# PNEUMATIC METAL SHEET BENDING MACHINE

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**Abstract** – *In today's industrial landscape, the utilization of bending machines has surged. Bending processes find extensive applications in industries, encompassing tasks such as blanking and pressing. Various bending methods exist, with pneumatic and hydraulic bending being the most prevalent. However, pneumatic bending holds a distinct advantage over hydraulic bending.*

*The foremost benefit of pneumatic bending lies in its remarkable speed, being ten times faster than hydraulic bending. This enhanced speed enables pneumatic bending machines to execute tasks swiftly and efficiently. Moreover, pneumatic bending machines offer exceptional flexibility, allowing placement in any desired position, including upside down, within a factory setting.*

*Our project aims to design and fabricate a pneumatic bending machine capable of bending 4mm thickness metal sheets. The primary goal is to introduce pneumatic sheet bending machines at construction sites, offering cost-effective solutions compared to existing bending machines while boosting stirrup productivity.*

*The bending machine stands as a pivotal tool in sheet metal workshops, primarily serving bending purposes. The bending operation is facilitated by a punch exerting significant force on the workpiece clamped on the die. Furthermore, the bending machine is engineered to operate automatically, enhancing efficiency and ease of use.*

## 1. INTRODUCTION

In the field of fabrication, metal bending is a common operation. Traditionally, manual or hydraulic bending machines were used for bending sheets and rods. However, we have developed a compact and lightweight machine that utilizes pneumatic pressure to bend low thickness metal sheets.

Nowadays, automatic plate bending machines have become prevalent in industries, particularly in the automobile sector. Previously, manual operation resulted in limited output. To enhance safety for operators, we have implemented a dual push-button system, requiring both hands of the operator to be engaged. This design ensures the prevention of injuries.

### NEED OF AN ATTACHMENT

Reason Behind selection of pneumatic metal sheet bending machine

Solutions:

1. To effectively bend metal sheet at low cost.
2. In hydraulic bending machine, the cost of hydraulic and maintenance is high. But in this machine, all these costs are approximately reduced.
3. Small scale industries cannot afford hydraulic machine. Instead, they can use pneumatic bending machine.

## 2. PROBLEM STATEMENT

- "In numerous workshops, workers manually bend sheets due to the high cost of automatic sheet bending machines for small-scale industries. Therefore, we aim to develop a cost-effective machine to automate this process."

• "In medium-scale industries, hydraulic sheet bending machines are commonly utilized. However, these machines present several issues such as leakages, oil accumulation on the floor, high cost, and greater maintenance requirements compared to pneumatic machines."

**OBJECTIVE**

- 1. Designing a bending machine capable of bending metal sheets up to 3mm thickness.
- 2. Developing a prototype sample of a pneumatic metal sheet bending machine.
- 3. Conducting experimental trials with the pneumatic metal sheet bending machine.
- 4. Analyzing and comparing the results obtained from the pneumatic metal bending machine study.

## 3. METHODOLOGY

**CONCEPT**

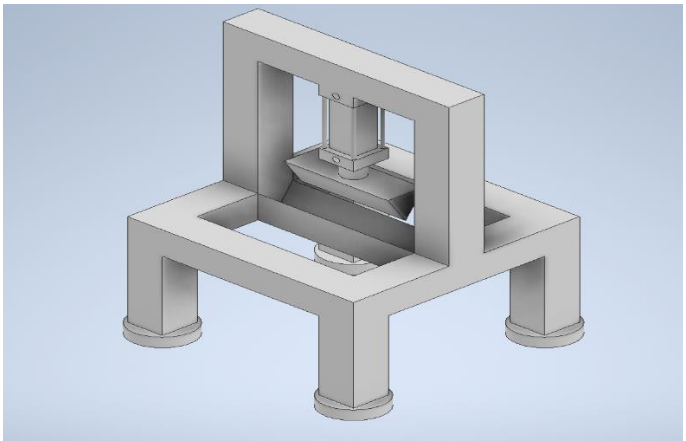

**Fig.3.1.** System setup

The bending machine utilizes a pneumatic double-acting cylinder to perform its bending operations. This cylinder is connected to the moving bending tool and is specifically designed for bending small metal sheets. The force required for bending is generated by compressed air from the compressor. To control the movement of the cylinder, a 5/2 direction control valve is employed, which has 5 ports and 2 positions. In one position, air is directed into the cylinder to push the piston, enabling the bending stroke. In the other position, air is directed to the opposite side of the cylinder, causing the piston to return and allowing for the releasing stroke. The speed of both the bending and releasing strokes can be adjusted using the timer control unit circuit. It's fascinating how these components work together to achieve precise and controlled bending operations!

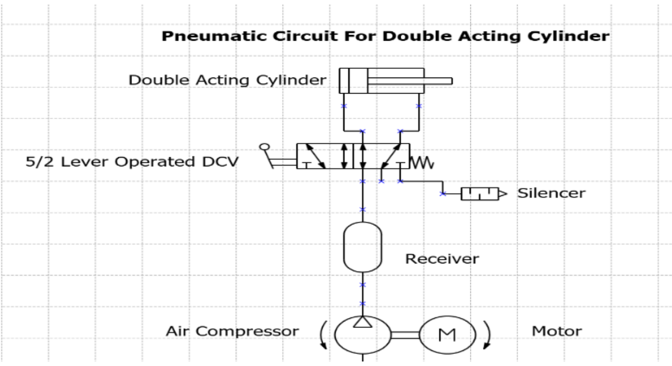


**Fig.3.2.**BlockDiagram

**MATERIAL TO BE USED**

1. Air compressor: The primary component of our project responsible for delivering compressed air to the double-acting cylinder.
2. Double-acting cylinder: Utilized to activate the upper die using compressed air.
3. 5/2 DC Valve: Determines the direction of compressed air flow, facilitating the activation or retraction of the double-acting cylinder.
4. Hose: Passage for the compressed air flow.
5. Square tube: Structural element used in construction.
6. L-section: Component used in die construction.
7. Metal Sheet: The workpiece to be manipulated.

