

Design and Fabrication of Sheet Metal Cutting Machine Using Hydraulic Systems

AjayPathave¹, AkshayJori², Pratik Jedgule³, Prof. A.A.Sakhare⁴

^{1,2,3}Dept of Mechanical Engineering

⁴Assistant Professor, Dept of Mechanical Engineering

^{1,2,3,4} DYPIT, Pimpri, Pune, India

Abstract- Sheet metal cutting is one of the most important processes used in the industries as sheets are used everywhere in the world. Lots of machines are available in the market which are working on different principles and different actuating forces. But all of these machines are having very sturdy constructions and are of very big size. These have resulted into a very high cost of these machines. As a result these machines cannot be used by the local workshops due to their heavy costs.

In such a case most of the times manual sheet metal cutting machines are used in the local engineering works due to their lower costs compared to other machines. But these machines are having some limitations as they are not able to cut the sheet metal of higher thicknesses, since the human operator is not able to apply such a large force.

So there is a scope of forming a machine of such kind which is having low cost and able to cut the sheets of higher thicknesses effectively. As hydraulics is the most dominating and convincing power sources available now-a-days, it will be helpful in fabrication of such kind of machine at lower cost and better operational affectivity.

Keywords :-Hydraulic System, Hydraulic Cylinder, Gear Pump, Analysis Using Ansys 15.0

I. INTRODUCTION

Hydraulic machines are machinery and tools that use liquid fluid power to do simple work. Heavy equipment is a common example. In this type of machine, hydraulic fluid is transmitted throughout the machine to various hydraulic motors and hydraulic cylinders and which becomes pressurized according to the resistance present. The fluid is controlled directly or automatically by control valves and distributed through hoses and tubes.

The popularity of hydraulic machinery is due to the very large amount of power that can be transferred through small tubes and flexible hoses, and the high power density and wide array of actuators that can make use of this power.

Hydraulic machinery is operated by the use of hydraulics, where a liquid is the powering medium.

Types of shearing Machine:

Sheet metal Cutting machines are classified according to the following:

- 1) Pneumatically operated
- 2) Hydraulically operated
- 3) Rack and pinion operated

II. DESIGN PROCEDURE

2.1 Material Selection

To prepare any machine part, the type of material should be properly selected, considering design, safety. The selection of material for engineering application is given by the following factors:-

- 1) Availability of materials
- 2) Suitability of the material for the required components.
- 3) Suitability of the material for the required components.
- 4) Cost of the materials.

The machine is basically made up of mild steel. The reasons for the selection are Mild steel is readily available in market. It is economical to use and is available in standard sizes. It has good mechanical properties i.e. it is easily machinable. It has moderate factor of safety, because factor of safety results in unnecessary wastage of material and heavy selection. Low factor of safety results in unnecessary risk of failure. It has high tensile strength. Low Coefficient of thermal expansion.

The materials of the sheets to be cut are taken as aluminum and plastic as they are replacing many metals in the present scenario because of their distinguished properties and features.

2.2 FORCE CALCULATION :-

Force required to cut the Sheet = $L \times t \times T_{max}$

For sheet of 3 mm thickness,
Force required = $20 \times 3 \times 200 = 12000 \text{ N}$

This is the force required to cut the sheet metal, however the initial force required to cut the sheet is more, so taking factor of safety as 1.5 ,

Therefore, max force required to cut the sheet = $1.5 \times F$
 $F_{\text{max}} = 1.5 \times 12000 = 18000 \text{ N}$

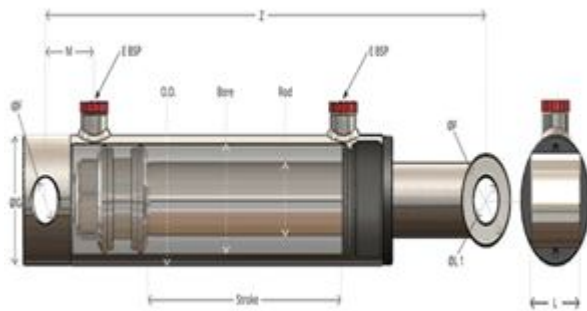


Fig.1- Standard hydraulic cylinder (detailed)[1]

The maximum force required is 18 KN, so we have to select the cylinder which delivers the required force working under the designed pressure.

