

Design and Manufacturing of Automatic Punching Machine

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ABSTRACT: This Project work deals with the Design, analysis and manufacturing of Punching Machine. The aim is to reduce the weight, use of electricity and cost of the Automatic Punching Machine without reducing the quality of the output. Using the best possible resources in design can affect decrease in the weight and cost of the Punching machine. One way of doing, it is the optimizing the volume of material utilized for building the complete structure of machine. For CAD modeling CATIA and for analysis purpose ANSYS has been used. Design and manufacturing of machine has been done in industry, under the guidance of skilled engineers and workers. This project is based on industrial application which reduces human efforts by system. To make the punching machine effortless and automatic we have used the servomotor based sliding arm which act as clutch causes punch to work, so servomotor is basically rotary actuator which control angular position, velocity and acceleration of clutch which is driven with help of sensors, microcontroller and power unit.

KEYWORDS: Mechanical, FEA, CAD

1. INTRODUCTION

We know that there are three types of punching machines mechanical, hydraulic and pneumatic. Their control system may be mechanical or electromechanical. Through these three major types of punching machines share some common features. The mechanical punching machine is most commonly used and researched. In a punching machine two major types are stationary bed and moving ram. Mechanical punching machine works on the principle of reciprocating motion and the main components for the power transmission are the flywheel, crankshaft and clutch. A motor gives rotational motion to flywheel and clutch is used to couple the rotation of flywheel to the crankshaft.

Punching Machines are used for producing large quantities of jobs quickly, accurately and economically made from mild steel and other materials. Punching tools are used to carry out punching operation. Deformation of work piece to desired size is done by applying pressure. In this Project Work Automatic Punching Machine is mainly used for punching operation of sheet metal and glass ring tube. Jigs or Fixtures used in punching machine are different for different jobs. It consists of bed, frame or bolster plate. The ram exerts force upon sheet metal or working material through tool mounted on the ram. The energy supplied from electric motor in the form of rotations to the pulley is used to rotate cam shaft. The rotational motion of cam shaft is converted in reciprocating motion with the help of ram.

Reciprocating motion of ram is used for punching operation. When job is mounted on the bed then the punching operation is carried out with the help of automatic system used.

Frame used to withstand the punching machine is of C type. The stress analysis and load are calculated manually and also with help of ANSYS software. The material will be used for manufacturing of frame and most of the machine parts are made up of mild steel. Punching Machine is commonly used for punching, stamping operations. Punching Machine is used for producing huge quantities of articles economically, quickly and accurately. The components which are produced range over a very wide field and are used all over industry. By means of particularly designed punching tools and combination of operations, most of the jobs of any shape are punched.

II . LITERATURE REVIEW

G.Naik and et al [1] incorporated design process successfully into a structural shape optimization problem. The aim of their work was reduction of bending stresses causing bending of frame of a hydraulic cotton lint bailing press by optimizing the Top & Bottom frame. Reduction of cost and Improvement in safety was another aim of their work. Software ANSYS was used for this work. Due to new design a reduction in weight of frame was 13%.

G. N.Chauhan and et al [2] designed & analyzed frame of a 63 tonne power press machine using Finite Element method. Due to the impact loading at the end of the bolster plate there was development of a crack at the corner and stress generated was more due to continuous loading and stress concentration. Modifications were done by introducing the fillets of proper size. Also plate thickness was reduced which saved material.

Ankit H Parmar and et al [3] performed optimization of a hydraulic press structure to decrease total mass of structure while assuring adequate stiffness. A method of structure optimization for hydraulic press was proposed in order to reduce mass while assuring adequate stiffness. Key geometric parameters of plates which have relatively larger impacts on mass and stiffness were extracted as design variables. In order to research relationship between stiffness, mass and design variables, common batch file was built by CREO and analysis was done in ANSYS. Top plate, movable plate and column design and analysis were done. A reduction of weight was 42 % keeping the stresses & deflection within limit.

