
5	Mg-Alloy	2.41175	0.0238	984.469	408.1976
6	CFRP	2.2177	0.02189	905.258	408.1976

Table 6.1 calculations of Design parameters ofthe flywheel for various materials

7. RESULTS & DISCUSSIONS

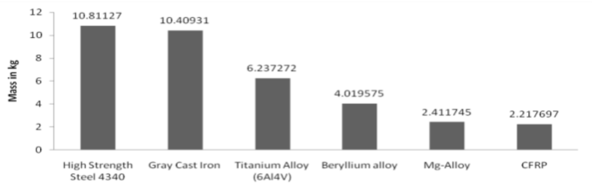

Fig. Comparison of mass of the flywheel

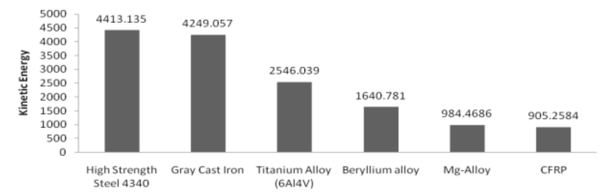

Fig. Comparison of Kinetic Energy of the flywheel

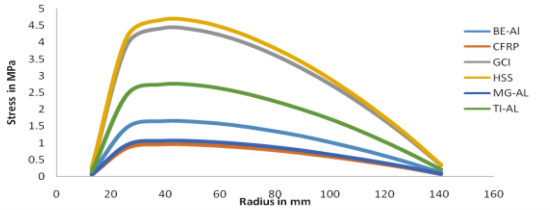

Fig. . Radial stresses of the Flywheel from theoretical calculations

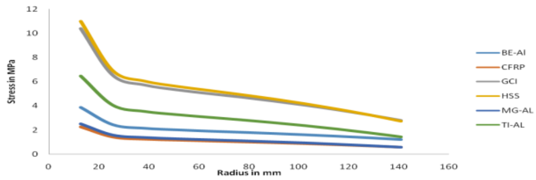

Fig..Tangential stresses of the Flywheel theoretical calculations

Material	Max / Min	Displace--ment u mm	Radial Stress σr N/mm²	Tangential Stress σt N/mm²	Von Mises Stress σv N/mm²	Radial Strain ε_r	Tangential Strain ε_θ	Equivalent strain
Beryllium alloy	max	7.00×10^{-4}	1.65	3.88	5.14	1.55×10^{-5}	6.42×10^{-5}	1.58×10^{-5}
	min	1.00×10^{-4}	0.09	1.35	1.14	-2.18×10^{-5}	1.51×10^{-5}	4.84×10^{-6}
CFRP	max	6.00×10^{-4}	0.95	2.25	2.43	4.19×10^{-6}	1.49×10^{-5}	1.49×10^{-5}
	min	1.00×10^{-4}	0.26	0.67	0.53	4.83×10^{-7}	3.98×10^{-6}	3.60×10^{-6}
Gray Cast Iron	max	4.50×10^{-3}	4.42	10.39	12.27	3.12×10^{-5}	1.02×10^{-4}	1.02×10^{-4}
	min	5.00×10^{-4}	1.19	3.25	2.64	-2.13×10^{-5}	2.95×10^{-5}	2.69×10^{-5}
High Strength Steel	max	2.20×10^{-3}	4.67	11.00	11.86	1.43×10^{-5}	5.20×10^{-5}	5.20×10^{-5}
	min	2.00×10^{-4}	1.26	3.24	2.55	1.53×10^{-6}	1.37×10^{-5}	1.24×10^{-5}
Mg-Alloy	max	7.00×10^{-4}	1.06	2.50	2.47	1.38×10^{-5}	5.62×10^{-5}	5.62×10^{-5}
	min	2.00×10^{-4}	0.06	0.69	0.52	1.10×10^{-6}	1.33×10^{-5}	1.21×10^{-5}
Titanium Alloy (6Al4V)	max	2.50×10^{-3}	2.75	6.47	6.40	1.55×10^{-5}	6.42×10^{-5}	6.42×10^{-5}
	min	3.00×10^{-4}	0.74	1.78	1.35	9.92×10^{-7}	1.51×10^{-5}	1.36×10^{-5}

