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Analytical Research of A Flywheel in A Printing Machine with A Modified Design

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Abstract: The function of the flywheel is to store excess energy during period of attestation and it supplies energy during period of starvation. The flywheel is massy wheel used in engines and machineries where reciprocal motion is converted into motion of a circular kind. It may provide a mechanical storage of kinetic energy. A flywheel induced high stresses when during high rotational speed. The stress state relies on the flywheel having various parameters like material properties, geometry and rotational speed. On the other hand, the stored kinetic energy relies on the rotational speed and mass moment of inertia. In our project we have studied various structure (cut section, solid, rim, 2rim) of flywheel and by using Finite Element Analysis are utilize to calculate the stored kinetic energy, deformation and stress for the respective flywheel, we can compare the Design and analysis result with existing flywheel and various structure.

Keywords- Flywheel, geometry, FEA, Kinetic Energy.

I. INTRODUCTION

The Finite Element Analysis (FEA) is a numerical method for solving problems of engineering fields. Useful for problems with complicated profiles, loadings, and material properties where analytical solutions cannot be obtained.Finite Element Modeling (FEM) and Analysis (FEA) are the two most distinguished mechanical engineering requests offered by concerning CAD/CAM systems. This is attributed to the truth that the finite element method is perhaps most popular numerical technique for solving problems. The method is common enough to solve what so ever like complex shape or geometry, material property, boundary, and loading conditions.

Our project deals with the flywheel. A flywheel is generally attached to shaft in order to have uniform torque throughout the shaft. They store energy at some time and give up when desired. Flywheel acts as a reservoir by storing energy during the period when the supply of energy is more than the requirement and releasing it during the period when the requirement of the energy is more than the supply.

Flywheel provides an effective way to smooth out the fluctuation of speed. The stored kinetic energy deepens upon the mass moment of inertia and rotational speed. A flywheel is a mechanical device with a significant moment of inertia used as a storage device for rotational energy of input. Flywheels counter changes in their rotational speed, which helps absorbs the rotation of the shaft. A little consideration will show that when the fly wheel absorbs energy, its speed increases and when it releases, the speed reduces. Hence flywheel does not maintain the constant speeds, it simply reduces the fluctuation of speed only. The performance of a flywheel can be attributed to three factors, i.e., material strength, geometry (cross-section) and rotational speed.has been done in the same domain or related domains with the name of the researcher and should be mentioned in the references.

1.1 MATERIAL STRENGTH

Robust materials could undertake huge working stresses, hence could be run at high rotational speeds allowing storing more energy. Hence could be run at high rotational speeds allowing storing more energy.

1.2 ROTATIONAL SPEED

Rotational speed of object rotating around an axis is the number of turns of the object per unit time, specified as revolution per minute (rpm) or revolution per second (rps). It directly controls the energy stored, higher speeds specified for more energy storage, but high speeds assert more loads on both flywheel and bearings during the shaft design.

II. GEOMETRY

It controls the desired Energy, kinetic energy storage capability of the flywheel. Any optimization effort of flywheel cross-section may contribute actual improvements in kinetic energy storage capability thus decreasing both overall shaft/bearing loads and material failure case. Flywheel performance includes the amount of specific kinetic energy and mechanical losses. To increase the quality of the product and in order to have safe and trusty design, it is need to investigate the stresses induced when the component during working condition. The flywheel rotates, centrifugal forces acts on the flywheel, because tensile and bending stresses are induced in a rim of flywheel. To confront the need of smoothing out the large oscillations in velocity during a cycle of a mechanism system, a flywheel is designed, optimized and analyzed.

