Outline And Dynamic Analysis of Flywheel

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Abstract - A flywheel is an inertial energy-storage gadget. In this paper completely all extents have discovered hypothetically to obliged control 20 kw Also it is pivoting starting with 400 rpm will 410 rpm. Fly wheel would displayed clinched alongside PRO/E 5. 0 programming and this may be investigated with recognizing toward separate time interim Also diverse stacking states bring discovered from hypothetically. Countering the prerequisite of smoothing out those substantial oscillations Previously, speed Throughout the cycle of a component system, a flywheel may be intended and investigated. In that four the long run intervals are acknowledged such as movement less, beginning position, evolving velocity Furthermore steady velocity. Weight decrease is major significant Also administer base stresses, here in turn three sort from claiming flywheels have decided .

Keywords: design of fly wheel, concentration at different stages, finite element technique.

INTRODUCTION

An flywheel will be An pivoting mechanical gadget that is used to store rotational vitality. Regular employments of a flywheel incorporate. It absorbs mechanical vitality Also serves as a reservoir, storing vitality Throughout those time when the supply of vitality will be more than the prerequisite What's more discharges it Throughout the period At the prerequisite of vitality may be more than those supply.

Fly wheels are for the most part utilizing for 1. Giving constant vitality when those vitality wellspring will be spasmodic. 2. Delivering vitality In rates past the capability of a nonstop vitality wellspring. This will be attained Toward gathering vitality in the flywheel About whether et cetera discharging the vitality quickly, toward rates that surpass the abilities of the vitality hotspot. Types of flywheels: Depending upon the requirements of *I*, mass moment of inertia, a flywheel can be classified as follows: 1.Solid circular disc, for small values of *I 2.*Rim and hub with solid, circular web, for moderate values of *I 3.*Rim, hub, and spokes, for large values of *I 4.*Rim, hub, and spokes with split type construction

Literature Review : Design optimization of flywheel of thresher using fem byS.M.Choudhary and D.Y.Shahare in his study solely focuses on exploring the effects of flywheel geometry on its energy st orage/deliver capability per unit mass, further defined as specific energy. Sudipta Saha, Abhik Bose, G. SaiTejesh, S.P. Srikanth have propose the importance of the flywheel geometry design selection and its contribution in the energy storage performance.

Design of fly wheel

Diameter has chosen according to space requirement as 0.6 m

Required power = 20 Kw and it is rotating from 400 RPM to 410 RPM.

