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DESIGN AND ANALYSIS OF FLYWHEEL IN MULTICYLINDER PETROL ENGINE

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Abstract

The flywheel used in a vehicle acts as a reservoir that stores energy during periods when energy supply exceeds demand and releases it when energy demand exceeds supply. CI. In an engine, power is generated in the power cycle, which is much greater than the engine load, and in the case of a four-stroke engine, power is not generated in the intake, compression, and exhaust strokes. Excess energy from the power stroke is absorbed by the flywheel and transferred without energy to the crankshaft on further strokes, causing the crankshaft to rotate at a constant speed.

The flywheel at one end of the crankshaft serves two purposes. First, stiffness allows each cylinder to smooth its stroke during ignition to reduce vibration. In this article, a steering wheel model is created using SOLIDWORKS tools and then exported to Ansys Workbench, where the steering wheel follows structural and dynamic boundary conditions. In this process, steel is treated as an existing material and replaced with three other materials (steel 440c, CFRP, al-7075). Finally, the diploma ends with the best content, relevant table.

1. INTRODUCTION

An internal combustion engine is an engine in which the combustion of a fuel (usually a fossil fuel) takes place in a heated chamber with an oxidizing agent (usually air). In an internal combustion engine, some parts of the engine such as pistons, turbine blades, or nozzles are directly affected by the expansion of hot and compressed gases during combustion. This force repels objects to generate usable electrical energy. The term internal combustion engine usually refers to internal combustion engines, such as the well-known four-stroke and two-stroke piston engines, with designs such as Winkle rotary engines. Another type of internal combustion engine uses constant heat. Gas turbines, jet engines, and many rocket engines are internal combustion engines based on the above principle.

Internal combustion engines (or internal combustion engines) differ significantly from external combustion engines such as steam engines or Stirling engines in that the energy is transferred to a working fluid with mixed or undiluted combustion products. The working water may be air, hot water, pressurized water, or sodium water heated in some types of boilers.

1.1 Applications

Internal combustion engines are commonly used to drive locomotives in vehicles and mobile units. In mobile applications, internal combustion is preferred because of the fuel's higher energy density and high energy-to-mass ratio. These engines are usually powered by fossil fuels (mainly oil) and are used in almost all vehicles such as cars, trucks, motorcycles, boats, airplanes, and various types of engines. Internal combustion engines are used in the form of gas turbines when a very high power-to-weight ratio is required. These applications include jet aircraft, helicopters, large ships and generators.

4 stroke adjustment function

4-stroke cycle (or automatic cycle)

1. Eat
2. Compression
3. Power
4. Let go

As the name suggests, the operation of a four-stroke internal combustion engine consists of four main phases that repeat every two engine cycles.

Air intake: delivers the combustible mixture to the combustion chamber

Squeeze: Squeeze the mixture.

Combustion (Electrical): Mixtures often ignite by combustion and explode in some systems. The mixture of hot air and fuel expands and compresses the engine parts and does useful work.

exhaust - low temperature combustion products released into the atmosphere. A jet engine does all the work simultaneously on different parts of the engine.

Combustion All internal combustion engines are based on an exothermic chemical combustion process. This is usually a reaction between fuel and oxygen in the air (you can also inject nitrous oxide to do the same thing and increase power). The combustion process usually produces large amounts of heat, as well as steam, carbon dioxide, and other hot chemicals. Temperature is determined by the chemical composition of the fuel and oxidizer (see stoichiometry) and by pressure and other factors.

1.2 Flywheel

The flywheel stores mechanical energy for later use. Therefore, it makes sense to think of it as an analogue of the kinetic energy of an electric inductor. As a result, it can be said that the general principle of energy storage is shown by the general concept of capacitors. Like other types of accumulators, flywheels act as low-pass filters for system mechanical motions (angles, etc.), significantly smoothing out the small changes required for system output. Specifically, the flywheel absorbs excess input power (the power produced by the system) as rotational energy and stores the energy to increase output power when input power is reduced.

Common applications of flywheels include smoothing engine power, energy storage, distributing energy at a faster rate than the source, and controlling the direction of mechanical systems using gyroscopes and feedback loops. .