B. Parthiban and et al [4] designed a „C“ type hydraulic press structure and cylinder. They analyzed press frame and cylinder to improve its performance and quality of press working operation. The frame and cylinder were modeled by using software CATIA. Structural analysis was done using analysis software ANSYS. An integrated approach was developed to verify the structural performance and stress strain distributions were plotted by using ANSYS software. According to the structural values the dimensions of the frame and cylinder were modified to perform the functions satisfactory.

D. Ravi and et al [5] analyzed a power press of 10 tone capacity under static condition. The modeling of the C- frame power press was done using Pro/E software. The 3D model of the power `involved the reduction in weight of the power press by varying or reducing the thickness of frame and bed and the press was analyzed in static condition to find the results. The result obtained from analysis package is within the limit.

Santoshkumar S. Malipatil and et al [6] made an attempt with the objective to reduce the volume of material of a press. They considered an industrial application project consisting of mass minimization of H-frame type hydraulic press. ANSYS software was used for this analysis the main aim was to reduce the cost of the Hydraulic presses without compromising on the quality of the output. With regarding to design specification, stress distribution, deflection, and cost, were focused on optimized design. The methodology followed in this work was comparison of stresses induced in machine for different thickness used for construction of frame and column of the H-frame type hydraulic press.

IV . DESIGN OF PUNCHING MACHINE

A.DESIGN OF FRAME/BODY

Permissible tensile stress for the plate is given by

$$6t = \frac{\text{Yield Stress}}{\text{FOS}} = \frac{304}{3} = \frac{101.33 \text{ N}}{\text{mm}^2}$$

as applications for use with less tried and loading and environmental conditions are not severetherefore f.o.s will be taken in between 2.5 to 3. cost of material is also taken in consideration while assuming the f.o.s.. based on this parameters factor of safety equal to 3 is sufficient.

Since two identical plates of C shapeare taken for the frame & these are joined by middle plates, the force on each plate is half the total force.

These ‘C’ plates are subjected to direct tensile stress & bending stresses. The stresses are maximum at the innerfiber.

At the inner fibers

$$6t = \frac{P}{A} + \frac{Mb * Y}{I}$$

σ_t = Permissible tensile stress

P = Force acting

A = Resisting area of C plate = Width of C plate x Thickness of C

plate Mb = Bending moment

y = Distance of neutral fiber from the point of application of force I = Moment of inertia of resisting cross sectional area of plate

Width of 'C' plate = 150 mm

Hence, put all values in above equations

$$101.33 = \frac{14715}{140xt} + \frac{14715 x (140 + 60)x80}{\frac{1}{12} x t x 150^3}$$

t=9.30 mm

Let us take third party standard 15 mm thick plate as per the industry experts and previous experience for C plates of the body.

Considering the height of the normal person, the space required for mounting the die & the free space for the hand movements etc. other dimensions of the C plate are finalized and are as shown in the Fig..

B.LOAD ON MACHINE

Cutting force = $l \times t \times \tau_{max}$

Industry job is Glass ring tube and the area of punch dimensions are given below



FIG.IV.I

L = 25 mm, B = 4 mm, T = 1.5 mm

P = perimeter of blank = 25+25+4+4 = 58 mm T = thickness

of blank

thickness of blank = 1.5 mm

for cold rolled sheet = 276 N/mm² for hot rolled sheet

= 345N/mm²

cutting force = 58 x 1.5 x 276 = 24012 N

$$= \frac{24012}{9.8}$$

$$= 2447kg$$

$$= 2.44Ton$$

By adding 20% Stripping force to it force become $F= 28814.4$

Therefore, Rounding it will need a punch of 3Ton

C.DESIGN OF PUNCH

We required high carbon steel for manufacturing of punch.

