Analysis of Stress and Critical Speed in Rotating Flywheel with different RPM

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Abstract –
In this study, the simulations of flywheels and six types of materials were analyzed for natural frequency and the configurations of flywheel design are proposed.

The results show that flywheel material like T1000G of flywheel the decrease in a critical speed number of modes simultaneously. The critical speed of the flywheel with different material is compared by using six types of materials and is predicted .Flywheel profile a T1000G gives higher frequencies and less critical speed in different modes.

Keywords –Flywheel, Shear Stress, Literature, Critical Speed, Natural Frequency.

I. INTRODUCTION

Flywheel is a machine element which is used to increase a momentum of rotating element and to control fluctuations which are induced on rotating element like shafts turbines etc. It also conserves energy for continuous rotation; Flywheel also reduces vibration on rotating element. It also acts as a damper.

A flywheel is a rotating mechanical gadget used to store kinetic energy. Flywheels have been in use for quite a lot of functions for the period of human historical past for enormous quantities of years. In the beginning they were used as a means to furnish stability, akin to a potter's wheel. During the economic revolution, they were principally integrated in steam engines. However, it was once no longer unless the late sixties/early nineteen seventies, with the appearance of composite substances and an increased interest in renewable vigor sources that study into the skills for flywheels as a plausible substitute to chemical batteries used to be carried out. The construction of magnetic bearings within the nineteen eighties additionally exacerbated curiosity and research. Flywheels may also be separated into two classes: conventional and high-performance (super flywheels). Conventional flywheels are built from standard materials, most probably metal, while super flywheels are composed of composite substances. The reward work includes evaluation on both forms of flywheels, however with the primary center of attention placed on traditional flywheels. These comprise mobile purposes, such because the automobile and aerospace enterprise, or vigor law in electrical energy producing plants.

II. MATERIALS USED

- Most of Flywheel is formed from steel, either medium- or low-carbon. However, top Strength steel, typically heat treated, is additionally selected for powerful applications.
- Metals, like brass, stainless steel or Al, are used where Corrosion may be a disadvantage or lightness is required.
- Small, light-duty Flywheels, like in family appliances, are additionally injection shaped.

III. RESULTS & DISCUSSIONS

Critical Speed and Frequency along the Flywheel with Different Diameter and Materials

A Structural and Modal - analysis was carried out to analyze critical speed of Flywheel with different material and diameter by using Campbell diagram and relation between natural frequency and spin speed a Six types of materials of CFRP, T1000G, T300, EPOXY, POM, SNCM616 with flywheel to determine the frequency distribution along the Flywheel. Frequency distribution contours in case of flywheel are shown in Figure, and the effect of different materials on Flywheel profile on the frequency and modes distribution for various materials are represented in the Figure.

Validation from previous research

Table 1.2 - Base paper results and Simulation Results of shear stresses of flywheel.

Validation	
Shear stress (T300)	
Base paper results	Simulation Results
30.2	29.464

Table 1.3 Shear stresses on different materials of flywheel.

Materials	Shear Stresses
CFRP	34.68
T300	29.464
T1000G	16.741
EPOXY	24.541
POM	26.637
SNCM616	126.35

Above table represents the validation of experimental results of flywheel and shear stresses of different material are also simulated for present analysis from above result we predict that simulation results shows convergence with experimental results, Hence our simulation is converged.

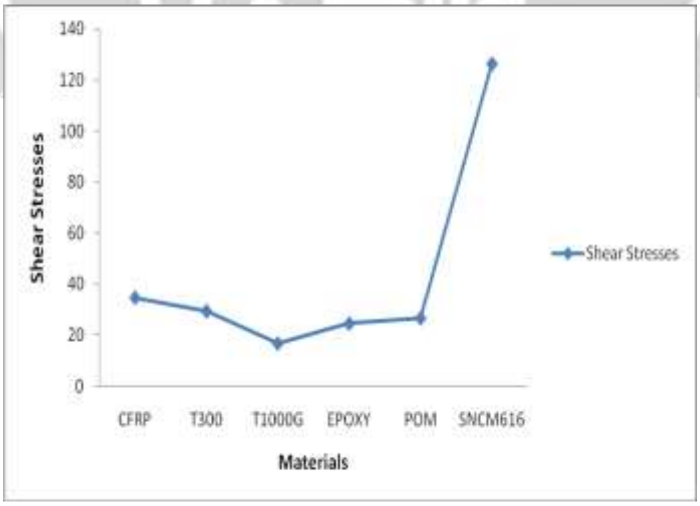

***Figure.**1.2 Graph of shear stresses of different material of flywheel.*

Critical Speed Results of Flywheel with different Material by Campbell Diagram approach