LITERATURE REVIEW

1) N.N. Suryavanshi1, Professor D.P. Bhaskar2 1ME Design, SRE Kopergaon.: Dual mass flywheel (DMF) is mainly used in automotive powertrains to reduce vibration and reduce transmission noise. We explained that a detailed initial model of DMP dynamics was presented. This mainly affects the two arc springs and the two masses in the DMF and their behavior. A dual mass flywheel test model is compared with a conventional flywheel. Finally, engine torque monitoring with DMF is discussed. For this, DMF should be prepared and tested or tested to see the results. The results are compared with conventional flywheels.

2. UlfSchaper, Oliver Sawodny, Tobias Mahl, UtiBlessing: Explain DMF, its uses and components. A detailed model of DMF dynamics is then presented. It mainly involves the modeling of two arch springs and their frictional behavior in DMF. Centrifugal effect and redirection forces act radially on the pressure spring, creating friction. Numerical methods are used to measure the validity of the model.

3. Bjorn Bolund, Hans Bernhoff, Mats Leijon: This document describes the use of flywheels. Modern flywheels are complex designs in which power is automatically stored and transferred to the flywheel by an integral motor or generator. The wheel was replaced by a steel or composite rotor and magnetic bearings were introduced. As the voltage increases, the current losses decrease and the otherwise required transformer stages become unnecessary.

4. Jordan Firth and Jonathan Black: This paper explains vibration interactions in multiple flywheel systems. A flywheel can be used to store kinetic energy. The problem considered in this paper is related to the vibration interactions between

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several unbalanced wheels. This article uses a linear state-space dynamics model to study the effects of vibrational interactions. Specifically, unbalanced induced vibrations in one flywheel rotor are used to generate resonant eddy vibrations in the other rotor. When both rotors rotate in the same direction, the vibration is stronger. Akshay P. Punde, G.K. Gattani [5] proposed to combat the need for smoothing large speed fluctuations during the IC cycle. Engine designed and analyzed the flywheel using the FEA method, calculated the pressure inside the flywheel, and the results of the design and analysis John A. Akpobi and Imafidan AD. Compared to base and existing flywheels. Different flywheel configurations (rim or solid) became the basis of software development. The graphical capabilities of the software were used to provide a visual interpretation of the solutions. The performance of the software has been tested in several numerical examples, some of which are described in this paper.

Sushma G. Bhavane, A.P. Ninawa, S.K. Chowdhury [7] and flywheel design

Analysis of the material selection process. The FEA model is described to better understand the mesh type, mesh size and boundary conditions applied to complete an efficient FEA model. Saidshojai, Syed Mustafahossein Ali Municipal Mehdi Tzdri Hamid Raza Chamani [8] IC. Flywheel. engine, AVL\EXCITE torsional vibration analysis results are compared to crankshaft angular displacement with no vibration, as well as fatigue considerations for flywheel fatigue analysis.

