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FABRICATION OF A MANUALLY OPERATED HYDRAULIC PRESS

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Abstract

The work was carried out at the Department of Mechanical Engineering, Oyo State college of Agriculture and Technology, Igboora. It presents the fabrication of a manually operated 20tons hydraulic press using locally sourced materials for major components of the machine like; the frame, working table/bed, hydraulic tank and hand lever. The other parts that were assembled includes: cylinder/ram assembly, pressure hose, pressure indicator and hydraulic pump. The fabrication was carried out in a view to reduce dependency on imported goods and promote cheaper indigenous Technology using locally sourced material in order to ease workshop activities. The hydraulic press performs various press and fitting works in workshops (especially small and medium scaled) by reducing the time and stress associated with installation and removal of bearings, and other forms of force fits in machine assemblies. When compared with imported hydraulic machine of the same working capacity, it competes favorably, this can likely reduce dependence on imported goods and promotes indigenous technology. The cost of fabricating the machine locally as at the time of fabrication was ₦180,000 (\$400) compared to the cost of purchasing the imported ones of same capacity which ranges from ₦3 15,000 - ₦450,000 (\$700 to \$1,000) excluding cost of importation.

It is therefore considered to be cheap and perform similar functions compared to imported hydraulic machine of the same working capacity.

Keywords: Hydraulic press, design, fabrication.

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 works on Pascal's principle; the pressure throughout a closed system is constant (Bansal, 2005). 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 that generates a correspondingly large mechanical force. Only small-diameter tubing (easily resists pressure) is needed if the pump is separated from the press cylinder.



Fig. 1 Illustration showing Pascal's Law

Pascal's law States that Pressure on a confined fluid is transmitted undiminished and acts with equal force on equal areas and at 90 degrees to the container wall. i.e. when pressure is applied on fluid in an enclosed system, the pressure throughout the system always remain constant. In a simple term a hydraulic press is a machine that exact pressure on the fluid to perform a certain task. A small effort force acts on a small piston which creates a pressure that is transferred through the hydraulic fluid to a large piston. (Rajput and Chand, 2008).

(Deepak *et al.*, 2015), describe a hydraulic press as a machine that uses hydraulic cylinder to generate a compressive force. Finite element Analysis (FEA) can be use in implementation, analysis and optimization of hydraulic press.

Hydraulic presses are used for most all industrial operations. But basically use for forging, blanking, punching, deep drawing, and metal forming operations (Ganesh *et al.*, 2018).

It can also be used for the thinning of glass, making powders in case of the cosmetic industry and forming tablets for medical use. The other common uses of the hydraulic presses include; Processing cocoa beans, Dewatering cassava, In Thermoplastic industry, for stamping metal material into a wide range of finished products and parts (Deepak *et al.*, 2015).

The hydraulic press has main advantage of positive response for the input pressure when compared to other types of machines. The force and pressure can be controlled accurately and the ram travel utilizes entire magnitude force that is available during forward stroke.

The fabrication of the manual hydraulic press and pull machine will bring relief by reducing the time and stress associated with the installation and removal of bearings, and other forms of force fits in machine assemblies, thereby ensuring easier and cheaper maintenance and repair of machines and plants (Ayodele *et al.*, 2005). From this project, all parts of the machine will be fabricated with locally sourced materials, thus reduces dependency on imported goods and promotes indigenous Technology.

Materials and methods

Table 1: Material and Specification

S/N	ITEM	SPECIFICATION	QTY
1	Hydraulic pump with pressure gauge	20 tons	1
2	U Channel	Thickness (6mm)	2 Standard lengths
3	Angle Iron	Thickness (4mm)	1 Standard length
4	Flat metal	Thickness (4mm)	2 Standard lengths
5	Mild steel rod	Thickness (25mm)	700mm
6	Hose	Thickness (0.25mm)	2 metres
7	Hose clips		4 pieces
8	Bolts and Nuts	22mm	(4) pieces
		17mm	(4) pieces
		10mm	(2) pieces
9	Electrode	12 gauge	2 packets
10	Paint	Colour Red	8litres
11	Body filler		3 packets

Design of Some Machine Components

Some of the hydraulic press parts that were fabricated includes: the frame (stand, base support, column, top plate, adjustable working table/bed, cylinder mounting table) hydraulic tank and hand lever. The other parts that were assembled includes: cylinder/ram assembly, pressure hose, pressure indicator and hydraulic pump.

