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Design and Stress Analysis of Composite Material Flywheel in Automotive

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Abstarct: An automotive system using a high speed, moderate mass regulator capable of storing and apace dissipating massive provides of mechanical energy let alone a transmission custom-made to allow the graceful unleash of keep mechanical energy from the regulator to the vehicle wheels and a charging means that for activity mechanical energy to the regulator at comparatively low energy levels. The system provides substantial fuel economy Associate in Nursingd pollution relief through an economical energy-conversion system. A regulator could be a rotating disc that stores mechanical energy. Actually, it's the energy that's keep within the type of mechanical energy. It resists modification within the motion speed, as a results of that the rotation of the shaft becomes steady. sensible quality flywheels square measure fabricated from metal, as they're light-weight. Carbon fiber is additionally being employed, because it ends up in high-energy storage. the burden of high-quality flywheels employed in engines ranges from 13-25 kilo so Very light. This light-weight ends up in fast engine response.

Key words: ASTM · NDE · AN · Nondestructive analysis

INTRODUCTION

A basic machinemotive gear mechanism or auto gear mechanism contains of varied transmission elements like gears, shafts and alternative components, that operate along to modify the movement of Associate in Nursing automobile. Automobile or automotive gear mechanism consists of varied devices that facilitate in transmission power from the engine through the drive shaft to the driving axle of Associate in Nursing automobile. Gears, brakes, clutch, coupler and alternative machine transmission components work along for remodeling the speed quantitative relation between the engine and wheels of a vehicle. The machine gear mechanism incorporates varied elements, that area unit hooked up to the rear of the engine and used for distributing the facility from the engine to the drive wheels.

A regulator may be a machine with a major moment of inertia used as a device for motility energy. Flywheels resist changes in their motility speed, that helps steady the rotation of the shaft once a unsteady torsion is exerted thereon by its power supply. flywheels became the topic of in depth analysis as power storage devices for uses in vehicles. regulator energy storage systems area unit thought of to be a lovely various to chemistry batteries attributable to higher keep energy density, higher life term, settled state of charge and ecologically clean nature. regulator is essentially a chargeable battery. it's accustomed absorb electrical energy from a supply, store it as K.E. of rotation and so deliver it to a load at the acceptable time, within the type that meets the load desires. As shown in Fig1, a typical system consists of a regulator, a motor/generator and controlled physical science for association to a bigger wattage system. Basic elements of regulator wheel energy storage system The input power might dissent from the output power in its temporal profile, frequency, or alternative attributes. it's born-again by the input physical science into a type applicable for with efficiency driving a variable-speed motor. The motor spins the regulator, that stores energy automatically, swiftness down because it delivers energy to a load. That decrease in energy is born-again into electrical type by the generator. A challenge facing the motor additionally the} generator designer is to size the system for the number of storage (energy) and delivery rate (power) needed and also to reduce losses. The output

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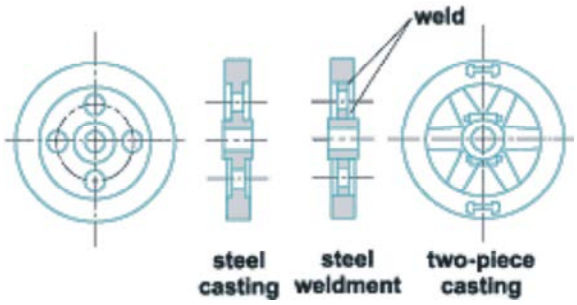
physical science convert the variable-frequency output from the generator into the electrical power needed by the load. Since the input and output area unit generally separated in an exceedingly timely manner, several approaches mix the motor and generator into one machine and place the input and output physical science into one module, to scale back weight and price.

