

# Design and Fabrication of Pneumatic Rod Bending Machine

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## ABSTRACT

Now in this world the use of bending machine is increased. Bending is used in industries for a wide variety of uses, including blanking and pressing. There are many different types of bending. The most popular are pneumatic bending and hydraulic bending. But pneumatic bending is more preferable than hydraulic bending. The greatest advantage of Pneumatic bending is their speed. Pneumatic bending is 10 times faster than hydraulic bending and they can perform many jobs faster and more efficiently. Pneumatic bending is extremely flexible, that they can be placed in a factory in any required position, even upside down. The objective of our project is to Design and Fabrication of Pneumatic bending capacity of and to make a Bend of 6mm thickness TMT rod. The main objective of this project is to implement the Pneumatic rod bending machine in the construction sites with less cost compared to the existing bending machines, and increasing the productivity of the stirrups. The bending machine is one of the most important machine tool in sheet metal work shop. It is primarily designed for bending. The bend has been made with the help of punch which exerts large force on the work clamped on the die. The bending machine is designed in such a way that, it works automatically.

## INTRODUCTION

### *Problem Summary:*

Since long time ago the labour work has essential role in constructions including mixing coarse aggregate sand water, cement, ramming sand, land leveling and digging the foundation for base of structure, cutting rode, etc. Now a days due to development in technology it is required to reduce the labour work and time since there are lot of resources. Several problems comes in to the picture when we consider the human work with respect to automation. By using conventional methods it is not possible to reduce construction time and building it as early as possible. So, automation in construction system is required. Now-a-days

in industries especially in automobile and other industries the automatic plate bending machines are widely used. Earlier the bending machines where operated manually. So the output of machine was very less. Now the technique of bending operation of the component is changed. Once the plate is loaded the operator should not only use once push button to start the machine, but he has operated two push buttons so that both the hands of the operator are engaged. This arrangement is made in order to avoid injuries to operators. The main aim of this project is to have the complete know how of pneumatic devices, sensors etc. by which the manually operated press or any machine can be converted into a semi or fully automatic unit. In this project the bending machine is a semi-automatic bending machine, in which the loading and unloading of the component is done manually and the bending of the rod is done pneumatically.

### *Objectives of the Project:*

1. To make a bending machine to bend a metal bar up to 20mm.
2. Analytical design of pneumatic tmt rod bending machine.
3. Modelling and simulation of pneumatic tmt rod bending machine.
4. Preparation of prototype sample of pneumatic tmt rod bending machine.
5. Experimental workout of pneumatic tmt rod bending machine.
6. Study of comparative result of pneumatic tmt rod bending machine.

### *Aim of Project:*

Pneumatic TMT rod bending machine will reduce the manual efforts of the user. Pneumatic TMT rod bending machine will be useful to the user to manage and generate

accurate results for TMT rod at the time of bending. It will reduce the time compare to manually doing.

#### *Project Details:*

Where your project or innovation will use?

Our project/innovation is going to be used in construction sites. Because we are seeing that the labours who are working at construction places have to do the rod bending by there own hands. It is creating physically problems for the workers.

POWER FOR ENDING CAN BE CLASSIFIED  
ACCORDING TO :

#### *Energy Supply*

Mechanical Bending Hydraulic Bending Pneumatic

Bending Steam Bending

Electromagnetic Bending

#### *Function*

Energy producing machines Force-producing machines

Stroke-controlled machines

#### *Construction*

C-frame presses or gap-frame Closed-frame presses or O-frame

2 - Pillar type

4 - Pillar type

#### *Operation*

Single-Action Press

Double-Action Press Triple-Action Press Multi-slide Press

#### **MECHANICAL BENDING:**

A bending is a device for applying a large force to some object or set of objects. Typical forces are in the range of one to fifty tons. In many cases the objects are metallic. A press may be used to form an object, to make a hole in it, or to force two objects together, amongst other purposes. If an electric motor or some other source of work other than human effort is used to drive the press then it is said to be a power press. If the press achieves the large forces required of it using, say, hydraulics then it is called an hydraulic press. If it uses some form of mechanical gearing to achieve the large forces that it imposes on the objects being processed, and the press is powered, then it is a mechanical power press. Probably the simplest form of mechanical press is shown in the top photograph in the article given by the link. Turning the handles at the top turns the screw which pushes the Work piece.

