DESIGN AND FABRICATION OF PNEUMATIC PUNCHING MACHINE

An Internal Project report submitted in partial fulfilment of the requirement

For the award of the degree of

BACHELOR OF TECHNOLOGY

IN

MECHANICAL ENGINEERING

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ABSTRACT

Paper boxes have become a more convenient way to store daily necessities and for packaging small quantities. The main idea of this project is to design and fabrication of punching machine for cutting the paper for paper box using Pneumatic System. Due to global factory's pressing need to increase the speed of packaging small materials and decrease operating costs, our team decided to design a machine that would automatically punch the paper boxes and process it to folding machines. The present work also focus on analyse the punching process for different sheet materials, percentage of punch-die clearances. The results of computer simulations can be used to forecast the quality of the final parts optimization.

With very few pre-existing designs for automated paper boxes/loading devices, we essentially had come up with a design. To make our machine design as simple as possible, we decided to make it primarily using punch and die. The need for ever-changing process innovations is persistently fuelled by rapid technology advancements and demands on organisations to improve their bottom line. The design of the machine can be one in various ways , we have gone through various software's among which we found Autodesk Inventor as user convenient and therefore finalised to do the design in that software. We also had a glance through the pneumatics simulation where lab volt software has come into existence. We have performed Finite element analysis of punching in Explicit dynamics module of ANSYS 15.0 on various sheet metals.

The Pneumatic punching machine is successfully fabricated at very low cost. Through FEA analysis the optimum clearance values for sheet metals of thickness 0.5mm of materials aluminium, copper and steel 1006 are determined.

CHAPTER-1
INTRODUCTION

1.1 INTRODUCTION

The automation concept and time conservation has changed the output service and products in factories since the industrialization time period in developing countries. Upgrading the time usage systems in automated machines and control systems changes the industrialisation vision. With the advance technology engineers always try to develop, invent and improve the machines which will make the work more efficient. In today's practical and cost-conscious world, sheet metal parts have already replaced many expensive cast, forged, and machined products. In most of the sheet metal operations punching or pressing operation is the main or initial operation in the process sequence. Automating this operation results in reduced lead time and also can reduce human effort. Automation can be defined as the "technology concerned with application of mechanical, electronic and computer based systems to operate and control production". There are many reasons for automating the process. The reason may be to reduce manufacturing lead time, to increase labour productivity or to improve the worker safety etc.

Punching is a metal forming process that uses a punch press to force a tool, called a punch, through the work piece to create a hole via shearing. The punch often passes through the work into a die. A scrap slug from the hole is deposited into the die in the process. Depending on the material being punched this slug may be recycled and reused or discarded. Punching is often the cheapest method for creating holes in sheet metal in medium to high production volumes. When a specially shaped punch is used to create multiple usable parts from a sheet of material the process is known as blanking. In forging applications the work is often punched while hot, and this is called hot punching.

The press includes a piston operated by the compressed air source to drive a piston rod to operate the press. This pneumatic press is suitable for small press tool works. It works on the principal of compressed air. A compressor plant, pipe lines control valve, drive-members and related auxiliary application. The air is compressed in an air compressor and for the compressor plant, the flow medium is transmitted to the pneumatic system, it is of vital important that the pressure drop between generation and consumption of compressed air is kept very low, it has been seen that pipeline fittings and joints are mostly responsible for drop in pressure, if any in pneumatic system.

This project title is to design and fabrication of feeder and punching mechanism for automated paper box. The project title is more focus to create the new idea for the paper box. The paper box has two common functions. First is the feeder mechanism .Second mechanism is the punching mechanism. It also can use for the storing of sweets and eatable items. The main idea for this making of paper box is automation. This making of paper box is different from the others in the market. This is because the design of the box is different as it includes automation.

1.2 PNEUMATICS

Pneumatics is a branch of fluid power technology, which deal with the study and application of use of pressurized gas to affect mechanical motion. Pneumatics system are extensively used in industry, where factories are commonly plumbed with compressed air or other compressed inert gases. This is because a centrally-located and electrically- powered compressed that powers cylinders and other pneumatic devices through lever operated valves in often able to provide motive power in a cheaper, safer, more flexible, and more reliable way than a large number of electric motors and actuators. Pneumatic system in fixed installation such as factories use compressed air because a sustainable supply can be made by compressing atmospheric air. The air usually has moisture moved and a small quantity of oil added at the compressor, to avoid corrosion of mechanical components and to lubricate them.

1.2.1 SELECTION OF PNEUMATICS

- Pneumatics is an attractive medium for low cost mechanization particularly for sequential and repetitive operations.
- Many factories and plant already have a compressed air system, which is capable of providing energy requirements and control system

- The main advantage of pneumatics system are usually economic and simplicity the latter reducing maintenance to a low level.
- It can have outstanding advantages in term of safety.

Mechanization is broadly defined as the replacement of manual effort by mechanical power. Pneumatic is an attractive medium for low cost mechanization particularly for sequential (or) repetitive operations. Many factories and plants already have a compressed air system, which is capable of providing the power (or) energy requirements and the control system (although equally pneumatic control systems may be economic and can be advantageously applied to other forms of power). The main advantage of an all pneumatic system are usually economic and simplicity the latter reducing maintenance to a low level. It can also have outstanding advantages in terms of safety.

1.2.2 ADVANTAGES OF PNEUMATICS:

- **SIMPLICITY OF DESIGN AND CONTROL**
- Machines are easily designed using standard cylinder & other components. **RELIABILITY**
- Pneumatic system tends to have long operating lives and require very little maintenance.
- Because gas is compressible, the equipment is less likely to be damages by shock.
- The gas in pneumatics absorbs excessive force, whereas the fluid of hydraulics directly transfers force.
- **STORAGE**
- Compressed gas can be stored, allowing the use of machines when electrical power is lost.
- **SAFETY**
- Very low chance of fire (Compared to hydraulic oil).
- Machines can be designed to be overload safe.

1.3 PUCHING PRESS

A punch press is a type of machine press used to cut holes in material. It can be small and manually operated and hold one simple die set, or be very large, CNC operated, with a multi-station turret and hold a much larger and complex die set.

The various punching presses are fly wheel drive, mechanical punch press, hydraulic punch press, servo drive turret punch press etc.

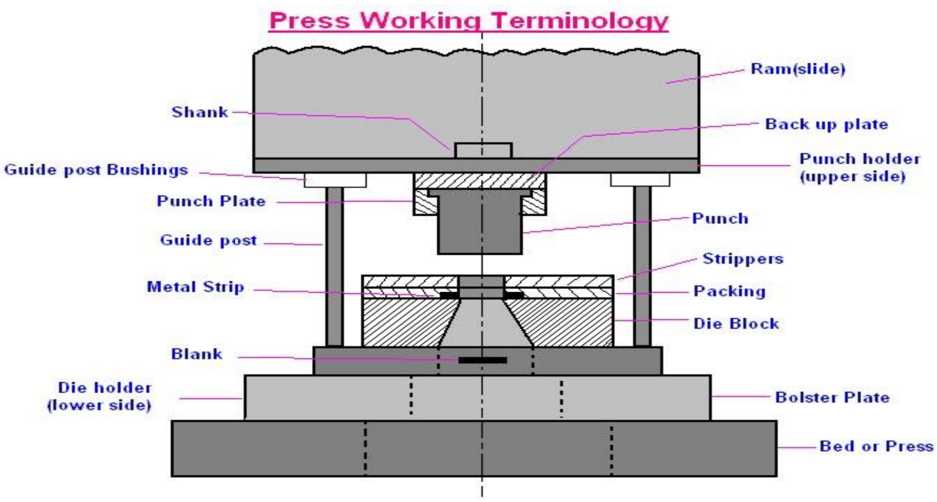


Fig 1.1 Punching Press

1.4 PNEUMATIC CONTROL COMPONENTS

1.4.1 Pneumatic cylinder

An air cylinder is an operative device in which the state input energy of compressed air i.e. pneumatic power is converted in to mechanical output power, by reducing the pressure of the air to that of the atmosphere.

(i) Single acting cylinder

Single acting cylinder is only capable of performing an operating medium in only one direction. Single acting cylinders equipped with one inlet for the operating air pressure, can be production in several fundamentally different designs.Single cylinders develop power in one direction only. Therefore no heavy control equipment should be attached to them, which requires to be moved on the piston return stoke single action cylinder requires only about half the air volume consumed by a double acting for one operating cycle.

(ii) Double acting cylinders

A double acting cylinder is employed in control systems with the full pneumatic cushioning and it is essential when the cylinder itself is required to retard heavy messes. This can only be done at the end positions of the piston stock. In all intermediate position a separate externally mounted cushioning derive most be provided with the damping feature.

The normal escape of air is out off by a cushioning piston before the end of the stock is required. As a result the sit in the cushioning chamber is again compressed since it cannot escape but slowly according to the setting made on reverses. The air freely enters the cylinder and the piston stokes in the other direction at full force and velocity.

1.5 Pneumatic Systems

Fluid power is the technology that the generation, control, and transmission of power, using pressurized fluids. Pneumatics is a branch of fluid power technology, which deals with the study and application of the use of pressurized gas to affect mechanical motion. Pneumatics system is extensively used in industry, where factories are commonly plumbed with compressed air or other compressed inert gases. This is because a centrally-located and electrically- powered compressed that powers cylinders and other pneumatic devices through lever operated valves is often able to provide motive power in a cheaper, safer, more flexible, and more reliable way than a large number of electric motors and actuators. A pneumatic system in a fixed installation such as factories uses compressed air because a sustainable supply can be made by compressing atmospheric air. The air usually has moisture moved and a small quantity of oil added at the compressor, to avoid corrosion of mechanical components and to lubricate them.

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, and mechanical clamps

1.6 Main pneumatic components

Pneumatic components can be divided into two categories:

i) Components that produce and transport compressed air.

ii) Components that consume compressed air.

All main pneumatic components can be represented by simple pneumatic symbols. Each symbol shows only the function of the component it represents, but not its structure. Pneumatic symbols can be combined to form pneumatic diagrams. A pneumatic diagram describes the relations between each pneumatic component, that is, the design of the system.

Examples of components that produce and transport compressed air include compressors and pressure regulating components.

1.6.1 Compressor

Fig 1.2 Air Compressor

A compressor can compress air to the required pressures. It can convert the mechanical energy from motors and engines into the potential energy in compressed air. A single central compressor can supply various pneumatic components with compressed air, which is transported through pipes from the cylinder to the pneumatic components. Compressors can be divided into two classes: reciprocatory and rotary

1.6.2 Pressure regulating component

Pressure regulating components are formed by various components, each of which has its own pneumatic symbol:

i. Filter – can remove impurities from compressed air before it is fed to the pneumatic components.

ii. Pressure regulator – to stabilize the pressure and regulate the operation of pneumatic components.

iii. Lubricator – To provide lubrication for pneumatic components

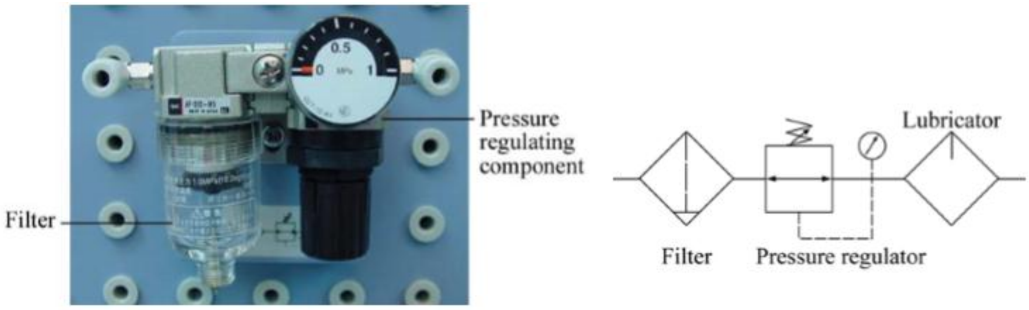


Fig 1.3 Pressure regulating component

Examples of components that consume compressed air include execution components (cylinders), directional control valves and assistant valves.

1.6.3 Execution component

Pneumatic execution components provide rectilinear or rotary movement. Examples of pneumatic execution components include cylinder pistons, pneumatic motors, etc. Rectilinear motion is produced by cylinder pistons, while pneumatic motors provide continuous rotations. There are many kinds of cylinders, such as single acting cylinders and double acting cylinders.

Single acting cylinder: A single acting cylinder has only one entrance that allows compressed air to flow through. Therefore, it can only produce thrust in one direction. The piston rod is propelled in the opposite direction by an internal spring, or by the external force provided by mechanical movement or weight of a load

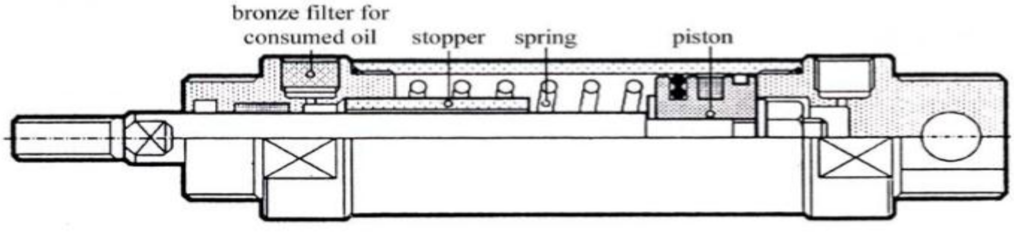


Fig 1.4(a) Cross section of a single acting cylinder

Fig 1.4(b) Single acting cylinder

The thrust from the piston rod is greatly lowered because it has to overcome the force from the spring. Therefore, in order to provide the driving force for machines, the diameter of the cylinder should be increased. In order to match the length of the spring, the length of the cylinder should also be increased, thus limiting the length of the path. Single acting cylinders are used in stamping, printing, moving materials, etc.

Double acting cylinder: In a double acting cylinder, air pressure is applied alternately to the relative surface of the piston, producing a propelling force and a retracting force. As the effective area of the piston is small, the thrust produced during retraction is relatively weak. The impeccable tubes of double acting cylinders are usually made of steel. The working surfaces are also polished and coated with chromium to reduce friction.

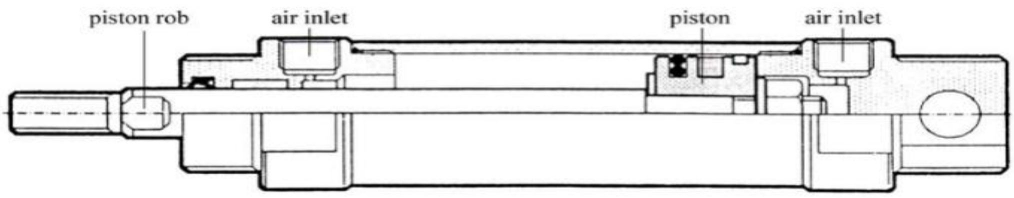


Fig 1.5(a) Cross section of a double acting cylinder

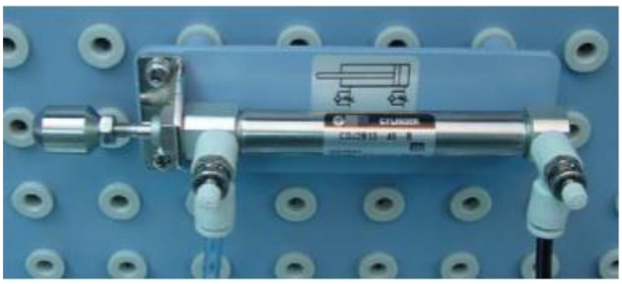


Fig 1.5(b) Double acting cylinder

i. **Spring return cylinder:** It is a cylinder in which a spring returns the piston assembly.

Fig 1.6 Spring return cylinder

ii. **Ram cylinder:** It is a cylinder in which the movable element is the piston rod

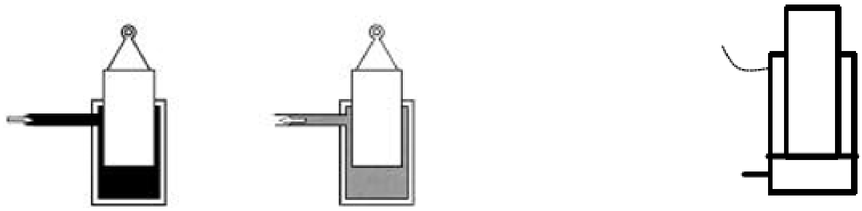


Fig 1.7 Ram cylinder

1.6.4 Design of single-acting cylinder with a piston rod

A standard pneumatic cylinder consists of five modules/parts:

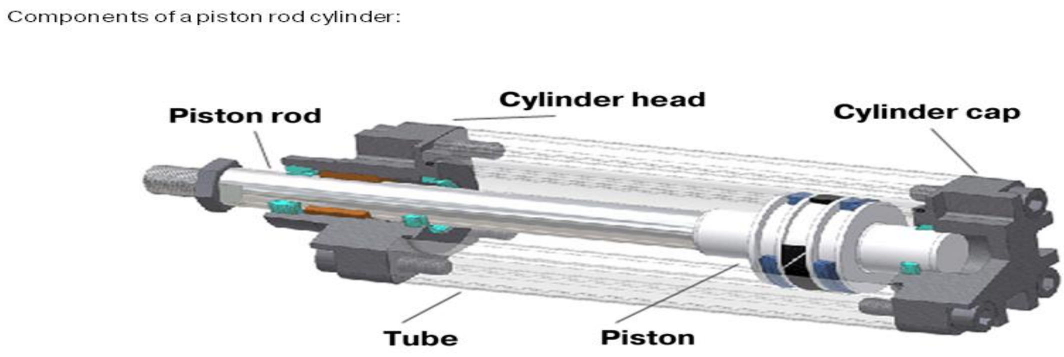


Fig 1.8 Pneumatic Cylinders

- Cylinder barrel
- Bearing cap
- End cap
- Piston
- Piston rod

i) Cylinder barrels: Originally, these really were "just" tubes. However, nowadays extruded profiles instead of a tube are used for most cylinders. The advantage is that a profile can also be used for additional functions.

ii) Bearing caps: The bearing cap closes the cylinder (cylinder barrel) on one side and at the same time forms a bearing and sealing point for the piston rod. One of the air connections is generally located in the bearing cap.

iii) End caps: The end cap closes the cylinder (cylinder barrel) on the other side. The second air connection is usually located in the end cap.

iv) Pistons: The piston which is in the piston rod carries out actual movement in the cylinder. However, the piston needs to do more than just carry out a movement. It forms a seal between the front and rear cylinder chamber. In addition, the piston has to convert the kinetic residual energy in the end position. The bearing and end caps also have their part to play.

v) Piston rods: The piston rod is the part which transmits the force and the movement of the cylinder to the outside. The tip of the piston rod generally has a thread so that other custom components can be attached to it.