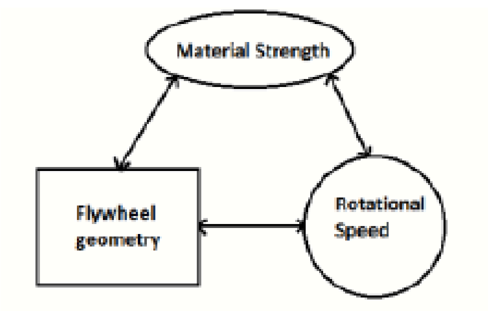


Fig 2.1 Factors affecting flywheel performance

2.1 GEOMETRICAL DIMENSIONS OF FLYWHEEL

Dimensions of flywheel are provided below. This flywheel is designed and analyzed.

Mass (m) =60kg.

Outer diameter (do) =600mm.

Inner diameter (di) =60mm.

Rpm (n) =750

Depth=90mm

2.2 MATERIAL FOR FLYWHEEL

Gray cast iron

Density=7510 kg/m3.

Poisons ratio (υ) =0.23.

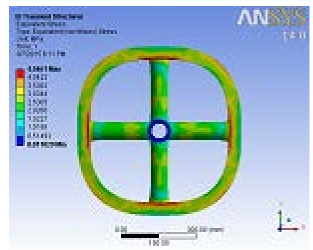
Modulus of elasticity = 101 Gpa

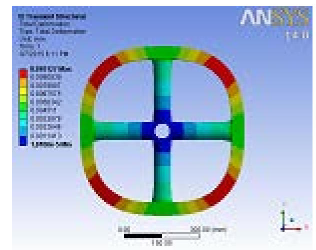
Modulus of rigidity = 41 Gpa

Torsion/shear strength=276 mpa

2.3 FLYWHEEL GEOMETRY

Exciting flywheel having structure, deformation and von-misses stress are given below;





2.4 MODIFIED DESIGN

Various flywheel geometries taken understudy are rim disk, webbed/ section cut; arm/spoke type .keeping mass constant as 60 kg and outside diameter 600mm, stored kinetic energy is calculated for these profiles. Other profiles of flywheel given below are designed and analyzed

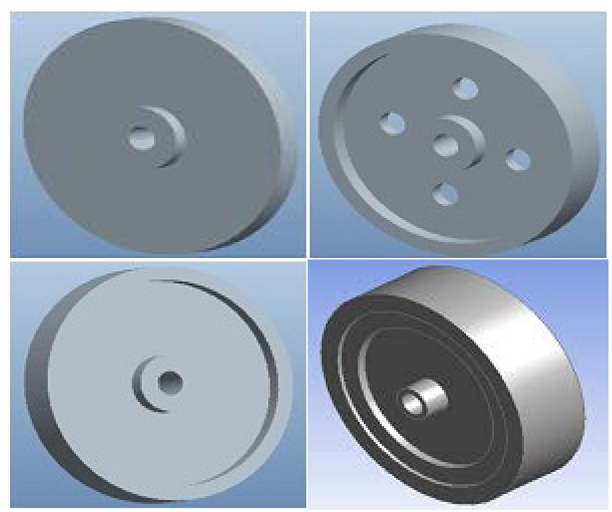


Fig 2.1 Modified design of flywheel

III. FINITE ELEMENT ANALYSIS OF FLYWHEEL

To build the physical system into a finite element model easily, some assumptions are needed:

3.1 ASSUMPTIONS

- Rigid installation is used to connect the flywheel and its drive-shaft, no key-ways are needed to drive the flywheel and there exist no slide, built-in stress and deformations on the connection surface; therefore, displacement constraints can be simply applied on the shaft hole
- The flywheel only works in the vertical plane (X-Y plane)
- Material used is isotropic
- Aerodynamically resistance can be neglected
- There exists no vibration
- Fillets/chamfers can be neglected.

3.2 ELEMENT TYPE

The element Soilid72, a 3D 4-node tetrahedral structural solid with rotations, is used to model meshes. The element is defined by 4 Nodes with 6 DOFs at each node and well suitable to create irregular meshes.