Table. Results from theoretical calculations

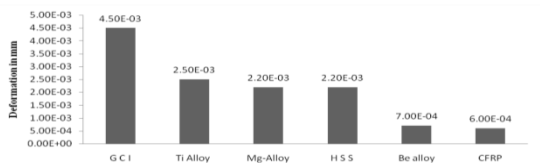

Fig.. Total deformation of the flywheel vs. materials from Theoretical Calculations

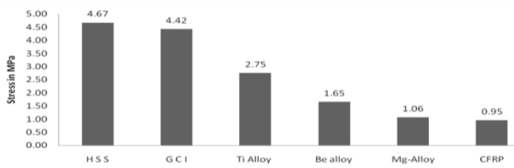

Fig.. Radial stresses of the flywheel vs. materials from Theoretical Calculation

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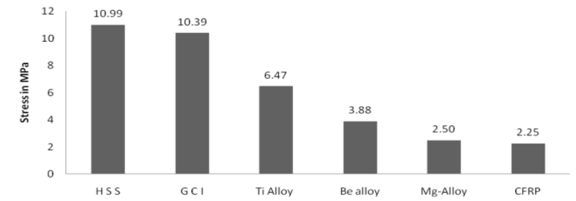

Fig.. Tangential Stresses of the flywheel vs. materials from Theoretical Calculations

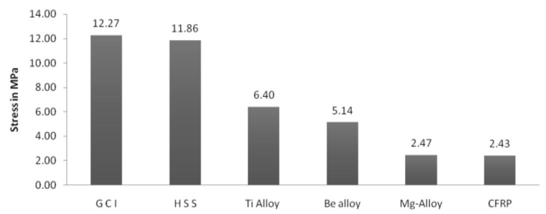

Fig. Von Mises stresses of the flywheel vs. materials from Theoretical Calculations

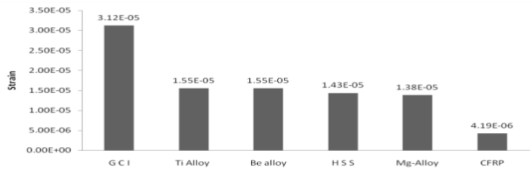

Fig. Radial Strain of the flywheel vs. materials from Theoretical Calculations

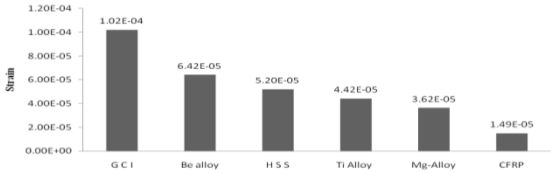

Fig. Tangential Strain of the flywheel vs. materials from Theoretical Calculations