1.6.5 Directional control valve:

Directional control valves ensure the flow of air between air ports by opening, closing and switching their internal connections. Their classification is determined by the number of ports, the number of switching positions, the normal position of the valve and its method of operation. Common types of directional control valves include 2/2, 3/2, 5/2, etc. The first number represents the number of ports; the second number represents the number of positions. A directional control valve that has two ports and five positions can be represented by the drawing in a figure as well as its own unique pneumatic symbol.

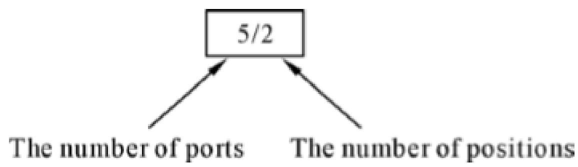
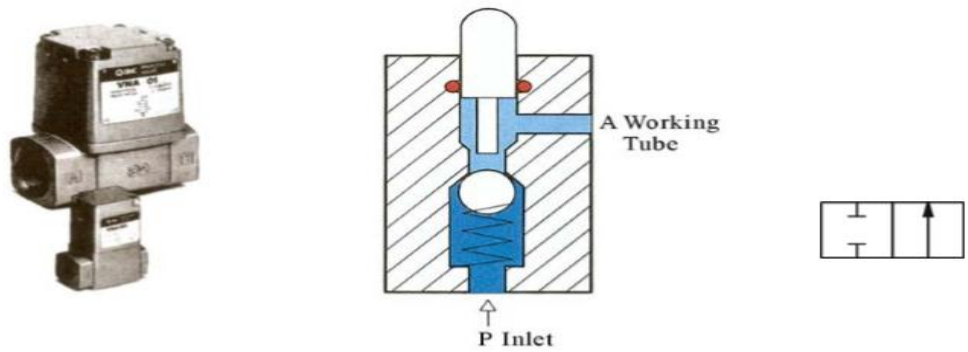


Fig 1.9 Describing (a) 5/2 directional control valve

i) 2/2 Directional control valve: The structure of a 2/2 directional control valve is very simple. It uses the thrust from the spring to open and close the valve, stopping compressed air from flowing towards working tube ‘A’ from air inlet ‘P’. When a force is applied to the control axis, the valve will be pushed open, connecting ‘P’ with ‘A’. The force applied to the control axis has to overcome both air pressure and the repulsive force of the spring. The control valve can be driven manually or mechanically and restored to its original position by the spring.

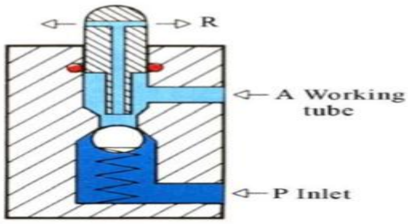


(a) (b) (c)

Fig 1.10 2/2 directional control valve

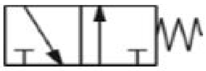
(a) 2/2 control valve
(b) Cross section
(c) Pneumatic symbol of a 2/2 directional control valve

ii) 3/2 Directional control valve: A 3/2 directional control valve can be used to control a single acting cylinder. The open valves in the middle will close until ‘P’ and ‘A’ are connected together. Then another valve will open the sealed base between ‘A’ and ‘R’ (exhaust). The valves can be driven manually, mechanically, electrically or pneumatically. 3/2 directional control valves can further be divided into two classes: Normally open type (N.O.) and normally closed type (N.C.)



(a) (b)

Fig 1.11 3/2 directional control valve (a)3/2 control valve (b) Cross section



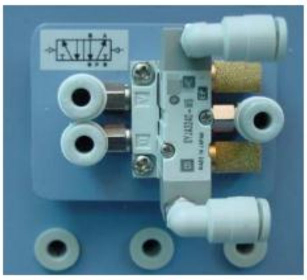
(a) (b)

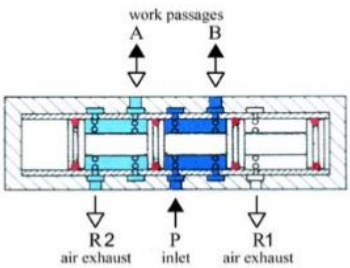
Fig 1.12 Pneumatic symbol of 3/2 directional control valve

(a) Normally closed type

(b) Normally open type

iii) 5/2 Directional control valve: When a pressure pulse is an input into the pressure control port 'P', the spool will move to the left, connecting inlet 'P' and work passage 'B'. Work passage 'A' will then make a release of air through 'R1' and 'R2'. The directional valves will remain in this operational position until signals of the contrary are received. Therefore, this type of directional control valves is said to have the function of 'memory'.





(a) (b) (c)

Fig 1.13 5/2 directional control valve

(a) 5/2 control valve

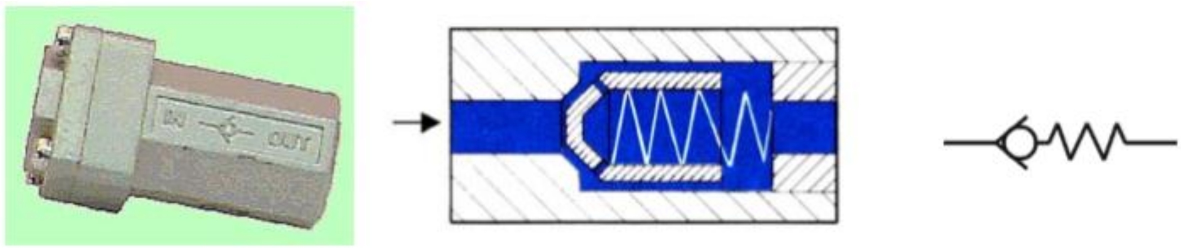
(b) Cross section

(c) Pneumatic symbol

1.6.6 Control valve

A control valve is a valve that controls the flow of air. Examples include non-return valves, flow control valves, shuttle valves, etc.

1) Non-return valve: A non-return valve allows air to flow in one direction only. When air flows in the opposite direction, the valve will close. Another name for non-return valve is poppet valve.



(a) (b) (c)

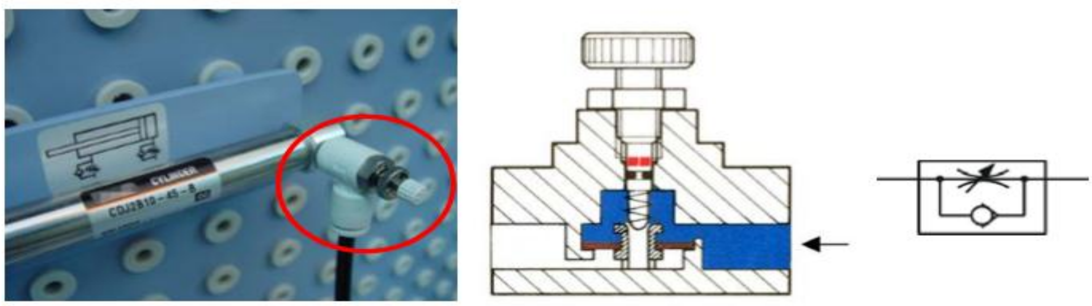
Fig 1.14 Non-return valve

(a) Non-return valve

(b) Cross section

(c) Pneumatic Symbol

(a) Flow control valve: A flow control valve is formed by a non-return valve and a variable throttle



(a) (b) (c)

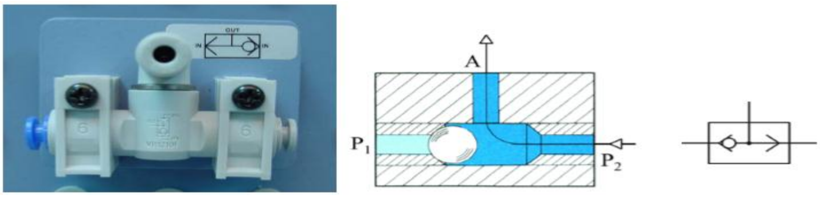
Fig 1.15 Flow control valve

(a) Flow control valve

(b) Cross section

(b) Pneumatic symbol

(b) Shuttle valve: A shuttle valve has two air inlets ‘P1’ and ‘P2’ and one air outlet ‘A’. When compressed air enters through ‘P1’, the sphere will seal and block the other inlet ‘P2’. Air can then flow from ‘P1’ to ‘A’. When the contrary happens, the sphere will block inlet ‘P1’, allowing air to flow from ‘P2’ to ‘A’ only



(a) (b) (c)

Fig 1.16 Shuttle valve

(a) Shuttle valve

(b) Cross section

(c) Pneumatic symbol

1.7 PUNCH AND DIE

A typical die and punch set used for blanking operation is shown below. The sheet metal used is called strip or stock. The punch which is held in the punch holder is bolted to the press ram while die is bolted on the press table. During the working stroke, the punch penetrates the strip, and on the return stroke of the press ram the strip is lifted with the punch, but it is removed from the punch by the stripper plate. The stop pin is a gage and it sets the advance of the strip stock within the punch and die.

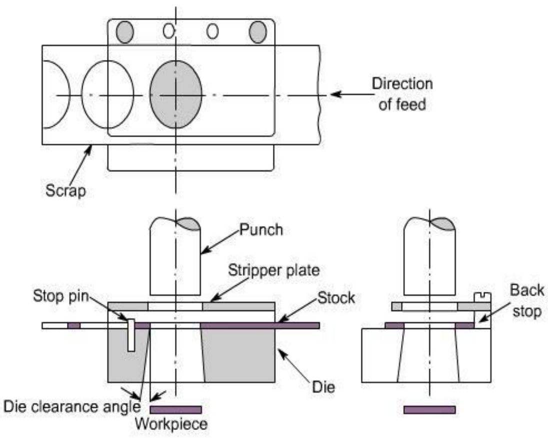


Fig 1.17 Punch and die

CLEARANCE

In blanking operation, the die size is taken as the blank size and the punch is made smaller giving the necessary clearance between the die and the punch.

1.7.1 TYPES OF DIES

The die set is made up of the punch holder which is fastened to the ram of the punch press and the die shoe which is fastened to the bolster plate of the punch press. Various types of dies are used some of the commonly used dies are as follows:

i) Inverted die is designed with the die block fastened to the punch holder and the punch fastened to the die shoe. During the downward stroke of ram, the blank is sheared from the strip. The blank and shedder are forced back into the die opening, which loads a compression spring in the die opening. At the same time the punch is forced through the scrap strip and a spring attached to the stripper is compressed and loaded.

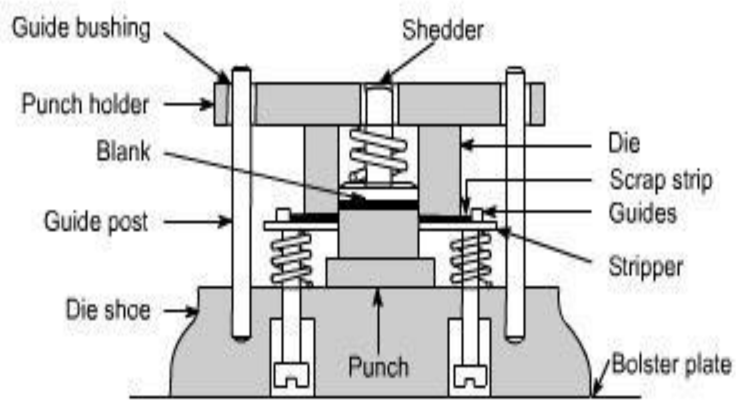


Fig 1.18 Inverted die

ii) Compound die combines the principles of the conventional and inverted dies in one station. This type of die may produce a work piece which is pierced and blanked at one station and in one operation. The piercing punch is fastened in the conventional position to the punch holder..

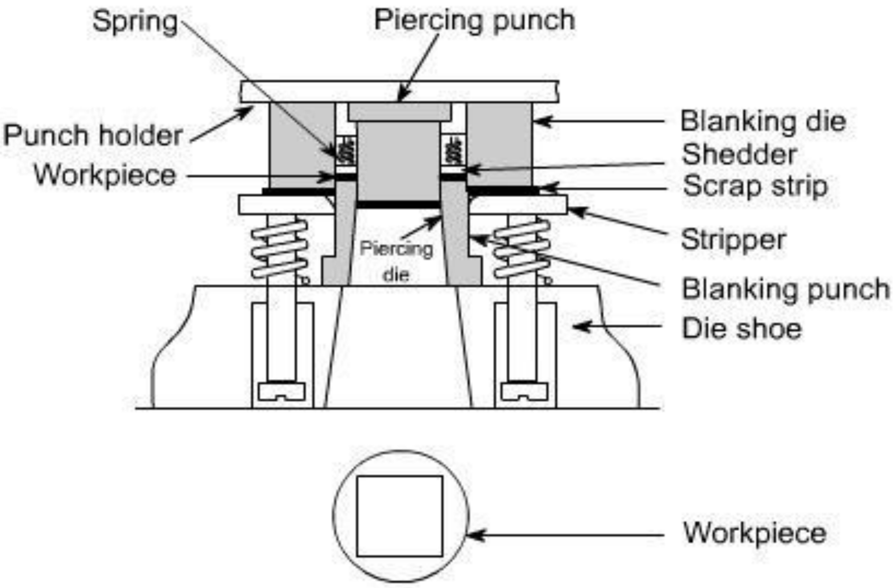


Fig 1.19 Compound die

iii) Progressive dies are made with two or more stations arranged in a sequence. Each station performs an operation on the work piece, or provides an idler station, so that the work piece is completed when the last operation has been accomplished. Thereafter each stroke of the ram produces a finished part. Thus after the fourth stroke of a four – station die, each successive stroke will produce a finished part

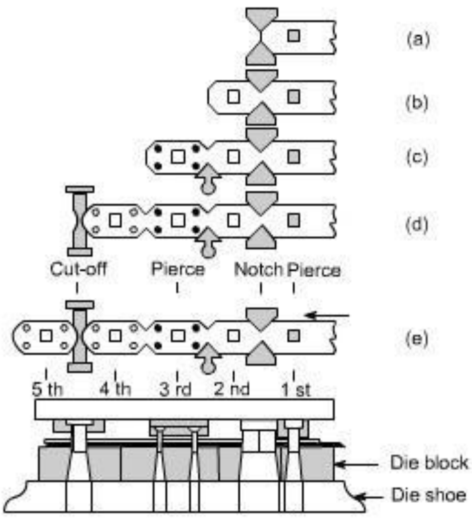


Fig 1.20 Progressive die

1.8 Definition of the problem:

Industries, these days always try to increase its production rate by reducing the wastage of time, manpower, by decreasing the operating costs and by optimizing the work to get ahead of their competition in this era. So, they often look for methods to automate various processes in their production line. One such industry is the packaging industry where most of the work is manually done because of the intricate shapes of packaging and distinct requirements of several clients but requires automation to boost its production rateThe making of paper boxes usually involved some manual work. In this project we are trying to eliminate the manual work and automate it which would save time and may decrease the labour cost. So, we have decided to design a paper box using punching mechanism and automate it. Hence the problem is identified first and is then defined and then is tried to eliminate that.

1.9 Objective of project

The main objective of the project is to fabricate a paper box maker and its automation. The main operation performed here is the punching operation and by using this punching operation we have to cut the paper with the required dimensions. By using punch and die we try to punch the paper with the required force. The present work also focus on analyse the punching process for different sheet materials, percentage of punch-die clearances. The results of computer simulations can be used to forecast the quality of the final parts optimization.

CHAPTER - 2

LITERATURE

Paper boxes have become a more convenient way to store daily necessities and for packing small quantities all over the places around us, but the requirements of this system like fixed installation, space consumption and energy consumptions limiting its applications in some fields. In order to overcome all these problems we come up with an idea of design and fabrication of an automated paper box maker using feeding and punching mechanism. The following papers were referred to study the mechanisms like feeding and punching and also design procedures of automated paper box maker.

2.1 Literature review

Pneumatics is a branch of engineering that makes use of gas or pressurized air. Pneumatic systems used in industry are commonly powered by compressed air or compressed inert gases. A pneumatic system controlled through manual or automatic solenoid valves is selected when it provides a lower cost, more flexible, or safer alternative to electric motors and actuators.

