Machining Level-III

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Acronym

BHF	Blank Holder Force
CF	Cutting Force
CMM	Coordinate measuring machines
IT	International Tolerance
LAP	Learning Activity Performance
NDT	Non-Destructive Testing
OHS	Occupational Health and Safety
OHSA	Occupational Healthy and Safety Association
PPE	Personal Protective Equipment
SPC	Statistical Process Control

Introduction to Module

Press operation is one of the most efficient methods for making metal parts is metal forming processes by rapidly shaping metal or other materials by pressing between two plates. These processes can bend the metal, punch out holes, or even create impressions like the face of a coin.

This module is designed to meet the industry requirement under the Machining occupational standard, particularly for the unit of competency of Advanced Press Operations.

The module covers the units:

- Basics of Press Operations
- Press Machines Set up and Operations
- Die and Mould Parts
- Set up of Mould and Moulding Machines
- Mould and press machines Operations
- Product Quality

Learning Objective of the Module:

- Determine Basics of Press Operations
- Perform Press Machines Set up and Operations
- Explain Die and Mould Parts
- Set up Mould and Moulding Machines
- Perform Mould and press machines Operations
- Determine Product Quality

Module Instruction

For effective use this modules trainees are expected to follow the following module instruction:

1. Read the information written in each unit
2. Accomplish the Self-checks at the end of each unit
3. Perform Operation Sheets which were provided at the end of units
4. Do the “LAP test” giver at the end of each unit and
5. Read the identified reference book for Examples and exercise

Unit one: Basics of Press Operations

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Press Operations and its Applications
- Drawings Instructions
- Tolerance and Fit
- Fitting tools and equipment
- OHS Requirements

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Explain Press Operations and its Applications
- Interpret Tolerance and Fit
- Interpret drawings instructions
- Select fitting tools and equipment
- Describe Emergency procedures

1.1. Press Operations and its Applications

1.1.1. Introduction to press Operations

Metal forming is one of the manufacturing processes which are almost chip-less. These operations are mainly carried out by the help of presses and press tools. These operations include deformation of metal work pieces to the desired size and size by applying pressure or force. Presses and press tools facilitate mass production work. These are considered fastest and most efficient way to form a sheet metal into finished products.

The Press Machines are designed to use mechanical force or pressure to mold or cut metal. With the use of a press machine, you may muold metal into any shape you want without having to remove any chips.

These press working operations are mainly divided into two categories – cutting and forming of metal. In this Cutting Operations of press work process, the sheet metal is subjected to tensile and compressive stresses to break its structure and separate it into different parts. Hence, it is considered an efficient material utilization operation. This cutting operation may include blanking; punching, Shearing, Trimming, Slitting, Notching and stamping slots or holes on the other hand the Metal Forming Operations is one of the most widely used processes that cause stress below the ultimate strength of the metal, which results in distortion. Sheet metal forming operations include Bending, Drawing, Squeezing or coining.

These operations are crucial in the sheet metal industry and encompass various techniques for forming and manipulating metal sheets. The machine used for press working is called a press.

The main features of the Press Working incorporate the following:

- A press consists of a frame supporting a ram or slide and a bed, with mechanisms to operate the ram both in line with and perpendicular to the bed.
- The ram is equipped with suitable punch/punches, while a die block is attached to the bed.
- A stamping is created as the ram moves downward, with the punch moving towards and into the die block.
- The punch and die block assembly is commonly referred to as a "die set" or simply "die."

1.1.2. Applications of Press Working Operations

Press working operations include a wide range of metal forming processes used in the manufacturing industry to shape and manipulate sheet metal and other materials. These operations utilize mechanical or hydraulic presses to apply pressure and force, transforming raw material into desired shapes and configurations.

The versatility and efficiency of press working operations have made them an integral part of modern manufacturing, contributing to the production of various components used in automotive, aerospace, electronics, and numerous other industries.

.Sheet metal items such as automobile parts (roofs, fenders, caps etc.), components of aircraft, parts of business machines, household appliances, sheet metal parts of electronic equipment, precision parts required for different industry etc., are manufactured by press tools.

Applications of press may include solid Wide neck; Flat Product is made like bucket, Automobile & Industrial parts, Moulded chairs, Computer/ TV/ Radio Cabinets, Washing machine Cabinets, Mobile, Power-tool housings, Moulded House hold items etc. by injecting molten thermoplastic material in to a closed mould which is relatively cool. Presses are generally employed in mass production of identical components.

1.1.3. Press Operation Products

Products include metal desks, file cabinets, appliances, car bodies, beverage cans, washers, kitchen sinks, aircraft panels etc.



Figure 1.1 Press Operations Product

1.2. Drawings Instruction

A production drawing, also referred to as working drawing, should provide all the dimensions, limits and special finishing processes such as heat treatment, honing, lapping,

surface finish, etc., to guide the craftsman on the shop floor in producing the component. The title should also mention the material used for the product, number of parts required for the assembled unit, etc.

All the principles of orthographic projection and the technique of graphic representation must be followed to communicate the details in a part drawing. A part drawing with production details are rightly called as a production drawing or working drawing.

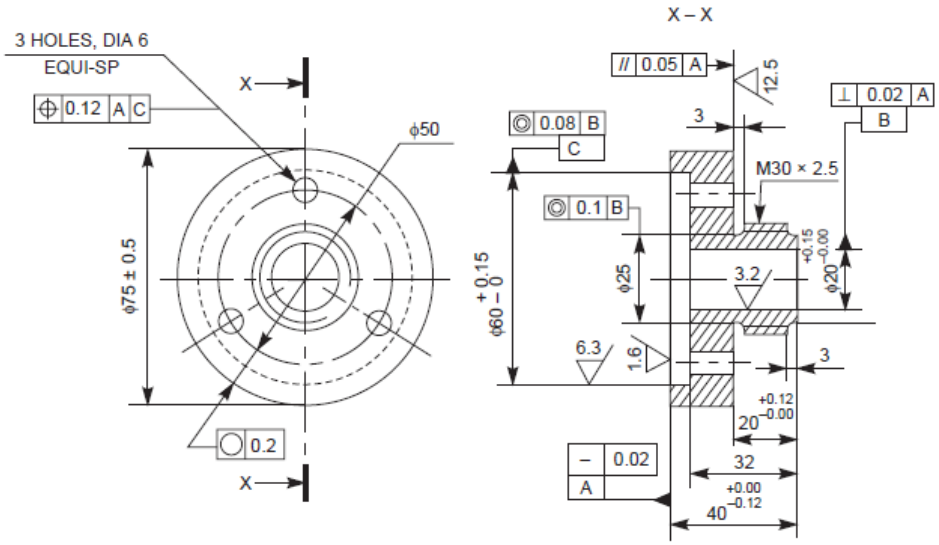


Figure 1.2 Production Drawing

A drawing that shows the various parts of a machine in their correct working locations is an assembly drawing

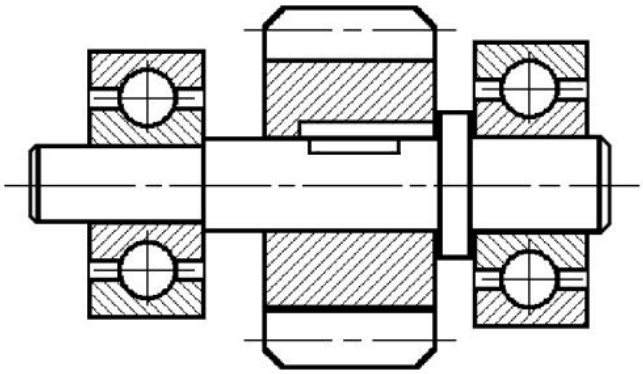


Figure 1.3 Assembly Drawings

1.3. Tolerance and Fit

Terminology in tolerance and fit as follow:

Nominal size: The size of a feature of perfect form as defined by the technical drawing.

