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Design and Development of Pneumatic Stirrup Bending Machine

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Abstract:

Nowadays the world is focusing into automation. Each and every work of human is reduced by a machine, but few areas like construction the usage of machines for bending rods for stirrups which are used to withstand loads in beams and columns are not done by machine because the cost of machine is high and need skilled labors to operate it. So this project is aimed to do bending operation for stirrups using Pneumatic and named as pneumatic rod bending machine.

The main objective of our 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.

INTRODUCTION

Now a day 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 because the movement of ram was done manually by rotating the screw. 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 objective of this project is to fabricate stirrups using automatic bending machine by reducing the human efforts for the concrete structure like beams and columns.Stirrups bind and hold longitudinal bars of steel in position. The object is to prevent the buckling or spreading out the longitudinal reinforcement and also to prevent concrete from splitting outwards and 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.

CORE COMPONENTS OF MACHINE

Pneumatic Cylinder

Pneumatic cylinders (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.

Fig 1. Double Acting Pneumatic Cylinder

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Direction Control Valve

Directional control valves are one of the most fundamental parts in hydraulic machinery as well as pneumatic machinery. They allow fluid flow into different paths from one or more sources. They usually consist of a spool inside a cylinder which is mechanically or electrically controlled. The movement of the spool restricts or permits the flow, thus it controls the fluid flow.

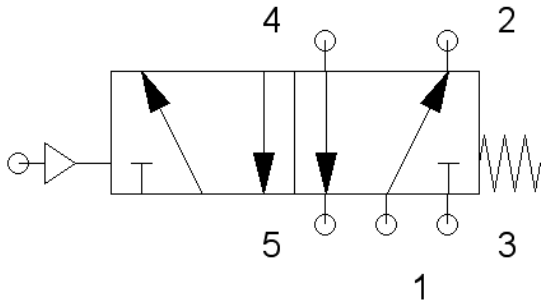

Fig 2. 5/2 Way Direction Control Valve

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, precision.

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. 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.

CONCEPTUALIZATION AND MODELLING

Basic Block Diagram

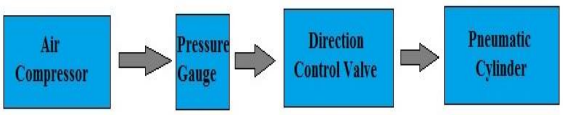

Fig 3. Block Diagram

3D parts

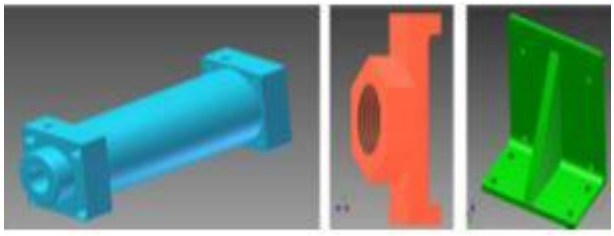

Fig 4.Pneumatic cylinder, Piston eye, Fixture

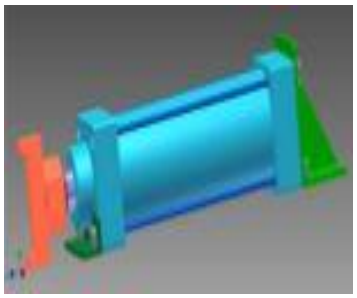

Fig 5. Assembly of Pneumatic cylinder

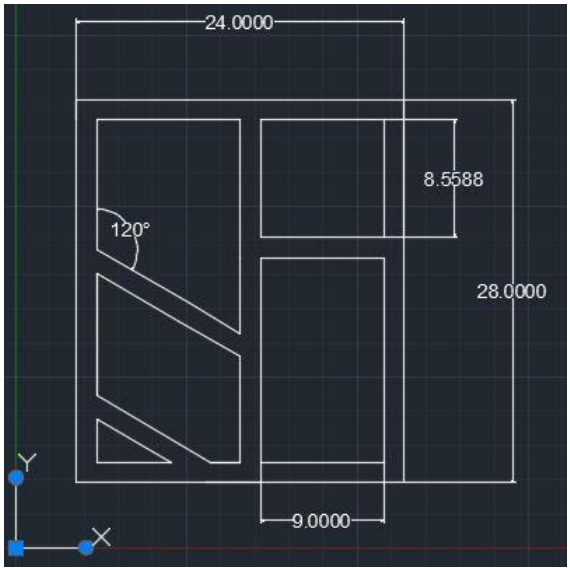

Fig 6. Base frame design

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Conceptual Sequence of Operation

