

EFFECT OF SPIN AND ENERGY STORAGE ON FLYWHEEL WITH COMPOSITES MATERIALS: A REVIEW

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Abstract — The analysis has presented the effect of shear Stress with different profiles of the flywheel with different layered (0.5mm, 1mm, 1.5mm) and different Hub angle (4°, 5°, 6°) the natural frequency and modes of different materials and shear stress effects were analyzed on different profile and materials of flywheel and distribution along the flywheel was studied. The natural frequency along the flywheel profile is found to be maximum of the T1000G material profile with multi rim flywheel and different hub angle. The shear stress distribution along the multi rim flywheel is maximum for T300-POM and minimum for T300-T1000G of a flywheel with different profiles. The magnitude of frequency is minimum in the case of T300-POM material profile with 4° hub angle. The nature of the natural frequency is maximum near its end in 3rd and 4th, 6th mode. The nature of the shear stress is maximum near its hub of flywheel with 0.5mm multi rim of T300-T1000G and 4° inclined hub angle.

Keywords— Fly Wheel, Shear Stress, Hub Angle, Composites

purposes, such because the automobile and aerospace enterprise, or vigor law in electrical energy producing plants.

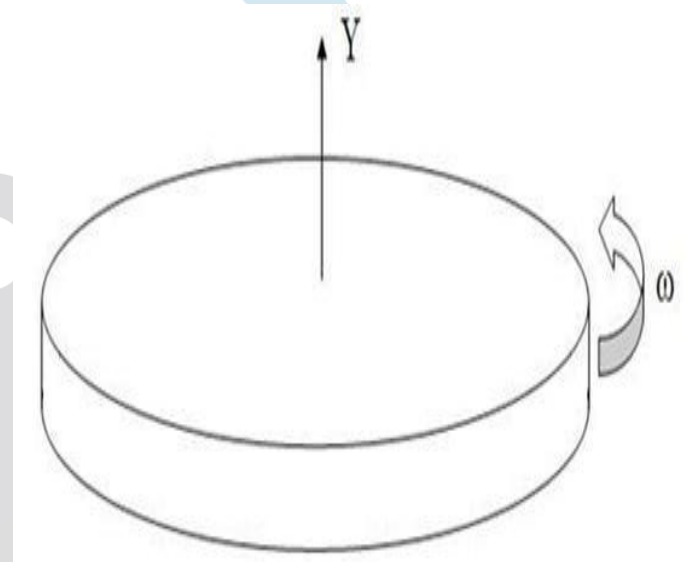


Figure 1-1. Basic flywheel diagram

I INTRODUCTION

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 potters 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. A usual flywheel is proven in Fig. 1-1. Flywheels had been proposed as an alternative or complement to average chemical batteries for the duration of various areas. These comprise mobile

Energy Storage- With the growing demand for oil world wide and dwindling non-renewable assets, curiosity in vigor storage has had an uptick in recent a long time. The current world vigour storage capacity is 90GW from a whole creation of 3400 GW (i.e. Handiest 2.6% of total electrical vigour in the world is in a position of being stored) [1]. Energy storage gadgets add balance and reliability to electrical grids. This in turn improves efficiency and reduces consumption of assets. Instabilities in electrical grids are brought on with the aid of load variants due to various factors, similar to fluctuating input masses from renewable resources (wind and sun), frequency deviations, and discrepancies between height and average electrical power demand. The quite a lot of ways of energy storage incorporate mechanical, electro-chemical, thermal, electro-magnetic, and chemical programs. Each of those distinct techniques is used depending on efficiency, cost/discharge expense, discharge time, storage capability, biking potential, self-discharge, environmental erects, and charges. Depending on their software, the programs can be divided into four classes [2]:

- Low-power application in isolated areas, essentially to feed transducers and emergency terminals.
- Medium-power application in isolated areas (individual electrical systems, town supply).

- Network connection application with peak leveling.
- Power-quality control applications.

Flywheel Design & Operation- Flywheels are highly versatile vigor management methods. On account that the 1980's, electrically related flywheel vigor storage systems had been deployed in a variety of commercial and commercial applications. Many of these programs store appreciable vigour and reward skills hazards. As a precondition to operation, defense of the approach ought to be certain. This is comprehensive via developing a plan for protection and demonstrating conformance with this plan. As codes and requirements have but to be developed expressly for flywheels, flywheel builders regularly derive safety criteria arbitrarily, most commonly from first principals.