Deviation: The difference between a size and the corresponding nominal size.

Hole: Internal feature of size of a workpiece, including internal features of size which are not cylindrical.

Shaft: External feature of size of a workpiece, including external features of size which are not cylindrical.

Upper deviation: The difference between the maximum limiting size and the corresponding nominal size of a feature.

Lower deviation: The difference between the minimum limiting size and the corresponding nominal size of a feature.

Limits of Size: Extreme permissible sizes of a feature of size.

Upper limit of size: Largest permissible size of a feature of size.

Lower limit of size: Smallest permissible size of a feature of size.

Tolerance: The difference between the maximum and minimum size limits of a part.

Fit: Relationship between an external feature of size and an internal feature of size (the hole and shaft of the same type) which are to be assembled.

Clearance: The difference between the size of the hole and the size of the shaft when the diameter of the shaft is smaller than the diameter of the hole.

Interference: The difference before mating between the size of the hole and the size of the shaft when the diameter of the shaft is larger than the diameter of the hole.

Clearance Fit: A fit type where clearance exists between assembled parts under all tolerance conditions.

Interference Fit: A fit type where interference exists between assembled parts under all tolerance conditions.

Transition Fit: A fit type where clearance or interference can exist between assembled parts depending on tolerance conditions.

Tolerance Grade

IT Grade 5-16: suitable for cutting operations like turning, milling, boring, grinding and sawing. **IT Grade 12-16**: suitable for manufacturing operations like pressing, rolling & other forming operations.

Different IT grade numbers represent different precision and suitable varying processing techniques. IT Grade 1-4: very precise, usually used for Gage making and precision work, precision measuring tools

IT Grade 5-16: suitable for cutting operations like turning, milling, boring, grinding and sawing.

IT Grade 12-16: suitable for manufacturing operations like pressing, rolling & other forming operations.

Table 1.1: Tolerance Grade with application, processes

Application,Process	Tolerance (µm)	IT Grade
Slip blocks, reference gages	1-2	**1**
High quality gages, plus gages	2-3	**2**
Good quality gages, gap gages	3-5	3
Fits produced by lapping	4-10	**4**
Ball bearings, Diomand or fine boring, fine grinding	5-12	**5**
Grinding, fine honing	6-20	**6**
High quality turning, broaching	12-35	**7**
Center lathe turning and boring, reaming	14-50	**8**
Horizontal or vertical boring machine	30-80	**9**
Milling, slotting, planing, metal rolling or extrusion	50-100	**10**
Drilling, rough turning and boring, precision tubing	70-140	**11**
Light press work, tube drawing	120-240	**12**
Press work, tube rolling	150-500	**13**
Die casting or molding, rubber moulding	250-1000	**14**
Stamping	400-1400	**15**
Sand casting, flame cutting	500-2000	**16**

Geometric dimensioning and tolerance

Symbol	Meaning
Ⓛ	LMC – Least Material Condition
Ⓜ	MMC – Maximum Material Condition
Ⓣ	Tangent Plane
Ⓟ	Projected Tolerance Zone
Ⓕ	Free State
Ø	Diameter
R	Radius
SR	Spherical Radius
SØ	Spherical Diameter
CR	Controlled Radius
(ST)	Statistical Tolerance
77	Basic Dimension
(77)	Reference Dimension
5X	Places

Symbol	Meaning
⌖	Dimension Origin
⌴	Counterbore
⌵	Countersink
↧	Depth
⌾	All Around
↔	Between
×	Target Point
▷	Conical Taper
⏥	Slope
□	Square

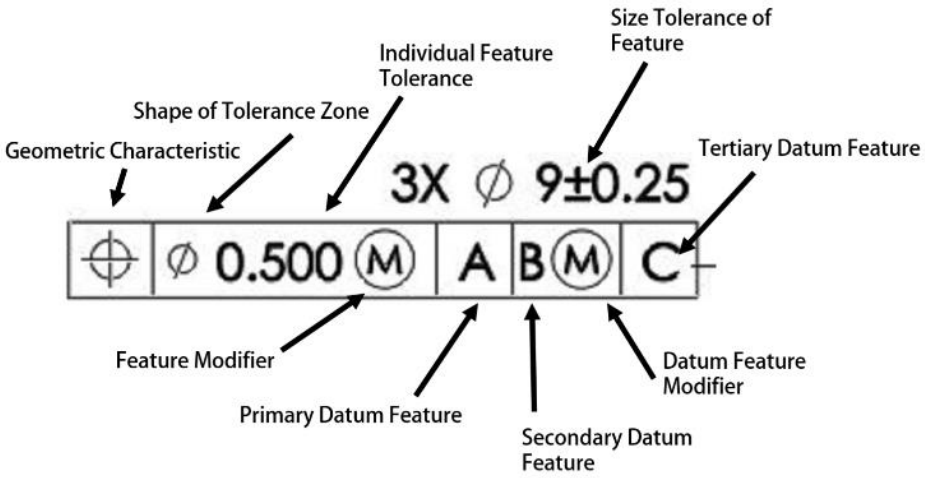


Figure 1.4: Geometric dimensioning and tolerance symbols

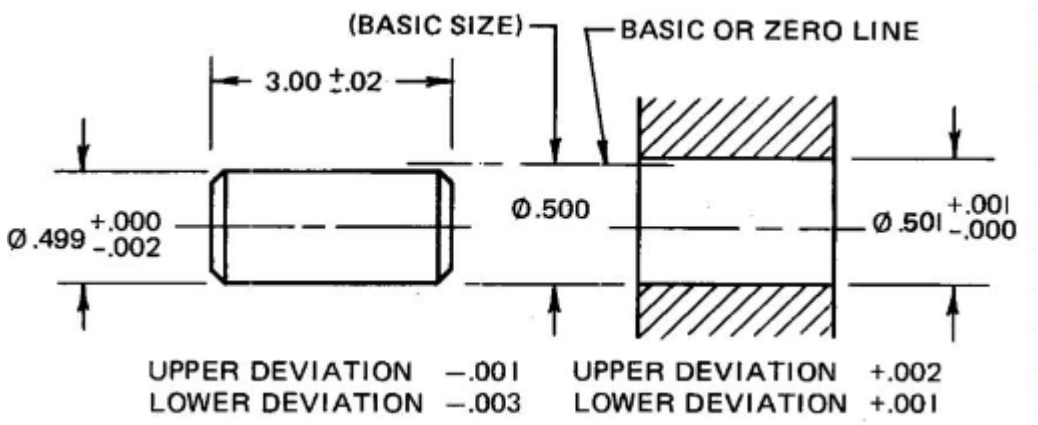


Figure 1.5: Tolerance and Limit of two matting Part

1.4. Fitting tools and equipment

Fitting tools and equipment are used to the attention of a fitter is required at various stages of manufacture starting from marking to assembling and testing the finished goods. These tools and equipment are:

Angle Plate: - An angle plate is used for supporting or setting up work vertically, and is provided with holes and slots through which securing bolts can be located. It is made of cast iron and ground to a high degree of accuracy.



