International Journal of Science and Research (IJSR)
ISSN: 2319-7064
ResearchGate Impact Factor (2018): 0.28 | SJIF (2018): 7.426

Analysing and Modifying Bending Machine

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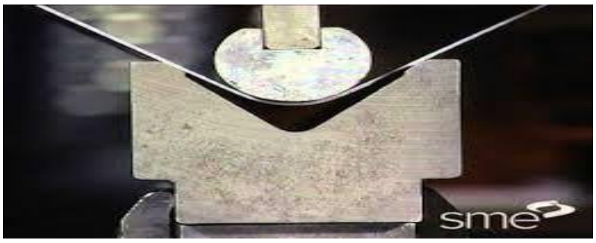
Abstract: ***Bending machine is used to bend different components like plates,sheets and pipes. The aim of this project is to measure the angular deflection at both side and find the discrepancy, to solve this discrepancy Link mechanism is used. A linkage is a simple mechanism containing rigid bars (the links) connected through pin and prismatic (linear) joints. Linkages are simple in structure but powerful in function, providing elegant solutions to motion control problems.***

Keywords: Bending press, Link mechanism and Sheet metal

1. Introduction

In the Industry, There is a Hydraulic Bending Press. They were using this bending press for bending operation of different components of the Agricultural implements. But they were facing a problem while performing bending of sheet metal. In Ideal Condition, The Machine Run Properly, But When the Work piece is placed for bending operation, bending error occurs in angular measurements at both the side of plate. To overcome from this situation, we are providing a mechanism to obtain equal amount of bending in angular measurement at both the side of plate. When bending is done, the residual stresses cause the material to spring back towards its original position, so the sheet must be over-bent to achieve the proper bend angle. The amount of spring back is dependent on the material, and the type of forming. When sheet metal is bent, it stretches in length.

1.1 Hydraulic press and link mechanism



In Hydraulic Press, Force Generation, Transmission & Amplification are Accomplished Using Pressurized fluid. This Liquid System Exhibits Characteristics of a Solid & Provides a Very Rigid and Positive Medium of Power Transmission and Amplification. In A Typical Application, A Smaller Piston Transfers High Pressurized Fluid to the Larger Piston Area Cylinder, Thus Amplifying the Force. A Typical Hydraulic Press consist of a Pump Which Provides the motive Power for the Fluid, The Fluid Itself Which Is the Medium of Power Transmission through Hydraulic Pipes and Connectors, Control Devices and the Hydraulic Mot-or Which Converts the Hydraulic Energy into Useful Work At The Point of Load Resistance. The Main Advantages of Hydraulic Presses over Other Types of Presses Are That They Provide a more positive response to changes In Input Pressure, The Force and Pressure Can be accurately be Controlled, and The Entire Magnitude of The Force Is Available. During, the Entire Working Stroke of The Ram travel. Hydraulic Presses Are Preferred When Very Large Nominal Force Is Required. A machine is a device that is capable of converting the available forms of energy to useful work. Each part of a machine, that undergoes relative motion with respect to some other part, is called kinematic link. Kinematic links help in the transmission of motion, from one machine part to another.

2. Problem and Specifications of Bending Press

As in that Hydraulic Press, in Ideal Condition Machine Run Properly. But When Sheet Metal Is Loaded for Bending, Bending Error Is occurring In Angular Measurement at Both Sides of Particular Sheet Metal So We Can Determine That There is Some Kind of Uneven Distribution of Force Is Present. To Overcome This Problem, We Have Proposed A Kind of Mechanism For Proper Distribution of Force.

Specifications of This Press Are As Follows:

Specification	Type/Value/Size
Type	10 ton 2 column hydraulic press
Application	Metal forming
Rated nominal pressure	1500 psi
Power nominal pressure	Hydraulic
Hydraulic oil	Grade 68
Pump	Gear pump
Oil tank	920x610x650 mm

3. Design and calculation of link mechanism

3.1 Calculation of force

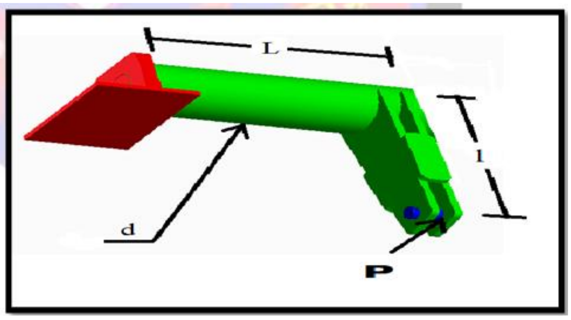
F =K∗UTS∗L∗t / W
= 1.33* 510 * 300 * 5^2 / 62
= 82052.4 N
= 8.3642 Ton
Where, K = Constant 1.33
UTS = Ultimate Tensile Strength
L = Length of Plate
t = Thickness of Plate
W = Width of Plate

3.2 Design of Link

3.2.1 Design of Rod

Case 1:
Force (P) = 82053 N
N_f = 1.25
$\sigma_{all} = \sigma_{ult}/N_f$= 408 N/ mm^2