Fly wheel: A regulator is just a significant wheel, sometimes composed of metal. it should be any form, from disk to saucer and is often regular. the foremost helpful property of a regulator is typically thought of to be its mass. There area unit a minimum of 2 mechanical functions for flywheels. the foremost common is analgesic speed fluctuations in Associate in Nursing engine through its inertia. this can be exactly the aim for the regulator you would possibly realize in Associate in Nursing everyday single cylinder internal-combustion engine, like a push power garden tool. Since the regulator is serious, fast spurts by the engine or sudden masses (such as hit a clump of weeds) area unit evened out. A second use for flywheels is way additional fascinating to researchers in fashionable energy storage technology. once we spin a regulator, we have a tendency to invest a precise quantity of energy that will increase the momentum of the regulator. a number of this energy is lost over time to friction; but, if we have a tendency to hold the regulator in an exceedingly comparatively friction free setting (say by suspending it in an exceedingly flux in an exceedingly vacuum), then it's able to store the energy we have a tendency to accustomed spin it within the kind of K.E.. Later, we have a tendency to is also able to retrieve this energy either through direct mechanical or electrical translation. for instance, we have a tendency to might fix magnets to the regulator Associate in Nursingd be able to use it because the core for an electrical generator. Of course, as we have a tendency to exclude energy (in the shape of electricity), the regulator slows down; thus we've not gained something, however we've managed to store the facility within the regulator.

Flywheel Structure: A heavy-rimmed rotating wheel accustomed minimize variations in angular speed and revolutions per minute, as in an exceedingly machine subject to fluctuation in drive and cargo. an identical device, particularly one accustomed regulate the speed of mechanism. serious wheel hooked up to a shaft to rid delivery of power from a motor to a machine. The inertia of the regulator opposes and moderates fluctuations within the speed of the engine and stores the surplus energy for intermittent use. In automobile engines, the regulator smoothes out the pulses of energy provided by the combustion within the cylinders and provides energy for the compression stroke of the pistons. In power presses the particular punching, shearing and forming area unit exhausted solely a fraction of the operative cycle. throughout the longer, nonnative amount, the speed of the regulator is constructed up slowly by a relatively powerless motor. once the press is working, most of the desired energy is provided by the regulator. A rotating mass accustomed maintain the speed of a machine between given limit whereas the machine releases or receives energy at a varied rate. A regulator is Associate in Nursing energy device. It stores energy as its speed will increase and offers up energy because the speed decreases. The specifications of the machine sometimes confirm the allowable vary of speed and therefore the needed energy interchange. the problem of casting stress-free spoked flywheels leads the trendy designer to use solid net castings or welded steel assemblies. For large, slow-turning flywheels on serious duty diesel engines or giant mechanical presses, cast-spoked flywheels of two-piece style area unit customary,



Typical flywheel structures

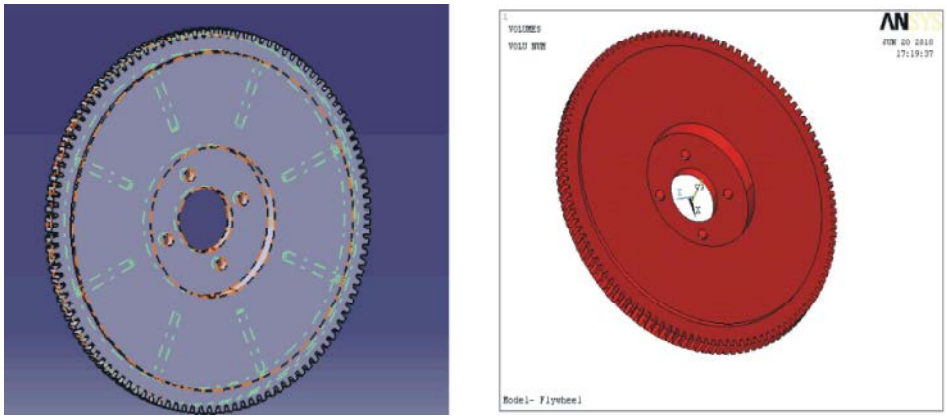
Flywheel, serious metal wheel hooked up to a drive shaft, having most of its weight focused at the circumference. Such a wheel resists changes in speed associate degreed helps steady the rotation of the shaft wherever an influence supply like a piston engine exerts an uneven force on the shaft or wherever the load is intermittent, as in piston pumps or punches. By slowly increasing the speed of a regulator alittle motor will store up energy that, if free in an exceedingly short time, permits the motor to perform a perform that it's normally too tiny. The regulator was developed by inventor in his work on the external-combustion engine.

