

DESIGN AND FABRICATION OF HYDRAULIC BENDING MACHINE

S.KIRAN KUMAR

M.TECH

BVRM KUMAR M.TECH

K.SUNEETH KUMAR REDDY

K.VAMSI KRISHNA

G.MAHITH RAJU

K.YASWANTH

M.JYOTHI PRAKASH

DEPARTMENT OF MECHANICAL ENGINEERING

ABSTRACT

The hydraulic metal bending machine is planned to do bending activity for utilizing a hydraulic power pressure. This bending machine bends a small piece of sheet metal, plates, pipes, bars, rods. The motto of this project is to develop a portable low cost bending machine. This project comprises of a hydraulic jack, pedestal bearings, basic casing, driving and driven rollers, metal shaft, nut and bolts. This works on a principle of three roller mechanism. The fundamental favorable position of our venture is Metal bar are twist fit as a fiddle (U-shape, circle twist) constantly and less human exertion in task.

Keywords: Bearing, Frame, Hydraulic Bending Machine Shape, Production, Rollers connection.

1. INTRODUCTION

This investigation is all about working and designing of bending machine. This bending machine can bends a small plate, rods, pipes, tubes. This kind of metal has its own particular thickness. The bending machine planner will think about various components including kind of metal, roller bender types, the kind of power supply and bending machine size. The bar is bending with the assistance of pressure driven power, in light of the fact that the energy of hydraulic power is vast, so with the assistance of hydraulic driven power we can bend the bar. Actually, bending is procedure of plastically deforming a metal bars, tubes etc and changing its shapes. Bending is adaptable process by which a wide range of shape can be achieved. Its produces shapes like v shape, u shape, and circular shapes can also be achieved. These Machines are to work easily and effectively.

Functions of Bending Machine:

- This bending machine can work manually.
- The hydraulic powered jack limit from 5 ton to additional.
- This machine needs less maintenance.
- To give U-shape, circular bend of metal bar.

Roller Requirement:

- Roller should be highly accurate and easy to manipulate.
- The minimum effort should be required to bend the pipe.
- It should provide the direction control

Elastic and plastic deformation

The plastic deformation of the bar is retained throughout the process. However, the elastic deformation is reversed as a section of bar leaves the area between the rollers. This “spring-back” needs to be compensated in adjusting the middle roller to achieve a desired radius. The amount of spring back depends upon the elastic compliance (inverse of stiffness) of the material relative to its ductility. Aluminum alloys, for example, tend to have high ductility relative to their elastic compliance, whereas steel tends to be the other way around. Therefore aluminum bars are more amenable to bending into an arc than are steel bars.

2. LITERATURE REVIEW

The paper oversees collecting of channels which use control worked sheet bending machine and physically worked sheet bending machine. It moreover fuses confinements of physically worked bending machine. From the outcomes of the paper the productivity of vitality worked bending machine is higher.

P. S. Thakare et al.[1]. Author told in late year's pipe bending machine is used as a piece of both industry and domestic purpose behind bending the pipe under the required edges and angles. From time to time Heat treatment is used for pipe bending however this strategy isn't safe and have issues are made in the pipes, for instance, wrinkling, twist forming, decreased thickness, whole encircling, diminished quality, basic wobbly. These bending machines have a great advantage over the heat treatment method.

V. SenthilRaja et al. [2]. In this paper, a bicycle consolidated pipe bending instrument has been laid out and made. The usages of bowed directs are in traces, bars, handle of bicycle. The dominant part of endeavours uses bowed pipes as air conditioning, boiler, control age, send building, furniture, railroad, auto, go earth street frolicking and develop adapt, flying machine et cetera. In view of adequate human power in countries like India, the human controlled machine will achieve change of the economy and work of nation. In Asian countries people are defying power cut-off in the midst of most of the days so such system expects a basic part in

commonplace areas.

H. A. Hussain et al. [3]. Weight driven equipment has wide use in various vehicle fields. These hydraulic controlled instruments are used for cutting down and bringing seat up in Barber shops and in dental clinics.

