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Hydraulic Sheet Metal Bending System

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Abstract: *Due to increasing Globalization it is very much essential for manufacturers to produce goods having highest reliability and in required time. This is achieved by using various manufacturing methods. The transformers which are currently assembled for Welding Machines require hammering of the extruded Metal plate. This method requires large Human effort in form of Hammering. Hence the safety of the operator is also at a risk. The main purpose of this system is to automate the bending process so that almost negligible amount of Human Effort is required and the process becomes completely safe. This paper concentrates on the basic factors which should be considered while designing bending machine especially when sheet metal can't be bent separately and having space constraint. Factors considered are force required, punch radius, reduction of spring back,*

Keywords*:Human Effort; Safety; Spring-Back; Punch Radius.*

I. Introduction

Due to the increasing Globalization the competition of the manufacturers to provide highlyreliable goods in the required time is growing. This increasing competition has led to the use of fast manufacturing processes. The processes of Sheet Metal Bending are used in various Industries for different applications. In large scale Industries various automated processes are used for Sheet Metal Bending. But in various MSME's Hammering process is used for Bending the Sheet Metal. This process although works fine, requires large amount of Human effort with high risk. Considering the safety and wellbeing of operator these industries are also looking for some methods to substitute the hammering process which can do the required process at low cost.

Likewise, Artech Welder Pvt Ltd,awelding Machine Manufacturing Company was looking to substitute the Hammering Process required in the assembly of the Transformer which are used in Welding Machines with an automated system.

Design hydraulic bending sheet system

FEATURES:

- Hydraulic
- Double Acting Cylinder
- Easily mounted on existing platform, no need of changing everything
- Smooth motion
- Easy maintenance
- Low cost

OBJECTIVES OF THE WORK: The following are the objectives of the work:

- To make a bending machine to bend metal sheets up to 13 mm.
- To make on simple working principle.
- To reduce the time for operation.
- To make in minimum cost.

II. Literature Survey

In this paper author has explained different types on bending processes like bottoming, coining, three-point bending, wipe bending, folding,etc. and which can be best suited with specific application. Wipe bending is best suited our application as it doesn't require building whole new machine. Also discussed the productivity analysis of manually or power operated sheet bending machine. Considering manual operation is replaced by power operated devices.It also gives information about limitation of manually operated sheet bending machine and power operated sheet bending machine. Various term related to bending like bend allowance, bend deduction,etc. are explained and their calculations. Problems associated with sheet metal/plate rolling machines, how to address them, maintenance and safety [1]

In these papers the author has explained why Hydraulic Systems are used over Pneumatic systems in Bending Systems due to their higher reliability, high power transmission capacity and self-Lubrication properties.[2]

In this paper author explains different factors/ways of Spring-back compensation in order to get the actual required dimensions which get deformed due to spring back. Spring-back is a very common and critical phenomenon in sheet metal forming operations, which is caused by the elastic redistribution of the internal stresses after the removal of deforming forces. Deformed shape will have very less accuracy and can affect many factors. Parameters which author has considered for compensating spring back are punch angle, grain direction of sheet metal material, die opening, ratio of die radius to sheet thickness, sheet thickness, punch radius, punch height, coining force, pre bend condition of strip etc. using which we can achieve perfect bend.[3]]

In his work author has used single acting cylinder for force application. His work is regarding handling loss of cylinder force. As a result, the machine becomes low in cost and light in weight simple operation and highly competitive marketable machine. This paper we also get formula for calculating bending force. [4]

On this blog, the author has explained when to use Linear Simulations and When to use non linear Simulations for an application.
A linear Analysis is used when
1.The Material is Linear Elastic, Where the Geometry will return to its original position once the load is removed.
2.Deformations are small in relation to the geometry of the model
3.Loads and restraints are constantly applied to the model, without change in magnitude or direction. Also, the loads do not cause separate parts to come in contact with one another
A Linear Static Solution is not valid if any of these points are violated. The relationship between Loads and response becomes Non- Linear and a Non-Linear Analysis must be performed in order to get accurate results that reflect True- to-life behavior [5]

III. Design and Construction

Our aim was to design a hydraulic bending system using the actuator which was available in the company. The company uses crane to move transformer from one place to anotherand it is mounted on a table where processes also take place. So, we had to design a fixture to Mount actuator such that it can be mounted on original setup.