Suraj V Bhosale1 et al [1] is carried out work on “Design and Fabrication of Pneumatic Sheet Metal Cutting Machine “Normally the sheet metal cutting machine is manually hand operated for medium and small scale industries. This paper gives an insight about the automatic sheet metal cutting machine. Any automatic machine aimed for economical use of man. In this paper, pneumatic cylinder is used for cutting in easy way which can be use in small scale industries at lower cost. The sheet metal cutting machine works with the help of pneumatic double acting cylinder. The piston is connected to the moving cutting tool which is used to cut the sheet metal. The cutting process is operated by a direction control valve by using compressor. In manual method sheet metals goes to the scrap sometime because of wrong dimensions, improper cutting etc. Hydraulic machines are also used for sheet metal cutting. But this machines are used for heavy metal cutting and its cost is very high. Hence, we are using a pneumatic system for sheet metal cutting in a easy manner. The main advantage of pneumatic sheet metal cutting machine is to improve product quality, repetition of work and increasing production rate.

A.S. Aditya Polapragada1 et al [2] has done work on "Pneumatic Auto Feed Punching and Riveting Machine"

Press tools are used to form and cut thin metals. Press tools operation can be simplified to a few the pneumatic systems has gained a large amount of importance in last few decades. This importance is due to its accuracy and cost. These simple operations involving a punch a die. There are Nemours types of presses in engineering field, which are used to fulfil the requirements. We are interested to introduce pneumatic system in presses. The main convenience in operating the pneumatic system has function of pneumatic press is to form or cut thin sheet made us to design and fabricate this unit as our metals or non-metals using pneumatic power. In this project we have used the punching process and riveting process for simple application.

The pneumatic press tool has an advantage of working in low pressure that is even a pressure of General Description: 6 bars is enough for operating the unit. The pressurized air passing through the tubes to the cylinder, forces the piston out whose power through the linkage is transmitted to the punch. The work piece thus got is for required dimensions and the piece can be collected through the land clearance provided in the die. The die used in this is fixed such that the die of required shape can be used according to the requirement. This enables us to use different type punch dies resulting in a wide range of products. Different types of punch as requirement can be thus got.

Ms anita v. hase et al [3] is carried out work on "Mechanically Operated Automation System "This Paper objective is to know the actual working of the Automation system. A mechanism for automatically pushing up tissues which includes a box and a pusher. The box stores a tissues in layers and has top wall with an opening formed therein for picking up tissues their through, the pusher disposed under the tissues in the box for pushing up tissues. In this working model, we have made the actual working or simulation of automation system so that it is easy to understand. Our main goal is to make a study model of punching, stamping and power transmission in automation system. With actual working of it only placing all the component in its proper positioning and simplifying the working of it for studying purpose of student it is exactly similar to that of the actual automation system used in industries.

Puneet Isarka et al [4] has done work on "Design and development of pneumatic punching machine " Pneumatic is a branch of engineering that deals which study of air/gas characteristic and also their use in engineering appliances either in atmospheric or above atmospheric pressure. Now a days number of application increases in pneumatics system due to high carrying capacity, low maintenance cost and most important not dangerous. Either compressed air or inert gas are generally used, this paper deals with different components of punching machine (proto type) and their assembly. .

S.p avadhani et al [5] studied on "Design and Analysis of Blanking and Piercing die punch" The sheet metal working processes are widely used in almost all industries like automotive, defense, medical and mechanical industries. The major advantage for using metal working process is to improve production rate and to reduce the cost per piece. Nowadays many people are working for developing die punches with innovative ideas. This project is also based on new design for die punch. The project mainly focuses on different operations done on single setup of die punch in a single stroke, presently these operations are done on three separate setups which leading to reduce the production rate and increasing cycle time with cost as well. The theoretical calculations were done for calculating cutting force, tonnage required, Von-Misses stresses, fatigue life, buckling load and total deformation. The 3D parts are modelled in CATIA-v5 and saved in .stp file format so that it can be imported from any of the analysis software. As per the companies requirement cad drawings are drawn in AUTOCAD software. The various analyses like Von-Misses stress analysis, fatigue life, are carried out on Ansys 14.0 workbench analysis software and results are compared with theoretical results. The results are within 5% of allowable limit. Key Words: Die punch, FEA, Ansys. Catia-V5, Autocad.

P.Goyal, et al [6] studied on "Design of pneumatically controlled small scale punching machine". This project work deals with the design of pneumatically controlled small scale punching machine to carry out piercing operation on thin sheets (1-2 mm) of different material (aluminium and plastic). Reduction in punching force requirement being the main aim of this project work is obtained by modification in punch tool design i.e. by provision of shear on punch face. Subsequently it results in reduction in amount of punching force requirement. And further a CATIA model of the machine is developed on the basis of calculations with respect to punching force requirement. AMIT M. GEDAM, 2014 - In today world, due to advance manufacturing process and advance machining process the time of production is reduces. Thus the productivity increases which effect on mass production and batch production. So it is essentially to products name plate parts to be the manufacture. There are a variety of crafts for an embossing machine that allow you to create unusual, signature pieces of artwork. Embossing machines come in several varieties. There are multi-tasking embossers available at craft and scrapbooking stores that allow you to embellish and cut card stock and paper pieces into a variety of different designs in a single motion. You can also use embossing machines that feature Custom-made thick rubber dyes secured with hand-held or desk-mounted metal handles. These machines allow you to create personal monogrammed or logoed designs with a raised surface, and they can be ordered through office and business supply stores.

2.2 Summary:

Hence by considering and studying the above journals we got an idea of how to use the different components. In this era we have got a clear idea on the manufacturing the required component in a required way. In this chapter, our detailed research on various research papers has been described. The inputs we took from these papers help us in designing and fabricating the model according to our requirements. These will be discussed in detail in subsequent chapters.

CHAPTER-3

Theoretical Design and Calculations:

Design theory has been approached and interpreted in many ways, from personal statements of design principles, through constructs of the philosophy of design to a search for a design science. In this design we have calculated the required punch force the clearance for the assembled punch and die. The required force calculations are also done .In order to get the required output we need to calculate the thrust force. The cylinder thrust force comes into picture both during the forward stroke and during the backword stroke.

3.1 Theoretical Design

In this theoretical design we will know all the required parameter for the final fabrication and in order to eliminate all the extra forces or unused forces. In order to eliminate the manual work and to reduce the time consumption we have decided to do this project.

In this project we are using the pneumatic cylinder as punching equipment. The compressed air from the compressor is used as the force medium for this operation. In one position, air enters to the top of the cylinder and pushes the piston so that the punching is done. In next position, air enters to the bottom of the cylinder and pushes the piston return back, so that the return stroke is obtained.

The key components used in this design and calculations are clearance, constant, punching force, forward stroke, return stroke, cylinder thrust, paper.

3.1.1 Clearance

Paper dimension-297 ×210 mm

Clearance = C×t×√(τ÷10)

C=Constant =0.01

τ=shear strength of sheet=20-50N/mm^2

=30N/mm^2

C=0.01

Clearance=0.01×0.5√ (τ/10)

=8.66025×10^{-3}mm

3.1.2 Force Calculations:

Cylinder thrust for double acting in forward stroke

F= (π/4) ×D^2×P

D-Diameter of bore =42mm

d- Piston rod diameter=12mm

P-pressure =5Kg/cm^2

=490332.5N/mm^2

F (forward stroke) =(π/4) ×42^2×490332.5N/mm^2

F=679.32N

Cylinder thrust for single acting in return stroke

F= (π/4) × $(D - d)^2$×P

F= (π/4) × $(42 - 12)^2$×P

=346.59N

The below are taken as a reference:

Table 1:Common Materials shear strength is as follows: unit KN/ mm^2

Aluminium	Brass	Low Carbon steel	Stainless steel
0.1724	0.2413	0.3447	0.5171

Table 3.2:Punch Machines die clearance

Plate thickness	Mild Steel	Aluminium	Stainless steel
0.8-1.6	0.15-0.2	0.15-0.2	0.15-0.3
1.6-2.3	0.2-0.3	0.2-0.3	0.3-0.4
2.3-3.2	0.3-0.4	0.3-0.4	0.4-0.6
3.2-4.5	0.4-0.6	0.4-0.5	0.6-1.0
4.5-6.0	0.6-0.9	0.5-0.7	

Punching Force (KN) =Perimeter (mm)*Plate thickness (mm)*shear strength (KN/mm^2)

Let the plate thickness=0.5 mm

For Aluminium

Punching Force= 774*0.5*0.1724

=66.7188 KN

For Brass

Punching force= 774*0.5*0.2413

=93.3831 KN

For Low Carbon Steel

Punching force=774*0.5*0.3447

=133.3989 KN

For Stainless Steel

Punching Force=774*0.5*0.5171

=200.11 KN

Hence the required punch force the cylinder thrust during the forward and return stroke the clearance required are calculated using certain formulas. The dimensions are in Newton and millimetre. Hence the theoretical design is done by the above calculations. The design is either to formulate a plan for the satisfaction of a special need or to solve a problem. If the plan result in the creation of something having a physical reality, then the product must be functional, safe, reliable, competitive, usable, manufacturable and marketable.

CHAPTER-4

MODELLING

In this chapter, modelling of various parts in the model can be done. Modelling can be done in various methods such as wireframe modelling, surface modelling, solid modelling etc. Design of a machine can be done in various ways such as it can be done using AutoCAD, solid works, Inventor the easiest way is chosen for design and modelling of the experimental setup. There are many packages for the design and modelling, out of which Autodesk Inventor has been selected for its ease of availability and as it is user friendly and is easily understandable, therefore we have chosen the package Autodesk Inventor.

4.1 AUTODESK INVENTOR:

Autodesk Inventor is 3D CAD modelling software used to design, visualize, and test product ideas. **Inventor** allows you to create product prototypes that accurately simulate the weight, stress, friction, driving loads, and much more of products and their components in a simulated 3D environment.

The main features of AUTODESK INVENTOR are:

- Inventor allows 2D and 3D data integration in a single environment, creating a virtual representation of the final product that enables users to validate the form, fit, and function of the product before it is ever built.
- Autodesk Inventor includes powerful parametric, direct edit and freeform modelling tools as well as multi-CAD translation capabilities and in their standard drawings.
- Inventor uses Shape Manager Autodesk's proprietary geometric modelling kernel. Autodesk Inventor competes directly with Solid Works, Solid Edge, and Creo.
- The automatic updating feature allows easy changes in models.
- With Inventor, prototyping can be accomplished easily by integrating 2D AutoCAD drawings and 3D data into a digital model which will serve as a virtual representation of the final product.
- By doing so, engineers are able to better design and simulate products without the need to create physical prototypes.

- Autodesk Inventor Introduction to solid works is perfect for the new user or for users making the switch from a completive 3D modelling application. Autodesk Inventor sheet metal will help you get the most out of the built in sheet metal tools found in Autodesk Inventor.

4.1.1 Data interoperability and exchange:

Inventor uses specific file formats for paths (IPT), assemblies (IAM) and drawing views (IDW and DWG). Files can be imported or exported in DWG format. Design Web format (DWF) is Autodesk's preferred 2D/3D data interchange and review format. Inventor includes a building information modelling (BIM) Exchange tool, used to create and publish simplifies 3D representations, intelligent connections points and additional information in native file formats for AutoCAD MEP (mechanical, electrical and plumbing) software. This data interoperability and exchange is used if an analysis is done.

4.2 Part Modelling:

The automatic paper box maker parts are modelled first in the Autodesk inventor.

The part modelling is done by the following steps by top down approach.

- Step 1: creating new part file with extension".ipt"
- Step 2: creating the base part 2D sketch
- Step 3: converting 2D sketch to required 3D model by using features like extrude, extrude cut, revolve, sweep, chamfers, fillets, holes, spiral etc.
- Step 4: Saving the file with desired part name.

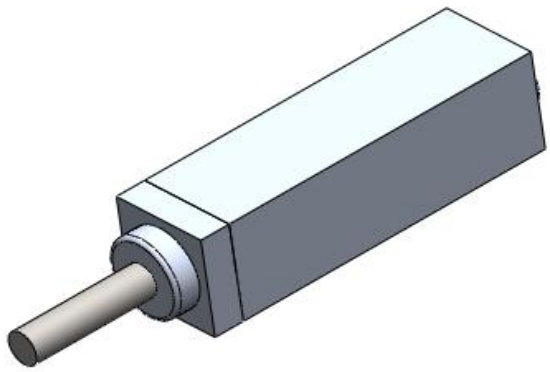
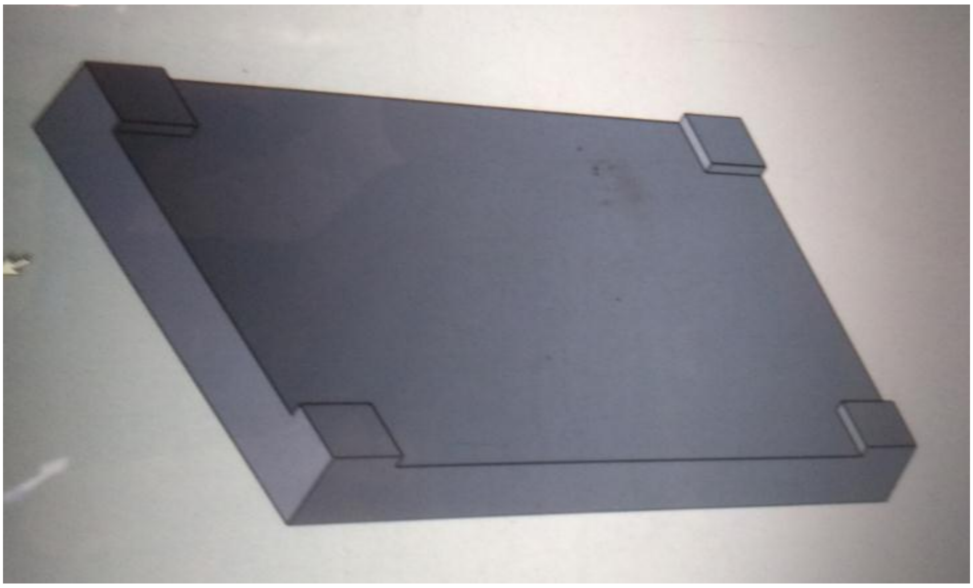
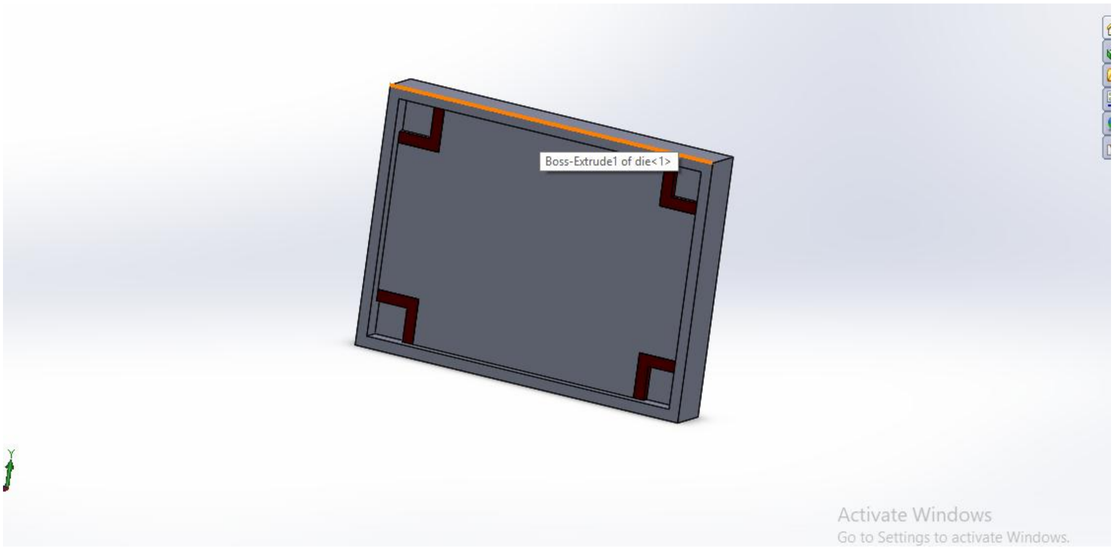


Fig 4.1PISTON



PUNCH

Fig 4.2



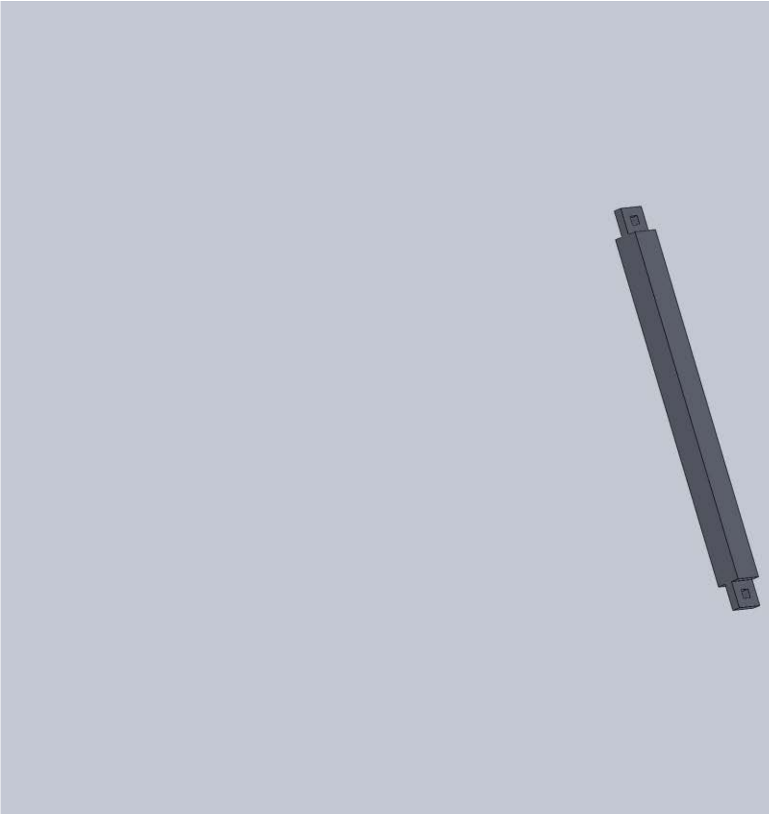
DIE

Fig 4.3

The design of various parts used in this project is as follows:

(i) Firstly we need to design a frame for the entire support of the equipment.