STORAGE OF ENERGY = 0.6 KN-M

Speed fluctuation

$$CS = N2 - N1 / N$$
$$= 410 - 400 / 405$$

N= average speed in RPM

Coefficient of speed fluctuation =0.02469

Energy storage $\Delta E = MV^2\ CS$

$$600 = M(\Pi X\ 0.6\ X\ \frac{405}{60})^2\ X\ 0.02469$$

MASS M=150 KG

MASS (M) = Π X D X B X t X ρ

150 = Π X 0.6 X 0.118 X t X 7510

Required Thickness t = 0.089 m

Outer diameter of rim = D+t =0.6+0.089

Outer diameter of rim =0.6897 m

Inner diameter of rim = D-t = 0.6-0.089

Inner diameter of rim =0.511 m

Design of shaft hub and key

Power P= $2\ X\ \Pi\ X\ N\ X\ T/60$

20000= $2\ X\ \Pi\ X\ 405\ X\ T/60$

T=471.57 N-M

N= average speed in RPM

Suppose max torque is equal to twice of mean torque THEN

= 43.14 N-M

Shear Stresses of for Shaft and Key Material Is 40 N/mm^2

$T_{max} = \frac{\pi}{16} X S X D^3$

diameter of shaft. (D)=49.5 mm

diameter of shaft. (D)= 50 mm

Outside diameter of hub may be assumed as twice the diameter of shaft

Outside diameter of hub = 2 X D

Outside diameter of hub =100 mm

Suppose let we take Length of hub = width of rim

Length of hub for fly wheel L=0.07 m

Width of hub for fly wheel $W = \frac{D}{4} = \frac{50}{4}$

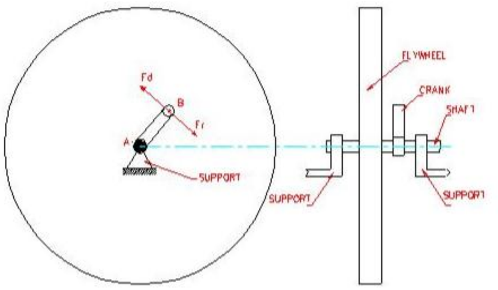
Width of hub for fly wheel =12.5 mm

Height of hub for fly wheel $H = \frac{D}{6} = \frac{50}{6}$

Height of hub for fly wheel =8.5 mm

Material properties

Material, class, specification	Gray cast iron, ASTM 30, SAE 111
Ultimate strength	Tension =214 M.Pa, shear =303 M.Pa
Modulus of elasticity	101 G.Pa
density	7510 kg/m^3
Poisson's ratio	0.23



Fly wheel arrangement to support and crank

Design of loading applied in analysis

1.Fly wheel is in motion less : When fly wheel is in motion less position we have to considered as only gravitational force like 9.81 m/s^2 2.Fly wheel is in starting position: At fly wheel is starting position we are considered the gravitational force and moment of fly wheel and angular

$D = \left(\frac{16 X 943.14 X 10^3}{\pi X 40}\right)^{1/3}$

velocity changes with respective to time like angular acceleration Force= 9.81 m/s^2

Angular velocity of fly wheel is $= \frac{VELOCITY \quad OF \ LINK}{LENGTH \quad OF \ LINK}$

$$= \frac{25}{0.1} = 25 \ rad \ /sec$$

Here length of link means engine crank length is 0.1 m And velocity of crank link is 25 m/s which is found from velocity diagram. Equivalent inertia of moment of mechanism about point of axis

j = mass x length of link

= 150 X 0.1^2

=1.5 kg. m^2 ,(Length of crank is 0.1 m)

Actual inertia moment of flywheel = 11.7278

Total moment of inertia = Equivalent inertia of moment + Actual inertia moment

Drive force is equal to 5000 N.

Angular acceleration = drive moment / total moment of inertia

= 5000 X0.10 / (11.7228 +1.5)

=37.799 rad /sec^2

Moment applied for fly wheel = actual moment of inertia X angular acceleration

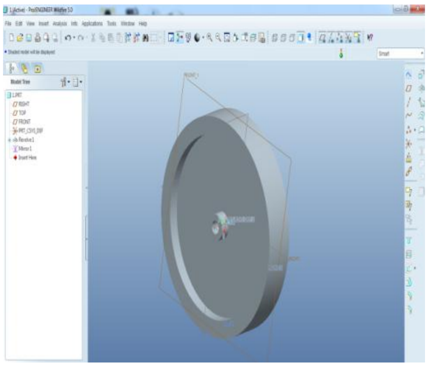
=11.7278 X 37.799

=221.651 N-M

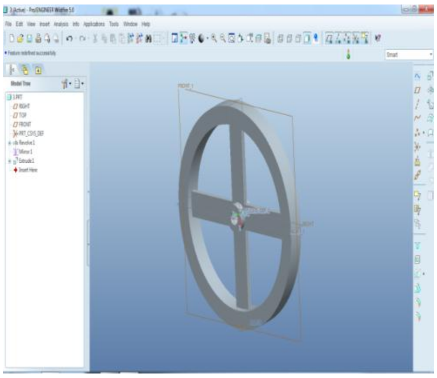
Stages considered in flywheel: 1. fly wheel is in motion less 2.fly wheel is in starting 3.flywheel is at changing speed 4. Flywheel is at constant speed

INTRODUCTION TO PRO/ENGINEER

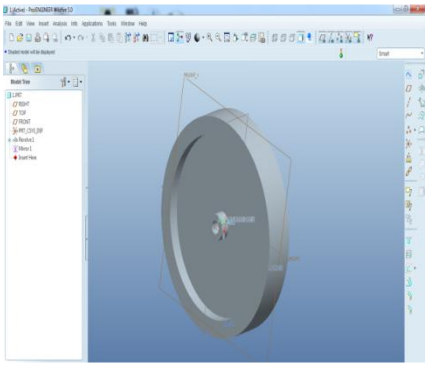
Pro/ENGINEER Wildfire is the standard in 3D product design, featuring industry-leading productivity tools that promote best practices in design while ensuring compliance with your industry and company standards. Integrated Pro/ENGINEER CAD/CAM/CAE solutions allow you to design faster than ever, while maximizing innovation and quality to ultimately create exceptional products.