Steps involved in designing the hydraulic bending system:
1.To choose between Hydraulic and Pneumatic system
2.To choose Single acting or Double acting Cylinder
3.To calculate the required force for bending the plate
4.To design the punch in such a way that to give minimum force
5.To simulate and check whether the calculations are valid
6.To design a frame on which the actuator can be mounted
7.To calculate number of bolts required

The reasons to choose Hydraulic system are:
1.Working Fluid is incompressible and has specific mass

2.It is used to transmit large force which is required in our application
3.As there is no delay in movement, the process is more gradual and smoother

The reasons to choose Double Acting Cylinder are:
1.It provides mores smoother operation
2.Both the strokes (Forward and Reverse) can be controlled

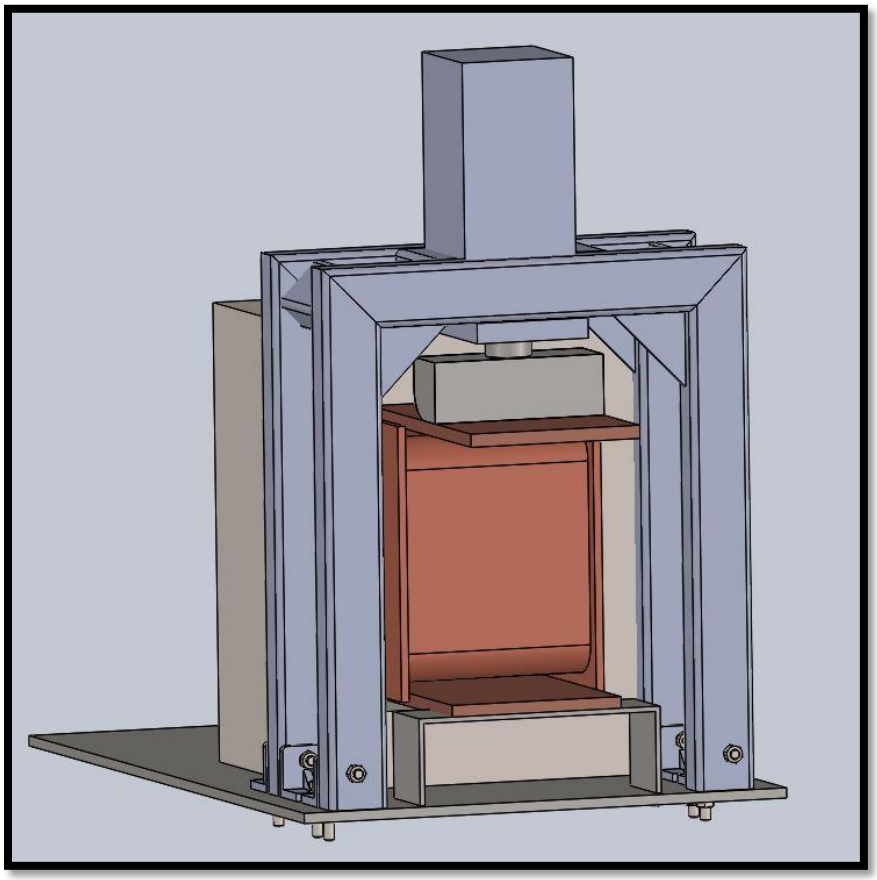

Figure 1 CAD Model of Bending System

Basic Components:
The basic components of Hydraulic Sheet Metal Bending System are given Below:

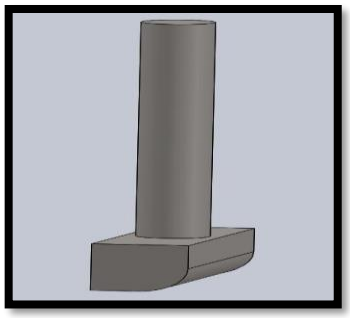

Figure 2 CAD Actuator Rod with Punch

1.Actuator rod with Punch:

Punch is made up of harder material than the bending material. Punch is screwed to a single acting cylinder actuator. Most important Factor to be considered during designing of the punch:

- Punch Radius: As the radius of the punch increases spring back also increases and as radius of the punch decreases spring back also decreases. Radius of the punch is compensating factor for spring back.
- Distance between Punch and Die: More the lesser is the force required to the metal sheet.

In our application the material used is Annealed copper, it shows very less springback nearly negligible and hence we have kept radius of the punch more. the radius of the punch is kept in such a way that the force required will be minimum but also the spring back will be eliminated.