#### **MATERIALS/TOOLS REQUIRED**

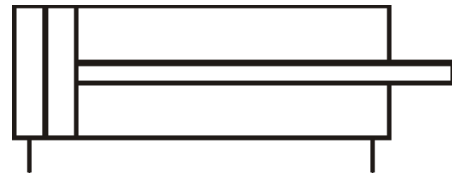
##### *Hardware Modules:*

Thermo-mechanical processing, also known as thermo-mechanical treated bars' (TMT), is a metallurgical process that integrates forging, rolling and/or work hardening with heat-treatment into a single process.

##### *Components:*

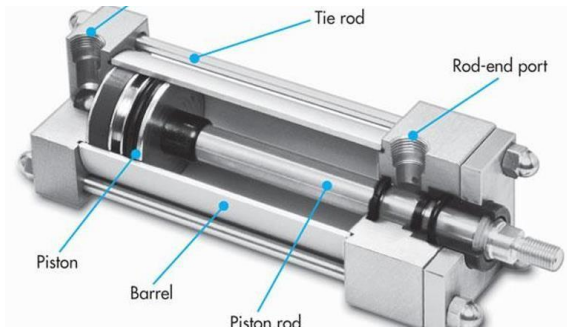
1. Pneumatic Cylinder
2. Solenoid Valve
3. Air Compressor
4. Air Pipe
5. Rods
6. Pressure Gauge

##### **Pneumatic Cylinder:**



#### **DOUBLE ACTING CYLINDER**

Pneumatic cylinder(s) (sometimes known as air cylinders) are mechanical devices which use the power of compressed gas to produce a force in a reciprocating linear motion. Like hydraulic cylinders, something forces a piston to move in the desired direction. The piston is a disc or cylinder, and the piston rod transfers the force it develops to the object to be moved. Engineers sometimes prefer to use pneumatics because they are quieter, cleaner, and do not require large amounts of space for fluid storage. Because the operating fluid is a gas, leakage from a pneumatic cylinder will not drip out and contaminate the surroundings, making pneumatics more desirable where cleanliness is a requirement.



#### Solenoid Valve :

A solenoid valve is an electromechanically operated valve. The valve is controlled by an electric current through a solenoid. In the case of a two-port valve the flow is switched on or off; in the case of a three-port valve, the outflow is switched between the two outlet ports. Multiple solenoid valves can be placed together on a manifold. Solenoid valves are the most frequently used control elements in fluidics. Their tasks are to shut off, release, dose, distribute or mix fluids. They are found in many application areas. Solenoids offer fast and safe switching, high reliability, long service life, good medium compatibility of the materials used, low control power and compact design.



#### TYPES OF CONTROL VALVES

Control valves are classified into three basic types, based on their function in the pneumatic system, as

- Pressure control valves
- Flow control valves
- Direction control valves

#### DIRECTIONAL CONTROL VALVES

As the name suggests, the function of a directional control valve (DCV) is to control the direction of flow in a pneumatic circuit. In other words, direction control valves (DCVs) regulate the direction in which the fluid flows in a pneumatic circuit.

#### 5/2 DIRECTIONAL CONTROL VALVE

The 5/2 directional control valve has five ports (two working ports, two exhaust ports and one pressure port and two positions. It is lever operated type.

#### Air Compressor:

An air compressor is a device that converts power (using an electric motor, diesel or gasoline engine, etc.) into potential energy stored in pressurized air (i.e., compressed air). By one of several methods, an air compressor forces more and more air into a storage tank, increasing the pressure. When tank pressure reaches its upper limit the air compressor shuts off. The compressed air, then, is held in the tank until called into use.

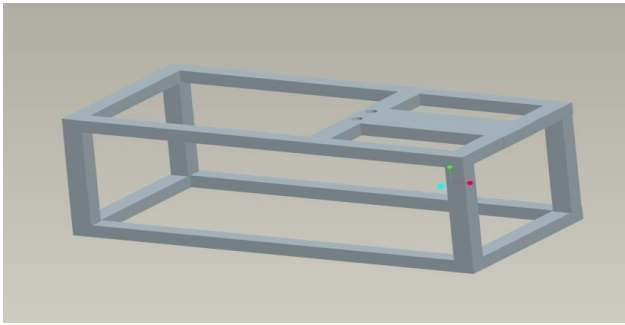
An Air Compressor is a device that converts power (using an electric motor, diesel or gasoline engine, etc.) into potential energy stored in pressurized air (i.e., compressed air). The energy contained in the compressed air can be used for a variety of applications, utilizing the kinetic energy of the air as it is released and the tank depressurizes.