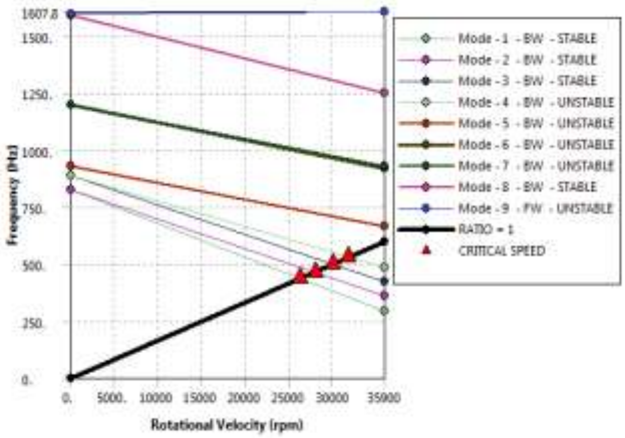

***Figure**.1.3 Result of Campbell diagram of Frequency and rotational velocity Distributions along the CFRP made flywheel*

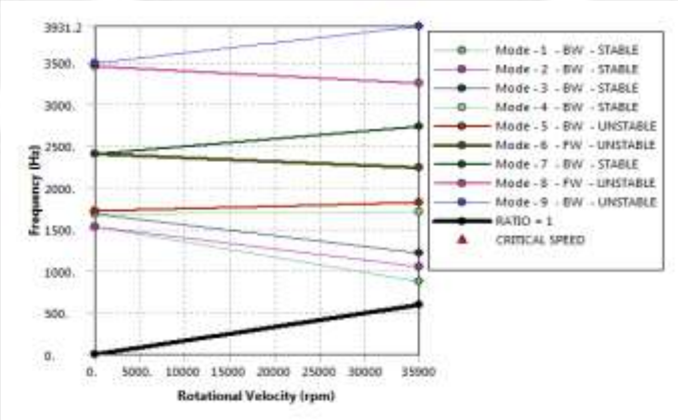

***Figure** .1.4 Result of Campbell diagram of Frequency and rotational velocity Distributions along the EPOXY made flywheel*

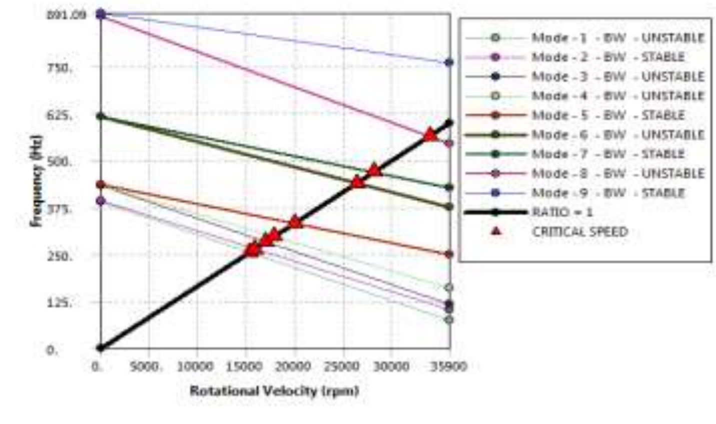

***Figure** 1.5 Result of Campbell diagram of Frequency and rotational velocity Distributions along the POM made flywheel.*

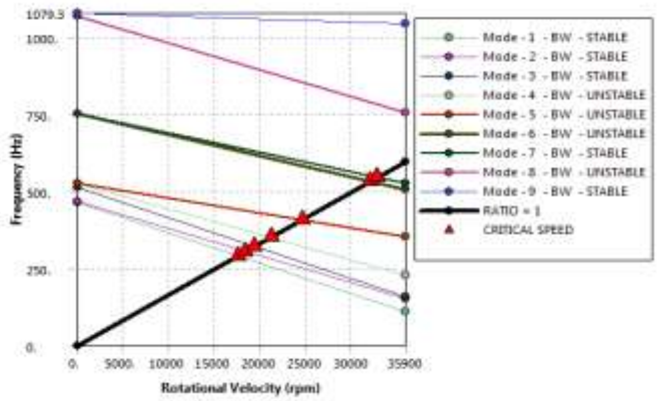

***Figure**.1.6 Result of Campbell diagram of Frequency and rotational velocity Distributions along the SNCM616 made flywheel.*

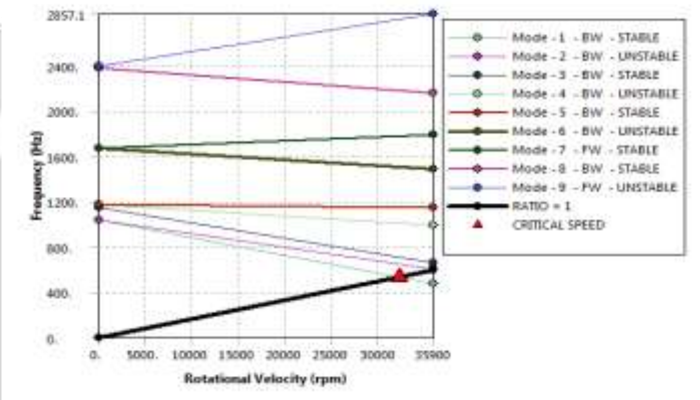

***Figure** .1.7 Result of Campbell diagram of Frequency and rotational velocity Distributions along the T300 made flywheel.*

