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# Design of Pneumatic Press for Bending and Punching Operation

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## ABSTRACT

This research paper gives the optimum design of pneumatic press for bending and punching operations. Presses are used in industries for a wide variety of uses, including bending, blanking, piercing and pressing and punching operations. There are many different types of presses. The most popular are pneumatic presses and hydraulic presses. The pneumatic presses are more preferable than hydraulic presses. The greatest advantage of Pneumatic presses is their speed. Pneumatic presses are 10 times faster than hydraulic presses and they can perform many jobs faster and more efficiently. They can also be stopped at any time by opening the valves to release the air. Pneumatic presses are extremely flexible, that they can be placed in a factory in any required position, even upside down. Pneumatic Press include number of operations but here we design a Pneumatic Press for only two operations bending and punching. This press easily bend Al plate of 5 mm and also done punching operation on it.
**Keywords:** Design, Bending, Punching, Working Pressure, model.

## I. INTRODUCTION

Pneumatics has been used for thousands of years, ever since hunters used the blow-gun to take down their prey. Using their lungs, with a capacity around 6000 cubic inches per minute, they could produce a pressure of 1 to 3 psi. The first compressors were seen around 3000 B.C. to provide small puffs of air to aid in starting a fire. These simple devices evolved into larger, more sophisticated units used in metal smelting about 1500 B.C. Around the 18th century, mechanical compressors were capable of developing almost 15 psi and were able to do more useful work.

A pneumatic press utilizes a compressed air source to control operation of piston of cylinder for high pressure to obtain desire component by using press tools [1]. Pneumatic forging press having capacity around 630 to 10000 ton [2]. Pneumatics was used to power a tunnelling project in Mt. Cenis, located in the Alps If traditional drilling methods were used (manual) the project would have taken upwards of 30 years. Using pneumatic drills, operating on many miles of line, the tunnel was completed in just 14 years and it was open to traffic in 1871. There are many different types of presses. The most popular are pneumatic presses and hydraulic presses. Pneumatic presses are 10 times faster than hydraulic presses and they can perform many jobs faster and more efficiently [3]. Press also used in paper plate making machine [4].

## II. METHODS AND MATERIAL

### 1. Press Types

There are many different types of presses. The most popular are pneumatic presses and hydraulic presses.

Press classified as:

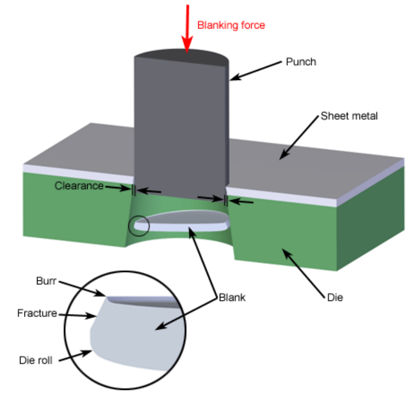
1. Manual Press:
   Foot press, Arbor press & Fly press
2. Power Press:

Crank press, Eccentric press, Cam press, Toggle press, Screw press, Rack & pinion press, Hydraulic press, Pneumatic press [5].

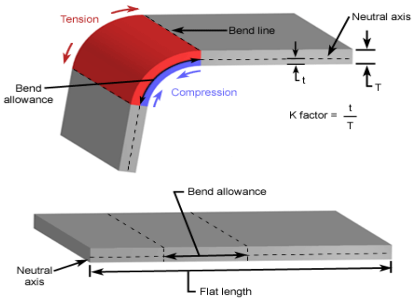
## 2. Pneumatic Press and Operations

A pneumatic system is a system that uses compressed air to transmit and control energy. Pneumatic systems are used in controlling train doors, automatic production lines, mechanical clamps, etc so pneumatic press uses air as working medium and performing several operations using equipment and working fluid.

There are number of operations performed like punching [4], bending [4], shearing, stamping, blanking [6], piercing etc. These operations are shown below,

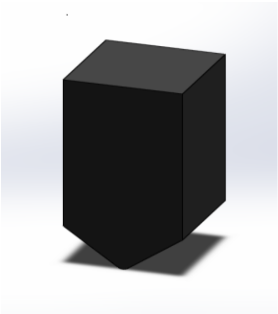



(a)




(b)

**Figure 1.** (a) punching and (b) bending operation



(a)

(b)

(c)

**Figure 1.** (a) Bending punch (b) Punching punch and die and (c) Model for actual operation.

## 3. Model and Components

The Fig.2 (a) shows bending punch, (b) shows Punching punch and die and (c) shows Model of pneumatic press for actual operation. It includes many components which listed below.

1. Double acting cylinder
2. Compressor
3. 5×2 Directional control valve
4. Connectors
5. Pipe : 8mm diameter
6. C-channel and Base plate

## 4. Design

We design pneumatic press which mainly done V-bending and punching operation. The main function of pneumatic press is to punch or bend thin sheet metals or non-metals using pneumatic power [7].