For this frame to be designed we need various small parts to be designed with certain dimensions.

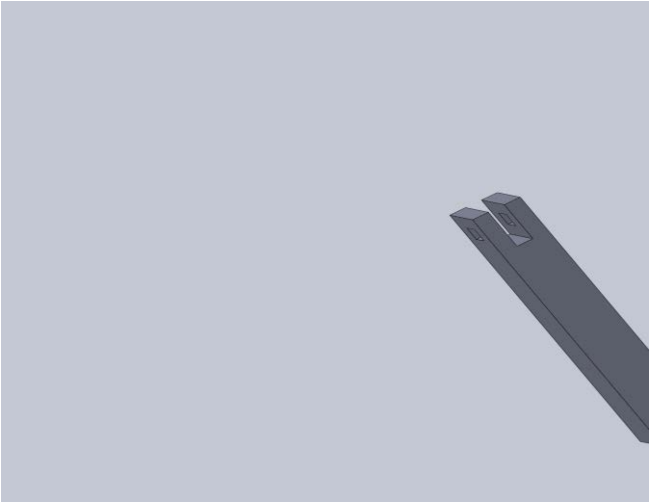


Mortise and tenon joint

Fig 4.4

Using wood material we prepare the frame. In the above part the dovetail joint is used to attach each other.

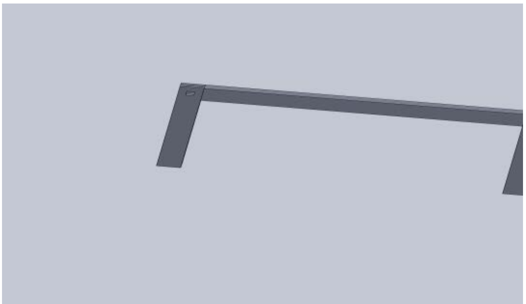
- For the automation to occur or to be made possible we need a base called as frame.
- Sometimes the frame sizes may be too small or too large also, we need to use it according to our requirement.
- Frame is often a structural system that supports other components of a physical construction and/or steel frame that limits the constructions extent.
- This is a mortise and tenon joint.
- A mortise and tenon joint connects two pieces of wood or of other material.
- It has a butt joint and hence it is advantageous.



Corner joint

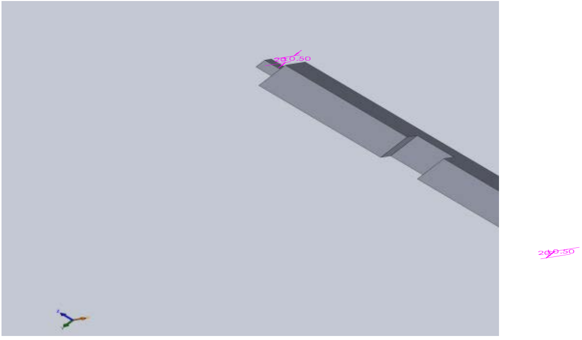
Figure 4.5

- This is a dovetail joint.
- A dovetail joint is a joinery technique most commonly used in wood working.
- It is the strongest of all joints.
- It has a large gluing area, is interlocking, resists being pulled apart, looks attractive, and would hold together even without glue.
- It has great precision and has good ease of operation.
- That is why dovetail joint is used in this type of frame which is a supporting member.



Legs

Figure 4.6



Half lap joint

Figure 4.7

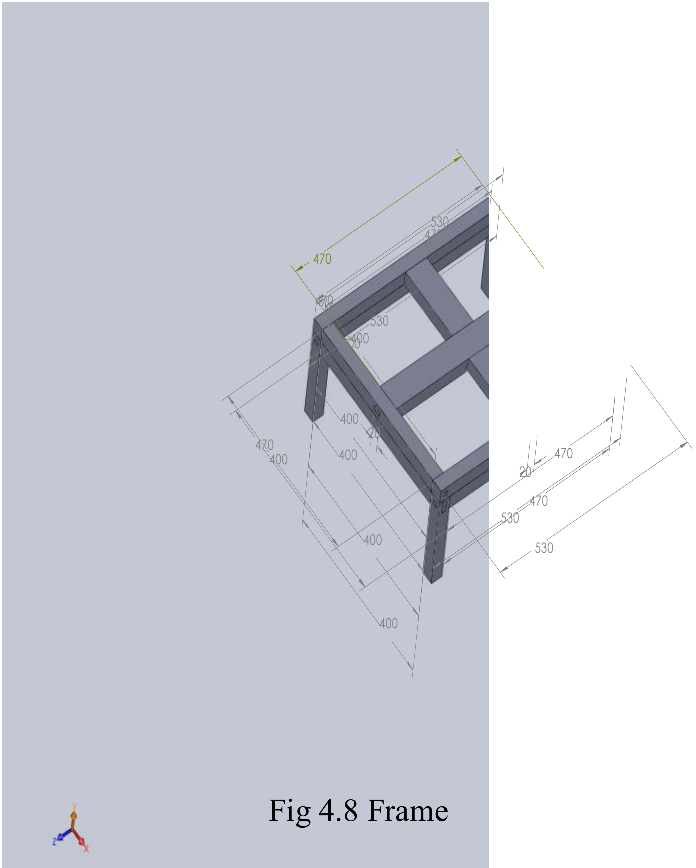


Fig 4.8 Frame

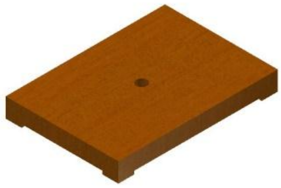
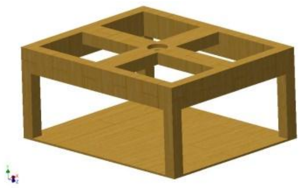
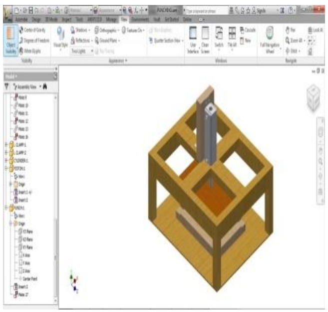
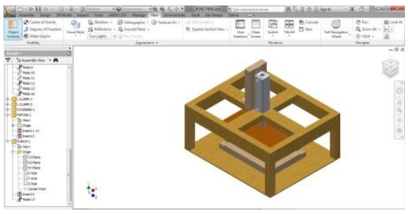
	 L-clamp	 Punch
 support block	 cylinder	 Die
 Frame	 Assembly	 Assembly

Fig 4.9 various parts in the model

4.3 Assembly Modelling:

The assembly of the parts is done with proper constraints in the following manner to allow the assembled model to simulate.

- Step 1: Crating new assembly file with extension ".iam".
- Step2: Import the base part first and ground it.
- Step3: Now import all the other parts and assemble them with various constraints to planes and features like mate, align, insert etc.
- Step 4: Give the revolutionary joint at which the motor shaft revolving fixture assembled.
- Step5: Saving the file with desired file name.

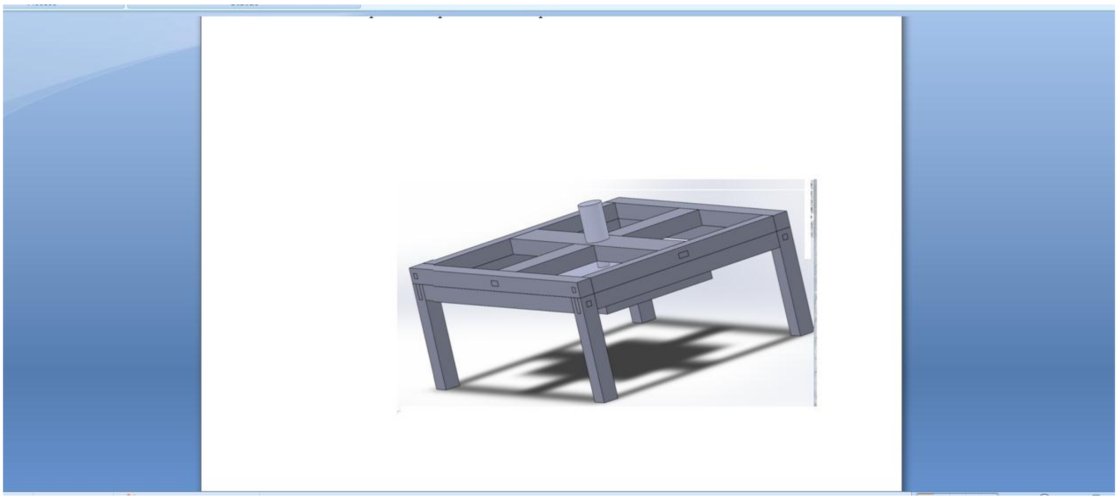


Figure 4.10 frame assembly

The above figure is done in solid works to just get a view on the total design and how it must be fabricated with proper and required dimensions.

The complete assembly of the paper box maker is shown in the above and below figure here.

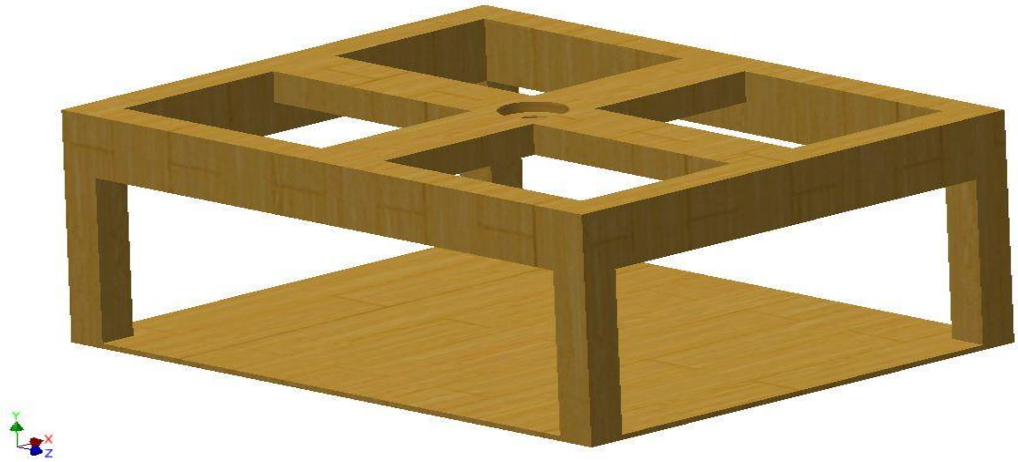


Fig 4.11 Frame

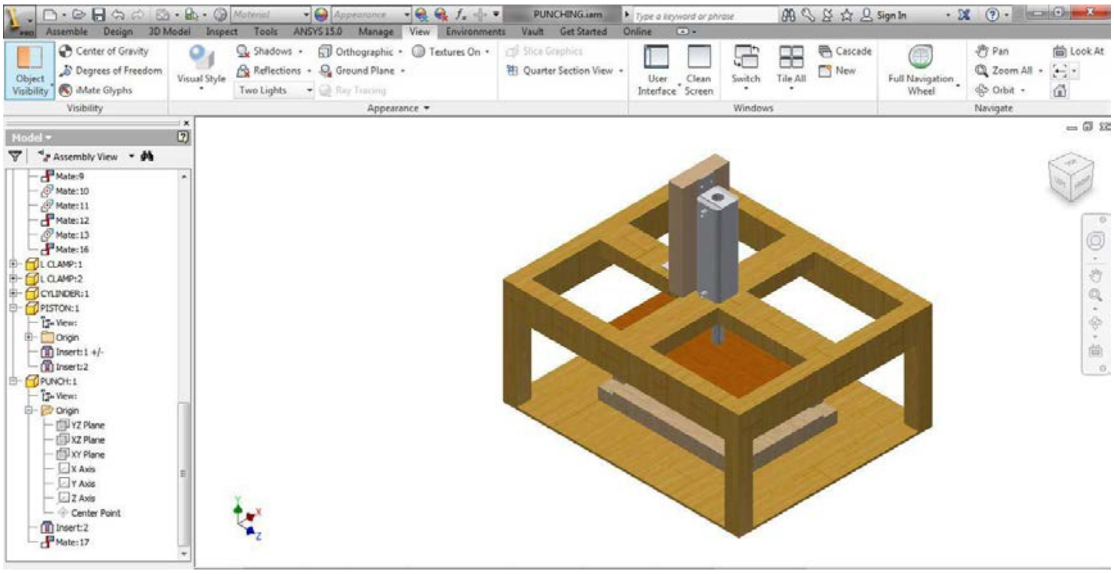
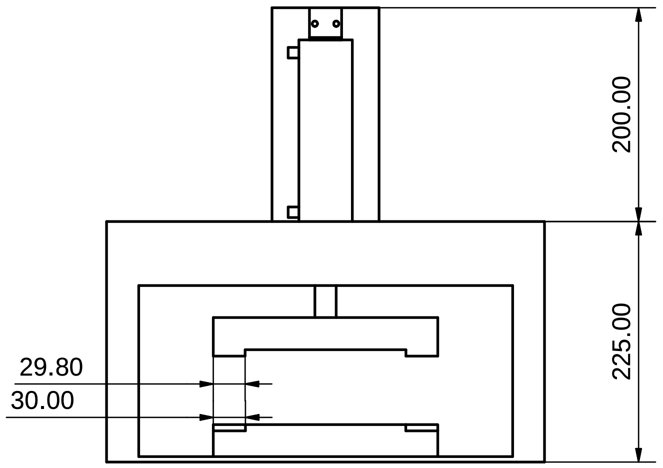
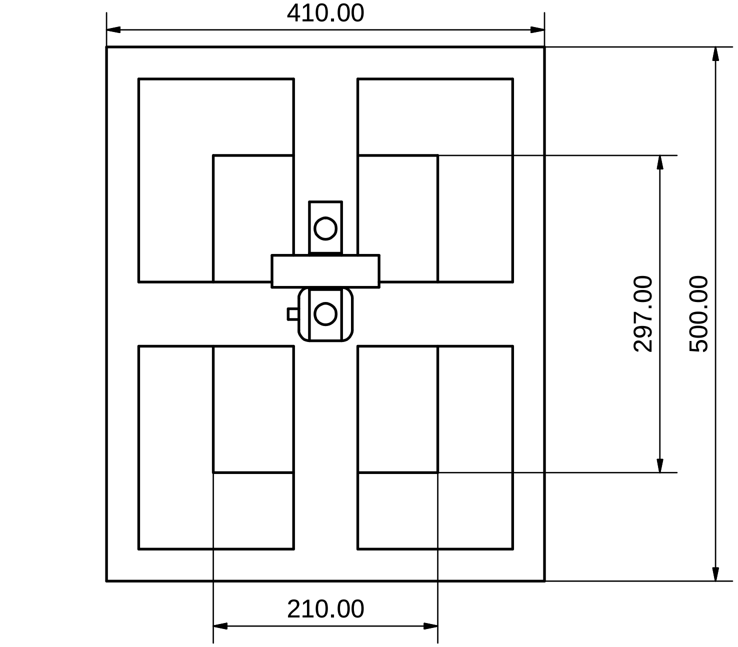
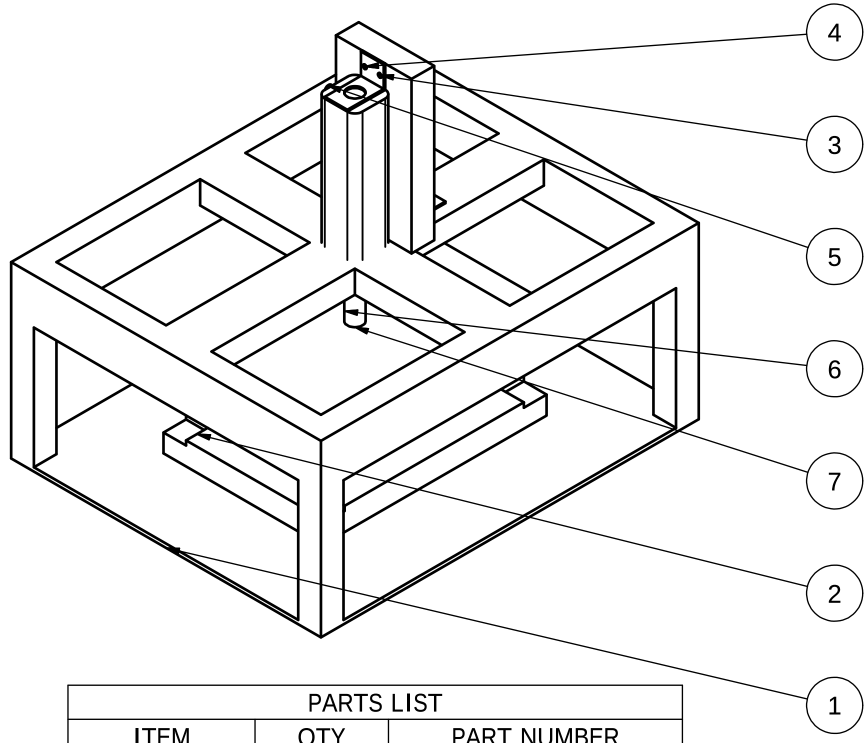


Fig 4.12 Final Frame Assembly

The modelling of various parts is done using the software Autodesk Inventor. The design of different joints required in the assembly of frame is done. The different joints used in the modelling are corner joint, mortise and tenon joint; half lap joint and reaming parts are also assembled to get the final model in the software.