## CALCULATION

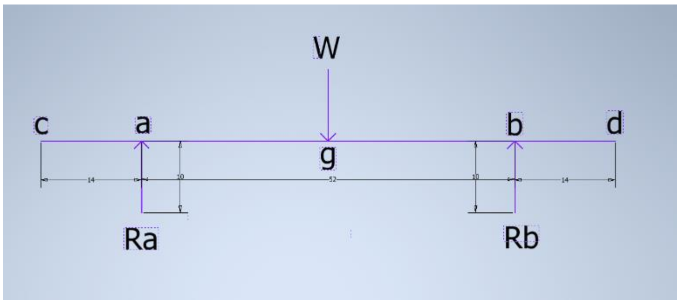


**Fig.3.3** Free body diagram

- **CALCULATION FOR SUPPORT REACTION- Ra & Rb**

**BY USING EQUILIBRIUM CONDITION**

Fy= 0 m =0

Ra + Rb = W ……… (1)

Ma = 0= -W ×26 + Rb × 52

$\frac{26W}{52}$ =Rb ………..(2)

Ra + $\frac{26W}{52}$=W

Ra =W- $\frac{26W}{52}$ ………..(3)

Calculation for BMD

BMc = 0

BMd = 0

BMa = 0×14 =0

BMb = 0 × 14 =0

BMg = 0 × 40 + Ra × 26

= 26Ra

= 26 × W - $\frac{W}{2}$

BMg = $\frac{26W}{2}$

- **BENDING MOMENT EQUATION**

$\frac{\sigma b}{y} = \frac{M}{I} = \frac{E}{R}$

$\frac{\sigma b}{y} = \frac{M}{I}$

$\frac{\sigma Alu}{t/2} = \frac{\frac{26W}{2}}{\frac{b \times t^3}{12}}$

156W = σAlu × b × $t^2$×2

W =$\frac{240 \times 80 \times 2^2 \times 2}{156}$

W =984.62 N

- **CYLINDER SELECTION**

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

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

$\frac{\pi}{4} \times D^2 = \frac{984.62}{1.2}$

D =32.32 mm

Hence we select the 32mm bore diameter cylinder.

- **VISUALIZING DATA**

| **Sheet thickness (in mm)** | **0.5** | **1** | **1.5** | **2** | **2.5** | **3** |
|---|---|---|---|---|---|---|
| **Force (in KN)** | 0.061 | 0.246 | 0.553 | 0.984 | 1.538 | 2.215 |
| **Pressure (in $\frac{n}{mm^2}$)** | 0.7 | 3 | 6.9 | 12 | 19.1 | 27.5 |

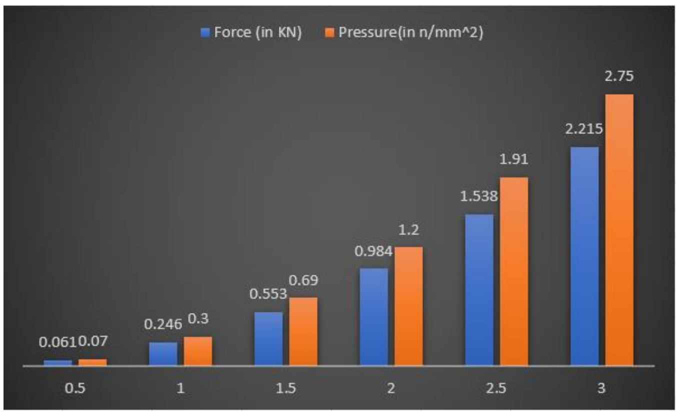


Fig.3.4 Bar chart

## 4. ADVANTAGES

1.High Durability and reliability: The bending machine exhibits exceptional durability and reliability, ensuring its ability to withstand demanding operational conditions and consistently deliver optimal performance.
2. Simple in construction: The design of the bending machine is characterized by its straightforward and uncomplicated construction, which enhances ease of use and maintenance.
3. Low cost: The bending machine is cost-effective, making it accessible to small-scale industries with limited budgets.
4. Easy Maintenance and repair: The bending machine is designed for easy maintenance and repair, minimizing downtime and ensuring smooth operation.
5. Quick response is achieved: The bending machine boasts rapid response times, enabling efficient and timely bending operations.
6. Improved output: With its advanced features and capabilities, the bending machine enhances productivity and output, contributing to increased efficiency in the bending process.
7. Easy handling & movement of machine: The bending machine is designed for easy handling and movement, allowing for convenient operation and transportation.
8. Environmentally Friendly: The bending machine incorporates environmentally friendly components and practices, reducing its impact on the environment.

## 5. CONCLUSIONS

From this project, we infer that pneumatic bending machines are significantly more cost-effective compared to hydraulic bending machines. By incorporating a high-pressure compressor, we can enhance the bending capacity. Such bending machines prove highly beneficial for small-scale bending industries unable to invest in expensive hydraulic bending machinery.

## 6. ACKNOWLEDGEMENT

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