3.3 MESHING METHOD

Free mesh with smart element sizing is adopted to automatically and flexibly mesh the model. Compared to mapped mesh, which is restricted to only quadrilateral (area) or only hexahedron (volume) elements; free mesh has no restrictions in terms of element shapes.

3.4 BOUNDARY CONDITIONS AND LOADS MOMENT

MZ, applied on the nodes on the shaft-hole surface ANSYS 11 will be utilized for finite element analysis The ANSYS Workbench, together with the Workbench project and tabs, provides a unified working environment for developing and managing a variety of CAE information and makes it easier for you to set up and work with data at a high level.

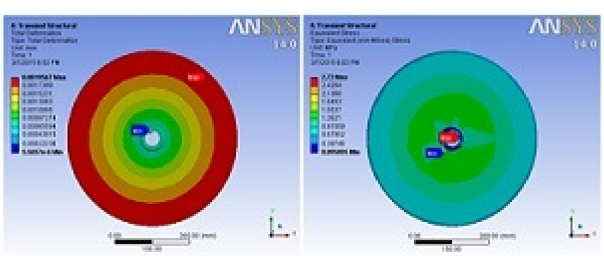


Fig 3.1solid type flywheel

The FE software i.e. ANSYS software is used to analyze by these various four profiles of flywheel having deformation and von- misses stress are given below;

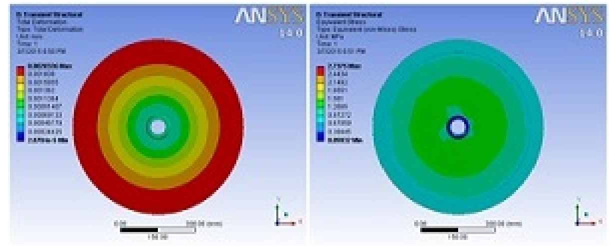


Fig 3.2 single Rim Type Flywheel

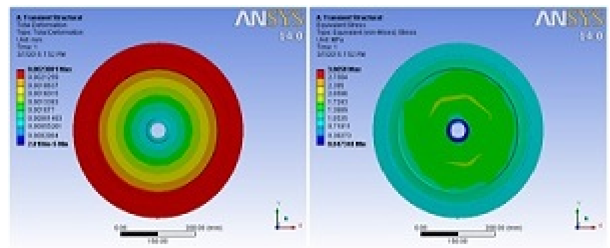


Fig3.3 Double Rim Type Flywheel

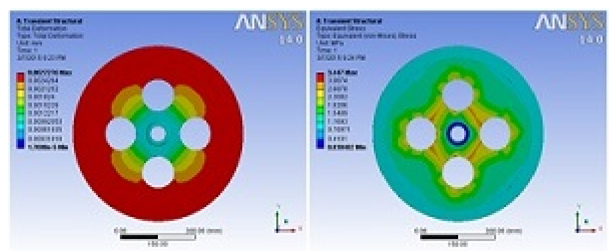


Fig3.4 Cut-Section Flywheel

IV. COMPARISON OF FUNCTIONAL VALUES OF FLY WHEEL

Functional values	Arm (4 arm)	Solid	Rim (single step)	Rim (double step)	Cut section
Load (angular velocity), rad/sec	78.3	78.3	78.3	78.3	78.3
Kinetic energy, KJ	1.95	1.9517	1.9668	2.427	3.6015
Equ. Van misses stress, mpa	4.5	2.72	2.7375	3.068	3.47
Total deformation, MM	0.010127	0.001567	0.0020326	0.0023881	0.0027276

V. CONCLUSIONS

Using FEM, this paper regarded near optimal structure of flywheels for kinetic energy storing and maximizes the moment of inertia. Brisk design of flywheel geometry has special effect on its specific energy performance. Amount of kinetic energy stored by wheel –shaped structure flywheel is greater than compared with any other flywheel. To obtain definite amount of energy stored; material induced in the spoke/arm flywheel is less than that of other flywheel, thus reduce the cost of the flywheel.

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