Length, L = 470 mm
l = 482.5 mm
Diameter=165mm



(Assume rod is fixed at one end)

- Bending Moment:

M = F * L
= 82053 * 470
= 38564910 N*mm

- Torque:

T = F * l
= 82053 * 482.5
= 39590572.5 N*mm

- Bending Stress:

σ_b= M Z = M y / I = 87.446 N/mm2

- Shear Stress:

τ=T∗ r / J=T (d) ∗d
= 44.8859 N/mm2

- Maximum Principal Stress :

$\sigma_1=\sigma_b/2 - \sqrt{((\sigma_b/2)^2 + \tau^2)}$
= 43.723 + 62.66
=106.38 N/mm^2

- Minimum Principal Stress:

$\sigma=\sigma_b/2 - \sqrt{((\sigma_b/2)^2 + \tau^2}$
= 43.723 – 62.66
= -18.937 N/mm^2

- According To Von Mise's Theory :

$\sqrt{(\ \sigma - \sigma * \sigma + \sigma)}\ = \sigma_{all}$
σ_{all} = 117 N/mm^2 < 408 N/mm^2
(Hence, Design is safe.)

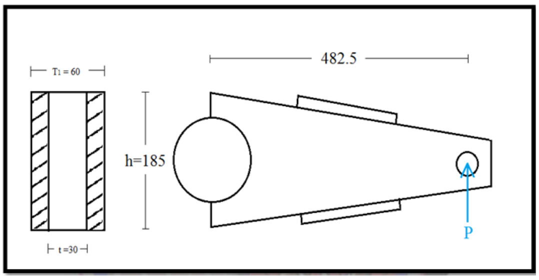
3.2.2 Design of lever

Force (P) = 82053 N
N_f = 1.25 $\sigma_{bl} = \sigma_{ult}/N_f$ = 408 N/mm^2
T_1 = 60 mm
t = 30 mm
l = 482.5 mm
h = 185 mm

The Maximum Bending Moment Acting on Lever:
M_L = F * l
= 82053 * 482.5
= 39590572.5 N*mm

The Section Modulus for the Lever Cross Section:
Z= I_{xx}/y = 171125 m^3

The Maximum Bending Stress Induced in a Lever:
σ_{bL}= M_L/Z
= 231.35 N/mm^2< 408 N/mm2
(Hwncw, Design is safe for lever.)



3.2.3 Design of Pin Joint

Force (P) = 82053 N
N_f = 1.25 $\sigma_{all} = \sigma_{ult}/N_f$= 510/1.25 = 408 N/mm^2
T_1 = 15 mm
t = 30 mm
d_p = 42 mm

The Maximum Bending Moment (at Section X-X) :

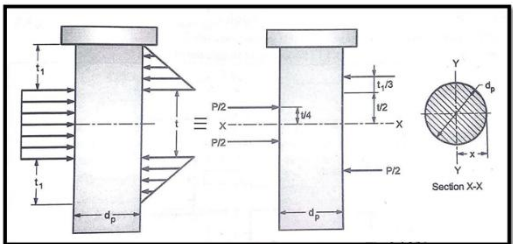
$$M=\frac{P}{2}\left[\frac{t}{4}+\frac{t_1}{3}\right]$$

$$=\frac{82053}{2}\left[\frac{30}{4}+\frac{15}{3}\right]$$

= 512831.25 N*mm

$$\sigma=\frac{Mx}{I_{yy}}$$

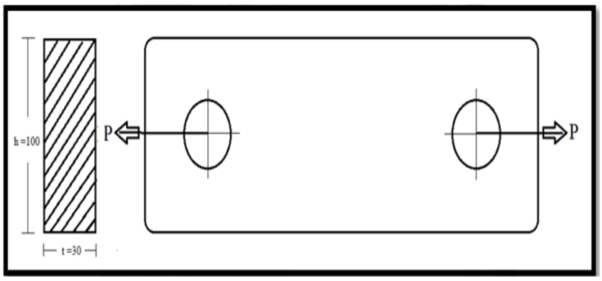
= 70.51 N/mm^2 < 408 N/mm^2



(Hence, Design of Pin Joint is Safe)

3.2.4 Design of Rectangular Bar

Force (P) = 82053 N
N_f = 1.25
$\sigma_{all}= \sigma_{ultl}/N_f$ = 408 N/mm^2
h = 100 mm
t = 30 mm
Tensile stress induce in a bar: $\sigma_t=P/\ h*t$
σ_t = 27.35 N/ < 408 N/mm2



(Hence, Design of Rectangular Bar is safe.)

4. Conclusion

We can say that bending error has reduced from 12˚ to 3.625˚. In bending operation of M.S Sheet Metal plates. We got nearly same bending angle throughout length of Sheet metals. Hence, we can conclude that after providing the link mechanism, The bending press has negligible angular deflection and It can now perform more effectively that will result ultimately in favor of the industries.

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