Hydraulic bending machine is the sensible equipment to contort channels, shafts and bars. The pipe or shaft to bend is kept between the rollers. With usage of water driven jack we realize compel on the pipe and bend it to the required point dependent upon the kicks the can used. Water controlled bending machine is less expensive, flexible and flexible stood out from those which are inspected previously. Along these lines it is quicker witted to supplant current standard machines by weight driven pipe curving machine.

3. PROBLEM IDENTIFICATION

The motivation to outline a bending machine for pipe bending is that as there is no such a small scale bending machine. The bending machine found in the market comes with too many varieties. There are bending machine such as roll bending machine, press brake bending machine and folding machine. In addition, the plan for the bending machine for pipe bending is to bend a metal pipe. It produces sheet metal bending with want level of bending aside from 90°. Other reason in regards to the bending machine plan, the bending machine in the market comes with the enormous size and the bending machine is costly. The current bending machine in the market is made for huge capacity for bending a metal pipe. With the limit of bending machine that exists in the market, the current bending machine isn't satisfying the necessity of the use. The prerequisite of task of bending machine is basic. In this manner it isn't appropriate to buy existing bending machine to be utilized for straightforward bending machine activity. Besides, the machine is so heavy and it also requires some more space.

4 . DESIGN

The design of the hydraulic bending machine is done by selecting the materials, bearings, hydraulic jack, hinges.

material selection:

The material selected for the fabrication of hydraulic bending machine is Iron and Mild steel. The properties for the following materials is as listed below.

PARAMETERS	VALUES
TENSILE STRENGTH	540 MPa
YIELD STRENGTH	50 MPa
POISSON'S RATIO	0.291
MODULUS OF ELASTICITY	200 GPa
SHEAR MODULUS	77.5 GPa
DENSITY	7.874 g/cm ³

Table (2) : properties of Iron

PARAMETERS	VALUES
TENSILE STRENGTH	440 MPa
YIELD STRENGTH	370 MPa
POISSON'S RATIO	0.290
MODULUS OF ELASTICITY	205 GPa
SHEAR MODULUS	80 GPa
DENSITY	7.874 g/cm ³

Table (2) : properties of MS

Basic components:

The basic components of Hydraulic bending machine is given below:

Basic Frame:

- Cross-section length for base=60cm
- Cross-section length for upper beam =29cm (each)
- Flange length=9cm
- Flange thickness=1cm
- Web length= 14cm
- Web thickness=1cm
- Hinge length=14cm
- Hinge width=20mm

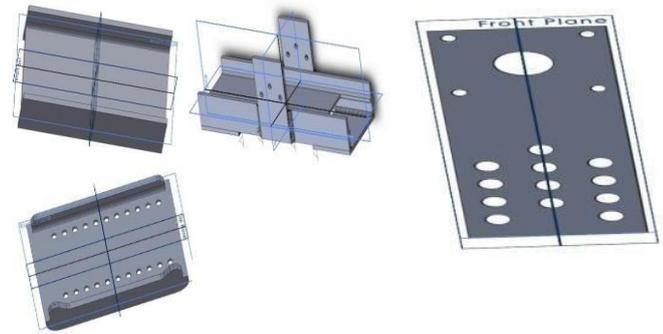


Fig (1) : Base and side frames

roller shafts:

A shaft is a rotating machine element which is used to transmit power from one place to another. In this undertaking the roller is utilized to twist a pipe fit as a fiddle. There are 3 rollers are utilized to twist a pipe in arch shape. Roller is a chamber that turns about a focal pivot and is utilized as a part of different machines and gadgets to move, level or spread something. A roller dependably comprises an orientation.

- Length of driving roller= 36cm
- Diameter of driving roller=25mm
- Length of driven roller=30mm
- Diameter of driven roller=20mm

Bearings :

A bearing is a machine element that constrains relative motion to only the desired motion, and reduces friction between moving parts. The design of the bearing may, for example, provide for free linear movement of the moving part or for free rotation around a fixed axis; or, it may prevent a motion by controlling the vectors of normal forces that bear on the moving parts. Bearing are utilized to give simple and helpful movement to roller by utilizing shafts which is append to roller. We take 4 bearing of 20 mm, for 2 piece of each driven roller, 2 bearing of 25 mm for driving roller.