When tank pressure reaches its lower limit, the air compressor turns on again and re-pressurizes the tank. The most common types of air compressors are: electric or gas/diesel powered compressors. The power of a compressor is measured in HP (Horsepower) and CFM (cubic feet of air per minute). The gallon size of the tank tells you how much compressed air "in reserve" is available.



#### FRAME WORK:

Our frame consists of square cross-sectioned tubes that are connected using welds. The entire apparatus is placed over the frame work; it acts as a base for our project. Material of the tubes is mild steel. Using the arc welding the frame work will finish.

**HINGE:**

A hinge is a type of the bearing that connects two solids objects, typical allowing only a limited angle of rotation between them. Two objects connected by an idle rotate relative to each other about a fixed axis of rotation. Hinges may be made of flexible or of moving components in biology many joints function as hinges.

**Air Pipe:**

A pipe is a tubular section or hollow cylinder, usually but not necessarily of circular cross section, used mainly to convey substances which can flow liquids and gases (fluids), slurries, powders, masses of small solids. It can also be used for structural applications; hollow pipe is far stiffer per unit weight than solid members.

**TMT Rod:**

Thermo-mechanical processing, also known as thermo-mechanical treated bars' (TMT), is a metallurgical process that integrates forging, rolling and/or work hardening with heat-treatment into a single process.

**Pressure Gauge:**

Pressure regulators, commonly called pressure-reducing valves, maintain constant output pressure in compressed-air systems regardless of variations in input pressure or output flow. Regulators are a special class of valve containing integral loading, sensing, actuating, and control components. Available in many configurations, they can be broadly classified as general purpose, special purpose or precision





### PNEUMATIC FITTINGS:

Fittings provide the essential link between components in any pneumatic system. Pneumadyne's Extensive offering of miniature pneumatic fittings accommodates numerous connector and tubing requirements.



### CYLINDER:

Cylinders are linear actuators which convert fluid power into mechanical power. They are also known as JACKS or RAMS. Hydraulic cylinders are used at high pressures and produce large forces and precise movement. For this reason they are constructed of strong materials such as steel and designed to withstand large forces. Because gas is unexpansive substance, it is dangerous to use pneumatic cylinders at high pressures so they are limited to about 10 bar pressure. Consequently they are constructed from lighter materials such as aluminum and brass. Because gas is a compressible substance, the motion of a pneumatic cylinder is hard to control precisely. The basic theory for hydraulic and pneumatic cylinders is otherwise the same.

#### DESIGN CALCULATIONS OF CYLINDER:

##### FORCE:

The fluid pushes against the face of the piston and produces a force. The force produced is given by the formula:

$$F = p/A$$

p is the pressure in  $N/m^2$  And A is the area the pressure acts on in  $m^2$ .

This assumes that the pressure on the other side of the piston is negligible. The diagram shows a double acting cylinder. In this case the pressure on the other side is usually atmospheric so if p is a gauge pressure we need not worry about the atmospheric pressure.

Let "A" be the full area of the piston and "a" be the cross sectional area of the rod. If the Pressure is acting on the rod side, then the area on which the pressure acts is  $(A - a)$ .  $F =$

p.A on the full area of piston. This force acting on the load is often less because of friction between the seals and both the piston and piston rod.

Diameter of rod = 10 mm

Material = TMT rod

Assume pressure is constant at 4 bar.

$$F = 4 * \left(\frac{\pi}{4} * D^2\right) = 4 * \left(\frac{\pi}{4} * 10^2\right)$$

$$= 4 * \left(\frac{\pi}{4} * 100\right) = 314 \text{ N}$$

$$F = 314 \text{ N}$$

#### Pneumatic Cylinder Design:

WE know pressure is given by,

$$P = \frac{F}{A}$$

$$A = \frac{\pi}{4} D^2 \quad \text{so,}$$

Assume pressure is constant at 4 bar

$$P = \frac{314}{\left(\frac{\pi}{4} * D^2\right)}$$

$$D^2 = 0.001 \text{ m}$$

$$D = 0.0317 \text{ m}$$

$$D = 31.62 \text{ mm}$$

So, select standard cylinder diameter as 32 mm.

