DESIGN, CONSTRUCTION AND PERFORMANCE TEST OF A HYDRAULIC TEST MACHINE

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Certification

This is to certify that the Project titled **"Design, Construction and Performance Test of A Hydraulic Test Machine."** was carried out by Md. Abu Yousuf, Md. Forhad Mia, Shahadat Hossain, Suvo Ahmed, and submitted to the Department of Mechanical Engineering, Sonargaon University as a partial fulfilment of the requirement for the award of Bachelor of Science Degree in Mechanical Engineering.

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"Authors"

Abstract

A hydraulic press is a machine using a hydraulic cylinder to generate a compressive force. Frame and cylinder are the main components of the hydraulic press. In this project press frame and cylinder are designed by design procedure. The frame and cylinder are modeled by using AutoCAD software. Using the optimum resources possible in designing the hydraulic press components can affect 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.

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CHAPTER 1

Introduction

1.1 Background

A hydraulic press is a device using a hydraulic cylinder to generate a compressive force. It uses the hydraulic equivalent of a mechanical lever, and was also known as a Bramah press after the inventor, Joseph Bramah, of England. He invented and was issued a patent on this press in 1795.

A hydraulic press is a machine using a hydraulic cylinder to generate a compressive force. Frame, hydraulic cylinder and press table are the main components of the hydraulic press. Hence a hydraulic press is a machine that makes use of the pressure exerted on the fluids to crush, straighten or mold.

The concept of the hydraulic press is based on Pascal's theory, which states that when pressure is applied on fluids in an enclosed system, the pressure throughout the system always remains constant.

For instance, the installation of bearings into housings or shafts and the extraction of such from a housing or shaft depend largely on the tools and methods used. If bearings are not properly installed or removed, the effect is felt on the entire assembled machine. Presses can be divided into the following categories: Hydraulic Presses which operate on the principles of hydrostatic pressure, Screw presses which use power screws to transmit power and Mechanical Presses which utilize kinematic linkage of element to transmit power [7].
The major advantages of hydraulic presses over the other types of presses (power screw and mechanical presses) include; hydraulic press provides a more positive response to changes in input pressure, the force and pressure can accurately be controlled, and the entire magnitude of force is available during the entire working stroke of the ram travel Hydraulic presses are preferred when very large a nominal force is required, hence the best option for mounting and dismounting force fits [6]. The hydraulic press is therefore a valuable equipment in the workshop and

laboratory especially for press fitting operations and for the deformation of materials such as in metal forming processes and material testing for strength [3].

In hydraulic press, the force generation, transmission and amplification are achieved using fluid under pressure. The liquid system exhibits the characteristics of a solid and provides a very positive and rigid medium of power transmission and amplification. In a simple application, a smaller piston transfers fluid under high pressure to a cylinder having a larger piston area, thus amplifying the force. There is easy

Transmissibility of large amount of energy with practically unlimited force amplification.

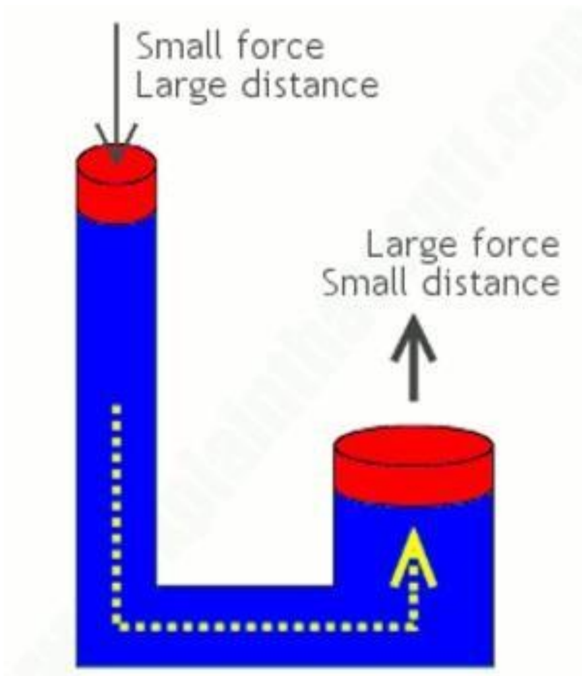

Figure 1 Force Transmission

1.2. Objective:

1. To ensure conform ability, design objectives and service ability. By performing experiment for different thicknesses of sheets