Design Calculations

Hydraulic press frame:

The frame which is a structure on which other units of the machine were assembled, was designed to accommodate the hydraulic pump, ram assembly, oil tank, and working table.

Structural analysis was carried out on the frame using Computer Aided Three Dimensional Interactive Application Software CATIAV5. The 20 Ton hydraulic press machine showed high deformation tendency on the pillars to be

high. The other frame members were analyzed using Analysis system (ANSYS) software that were subjected to simple bending stresses.

➤ **Volume of hydraulic tank**

$V =$

$$L \times W \times H$$

Where L is the Length (L) = 110mm

W is the width = 120mm

H is the Height = 180mm

$$\text{Volume (V)} = 110 \times 120 \times 180 = 0.002376\text{m}^3$$

➤ **Oil Flow Rate**

Oil flow rate of the pump was determined using the Equation

$$Q = AV$$

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 .

$$\text{Area} = \pi r^2$$

$$\text{Area} = 3.142 \times 0.0095^2$$

$$\text{Area} = 0.0009025\text{m}^2$$

$$Q = 0.0009025 \times 3.25$$

$$= 0.002933\text{m}^3/\text{s}$$

➤ **Hydraulic Power**

Hydraulic Power of the machine was determined using the Equation

$$P_h = Q\rho gh$$

where Q is the flow rate in m^3/s , $0.002933\text{m}^3/\text{s}$

ρ is the density of oil in kg/m^3 , at $60^\circ\text{F}(15.6^\circ\text{C}) = 0.871 \times 10^3$

g is the acceleration due to gravity in m/s^2 . $9.8\text{m}/\text{s}^2$

h is the differential head in metres (m). = 1.03m

$$P_h = Q\rho gh$$

$$P_h = 0.002933 \times 0.871 \times 10^3 \times 9.8 \times 1.03$$

$$= 25.79\text{W}$$

Table 2 Some Design Factors and Values.

S/N	DESIGN FACTOR	DESIGN VALUES
1	Volume of Hydraulic tank	0.002376m^3
2	Velocity of flow of fluid	3.25m/s
3	Oil flow rate, Q	$0.002933\text{m}^3/\text{s}$
4	Hydraulic Power, P_h	25.79W

Drawings of the Machine

The detailed Isometric view and Orthographic view of the machine are shown below.