#### Stroke Length:

Minimum bending length of bar 60 mm

Clearance between striker and rod diameter = 20 mm

Cylinder stroke length = bending length + clearance = 60 + 20 = 80 mm

Select standard length is 100

### Components Specification:

#### *Pneumatic Cylinder:*

Type-Single acting cylinder

Diameter = bore diameter = 25mm

L=stroke length = 100mm

Max. Supplying pressure =  $10\text{kgf/cm}^2$

Max. Operating pressure =  $5\text{--}8\text{kgf/cm}^2$

#### *TMT Steel Rod:*

Length of rod = 100mm

Diameter of the rod = 10-12 mm

#### *Pressure Gauge:*

Max. Supplying pressure =  $15\text{kgf/cm}^2$

Max. Operating pressure =  $9.9\text{kgf/cm}^2$

Regulating range = 0.5-8.5kg

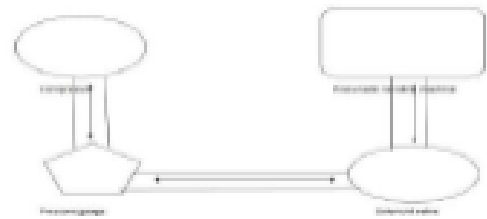
Ambient and media temperature =  $5\text{--}60^\circ\text{C}$

#### **Solenoid Valve:**

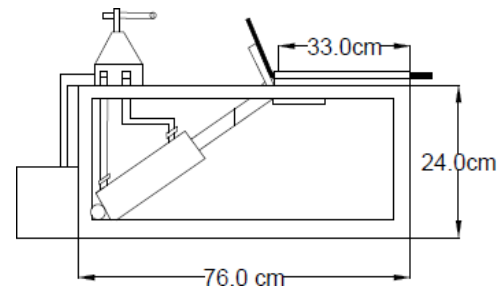
Max. Supplying pressure =  $10\text{kgf/cm}^2$  Max. Operating pressure =  $5\text{--}8\text{kgf/cm}^2$

#### **WORKING PRINCIPLE:**

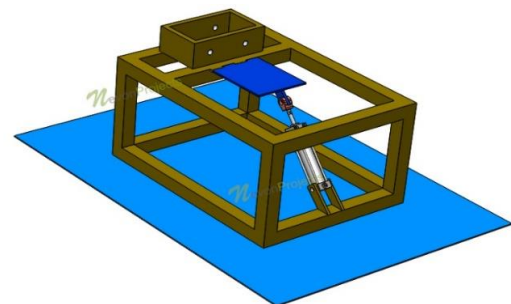
The bending machine works with the help of pneumatic single acting cylinder. The piston disconnected to the moving bending tool. It is used to bend the small size of the TMT Rod. The machine is portable in size, so easy transportable. The compressed air from the compressor issued as the force medium for this operation. There are pneumatic Single acting cylinders solenoid valves, flow control valve and the timer unit is used. The arm from the compressor enters to the flow control valve. The controlled air from the flow control valve enters to the solenoid valve. The function of solenoid valves all of air correct time interval. The 3/2 solenoid valve is used. In one position air enters to the cylinder and pushes the piston so that the bending stroke is obtained. The next position air enters to the other side of cylinder and pushes the piston return back, so that the releasing stroke is obtained. The speed of the bending and releasing stroke is varied by the timer control unit circuit.

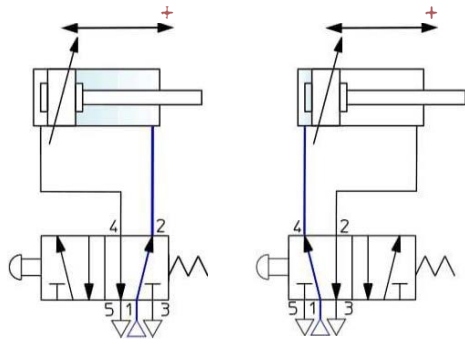


2D LAYOUT FOR PROPOSED MODEL



Project deals with the semi-automatic bending of rod. The hardware consists of pneumatic cylinder constructed with steel, pressure gauge, and rod. A rod which is to be bent is taken. The length of the rod is around 60 mm. As our project is semi-automatic, human interference is needed. The rod is placed on the pneumatic cylinder machine. Pressure is set in the pressure gauge. The pressure can be change. The pressure gauge is operated by human. When the rod is placed, the point where it should be bent is marked on it. With the help of pressure gauge, the force is applied on the rod for bending. When the pressure is applied, the piston pushes the rod to the front side of the machine. Due to the pressure applied, the rod is bent per the human need. This is a semi- automatic project so both human and machine interference is needed.