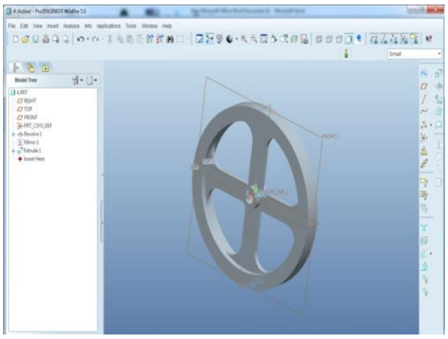
1 st model created in pro/e



3 rd model created in pro/e



2 nd model created in pro/e

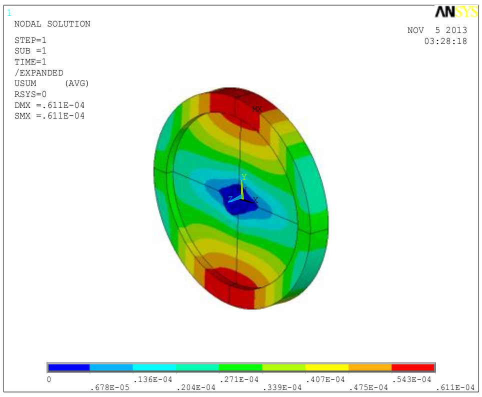


Fourth model created in pro/e

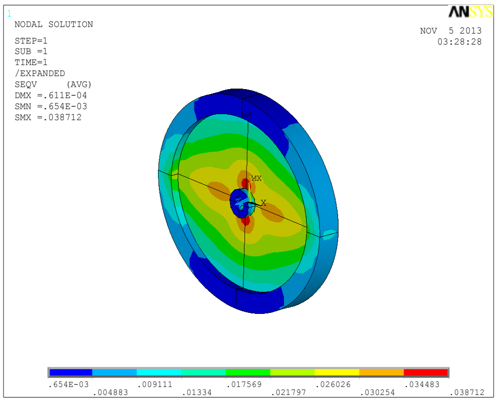
STRUCTURAL ANALYSIS OF FLY WHEEL

Totally dynamic structural analysis is performed in ANSYS 12.0 software. In that brick 8 node has chosen for solid flywheel. ¼ models are considered in this analysis. Symmetric boundary conditions are applied and at hub support translation of x, y and directions are totally constrained. And rotation z is released as free to rotate.

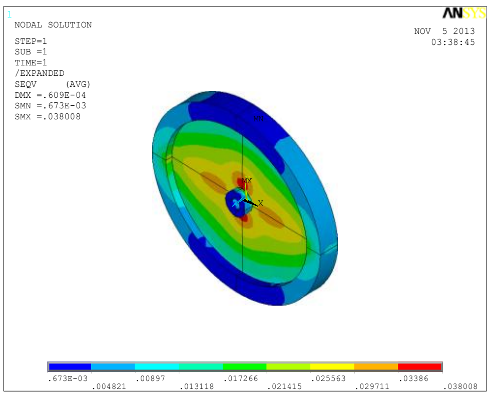
In that four time intervals are considered as first fly wheel is in motion less at which self weight is acting, at second interval fly wheel is start position in which moment, self weight and angular acceleration are applied, at third interval fly wheel is at changing speed at which moment, angular acceleration, angular velocity and self weight is applied and at fourth stage fly wheel is in constant speed at which angular velocity and self is assigned.