Fig (2) : Bearing

Hydraulic jack:

The Hydraulic jack is worked with the assistance of the given handle. Hydraulic jack is based on the **Pascal's law** which states that increase in pressure on the surface of a confined fluid is transmitted undiminished throughout the confined vessel or system. This jack can be utilized to apply a lot of power and weight, because of the nearness of pressure driven liquid. The hydraulic jack that can lift up to 5 tonnes.

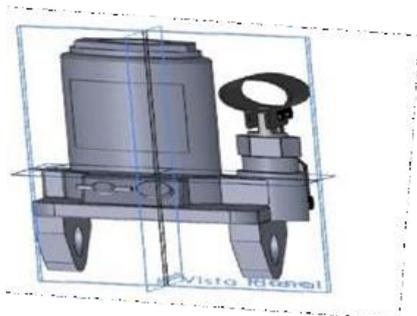


Fig (3) : hydraulic jack

4.2.6 Hinges:

A hinge is a mechanical bearing that connects two solid objects, typically allowing only a limited angle of rotation between them. Two objects connected by an ideal hinge rotate relative to each other about a fixed axis of rotation: all other translations or rotations being prevented, and thus a hinge has one degree of freedom. Hinges may be made of flexible material or of moving components. In biology, many joints function as hinges like the elbow joint. Sizes of the hinges vary with respect to the types, as known to the professional interior designers. The data required for selecting the types of hinge are: door/panel thickness, the components weight and the space available.

5. WORKING

Here, we are going to design and develop a hydraulic metal bending machine with the help of hydraulic jack and rollers as shown in the figure. The one driving roller is at the upper position for positioning of the metal workpiece. The two driven rollers are at the lower position. The hydraulic bottle jack is used to give the motion by applying pressure while bending the metal. The metal piece is feed from the roller and because of the hand wheel the metal piece is passed from the rollers by the rolling motion. The work piece is inserted between the driven roller and driving roller as shown in fig. The bending force is applied through hydraulic jack when the handle is operated and the workpiece can be adjusted. Thus the work piece is bend. It works on the hydraulic principle due to pressure of hydraulic is very high. The figure shown below is working of hydraulic bending machine.

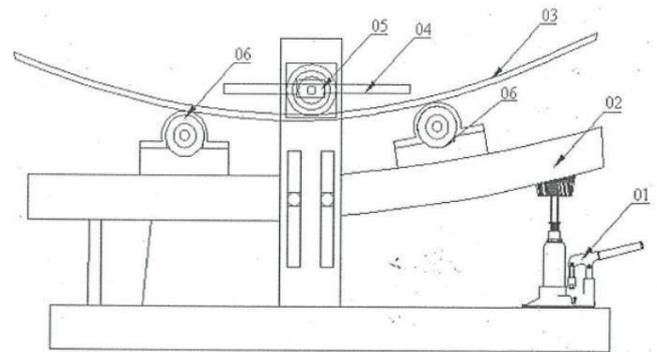


Fig (4) : Sketch of hydraulic bending machine

- 1-Hydraulic Jack
- 2-Workbench
- 3-Workpiece
- 4-Handle
- 5-Driving Roller
- 6-Driven Roller

6. PROCESS OF ROLLING

Actual process of rolling:

In the first stage the plate is kept between top roller and bottom rollers as shown in Figure and the top roller is given vertical displacement to get the required bend. In next stage the bottom rollers are driven using motors in forward direction to get the roll bending of the plate. Similarly the rollers are driven in reverse direction to get better dimensional accuracy of the final product. The bent plate is than unloaded by raising the top

roller. For continuous single-pass four roll thin plate bending a model was proposed considering the equilibrium of the internal and external bending moment at and about the plate-top roll contact. They had considered varying radius of curvature for the plate between the rollers and proposed a mathematical model to simulate the mechanics in a steady continuous bending mode for four-roll thin plate bending process and also investigated Influence of material strain hardening on the mechanics of steady continuous roll and edge-bending mode in the four-roll plate bending process For continuous multi-pass bending of cylinder on 3-roller bending machines with non compatible (cylindrical) rollers, Gandhi et al. had reported the formulation of spring back and machine setting parameters They incorporated the effect of change of flexural modulus during the deformation in the formulation to study the effect on spring back prediction. For plane strain flow of sheet metal subjected to strain rate effects during cyclic bending under tension

