DESIGN AND FABRICATION OF HYDRAULIC PRESS

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Abstract: A Hydraulic Press is a machine that employs a hydraulic cylinder to produce compressive force, which works on Pascal's Principle. The work comprises of the design and fabrication of a 10 Ton Hydraulic Press machine. The project consists of the press frame, cylinder and other components were designed by various design procedures. Each component of the machine were modelled by using modelling software PTC Creo. Using optimum resources the overall weight of the machine was decreased thus reducing the volume consumed by the machine and the mechanical properties of the machine was considered, assuring that the press machine had adequate stiffness to withstand the various loading conditions.

Keywords: Hydraulic Press, 10Ton, Design and Fabrication, PTC Creo

1. INTRODUCTION

A hydraulic press is a machine press using a hydraulic cylinder to generate a compressive force. It uses the hydraulic equivalent of a mechanical lever. The hydraulic press depends on principle, the pressure throughout a closed system is constant. One part of the system is a piston acting as a pump, with a modest mechanical force acting on a small cross-sectional area, the other part is a piston with a larger area which generates a correspondingly large mechanical force. Only small-diameter tubing resists pressure, if the pump is separated from the press cylinder. A small force acts on a small piston. This creates a pressure which is transferred through the hydraulic fluid to a large piston.

Hydraulic presses are commonly used for forging, clinching, molding, blanking, punching, deep drawing, and metal forming operations. The uses of a hydraulic press are compacting food and other consumables, making appliances, manufacturing electrical parts, making ceramics, manufacturing car parts, building aircraft and military application. Light-weight parts for aerospace, automotive appliances and many other industries, Servo Hydraulic and Hydraulic presses have become a key tool for the thermoplastic Industries. The consideration while setting up any hydraulic system is that of its size and portability. Due to all of the heavy maneuvers hydraulic presses have to undergo on a regular basis, some problems associated with this machinery. Some of the most common problems are Oil Leaks, Overheating, Slow Pressure Build-Up and Abnormal Noise which can be rectified by regular maintenance.

2. LITERATURE SURVEY

A literature survey was conducted for this project in order to decide whether the design process was optimum and an analysis of the various components would prove true in actual working conditions.

K. Shravan Kumar et.al [1] used the optimum resources possible in designing the hydraulic press components that could effect reduction in the cost by optimizing the weight of material utilized for building the structure. An attempt has been made in this direction to reduce the volume of material, cost of the press and to make is portable.
Fisayo Adesina et.al [2] have presented the development of a manually operated hydraulic press which encompasses the design, fabrication and performance evaluation of the press. The components of the machine were designed using various design equations. The design results were used to select materials for various components. The detailed drawing of the developed machine was done using Pro E software. In fabricating the machine, mild steel was used as the locally sourced material. The use of mild steel is due to the fact that its strength, rigidity and machinability falls within the design specifications. Some components of the machine developed include; the frame, cylinder mounting table, press pin, working table, hydraulic tank, and hand lever. Some of the bought out parts include: ram assembly, pressure hose, pressure indicator and hydraulic pump.
Malachy Sumaila et.al [3] have attempted to alleviate the problem of the dearth of equipment in laboratories a 30-ton hydraulic press was designed, constructed and tested using locally sourced materials. The principal parameters of the design included the maximum load, the distance the load resistance has to move, the system pressure, the cylinder area and the volume flow rate of the working fluid. The major components of the press designed includes the cylinder and piston arrangement, the frame and the hydraulic circuit. The machine was tested for performance with a load of 10kN provided by two compression springs of constant 9 N/mm each arranged in parallel between the upper and lower platens and was found to be satisfactory.
Ankit H Parmar et.al [4] have the goal of structure optimization to decrease total mass of hydraulic press while assuring

adequate stiffness. Key geometric parameters of plates which have relatively larger impacts on mass and stiffness are extracted as design variables. In order to research relationship between stiffness, mass and design variables, common batch file is built by CREO and analysis is done in ANSYS. Top plate, movable plate and column design and analysis was done. **Deepak Annasaheb More et.al [5]** have studied the frame, cylinder and press table are designed by the design procedure. They are analyzed to improve their performance and quality for press working operation. Using the optimum resources possible in designing the hydraulic press components can effect reduction in the cost by optimizing the weight of material utilized for building the structure. An attempt has been made in this direction to reduce the volume of material. So we considered an industrial application project consisting of mass minimization of H frame type hydraulic press. This press has to compensate the forces acting on the working plates and has to fulfill certain critical constraints. Here we use FEA implementation for analysis and optimization of hydraulic press.

