

Design and Fabrication of Pipe and Rod Bending Machine

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ABSTRACT

The world is focusing on automation. Humans are been replaced by machines, but in few sectors like fabrication and construction where huge number of pipes and rods are to be bend are still not done by machines due to high machine cost and needs skilled labour. The main objective of designing this machine is to bend pipe and rod in different angle curvature and shape as per requirement of work. The principal advantages of this machine are less time consuming, production of identical shapes, higher production rate than old traditional method.

The experimentation performed on this machine resulted in reducing the rejection rate by 30%, increased the production rate by 65% & decreasing the cost by 48% and achieving other objectives like improving the surface finish and eliminate the need of skilled labour.

1. INTRODUCTION

Rod and Pipe is extensively used in the construction of buildings and fabrications. Due to heavy prices rod bending machines did not reach to small scale construction workers. The rod and pipe bender is designed for small scale constructional bending purpose which is also very adjustable. In traditional method bending of straight reinforcement rod is done with hand operated mechanism. Whole accuracy of bend depends on Skill & experience of worker. So our project is to design and develop Rod and Pipe Bending Machine, which is used to bend rod of any free size with higher speed and desired accuracy. there are machine works on pneumatic and hydraulic are also used for making different shapes but those machine has major disadvantage of requirement of large space for storage tank and compressor which makes machine heavy and immobile.

2. LITERATURE REVIEW

Mohammed, S.Ravivishwanth, N.Saravanan discussed about minimizing the human effect but in case of stirrups making, it involves the manual effort because of cost efficient and labour work is involved to some extent.

P. S. Thakare discussed about use of bending machine in industry and domestic purpose for bending the stirrups under the required edges and angles. This bending machines had disadvantages like high operation time and low productivity. Because of labour operated the process is not fast and continuous.

P. Sureshkumar discussed about usage of hydraulic load to deliver higher power compared to the gas and electrical system.

A.D Zope, et. Al. developed a portable bending machine used for bending sheet into curve shape. These machine is very small in size compare to other pipe bending machine. These machine used to bend up-to 8mm thick sheet. 3 rollers are used in bending machine in a paper on design and development of metal bending machine.

Jun Zhao Gaochao Yu Rui Ma [3]“Journal Of Material Processing Technology” discussed a mechanical model of static bending deformation in the symmetrical three-roller setting round process is established, and the quantities

relationship between the upper roller load, bending curvature of each micro-pipe-wall element and the reduction are predicted. This not only lays a theoretic foundation for the development of the three-roller special setting round machine and control strategies, but also provides an idea for resolving a many degree of statically in determine problem with an elastic-plastic deformation.

3. PROBLEM DEFINITION

It had come to over notice that the workers in the industry had to apply an immense amount of pressure to bend the workpiece. As the hardness and thickness of the material increased the effort required to bent is enormous. Which in turn, increases the workforce. This does not only increases production cost but also the blunders, errors and rejection. The rejection rate is higher because of bending defects and low surface finish. Also, the accuracy of the workpiece bent manually was low. To survive in this market with cut-throat competition, the provision is to give more than the requirement and at the same rates.

4. PROPOSED METHODOLOGY

The main objective of our project is to develop an semi-automatic rod and pipe bending machine. In the construction sites and for fabrications rod is bent manually by the skilled worker. So, to scale back the work of the labour this machine is developed with less initial value and maintenance value. The accuracy of the machine is good and productivity is high.

5. OBJECTIVE

This project is developed to study about the automation in process of pipe bending machine industries. Mainly preferable for small industries. The purpose of this project is listed below:

- To increase the accuracy of product.
- To reduce the time consumption.
- Less machine setup time is required.
- To produce curve and curvature shaped bend pipe.
- Pipe should be bent in 90 degree.

6. CONSTRUCTION AND WORKING PRINCIPLE

Rod bending machine consist of a metal frame structure made of Mild Steel, Electric Motor, Gear Drive box, Extended shafts, gear drive for transmission, Jigs and Fixture arrangement for bending of rods and pipes to desired shape and angle. The metal frame is a table type structure above which the jig and fixture is installed. The down side of the frame has several rods for the mounting of the motor and the gear box. The power from the gearbox is transferred to the jig through gears.

The electric motor is given electric supply and mechanical work is obtained from it. The pulley of the motor rotates and then it is transmitted to the gear box. The speed obtained from motor is high but torque is low so the gear box is used to reduce the speed and increase the torque which is used to bend the rids and pipes. Belt drive is used for transmission from motor to gear box. The further transmission is done through gear arrangements. The jig has a pulley fitted in it which is used for holding the rod or pipe. The fixture is used for holding the rod in a certain position and it does not allow the rods to slip off its position during the bending operation. The motion is provided to the jig and pulley through the transmission system below. And it generates the power and torque to bend the pipes to the desired shape.