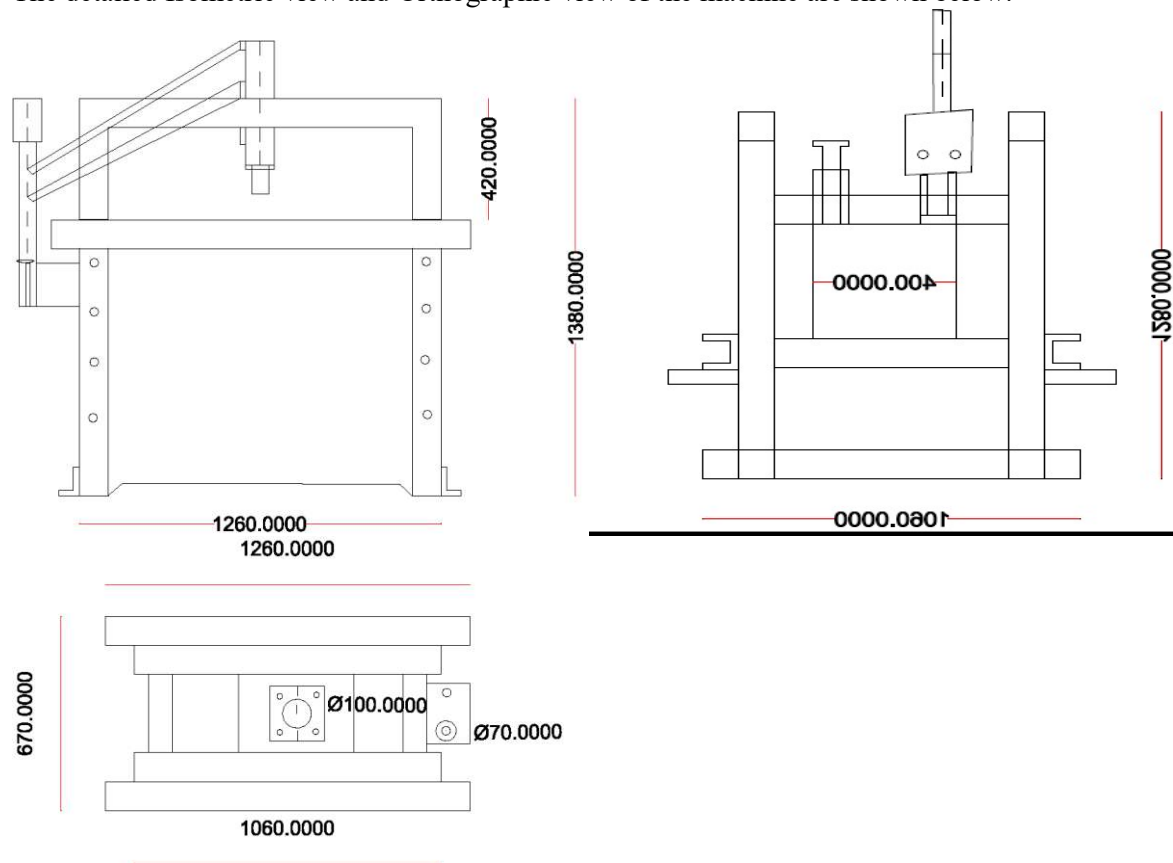


Fig. 3. The isometric drawing of the Machine.



Fig. 4. Picture showing the fabricated machine being put to test.

Fabrication Processes.

The following processes were undergone when fabricating the machine

Measurement: Materials were laid out and measurement made according to the design.

Marking out: After the measurements were taken, some areas were marked out.

Cutting: Marked out areas were cut to form a member.

Drilling: Holes were made on each of the column. This is to give room for adjustment of the working table.

Welding: Various members were welded together to form individual part of the hydraulic press, an electric arc welding technique was adopted to create enough heat to melt metal, and the melted metals when cool resulted in adequate binding of the metals, heat concentration also increases the depth of penetration and speed up the welding operation.

Assembling: The piston and cylinder were fastened and mounted on the base of the frame with bolts which were previously welded together.

The tank which serves as oil reservoir for the hydraulic pump, a mild steel rod hand operated lever was connected to oil tank with the aid of a pivot. Pressure hose was attached to the hydraulic oil tank in order to supply hydraulic oil to a single acting hydraulic pump from the tank. The hydraulic pump has a load capacity of 20 tons.

Finishing: The welded joints were grinded and the surface were filled with body filler to have a smooth finish followed by the application of paint.

Fabrication Considerations

The hydraulic press was designed to operate manually by push and pull force. It was designed for adjustment to be able to accommodate different work piece.

The machine was fabricated using locally sourced and available materials for easy operations and repairs. Standard components/parts were assembled to fabricated. Parts to ensure the low cost of production and maintenance of the machine.

Results and Discussion

After the fabrication and installation of hydraulic press machine, Prior to testing the machine, Physical inspection was carried out on major parts of the machine in order to check for any fault most especially, leakage of hydraulic oil.

Tests were carried out on the machine by using it to press different metals (materials) at maximum pressure.

A metal sheet of 6mm thickness was placed on its working table to be bent, it was discovered that bending of this plate started at a pressure of 8 bar and maximum bending was taken to be 15 bar.

In contrast, performance of the machine developed by (Sumaila, M. *et al.*, 2011) with operating capacity of 30 Tons was tasted with A mild steel plate of length 220 mm, breadth 70 mm and thickness 20 mm bending occurred at a pressure of 50 bar as indicated on the pressure gauge. Also, a 3 mm steel plate of 290 mm × 225 mm was placed on the machine working table (bed) to be bent. It was observed that bending of the plate started at a pressure of 15 bar and maximum bending took place at 20 bar.

Similarly, both machines were able to remove and install bushing into vehicle suspension arm at a pressure of 10 bar.

The fabricated machine worked satisfactorily without any failure under the varying loads, other operations which the machine could perform include but not limited to deep drawing, fitting and stamping.

Conclusion

A hydraulic press was fabricated using locally sourced materials. The machine is capable of performing various press and fitting works, such as; punching, bending and stamping. The machine was used to carry out fitting, removal and installation of bearing from a shaft at a pressure of 10 bar. Comparing the machine with imported hydraulic machine of the same working capacity, it was observed that both had similar functions.

The cost of fabricating the machine locally was N180,000 (\$400) compared to the cost of purchasing the imported ones of same capacity with price ranging from N315,000 - N 450,000(\$700 to \$1,000) excluding the cost of importation. The fabrication of the manual hydraulic press and pull machine will ease workshop activities (especially small and medium scaled) in fitting operation safely with less dependent on electricity, considering the erratic supply of electricity in the nation.

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