DESIGN PROCESS

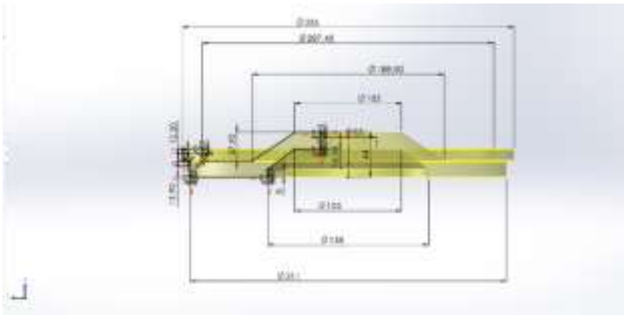

Fig 3.9.1

Fly wheel model is developed with the help of revolve option,

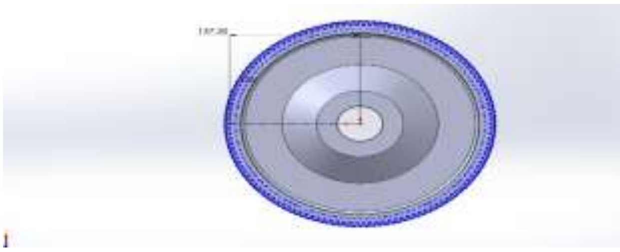

fig 3.9.2

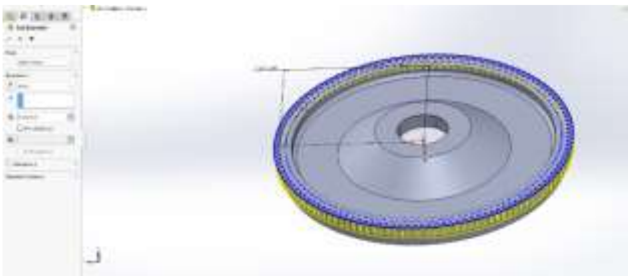

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fig.3.9.3

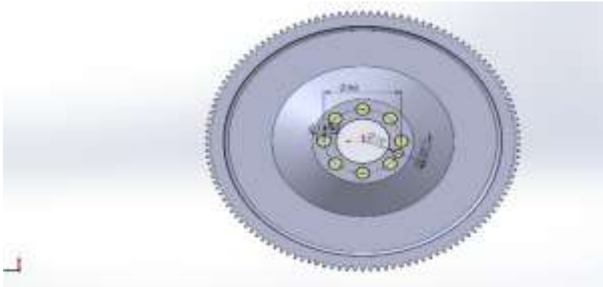

Fig.3.9.4

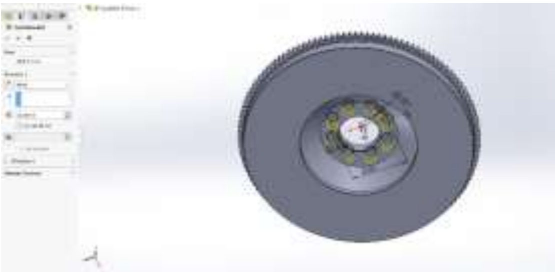

fig.3.9.5

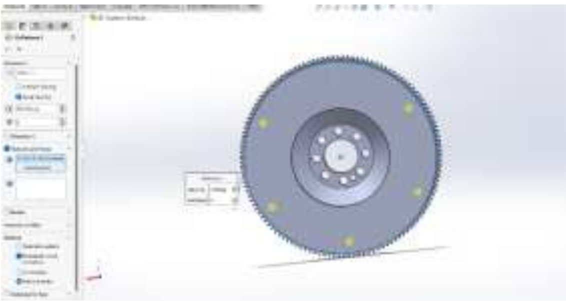

fig.3.9.6

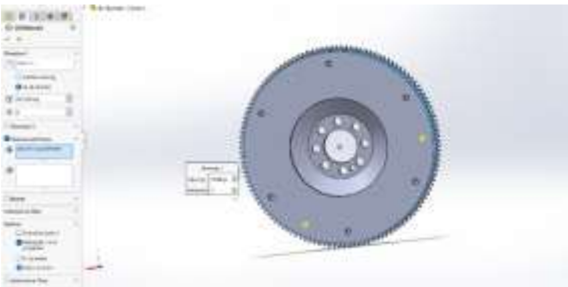

fig.3.9.7

Fig 3.9.8 Fly wheel final design

4.5.1Material properties

4.5.1.1 Mild Steel

Density (kg/m^3): **7850**

Young's modulus (Pa): **200e9**

Poisons ratio**: 0.3**

Yield strength (Mpa): **250**

4.5.1.2 Steel 440c

Density (kg/m^3): **7650**

Young's modulus (Pa): **200e9**

Poisons ratio**: 0.275**

Yield strength (Mpa): **490**

4.5.1.3 cfrp

Density (kg/m^3): **1600**

Young's modulus (Pa): **70e9**

Poisons ratio**: 0.1**

Yield strength (Mpa): **600**

4.5.1.4 Al-7075

Density (kg/m^3): **2810**

Young's modulus (Pa): **71.7e9**

Poisons ratio**: 0.33**

Yield strength (Mpa): **503**

4.6Meshing

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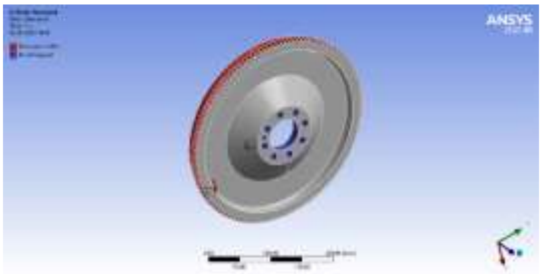
fig 4.6

Boundary conditions



Boundary conditions pressure apply
2Mpa ok

Solution deformation, stress, strain, shear stress, safety factor

fig 4.