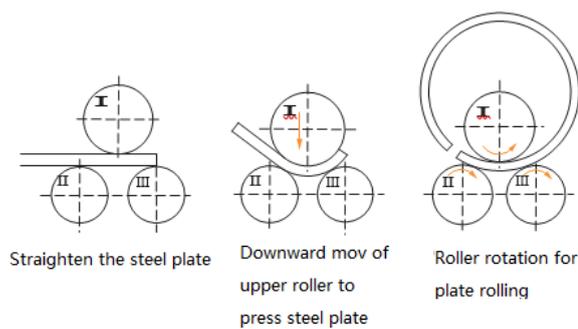


Fig (5) : process of rolling

Modified rolling process

Here the modification made is the IIIrd roller is moved upwards according to the requirements.

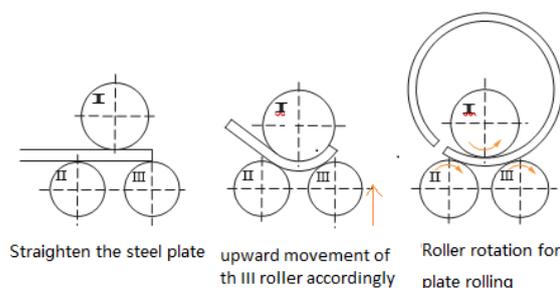


Fig (6) : modified process of rolling

This movement is achieved by increasing the height of the hydraulic jack piston by pumping the jack.

7. FABRICATION

To start with, we used a piece of home girder with total length 144cm, 18cm width and 9cm height. Then, we cut it in four pieces, 3 pieces of 28cm and another one of 60cm. We made the basis of our machine by putting the long piece on the basis and then we welded one of the pieces of 28cm vertically, on it. On the last piece, we connected another one piece of 28cm horizontally. In this way, we completed the basis of our machine.

Regarding the remaining piece, we connected it with a hinge of 20mm thickness and 18cm length on the horizontal, stable piece of 28cm. In this way, we created the moveable piece of the metal bender that regulates the inclination that we want to have on the bending pieces. On the two pieces of 28cm both the moveable one and the immovable one, we placed 4 bearing of 20mm, 2 in each piece. While between the two pieces, we placed a bearing with a flange of 25mm. The height of these bearings is regulated with some holes that we created at the sides of the metal bender in order to regulate the height of the central axis according to the thickness of the material that we want to bend and they have the potential to alter positions according to the height of these bended materials. In this way, placing three metallic axis, 2 of 20mm thickness and one of 25mm thickness, we created the rollers, on which the irons roll during the bending. The inclination on the moveable piece is made with a bottle jack that it can lift up to 5 tonnes. Moreover, placing a screw at the central point of the axis, we can put the drill to revolve the axis and bend metals as well as revolve using also the hand supported by a wheel that is located on the same point.

One detail that increases the potentials of the particular construction is that all the required adjustments have been made so that the axes from the one side can be exerted in order to make some space to place the rollers for bending tubes or circular iron materials. Also, another crucial detail that increases the functionality of our machine is the regulation through the holes, with which we can move the bearings of 20mm away from the center or vice versa. This is very important as while bending thick metals, the bearings decrease the power when they are away from the center while for the creation of narrower bending, the bearings are placed as closer to the center as possible.

8. DESIGN CALCULATION

Load and deflection calculations for Hydraulic jack

W = Load applied through jack

A = Area

S_{yt} = Yield strength of material

δ = Deflection

L = Length between two bobbins

E = Modulus of elasticity

$$\delta = \frac{WL^3}{48EI}$$

$$W = S_{yt} * \text{Area}$$

S.NO	Length(mm)	Pipe Diameter(mm)		Load(N)	Deflection (mm)
		Outer dia	Inner dia		
1.	200	20	18	23637.3	6.48
2.	200	25	20	69978.9	4.98
3.	300	20	18	23637.3	22.90
4.	300	25	20	69978.9	15.47
5.	400	20	18	23637.3	51.92
6.	400	25	20	69978.9	36.70

Table (3) : load and deflection calculation

9. 3D MODELLING

The modelling for this machine is done in

Solidworks software, the main reason to do in Solidworks is it is easy and accurate to model anything effectively.