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.
- In a plastic material cherish T300, T1000G, EPOXY or Poly Plastic..

Application

Flywheels are often used to provide continuous power output in systems where the energy source is not continuous. For Instance, a flywheel is used to easy speedy angular pace fluctuations of the crankshaft in a reciprocating engine. In this situation, a crankshaft flywheel stores electricity while torque is exerted on it through a firing piston, and returns it to the piston to compress a sparkling charge of air and fuel. Another instance is the friction automobiles which powers devices together with toy cars. In unstressed and inexpensive cases to save on cost the bulk of the mass of the flywheel is toward the rim of the wheel. Pushing the mass away from the axis of rotation heightens rotational_inertia for a given total mass.

A flywheel may also be used to supply intermittent pulses of energy at power levels that exceed the abilities of its energy source. This is accomplished by using gathering energy within the flywheel over a period of time, at a fee that is compatible with the strength supply, after which freeing energy at a far better fee over a especially quick time whilst it's miles wanted. For example flywheels are used in power hammers and riveting machines. Flywheels may be used to manipulate course and oppose unwanted motions, see gyroscope. Flywheels on this context have a extensive range of packages from gyroscopes for instrumentation to ship balance and satellite tv for pc stabilization (reaction wheel), to keep a toy spin spinning (friction_motor), to stabilize magnetically levitated objects (Spin-stabilized_magnetic_levitation)

Flywheel Functions

The flywheel provides the engine side face for the clutch to bite into, but its main job is to store kinetic energy. Its kind of

like when you spin a bicycle wheel in mid air and it free wheels for a while. That's the wheel storing the energy you put into it and releasing it as it slows down due to things like friction.

It helps keep the engine running by maintaining crankshaft momentum between combustion strokes but most importantly, it plays a major part in how a vehicle drives.

A heavier flywheel will dull engine response, but will help a car maintain momentum up hills or while towing. It also makes it easier to take off from a standstill and it has the mass to get the car rolling smoothly when the clutch is disengaged.

Lighter flywheels can improve engine response and acceleration due to their lower rotating inertia. For years they have been seen as releasing free horsepower and have been fitted to everything from highly strung four cylinders to big cube eights.

Types of Flywheel

Single mass flywheels: Most factory standard flywheels are usually made from cast steel, Heavy however difficult wearing and durable. The maximum not unusual type of mild weight flywheels are made from chrome moly or aluminum with bolt in friction plates. Chrome moly is right, the aluminum ones can motive a few troubles in the event that they aren't effectively geared up, but they still have there place in certain applications.

Dual mass flywheels: They were designed purely for reducing noise, vibration and harshness. They paintings further to the sprung centre clutch disc in that they use springs to hose down driveline surprise and harmonics. They are not honestly appropriate for performance applications as they may be a whole lot heavier than a conventional flywheel and are prone to failure under heavy use or extreme heat

Uses of Flywheel

Providing continuous energy when the energy source is discontinuous. For example, flywheels are used in reciprocating engines because the energy source, torque from the engine, is intermittent.

Delivering energy at rates beyond the ability of a continuous energy source. This is achieved by collecting energy in the flywheel over time and then releasing the energy quickly, at rates that exceed the abilities of the energy source.

Controlling the orientation of a mechanical machine. In such programs, the angular momentum of a flywheel is purposely transferred as a torque to the attaching mechanical machine when energy is transferred to or from the flywheel, thereby inflicting the attaching system to rotate into a few preferred role.

Flywheels are typically made of steel and rotate on conventional bearings; these are generally limited to a revolution rate of a few thousand RPM. Some modern flywheels are made of carbon fiber materials and employ magnetic bearings, enabling them to revolve at speeds up to

60,000 RPM. Carbon-composite flywheel batteries have recently been manufactured and are proving to be viable in real-world tests on mainstream cars. Additionally, their disposal is more eco-friendly.

II COMPOSITES

Composite is a fabric which is combo from exclusive factor. There unit lots of blended object around you. Cement possibly a mixture. It can be great from concrete, rock, and sand, and generally has steel poles inside to enhance it. These sparkly inflatable you get throughout the medication middle as soon as you are worn out square measure stunning from a combo, which includes of a polyester sheet an Al thwart sheet, made right into a sandwich. The compound combination fabricated from polymers, or from polymers next to fully unexpected form of substances. In any case, specifically the fiber-strengthened mixture rectangular measure materials within that a fiber extremely good from one material is inserted in a further fabric.