Based on the literature review research gap have been identified and formulated design and fabrication of Hydraulic Press and the basic objectives of the hydraulic press are as follows:

- To design and fabricate a fully portable hydraulic press machine.
- To model the prototype using modeling software CREO.
- To perform operations such as punching, blanking, stamping and pressing.
- To analyze critical components using ANSYS.

3. DESIGN CALCULATIONS OF HYDRAULIC PRESS

- Determination of volume of Hydraulic Tank

The volume of the Hydraulic Tank was calculated from the equation (1)

$$V=LWH \tag{1}$$

where,
L- is the length of the tank in meters
W- is the width of the tank in meters
H - is the height of the tank in meters

- Design of bolts

The diameter of bolt was determined according to Khurmi and Gupta, 2005 which is given by equation (2)

$$P = \frac{\pi}{4}(d)^2 \sigma n \tag{2}$$

Where,

P is the external load acting on the cover plate, d is the core diameter of the bolt thread, is the allowable tensile stress for the bolt material and n is the number of bolts

- Determination of Tensile Stress Due to Stretching of Bolt

Initial tension in a bolt based on experiments may be found by the relationship in Equation (3) as given by Sumaila and Ibhadode, 2011

$$P_i = 2840d \tag{3}$$

where P_i is the initial tension in a bolt (N), d is the nominal bolt diameter

- Determination of Weight of the Piston of the Hydraulic Press

The weight of piston was determined from Equation (4)

$$Density\ of\ metal(\rho) = \frac{Mass\ of\ metal(m)}{Volume\ of\ piston\ (V_p)} \tag{4}$$

Volume of piston $V = \pi r^2 h$

Mass of Piston $M_p = \rho_m V_p$

Weight of Piston $W_p = m_p g$

- Determination of the Weight of Press Cylinder

The weight of press cylinder was determined by applying Equation (5)

$$\text{Weight of cylinder } (W_c) = \rho_m V_c g \tag{5}$$

where V_C is the volume of cylinder

$$V_c = \pi(r_2^2 - r_1^2)h \tag{6}$$

h is the height of cylinder, r_1 is the internal radius, r_2 is the outer radius

- Determination of Oil Flow Rate

Oil flow rate of the pump was determined using Equation (7)

$$Q = AV \tag{7}$$

To determine the hydraulic power of the machine hydraulic Power we can use equation (8)

$$P_h = Q\rho gh \tag{8}$$

Where

Q is the flow rate in m^3/s, V is the velocity of flow in m/s, A is the area of pipe in m^2, ρ is the density of oil in kg/m^3, g is the acceleration due to gravity in m/s^2, h is the differential head in meters (m).

- **HYDRAULIC CIRCUIT**

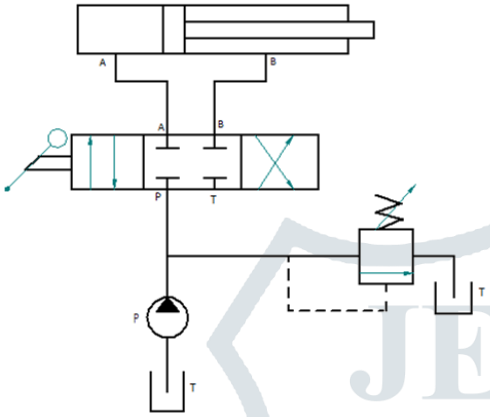


Fig. 1 Hydraulic Circuit of the Hydraulic Press

4. MATERIALS AND METHODOLOGY

After the design process appropriate materials were selected for the various parts of the Hydraulic Press and fabricated the various parts of the Hydraulic Press. The following table shows the key components after the fabrication process.