List of Components:

| S.N<br>O | COMPONENT<br>NAME      | QUANTITY      |
|----------|------------------------|---------------|
| 1.       | Hinges                 | 1             |
| 2.       | Single Acting Cylinder | 1             |
| 3.       | Pneumatic Pipes        | 1 (8mm X 5mm) |
| 4.       | Pneumatic Fittings     | 1             |
| 5.       | Pneumatic Valves       | 1             |
| 6.       | Solenoid Valve         | 1             |
| 7.       | Pressure Gauge         | 1             |
| 8.       | TMT Rod                | 2-3           |
| 9,       | Air Compressor         | 1             |

*Advantages of Pneumatic TMT Rod Bending Machine:*

- High durability and reliability
- Simple design
- High adaptability to harsh environment
- Pneumatic systems are safer than electromotive systems
- Environmental friendly
- Economical low cost
- less power
- The pneumatic is more efficient in the technical field
- Quick response is achieved
- Simple in construction
- Easy maintenance and repair
- Cost of unit is very less
- No fire hazard problem due to overloading
- Continuous operation is possible without stopping
- Reduction of man power employed.
- Improved output
- Increased safety
- Easy handling & movement of machine
- Easy access to all areas

*Disadvantages of Pneumatic TMT Rod Bending Machine:*

- Silence must be used while compressing the air
- High torque cannot be obtained
- Load carrying capacity is low

*Applications of Pneumatic TMT Rod Bending Machine:*

- Angle bending
- Metal bending
- In construction field
- In production
- This machine is very useful for small scale industries
- All industrial application

### CONCLUSION OF PROJECTREPORT:

From this project we conclude that Pneumatic bending machine is very cheap as compared to hydraulic bending machine. We can increase the bending thickness by arranging the high pressure compressor. This machine can also be used where electricity problems occur. This type of bending machine uses compressed air. So, when electricity problem occurs we can change our electric compressor to IC-Engine installed compressor. This type of bending machine is very

Useful to small scale bending industries because they can't afford the expensive hydraulic

Bending machine. In this machine the manually controlled press is converted into automatic machine. So, we can save maximum operating time and the output will also increase compared to manual. In this project the humans have to only load and unload the TMT bars. It can be also called as semi-automatic type bending machine. This machine can also be converted into fully automatic machine so the loading and unloading will be done automatically. For making automatic one should have to be fully knowledgeable in this particular field. By doing so the existing old machines can be modified and made automatic by which the initial cost, to procure new automatic machines may be minimized. Thus there is a lot of scope in this area (automation). We can achieve many types of shapes by using many types of fixtures in bed. This system is easily handle by any worker.

The worker don't have to be someone knowledgeable. Because of its cheap and simple design this machine can be sell everywhere with ease . Advance bar bending machine use for mass production. By using advance bar bending machine increases production rate and reduce labour cost. With the bending machine the manual usage and cycle time is reduced. They are compact in size and reliable

### FUTURE SCOPE:

Operation for making rod bend is tedious and required continuous manual work to perform the bending operation. This will minimize human efforts for less physical exertion of the operator. Adverse effect of repetitive work on human health is 22inimizing. Reduce the wastage of stirrup and this will reduce the cost of stirrup making activity. There is a scope to design the stirrup with safety standards and with ergonomic considerations which will help to avoid the incidents during manually stirrup making. There is a scope

to improve the stirrup making efficiency and production capacity of stirrup by using human powered flywheel motor of stirrup making. The currently available machines are motor power (electrical supply) operation machines and hydraulic type machine which cannot work where non availability of electricity. This research presents a new urge as method to bend the given rod of 10, 12 mm diameter with the help of human power as a energy source for performing the job.

Since old age man is always trying to gain more and more luxurious. Man is always trying to develop more and more modified technique with increasing the aesthetic look and economic consideration. Hence there is always more and more scope. But due to some time constraints, and also due to lack offunds, we only have thought and put in the report the following future modifications.1. It can be made rack and pinion operated or spring and lever operated, by replacing the pneumatic circuit by rack and the pinion arrangement by the square threaded screw and entrancement. 2. The place where there is scarcity of the electricity the electric motor operate compressor is replaced by an I.C. Engine installed compressor. 3. In this machine, compressed air is used to move the cutting tool for carrying out cutting operation. After the completion of the cycle the air moves out through the out port of Solenoid valve. This air is released to the atmosphere. In future the mechanism can be developed to use this air again for the working of cylinder. Thus in future there are so many modifications, which we can make to survive the huge global world of competition

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## PHOTOGRAPHY