### 4.1 Design of Tool For Bending And Punching Operations:

**Operating Condition:**

**Temperature Range :** 0° C to 85° C

**Pressure Range:** 10 Kg/cm$^2$ (150 PSIG) for compressed air 25 Kg/cm$^2$ (350 PSIG) for oil.

**Cushions:** For 19 and 25 mm Bore rubber shock absorbers as optional. Above 25 mm Bore adjustable cushions as standard.

**Consumption:** Litres of free air per 100 mm single stroke at 5 Kgf/cm$^2$

$$1 \text{ kgf} = 9.8664 \text{ N}$$
$$\therefore 10 \text{ kgf} = 98.664 \text{ N} / cm^2$$
$$= 98.664 \times 10^4 \text{ N} / m^2$$

Cylinder Tube: For bore of 19, 25, 40, and 50 mm hard drawn, polished brass/aluminium tube and for bores of 65, 75, 100, 125, 150, 200, 250 and 300 mm seamless honed & hard chrome plated tube is used.

Piston Rod: High tensile steel, Ground & hard chrome plated.

Seals: Buna "N" ( Nitrile elastomer )
End cover & piston: Close grained cast iron.

**Cushions:** For 19 and 25 mm Bore rubber shock absorbers as optional. Above 25 mm Bore adjustable cushions as standard.

**Consumption:** Litres of free air per 100 mm single stroke at 5 Kgf/cm$^2$

$$1 \text{ kgf} = 9.8664 \text{ N}$$
$$\therefore 10 \text{ kgf} = 98.664 \text{ N} / cm^2$$
$$= 98.664 \times 10^4 \text{ N} / m^2$$
$$= 98.664 \times 10^4 \text{ Pa}$$

4.2 Force exerted by the piston for double acting cylinder :

**Figure 3.** Pneumatic cylinder used in press for convey *power*

$$\therefore F = P \times A$$
$$= P \times (A - a)$$

Force for downward stroke = $P \times \frac{\pi}{4} \times D^2$

Upward stroke = $P \times \frac{\pi}{4} \times (D^2 - d^2)$

According to the standard data of cylinders,
Diameter of the piston and piston rod for pressure 20 bar is,

D = 2 inch = 50.8 mm
= 0.0508 m

Piston rod diameter d = 25 mm = 0.025 m

Downward stroke = $P \times \frac{\pi}{4} \times D^2$

$= \frac{\pi}{4} \times (0.0508)^2 \times 98.664 \times 10^4$

= 1998.67 N

Upward force = $P \times \frac{\pi}{4} \times (D^2 - d^2)$

$= \frac{\pi}{4} \times ((0.0508)^2 - (0.025)^2) \times 9.8664 \times 10^4$

= 1010.24 N

4.3 DIE Design for Bending:

According to the standard table,
We know that the stress for Mild Steel is,

$\sigma_{y0}$ = 345 N / m$m^2$

n = 517 N / m$m^2$

μ = 0.1

Where, $\sigma_{y0}$ = Yield stress
n = Strain hardening rate

$\sigma_{y1}$ and $\sigma_{y2}$ = Maximum stresses at inner and outer fiber

Shear Strength = 325 MPa
Tensile Strength = 452 MPa

We want to bend 4 mm thick plate and length of bend we assume 35 mm, so nose radius of the plate is 2 mm. First we find the fracture strain,

$\varepsilon_{max}$ = ln [1 + ( $r_p$+t)– ( $r_p$–0.45 t)/ ( $r_p$+0.45 t) ]
= ln [1 + (2+4)– (2–0.45×4)/ (2+0.45 ×4) ]
= 0.92

**Now:**

$\sigma_{y1} = \sigma_{y0} + n \cdot \varepsilon_{max}$
= 345 + ( 517 x 0.92 )
= 820.64 MPa

$\sigma_{y2} = \sigma_{y0}$ + n · ln [1 + ( $r_p$+t)– ( $r_p$–0.45 t)/ ( $r_p$+0.45 t) ]
= 534.275 MPa

∴ M = $(0.55t)^2 \{ (\sigma_{y0}/6) + (\sigma_{y1}/5) \} + (0.45t)^2 \{ (\sigma_{y0}/6) + (\sigma_{y2}/5) \}$
= 1179.16 + 763.31
= 1924.47