Figure 1.6: Angle Plate

Vernier Height Gauge: The vernier height gauge is widely used in layout work and for height measurement up to and accuracy of 0.02mm. It is generally used on a surface plate. The three main parts of height gauge are the base, the column, and the slide arm. The main

scale is on the column and the vernier scale is attached to the slide arm. A flat scriber is secured to the slide arm for layout work as shown in fig.

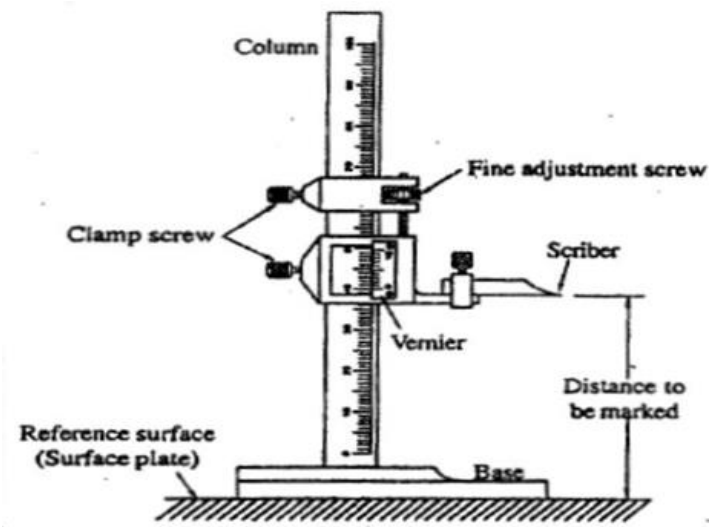


Figure 1 7: Vernier Height gauge

Power hacksaws is used to **cut large sizes (sections) of metals** such as steel. Cutting diameters of more than 10/15mm is very hard work with a normal hand held hacksaw. Therefore power hacksaws have been developed to carry out the difficult and time consuming work.

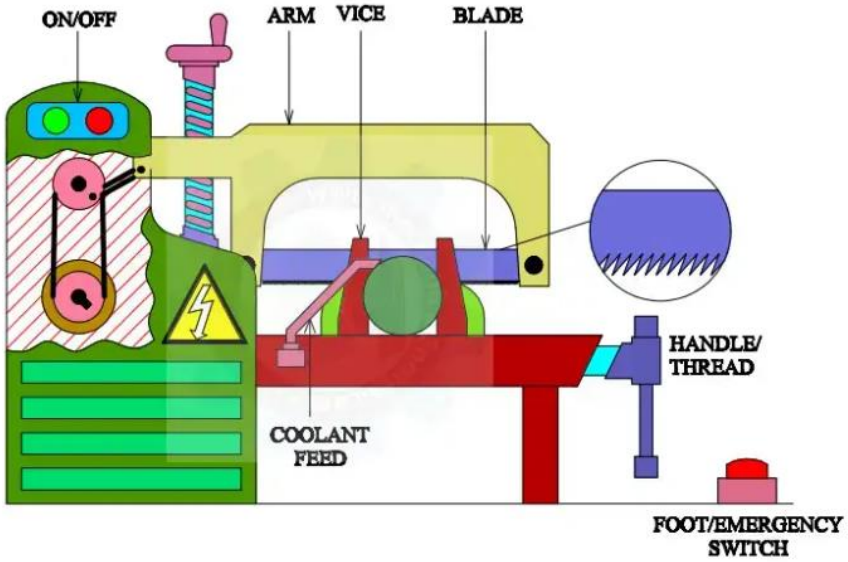


Figure 1.8: Power Hacksaw Machine

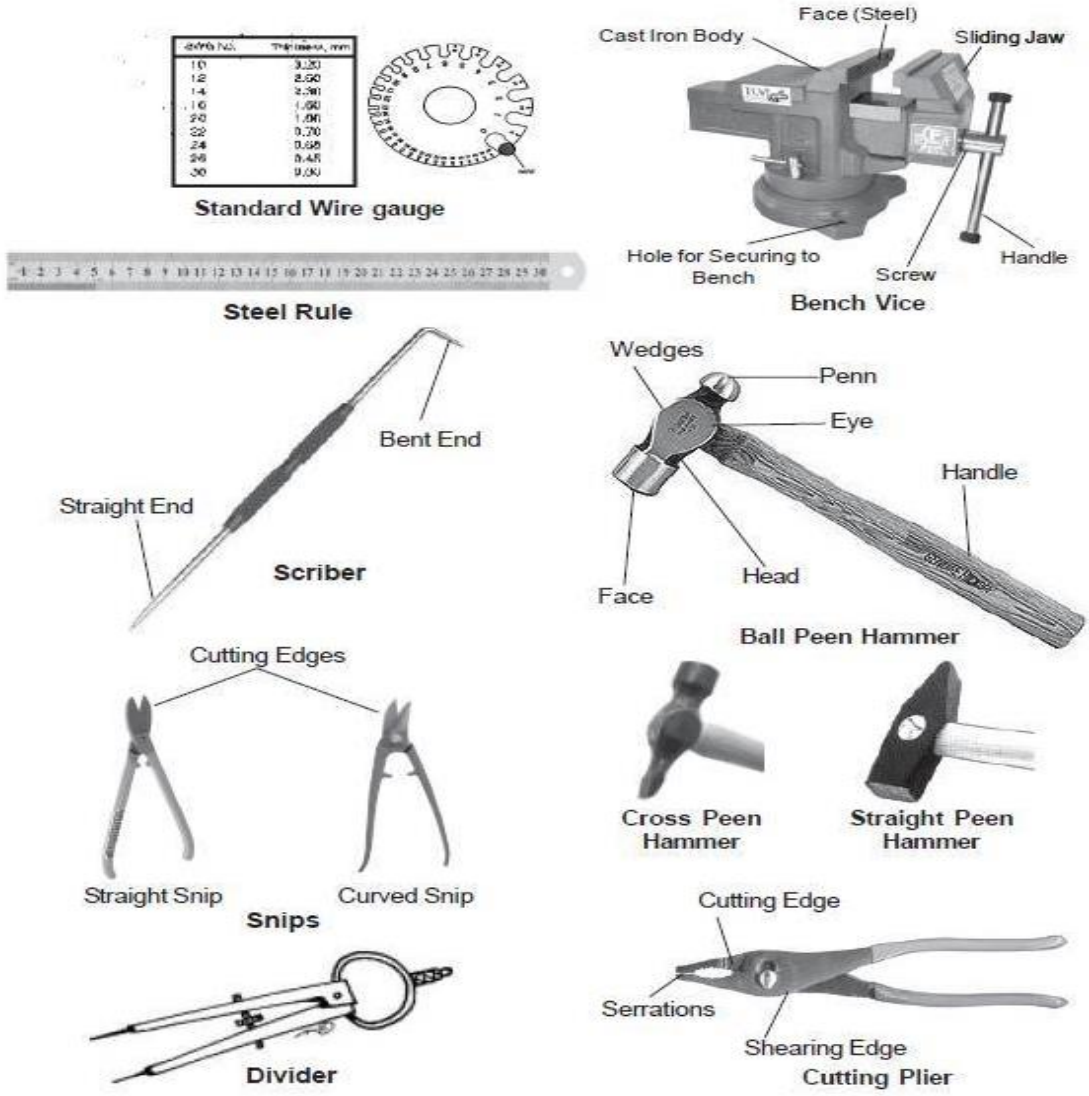


Figure 1.9: List of Tools

Surface Plate:- It is used for testing the flatness, trueness of the surface. It is made up of cast iron or graphite. Its upper face is flat to form a very smooth surface. It is covered with a wooden cover while not in use. It is used to test a try square and this plate is used as a base for V-block, sine bar etc. and other measuring instruments during measurement.