4.8RESULTS

4.8.1.1 Steel Deformation

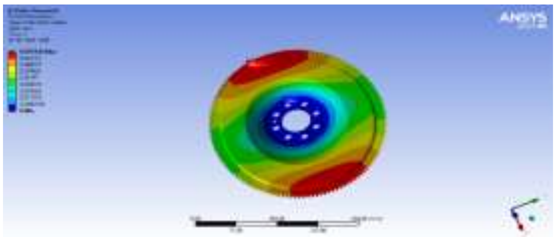


fig 4.8.1.1

Above image, represent multi cylinder petrol engine flywheel, when applied 2mpa pressure it has maximum deformation value 0.059345mm, and minimum deformation value for this flywheel is zero mm. In addition, it has steel material.

4.8.1.2Stress

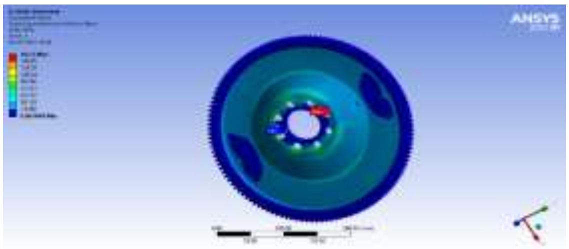


fig 4.8.1.2

Above image, represent multi cylinder petrol engine flywheel, when applied 2mpa pressure it has maximum stress value 162.5Mpa, and minimum stress value for this flywheel is 0.007841Mpa. In addition, it has steel material.

4.8.1.3Strain

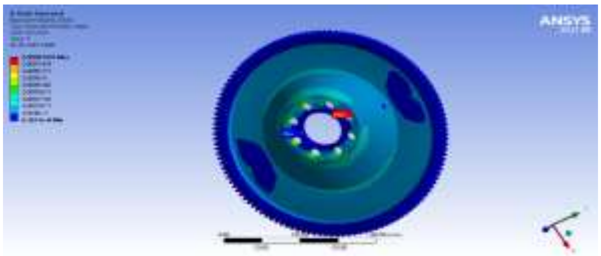


fig 4.8.1.3

4.8.1.4Shear stress

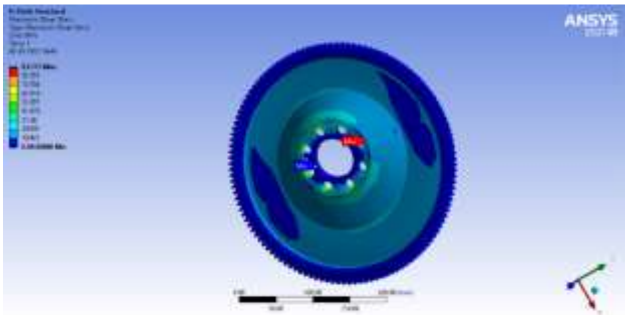


fig 4.8.1.4

Tables

	steel	Steel 440c	CFRP	Al-7075
Deformation(mm)	0.059345	0.058729	0.15239	0.1674
Stress (Mpa)	162.5	163.51	169.57	161.2
Strain	0.00081476	0.00081967	0.0024269	0.002255
Shear stress (Mpa)	93.771	94.345	97.808	93.029
Safety factor	1.5384	2.9968	3.5383	3.1203

Above table represent the deformation values of each materials, among all materials steel and steel 440c materials has maintained low deformation values, and cfrp and al-7075 materials has high deformation values, but all these deformation values are under yield limit conditions only, it means even if the deformation value is high there is no permanent deformation occurred. Therefore, both cfrp and al-7075 materials are consider being safe at this deformation.

Above table represent the stress values of each materials, among all materials steel and steel 440c and al-7075 materials has maintained low stress values, and cfrp materials has high stress values, but all these stress values are under yield limit conditions only, it means even if the stress value is high there is no damage occurred. Therefore, cfrp material consider being safe at this stress

Above table represent the strain values of each materials, among all materials steel and steel 440c materials has maintained low strain values, and cfrp and al-7075 materials has high strain values, but all these strain values are under yield limit conditions only, it means even if the deformation value is high there is no permanent strain occurred. Therefore, both cfrp and al-7075 materials are consider being safe at this strain.

Above table represent the shear stress values of each materials, among all materials steel and steel 440c and al-7075 materials has maintained low shear stress values. and cfrp materials has high shear stress values, but all these shear stress values are under yield limit conditions only, it means even if the shear stress value is high there is no damage occurred. Therefore, cfrp material consider being safe at this shear stress.