Force = Pressure \times cross sectional area

$$F = P \times (\pi/4) \times d^2$$

$$F = 210 \times 105 \times (\pi/4) \times (0.063-0.04)^2$$

$$F = 39072.77 \text{ N}$$

$$F = 39.072 \text{ KN}$$

Here this cylinder will deliver the required force.

Hence we are selecting the cylinder with ,

Bore diameter = 63 mm

Rod diameter = 40 mm

Rated pressure = 210 bar

Stroke = 400 mm

2.2.1 Design Summary

1. Cylinder:

Bore diameter : 63 mm

Rod diameter : 40 mm

Rated pressure : 210 bar

Stroke : 400 mm

2. Pressure developed : 96.77 bar

3. Flow rate of pump : 12.469lpm
4. Total oil required : 8 liters(approx.)
5. Motor Rating : 3 HP

III. WORKING PRINCIPLE

In this machine, the hydraulic oil from the reservoir is cleaned by filter and sucked by the pump when driven by motor. The pump increases the pressure of oil high pressure oil is then passed through the pressure relief valve to drain excess press. Now oil is circulated to the direction control valve to the actuator. The pressure of 120 to 125 bar is passed through a pipe connected to the Solenoid valve with one input.

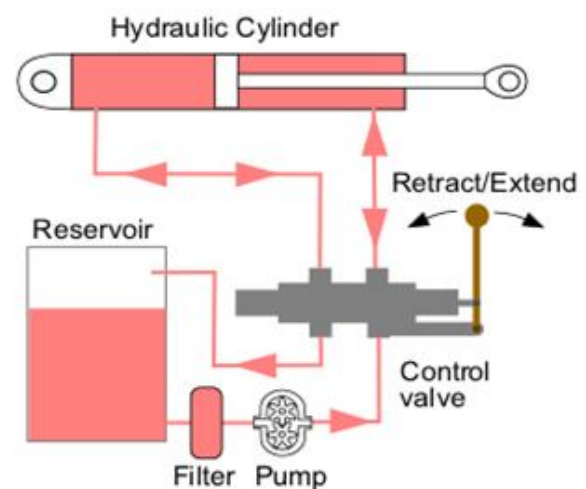


Fig.2- Simple hydraulic system

The oil moves to piston and rod to give output required force. The actuator connected to blade or high strength cutter which utilizes the force to performing the cutting work. The oil from relief valve and outlet of the actuator is transferred to the reservoir through drain line and recirculate in hydraulic system as shown in fig.7. Hydraulic system using the on-off type or logic control device to its control objective is to maintain the stability of value to be transferred or simple changes of direction, also called the order of valuation and control components.[1]

The same principle applies for a hydraulic pump with a small swept volume that asks for a small torque, combined with a hydraulic motor with a large swept volume that gives a large torque. In such a way a transmission with a certain ratio can be built.

Most hydraulic drive systems make use of hydraulic cylinders. Here the same principle is used.

The following diagram gives the pictorial view of the shearing principle used in the sheet metal cutting process.