PARTS LIST		
ITEM	QTY	PART NUMBER
1	1	FRAME
2	1	DIE
3	1	SUPPORT BLOCK
4	2	L CLAMP
5	1	CYLINDER
6	1	PISTON
7	1	PUNCH

ANIL NEERUKONDA INSTITUTE OF TECHNOLOGY & SCIENCES(A)

PART NAME: PUNCHING MACHINE ASSEMBLY

PROJECT MEMBERS	PROJECT GUIDE
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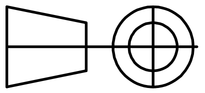


DRAWING NO:4.1

SCALE: 1:5

CHAPTER-5

PNEUMATIC SIMULATION

5.1 Introduction

The lab-volt virtual laboratory (LVVL) is a three-dimensional classroom laboratory displayed on a computer screen. Various subject such as hydraulics, pneumatics, electromechanically systems, and digital telecommunication can be studied using this virtual equipment.

The virtual equipment sets form complete training systems which are faithful three-dimensional reproduction of actual lab-volt training systems. They have the same physical appearance and behave in the same way as the actual training systems.

As we are using Pneumatics in our project, we deal with the Pneumatics Equipment in the software.

5.2 Pneumatics Equipment Bar

The Pneumatics Equipment Bar is a set of buttons. Each button corresponds to a piece of pneumatic equipment. The buttons on the Pneumatics Equipment Bar are used to install the Work Surface and the Air Compressor in the Lab-Volt Virtual Laboratory (LVVL), and to install a pneumatic component on the Work Surface. See Installing Pneumatic Equipment to obtain additional information.

The buttons on the Pneumatics Equipment Bar and the name of the component corresponding to each button are displayed below. You can click one of the following topics to obtain a detailed description on the component related to one of the buttons on the Pneumatics Equipment Bar.

5.2.1 Work Surface

The Work Surface provides a uniform surface on which to install pneumatic components

Fig 5.1 Work Surface

5.2.2 Air Compressor

The Air Compressor supplies air under pressure to the pneumatic system. It consists of a compressor, a receiver, and two connection ports labeled Outlet Ports.

In order for the Air Compressor to supply air to the circuit, one of its outlet ports has to be connected to the inlet port of the Conditioning Unit.

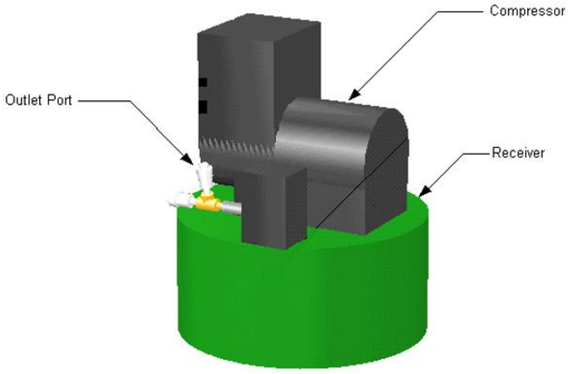


Fig 5.2 Air Compressor

5.2.3 Conditioning Unit

The Conditioning Unit filters regulate the system pressure and distribute conditioned air to the pneumatic circuit. The Conditioning Unit consists of an air inlet port, an exhaust port, the main shutoff valve, a filter, a muffler, a pressure regulator, a pressure gauge, a 4-port manifold, 4 branch shutoff valves, and 4 outlet ports. In order for the Conditioning Unit to supply air to the circuit, it must first be connected to the Air Compressor.

The main shutoff valve controls the air supply to the pressure regulator. The main shutoff valve is open when its control knob is in the upper position and is closed when its control knob is in the lower position. The position of the control knob is changed by clicking the mouse left button on the main shutoff valve.

The pressure regulator is used to set the pressure in the circuit. Clicking the control knob of the pressure regulator opens a dialog box that allows you to change the pressure regulator setting.

The pressure gauge allows the monitoring of the regulated pressure. It is possible to obtain a close-up view of the dial by clicking the mouse right button on the Conditioning Unit and selecting Meter View in the context-sensitive menu.

The conditioned air is available through the 4 outlet ports individually controlled by branch shutoff valves. The shutoff valves are open when their collar is in the upper position and are closed when their collar is in the lower position. The position of the collars is changed by clicking the mouse left button on the branch shutoff valves.

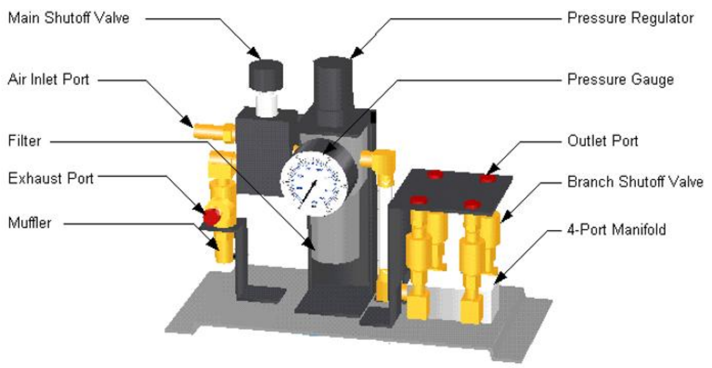


Fig 5.3 Conditioning unit

5.2.4 Accumulator

The Accumulator is used to store pressurized air and to provide a short-term supply of compressed air to a particular device. It has one connection port labelled Accumulator Port.

Fig 5.4 Accumulator

5.2.5 Directional Valve, Pushbutton Operated

A Directional Valve, Pushbutton Operated is used to control the direction of air flow in a pneumatic circuit. The Directional Valve, Pushbutton Operated which is used in the Lab-Volt Virtual Laboratory is a two-way, two-position, pushbutton operated directional valve.

It has three connection ports that allow normally closed and normally open configurations. Flow-path configurations are reversed by depressing the pushbutton. To depress the pushbutton, place the mouse pointer on the pushbutton, click the mouse left button and maintain it down. The pushbutton returns to its released position when the mouse left button is released.

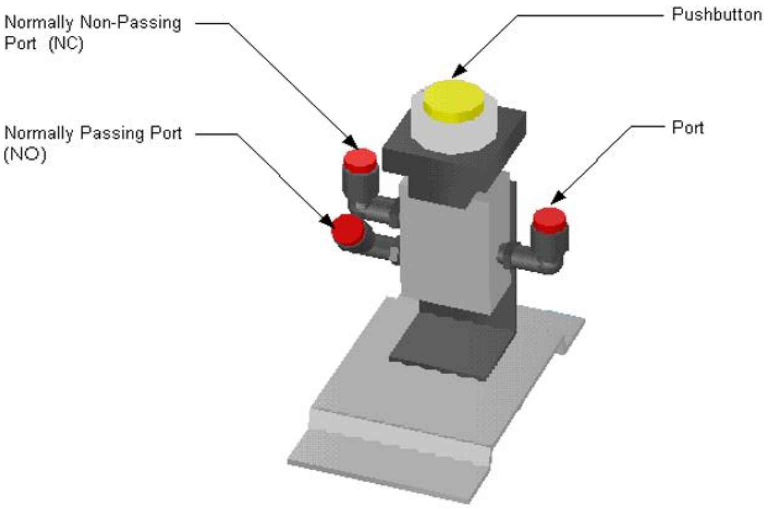


Fig 5.5 Pushbutton operated directional valve

5.2.6 Flow Control Valve

The Flow Control Valve is designed to adjust the resistance to airflow in a pneumatic circuit. It has one Inlet Port, one Outlet Port, and a Control Knob.

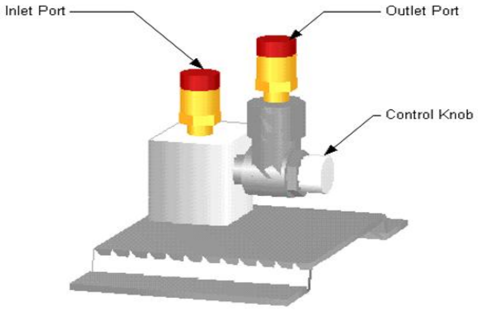


Fig 5.6 Flow control valve

5.2.7 Pressure Regulator

The Pressure Regulator is a valve designed to maintain a constant pressure in pneumatic circuits. It has two connection ports, labelled Inlet and Outlet as well as an exhaust port.

The Pressure Regulator is a normally passing valve that regulates pressure by closing partially or completely an opening that allows fluid to flow from the Inlet port to the Outlet port. The pressure at the Outlet port pushes (via a diaphragm) against a spring inside the valve, to automatically adjust the valve opening so as to maintain the desired pressure at the Outlet port.

The regulated pressure, that is the pressure at the Outlet port, is set by turning the adjustment knob on the Pressure Regulator. Turning the adjustment knob clockwise compresses the spring inside the valve more and more, and thereby, increases the regulated pressure setting.

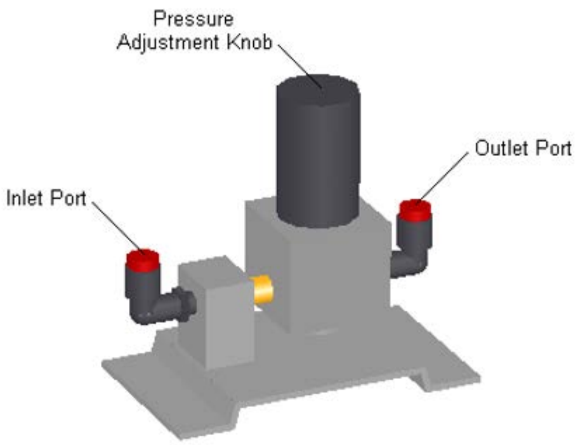


Fig 5.7 Pressure Regulator

5.2.8 Single-Acting Cylinder

The Single-Acting Cylinder is a spring-return cylinder. It converts fluid energy into linear mechanical energy which can be used to perform work in only one direction. It has one connection port labelled Cap End Port.

When airflow is directed toward the Cap End Port of the cylinder, the pressure in the cap end rises until enough force is generated to compress the spring, and the cylinder rod extends. When the air pressure is released, the force of the spring makes the cylinder rod retract. The cylinder rod can also be extended and retracted manually. To do so, place the mouse pointer on the cylinder tip. The arrow pointer changes to a hand pointer. Click the mouse left button and drag the rod outside or inside the cylinder. Then release the mouse left button.

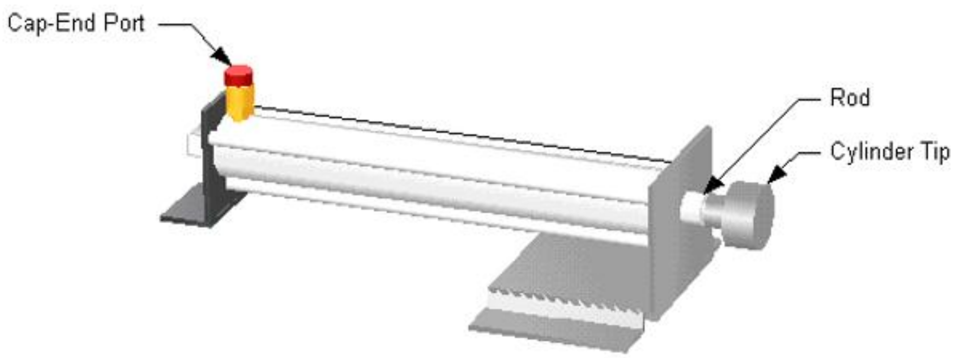


Fig 5.8 Single acting cylinder

5.3 Pneumatic Circuit

The pneumatic circuit is designed using all the controls in the pneumatics equipment bar. A limit switch assembly is also used which senses the movement of the piston and controls its movement.

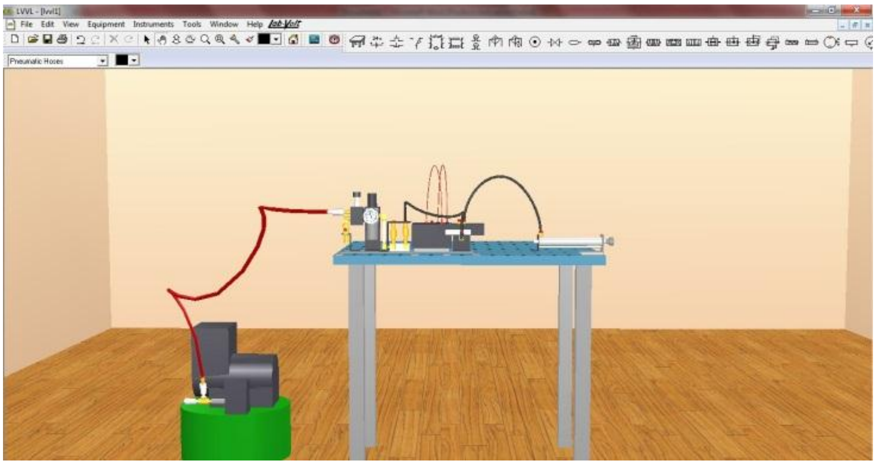


Fig 5.9 Pneumatic circuit in Lab volt

The pneumatic circuit is designed using all the controls in the pneumatics equipment bar. A limit switch assembly is also used which senses the movement of the piston and controls its movement.

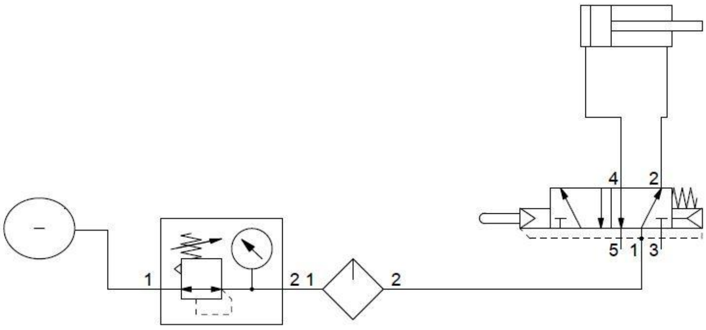


Fig 5.10 Pneumatic circuit

By using this we have learnt about what is simulation why we used that and all the equipment used in the simulation. Simulation gave us a whole idea on how the equipment works once if it is fabricated. The flow of the compressed air through the hoses and its direction is observed. All this we have learnt by using Pneumatic Simulation.

CHAPTER – 6

FABRICATION

The wood fabrication is different methods to machine wood materials are quite similar to those for metal working process. In a wood workshop there are commonly lathes, milling centres and grinding machines. In addition there are also sawing machines. Sawmills usually have similar equipment and machine tools , but can handle much larger quantities and dimensions .wood ales reacts differently depending on which direction a cut is made .Workshops specializing in wood work have become scarce. Mostly there are small workshops which do wooden moulds, prototypes and models for manufacturing companies, or small-scale furniture pieces. The heavier production is usually made directly. Even if the machine tools are almost alike, wood has completely different characteristics. Generally, wood is softer, more brittle and more fragile compared to metals.

6.1 CARPENTARY

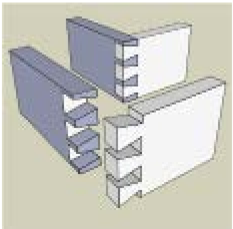
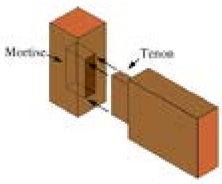
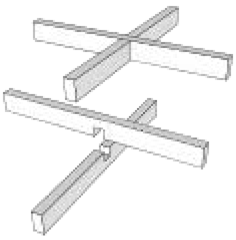
carpentry is a skilled trade and a craft in which the primary work for performed is the cutting, shaping and installation of building materials during the construction of buildings, ships, timber bridges, concrete formwork , etc. Carpenters traditionally worked with natural wood and did the rougher work such as framing, but today many other materials are also used and sometimes the finer trades of cabinetmaking and furniture building are considered carpentry. Carpenters are usually the first tradesmen on a job and the last to leave. Carpenters normally framed post-and-beam buildings until the end of the 19th century; now this old fashioned carpentry is called timber framing.

The types of joints used in project for the design and fabrication of the frame using wood are

6.1.1 DOVETAIL JOINT

A dovetail or simply dovetail is a joinery technique most commonly used in woodworking joinery (carpentry) including furniture, cabinets. Noted for its resistance to being pulled apart (tensile strength), the dovetail joint is commonly used to join the sides of a drawer to the front. A series of 'pins' cut to extend from the end of one board interlock with a series of 'tails' cut into the end of another board. The pins and tails have a trapezoidal shape. Once glued, a wooden dovetail joint requires no mechanical fasteners.