Results from Ansys

Material 1: Beryllium Alloy

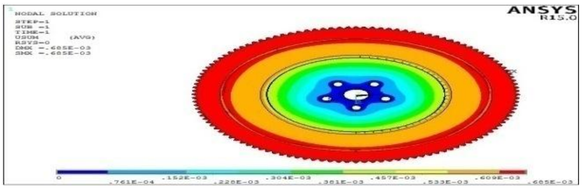

Fig. Deformation Be-Alloy

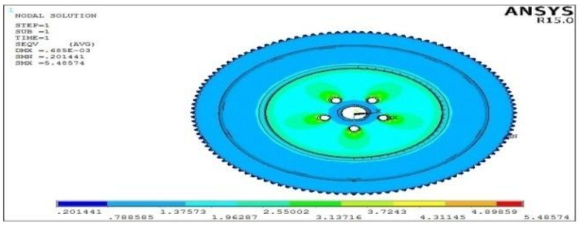

Fig.Equivalent stresses of Be-Alloy

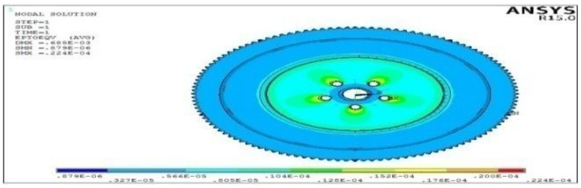

Fig. Equivalent strains of Be-Alloy

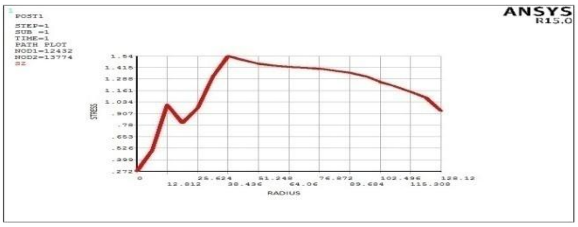

Fig. Radial stresses of Be-Alloy

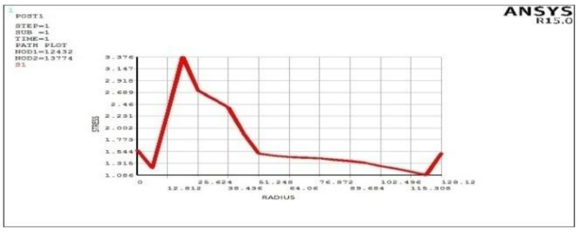

Fig.Tangential stresses of Be-Alloy

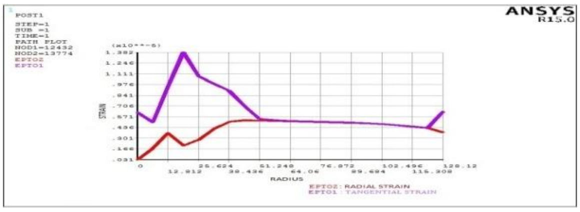

Fig. Radial and tangential strains of Be-Alloy

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Carbon Fiber Reinforced Plastic

