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Mechanization of Hand Press Brake

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ABSTRACT

A press brake, also known as a brake press, is a machine tool for bending mostly sheet metal. It forms predetermined bends by clamping the work piece between a matching punch and die. It is essential tool for any machine shop. There was hand press brake in our workshop which was operated manually. Two persons were required to operate the power screws to lower the knife edge. We have taken a task of reducing the man power and human effort required to operate the press at lowest possible cost. We have used hydraulic mechanism for achieve our main goal to reduce human effort and the cost. For this we used bottle jack, C-channel, springs, hooks, solid rings & rods. Pressure is generated by bottle jack with handle, bottle jack moves down because the top of the ram of bottle jack is restricted by c-channel and bottom of the bottle jack is fixed on the top of knife edge. So, the knife edge moves down, which press the sheet. This concept was developed to reduce the man power at lowest possible cost. This entire mechanization is done with cost of only Rs. 5500.

Keywords: Press Brake, Mechanization

I. INTRODUCTION

A press brake can be described by basic parameters, such as the tonnage and the working length of sheet metal. Additional parameters include the amplitude or stroke, the distance between the frame uprights or side housings, distance to the back gauge, and work height. There are several types of brakes as described by the means of applying force: mechanical, pneumatic, hydraulic, and servo-electric.

There are three basic types of bending can be done on a press brake; each is defined by the relationship of the end tool position to the thickness of the material. These three are Air Bending, Bottoming and Coining.
Air bending method bends material by pressing a punch into the material, forcing it into a bottom V-die, which is mounted on the press. The punch forms the bend so that the distance between the punch and the side wall of the V is greater than the material thickness. Air Bending is the most common type of bending process used in sheet metal shops today.

In bottoming, the sheet is forced against the V opening in the bottom tool. U-shaped openings cannot be used. Space is left between the sheet and the bottom of the V opening.

In coining, the top tool forces the material into the bottom die with 5 to 30 times the force of air bending, causing permanent deformation through the sheet. There is little, if any, spring back.

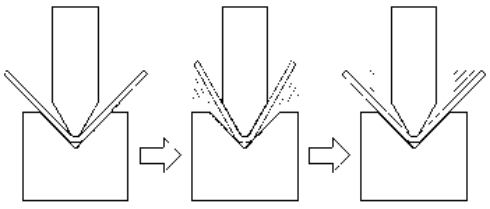

Figure 1: Air bending

There was hand press brake available in our workshop as shown in figure. Max width of the sheet that can be inserted in press brake is 1920mm.

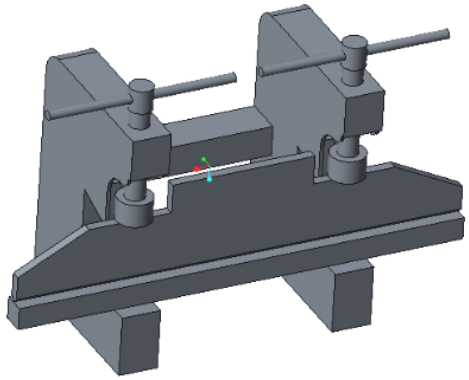

Figure 2: Modeling of available hand press brake

II. COMPONENTS USED FOR MECHANIZATION

A. C-channel

There are many sections are available which can sustain bending load like box section, I-beam, c-channel, T-section, etc. we used C-channel because of availability in our work shop.

Dimensions of available C-channel:

- b = 70 mm d = 200 mm
- t = 8.1 mm h = 185.2 mm
- l = 173.2 mm y = 100 mm
- L = 365 mm σ_b = 300 N/mm^2

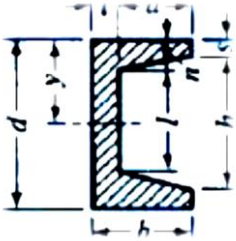

Figure 3: C-channel section

Moment of Inertia (I) = $\frac{1}{12}[bd^3 - \frac{1}{8g}(h^4 - l^4)]$

Flange slope, g = $\frac{h-l}{2(b-t)} = \frac{185.2-173.22}{2(70-8.2)} = 0.0969$

Moment of Inertia (I) =

$\frac{1}{12}[70\ x\ 200^3 - \frac{1}{8\ x\ 0.0969}(185.2^4 - 173.2^4)]$

= 16.94×106 mm^4

σ_b = My/I = FLy/I

F = σ_bI / Ly= 300 × (16.94×106) / 365 × 100

= 139,230 N

F=13.923 tones (sustainable capacity with half length)

F= 27.846 tones (sustainable capacity with full length C-channel)

B. Bottle Jack

Tonnage of press brake to bend the sheet metal is calculated as shown:

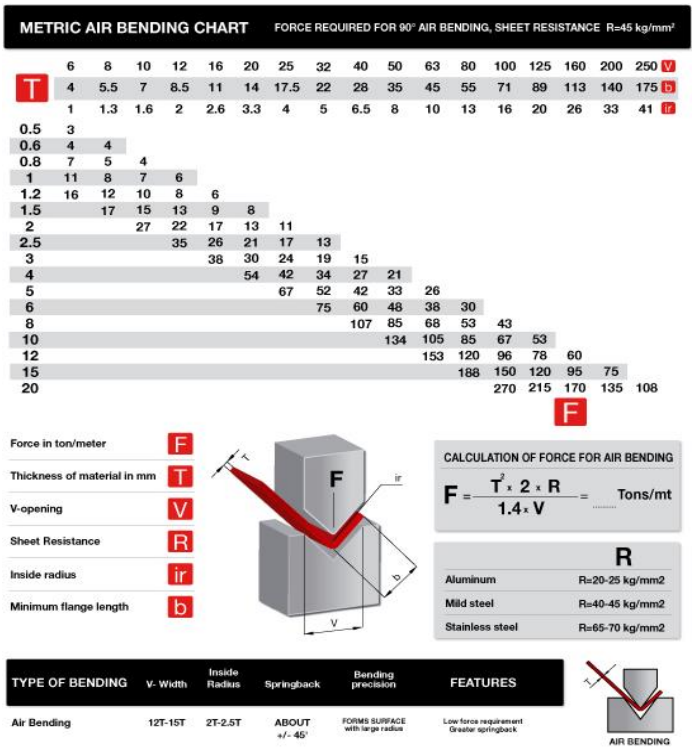

Figure 4 : Metric air bending chart [1]

Force on the knife edge is equal to force on C-channel, F = 27.846 tones ~ 30 tones.

Standard capacity bottle jack available in market is 30 and 50 tones. But the cost of the both jack is approximately same and from safety point of view, we have decided 50 ton capacity bottle jack.

Figure 5: Bottle Jack

Specification of purchased bottle jack:

- Rated load = 50 tones
- Min height = 350 mm

- Lifting height(stroke) = 200 mm
- Net weight = 35 Kgf

C. Sheet Metal Thickness

$$F = \frac{T^2 \times 2 \times R}{1.4 \times V}$$

F = Force in tones/meter = 13.923 tones/meter (From C-channel calculations)

T = Thickness of the material in mm

R=Yield point of material or sheet resistance in kg/mm^2

V = Die opening in mm = 75 mm (available)

$$T^2 = \frac{1.4 \times V \times F}{2 \times 45} = \frac{1.4 \times 75 \times 13.923}{2 \times 45} = 16.24$$

T = 4.03 mm ~ **4 mm**

So, 4 mm sheet metal thickness can be bent with available C-channel.

D. Springs

Shear stress in spring,

$$\tau = K\frac{8PC}{3.14d^2}$$

Where,

P = load on springs = 2000 N for 2 springs = 1000 N for 1 spring

τ = shear strength = 450 N/mm^2

$$d^2 = K\frac{8PC}{3.14\tau}$$

$$d^2 = 1.2525\frac{8 \times 1000 \times 6}{3.14 \times 450} = 42.55$$

$$d = 6.52\ mm$$

Now,

$$C = \frac{D}{d}$$

$$D = C \times d = 6 \times 6.6 = 39.6\ mm$$

$$D = 40\ mm$$

Now,

$$y = \frac{8nPD^3}{Gd^4}$$

Where,

y = deflection = 50 mm

G = 0.84 x 10^5 N/mm^2

n = No. of active turns

$$n = \frac{yGd^4}{8PD^3}$$

$$n = \frac{50 \times (0.84 \times 10^5) \times 7^4}{8 \times 1000 \times 40^3}$$

$$n = 19.69$$

Figure 6: Helical Tension Spring

Figure 7 : Modified press brake

III. COST OF MECHANIZATION

TABLE I
COST CALCULATION

Sr. No.	Name of component	Qty	Actual price Rs.
1	Bottle jack	1	3000
2	C – Channel	1	1500
3	Solid rods (at one end)	2	40
4	Simple hooks (at one end)	2	40
5	Spring	2	240
6	S-type hooks (at another end)	2	40
7	Solid rings (at knife edge)	2	40
8	Miscellaneous & consumables	-	600
		Total	**5500**

IV.CONCLUSION

It can be concluded that any manual press brake can be mechanized with different ideas. We did mechanization of press brake by bottle jack, available C-channel, springs and miscellaneous components with lowest possible cost. We have successfully completed this with cost of Rs. 5500.

V. REFERENCES

[1] http://www.mate.com/technical-resources/press-brake-tooling/bending-basics/

[2] Design of machine elements by V. B. Bhandari