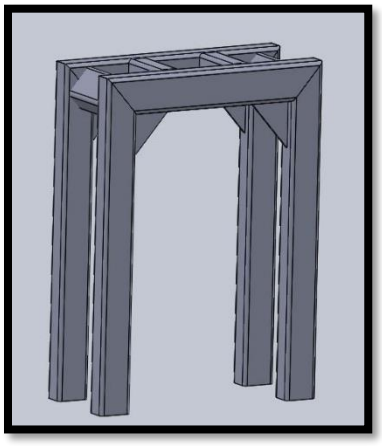

Figure 3 Basic Frame

Rectangular Hollow cross Section is used for our application for the frame of the fixture to mount the actuator. Hollow rectangular cross section provides more moment of inertia and hence less bending of the frame and more rigidity. Rectangular hollow section tube of mild steel having Yield Strength of 370 N/mm2 and cross section of 60x40x3.2 is used. Frame is welded in U shaped but can be forged or casted in U shape. Actuator is mounted below the frame so that when actuator is in action the reaction force is applied on the frame. This frame is bolted on the table using plates. Internal supports are added so as to distribute load in two vertical members.

2.L Shaped Brackets to support the frame

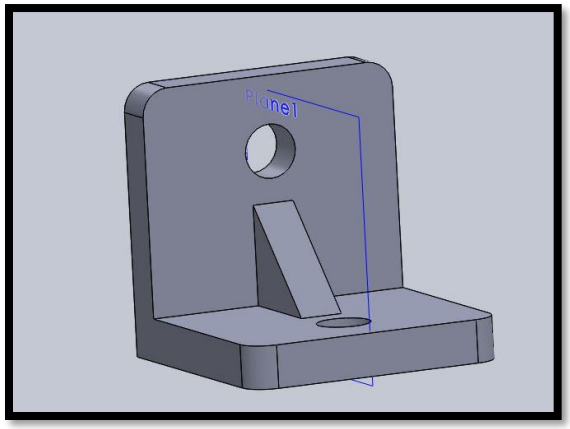

Figure 2 L Shaped Bracket

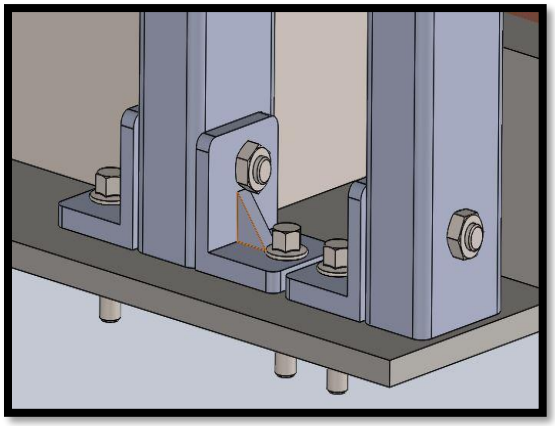

Figure 3 Use of Bracket to support the frame

The L shaped brackets are used to fix the Basic frame to the working Table. As shown in the above Figure.

IV. Working

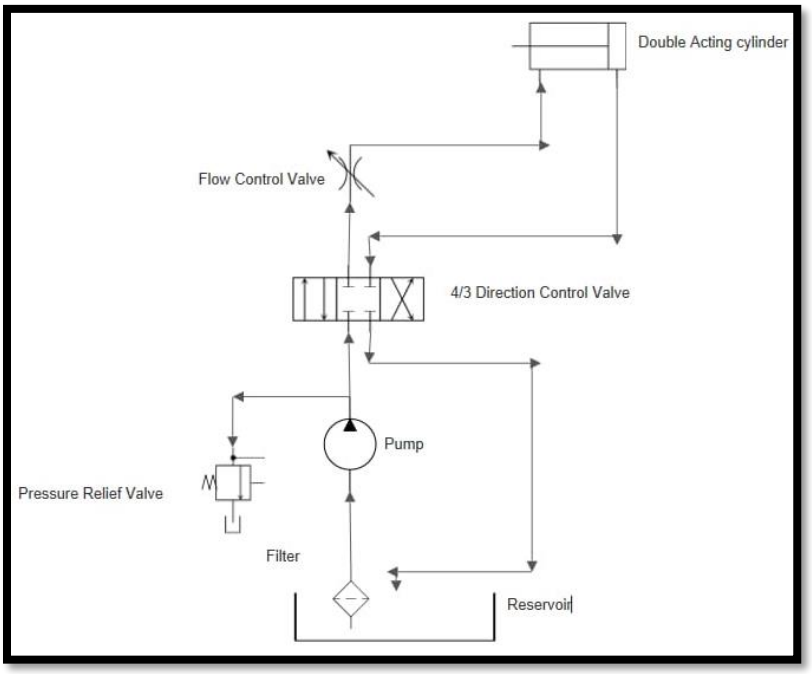

Figure 6 Hydraulic Circuit Diagram

This apparatus works on a Hydraulic System. The main components of this system are:
1. Reservoir
2. Pump
3. Prime Mover
4. Pressure Relief Valve
5. 4/3 Direction Control Valve
6. Flow Control Valve
7. Single rod Double acting Cylinder
8. Actuator Rod with punch
9. Hose
10. Oil