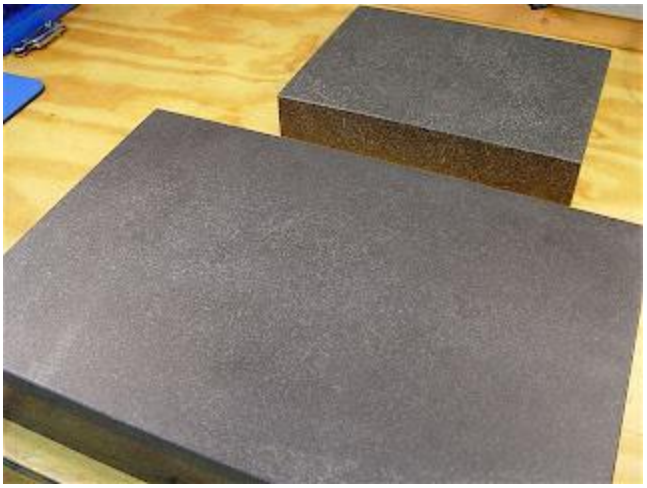


Figure 1.10: Surface plate

Dowels:- Fasteners and Dowels. Dowels hold parts in perfect related alignment by absorbing side pressures and lateral thrusts. They facilitate quick disassembly and reassembly of tool elements in their exact former relationship. Dowels are precise in their accuracy and in their surface finish.

Filing machine:- A filing machine or die filer, is just what it sounds like, **a machine for filing**. It its most basic form it is a table with a file that goes up and down. Despite the simplicity a high degree of precision is achievable making them popular among clock and model makers.

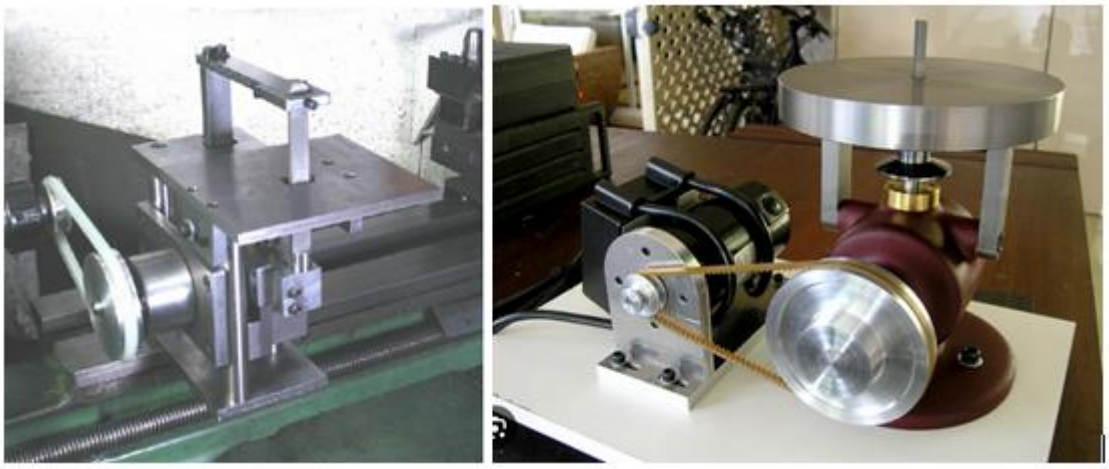


Figure 1.11: Filing Machine

Die lifters are intended for T-slot or U-slot bolster mounting and reduce the effort/force required to quickly located tools. Tools of 4,000 pounds or less can often be moved by hand. Sub-plates under the lower die are required. Generally, Die lifter is used to minimize the amount of force you need to lift heavy dies. Depending on their working principles, die lifters are standardized into three

categories: spring-loaded, hydraulic, and pneumatic.

- Rolling systems based on balls (most flexible movement), rollers (move the die in a linear direction), and bars (smooth movement)
- 3 operating technologies are available: Mechanical (for small and mid-sized dies and no power needed), Hydraulic (heavier dies), and Pneumatic (for clean application and higher loading capacities)

Purpose of die Lifter

To lift, move, position and lower heavy dies on vertical presses, like stamping presses and vertical injection molding machines.

Advantages

- Clean operation
- Minimum effort
- Faster operation
- With or without power to be operated



Figure 1.12. Hydraulic ball bar die lifter system



Figure 1.13. spring-loaded mechanical die lifter balls

1.5. OHS Requirements

1.5.1. Safety Rules

Safety information for using press machines is also available in the operator's manuals of press machines and the warning labels affixed to the press machines. Some of safety rules used in press work shop may include:

- Read the machine user manual carefully before operating the press.
- Pay attention to the warning signs on the press.
- Only trained operators should use this press.
- In the operator training, information should be given about risks that may arise from the use of the press and the measures to be taken.
- The user must also be trained on protection systems and safety parts and periodic checks of these parts.
- The user must never leave the press running.
- The press is designed to be used by one person at most.
- This press is built to provide not only a high degree of safety, but also a high level of efficiency.
- The manufacturer is not responsible for any damages that may arise from corrections made on the press.
- Do not use this press if you are under the influence of alcohol, drugs or medication.

1.5.2. Personal Safety

Before operating the press, the machine operation and maintenance manual must be read. Your eyes are the best security tool. Please carefully look at the equipment before using the press. Experience shows that there are many objects on the person that can cause injuries: remove your rings, watch, bracelets, button up the buttons on your arm tightly, remove your clothes such as ties, threads that can get stuck in tight places, collect your hair (under a cap or with an elastic hair pin), Wear recommended work shoes.

All operators must wear personal protective equipment (PPE) to prevent unnecessary press machine injury. Items include:

- Safety glasses or face masks to protect against flying debris.
- Ear muffs that meet regulatory agency requirements for noise exposure.

- Close-fitting clothing, sturdy aprons or vests to reduce the chance of the machine catching apparel.
- Protective footwear with additional safety features, such as steel toe inserts and tall uppers.
- Gloves and arm coverings.
- Protective headgear or headdress.
- Dangers that may arise from incorrect electrical connection
- Dangers can arise from incorrect installation.

1.5.3. Workplace Safety

- Before starting to work, the working area must be thoroughly cleaned and the wastes in oily or similar places must be removed.
- Employees must be made aware of the condition of the ground.
- Work shoes (with steel protection zone and rubber sole) must be worn and protective equipment (protective gloves etc.)must be used.
- Only the authorized operator must be in the work place.
- In order for the operator to stay outside the dangerous area, there must be a good lighting and sufficient working place in the work area.
- The floor must be flat against the danger of slipping and there must be no obstacle parts on the floor.
- All unused tools, equipment and connection extensions must be removed. Similar materials such as cables or cords must be removed from the work area to avoid tripping hazards.

1.5.4. Machine Safety

Start the press when all safety systems are properly installed and suitable for use. Use only hand- powered tools. The guards must be installed while the machine is turned off. The use of press machine is not allowed unless the following conditions are provided;

- While the press is running, never remove any part of the main body.
- When closing the press, turn it off after taking the operation to its final position.
- Make sure that the procedure between electrical fields, including testing and documentation is done safely.

- While the press connection apparatus and other parts are loaded or unloaded, the body parts of the employees should never remain between the load and the parts.
- The noise level of the press is below the critical threshold.