Table 6.1: Types of joints in carpentary

Joint	Image	Description
Butt joint		The end of a piece of wood is butted against another piece of wood. This is the simplest and weakest joint. Of those, there is the a) T-butt, b) end-to-end butt, c) T-lap d) Miter butt and e) edge-to-edge butt.
Dovetail joint		A form of box joint where the fingers are locked together by diagonal cuts. More secure than a box joint.
Mortise and tenon		A stub (the tenon) will fit tightly into a hole cut for it (the mortise). This is a hallmark of Mission Style furniture, and also the traditional method of jointing frame and panel members in doors, windows, and cabinets. This joint is a good strong joint to use.
Cross Lap		A joint in which the two members are joined by removing material from each at the point of intersection so that they overlap.

6.1.2 HALFLAP JOINT:

Half lap joints are among the most basic of woodworking joints, but there are times where they are the perfect choice for connecting two pieces of stock. A half lap joint is where two pieces of stock, which are typically the same thickness, have half of the material removed so that the two boards fit together so that the joint adds no thickness at the joint. These joints work well for right-angle connections, especially since both boards have material removed so that they fit together seamless.

6.1.3 CORNER JOINT:

The corner joint may be regarded as a butt joint and is used to join two plates at right angles to each other. It can be difficult to assemble and maintain correct alignment, particularly in thin flexible sheet. The root of a single-sided weld when loaded in tension is very weak and for the highest strength the corner joint needs to be welded from both sides. The single-sided weld may also have a crease containing oxides along the centre line of the penetration bead, further reducing the strength of the weld. Pulsed AC-TIG has been found to be effective in reducing the occurrence of this feature. The corner joint is most often found in low load- carrying applications and in sheet metal work.

6.2 Fabrication Procedure:

(i) Using the scrap such as left parts of wood, we fabricated a frame for the working model.

(ii) This frame involved a lot of joints for the assembly.

(iii) In order to provide proper support for the frame and for the mobility of the working model, we attached plywood beneath the frame.

(iv) By locating the centre of the frame we have drilled a whole in the middle according to the diameter of the piston cylinder used.

(v) The cylinder is fitted into the hole with a certain stroke length and for the piston to be stable it is clamped to the top part of the frame.

(vi) The punch is fixed to the piston rod of the cylinder

(vii) And to the bottom the die is fixed

(viii) These punch and die are made with the wood left as for scrap.

The die and punch are shown in figures 6.1 and 6.2 and finally assembly is shown in 6.3

Fig 6.1 Punch

Fig 6.2 Die

Figure 6.3 Pneumatic Punching Machine

CHAPTER-7

FINITE ELEMENT ANALYSIS

7.1 Finite-Element Method

Finite-element method (FEM) is a good choice for the analysis of sheet metal processes since it helps in eliminating the need for time-consuming experiments to optimize the process parameters such as sheet metal thickness, the material of the sheet, punch fillet and percentage clearance. The FEM simulations are increasingly used for investigating and optimizing the punching process. Computer simulations reduce the number of experiments and can obtain accurate results. The results depend on the element type and type of mesh considered for analysis. The main objective of the present work is to create a finite element model to predict the shape of the cut side of a blanked product and to investigate the effect of process parameters' influence on the punching process. Shock waves produced because of crash and drop test, which can be analysed using ANSYS explicit dynamics.

In high-speed dynamic problems, the time required is compared with reference to the standard specimens and analysed. Using explicit dynamics, we can reduce the number of steps in the analysis, thereby reducing the time for computing.

7.2 Effect of process parameters on punching

The process parameters play a significant role in determining the nature and geometry of the material, obtained after the punching operation is done.

7.2.1 The Effect of Clearance

Clearance (C) is the space (per side) between the punch and the die tool. Proper clearance is provided between cutting edges which enable fractures to start ideally at the cutting edge of the punch and also at the die. The fracture will proceed toward until the cracks meet each other and the fractured portion of the sheared edge then has a clean appearance.

With correct clearance, the angle of fractures will permit clean break below the burnish zone (plastic deformation of the surface caused due to sliding contact with another object) because the upper and lower fractures will extend toward one another. Burnishing generally occurs, if the contact stresses locally exceed the yield strength of the material. Excessive clearance can end in tapered cut edge as a result of any cutting operation, the alternative aspect of the fabric that the punch enters when cutting is going to be a similar size because of the die gap.

Harder metals require large clearance and permit less penetration by the punch than ductile materials; dull tool (punch and die) creates an effect of too small a clearance as well as burr on the die side of the stock. Clearance is generally expressed as apercentage of the material thickness, but some recommend absolute values.

7.2.2 The Effect of Punch Fillet

Shear angles/chamfers on the punches are used for easy stack up of the slugs. By assuming different punch corner radii in punching, the effect of tool wear can be simulated. As punching is a rapid process, the punch, i.e. the tool, gets easily worn out. To avoid such worn outs and increase the punch life, punch fillets are used.

7.2.3 The Effect of Sheet Thickness

For a given material, the energy demand in punching is influenced by the sheet thickness. It's been discovered that:

• The punching energy decreases with increasing clearance to sheet thickness magnitude relation c/t and will increase with increasing sheet thickness.

• The proportions of different depth characteristics of the sheared profile are affected by the thickness.

7.2.4 The Effect of Material of Sheet

The part edge quality also depends on the material being blanked. Materials with large ductility, low yield strength and homogeneity will have better blanked edge quality, dimensional tolerances and longer tool life.

In this project the effect of punching is studied by varying the clearance and material under similar conditions in the ANSYS 15.0.

7.3 Experimental Procedure

Explicit dynamics module is selected in the ANSYS Workbench 15.0 to perform the punching analysis on various geometrical models that were created in AUTODESK INVENTOR software

Analysis steps:

- ➢ Initially the material is selected in materials library
- ➢ The model is imported into geometrical model
- ➢ Material is assigned to the solid bodies in Mechanical module
- ➢ Punch and die are considered as rigid and sheet as flexible
- ➢ The contact between sheet and die is considered as rough
- ➢ Mesh is auto generated. The mesh formation of Sheet is done hex dominant and punch and die in tetrahedrons.
- ➢ Die is fixed and punch is applied with initial velocity and force. Punch degree of freedom is arrested in all other direction except punching direction
- ➢ Analysis maximum number of cycles and end time is updated
- ➢ In the solution the total deformation, shear stress and von-Mises are studied.

The analysis is performed on the sheet metal of thickness 0.5 mm by considering different clearance values ranging from 0.05mm to 0.25mm. The sheet metal materials considered are Aluminium, Copper and Steel 1006. The Analysis setup of ANSYS Workbench is shown in figure 7.1. The mesh bodies are shown in 7.2 and meshed view of sheet is shown in figure 7.3.

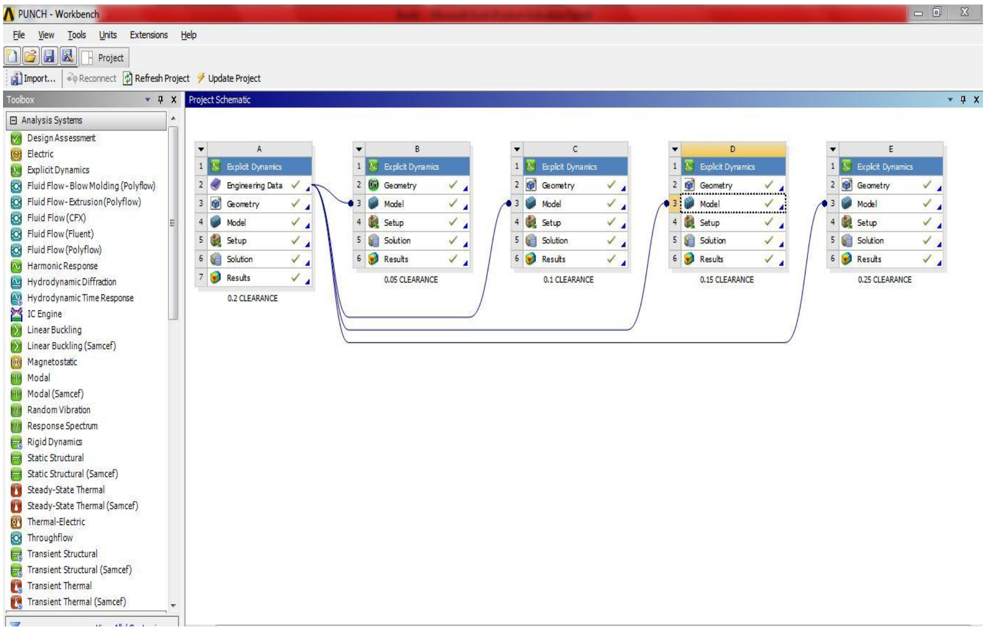


Fig 7.1 The Analysis setup of ANSYS Workbench

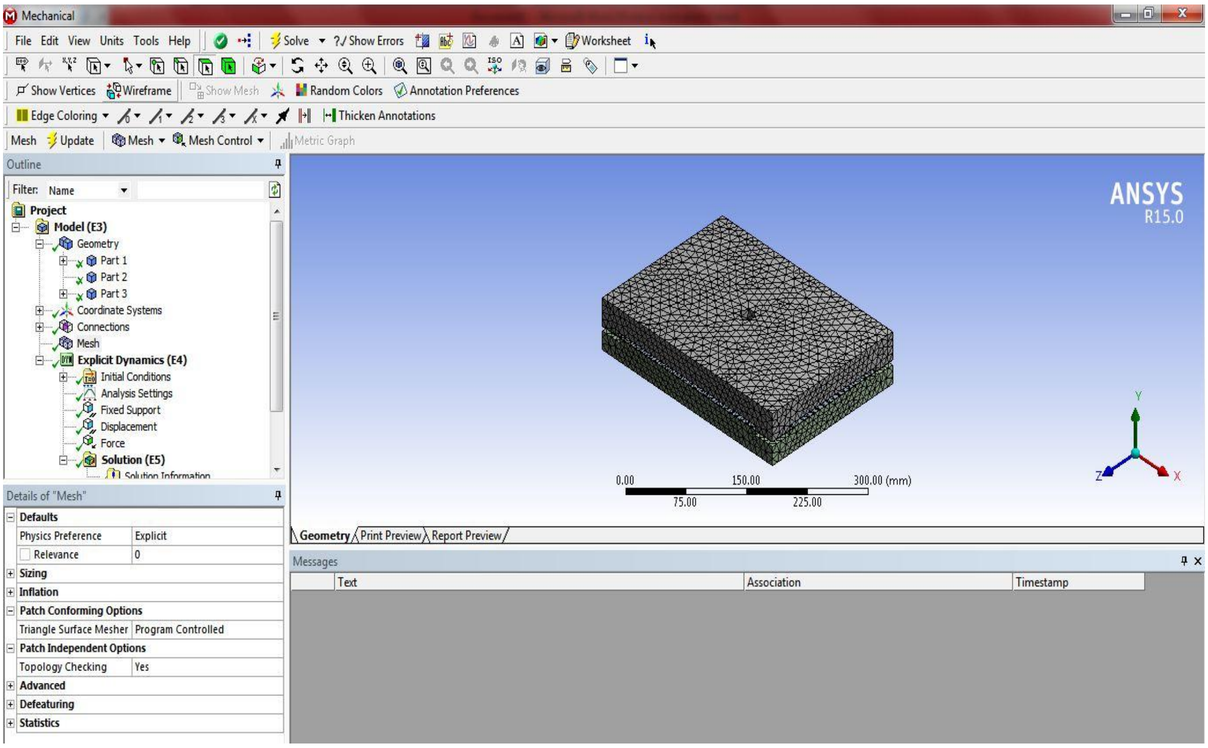


Fig 7.2 The mesh bodies

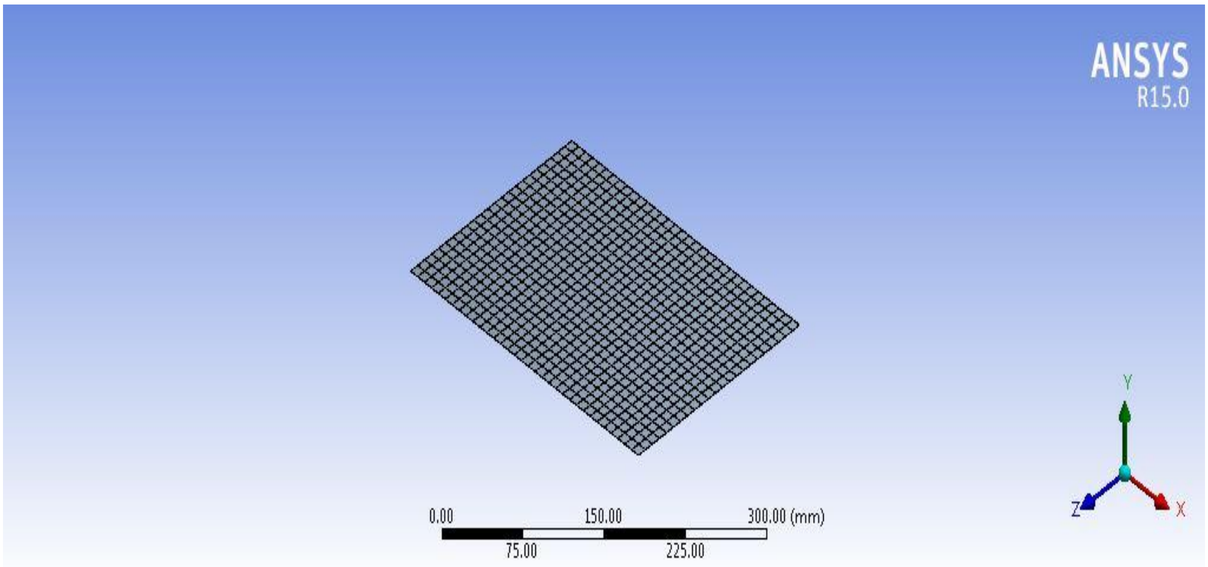


Fig 7.3 meshed view of sheet

The Total deformation, Shear stress and von-Mises stress of aluminium sheet with clearance 0.2mm is shown in figures 7.4 respectively, copper in figures 7.5 respectively and Steel 1006 in figures 7.6. The other results are tabulated material wise in the tables 3(Aluminium), table 4(Copper) and table 5 (Steel 1006).