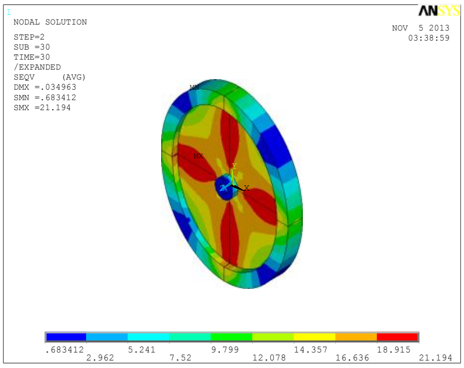
Deformation of 1 st model at 1 sec



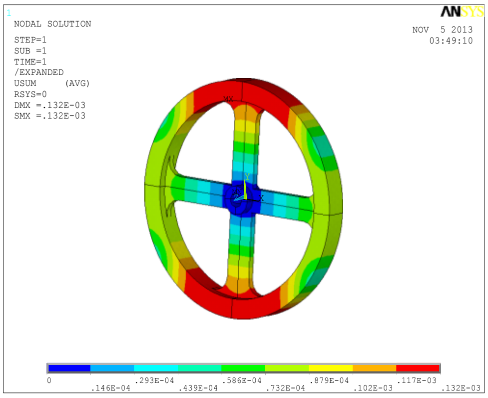
Stresses of 1st model at1sec



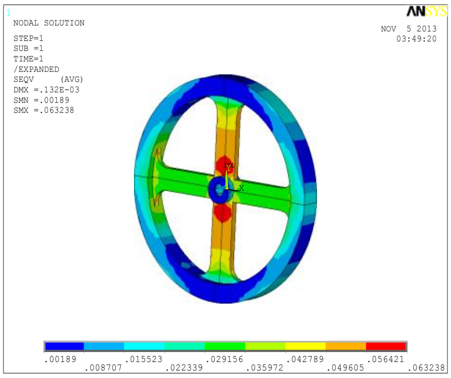
Stresses of 2 nd model at 1 st sec



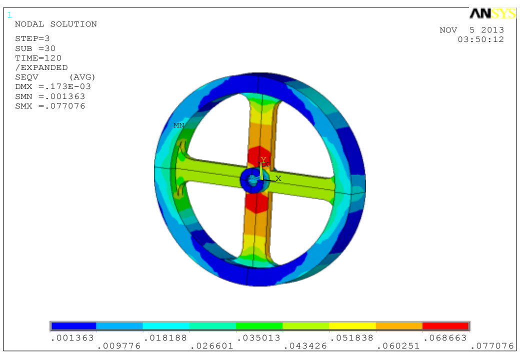
deformation of 2 nd model at 30 sec



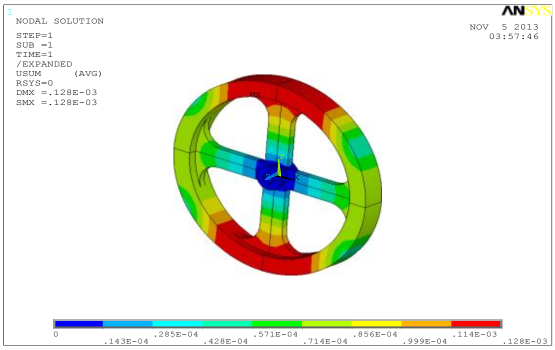
Deformation of 3 rd model at 1 sec



Stresses of 3 rd model at 1 sec



Stresses of 4 th model at 1 sec

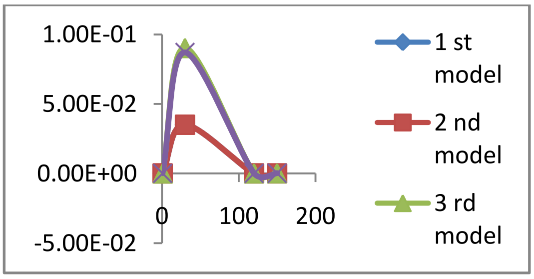


Deformation of 4 th model at 1 sec

3 rd model		
time	deformation	stresses
1	1.32E-04	0.6323
30	0.090301	39.652
120	1.73E-04	0.077076
150	2.33E-04	0.1074