Table 1.2: Safety Signs Used and Their Means

	DANGER	Indicates that if the instructions for use are not followed, death/ Serious injury or serious damage to the product may ocur.
	ELECTRIC SHOCK	The sign indicates electrical hazards that can result in personal injury or death.
	CRUSHING HAZARD (HAND/ FINGER)	The sign determines the risk of accidents with moving parts, jamming and injuring personel.
	DANGER OF BEİNG UNDER LOAD	The sign indicates the risk of İnjury as a result of the load falling on personel.
	İMPORTANT NOTE	Warning sign about important points and issues
	USER MANUEL	Indicates that the user manuel should be read before the operation.
	UNAUTHORİZED PERSONS DANGER OF ENTERİNG THE WORK AREA	Indicates that people should not enter dangerous areas

1.5.5. Emergency Stopping

When the active state of the emergency stop device expires following a stop command, this command must be made to perpetuate the activation of the emergency stop device until this operation is specifically overridden. It must not be possible to activate the device without triggering a stop command. Disengagement of the device must only be possible with an

appropriate action, and disengagement of the device must not restart the machine, but allow a start. The emergency stop function must be available and working at all times, regardless of the operating mode.

Emergency stop devices are a supplementary element for other protective measures and cannot replace these measures. Emergency stopping devices: Standards call for accessible stop buttons and power disconnection methods. OSHA rules also permit presence-sensing devices to automatically stop operation when a person or object disrupts the light beam transmitting between sensors. Report all incidents to supervisor, including injuries, equipment damage, and near misses.



Figure 1.24: Emergency Stop Button

Self-Check 1

Directions: Answer all the questions listed below.

Part I: White True if the statement is Correct and write False if the statement is not correct

_____ 1. Press operator not Read the machine user manual carefully before operating the press

_____ 2. Dangers that may arise from incorrect electrical connection

_____3. Hole size of a feature of perfect form as defined by the technical drawing

_____4. Dowels hold parts in perfect related alignment by absorbing side pressures and lateral thrusts.

Part-II: Choose the correct answer from the given alternatives

1. _____to minimize the amount of force you need to lift heavy dies.
   A. Die holder
   B. Die Lifter
   C. Filing Machine
   D. Moulding machine
2. The difference between the maximum and minimum size limits of a part.
   A. Tolerance
   B. Clearance fit
   C. Interference fit
   D. Fit
3. It is used for testing the flatness, trueness of the surface.
   A. Surface Plate
   B. Angle Plate
   C. Surface Gauge
   D. Parallel Plate
4. IT Grade 12-16: suitable for manufacturing operations like _____ operations.
   A. Pressing
   B. Rolling
   C. Forming
   D. All

Part III: Fill in the blank space

1. _____ is one of the manufacturing processes which are almost chip-less.
2. _____is equipped with suitable punch/punches, while a die block is attached to the bed.
3. A drawing that shows the various parts of a machine in their correct working locations is known as_____.
4. Presses are generally employed in _____ production of _____ components.

Unit Two: Press Machines Set up and Operations

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Types of Press Machines
- Parts of Press Machine
- Die set and die accessories
- Properties of materials
- Press Machine Set up
- Die and Punch Set up
- Press Ram Adjustment

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Identify types of Press Machines
- Explain Parts of Press Machine
- Mount die set and die accessories
- Identify Mechanical Properties of materials for press operation
- Understand the procedures of starting-up Press Machine
- Follow the methods of die and punch Supporting
- Understand the steps of Press Ram Adjustment

2.1. Types of Press Machines

Press machines are majorly used in sheet metal industries for providing any shape or punch to the sheet metal. The Press Machines are designed to use mechanical force or pressure to mold or cut metal. With the use of a press machine, you may muold metal into any shape you want without having to remove any chips. There are various types of categorizing presses into various categories.

2.1.1. Manually Operated Press Machines

These machines are the simplest form of Press machine in which press is applied manually. This kind of machine is used when working operations are of thin metal sheet where less force and pressure are required. It is operated manually. These presses are used to perform small operations like piercing, blanking, bending, etc. The types of manual press machines are hand press, ball press, and fly press.

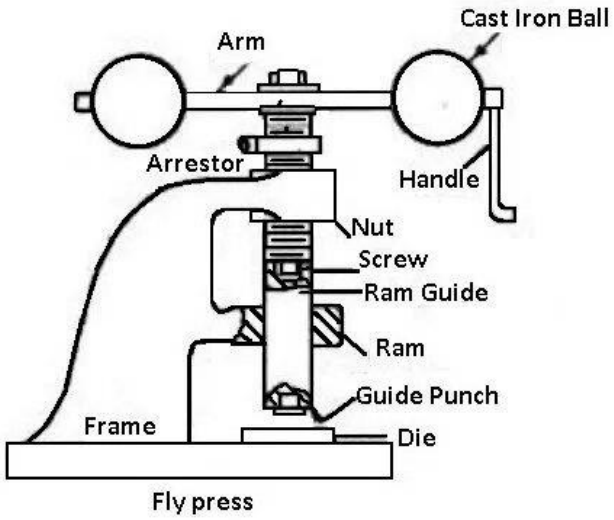


Figure 2.13: Manual Operated Press Machine

The main parts of the hand press machines are the frame, ram, nut and screw, iron ball, handle, guide-way, punch, and die. The cast iron balls are mounted at two ends which are bolted to screw. The ram moves up and down by rotating the arm manually and performing operations. The sheet is placed on the bed, and the ram is equipped with a punch.

2.1.2. Mechanical Power Press

These are the most famous machines which are mainly used in workshops. The function is the same as the hand press but the only difference is that the ram is operated by power. The power source of this kind of machine is either an electric motor or engine.

The major components for power transmission on a mechanical power press are the clutch, crankshaft, flywheel, moving ram, and stationary ram. The slide is joined to a crankshaft with connecting rods ("pitmans").

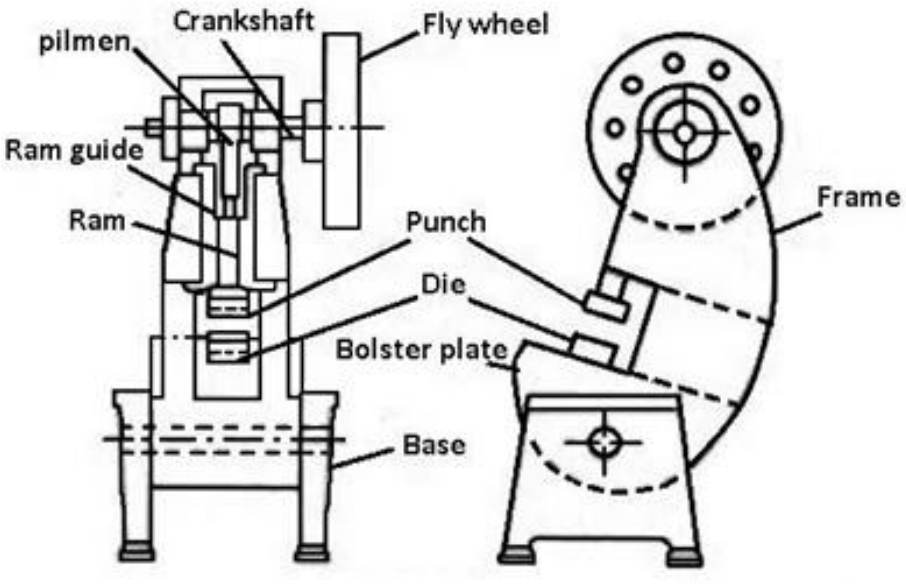


Figure 2.2: Power Press Machine

The crankshaft is coupled with the flywheel, which is constantly rotating while the motor is running. A clutch connects the spinning flywheel with the crankshaft. The crankshaft converts the flywheel's rotational motion to the upward and downward motions of the press slide.