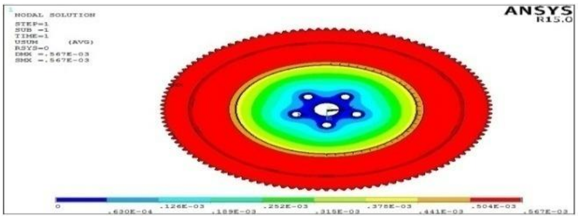

Fig.Deformation CFRP

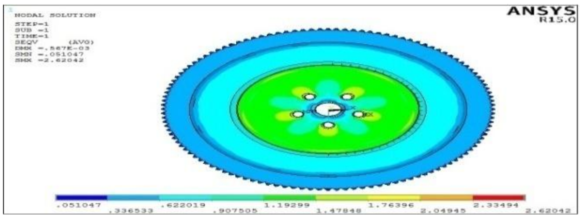

Fig.Equivalent stresses of CFRP

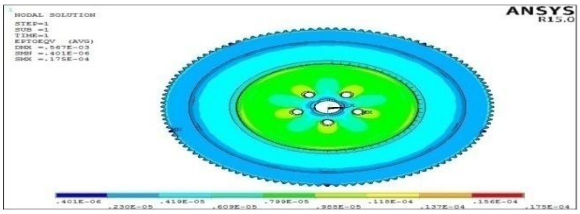

Fig. Equivalent strains of CFRP

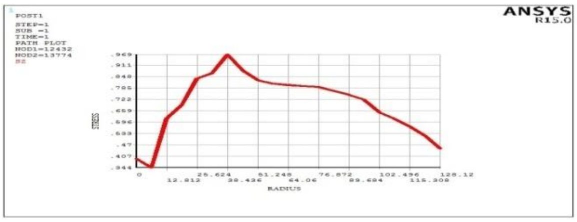

Fig. Radial stresses of CFRP

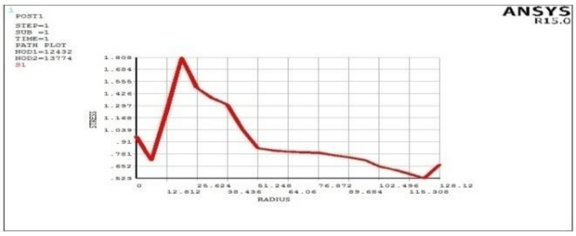

Fig.Tangential stresses of CFRP

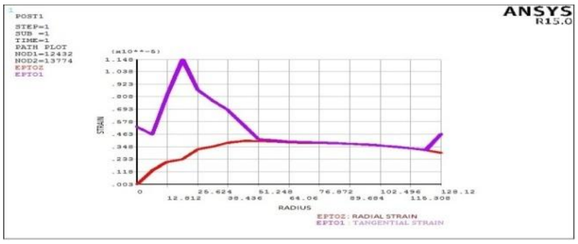

Fig.Radial and tangential strains of CFRP

Gray Cast Iron

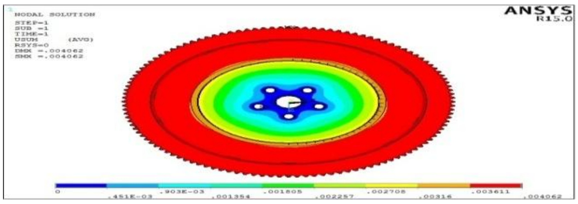

Fig. Deformation GCI

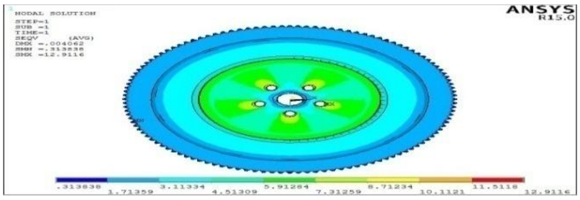

Fig. Equivalent stresses of GCI

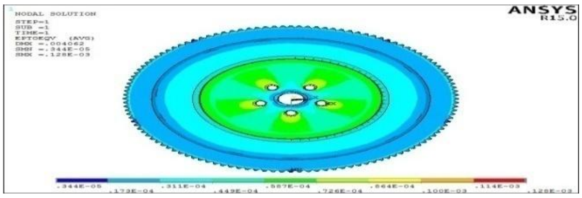

Fig. Equivalent strains of GCI

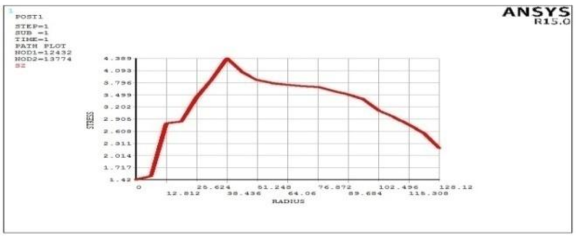

Fig. Radial stresses of GCI

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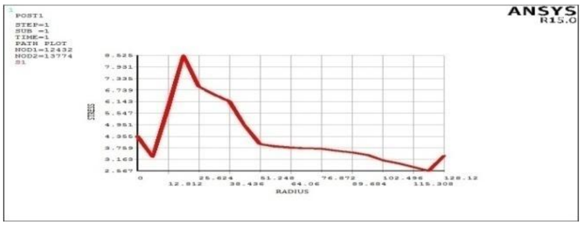