2. To use for blanking, punching, deep drawing, and metal forming operations.

3. To reduce human work at pressing using fluid compressive system by using hydraulic press machine

CHAPTER 2

Literature Review

Per-Willy Lazuli and Bjorn Victor Lund (2010) [1] presented in a study the results of modeling and simulation of a physical hydrostatic transmission with three different modeling tools; Simulink, Sim Hydraulics and Simulation X. The aim has been to get the simulations from the different models to be as similar as possible to the two measured pressures and the rotational speed of the load. The Simulation X model gave the best results compared with the measurements. The largest challenge has been to simulate the model in Simulink and to find the frictional losses in the hydraulic motor by performing different tests. The solver in Simulink could not solve the equations and it was difficult to find the tests for finding two of the friction parameters.

Mohamad M. Saleh (1992) [2] in this paper Author has given a complete thesis on design study of a heavy duty hydraulic machine using finite element techniques. The machine is designed by ENERPAC without any measurement or variable hydraulic system. The investigation dealt the theoretical and experimental model of the machine to establish the accurately optimal design analysis and further development of the present machine at minimum time and lower cost. The applicability of the existing PC based FE package as a computer aided design tool is also investigated. A comparison has been made between the experimental and theoretically predicted results. Both the results are found to be in good agreement with each other.

Sinha and Murarka (1988) [3] in this paper Authors has conducted a study on hydraulic presses. It represented a 3-Dcomplex structure. It is found that an exact analytical method of stress and deformation analysis is cumbersome and time- consuming. In order to reduce core memory requirement and the cost of computation, a simplified plane stress (PS) FEM model for a hydraulic press structure (welded frame) has been identified for its analysis. On the basis of this investigation, certain significant guidelines have been obtained for the design of press frames. Such a model has resulted in savings in computational time, core memory requirement and cost of analysis.

Zhang Meng et al [4]: -The press system for shaping is incredibly necessary instrumentality in part business. Since this type of system is incredibly complicated, like flow nonlinear, this may cause that its dynamic performance is tough to get. During this paper, a simulation primarily based dynamic performance analysis methodology is projected to investigate the system dynamics. First, a simulation model of the press system is made supported the industrial package AME Sim, upon that its dynamic performance is analysis and calculable. Then simulation results show the effectiveness of the projected methodology

Seong Jin Cho et al [5]:-Several industrial motion systems use electronic motors. However, huge power systems that create automobile frames, roll mixing machines and lots of alternative systems can't use electronic motors due the latter's comparatively little power. So as to unravel this downside, we have a tendency to propose victimization hydraulic systems. The open-loop management methodology and therefore the close-loop management methodology are wide wont to management hydraulic systems. Among hydraulic systems, we have a tendency to specialize in the management press system; significantly, the press system thatoperates with vertical movement and has huge weight. During this case, if the close-loop methodology is applied to the press system, then vibration and noise issues can occur because of the inertia of the press system

Hydraulic System

A hydraulic system contains and confines a liquid in such a way that it uses the laws governing liquids to transmit power and do work. This chapter describes some basic systems and discusses components of a hydraulic system that store and condition the fluid. The oil reservoir (sump or tank) usually serves as a storehouse and a fluid conditioner. Filters, strainers, and magnetic plugs condition the fluid by removing harmful impurities that could clog passages and damage parts. Heat exchanges or coolers often are used to keep the oil temperature within safe limits and prevent deterioration of the oil. Accumulators, though technically sources of stored energy, act as fluid storehouses

CHAPTER 3

Working Principle / Theoretical Aspect

A hydraulic press is a machine that uses pressurized liquid to create force. These machines are composed of a simple cylinder and piston mechanism. The press consists of a large cylinder, with a large piston, and a small cylinder and a small piston. The large cylinder and the small cylinder are connected to one another by means of a pipe. The two cylinders, and the pipe connecting them, are filled with a liquid. At this point, the function of the hydraulic press depends on Pascal's Principle.