A Composite material (T300, T1000G, EPOXY, POM) is a material made from two or more constituent materials with different physical or chemical properties that, when combined, produce a material with characteristics different from the individual components. The individual components remain separate and distinct within the finished structure. The new material may be preferred for many reasons: common examples include materials which are stronger, lighter, or less expensive when compared to traditional materials. More recently, researchers have also begun to actively include sensing, actuation, computation and communication into composites.

Composites are made up of individual materials referred to as constituent materials. There are two most important categories of constituent substances: matrix (binder) and reinforcement. At least one component of every kind is required. The matrix cloth surrounds and supports the reinforcement substances by way of maintaining their relative positions. The reinforcements impart their special mechanical and bodily houses to decorate the matrix residences. A synergism produces cloth residences unavailable from the person constituent substances, even as the extensive style of matrix and strengthening materials lets in the fashion designer of the product or shape to select an superior mixture. Composite substances must be fashioned to shape. The matrix fabric can be added to the reinforcement earlier than or after the reinforcement cloth is located into the mildew hollow space or onto the mold surface. The matrix material experiences a melding event, after which the part shape is essentially set. Depending upon the nature of the matrix material, this melding event can occur in various ways such as chemical polymerization for a thermoset polymer matrix, or solidification from the melted state for a thermoplastic polymer matrix composite.

A variety of moulding methods can be used according to the end-item design requirements. The predominant factors impacting the methodology are the natures of the chosen matrix and reinforcement substances. Another essential component is the gross amount of fabric to be produced. Large portions may be used to justify high capital expenses for speedy and automated manufacturing era. Small production portions are accommodated with decrease capital costs however higher labour and tooling expenses at a correspondingly slower charge. Many commercially produced

composites use a polymer matrix cloth regularly known as a resin answer. There are many one-of-a-kind polymers to be had relying upon the starting raw components. There are several large categories, each with numerous variations. The most commonplace are called polyester, vinyl ester, epoxy, phenolic, polyimide, polyamide, polypropylene, PEEK, and others. The reinforcement materials are regularly fibres however additionally usually floor minerals. The numerous techniques defined under had been advanced to lessen the resin content of the very last product, or the fibre content material is extended. As a rule of thumb, lay up outcomes in a product containing 60% resin and 40% fibre, whereas vacuum infusion gives a final product with 40% resin and 60% fiber content material. The strength of the product is greatly dependent on this ratio.

Advantages of Composite Materials

Design Flexibility – Thermoset Composites give designers nearly unlimited flexibility in designing shapes and forms. They be molded into the most intricate components and can be made a wide range of densities and chemical formulations to have precise performance properties.

Low cost per cubic inch – When comparing costs based on volume, thermoset composites have lower material costs than traditional materials such as wood, engineered thermoplastics and metals. In addition, because thermoset composites have a low petroleum-based content, they are not subjected to the price fluctuations experienced in petroleum-based products.

Lower material costs – Because thermoset composites can be precisely molded, there is little waste and therefore significantly lower overall material costs than metals products.

Improved productivity – Industrial Designers and Engineers are able to reduce assembly costs by combining several previously assemblies parts into a single component. Also, inserts can be molded directly into the part during the molding process thereby eliminating the need for a post-process. In addition, composites do not usually require additional machining, thereby reducing work-in-process and time to market.

Light Weight - Composites are light in weight, compared to most metals. Their lightness is important in aircraft, where less weight means better fuel efficiency (more miles to the gallon).

Strength Related to Weight - Strength-to-weight ratio is a material's strength in relation to how much it weighs. Some materials are very strong and heavy, such as steel. Composite materials can be designed to be both strong and light. This property is why composites are used to build airplanes—which need a very high strength material at the lowest possible weight.

Corrosion Resistance - Composites resist damage from the weather and from harsh chemicals that can eat away at other materials. Outdoors, they stand up to severe weather and wide changes in temperature.

Part Consolidation - A single piece made of composite materials can replace an entire assembly of metal parts. Reducing the number of parts in a machine or a structure saves

time and cuts down on the maintenance needed over the life of the item.

Dimensional Stability - Composites retain their shape and size when they are hot or cool, wet or dry. They are used in aircraft wings, for example, so that the wing shape and size do not change as the plane gains or loses altitude.

