



Full Length Research Article

EXPERIMENTAL DESIGN AND FABRICATION OF A PORTABLE HYDRAULIC PIPE BENDING MACHINE

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ABSTRACT

Hydraulic operated equipments are used in various fields. Some of them include lowering and raising of chair hydraulically in Barber or Dentist shops, In an Automobile hydraulic jack is raised for grease job. Stepping on the brake pedal creates the hydraulic power, which stops the rotation of the four wheelers or two wheelers to stop. In order to bend pipes, rods and bars hydraulic bending machine is the most suitable equipment. The pipe or rod to be bent is supported between the holders and jack is actuated on pipe. It exerts force on the pipe and bends it to the suitable angle depending on the dies used. Actuation of hydraulic jack is simple and easy to maintain. In industries, they use presses and load appliers to bending applications. These are bulky and expensive. Hydraulic bending machine is portable, flexible and less expensive than those which are discussed earlier. Hence it is better to replace conventional machines by hydraulic pipe bending machine. It helps in reducing size, space occupied, cost employed can be minimized. Manually operated bending machine requires no maintenance and power consumption. During mass production it can be converted into automated or electrically operated jack so that the rate of production can be increased. Applications of bending machines are found to be in production industries, petroleum, chemical, automobile etc.

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INTRODUCTION

The hydraulic bending press is one of the most flexible machines in the market, allowing the fabricator or ironworker to shear, punch, bend, scroll, and press thousands of different parts. When considering industrial machinery, the hydraulic bending press is the perfect machine shop tool for the metal fabricator. The hydraulic pipe bending press fits any small to medium-sized industry when machinery for large-scale production must necessarily make way for machinery with distinctly lower production costs. The operating procedure of hydraulic pipe bending machine is simple when compared to other pipe bending machine (Colliers Encyclopaedia, 1997). Tube bending as a process starts with loading a tube into a pipe bender and clamping it into place between two dies, the clamping block and the forming die. The tube is also loosely held by two other dies, the wiper die and the pressure die.

The process of tube bending involves using mechanical force to push stock material pipe or tubing against a die, forcing the pipe or tube to conform to the shape of the die. Often, stock tubing is held firmly in place while the end is rotated and rolled around the die. Other forms of processing including pushing stock through rollers that bend it into a simple curve. For some tube bending processing, a mandrel is placed inside the tube to prevent collapsing. The tube is also held in tension by a wiper die to prevent any creasing during stress (Kalpakjian, 1997 and Acherkan, 1973). A wiper die is usually made of a softer alloy i.e. aluminium, brass to avoid scratching or damaging the material being bent. Much of the tooling is made of hardened steel or tooled steel to maintain and prolong the tools life. However wherever there is a concern of scratching or gouging the work piece, a softer material such as aluminium or bronze is utilized. For example, the clamping block, rotating form block and pressure die are often formed from the hardened steel because the tubing is not moving past these parts of the machine. On the other hand, the pressure die and the wiping die are formed from aluminium or bronze to maintain the shape and surface of the work piece as it slides by. Pipe bending machines are typically human powered,

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pneumatic powered, hydraulic assisted, hydraulic driven or electric servomotor. Hydraulic machines are machinery and tools that use liquid fluid power to do simple work. Heavy equipment is a common example. In this type of machine, hydraulic fluid is transmitted throughout the machine to various hydraulic motors and hydraulic cylinders and which becomes pressurised according to the resistance present. The fluid is controlled directly or automatically by control valves and distributed through hoses and tubes. The popularity of hydraulic machinery is due to the very large amount of power that can be transferred through small tubes and flexible hoses, and the high power density and wide array of actuators that can make use of this power. Hydraulic machinery is operated by the use of hydraulics, where a liquid is the powering medium (Beer and Johnston, 1992 and Dagwa and Ibadode, 2005).