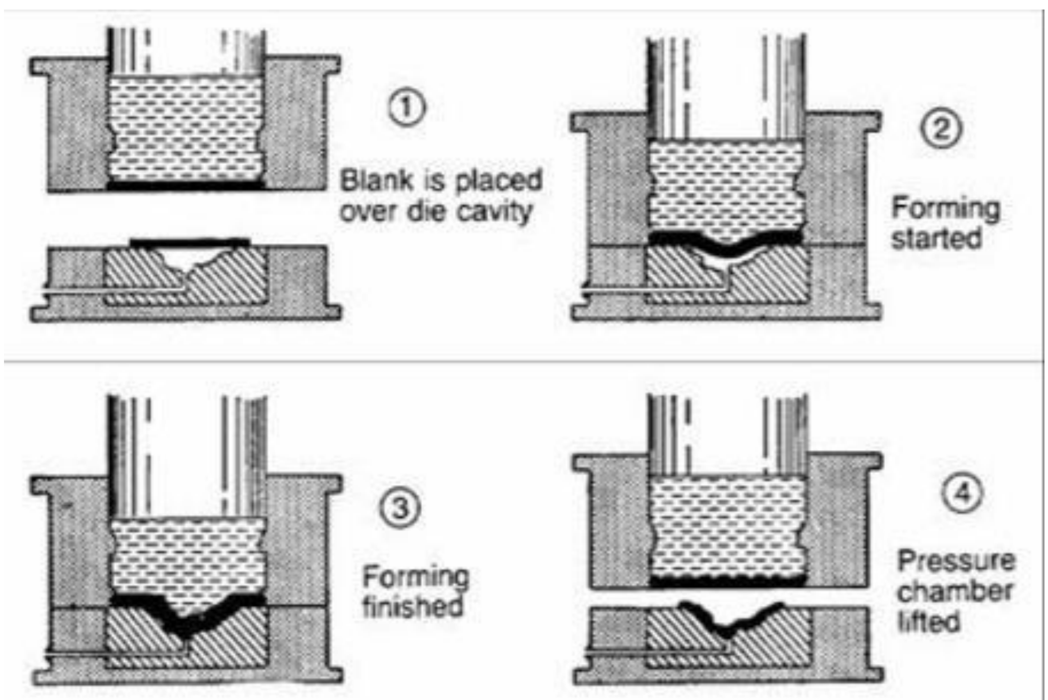

Figure 9 Working of hydraulic press

Pascals Law.

Pascal's Principle states that when pressure is added to a liquid at rest, there is an identical increase in pressure at all points. Applying this principle to the hydraulic press means that any force that is added to the piston in the smaller cylinder will be transferred to the piston in the larger cylinder, in a proportionally increased level of force. This allows a hydraulic press to produce a great deal of force from the application of a small amount of force to the small piston.