Composite Material Regulator: Composite flywheels for energy storage are planned and investigated for the past many decades. flourishing applications square measure, however, restricted attributable to the lack to predict the performance, particularly the long- term sturdiness. during this investigation, a comprehensive study was planned with the intent to implement composites in superior flywheels. The potential failure mechanism of flywheels created with fiber composites was evaluated. Analytical codes for predicting elastic and elastic (long-term) behavior were developed for regulator style. Material characterization and take a look at matrices were planned to style flywheels with most performance. Component-level take a look at strategies and devices were developed to validate regulator performance. Finally, a technique incorporating these studies is given for the planning and manufacture of composite flywheels. The quicker we will spin a regulator and therefore the additional large we will build it, the regulator, the additional K.E. we will store in it. However, at extreme speeds, even metal flywheels will virtually tear themselves excluding the shear forces that square measure generated. Further, the energy storage characteristics of the regulator square measure influenced additional powerfully by its maximal motility speed than by its mass. thus a stronger, lighter regulator could also be able to store the maximum amount or additional energy than its gold-bearing counterpart

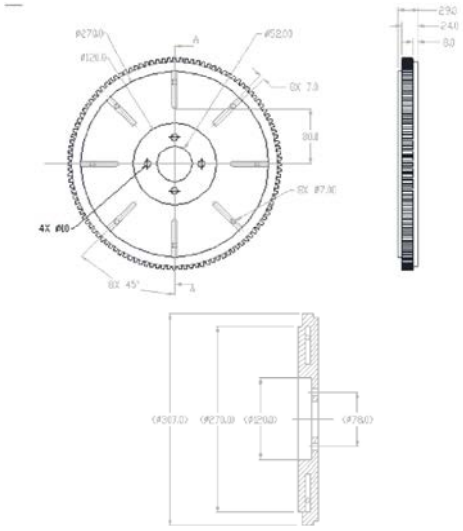
Analysis: Composite flywheels square measure being developed to {supply|to produce} associate degree uninterruptible power supply for advanced region and industrial applications. Flywheels will facilitate forestall irregularities in voltage caused by power spikes, sags, surges, burnout and blackouts. different applications embrace load-leveling systems for wind and solar energy facilities, wherever energy output fluctuates with weather. Advanced composite materials square measure being thought-about for these elements as a result of they're considerably lighter than typical gold-bearing alloys and have high specific strength and stiffness. However, way more analysis is required before these materials is absolutely utilised, as a result of there's deficient knowledge regarding their fatigue characteristics and nonlinear behavior, particularly at elevated temperatures. Moreover, these advanced varieties of structural composites cause larger challenges for nondestructive analysis (NDE) techniques than square measure encountered with typical monolithic engineering metals this is often significantly true for ceramic chemical compound and metal matrix composites, wherever structural properties square measure tailored throughout the process stages. In absolutely densified elements, NDE techniques should notice and characterize numerous varieties of distinct defects like cracks, voids and different barefaced discontinuities. it's additionally vital to notice and characterize small structural and diffuse flaw conditions that govern overall strength, fracture toughness, impact resistance and resistance to thermal-mechanical-chemical degradation. These diffuse flaw states will cut back dependableness and diminish service life even as very much like distinct flaws. additionally, the process of innovative high-temperature materials needs the synchronal development of innovative NDE technologies. The nondestructive characterization of materials and correct feedback facilitate optimize the process procedures. Applying yank Society for Testing and Materials (ASTM) standards in nondestructive quality scrutiny assures the dependableness of hand-picked materials. prompt the new NDE standards and methodologies ought to mature at the same time with advancements in materials development.

Design of Composite Flywheel: The figures given during this article represent typical NDE–FEA results. the primary preceding figure shows for a chemical compound matrix composite rotor in 3D. It illustrates the defects attributable to centrifugal loading extracted within the rotor (spun at thirty four,000 rpm); additionally, a cross-sectional read of the crack that's parallel to the axis of rotation of the regulator is shown.. The second figure is that the FEA model of the rotor-ring gear assembly. This paper are going to be presents results of stress analysis of analysis of static mechanical and fatigue properties of long fiber bolstered stuff with a multi axial orientation of glass fibers to be used for a manufacture of the regulator hub disc.