The reservoir is used to store the oil which is the working Fluid of the System. The Reservoir also helps to settle the dust and debris in the oil to make the fluid flow friction free. The Pump which is driven by the prime mover is used to pressurize the fluid from Low pressure level to High Pressure Level. To keep a check to the flow a pressure relief valve is used so as to bypass the fluid if the pressure generated by the pump exceeds the working pressure. The fluid then passes to a Direction Control Valve (4/3- 4 ways 3 switching positions) which directs the fluid to required ports. When the DCV is placed at position 1 the fluid passes further to the Flow Control Valve which controls the rate of fluid flowing towards the actuator which in turn controls the speed of the forward actuation.
A special designed punch is attached to the end of the actuator rod. The work of the punch is to transfer the hydraulic force from the actuator to the extruded plate.

Calculations:
The process used to bend the copper plate is called as edge bending/Wipe Bending.

F = Required Vertical Force in Newton
K= Bend Factor (0.33 in case of Wipe Bending)
S= Tensile Strength of Sheet Metal in Newton per Millimeter Square
L= Length of Bend in Millimeter
T= Thickness in Millimeter
W= Die opening width in Millimeter

$$F = \frac{K * S * L * T^2}{W}$$

For the Current application:

K = 0.33
S = 240 N/mm^2
L = 150 mm
T = 13mm
W = 68mm

Therefore, the required force is

$$F = \frac{0.33 * 240 * 150 * 13 * 13}{68} = 29525.29\ N$$

The further calculations for design of the other components were done with the help of above calculated force with 1.5 as Factor of Safety.

V. Validation of Calculated Force

After the design is ready with calculations next step is to validate calculations using simulation software.
Bending is done beyond the elastic zone, so for our application non-linear simulation is used.
First, we used Ansys but it doesn't show actual bending, it just shows stress concentration.Then we switched to SolidWorks simulation. In SolidWorks we designed cad model and assembled parts and made it simulation ready.
In earlier stages we got results with very high force than the calculated force. After trails and simulations of different parts we validated the force as seen in the below figure.

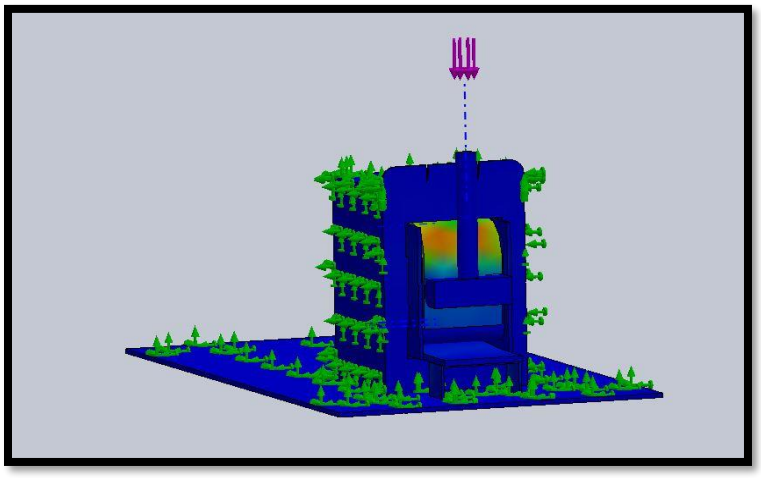

Figure 7 Stress Plot.

VI. Conclusion

1.The Hydraulic bending System nearly negates the Human effort required.
2.This system also reduces the Time required for the operation.
3.A more sophisticated approach is adopted in the manufacturing process.
4.It offers a quick, easy and Simple Method for Bending Process.

VII. References

[1]. "Sheet Metal Bending Machine"- Aniruddha Kulkarni, Mangesh Pawar, Pravin Yadav. 2015
[2]. "Factors affecting on Springback in Sheet Metal Bending: A review"- S.P. Chikhalthankar, G.D. Belurkar. 2014
[3]. "Development of Single Hydraulic Cylinder Operated Sheet Metal Bending Machine"- Ajay Jaswal. 2018
[4]. "Design and fabrication of Hydraulic Bending Machine"- Pankaj Kumar Pandey, 2015
[5]. "https://www.javelin-tech.com/blog/2014/05/nonlinear-analysis/"