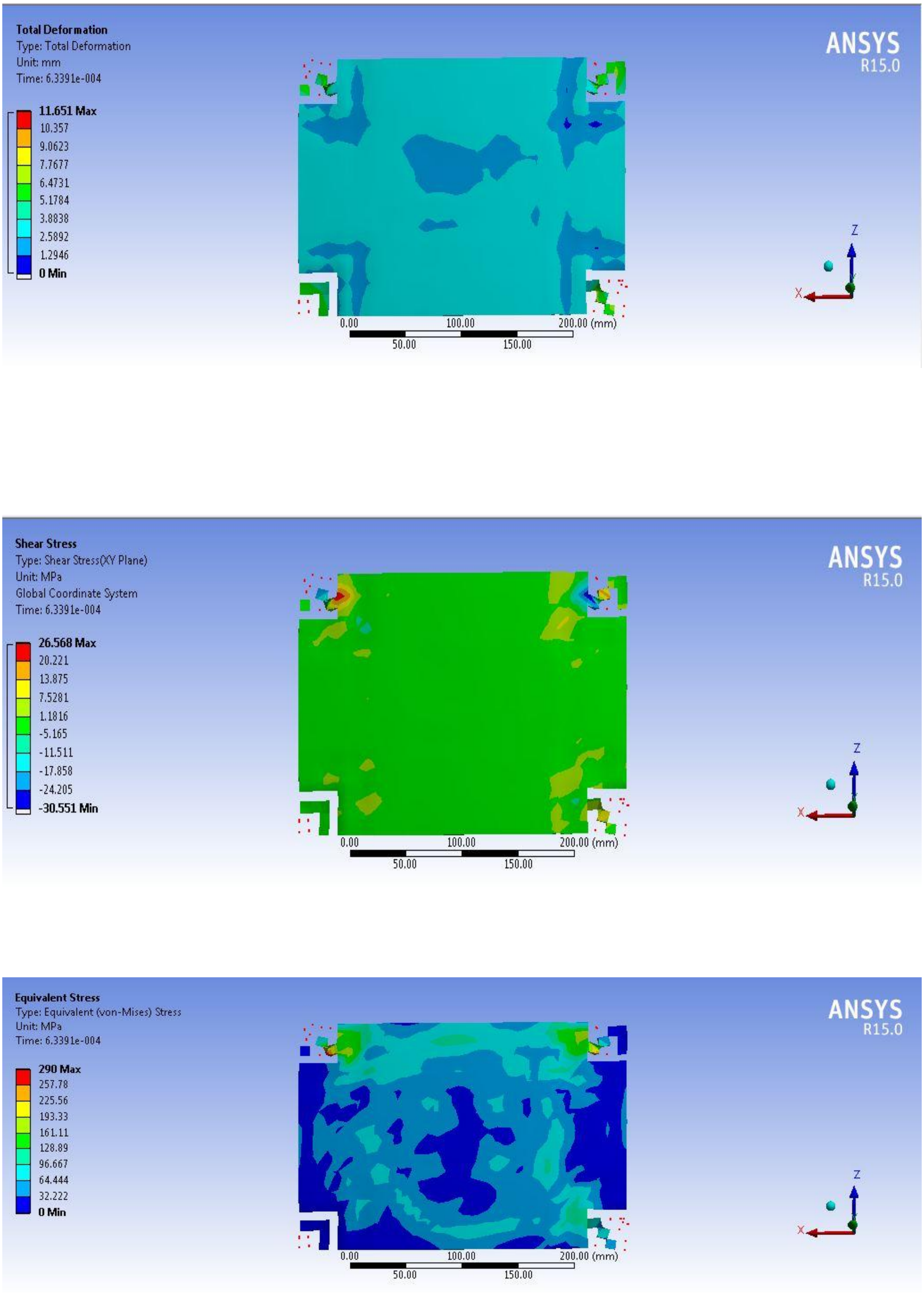


Fig 7.4 FEA analysis of punching on aluminium sheet

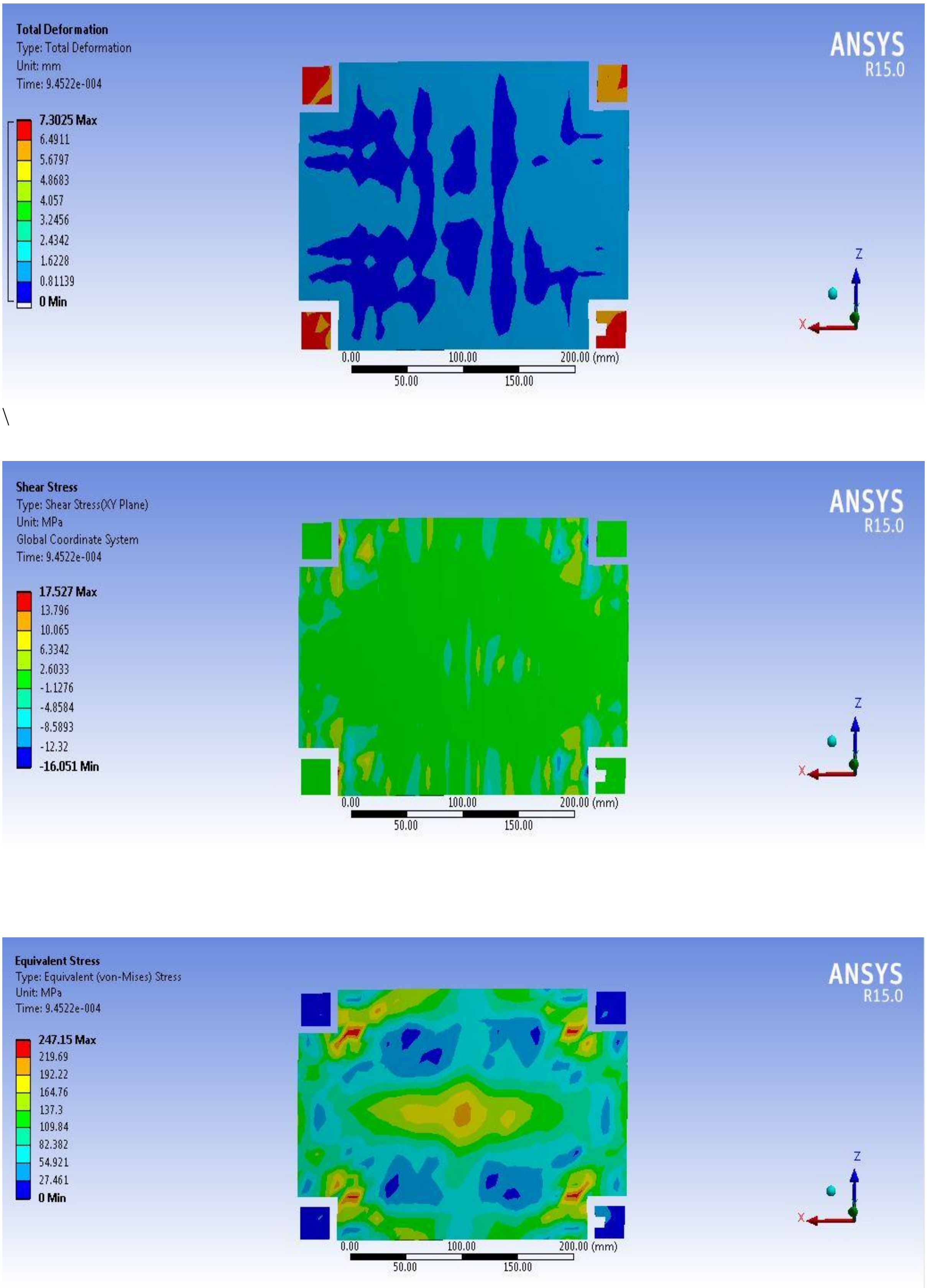


Fig 7.5 FEA analysis of punching on Copper sheet

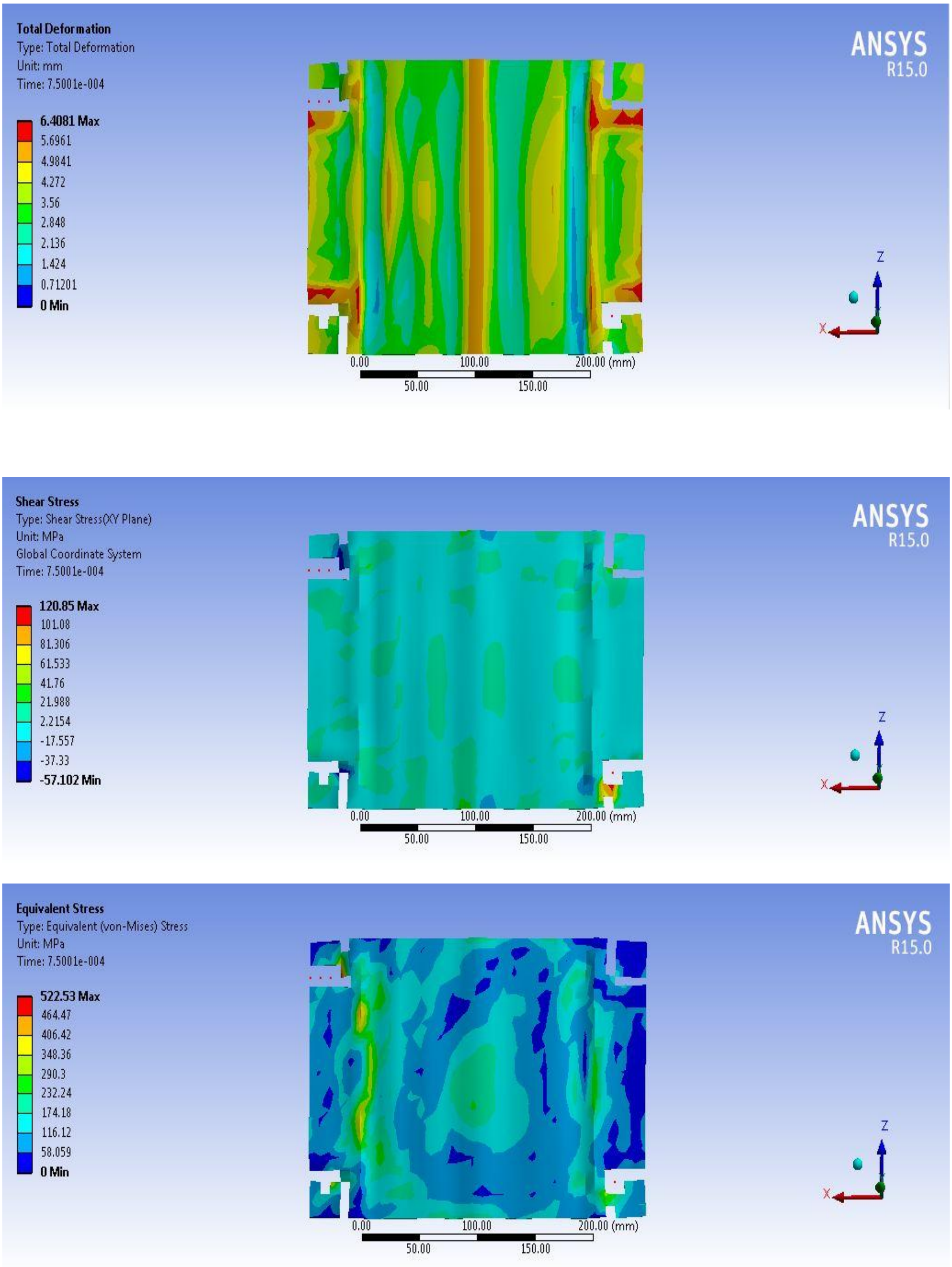


Fig 7.6 FEA analysis of punching on Steel 1006 sheet

Table 7.1: FEA analysis of punching on aluminium sheet for various clearances

Aluminium	MAXIMUM		
Clearance in mm	Total Deformation in mm	Shear stress in Mpa	von-Mises Stress in Mpa
0.05	10.284	58.15	290
0.1	10.298	59.168	290
0.15	13.633	47.619	206.42
0.2	11.651	26.568	290
0.25	15.955	130.55	290

Table 7.2: FEA analysis of punching on copper sheet for various clearances

Copper	MAXIMUM		
Clearance in mm	Total Deformation in mm	Shear stress in Mpa	von-Mises Stress in Mpa
0.05	7.0433	166.29	450
0.1	6.7902	104.36	450
0.15	8.4034	16.959	373.03
0.2	7.3025	17.527	247.15
0.25	9.42	15.336	287.26

Table 7.3: FEA analysis of punching on steel 1006 sheet for various clearances

Steel 1006	MAXIMUM		
Clearance in mm	Total Deformation in mm	Shear stress in Mpa	von-Mises Stress in Mpa
0.05	6.0345	44.103	435.81
0.1	6.3583	67.999	484.75
0.15	6.3666	66.625	484.07
0.2	6.4081	120.85	522.53
0.25	7.3661	107.27	621.18

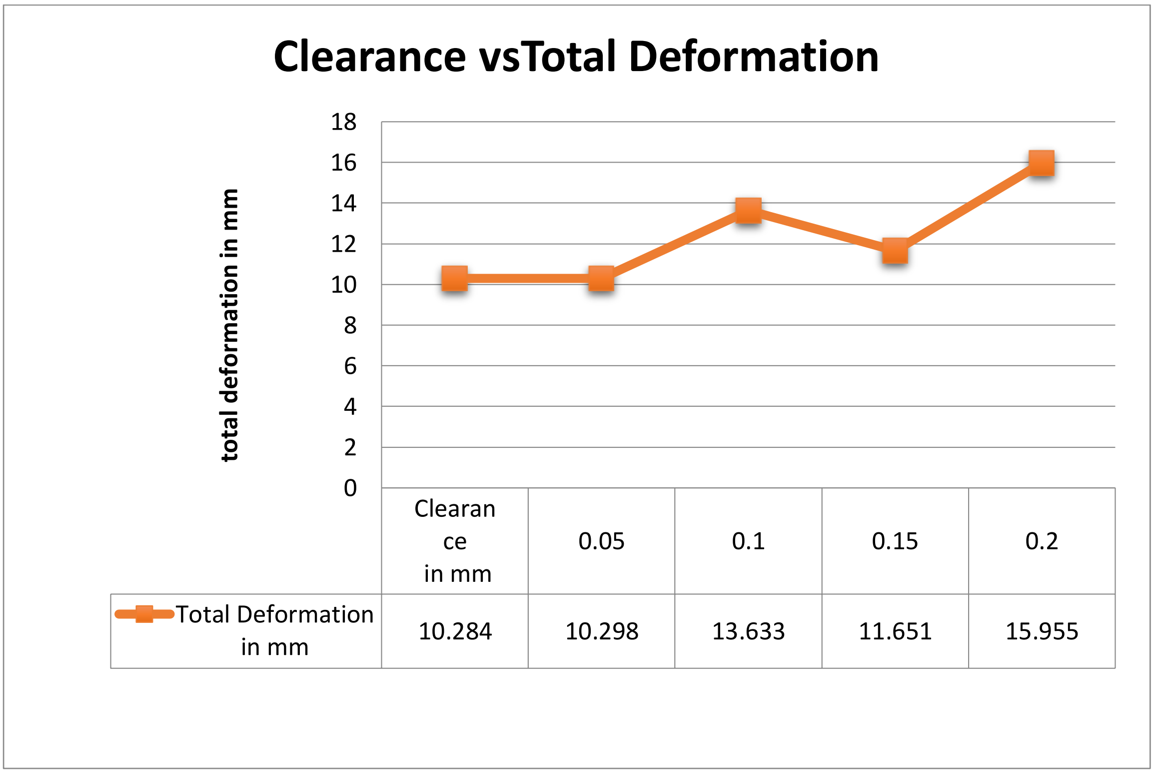
CHAPTER – 8

RESULTS AND DISCUSSIONS

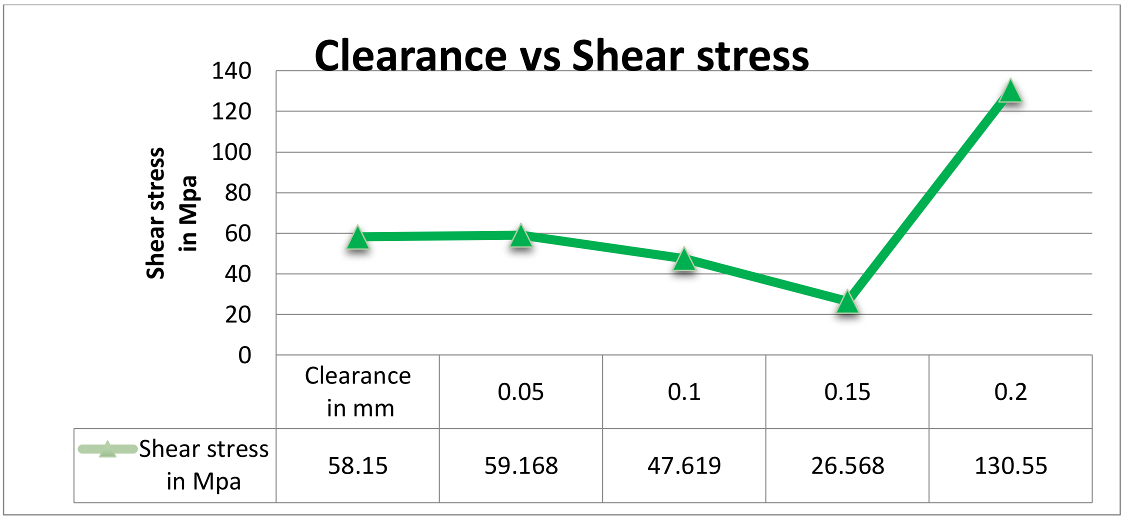
In this chapter, a summary of our analysis and results are studied and cost analysis of the pneumatic punching machine is discussed.

8.1 FEA analysis of punching on aluminium sheet

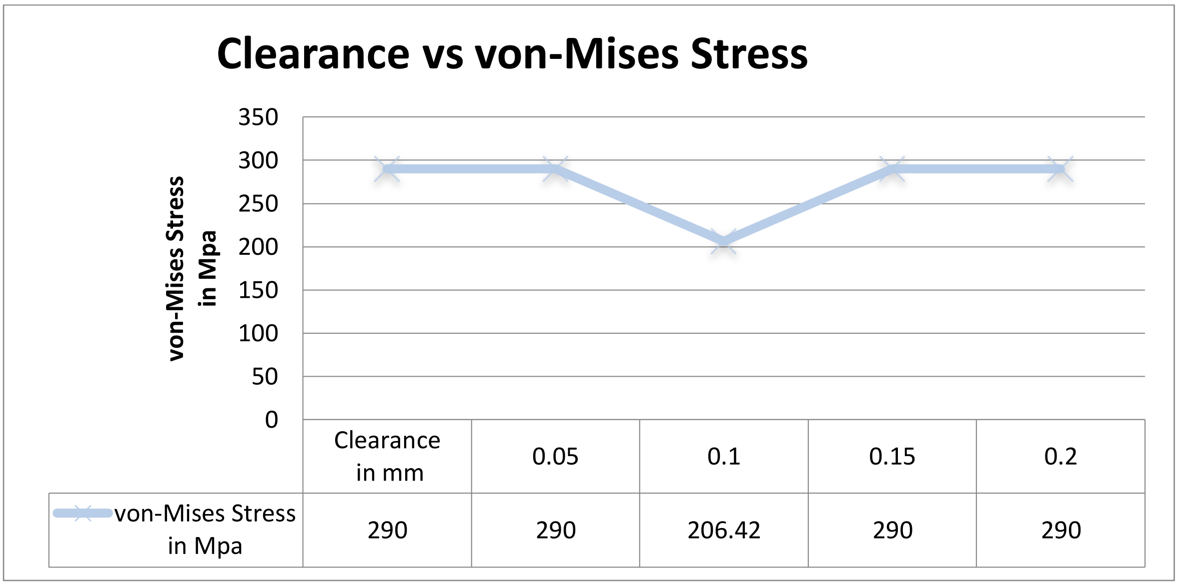
A detailed study of punching is carried out on aluminium sheet of thickness 0.5mm in explicit dynamics module of ANSYS 15.0 by varying clearance between punch and die. The total deformation, shear stress and von-Mises stress are studied to identify the optimum clearance. For aluminium sheet metal the clearance vs total deformation, shear stress and von-Mises stress graphs are plotted in graphs 7.1, 7.2 and 7.3 respectively. The optimum clearance by comparing all results for aluminium of 0.5 mm thick sheet metal is 0.1 mm.