Fig.Tangential stresses of GCI

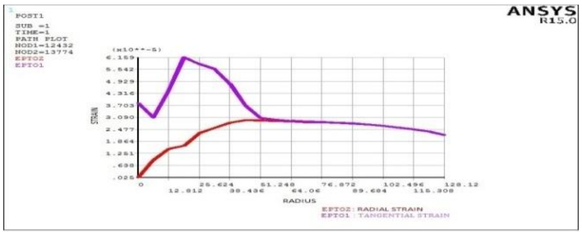

Fig. Radial and tangential strains of GCI

HIGH STRENGTH STEEL

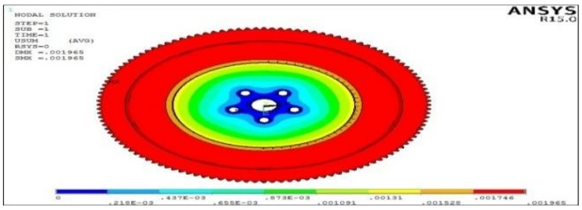

Fig.Deformation HSS

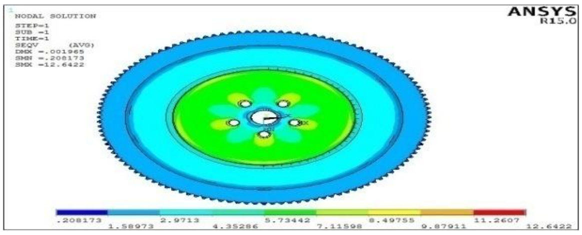

Fig.Equivalent stresses of HSS

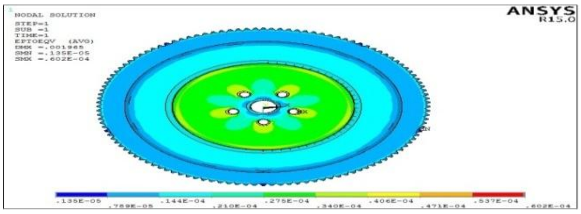

Fig.Equivalent strains of HSS

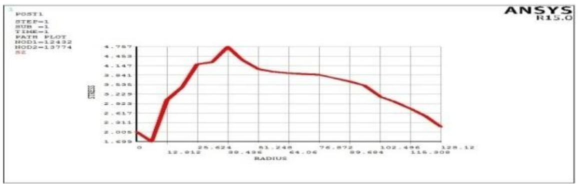

Fig.Radial stresses of HSS

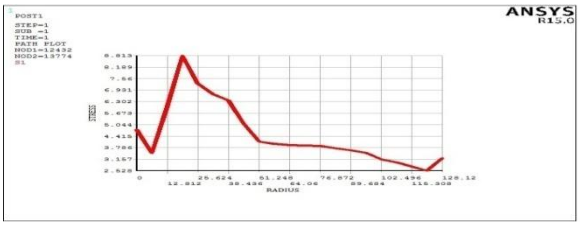

Fig. Tangential stresses of HSS

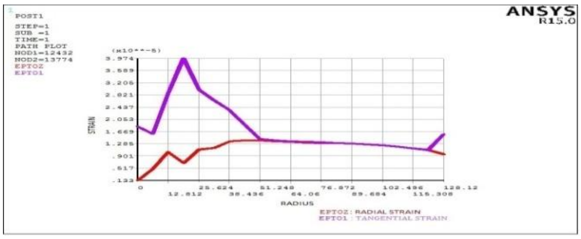

Fig.Radial and tangential strains of HSS

Magnesium Alloys

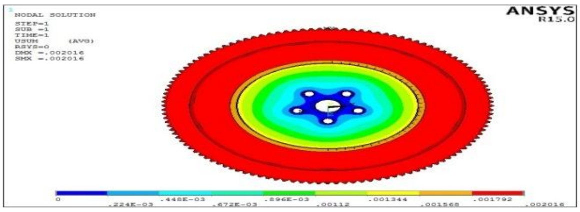

Fig.Deformation Mg-Alloy

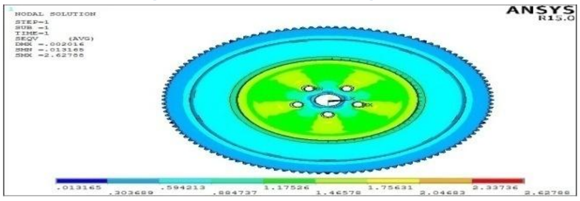

Fig.Equivalent stresses of Mg-Alloy

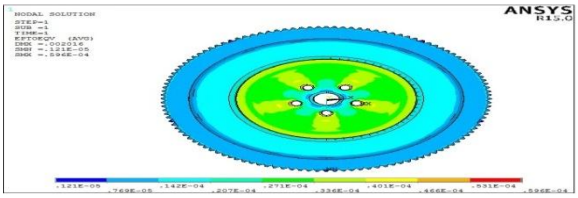

Fig. Equivalent strains of Mg-Alloy

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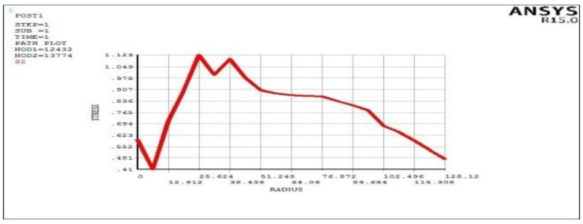