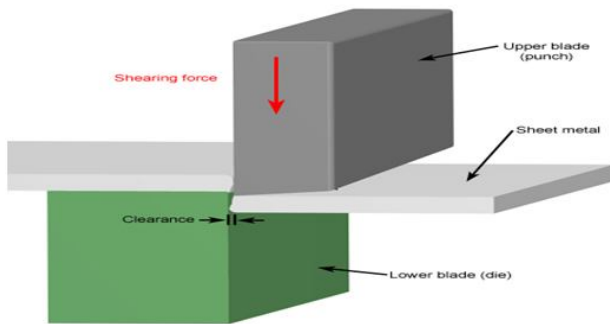
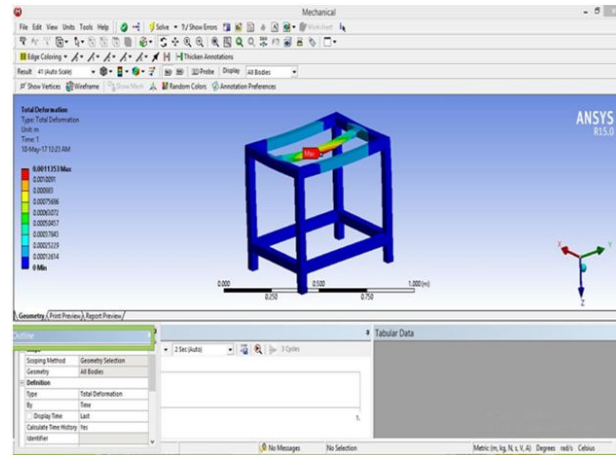
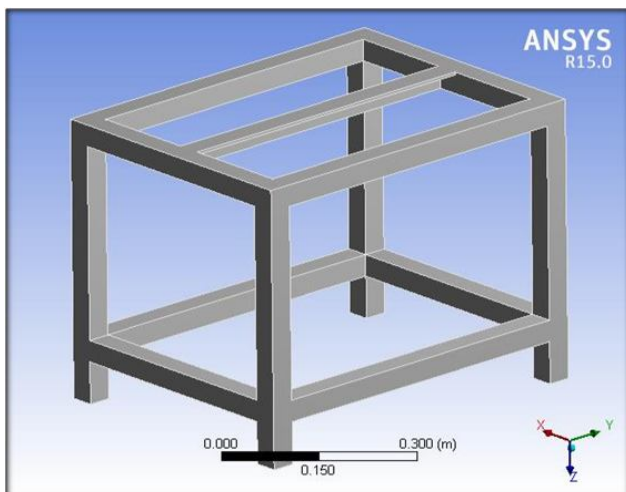


Fig.3- Shearing principle [9]

A power shear is electrically or pneumatically powered hand tool designed to blank large pieces of sheet metal. They are designed to cut straight lines and relatively large radius curves. They are advantageous over a hand saw because there is not a size limit. Large versions can cut sheet metal up to 12 gauges.

An alternative to the hand tools are hydraulically powered tools attached to heavy machinery. They are usually used to cut materials that are too bulky to be transported to a cutting facility, too big or dangerous for the hand tools and are stored at remote locations (e.g. mines, forests) [7]

Ideas for a new business project, a new product, a means of reducing manufacturing costs or for solving industrial labor problems, begin in the human mind.



IV. WORKING MODEL OF HYDRAULIC SHEET METAL CUTTING MACHINE



V. CONCLUSION

By doing all the study and actual fabrication of model, it is clear that the hydraulic sheet metal cutting machine is very easy to construct and it's working is also very simple and cheap. Very less research has been done on this topic as hydraulics is the source considered for the heavy applications most of the times. But now it is easily understandable that the principles of hydraulics can also be implemented in light duty applications with better operational effectiveness. The range of the cutting thickness can be increased by arranging a high capacity cylinder and this machine is advantageous to small sheet metal cutting industries. This machine can be used as a multipurpose sheet metal working machine which is very beneficial in local engineering works with reduced sound pollution.

VI. FUTURE SCOPE

This machine can be easily converted into a sheet metal forming machine by just replacing the blade of the machine with punch and die arrangement. In general engineering works where the prime investment is always a

major issue along with the requirement of the floor space area for having different machines for different works this will be the better solution to them.

Simply this machine can be developed as a multipurpose sheet metal working machine by doing small modifications and can perform operations like punching, blanking, coining, press forging and drawing easily when the forces required are within the scope of the machine.

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