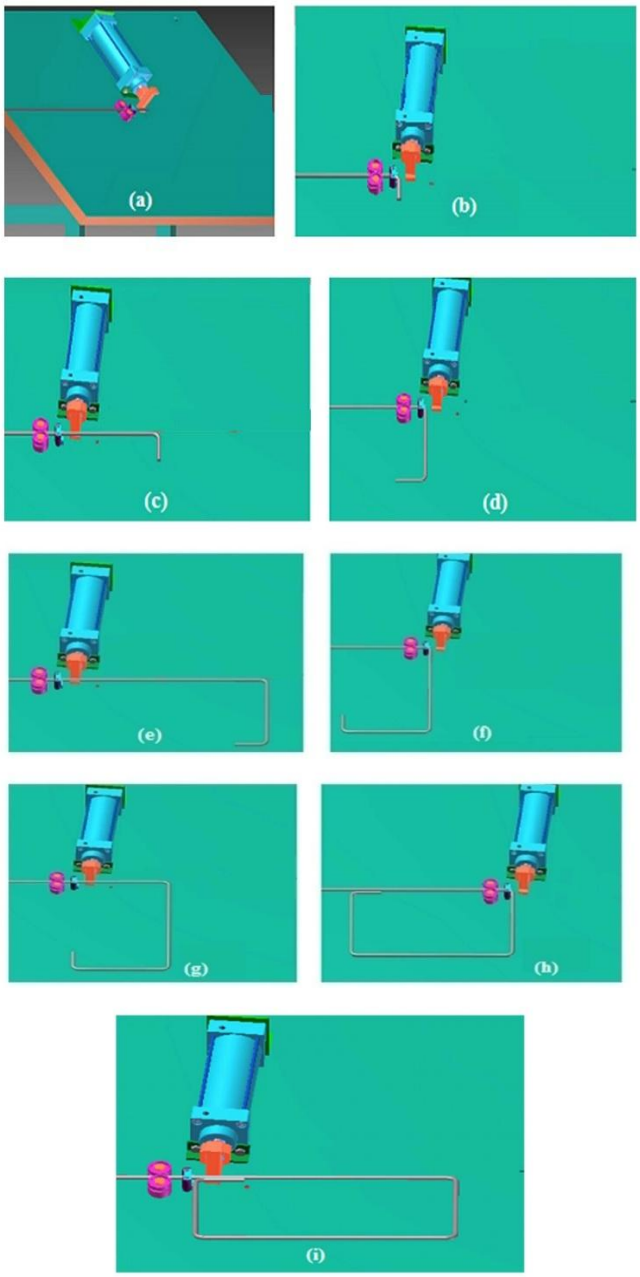

Fig 7. Conceptual sequence of operation

- Our project deals with the semi-automatic bending of rod. Loading and unloading of rod is done manually and DCV is operated manually.
- Pressure is set in the pressure gauge as per requirement.
- Rod placed in the initial position and is about to be bent as shown in figure 7a
- First bend takes place when the direction control valve is operated piston moves forward and the bend takes place as shown in the figure.7b
- After First rod is advanced in the forward direction operate dcbv so that piston again moves forward and second bend takes place as shown in the figure 7c and fig 7d.
- Continue bending process two more times for rectangular or square stirrup.
- This is a semi-automatic project so both human and machine interference is needed.

MECHANICAL DESIGN AND CAPACITY CALCULATIONS

Force Required For Bending

Calculation of force to bend 6mm diameter rod.

σ_{yield}= 500 N/mm^2, $\sigma_{ultimate}$= 545 N/mm^2 (As per TATA TISCON Steel Standards)

Bending equation $\sigma_b = \frac{M*y}{I}$

Where M = P*distance from the bend, Y = distance from the neutral axis = d/2,

I= moment of inertia = $\frac{\pi}{64}d^4$= 63.61

$\sigma_b = \sigma_{yield}$= 500

$500 = \frac{p*45*\frac{6}{2}}{63.61}$

∴P = 235.8 N.

Similarly for 8 mm diameter rod, moment of inertia I= 201.06

$\sigma_b = \sigma_{yield}$= 500

$500 = \frac{p*45*\frac{8}{2}}{63.61}$

∴P = 561.7 N

Pneumatic Cylinder Specifications

Type-Double acting cylinder
Bore diameter-50 mm
Piston rod diameter = 20mm
Stroke length-100mm
Max operating pressure=0.5-10Kgf/cm^2

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PROTOTYPE AND EXPERIMENTAL RESULTS

Actual Prototype Model

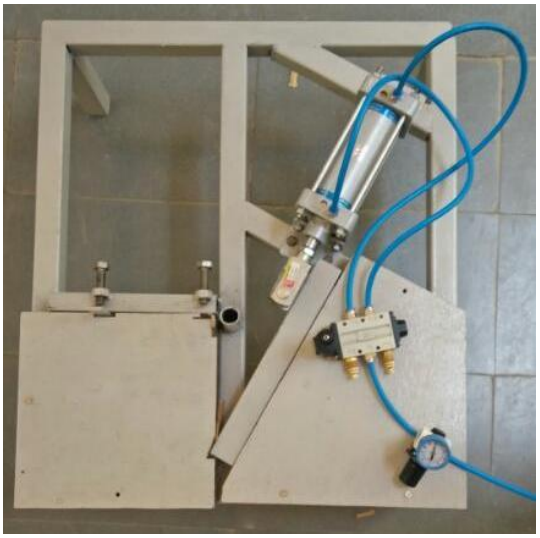

Fig 8.steup of components in actual prototype

Experimental Results

Fig 9.square Stiruup 20x20 mm

ADVANTAGES AND APPLICATIONS

Advantages:

- 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

Applications:

- Angle bending
- Metal bending
- In construction fields
- In production

CONCLUSION

The manually controlled press is converted into automatic machine by which maximum operating time will be saved. Thus the output will be more. In this project the human intervention is for loading and unloading the plate. It may be called as semiautomatic machine. This machine can be converted into a fully automatic machine where loading and unloading of the plate can be done automatically.

To conclude, this project is made keeping in mind that any manually operated machine can be converted to automatic machines by using pneumatic, electrical and electronic devices. For these purpose one should have the full knowledge on how the devices are being used. 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.

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