Length of punch

$$Lp = 2 \left[t \times \frac{1}{8} \right] \left[E \times \left(\frac{t}{z} \times t \right) \right] \times 0.5$$

$Lp = 115$ mm Where,

Lp = length of punch

t = thickness of material to be cut l = length of blank

τ = shear stress

Die block thickness, P = perimeter of blank

$$= 2 \times (l + b)$$

$$= 2 \times (25 + 4)$$

Perimeter of blank= 58 mm

Now the thickness of die block is (T) $T=15$ mm for $p= 25-$

75 mm

$T= 25$ mm for $p= 75-250$ mm

$T= 30$ mm for $p=$ larger than 250 mm

Cutting force,

AS discuss earlier cutting force =28814.4N

Now, work done per units $W = F \times P \times t$

F = cutting force, p = penetration of cut, T = thickness

$$W = 28814 \times 0.5 \times 1.5$$

$W = 21$ N-mm

Now, torque ,

$$workdone = torque \times Angular displacement (rad)$$

$$Torque = \frac{Workdone}{Angular displacement (rad)}$$

Angular displacement is of 90 degree as the stroke goes by sharing the 1.5 thickness of pipe,

$$\text{Thus } 90 \text{ degree means } 1.57 \text{ rad } Torque = \frac{21}{1.571}$$

$$Torque = 13 \text{ N} - m$$

As we *analyse* available punchine machines in industry we we came across the result that machine perform 30 to 50 strokes per min.

Now as 30 to 50 strokesof ram per minute by taking average of strokes. Consider 40 strokes (the stroke is given by

cam hence, $40 \times 4 = 160$ rpm)

Thus power required will be, $P = 2 * \pi * N * T / 60$

$$= 2 * \pi * 160 * 13 / 60 P$$

$$= 218 \text{ watt}$$

Thus motor requirement is of 218 watt but by considering the factor of safety with respect to Following cases.

- 1) If ram is having more friction due to less maintenance
- 2) Starting power requirement of the machine.
- 3) Impact of weight of flywheel, shaft, cam, on starting conditions

Hence,

$P = p \times f.o.s$

$$P = 218 \times 2 = 436W$$

Thus converting it into HP

We will need the motor of 0.75 HP

D.DESIGN OF PULLEY

The input rpm from motor is 1440 rpm and we need 170 rpm at cam shaft hence 1:8.5 Reduction ratio will be 1:8.5 thus pulleys should reduce the speed.

By assuming the motor pulley diameter as 40 mm we will calculate the pulley of flywheel So we can get the speed reduction

$d/D = N/n$ where,

d = diameter of motor pulley = 20 mm

n = Speed of motor pulley = 1440 rpm

N = Speed of flywheel = 170 rpm

$$\frac{40}{D} = \frac{170}{1440}$$

$$D = 320 \text{ mm}$$

(selecting the std size of 320 mm) Diameter of flywheel

will be 320 mm.