Fig.2 Cylinder assembled along with top plate

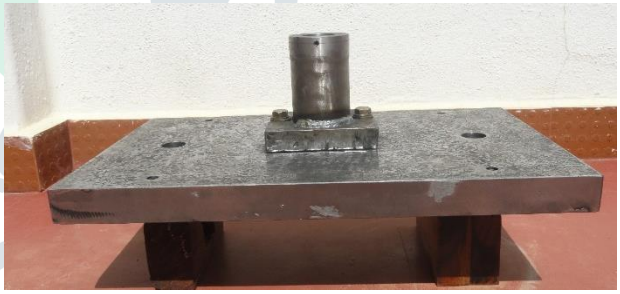


Fig.3 Bottom plate along with Bottom die fixture

Fig.4 Tank fitted with DCV, pump and motor

Fig.5 Frame of the Hydraulic Press

Fig.6 Tie rods of the Hydraulic Press

Fig.7 Round, Square and Slotting dies

Fig.8 Test assembly of the Hydraulic Press

Fig.9 Punched sheets of the Hydraulic Press

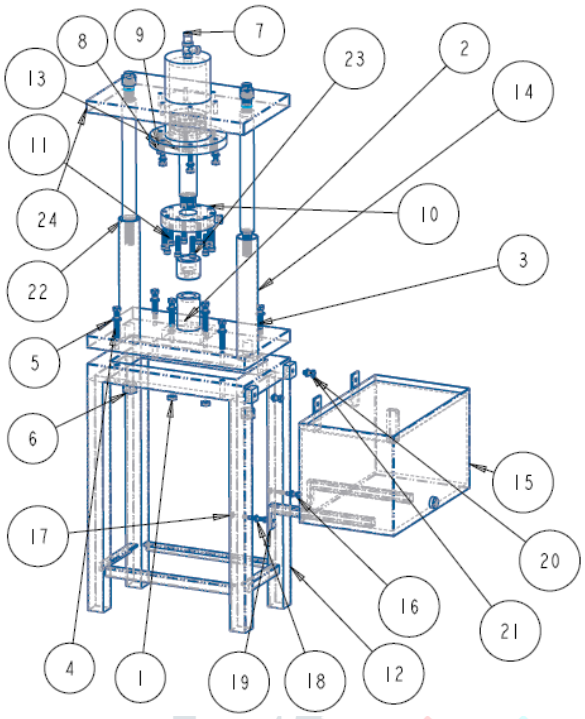
Table 1. Parts of the Hydraulic Press during various stages of fabrication

Item Number	PART NAME	QUANTITY
1	Bottom fixture nut	2
2	Bottom fixture	1
3	Bottom plate	1
4	Bottom plate bolt	6
5	Bottom plate washer	6
6	Chuck nuts	4
7	Cylinder	1
8	Cylinder bolt	6
9	Cylinder washer	6
10	Flange	1
11	Flange bolt	10
12	Frame	1
13	Piston and Rod	1
14	Sleeve	2
15	Tank	1
16	Tank bottom bolt	2
17	Tank bottom nut	2
18	Tank bottom washer	2
19	Tank support	2
20	Tank top bolt	2
21	Tank top washer	2
22	Tie rods	2
23	Top fixture	1
24	Upper plate	1

Table 2. Part list of the Hydraulic Press

5. RESULTS AND CONCLUSIONS:

The Hydraulic Press was successfully designed and fabricated according to the design. The exploded view of the Hydraulic Press is shown below.



ITEM NO	PART NAME	QTY
1	BOTTOM_FIXTURE_NUT	2
2	BOTTOMFIXTURE	1
3	BOTTOMPLATE	1
4	BOTTOMPLATEBOLT	6
5	BOTTOMPLATEWASHER	6
6	CHUCKNUT	4
7	CYLINDER	1
8	CYLINDER_BOLT	6
9	CYLINDERW_WSHER	6
10	FLANGE	1
11	FLANGE_BOLT	10
12	FRAME	1
13	PISTON_AND_ROD	1
14	SLEEVE	2
15	TANK	1
16	TANK_BOTTOM_BOLT	2
17	TANK_BOTTOM_NUT	2
18	TANKBOTTOMWASHER	2
19	TANKSUPPORT	2
20	TANKTOPBOLT	2
21	TANKTOPWASHER	2
22	TIERODS	2
23	TOP_FIXTURE	1
24	UPPER_PLATE	1

Fig.10 Exploded view of the Hydraulic Press

The following conclusions are inferred from our study:

- The critical components have been designed to withstand the load.
- The components were fabricated as per the design and assembled.
- Operations such as blanking, punching and slotting can be performed on the following materials:
  - Mild Steel - 0.5mm thickness
  - Brass - 1.0mm thickness
  - Copper - 1.5mm thickness
  - Aluminium – 3.0mm thickness

APPLICATIONS

The following are some of the applications of a Hydraulic Press machine.

- Punching holes: This machine can be used for punching holes of different sizes on sheet metals. This is achieved by using appropriate sized dies.
- Blanking: This machine can be used for performing blanking operation. The compressive force and the die used, together press the sheet metal producing blanks of various sizes based on the dies used.
- Stamping and Pressing: The various manufacturing processes involved in stamping can be performed by this machine. Pressing operation which is widely used in industries for assembling and disassembling components in order to achieve tight fits can be performed by the hydraulic press machine.

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