Above graph represent the safety factor values of each materials, among all materials steel and steel 440c materials has maintained low safety factor values, and cfrp and al-7075 materials has high safety factor values, but all these safety factor values are above 1.5 only. Among all cfrp has highest safety factor values and then al-7075 material has second best safety factor values. Steel 440c and steel materials are considered to be 3rd and 4th place respectively

Graphs

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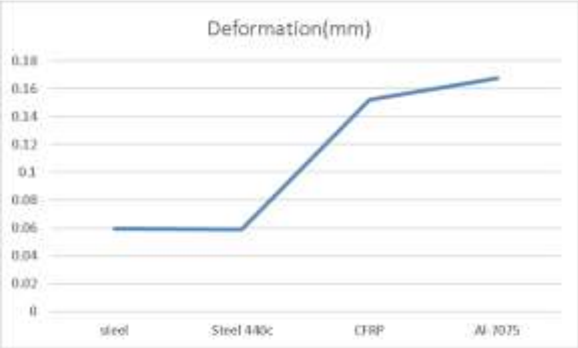

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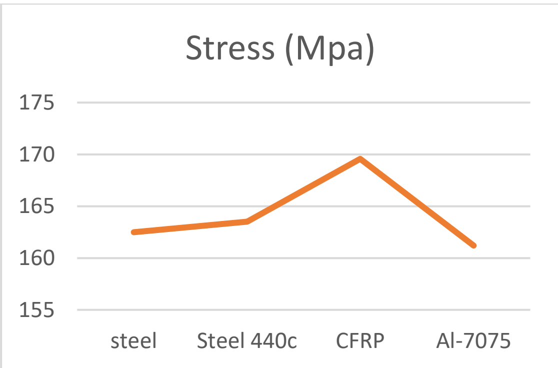
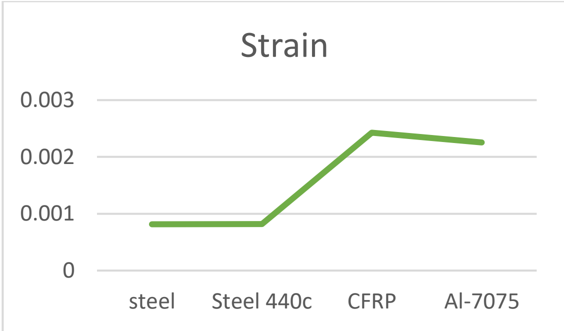
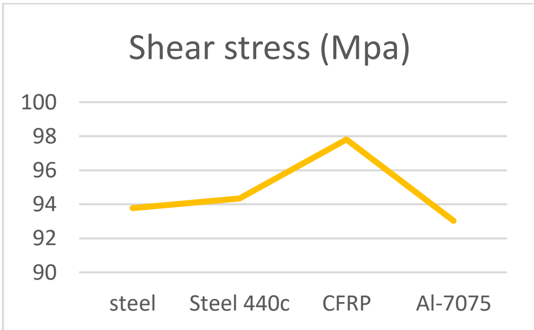


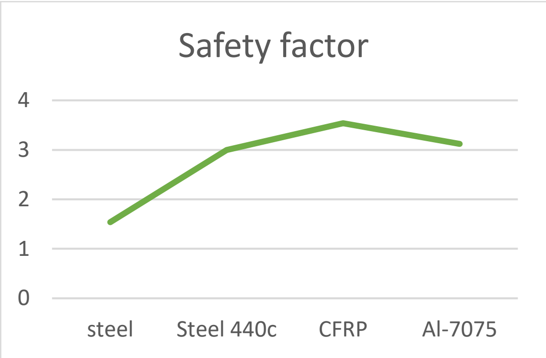
Above graph represent the stress values of each materials, among all materials steel and steel 440c and al-7075 materials has maintained low stress values, and cfrp materials has high stress values, but all these stress values are under yield limit conditions only, it means even if the stress value is high there is no damage occurred. Therefore, cfrp material consider being safe at this stress.



Above graph represent the strain values of each materials, among all materials steel and steel 440c materials has maintained low strain values, and cfrp and al-7075 materials has high strain values, but all these strain values are under yield limit conditions only, it means even if the deformation value is high there is no permanent strain occurred. Therefore, both cfrp and al-7075 materials are consider being safe at this strain.