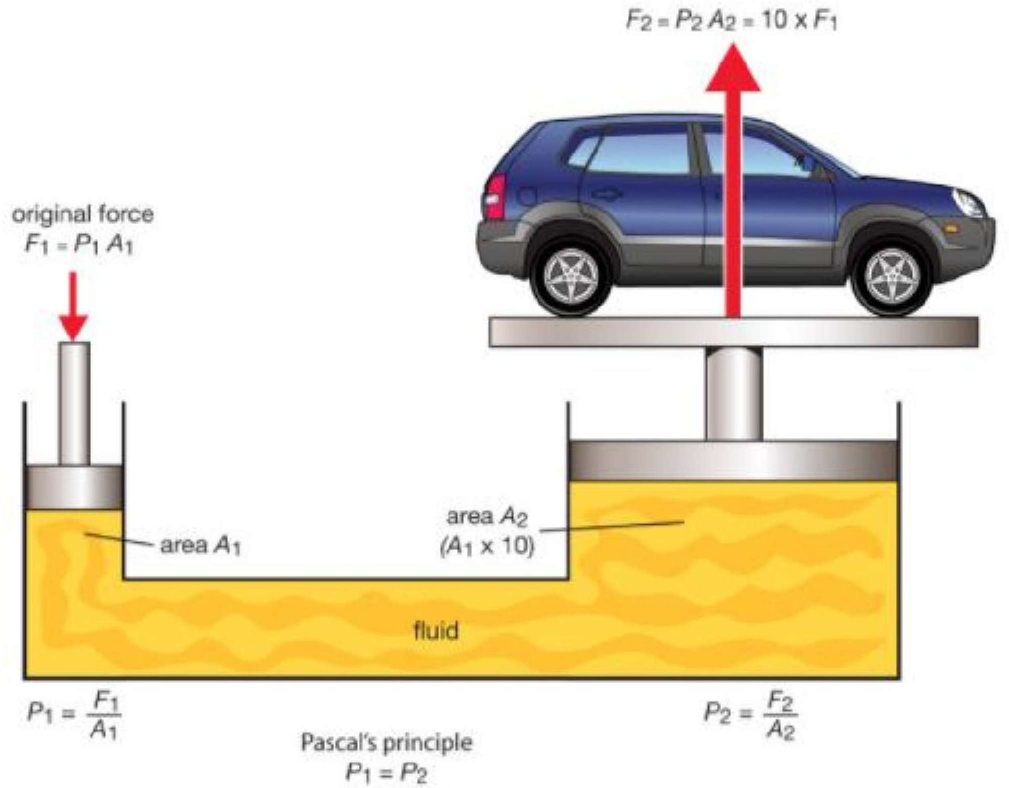

Figure 10 Pascals Law

The increase of the force produced by the larger piston is proportionally larger than the force exerted on the small piston. The amount of increase depends on the ratio of the sizes of the pistons. The ratio of the areas of the two pistons is multiplied by the amount of force applied to the small piston to determine the amount of force that the large piston can produce. For example, if the ratio of the sizes of the two pistons is 10, and the amount of force applied to the small piston is 50 N, the amount of force that the large piston will produce is 500 N.

Hydraulic presses can be used in any task that requires a large amount of force. These can include any type of lifting as well, since the hydraulic press can work

as a type of lever. These presses are the most efficient contemporary press, as well as the most common.

Since the hydraulic press works on the basis of Pascal's Law, its working is similar to the one of the hydraulic systems. A hydraulic press consists of basic components used in a hydraulic system that includes the cylinder, pistons, the hydraulic pipes, etc. The working of this press is very simple. The system comprises of two cylinders, the fluid (usually oil) is poured in the cylinder having a small diameter. This cylinder is known as the slave cylinder.

The piston in this cylinder is pushed so that it compresses the fluid in it that flows through a pipe into the larger cylinder. The larger cylinder is known as the master cylinder. The pressure is exerted on the larger cylinder and the piston in the master cylinder pushes the fluid back to the original cylinder. See the Fig- 3.3

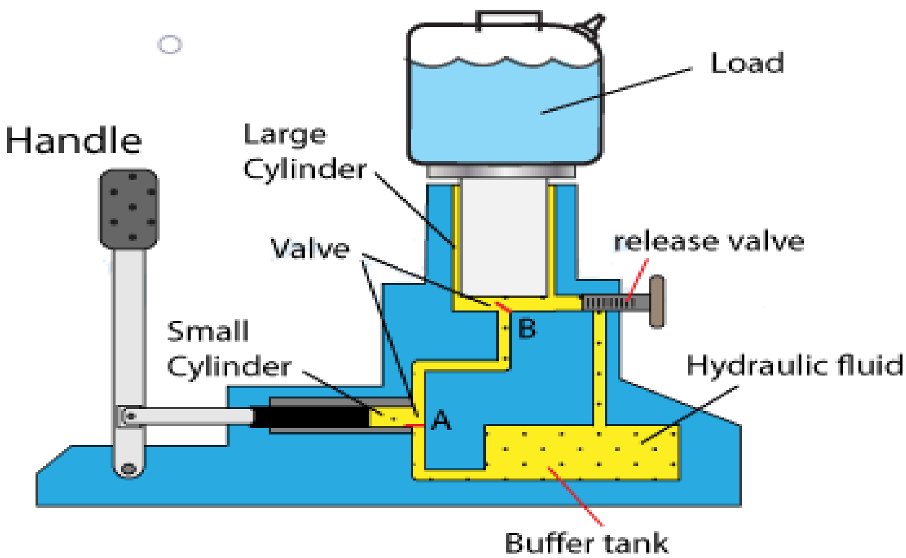

Figure 11 Cylinder Operation

The force applied on the fluids by the smaller cylinder results in a larger force when pushed in the master cylinder. The hydraulic press is mostly used for industrial purposes where a large pressure is required for compressing metals into thin sheets. An industrial hydraulic press uses the material to be worked upon along with the help of the press plates to crush or punch the material into a thin sheet.