7. 3D CAD MODEL

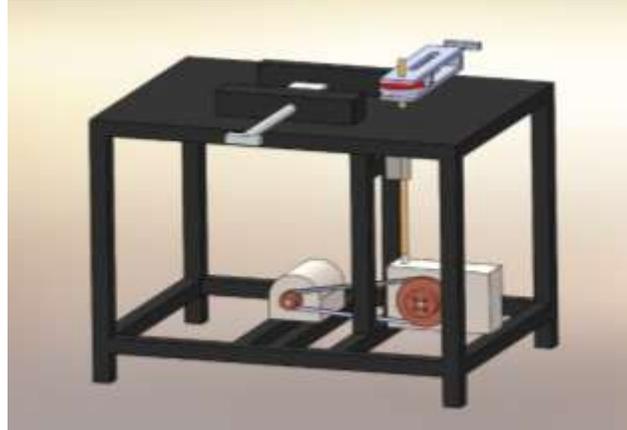


Fig -1: 3D Design of Machine

8. CALCULATIONS

8.1 Mild Steel Pipe

Grade : 1008

Diameter : OD =30mm

ID = 27.3 mm

Ultimate Strength : 285 MPa

Bend Radius : 30mm

Moment of Inertia

$$I = \frac{\pi}{64} * (OD^4 - ID^4) = 12.49 * 10^3 \text{ mm}^4$$

Factor of Safety

F.O.S = 5

Bending Stress

$$\sigma(b) = \frac{S_{yt}}{FOS} = \frac{285}{5} = 57 \text{ N/mm}^2$$

y = 30mm

Bending Moment

$$M = \frac{I * \sigma b}{y} = \frac{12.49 * 10^3 * 57}{15} = 23.731 * 10^3 \text{ N-mm}$$

Length of the pipe where bend has to be done

L = 200mm

Force Calculation

M = F * L

$$23.731 * 10^3 = F * 200$$

F = 118.655 N

This is the force at which Rod Starts to bend

Torque Calculation

$$T = \frac{F * R}{1000} = \frac{118.655 * 30}{1000}$$

T = 3.56 N-m.

Power Required

$$P = \frac{2\pi NT}{60} = \frac{2 * \pi * 6 * 3.56}{60} = 2.23 \text{ K.W}$$

Converting KW to HP

P = 2.23 * 1.34

P = 2.99 HP

The Power required for the Bending operation is 2.23 KW or 2.99 HP.

9. EXPERIMENTATION

Table -1: Experimentation

Sr.No	Component	Material	Dimensions
1	Rod	M.S	D=10mm
2	Pipe	M.S	O.D = 30 mm I.D = 27.3 mm
3	Rod	S.S	D=10mm
4	Pipe	S.S	O.D = 30 mm I.D = 27.3 mm

10. RESULTS

10.1 Time Analysis

Table -2: Time Analysis

Component	Manual	Machine
	Total time	Total time
S.S pipe	180 sec	110 sec
M.S pipe	150 sec	95 sec

10.2 Rejection Rate

Table -3: Rejection rate

Component	Manual Operation	Machine Operation
S.S pipe	4	1

10.3 Production Rate

Table -4: Production rate

Component	Products produced per hour	
	Manual	Machine
S.S pipe	20 pcs	33 pcs
M,S pipe	24 pcs	37 pcs
S.S rod	17 pcs	29 pcs
M.S rod	24 pcs	37 pcs

10.4 Cost analysis

Table -5: Cost analysis

Manufacturing cost		Total Cost	Savings per month	Payback time
Components	Fabrication			
41,200	7,000	48,200	24,250	2 months

11. ADVANTAGES

1. low cost as compared to hydraulic and pneumatic machines.
2. Less skilled and uneducated worker can also operate this machine.
3. Less time consuming.
4. Less effort required.
5. Higher production rate with desired accuracy

12. CONCLUSION

Rod and pipe bending machine is a semi-automatic machine which is able to bend Rods & pipes of various dimensions very accurately. This Machine overcomes the limitations faced by manual bending operation. This machine will be helpful in many small scale industries due to its compatibility, efficiency and reliability.

1. Rod and Pipe bending machine to produce bend pipes and rods of desired accuracy and surface finish
2. The production rate is also high as compared to manual operations. Production rate is increased by 65%.
3. The labour cost is reduced due to requirement of less labour and also due to less time required for producing the certain lot of bends
4. Time taken to manufacture was reduced by 35%
5. The per piece cost of manufacturing is decreased by 48% and also the production is boosted

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