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FEM Analysis of Flywheel Used In Press - A Review

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ABSTRACT

In this paper author has analyze the flywheel used in Press by using FEM analysis. A different type of forces acting on flywheel & design parameters has taken into consideration for optimizing design of flywheel. Flywheel is basically a energy storing device .In present investigation more focus is given to energy storing capacity of flywheel during a cycle of mechanical system, flywheel is designed & analyzed .During this we study different parameters like material stress acting on flywheel, efficiency, cost of flywheel, output, energy storing capacity & compare these parameters with existing flywheel.

Keywords:- flywheel, Analysis, Finite element analysis (FEA).

I. INTRODUCTION

A flywheel is used in machines serves as a reservoir, which stores energy during the period when the supply of energy is more than the requirement, and releases it during the period when the requirement of energy is more than supply. The flywheel is generally attached at one end of the shaft in order to have uniform torque. They store energy when it is in excess, and releases it when desired. Hence a Flywheel can be considered as a reservoir of energy, which gives energy at desired time. The Flywheel is required when there is no uniform torque transmission.It may be generalized that Flywheel is needed in two types of machines, one in which the operation is intermittent. In this type of machine, the Flywheel absorbs energy from a power source during the ideal period and delivers a large amount of stored energy in very short useful portion of cycle. The machines of this type include press, riveting machines, etc. So it is obvious that in these machines, a large amount of energy is required during working period for performing the operation. Without Flywheel, one should be compiled to install a motor at very high power, but during the rest of the cycle, when no energy is required, the motor will be running at no load. So by using a Flywheel a smaller power unit can be used and large power can be obtained for a shorter period. In the second type of machines, necessity of Flywheel is realized where torque generated is in the form of peaks and troughs (non uniform torque), as in the case of I.C engines, steam engines, etc. Here Flywheel smoothens out the speed fluctuations caused *by* the non uniform flow of power from piston during working stroke.
In this paper author has analyze & trying to optimize the flywheel which is used in press by considering all design parameters & by doing extensive literature review it has been observed that following different parameters is required to consider for optimizing the flywheel. By modeling & FEM analysis flywheel has been analyzed successfully.

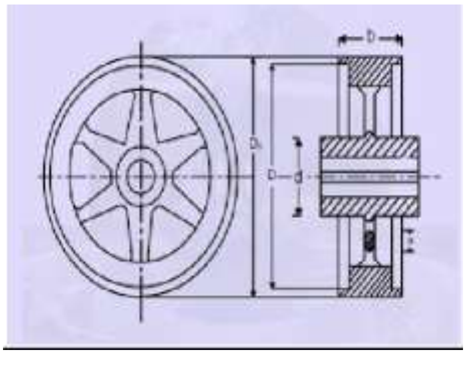
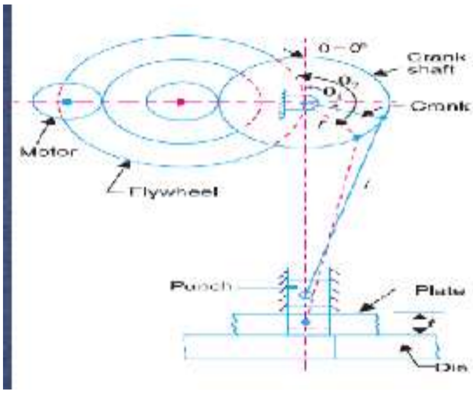


Fig:-Cross section of flywheel

II. PRESS OPERATION

In mechanical presses,the linear movement of the ram is obtained with the help of a flywheel driven system.The heavy flywheel absorbs energy continuously from an electric motor & deliver it to the ram & hence to workpiece intermitently .The flywheel of mechanical press drives the main shaft.The rotary motion of the main shaft is converted into the linear motion of the ram.The most common drive is crank shaft which is used for longer stroke.



Press performed the operation like blanking,piercing,stamping etc.Press are classified on the basis of,

- Sourse of power
- Method of actuation of ram
- Number of slides
- Type of frame
- The type of work for which press is designed.

Different press operation are as follows,

- **Blanking :-** Blanking is operation of cutting a flat shape from sheet metal . The article punch out is called the "blank " & is the required product of the operation .The hole & the metal left behind is discard as waste .
- **, :-** It is cutting operation by which various shaped holes are made in sheet metal. Punching is similar to blanking except that in punching ,the hole is desired product, the material punched out to from the hole being waste.
- **Bending :-** In this operation ,the material in the strained around a linear axis which lies in the neutral plane & perpendicular to lengthwise direction of the sheet or metal.or form of flat sheet or strip , is uniformly strained.