The ram is equipped with a punch and is used to work on the job that is held on the die block and bolster. The flywheel receives energy from the electric motor, which is then transferred to the ram via a clutch and crankshaft.

Flywheel is a driven pulley or driven gear is made in the shape of a flywheel (which is used to store the energy reserve) in order to maintain a constant ram speed when the punch is

pressed onto the work piece. The flywheel is fixed at the driving shaft's edge and is attached to it via a clutch.

2.1.3. Gap Frame Press

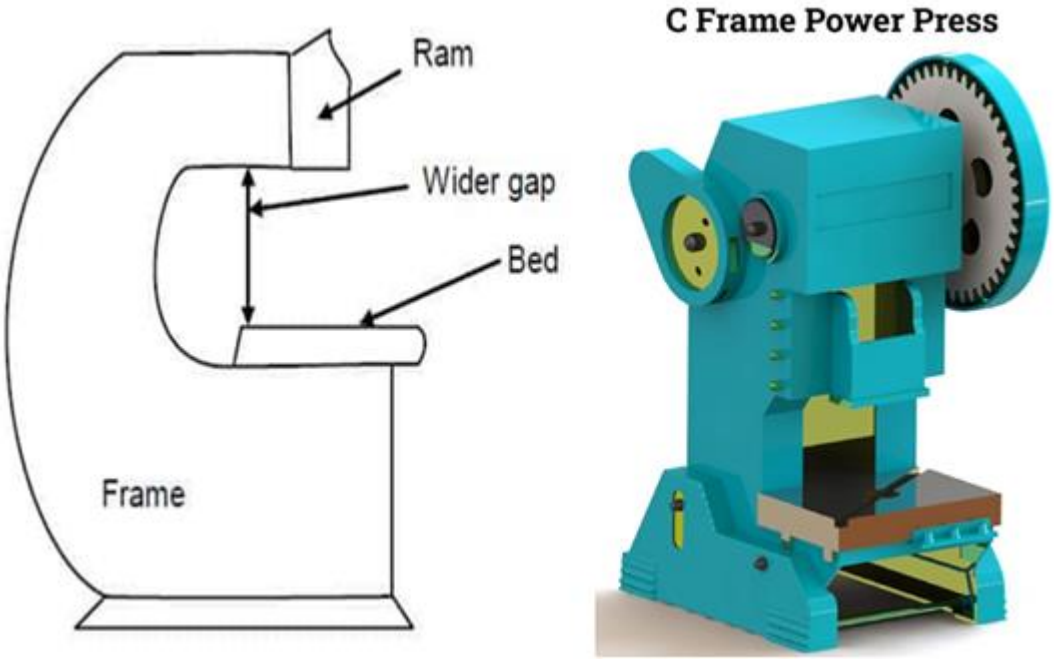


Figure 2.3: C-Frame Power Press

As seen in the above figure, it has the larger frame opening part which indicates the wide gap between ram and bed. It is also called C-Frames machines. This type of machine is beneficial for the accommodation of large work pieces with longer beds as seen in the figure.

2.1.4. Hydraulic presses machine

Hydraulic press is a tool to produce compressive force by means of fluid. It depends upon Pascal's principle that the pressure throughout an enclosed entity is constant. By means of hydraulic system larger forces can be produced in contrast with mechanical and electrical systems

Hydraulic presses are commonly used for forging, clinching, moulding, blanking, punching, deep drawing, and metal forming operations. Hydraulic presses are also used for stretch forming, rubber pad forming, and powder compacting.



Figure 2.4: Hydraulic Press Machine

Typical oil specifications:

BP	Energol HLP 32-46	Q8	Haydn 32-46
Shell	Tellus Oil S 32-46	Castrol	Hyspin AWS 32-46
TEXACO	Rando Oil HD-32-46	STATOIL	HydraWay HM32-46

Typical oil specifications:

	32	46
Flash point	210°C	220°C
Pour point	-32°C	-32°C
Viscosity at 40°C	31 mm^2/s (cSt)	45mm^2/s(cSt)
Viscosity grade	105	
Neutralization grade	0,4mg KOH/g	0,4mgKOH/g
Foam tendency (ASTM D 892) ved 24°C	0/0ml	0/0ml
Foam tendency (ASTM D 892) ved 93°C	20/0ml	10/0ml
Air release (ASTM D 3427)	1,5	1,0

2.1.5. Adjustable Bed Frame Press

Because it has a knee-type bed supported on a column-shaped frame, it's also known as the column and knee-type press. Its bed (knee) can be moved vertically up and down with the use of power screws to any desired height. In comparison to other structures, this construction has a small lack of stiffness. It is depicted in Figure.

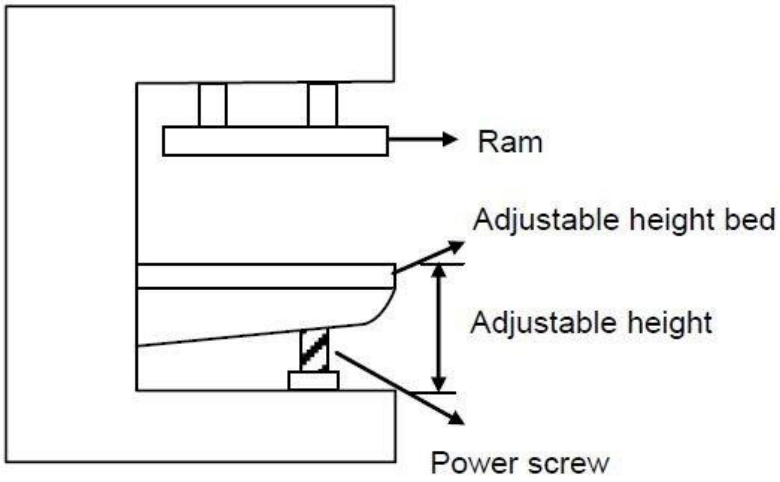


Figure 2.5. Adjustable Bed Frame Press

2.2. Parts of Press Machine

Different types of presses have almost common types of main parts. These parts are described below.

i. Base

Base is the one of the parts of a press. It is main supporting member for work piece holding dies and different controlling mechanisms of press. Size of the table limits the size of work piece that can be processed on a press. In case of some special presses the base carries mechanism for tilting the frame in any desirable inclined position too.

ii. Frame

Frame constitutes main body of the press located at one edge of its base. It houses support for ram, driving mechanism and control mechanisms. Some of the press have column shaped frame.

iii. Pitman

It is the part which connects the ram and crankshaft or ram eccentric

i. Ram

This is main operating part of the press which works directly during processing of a work piece. Ram reciprocates to and fro within its guide ways with prescribed stroke length and power. The stroke length and power transferred can be adjusted as per the requirements. Ram at its bottom end carries punch to process the work piece. .