Component of the storage unit accumulating mechanical energy of a vehicle throughout braking for any use throughout acceleration. tho' humidness isn't speculated to be a problem operational of the unit, AN evaluating the fabric static strength and sturdiness beneath combination of static load with speed of the element are going to be disbursed to complete the general material characterization.

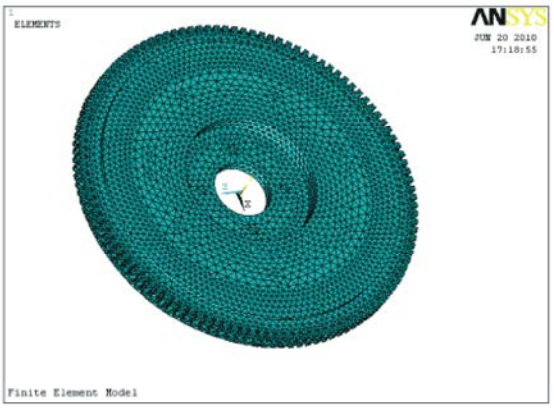


Model of composite flywheel



2D-Drawing of composite flywheel

Analysis of Composite Regulator: Initially we've to form the best with use of revolve or create comment and provides as a reputation ring. Than build the hub use of revolve and build the holes for mounting purpose. Mounting is completed by use of fasteners. Then build the slots organized in radially, balls square measure provided in these slots. These balls square measure compensating the standard regulator functions. These 2 arrangements square measure assembled and build together. This assembly is born-again to IGES file format and move in to ansys for analysis.

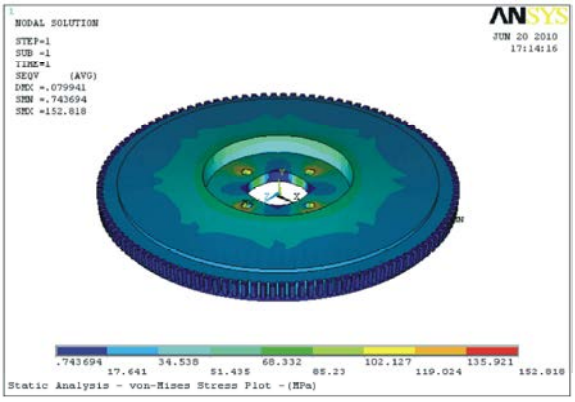


Meshing of composite flywheel

RESULTS

Radial stress distribution is presented. Crack propagation is also documented in these. Stress levels due to the applied loading are noted. Tensile stresses at the crack tip reached nearly 6 ksi while the region where the rim contacts the hub remained compressive as anticipated. It can be concluded from the data that the

finite element fracture mechanics closely findings. Furthermore, this work has established the preliminary grounds for an NDE–FEA–Fracture Mechanics interface methodology that can be used for the structural analysis of composite flywheel.



Von-Mises Stress Plot

DISCUSSION

Stress distribution and deformation is presented. Values also documented in below table. Stress levels due to the applied loading are noted. Von misses stresses in this carbon fiber flywheel is reached nearly 152.818 MPa while the boundary region and the carbon fiber flywheel deformation nearly 0.079941 mm. And natural frequency of this carbon fiber flywheel is 0.18059 Htz. It can be concluded from the data that the finite element result closely findings.

Material Name	Material Ultimate Strength	Natural Frequency
carbon fiber	565 Mpa	0.142658 Htz

Component Name	von Misses Stress	Deformation	Natural Frequency
Carbon Fiber Flywheel	152.818 Mpa	0.079941 mm	0.18058 Htz

carbon fiber flywheel component results

CONCLUSIONS

The above found results represents the Von misses Stresses, Deformation and Natural frequency. From the table, it is seen that the Von misses stresses is 152.818 MPa, Deformation is 0.079941 mm and Natural frequency is 0.18059 Htz.. So, this observed analyses values has better tensile strength when compared to existing Flywheel. Using Ansys Modal Analsys the fundamental material natural frequency of carbon fiber and component of carbon fiber flywheel value is determined and values are tabulated. So, this observed analyzed natural frequency values were found to good compare to material natural frequency. From the results of composites it is obvious that the modified composite carbon fiber flywheel can be used for engineering and automobile applications to provide better performance.

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