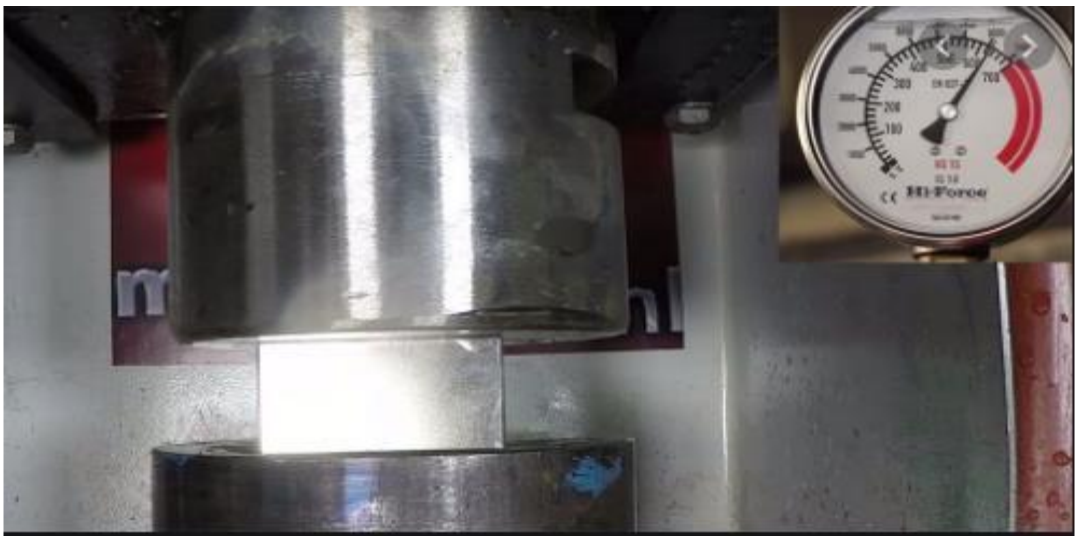

Figure 12 Pressed the plate to crush or punch the material.

CHAPTER 4

Design & Construction

Construction:
Hydraulic presses are available in many types of construction which is also true of mechanical presses. Following construction details just gives the basic idea of dimensions of different parts used in the design module.

Base plate is manufactured from 430x110x10 mm plate by drilling of ϕ18 at each corner using vertical drilling machine. The die used for a particular given shape is welded at the bottom plate as shown in figure 2.

The dimensions of Top and Middle plate is 430x110x17 mm. Pillar having diameter of 20 mm and height 510 mm, which is allowed to pass through the holes of the plates.

After that spring having free length 230 mm is passed through the pillar which is fixed between middle plate and base plate so as to get the flexible movement of the Movable plate. Punch is welded at the bottom of the movable plate. Jack is mounted in between the top and middle plate. The basic Manufacturing process is shown in below figure.

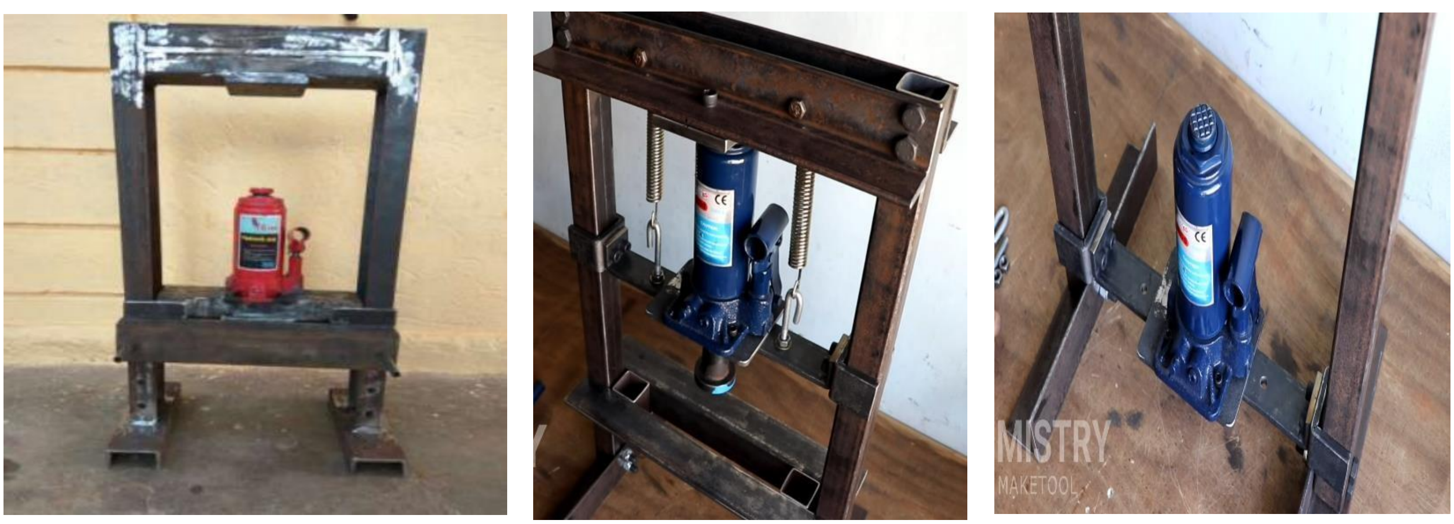

Figure 13 When the Project was under Manufacturing

Design:

Fluid power systems are designed by objective [9]. The primary problem to be solved in designing the system is transposing the desired performance of the system into system hydraulic pressure and volume flow rate and matching these characteristics with an available input to the system to sustain operation. The principal parameters of the design included the maximum load (05 KN), the distance the load resistance has to move (piston stroke,150 mm), the system pressure, the cylinder area (piston diameter = 30 mm) and the volume flow rate of the working fluid.

Isometric View of a Hydraulic Press Machine

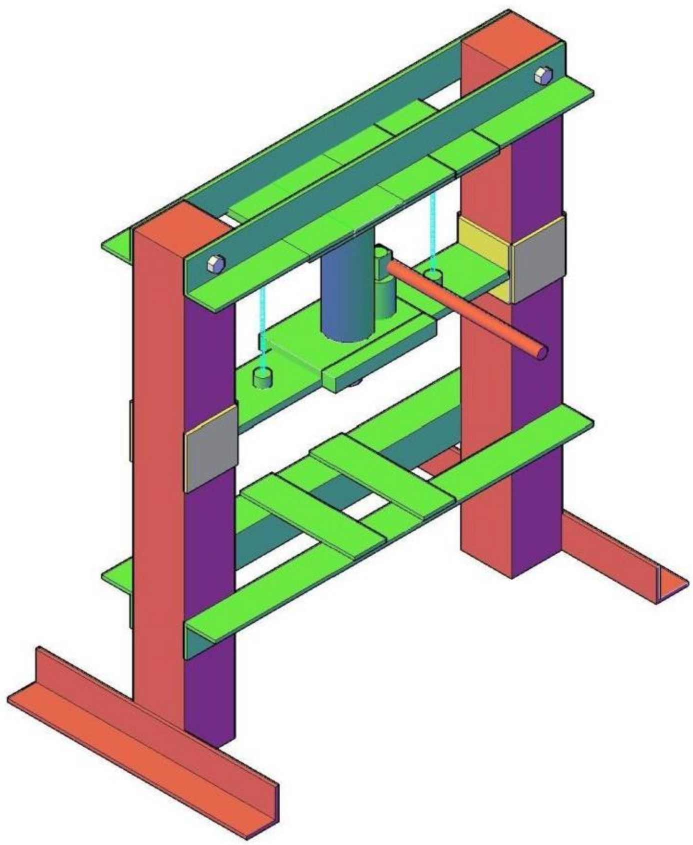

Figure 2 Three-Dimensional View

Front View and Side View of the Hydraulic Press Machine.