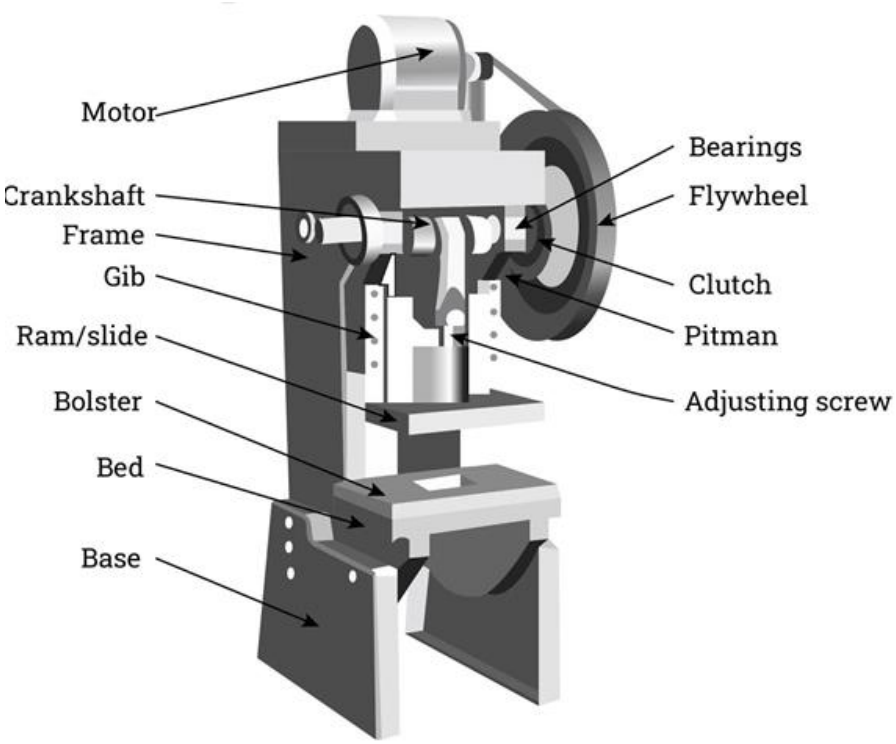


Figure 2.6: Parts of power Press Machine

ii. Driving Mechanism

Different types of driving mechanisms are used in different types of presses like cylinder and piston arrangement in hydraulic press, crankshaft and eccentric mechanisms in mechanical press, etc. these mechanisms are used to drive ram by transferring power from motor to ram.

iii. Controlling Mechanisms

Controlling mechanisms are used to operate a press under predetermined controlled conditions. Normally two parameters are adjusted by controlling mechanisms length of stroke of ram and power of stroke. Transfer of power can be disengaged with the help of clutch provided with driving mechanisms as per need. In most of the presses controlling mechanisms is in built with the driving mechanisms. Now-a-days compute controlled presses are being used in which controlling is guided by microprocessor. These presses provide reliable and accurate control with automation.

iv. Flywheel

In most of the presses driven gear or driven pulley is made of the shape of flywheel, which is used for storing the energy reserve wire of energy) for maintaining constant speed of ram when punch is pressed against the work piece. Flywheel is placed in the driving mechanism just before the clutch is sequence of power transmission.

v. Brakes

Brakes are very urgent in any mobile system. Generally two types of brakes are used normal brake, which can bring the driven shaft to rest quickly after disengaging it from flywheel. Other is emergency brakes which are provided as foot brake to any machine. These brakes include power off switch along with normal stronger braking to bring all motions to rest quickly.

vi. Bolster Plate

It is a thick plate attached to the bed or base of the press. It is used to clamp the die assembly rigidly to support the work piece. The die used in press working may have more than one part that is why the phrase die assembly is being used at the place of die.

2.3. Die set accessories

Die sets are manufactured in a bewildering variety of sizes and shapes and it is the purpose of this section to inform you with the various styles as well as to indicate proper methods of selection and placement.

The complete die set consists of a punch, die and some other accessories. Perfect alignment of punch and die is most important for satisfactory working of punch. Accessories of die set provides the require alignment and rigidity to the system and improves accuracy of the system performance. These accessories are used for finished parts removal, removal of waste.

Advantages realized when tool components are retained in a properly selected die set are:

Members are kept in proper alignment during the cutting process even though some looseness may exist in the press ram. Thus, uniform clearance are maintained around the cutting edges for producing blanks free of burrs.

- Tool life is increased.
- Tools can be installed in the press in the minimum amount of time because they are self-contained units.
- Storage is facilitated. There is no possibility of loss of loose parts.
- Properly designed tools can be sharpened without removal of cutting members.

Standard die sets range from 3 by 3 inches to 45 by 60 inches. Bottom plate and top plate thick nesses range from 1 to 3 ½ inches, by quarter inches.

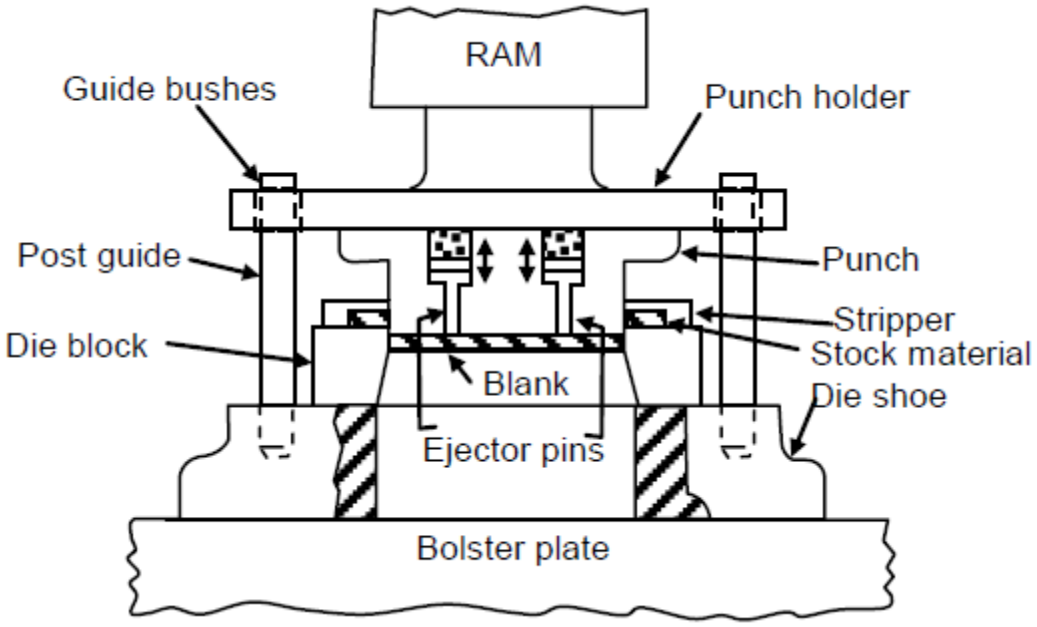


Figure 2.7: Die Accessories

a) Punch Holder

It is also known by its other name upper shoe of die set. Punch holder is clamped to the ram of press. It holds the punch below it.

b) Punch

It is the main tool of die assembly which directly comes in contact of workpiece during its processing, its detail have already been described.

c) Die Holder

It is also called die shoe. Its work as a support for the die block and it is rigidly fastened to the bolster plate of the press.

d) Stops

Stops are used for maintaining correct spacing of the sheet metal when it is fed below the punch to maintain the quality of output. These restrict the feed of stock (workpiece) to a pre-determined length each time without doing any precise measurements. Normally two types of stops are used bottom stop and lever stop as described below.

e) Bottom stop

Bottom stop is a tape of mechanical mechanism. This mechanism stops the movement of punch after end of each cut. A button is located in such a manner when fresh stock is fed to

die, the button is pressed due to the impact of the fed stock, indicating feeding of true length of the stock. This way the mechanism also acts as a fixture. Pressing of button enables the system ready for next cutting action. The button stop is used in hand presses and in slow acting power presses.