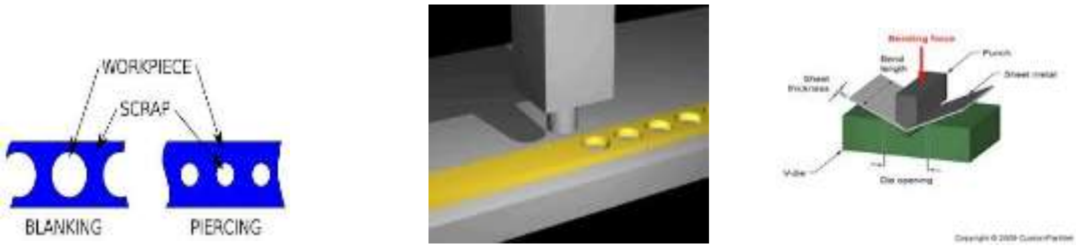
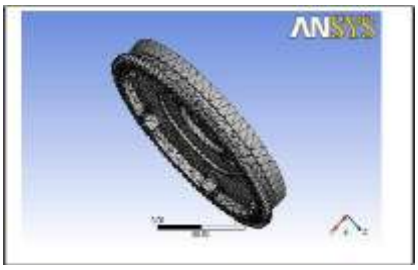


Fig:- Blanking, Punching, Bending

III . LITERATURE REVIEW

Literature review is an assignment which gives idea about previous work done by different authors & from the research paper published by them in different journals gives the data about there research work which are helpful in our project. It gives the guideline or path for progressing our task.Earlier many authors work on same. So we are collecting some usefull information for our project.For designing the flywheel following parameters has taken into consideration by reviewing literature review.

The study entitled, "**Analysis and optimization of flywheel"** in 2012,Sushama G.bawane, A.P.Ninawe,& S.K.Choudhary [1] had proposed flywheel design .They study different types of flywheel & use different types of material for the analysis purpose.



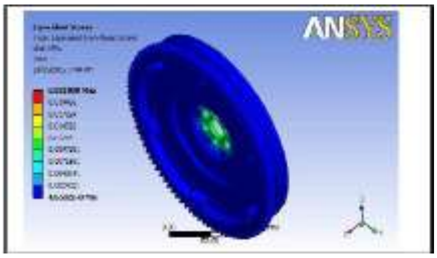
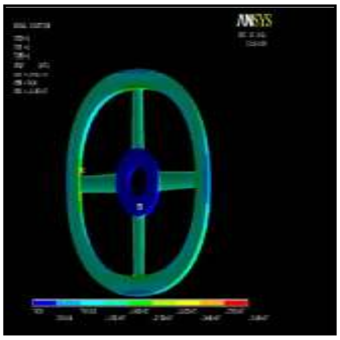


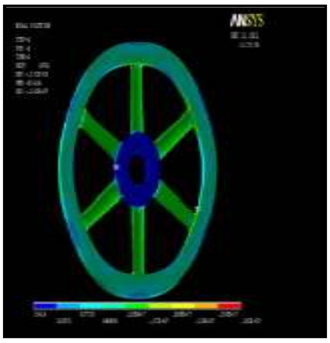
Table 1-Comparison of two material

By using FEA analysis, different stresses as well as deformation for Gray Cast iron & Aluminum Alloy are calculated & from above table sugested that Gray Cast iron is the best mateial for the flywheel.

S. M. Dhengle , Dr. D.V.Bhope, & S.D.Khamankar [2], **"Investigation of stresses in arm type rotating flywheel"** shows the comparison between analytical stresses and FE stresses in Rim by varying no. of arms & comparison between FE stresses on arm and analytical calculated bending stresses in arms. They also seen that as a number of arms increases from 4 to 8, the stresses in the arms goes on reducing. This may be due to sharing of load by larger no. of arms show the comparison of FE stresses and analytical bending stresses near the hub end of arm for 4, 6 and 8 arms flywheel under the influence of tangential forces on rim.