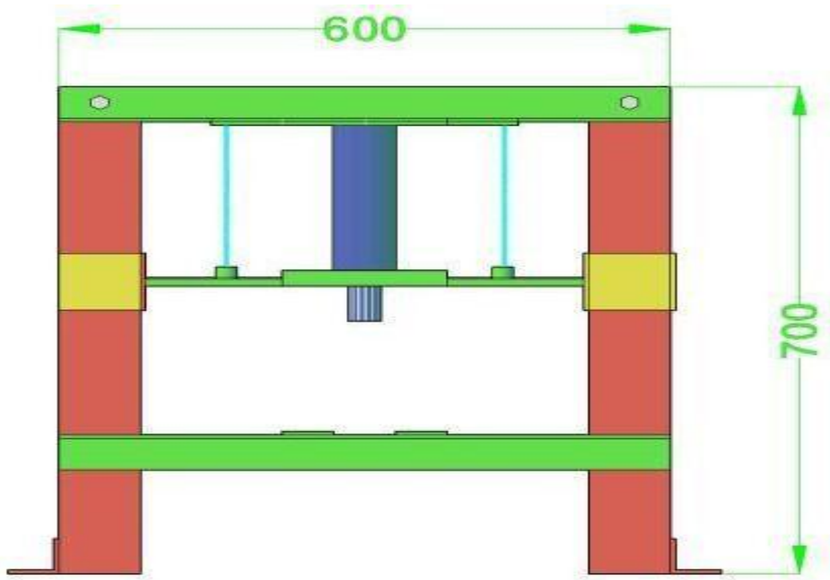

Figure 3 Front View

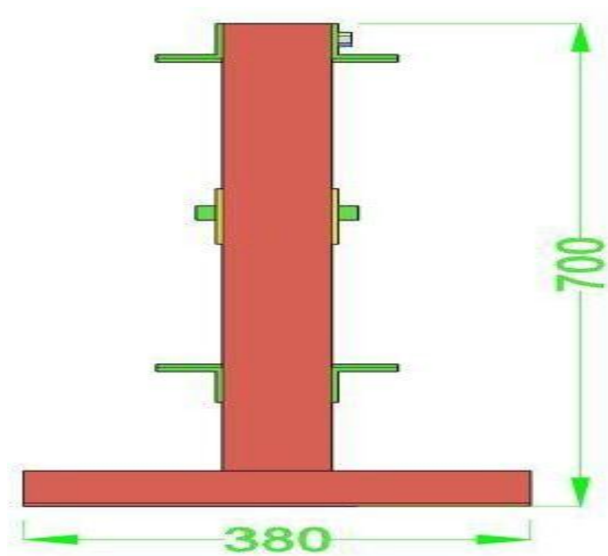

Figure 4 Side View

Table 1   2.4 Raw Material Chart

Table I includes details of all components required for building the actual model of hydraulic press.

SL NO	NAME OF PART	MATERIAL USED
1	Base	Mild steel
2	Movable plate	Mild steel
3	Upper plate	Mild steel
4	Pillar road	Mild steel
5	Washer	Mild steel
6	Nut	Mild steel
7	Spring	Mild steel
8	Jack	-
9	Spindle	Stainless steel
10	Body	Cast iron
11	Die	Mild steel (Case hardened)
12	Punch	Mild steel (Casehardened)

2.5 Specification:

Pillar Rod:

- Height: 510 mm
- O.D: 20 mm
- Tapping: 3 mm
- Thread: 18 mm

Figure 5 Spring (a)

Spring: Compression Type

- No. of Quantity: 2
- Free length: 230 mm

Base Die:

Figure 6 Base Die (b)

- O.D: 95 mm
- I.D: 65 mm
- Height: 40 mm

Washer:

- I.D: 20 mm
- O.D: 40 mm
- Thickness: 1 mm

Figure 7 Washer (c)

2.6 Design procedure:

1. Design of ram:

= /4 x 2

Dr = 65 mm

2. Design of cylinder:

$$= /2 \left[\sqrt{\frac{\sigma_t + p}{\sigma_t - p}} - 1 \right]$$ where, T= Thickness

t=Stress

$_{ci} = _{ro} + d_{ci} = 65.04$ mm

outside diameter of cylinder,

$_{co} = _{ci} + 2$

$_{co} = 70$

3. Design of pillars:

Load on each pillar = /4 x D_r^2 t (D=Diameter

(t=Tangential Stress)

= 39240 N, (σ_t = 56 for M.S.)

d_p = 22 mm

4. Design of spring:

Solid length: $L_s = '$ L=Length

$'$ =15, d = 8 mm d=Diameter

L_S = 120 mm. $'$=coil number

Free length: $L_f = ' +_{max} + 0.15_{max}$ = 238 m

Spring index: = /

= 5.875

Stiffness: = /

=10.51

5. Design of plate:

Top plate: $= \times \sqrt{\frac{p}{2f_t + (a^2 + b)^2}}$

P= intensity of pressure = 1.66 N/mm2

t_c = 16 mm

Bottom plate:

Thinness = 10 mm

Movable plate

Thickness = 10 mm

6. Frame Design:

The frame provides mounting points and maintains proper relative positions of the units and parts mounted on it over the period of service under all specified working conditions. It also provides general rigidity of the machine [1]. The design consideration is that of direct tension imposed on the pillars.

Figure 8 Hydraulic Press machine

CHAPTER 5

Results and Discussion

5.1. Performance Test Result:

It is a normal practice to subject engineering products to test(s) after manufacture. This is a significant step in the manufacturing process. Under tests the product is checked to see if functional requirements are satisfied, identify manufacturing problems, ascertain economic viability, etc. Testing is therefore employed to prove the effectiveness of the product. For the hydraulic press, test for leakages is the most significant test. The test commenced with the initial priming of the pump.