V. DIAGRAM

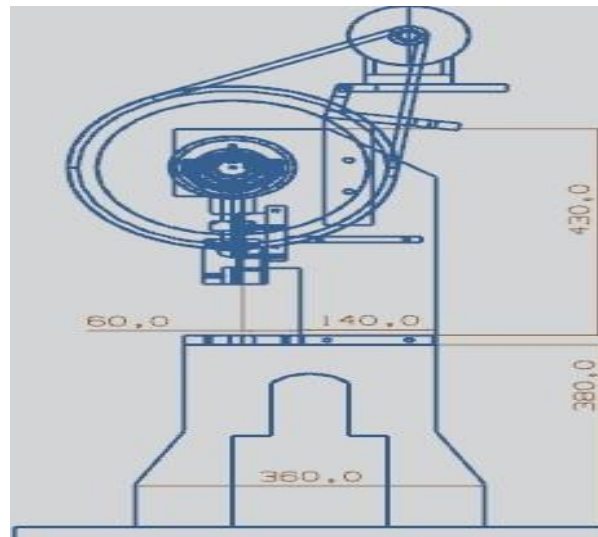


FIG.V.I. S.V
VI. ANALYSIS OF MACHINE

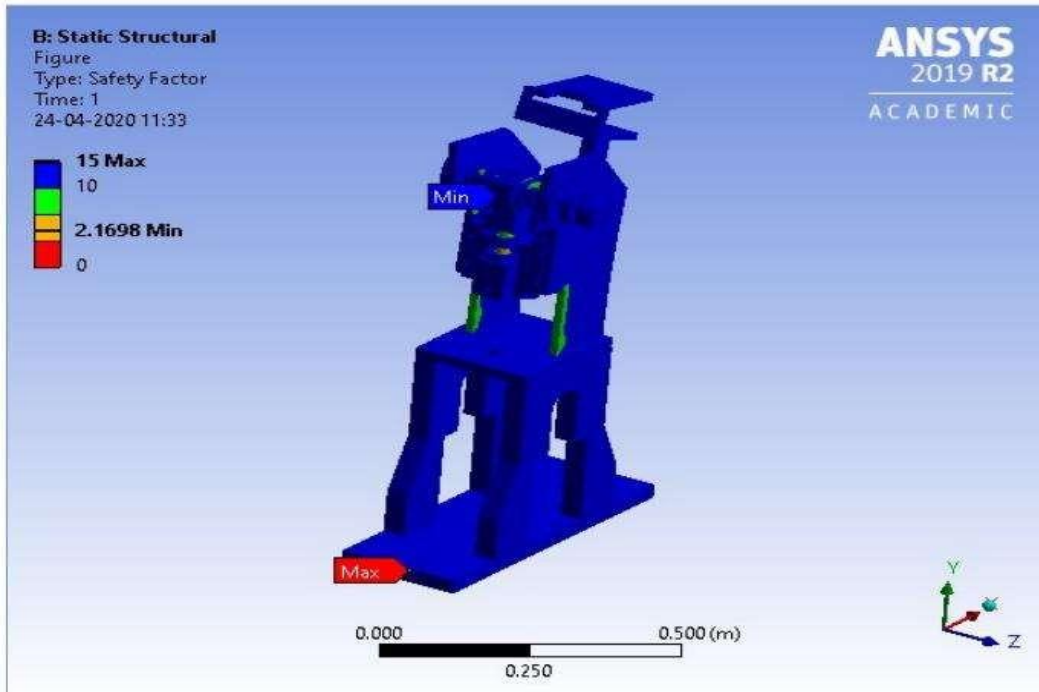


FIG1. FACTOR OF SAFETY

Model (B4) > Static Structural (B5) > Solution (B6) > Total Deformation > Figure

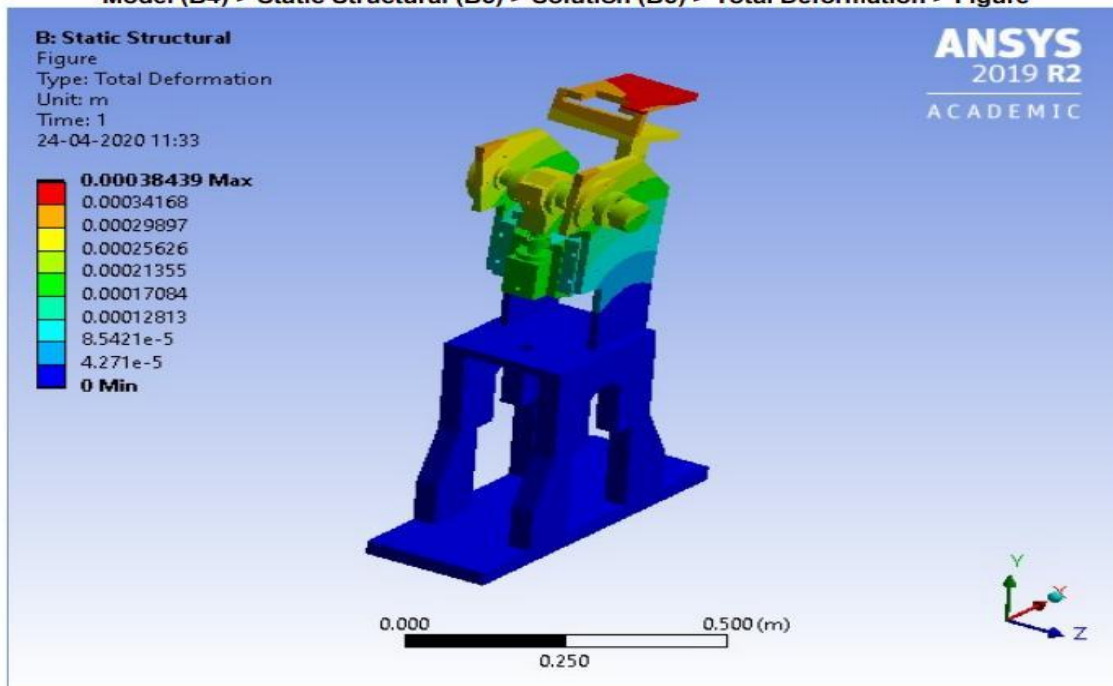


FIG2. TOTAL DEFORMATION

A.ANSYS RESULT

1.Object Name = Safety Factor
State = Solved
Results
Minimum f.o.s= 2.1698 min
Minimum Occurs On Cam_Bush_Lock_Plate

2.Object Name= Total Deformation
Minimum = 0
Maximum = 3.8439e-004 max
Maximum Occurs On Mototr_Base_Plate

VII. CONCLUSION

In this work, a Mechanical punching is designed as per the requirement. As compare to other system Mechanical system is good for punching operation. Machine contains automatic system which reduces human efforts. Design of 'C' framed punching machine is easy. We choose simple C-frame which occupies less space. Finite Element Analysis of the machine should be done to get overall stress distribution & deformation. Model of the punching machine is drawn by software. Further modification in our project will increase its applications.

REFERENCES

1. A. G. Naik, N. K. Mandavgade, "FEA Implementation In Analysis And Optimization Of Top And Bottom Frame For Hydraulic Cotton Lint Bailing Press", International Journal of Scientific & Engineering Research Volume 3, Issue 7, 2012