Quantity	Gray Cast iron	Aluminum Alloy
Equivalent(von-mises) stress, MPa	0.02189	0.02164
Normal stress, MPa	0.003073	0.003591
Shear stress, MPa	0.001474	0.001556
Total deformation, mm	1.419 *10-5 mm	2.24 *10–5 mm





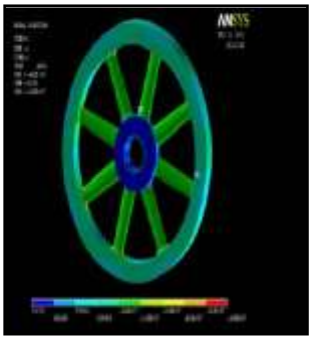


Fig -Von mises stresses in 4, 6 and 8 arm Flywheel

It is observed that with increase in angular velocity the stresses are increasing. From the result author concluded that, due to larger centrifugal forces acting on the flywheel rim. When the gravity effect along with angular velocity are considered, it is observed from table 4 that the stresses at the junction of rim and arms are more than that of neglecting gravity effect. Thus the gravity effect contributes to rise in the stresses in flywheel rim.

Table 2-Von mises stresses and max. deflection for constant angular velocity of flywheel

No.of Arms	Load (w)	Von mises stresses in rim at 45,30,& 22.5(N/m2)	Maximum Deflection(m)
4	Omega _z25.12 rad/sec	$0.170*10^{7}$	$0.69*10^{-5}$
6	Omega _z25.12 rad/sec	$0.140*10^{7}$	$0.53*10^{-5}$
8	Omega _z25.12 rad/sec	$0.120*10^{7}$	$0.46*10^{-5}$

D.Y. Shahare and S. M. Choudhary [3] (2013) in , "**Design Optimization of Flywheel of Thresher using FEM.**" had given main focus on various profiles of flywheel such as solid disk, disk rim ,webbed/section cut, arm/spoke flywheel. flywheel geometry has significant effect on its specific energy performance. Amount of kinetic energy stored by wheel –shaped structure flywheel is greater than any other flywheel. From the analysis it is found that maximum stresses induced are in the rim and arm junction.