Graph 8.1 Aluminium sheet of 0.5 mm thickness, clearance vs Total deformation



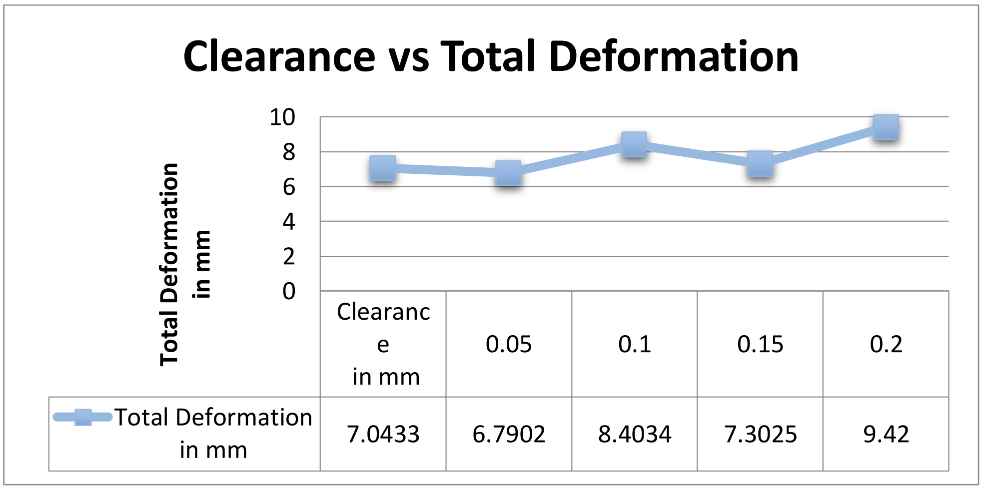
Graph 8.2 Aluminium sheet of 0.5 mm thickness, clearance vs Shear stress



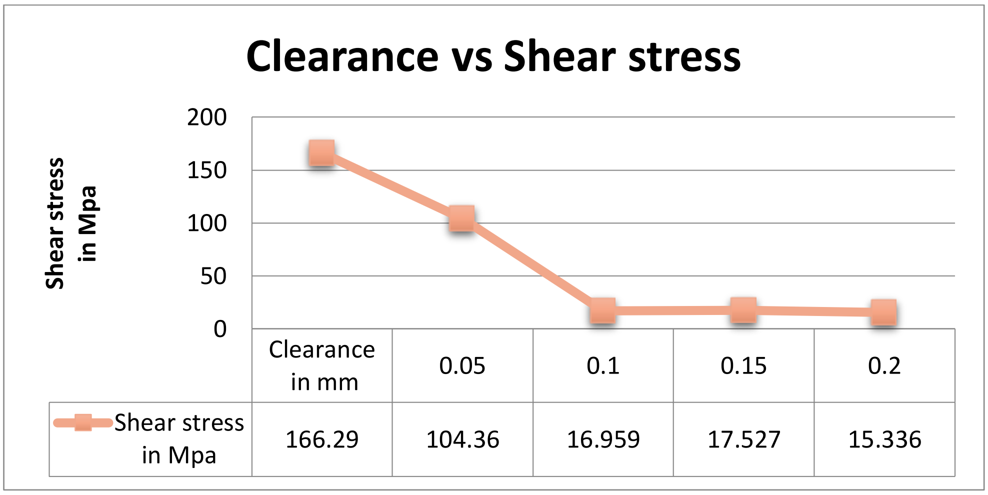
Graph 8.3 Aluminium sheet of 0.5 mm thickness, clearance vs von-Mises stress

8.2 FEA analysis of punching on Copper sheet

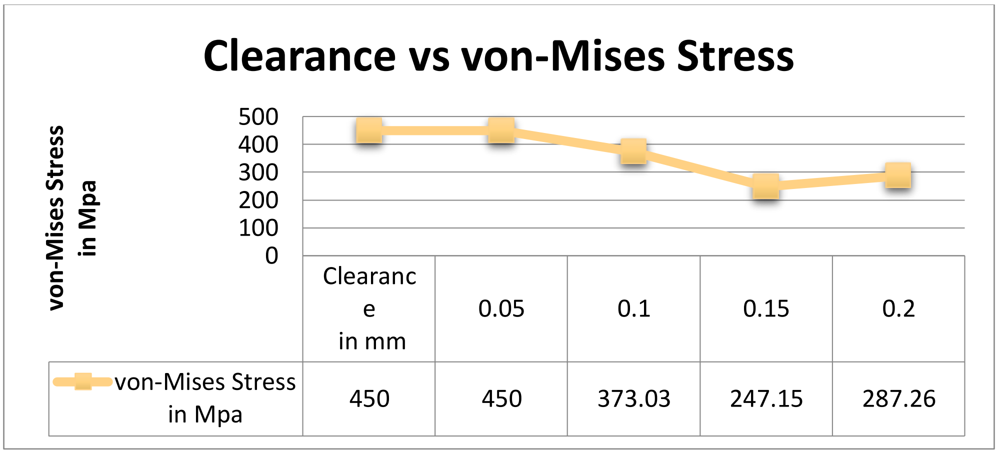
A detailed study of punching is carried out on Copper sheet of thickness 0.5mm in explicit dynamics module of ANSYS 15.0 by varying clearance between punch and die. The total deformation, shear stress and von-Mises stress are studied to identify the optimum clearance. For copper sheet metal the clearance vs total deformation, shear stress and von-Mises stress graphs are plotted in graphs 7.4, 7.5 and 7.6 respectively. The optimum clearance by comparing all results for Copper of 0.5 mm thick sheet metal is 0.05 mm.



Graph 8.4 Copper sheet of 0.5 mm thickness, clearance vs Total deformation



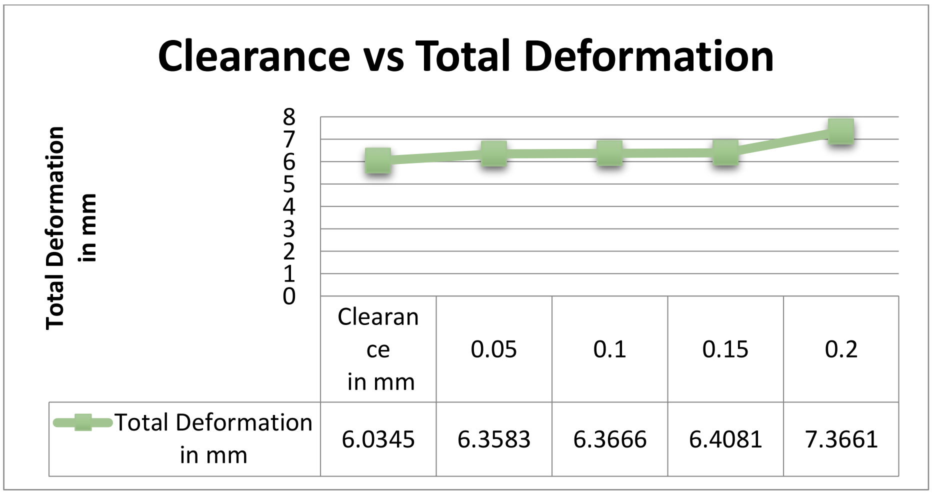
Graph 8.5 Copper sheet of 0.5 mm thickness, clearance vs Shear stress



Graph 8.6 Copper sheet of 0.5 mm thickness, clearance vs. Von-Mises stress

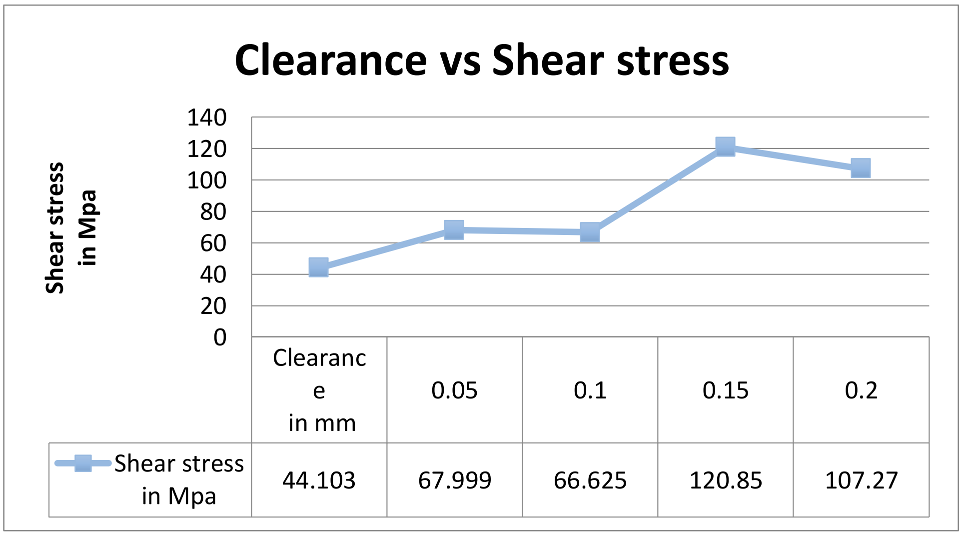
8.3 FEA analysis of punching on Steel 1006 sheet

A detailed study of punching is carried out on Steel 1006 sheet of thickness 0.5mm in explicit dynamics module of ANSYS 15.0 by varying clearance between punch and die. The total deformation, shear stress and von-Mises stress are studied to identify the optimum clearance. For Steel 1006 sheet metal the clearance vs total deformation, shear stress and von-Mises stress graphs are plotted in graphs 7.7, 7.8 and 7.9 respectively. The optimum clearance by comparing all results for Steel 1006 of 0.5 mm thick sheet metal is 0.15 mm.



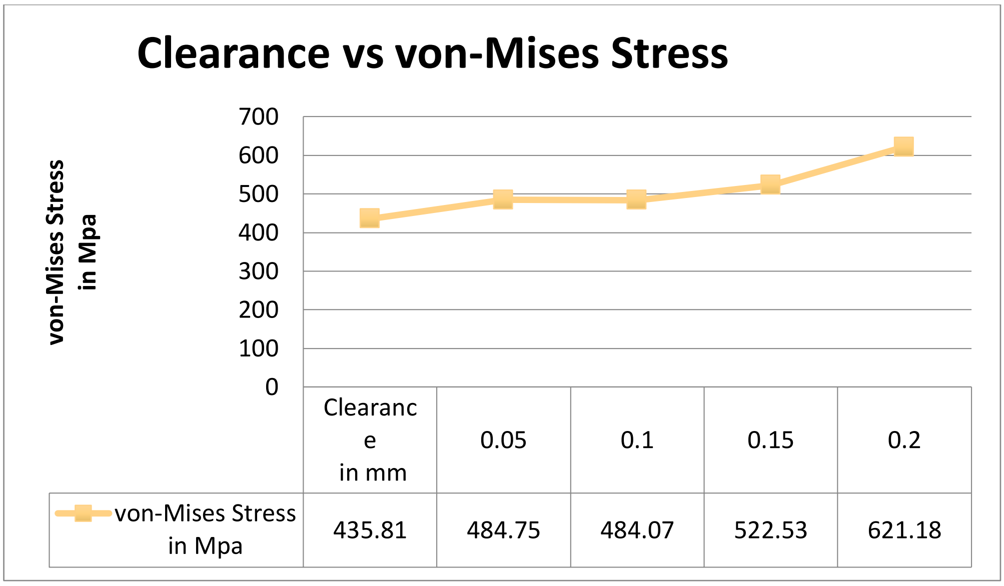
Clearance in mm	0.05	0.1	0.15	0.2
Total Deformation in mm	6.0345	6.3583	6.3666	6.4081	7.3661

Graph 8.7 Steel 1006 sheet of 0.5 mm thickness, clearance vs Total deformation



Clearance in mm	0.05	0.1	0.15	0.2
Shear stress in Mpa	44.103	67.999	66.625	120.85	107.27

Graph 8.8 Steel 1006 sheet of 0.5 mm thickness, clearance vs Shear stress



Graph 8.9 Steel 1006 sheet of 0.5 mm thickness, clearance vs von-Mises stress

8.4 Cost Analysis

Table 6 : Cost analysis

S.No	Name of the Component	Cost in Rs.
1	Pneumatic Cylinder	800
2	Wood	1500
3	Plywood	240
4	Bolts nuts and nails	40
5	Hoses	90
6	Connectors	100
7	Pneumatic Ports	150
8	5/2 mechanical lever valve	1300
9	Pressure regulator	700
10	Labour cost for carpentry and drilling	1000

Total Cost: Rs.5920/-

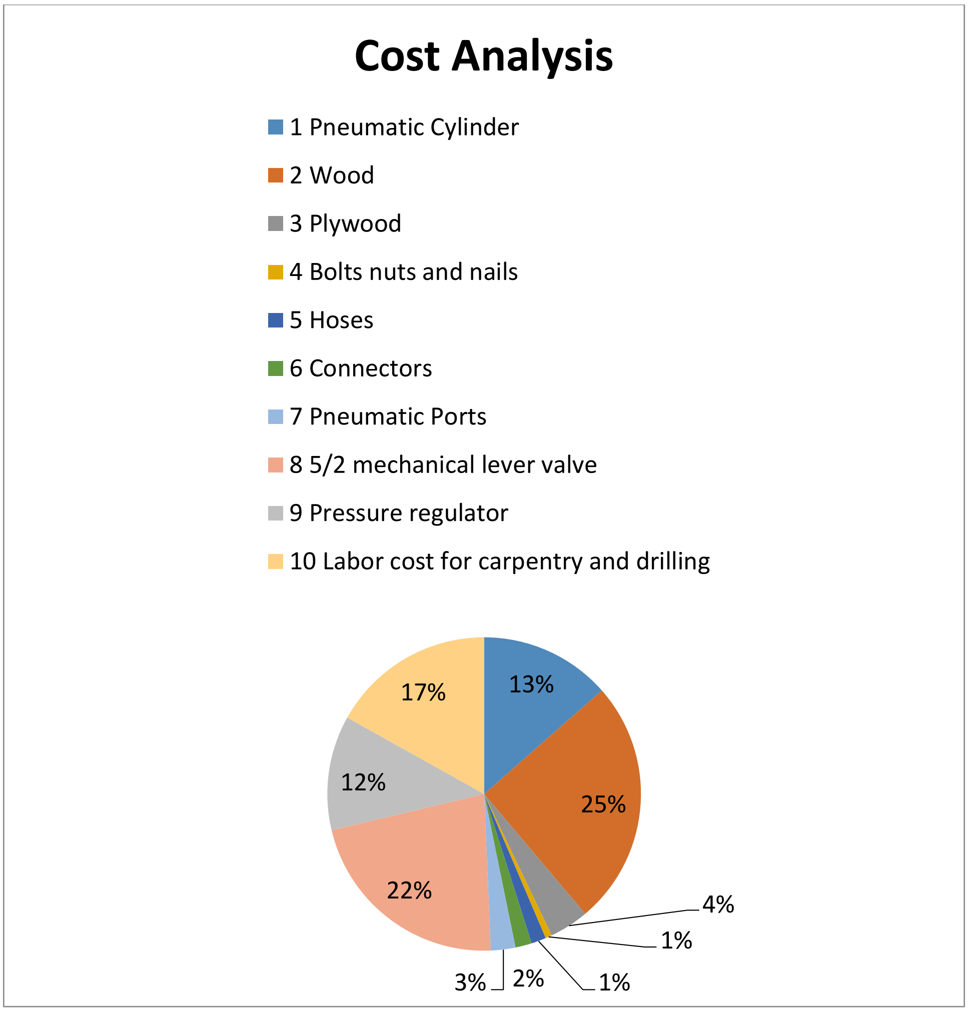


Chart 8.1 Cost analysis

The cost analysis of the total setup is done and tabulated in table 8.1 and pie chart is shown in chart. 8.1. The total cost comes to Rs. 5,920/-. And maximum portion is spent on pneumatic system

CHAPTER-9

CONCLUSIONS

We have fabricated the machine using pneumatic systems and it is tested in punching the paper. It can be used in manufacturing industry for punching the paper and if proper allowances are given the paper gets cut. We have performed Finite element analysis of punching on various sheet metals and determined the optimum clearance values for sheet metals of thickness 0.5mm of materials aluminium, copper and steel 1006.

The project carried out by us made an impressing task in the field of small scale industries to reduce manual work. It is very usefully for the workers to do the work as fast as possible. This project has also reduced the cost involved in the concern. Project has been designed to perform the entire requirement task which has also been provided.

9.1 Conclusions

We conclude that for the manufacturing of one or two boxes, there exists only a small difference between manual and automated operations. But, in order to manufacture large amounts of boxes, a lot of time will be consumed by the manual operation but in our experimentation we have come to know that if the proper allowance is given the paper gets cut in four ends according to the required dimensions.

- The arrangement of the entire equipment is done, i.e the 3D model of the box punching machine is developed according to the formulated design and its mechanism status is successfully studied by pneumatic simulation.
- The box punching machine is fabricated with minor changes due to manufacturing feasibility.
- The total cost is spent to fabricate the machine is Rs 5,920/-
- Hence in order for the paper to get cut the allowances must be given correctly so that at once when the punch falls with a force the paper should get cut with the required place with the required dimensions.
- The optimum clearance for aluminium of 0.5 mm thick sheet metal is 0.1 mm.
- The optimum clearance for Copper of 0.5 mm thick sheet metal is 0.05 mm.
- The optimum clearance for Steel 1006 of 0.5 mm thick sheet metal is 0.15 mm.

9.2 Future Scope

The modelling and fabrication of the model is already done but there is lot of scope for improvement for this machine.

- FEA analysis can be done on frame and other joints to determine the optimum dimensions.
- PLC or microcontroller can be used to automate the whole process which will reduce the time, which is widely used in industries.
- Hydraulic systems can be used and the same model can be used for metal sheets.
- The feeding mechanism can also be used to feed the paper or sheet to machine.

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