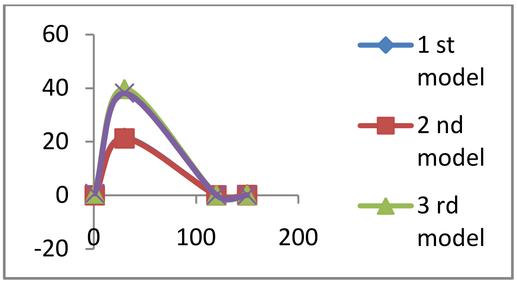
4 th model		
time	deformation	stresses
1	1.28E-04	0.65391
30	0.086919	38.064
120	1.58E-04	0.078093
150	2.21E-04	0.108759

1 st model		
time	deformation	stresses
1	6.11E-05	0.038712
30	0.35118	21.404
120	5.68E-05	0.036
150	4.61E-05	0.0294



Deformation plot for all models

2 nd model		
time	deformation	stresses
1	6.09E-05	0.038
30	0.03496	21.194
120	6.60E-05	0.040552
150	9.35E-05	0.079077



Stresses plot for all model with respective to time

MODE SHAPE	FREQUENCY IN HZ
1	6.27
2	12.57
3	43.21
4	59.48
5	62.94

MODE SHAPE	FREQUENCY IN HZ
1	20
2	36.5
3	57.62
4	90
5	101

1 ST MODEL FREQUENCIES

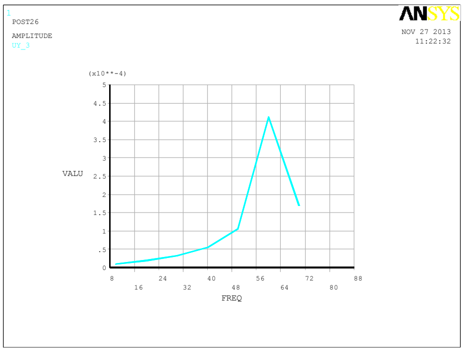
2 ND MODEL FREQUENCIES

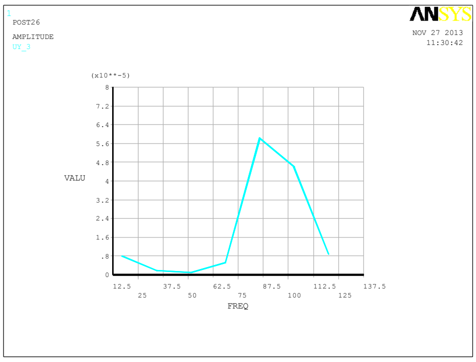
MODE SHAPE	FREQUENCY IN HZ
1	4.21
2	11.30
3	37.86
4	46.53
5	57.732

MODE SHAPE	FREQUENCY IN HZ
1	4.46
2	11.38
3	38.21
4	46.32
5	57.93

3 RD MODEL FREQUENCIES

4 TH MODEL FREQUENCIES





Harmonic analysis results for 1 st model

Harmonic analysis results for 2 nd model

CONCLUSION

Based on above design and analysis, the following conclusion can be drawn

1. The maximum stress and deflection usually occur at the starting and speed-changing stages, respectively. The situation of stress and deflection at these stages should be paid enough attention.

2. The larger shaft-hole and longer hub are useful to decrease the stress caused by the drive moment.

3. The stress and deflection are alternating transiently as the flywheel is running. These transient changes may lead to the fatigue failure of the flywheel.

4. The stress in the rim is not as large as estimated.

5. The wheel-shaped structure contributes to decrease stress concentration.

6. The wheel-shaped structure is advantageous to get good performance and reduce the cost.

7. The transition through large fillets is favorable to reduce stress concentration at the arms.

8. The over-long arms may result in the large deformation in the rim.

9. There exist certain relationships between angular velocity, stress and deflection at constant speed stage.

10. The good geometry will contribute to decrease the stress concentration in the product and thus improve its

lifetime. Free mesh with smart element sizing is useful to mesh complicated mode.

11. Model analysis are performed to find out natural frequencies and where the resonance will occur.

12. Harmonic analysis also performed to find out where the maximum deformation will occur at which frequency.

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