Radar Transparent - Radar signals pass right through composites, a property that makes composites ideal materials for use anywhere radar equipment is operating, whether on the ground or in the air. Composites play a key role in stealth aircraft, such as the U.S. Air Force's B-2 stealth bomber, which is nearly invisible to radar.

Durable - Structures made of composites have a long life and need little maintenance. We do not know how long composites last, because we have not come to the end of the life of many original composites. Many composites have been in service for half a century

Other key advantages include:

- As molded dimensional accuracy
- Tight tolerance, repeatable moldings
- Low-post mold shrinkage
- Chemical Resistance
- Consolidated Parts and Function
- Corrosion Resistance
- Design Flexibility
- Durable
- High Flexural Modulus to Carry Demanding Loads
- High Impact Strength
- High Performance at Elevated Temperatures
- Heat Resistance
- Naturally Flame Retardant
- Creep Resistance
- Mechanical Property Retention
- Superior Thermal Stability
- Lighter Weight than Metal
- Lower Costs vs. Die Cast
- Low Petrochemical content
- Better cost stability than commodities
- Lower Cost per Cubic Inch as compared to Thermoplastics
- Molded-in Color
- Molded in inserts
- Outstanding Electrical Insulation
- Arc and Track Resistance
- Ability to Quench

Type of Composites

Composite materials are usually classified by the type of reinforcement they use. This reinforcement is embedded into a matrix that holds it together. The reinforcement is used to strengthen the composite. For example, in a mud brick, the matrix is the mud and the reinforcement is the straw. Common composite types include random-fiber or short-fiber reinforcement, continuous-fiber or long-fiber reinforcement, particulate reinforcement, flake reinforcement, and filler reinforcement.

Material	Mass density (kg/m ³)	Longitudinal elastic modulus (GPa)	Poisson's ratio (μ)	Tensile strength (MPa)
T300	1760	230	0.31	3530
T1000G	1800	294	0.31	6370
EPOXY	1250	3.4	0.36	NA
POM	1400	2.5	0.35	63

Table 2.1: Properties of Material

Classification of composites

1. **Short-fiber reinforced composites.** Short-fiber reinforced composites consist of a matrix reinforced by a dispersed phase in form of discontinuous fibers
 - Composites with random orientation of fibers.
 - Composites with preferred orientation of fibers.
2. **Long-fiber reinforced composites.** Long-fiber reinforced composites consist of a matrix reinforced by a dispersed phase in form of continuous fibers.

III LITERATURE REVIEW

Sara Caprioli et al. [1], in this paper Thermal cracking of railway wheel treads is investigated using a combined experimental and numerical approach. Results from control break rig tests of repeated stop braking cycles for a common railway wheel in rolling contact with a name called rail wheel is presented. Test conditions are then numerically analysed using finite element (FE) simulations that basically account for the thermo mechanical loading of the wheel tread. For the studied wheel braking case, thermal cracks are found in the wheel tread after few brake cycles. Results from thermal imaging shows a frictionally excited thermo elastic instability pattern basically called "banding" where the contact between brake block and wheel takes place only over a fraction of the block width

A. Rupp et al. [2], the introduction of flywheel energy storage device in a light rail transit train is analyzed. Mathematically operated models of the train, driving cycle pattern and mainly flywheel energy storage systems are developed. These type of models are required to study the energy use and consumption and the operating and running cost of a light rail transit train with and without flywheel energy storage capacity. Results tell that maximum energy savings of 31% can be obtained using flywheel energy storage systems with the help of energy and power capacity of 2.9 kWh and 725 kW systematically. Cost savings of 11% can be possessed by utilizing different flywheel energy storage systems with power rating of 1.2 kWh and 360 kW. The basic introduction of flywheel energy storage systems in a light rail transit train can basically result in substantial energy and cost savings.

Xujun Iyu et al. [3], Energy storage flywheels helps on active magnetic bearings (AMBs) have attracted much attention both

in the academia and in the industry due to many of their advantageous features, such as short charging time, high specific energy, no pollution and long lifespan. Feedback controlling is essential in the operation of AMB support systems. However, actual types of AMB suspended energy storage flywheels are not widely available for research on feedback control design. To deliver an economic and efficient platform for the study of AMB supported energy storage flywheels, which includes research on the design of their feedback controllers, we propose in this paper to match or emulate the operation of such flywheels on a rotor AMB test rig we recently constructed