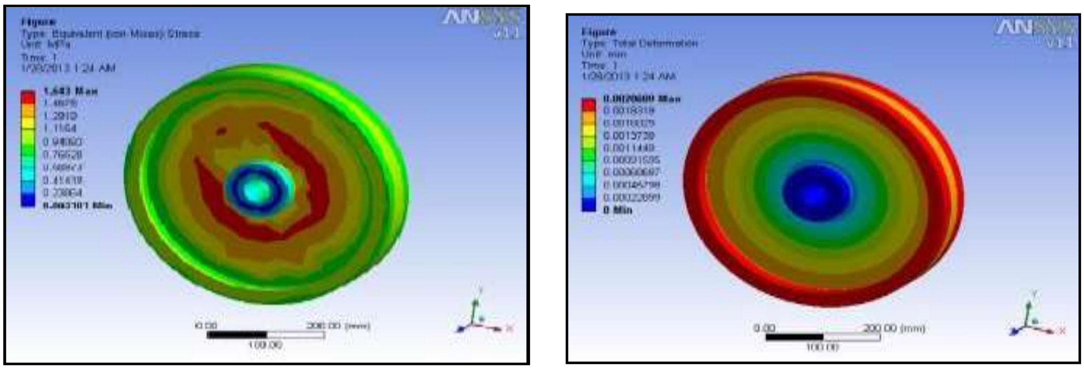


Fig - Analysis of rim type flywheel

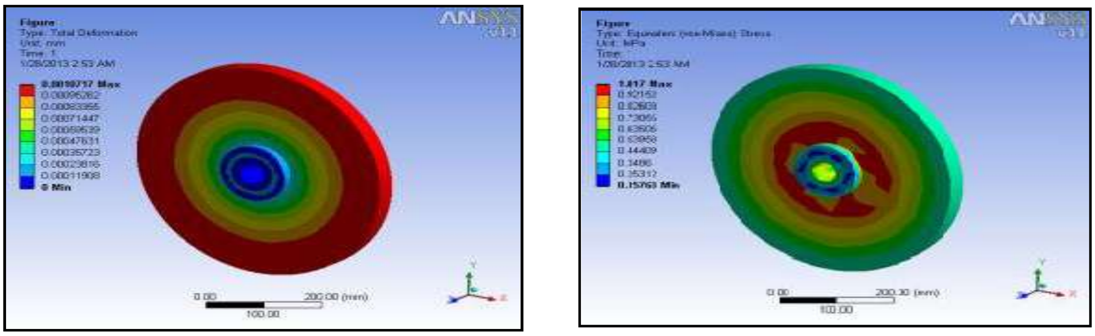


Figure 3.5- Analysis of solid flywheel

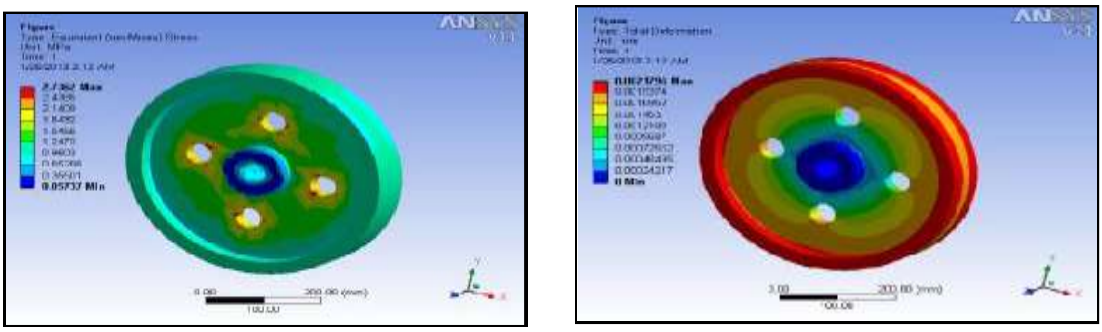


Fig- Analysis of section cut flywheel

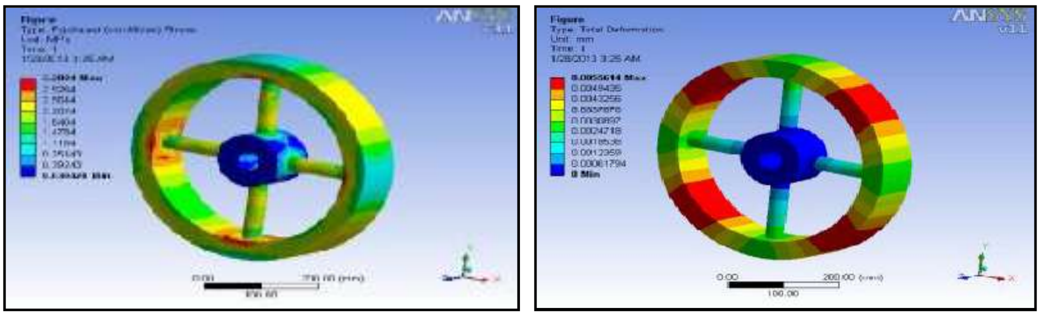


Fig- Analysis of spoke type flywheel

Table 3-deformation in Different type of flywheel

Type of Flywheel	Load	Equi.Von mises stresses (mpa)	Total Deformation
Solid	w=78.53rad/sec	1.017	0.00107
Rim	w=78.53rad/sec	1.643	0.00206
Web	w=78.53rad/sec	2.736	0.00217
Arm	w=78.53rad/sec	3.228	0.00556

In 2013,Akshay P. Punde , G.K.Gattani [4] in "**Investigation of stresses in arm type rotating flywheel"**, had proposed the flywheel design & study stress analysis of gray cast iron & S.Glass epoxy material by using FEA analysis.

Table 4-Comparison of two materials

Material	Normal stresses(Mpa)	Deformation (m)
Gray cast iron	44.07	1.0484*10-3
S.Glass epoxy	11.54	5.3399810-4

After comparing two material it is observed that, cast iron flywheel have heigher stresses & deformation .So, S.Glass epoxy is used in flywheels to store energy with less mass & is used for high speed apllication.During the study of "**Design and analysis of light weight Motor vehicle flywheel"** In 2013, **[5] ,** M.Lavakumar , R.Prasanna Shrinivas had also proposed stress analysis & observed that The maximum deflection of mild steel alloy is 0.444E-05 meters which is less than maximum deflection of mild steel which is found to be 0.369E-03 meters. Thus mild steel alloy is best, from rigidity point of view & sugested that design is much safe for mild steel alloy than for mild based on strength point of vi.

IV.CONCLUSION

The findings of paper reffered for the project work are as per follows,Findings of author 1 is based on material properties & sugest the best material for flywheel.Simillarly, findings of author 2 is based on geometry of flywheel & observed that as a number of arms increases from 4 to 8, the stresses in the arms goes on reducing. Author 3 concentrate on various profiles of flywheel & concluded that, amount of kinetic energy stored by wheel –shaped structure flywheel is greater than any other flywheel. By referring various paper published with reference to FEM analysis of flywheel. During our project, the way of various author modeled the flywheel will be same & the methodology adopted during FEM analysis will be similar only addition will be energy calculation.The methodology required for the project work is purely based on energy calculation, so major focus will be given for energy calculation of flywheel for various product processed in the press work & then product requiring higher energy will be referred for further design & analysis (optimizing) the flywheel.

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