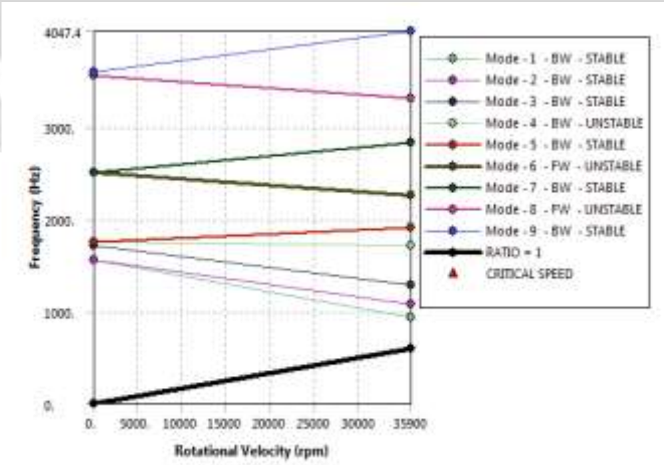

***Figure** .1.8 Result of Campbell diagram of Frequency and rotational velocity Distributions along the T1000G made flywheel.*

V. NATURAL FREQUENCY ANALYSIS OF FLYWHEEL WITH DIFFERENT MATERIAL

Table .1.16 Natural Frequency of Variable Materials with their different modes

Natural Frequency						
Modes	**CFRP**	**T300**	**T1000G**	**EPOXY**	**POM**	**SNCM616**
1	976.23	1194.9	1792.2	1769.6	450.92	534.59
2	976.32	1195	1792.4	1769.8	450.95	534.64
3	998.85	1216.3	1824.3	1805.4	461.83	543.3
4	999.27	1248.6	1872.8	1806.2	462.26	561.25
5	1000.5	1249	1873.4	1815.3	462.45	561.46
6	1254.3	1584.5	2376.7	2263.7	581.01	713.97

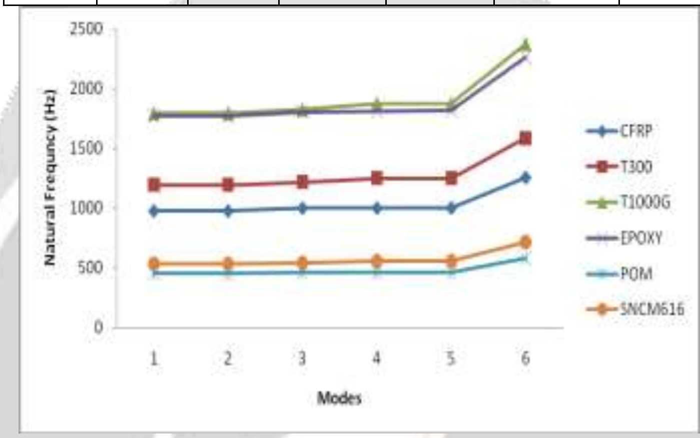

Figure *.1.9 Graph shows modes and frequency of a Flywheel with different material.*

VI.Conclusion

Influence of different Flywheel profiles

- The natural frequency along the Flywheel profile is found to be maximum of the T1000G material profile with Flywheel diameter 238 mm and varies along the circumference up to the Flywheel profile. The critical speed distribution along the Flywheel is maximum for SNCM616 and minimum for T1000G of a Flywheel profile.
- The magnitude of frequency is minimum in the case of POM material profile. The nature of the natural frequency is maximum near its end in 3rd and 4th,6th mode.
- The nature of the critical speed is maximum near its masses and hub of the Flywheel where masses are high of Flywheel and changes with respect to Flywheel material profile towards the end and between masses of the Flywheel for the same RPM and different modes of natural frequency.

- In a comparison with the CFRP, T1000G, T300, EPOXY, POM, SNCM616 material resulted in higher frequency characteristics close to the end of the Flywheel for a different material Flywheel profile. The critical speeds are maximum for SNCM616 at low frequency and negligible for T1000G at high frequency on same RPM.

Future Scope

- Solid Flywheel and thicker Flywheel could be used to analyze critical speed for different dimensions.
- Different materials can be used for analyzing frequency and critical speed for different types of Flywheel.
- Different masses could be also analyzed for different RPM to predict critical speed for Flywheel for save design.

- Stiffness of bearing should be changed and also with damping coefficient for study of Flywheel system on Campbell diagram.

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