Fig.Radial stresses of Mg-Alloy

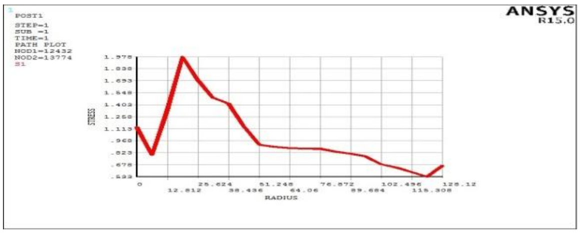

Fig.Tangential stresses of Mg-Alloy

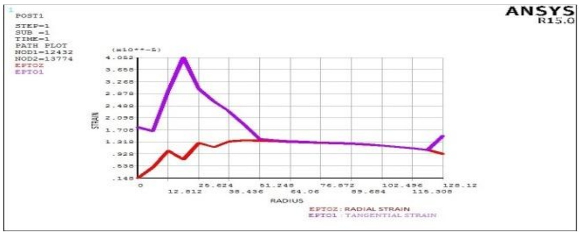

Fig. Radial and tangential strains of Mg-Alloy

Titanium Alloy

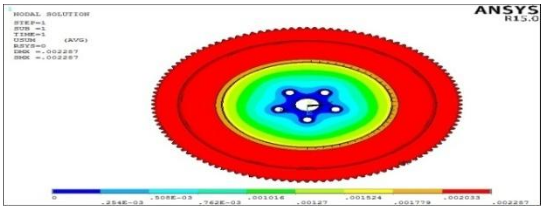

Fig.7.41 Deformation Ti-Alloy

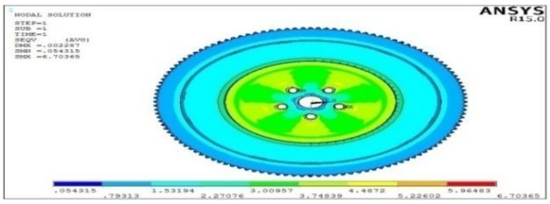

Fig.Equivalent stresses of Ti-Alloy

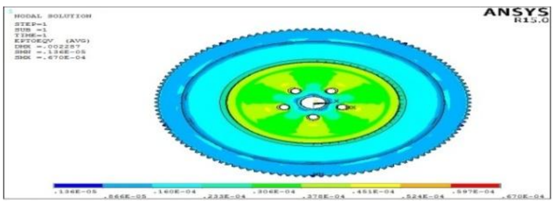

Fig. Equivalent strains of Ti-Alloy

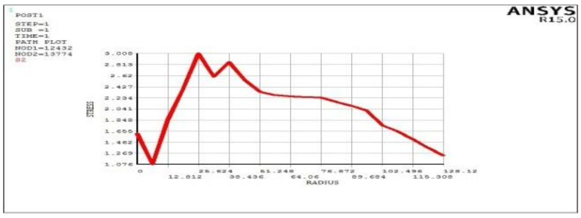

Fig.Radial stresses of Ti-Alloy

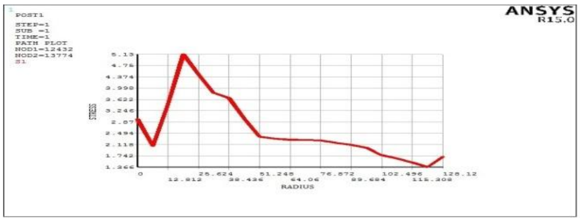

Fig.Tangential stresses of Ti-Alloy

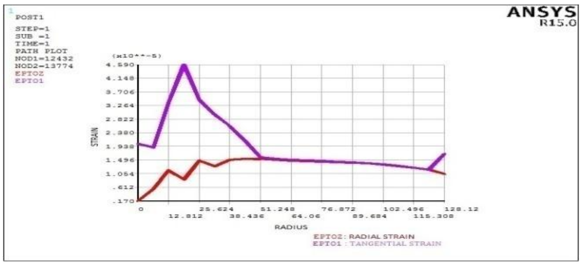

Fig. Radial and tangential strains of Be-Alloy

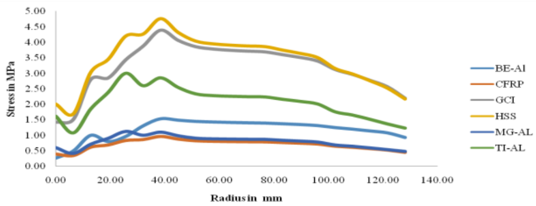

Fig.Results of Radial Stresses from Ansys

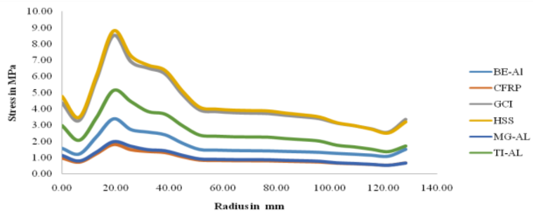

Fig.Results of Tangential Stresses from Ansys

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Material	Max / Min	Displace--ment u mm	Radial Stress σr N/mm²	Tangential Stress σt N/mm²	Von Mises Stress σv N/mm²	Radial Strain ε_r	Tangential Strain ε_θ	Equivalent strain