SolidWorks is a solid modeling computer-aided design (CAD) and computer-aided engineering (CAE) computer program that runs primarily on Microsoft Windows. While it is possible to run SolidWorks on MacOS, It is not supported by SolidWorks. SolidWorks is published by Dassault Systèmes.

SolidWorks is a solid modeler, and utilizes a parametric feature-based approach which was initially developed by PTC (Creo/Pro-Engineer) to create models and assemblies. The software is written on Parasolid-kernel.

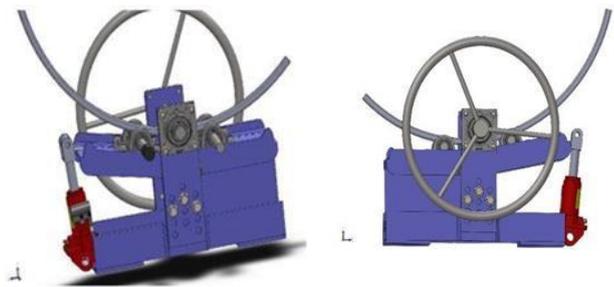


Fig (4) : solidworks model of hydraulic bending machine

10. EXPERIMENTAL CALCULATIONS

After fabrication the experiment is done with same dimensions as in the design calculation. The experimental calculation of load and deflections are

S.NO	Length(mm)	Pipe Diameter(mm)		Load(N)	Deflection (mm)
		Outer dia	Inner dia		
1.	200	20	18	22085.4	5.89
2.	200	25	20	65384.4	5.01
3.	300	20	18	22085.4	19.83
4.	300	25	20	65384.4	16.02
5.	400	20	18	22085.4	53.01
6.	400	25	20	65384.4	36.01

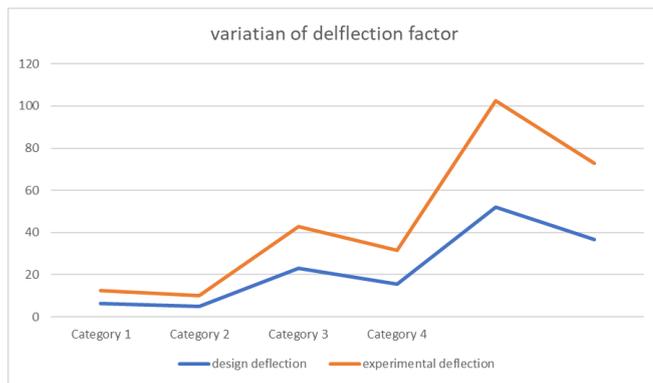
Table (4) : Experimental calculation

10. RESULTS

As per research of different working territories this machine is valuable for bending a pipe, metal piece. This machine can be used for domestic purpose or for small scale industry. As per the calculations, it is able to bend bars, rods of various sized like 6,8,10,12 mm of rods and upto 25mm for hollow bars. This machine does not elongate the workpiece but deflects the bar to a required angle it may till 60°. It is concluded that this machine can bend the rods of over 60% of its driving roller size i.e diameter of rods and can bend the bars of about 90% of its driving roller shaft size i.e diameter for bars.

14. REFERENCES

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Graph (10.1) : variation of load and deflection

11. CONCLUSION

Hydraulic Bending machine is a procedure which is utilized to make part for car, aviation, families and control plant ventures and so on. Our Hydraulic bending machine is more affordable, light in weight in contrast with different machines along these lines, it can be ideal for small industry holders, small workshop holders, in school organizations and so forth.

12. LIMITATIONS

- Hydraulic jack sometimes gets leaked
- Quite heavy due to iron channels
- The rollers should be replace with heavier materials to withstand bending.

13. FUTURE SCOPE

There are many ways to improve this machine to the next level of machining.

- By increasing size of the bearings and rollers, we can bend any shapes and sizes.
- By reducing the weight by alternate consideration of materials for base frame and rollers.
- By changing the roller's material, we can increase the efficiency of the machine.
- By introducing electrical and electronic components we can reduce human efforts.
- After alternate material consideration increasing the size also plays a role for small scale enterprises to work effectively.