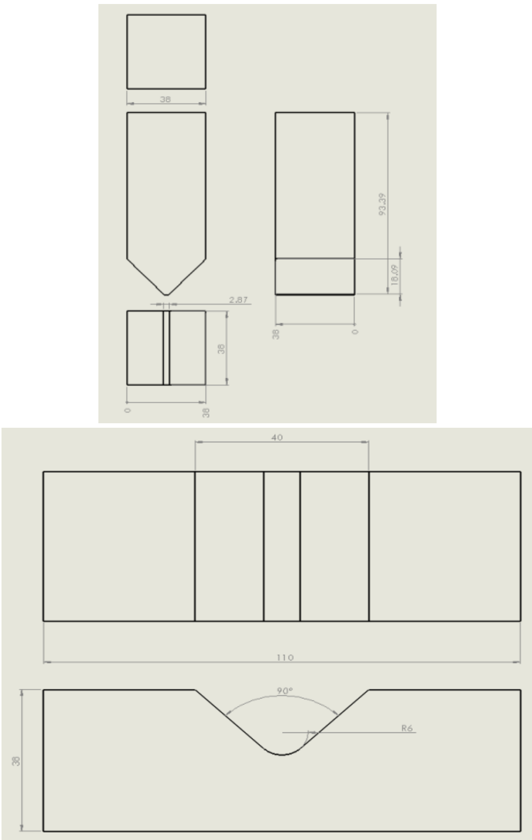


**Figure 4.** Punch and die 2D image for preparation of tool and die for bending operation.

4.4 Spring Back Effect

This is the important phenomena in bending of sheet metal.Warm and hot stamping processes are attractive in reducing springback and in improving formability of ultrahigh- Tensile-strength steel sheets [8].

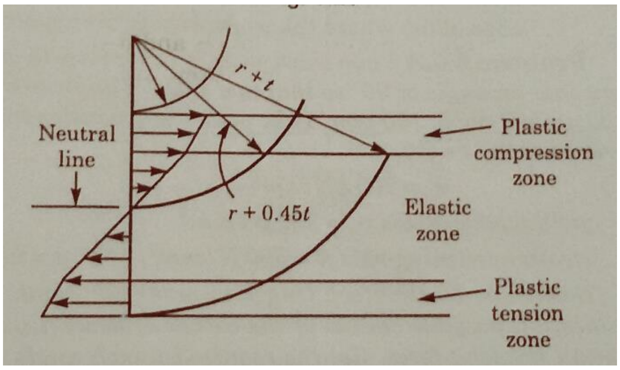



**Figure 5.** spring back effect in bending operation.

$$\therefore \quad \frac{2\phi}{\alpha} = \frac{12\,(r_p + 0.45\,t)M}{6 - t^3}$$

Where, 2ϕ = Spring back angle
α = Included angle of bend

∴ 2ϕ = 0.0309 α
∴ α = 90 – 2ϕ
∴ α = 88.30 Angle which one bend due to the spring effect

Required stroke length of the punch,

L= 2 ( $r_p$+0.45 t) × $\frac{\pi}{4}$ + 50 – ( $r_p$+t)
= 93.96 mm
≅ 94 mm

So we are selecting the cylinder of this diameter and stroke of 94 mm for bending 4 mm thick plate, we selecting 2.5 x 2 inch cylinder for bending.

So, the length of the punch should be 93.96 mm.

4.5 Dimension of Punch And DIE:

The punching operation that takes place when a punch shears through a piece of material has typically three stages: (1); plastic deformation, (2) shear; and (3) fracture [9].

**We know that,** $\sigma = \frac{P}{A}$

$\therefore P = \sigma \times A$

Checking compressing stress for punch

$$\sigma_c = \frac{P}{A}$$
$$= \frac{1998.67}{38 \times 38}$$
$$= 1.38 \text{ MPa} < \sigma_c$$

So, the design is safe.

4.6 Design For Punching

FOR THE CLEARANCE:

$$P = 12 \text{ bar}$$
$$P = \frac{F}{A}$$
$$\therefore F = P \times A$$
$$\therefore F = 3170.499 \text{ N}$$

As we know that P = F

$$\therefore 3170.499 = \pi \times D \times \tau \times t$$
$$\therefore t = 1.20 \text{ mm}$$
$$\varepsilon_{max} = 0.92 \text{ as above}$$

$$\therefore \frac{t}{c_0} = 1.36 \text{ e } (0.92) \times \frac{2.3 \text{ e} \times P\ (0.92)-1}{2.3 \text{ e} \times\ (0.92)-1}$$

$$\therefore \frac{1.20}{c_0} = 3.28$$

$\therefore$ Clearance $c_0 = 0.36$ mm

And length of the stroke is as above.

## III. CONCLUSION

This research paper gives the optimum design of pneumatic press for bending and punching operations. Presses are used in industries for a wide variety of uses, including bending, blanking, piercing and pressing and punching. The main function of pneumatic press is to punch or bend thin sheet metals or non-metals using pneumatic power. We successfully make the design of Pneumatic Press for the bending and punching operations. Our design has met its objective to produce the bend and punch in the sheet. From the above calculation our design is safe.

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