Beryllium alloy	max	6.86×10^{-4}	1.49	3.84	5.49	1.33×10^{-5}	5.38×10^{-5}	2.24×10^{-6}
	min	2.03×10^{-6}	0.71	1.51	0.20	2.80×10^{-6}	6.38×10^{-6}	8.79×10^{-7}
CFRP	max	5.67×10^{-4}	0.97	1.89	2.62	4.03×10^{-6}	8.66×10^{-6}	1.75×10^{-5}
	min	2.28×10^{-6}	0.45	0.67	0.05	2.78×10^{-6}	3.33×10^{-6}	4.01×10^{-7}
Gray Cast Iron	max	4.06×10^{-3}	4.39	9.92	12.91	3.07×10^{-5}	9.27×10^{-5}	1.28×10^{-4}
	min	7.22×10^{-6}	2.19	2.77	0.31	2.02×10^{-5}	2.48×10^{-5}	3.44×10^{-6}
High Strength Steel	max	1.97×10^{-3}	4.76	10.28	12.64	1.39×10^{-5}	3.99×10^{-5}	6.02×10^{-5}
	min	8.99×10^{-6}	2.18	2.76	0.21	9.56×10^{-6}	1.14×10^{-5}	1.35×10^{-6}
Mg-Alloy	max	2.02×10^{-3}	1.10	1.9	2.63	1.36×10^{-5}	3.34×10^{-5}	5.96×10^{-5}
	min	1.71×10^{-5}	0.48	0.59	0.01	9.31×10^{-6}	1.11×10^{-5}	1.21×10^{-6}
Titanium Alloy (6Al4V)	max	2.29×10^{-3}	3.01	5.45	6.70	1.53×10^{-5}	3.44×10^{-5}	6.70×10^{-5}
	min	1.32×10^{-4}	1.23	1.52	0.05	1.05×10^{-5}	1.25×10^{-5}	1.36×10^{-6}