Daniel Jung et al. [4], the crankshaft angular velocity measured and calculated at the flywheel is a commonly used signal for engine misfire detection. However, flywheel manufacturing errors or defects result in vehicle-to-vehicle change or variations in the measurements and have a diverse impact on the misfiring detection performance. A misfiring detection algorithm must be able to compensate for this type of vehicle-to-vehicle changing if it is being used in production cars to assure that legislations are satiated. It is shown that flywheel angular variations between vehicles in the magnitude of 0.05° have a prominent impact on the measured or calculated angular velocity and should be compensated for to make the misfire detection algorithm robust. A misfire detection algorithm is basically proposed with the flywheel error adaptation in order to increase robustness and decrease the number of mis-classifications

Makbul A.M. Ramli et al. [5], this paper analyzes a hybrid energy system performance with photovoltaic (PV) as well as diesel systems as the main energy sources. The hybrid energy system is equipped with flywheel to store excess energy from the PV. HOMER software was employed to study the basic economic and important environmental benefits of the particular system with flywheels energy storage for Makkah, Saudi Arabia. The analysis focused on the impact of utilizing flywheel on the power generation, total energy cost, and the net present cost for certain configurations of the hybrid system. Analyses on fuel consumption and carbon emission reductions for the system configurations were also presented in this paper

Zanjhi Wei et al. [6], the micro vibrations generated by flywheels running at full speed onboard high precision spacecrafts will affect stability of the spacecraft bus and further degrade the pointing correctness of the payload. A passive vibration isolation type of platform comprised of multi-segment zigzag beams is proposed to isolate disturbances of the flywheel. By presuming the flywheel and the platform as an integral and undivided system with some gyroscopic effects, an equivalent dynamic model is developed and verified through eigen value and frequency response analysis. The critical speeds of the system are concluded and expressed as functions of some system parameters.

IV MECHANICAL PROPERTIES MEASUREMENTS

4.1 Resistance Ability

Strength is a mechanical property they will have to have the ability to determine with; two fold reside talking in regards to polymers. To begin with, there is very one type of strength. There's extension strength. A compound has lengthening strength if it can be solid specific one pulls hence. Lengthening force would be a significant quantity of

important for an ancient rarity that's expecting to be multiplied or underneath stress. Materials want eager prolongation strength.

4.2 Effect of Elongation

There is quite a few to comprehension a polymer's mechanical houses than truly understanding however study its. All excellent tells North yank nation is the object that sum prolongation is predicted to interfere with one aspect. That is the position it pays to concentrates the stress behavior of a compound. Stress may be an awfully distortion. Twisting is basically an alteration in variety that one factor beneath goes below extension. Once we're speaking involving prolongation push, the example twists by way of extending, reworking into longer. We are likely to generally tend to allude to as that extension, certainly. Usually we tend to tend to name paper prolongation, that is handiest the size the compound specimen is earlier than it's extended, partitioned via the fundamental size of the example, accordingly misrepresented by way of 100.

1.10 Effect of Magnitude

In the elastomers unit require the high flexible anxiousness. Beside additional types of substances, Plastics, it's almost always they now not lengthen or twist so without problems. Within the occasion that we are likely to all catch that nonetheless good an ancient rarity opposes add up to twisting, we are likely to generally tend to are living one variable alluded to as modulus. To reside extension modulus, we are inclined to are inclined to try to indistinguishable problem as we tend to generally tend did to gauge satisfactory and preeminent stretching. That time we are inclined to are inclined to quantify the strain we're applying on the fabric, somewhat like we are likely to generally tend to do once we are inclined to were live stretching best. First is step by step increasing the quantity of stress, thusly we are inclined to gauge the extension the specimen experiences at each and every anxiousness level. We are likely to tend to stay doing this unless the illustration remoted into a couple of sections. This plot could also be an alluded to as stress pressure bend. The stature of the bend once the instance partitioned into a few sections is that the extension first-rate, all matters considered as a result the elastic modulus is that the incline of this plot. On the off danger that the incline is steep, the illustration choices a excessive elastic modulus, which recommends it hostile. In the event that the slant is smooth, then the case choices an espresso elastic modulus, which recommends its clear all distorted. There square measure over and over as soon as the anxiety stress bend is not respectable and straight, much like we tend to are inclined to noticed on high of. The slant isn't regular as stress can increment. The slant, this probably the modulus, is changing with stress. All via this paper like this we are inclined to now and again, the underlying slant trade as an aftereffect of the modulus adjustment.

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