Description of the Work

The horizontal press brake was first introduced by SIMASV in 1957, are particularly distinguished by their flexibility and versatility. User-friendly and easy to maintain, the horizontal press brakes can be fitted with countless tools. The horizontal bending press fits any small to medium-sized industry when machinery for large-scale production must necessarily make way for machinery with distinctly lower production costs. The hydraulic pipe bending consists of two series of horizontal press brakes, the standard series and the super series. Both series have gone through decades of improvements which is why no other bending press offers as much value for the investment. One of our biggest improvements was placing the Hydraulic Jack below the table. After years of producing machines with the cylinder above the table (which we still produce today upon request) we standardized on machines with the cylinder below, offering the greatest working environment, and the most bend accuracy due to less deflection in the table. The horizontal machine has the following features:

- Cylinder under work table allowing for better accuracy and more work surface;
- User performs operation in front of the machine instead of the side of the machine making it easier to produce quality products, and frontal position on our press brakes is protected and practical position for the operator;
- Our patented conical pins with lock-on bayonet fittings eliminate all mechanical slack as far as tolerance is concerned, providing maximum rigidity with minimal flexing of work table. This patented feature is why no other horizontal bending press is as accurate;
- Our super series stroke control is by means of hydraulically controlled stroke end devices that allows for greater accuracy (compared to limit switch stroke end control) allowing for continuous movement under pressure, achieving maximum accuracy and repeatability in position; and much more.

Twenty-five tons is the proper tonnage for approximately 50 % of all applications out there. The horizontal press brake the operator should start with a machine no lower than 25 tons if they want to capitalize on a greater amount of profitable work that can be shifted to the machine. The unique cylinder is under the table allowing for the perfect flat open work table

environment that will bring more profit to the end user. This series is a simple series where the operator controls the stroke in and the stroke back by two hand wheels. Simplicity means profit. The 45 ton machine is the proper tonnage for 90% of all applications for a horizontal press brake. For many people who buy or 25 ton machine soon wish they would have made the small extra investment, because the 45 ton machine covers the biggest spectrum of profitable jobs. The most profitable machine in line up for the investment made.

MATERIALS AND METHODS

Hydraulic jack consists of piston, piston rod, screw rod and hydraulic oil. The hydraulic jack reciprocating handle is move upward and downward continuously, so that the compressed oil goes to the hydraulic jack piston. The end of the piston rod the moving die is fixed. The compressed oil pushes the hydraulic jack piston forward. Already the pipe to be bended is fixed in between revolving die and moving die. The die is supported by the die holders. By changing the die in the hydraulic pipe bending machine, we have to produce different shape of bended pipe such as "V" type, "L" type etc. The ram (moving die) is strike the pipe forcibly, so that the pipe is bended according to the shape of the die in the die holder. This is a simple pressing mechanism (Degarmo *et al.*, 1997 and Khurmi and Gupta, 1997). The main components in a portable hydraulic pipe bending machine are hydraulic cylinder, ram, oil tank, plunger pump, release valve lever, handle, die, die holder, helical spring and hydraulic drive. Hydraulic systems possess numerous advantages over other systems of power operation. They are light in weight; they are simple and extremely reliable, requiring a minimum of attention and maintenance. Hydraulic controls are sensitive, and afford precise controllability.

Design Details

There is no fixed machine design procedure for when the new machine element of the machine is being designed a number of options have to be considered. When designing machine one cannot apply rigid rules to get the best design for the machine at the lowest possible cost. The designer who develops the habit of following a fixed line of steps for designing the machine or machine elements cannot come out with the best product. Figure 1 shows the design details of the hydraulic pipe bending machine.

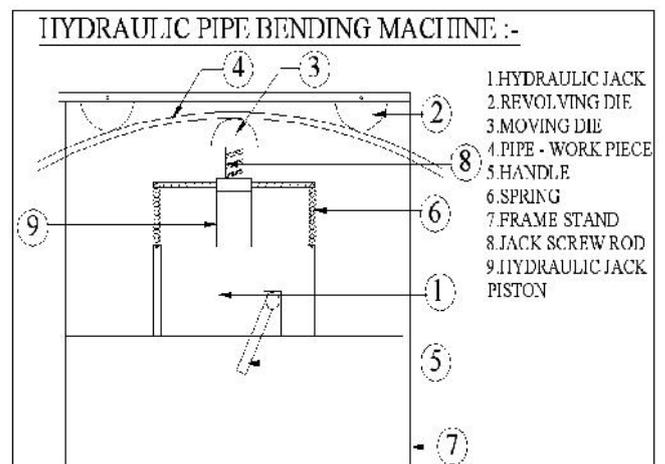


Fig. 1. Design details of Hydraulic Pipe Bending Machine

When the new product is to be developed the problems keep on arising at design stage, and these can be solved only by having flexible approach and considering various ways.