After which the fluid was pumped. This was carried out under no-load condition. The machine was left to stand in this position for two hours. The machine was then subjected to a load of 05 KN provided by two compression springs of constant 9 N/mm each arranged in parallel between the platens. The springs were then compressed axially to a length of 100 mm. This arrangement was left to stand for two hours and was observed for leakages. Leakage in the system was not indicated as the lower platen did not fall from its initial position.

Bending force calculation: We take structural steel for the load calculation by using formula, $F = 1.42 \times L \times Rm \times t^2 \times W$

Where, F= Press capacity = Material length, Rm = Tensile strength, t = Material thickness, W = Width of the die(which standard is 8×t)

Materials	Materials Length	Materials thickness	Die opening	Bending Force
S 235 Stainless steel	200 mm	3 mm	24	3.94 ton
S 355 Steel	150 mm	3 mm	24	4.15 ton

Punching Force Calculation

Materials	Thickness	Steel Plate side Length	Perimeter	Shear strength	Punch Force
Mild Steel	3 mm	10 mm	40 mm	0.3447 KNS/mm	4.21 ton
Mild Steel	2.5 mm	12 mm	48 mm	0.3228 KN/mm	3.948 ton

5.2. Advantages:

A hydraulic system has four major advantages, which makes it quite efficient in transmitting power

1. Ease and accuracy of control: by the use of simple levers and push buttons, the operator of a hydraulic system can easily start, stop, speed up and slow down.
2. Multiplication of force: A fluid power system (without using cumbersome gears, pulleys and levers) can multiply forces simply and efficiently from a fraction of a pound, to several hundred tons of output.
3. Constant force and torque: Only fluid power systems are capable of providing a constant torque or force regardless of speed changes.
4. Simple, safe and economical: In general, hydraulic systems use fewer moving parts in comparison with mechanical and electrical systems. Thus, they become simpler and easier to maintain

5.3. Disadvantages:

In spite of possessing all these highly desirable features, hydraulic systems also have certain drawbacks, some of which are;

1. Handling of hydraulic oils which can be quite messy. It is also very difficult to completely eliminate leakage in hydraulic systems.
2. Hydraulic lines can burst causing serious human injuries.
3. Most hydraulic fluids have a tendency to catch fire in the event of leakage, especially in hot regions.

CHAPTER 6

Table 2 Cost Estimation

SL No.	Name of the Equipment's/Materials	Price
1	Hydraulic Jack	11,000/-
2	MS Plate	1000/-
3	MS Angle	2500/-
4	Washer	100/-
5	Nut	200/-
6	Spring	1000/-
7	MS Square Box	2000/-
8	Spindle	800/-
9	Die	300/-
10	Punch	250/-
11	Die	500/-
12	Punch	300/-
13	Labor cost	7050/-

The cost estimate for the hydraulic press was 27000 BDT at prices in Dhaka City, Bangladesh as at the time of press manufacture. However, the unit cost of a product in most cases is several times higher than for quantity-based production. Hence, the items bought were as required for the press manufacture. The transportation and contingencies were also included in the cost of labor.

CHAPTER 7

Conclusion & Recommendation

It is a multi-purpose machine as it can be used for performing different tasks. By changing the die different operation like bending, blanking etc. can be performed on a hydraulic press machine. The design has main focus on reducing operator fatigue and increase safety, improving the flexibility and makes operation more convenient, and to achieve dimensional and positional accuracy. Components of press are designed to avoid bending failure due to applied load. Mild steel is selected as material based on its properties such as high bending & tensile strength, it compatibility with operation like machining, welding, finishing, cutting, etc. and cost as economic factor.

Starting today, pressure driven presses are accessible in both the classifications, i.e., programmed and physically worked. If there should arise an occurrence of physically worked pressure driven presses, numerous well-being measures must be accepted, for example, utilizing interlocking and obstruction watches.

If you are unable to find the exact design and capabilities of a hydraulic machine to meet your needs, remember, that many presses are presses are custom-built to meet the desired results of most any type of application.

Starting today, pressure driven presses are accessible in both the classifications, i.e., programmed and physically worked. If there should arise an occurrence of physically worked pressure driven presses, numerous well-being measures must be accepted, for example, utilizing interlocking and obstruction watches.

A 5-ton hydraulic press was designed, manufactured, and calibrated. The machine was tested to ensure conformability to design objectives and serviceability. The machine was found to be satisfactory at a test load of 05 KN. Further testing to the design load is yet to be carried out.

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