Table. Results from Ansys

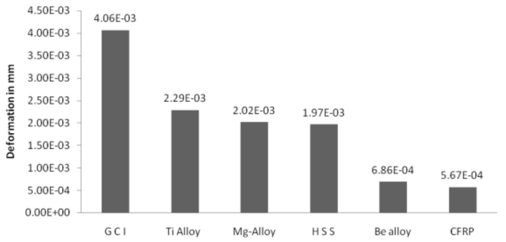

Fig.Total deformation of the flywheel vs. materials from FEM

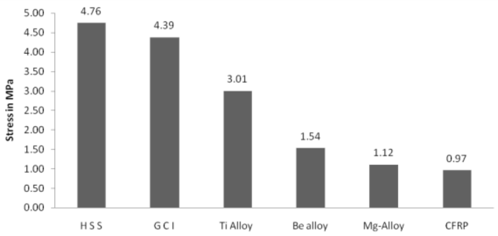

Fig. Radial Stresses of the flywheel vs. materials from FEM

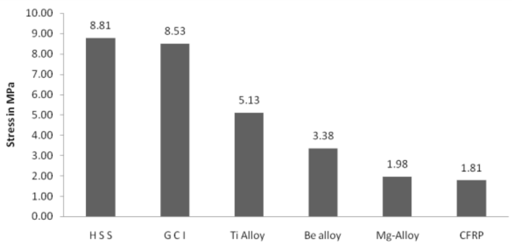

Fig. Tangential Stresses of the flywheel vs. materials from FEM

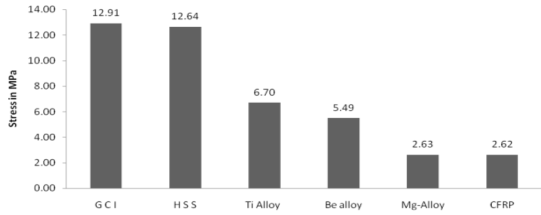

Fig. Von Mises Stresses of the flywheel vs. materials from FEM

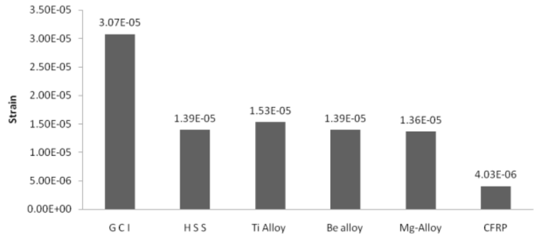

Fig. Radial Strain of the flywheel vs. materials from FEM

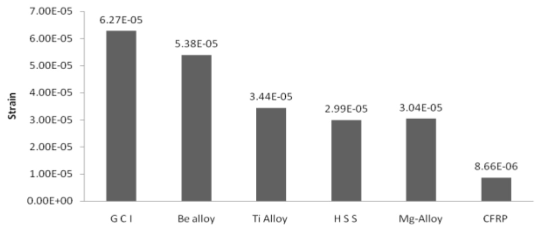

Fig. Tangential Strain of the flywheel vs. materials from FEM

Conclusion and Future Scope

Conclusion:

This optimization is carried out between the various materials, to find the minimum mass and respective values of stresses along radius by conducting static analysis. From the analysis, it is clear that, Carbon Fiber is the best material it is having low mass as compared to the other material and also the stresses and strains in the carbon fiber is also low compared to the other materials. Magnesium alloy is also the best material which is capable of withstanding stresses that are developed within the flywheel.

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
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From the analysis, by using the magnesium alloys we can reduce the stresses 77% when compared to H S steel, 75% when compared to cast iron, also by using Magnesium alloys we can reduce the mass up to 75%.

Future Scope

There is a wide scope for future work in this area. Now a day's magnesium alloys are also the best suitable for many applications. Hence in future, optimization and evaluation can be done by varying the various compositions of magnesium alloys for better results. Experimental analysis can be carried forward and life of the object can be studied.

References

[1] S.G Bawane, "Analysis and optimization of flywheel" International journal of mechanical engineering & robotics research, ISSN2278 – 0149, Vol. 1, No. 2, July 2012.

[2] S. M. Dhengle "Investigation of stresses in arm type rotate in flywheel" International Journal of Engineering Science and Technology (IJEST).

[3] M. Lava Kumar, "Design and analysis of light weight Motor vehicle flywheel" International Journal of Computer Trends and Technology (IJCTT) – volume 4 Issue 7–July 2013.

[4] Akshay P., Gattani G.K, 2013. Analysis of Flywheel. Modern Engineering and Research, pp.Vol.3, ISSN: 2249-6645 1097-1099.

[5] D.Y. Shahare, "Design Optimization of Flywheel of Thresher using FEM." Advanced Materials Manufacturing & Characterization, Vol3 Issue 1 (2013).

[6] Hongliang Chen,Changsheng Zhu and Peng Ye "A Comparison of Analysis Flywheel Stress Distributions Based on Different Material"Applied Mechanics and Materials Vols. 536-537 (2014) pp 1291-1294.

[7] JohnA.Akpobi&Imafidon A.Lawani "computer-aided-designs of Flywheel" Volume 37 Issue 4, April 2006, ISSN: 0965-9978.

[8] S. Saha "Computer aided design & analysis on flywheel for greater efficiency" International Journal of Advanced Engineering Research and Studies E-ISSN2249– 8974.

[9] Mouleeswaran Senthil Kumar and Yogesh Kumar "optimization of flywheel materials using genetic algorithm" Acta Technical Corvininesis - Bulletin of Engineering;Oct-Dec2012, Vol. 5 Issue 4, p37.

[10] Aswin Inbaraj Jaison and Karuppasamy "Design and Optimization of Flywheel for Automobile Applications" ISSN 0973-4562 Vol. 5 No.1 (2015)

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