Some of the design details estimated in the work is as follows:

1. For diameter 40 mm, stroke 100 mm and shaft diameter 12 mm, load exerted on the hydraulic cylinder is 26138 kg.
2. For hydraulic pipe bending machine, design of frame deals with two reaction forces, where load $W = 4.5$ kN.
3. Maximum bending moment = 170 kNmm.
4. Stress on the beam = 190 N/mm².
5. Load exerted on the side bar = 1/136 kN.
6. Load exerted on each legs = 580 N.
7. Factor of Safety = 2.16, since it is greater than 1, the design is safe.

Figure 1 enumerates the list of materials is enclosed below:

Fig. 1. List of materials

SL. NO.	NAME OF THE PARTS	MATERIAL	QUANTITY
1	Hydraulic Jack	C.I	1
2	Spring	Steel	2
3	Oil	Servo-38	250 M.L
4	Moving Die	C.I	1
5	Revolving Die	M.S	2
6	Die Holder	M.S	2
7	Frame Stand	M.S	1
8	Shaft	M.S	2
9	Bush-1	M.S	1
10	Bush-2	M.S	1



Fig. 2. Fabricated Hydraulic Pipe Bending Machine

Cost Estimation

Figure 2. Material Cost

SL. NO.	NAME OF THE PARTS	MATERIAL	QUANTITY	AMOUNT
1	Hydraulic Jack	C.I	1	5200
2	Spring	Steel	2	200
3	Oil	Servo-38	250 M.L	150
4	Moving Die	C.I	1	500
5	Revolving Die	M.S	2	600
6	Die Holder	M.S	2	400
7	Frame Stand	M.S	1	2000
8	Shaft	M.S	2	450
9	Bush-1	M.S	1	200
10	Bush-2	M.S	1	150
TOTAL				9850/-

Labour Cost

Lathe, Drilling, Welding, Grinding, Power Hacksaw, Gas Cutting

Cost = 1200/-

Overhead Charges

The overhead charges are arrived by "Manufacturing cost"

Manufacturing Cost = Material Cost + Labour cost
= 9850+1200 = 11050/-

Total cost for this project = 11050/-

Scope for Future Work

Existing hydraulic bending machines are manually operated and requires no power consumption. It also has no maintenance cost and hence it makes cost effective, but when mass production is being carried out its manufacturing lead time and cycle time is very high. This makes it slower and requires some changes. Manually operated can be converted into electrically operated or pneumatic operated by using necessary equipments. This makes the device suitable for mass production. This reduces manufacturing lead time and cycle time, but converting manual into automated system requires high initial cost and maintenance cost. It also becomes bulky and complex with the addition of new components (Lange, 1975). This method is useful as it increases the rate of production and finds extensive applications in automobile industries. Tubes can also be bent in automatic control. We measure the bends by using vernier caliper. In case of flat bend, the mandrel should be advanced.

Conclusion

This work has provided an excellent opportunity and experience, to use limited knowledge. It has gained a lot of practical knowledge regarding, planning, purchasing, assembling and machining while doing this project work. The work is a good solution to bridge the gates between institution and industries. The work is completed the work with the limited time successfully. The "HYDRAULIC PIPE BENDING MACHINE" is working with satisfactory conditions. Before concluding a point to note is that the particular pipe bending machine which we have designed for multiple operation. To facilitate the above, there is a provision in the frame to change the table if necessary. Thus if we want to perform any press operations using die and punch, than a table having a provision to hold a die can be used and corresponding punch can be fixed to the ram end.

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