2. H.N.Chauhan & M.P.Bambhania, "Design & Analysis of Frame of 63 Ton Power Press Machine by Using Finite Element Method", Indian Journal of Applied Research, Vol.:3, Issue:7, pp.285-288, 2013
3. Ankit H Parmar and et al, "Design and Modification of Foremost Element of Hydraulic Press Machine", International Journal of Advanced Scientific and Technical Research, Issue 4, Vol. 3, 2014
4. Bhavesh Khichadia, Dipeshkumar Chauhan, "A Review on Design And Analysis of Mechanical Press Frame", International Journal of Advance Engineering and Research Development, Volume 1, Issue 6, 2014
5. B. Parthiban and et al, "Design and Analysis of C type hydraulic press structure and cylinder", International Journal of Research in Aeronautical and Mechanical Engineering, Vol.2 Issue.3, pp. 47-56, 2014.
6. D. Ravi, "Computer Aided Design and Analysis of Power Press", Middle-East Journal of Scientific Research 20 (10): pp.1239-1246, 2014
7. Rangraj S. More, Shreenidhi R kulkarni, "Finite Element Analysis and Optimization of C Type Hydraulic 200 ton press", International Research Journal of Engineering and Technologies, Vol.2, Issue 3, pp.1385-1391, 2015
8. V. B. Bhandari, "Design of Machine Elements", Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2008
9. Bernard Hamrock, "Fundamentals of Machine Elements", McGraw-Hill Publication, 1999
10. R. S. Khurmi, J. K. Gupta "A Text Book of Machine Design", S. Chand Publications, New Delhi 2012