Above graph represent the shear stress values of each materials, among all materials steel and steel 440c and al-7075 materials has maintained low shear stress values. and cfrp materials has high shear stress values, but all these shear stress values are under yield limit conditions only, it means even if the shear stress value is high there is no damage occurred. Therefore, cfrp material consider being safe at this shear stress.



Above graph represent the safety factor values of each materials, among all materials steel and steel 440c materials has maintained low safety factor values, and cfrp and al-7075 materials has high safety factor values, but all these safety factor values are above 1.5 only. Among all cfrp has highest safety factor values and then al-7075 material has second best safety factor values. Steel 440c and steel materials are consider to be 3rd and 4th place respectively

5.2 NATURAL FREQUENCY

A sound wave is created as a result of the vibration of an object. A vibrating object is a sound source traveling through a medium. A vibrating object that produces sound can be a person's vocal cords, the vibrating strings and soundboard of a guitar or violin, the vibrating tips of a tuning fork, or the vibrating diaphragm of a radio speaker. Any object that vibrates creates sound. The sound can be musical or loud; but regardless of its quality, it is the vibrating object that creates the sound wave.

Natural frequency is important for several reasons:

1. Every object in the universe has its own frequency, and many of them have multiple frequencies.
2. If you know the natural frequency of an object, you know how it will vibrate.
3. If you know how an object vibrates, you know what waves it creates.
4. If you want to create certain types of waves, you need to create objects with natural frequencies that match the waves you want.

All bodies have natural frequencies because all bodies have mass and stiffness. Mechanical vibration is a game between inertial and elastic forces.

5.7Tables

	Steel	Steel 440c	cfrp	Al-7075
Mode 1 (Hz)	982.2	992.88	1281	986.04
Mode 2(Hz)	986.03	996.66	1285.3	989.99
Mode 3 (Hz)	1331.6	1341.8	1686.6	1331.3
Mode 4 (Hz)	1334	1354.9	1798.3	1333.8
Mode 5 (Hz)	1337.2	1357.8	1801.8	1342.8
Mode 6 (Hz)	2310.8	2362.3	3279.2	2287.9

From above table, it represent the results of multi cylinder petrol engine flywheel dynamic behavior. Here material chosen steel, dynamic analysis shows how strong object in vibrating conditions, it means if object has high natural frequency values then it can withstand high vibrations. from mode 1 to 6 results has been calculated, from the given data steel material has natural frequency range from mode 1 982.2hz to 2310.8hz at mode 6.

From above table, it represent the results of multi cylinder petrol engine flywheel dynamic behavior. Here material chosen steel440, dynamic analysis shows how strong object in vibrating conditions, it means if object has high natural frequency values then it can withstand high vibrations., from mode 1 to 6 results has been calculated, from the given data steel material has natural frequency range from 1 mode 992.88hz to 2362.3hz at mode 6.

From above table, it represent the results of multi cylinder petrol engine flywheel dynamic behavior. Here material chosen cfrp, dynamic analysis shows how strong object in vibrating conditions, it means if object has high natural frequency values then it can withstand high vibrations, from mode 1 to 6 results has been calculated, from the given data steel material has natural frequency range from 1st mode 1281hz to 3279.2hz at mode 6.

From above table, it represent the results of multi cylinder petrol engine flywheel dynamic behavior. Here material chosen al-7075, dynamic analysis shows how strong object in vibrating conditions, it means if object has high natural frequency values then it can withstand high vibrations, from mode 1 to 6 results has been calculated, from the given data steel material has natural frequency range from first mode 986.04 Hz to 2287.9 Hz at mode 6.From above all dynamic analysis results, it is clearly noted down that cfrp material high natural frequency values compare to remain three materials, whereas steel 440c consider as second highest, and al-7075 & steel materials 3rd and 4th place respectively.

CONCLUSION

In this thesis, the flywheel model was developed with the help of SolidWorks tool and then exported to Ansys Workbench, where the flywheel is subjected to structural and dynamic boundary conditions. In this process the steel material is considered as the existing material and then replaced by 3 other materials (440c steel, cfrp, al-7075)

From the analysis results, the steel material flywheel can only bear the maximum pressure up to 2Mpa, which means that if the pressure is increased above 2Mpa, the material will undergo permanent deformation, among all materials, cfrp has the highest strength and weight. Ratio in structural and dynamic conditions.

Finally, the thesis ends with cfrp material; this material can increase the strength of the object and reduce its weight. The weight-to-weight ratio will increase with this item.

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