f) Lever Stop

This mechanism operates with the help of a lever. After the completion of one cut, the stop mechanism stops the downwards movement of punch for next cut when fresh stock is fed it is stopped by a lever after feeding it up to certain length. The lever also enables the punch to move for cut.

g) Pilots

Pilot is used for correct location of blank when it is fed by mechanical means. The pilot enters into the previously pierced hole and moves the blank to the correct position to be finally spaced by the stops. Normally pilots are fitted to the punch holders.

h) Strippers

Stripper is used to discard the work piece outside the press after the completion of cutting or forming operation. After the cutting when punch follows upward stroke the blank is stripped off from the punch cutting edge and prevents it from being lifted along with the punch. This action of prevention is performed by the stripper.

i) Knockouts

Knockout is also a type of stripper which is used generally in case of inverted dies. After the completion of cutting action, the blank is ejected by the knockout plate out of cutting edge.

j) Pressure Pads

Pressure pads are plates which grip the work piece very tightly at the ends when it plastically flows between the punch and the die. This tight griping eliminates the chances of wrinkling in the process of metal forming. A spring loaded plunger acting on the bottom of work piece plate also serve the same function. The pressure pads do a type of ironing on the sheet metal work piece.

k) Guide Posts

Accurate alignment between die opening and punch movement is very important. Guide posts are used for correct alignment of punch and die shoe.

l) Punch Plate

Punch plate is also known as punch retainer. This is fixed to the punch holder. Punch plate serves as a guide way to hold the punch in right position

m) Backing Plate

Backing plate is used to distribute pressure uniformly over the whole area (maintains uniform stress), it prevents the stress concentration on any portion of punch holder. This is generally made of hardened steel inserted between the punch and punch holder.

n) Die Retainer

The purpose of die retainer is same that is of punch plate and punch holder. Die retainer is fixed to the bed (base) of the press to hold the die block in correct alignment with the movement of punch. In some specific cases die shoe itself works as a die retainer.

2.4. Properties of materials

During press working operations, several material properties are considered to ensure successful forming processes and high-quality finished parts. Here are some key material properties that are commonly taken into account:

- **Ductility:** Ductility refers to a material's ability to be permanently deformed without fracturing. Materials with high ductility, such as soft metals like aluminum or mild steel, are often preferred for press working operations. They can undergo significant deformation without tearing or cracking, allowing for complex shapes to be formed.
- **Strength:** Material strength is crucial in press working operations to resist deformation forces. High-strength materials, such as stainless steel or high-strength alloys, are often used when structural integrity and load-bearing capabilities are required. The strength of the material determines the maximum force that can be applied during forming without causing failure.
- **Work Hardening:** Work hardening, also known as strain hardening, is the increase in material hardness and strength that occurs as a result of plastic deformation. Materials that exhibit good work hardening characteristics, like certain types of steel, can undergo significant deformation without excessive spring-back, allowing for precise forming and dimensional accuracy.

- **Elasticity:** Elasticity refers to a material's ability to return to its original shape after deformation. A certain level of elasticity is desirable during press working to minimize residual stresses and spring-back. Materials with high elasticity, such as certain polymers or low-carbon steels, can be advantageous in specific applications where dimensional accuracy is critical.
- **Formability**: Formability is the ease with which a material can be formed into a desired shape without defects or excessive force requirements. It depends on factors such as the material's ductility, work hardening behavior, and strain rate sensitivity. Materials with good formability, like aluminum or copper, are often chosen for applications requiring intricate or complex shapes.
- **Thickness and Homogeneity:** The thickness and homogeneity of the material are important considerations in press working operations. Uniform material thickness ensures consistent forming throughout the part, while material homogeneity minimizes variations in mechanical properties and reduces the risk of defects.
- **Friction Characteristics:** The friction between the material and the tooling surfaces plays a significant role in press working operations. The coefficient of friction between the material and the die affects the material flow, springback, and the occurrence of defects like wrinkles or surface scratches. Proper lubrication or surface treatments can be utilized to control friction and improve the forming process.

These material properties influence the selection of appropriate materials for specific press working applications and help determine the process parameters, tooling design, and lubrication requirements to achieve desired forming outcomes. Understanding these properties is essential for optimizing the press working process and ensuring the production of high-quality formed parts.

2.5. Press Machine Set up

Setting up a press machine involves several important steps to ensure safe and efficient operation. Here's a general guideline for setting up a press machine:

- **Safety Precautions:** Before starting any setup activities, ensure that proper safety measures are in place. This includes wearing appropriate personal protective equipment

(PPE), such as safety glasses, gloves, and hearing protection. Familiarize yourself with the machine's emergency stop controls and ensure they are easily accessible.

- **Machine Inspection and Maintenance**: Inspect the press machine for any signs of damage or wear. Check for loose connections, damaged wires, or faulty components. Ensure that all safety guards are in place and functioning correctly. If any issues are found, address them promptly and, if necessary, consult with maintenance personnel or the appropriate technicians.
- **Tooling Setup:-** Install the appropriate tooling or dies required for the specific forming operation. Ensure that the tooling is clean, undamaged, and properly aligned with the press machine. Follow the manufacturer's instructions for mounting and securing the tooling, including any necessary adjustments or shimming.
- **Press Parameters:** Configure the press parameters according to the requirements of the forming process. This includes setting the press force, stroke length, speed, and dwell time. Consult the press machine's manual or operating guidelines for the recommended parameters. Adjust the parameters based on the material properties, desired part dimensions, and process considerations.
- **Lubrication:-** Apply the appropriate lubricant to the tooling surfaces and the material being formed. Lubrication helps reduce friction and improve the material flow during the pressing process. Follow the manufacturer's recommendations for the type and application method of the lubricant.
- **Material Handling**: Prepare the material to be formed and ensure it is properly positioned and aligned within the press machine. Verify that the material feed mechanisms, such as rollers or feeders, are functioning correctly and adjusted to the appropriate tension or speed. Pay attention to material thickness, flatness, and orientation to ensure consistent forming.
- **Test Run and Adjustment**: Perform a test run with a small batch of parts to verify the setup and make any necessary adjustments. Inspect the formed parts for dimensional accuracy, defects, or any unexpected issues. If adjustments are required, fine-tune the press parameters, tooling setup, or lubrication to achieve the desired results.

- **Ongoing Monitoring:** During press operation, continuously monitor the forming process and inspect the formed parts at regular intervals. Pay attention to any deviations, such as excessive noise, vibrations, or abnormalities in the formed parts. Address any issues promptly to ensure the quality and efficiency of the press operation.

Remember, these steps are general guidelines, and the specific setup process may vary depending on the press machine model, forming process, and materials involved.

2.6. Die and Punch Set up

Setting up a die and punch on a press machine involves several steps. Here's a general guide to help you:

- **Prepare the press machine**: Ensure that the press machine is clean, lubricated, and in good working condition. Follow any safety procedures and guidelines specified by the manufacturer.
- **Choose the appropriate die and punch set:** Select a die and punch set that matches the desired shape and size for your application. Consider factors such as material thickness, desired hole size, and required tolerances.
- **Secure the die**: Place the die onto the die holder or bolster plate of the press machine. Ensure that it is properly aligned and securely fastened. Use appropriate clamps or bolts to secure the die in place.
- **Mount the punch**: Insert the punch into the ram of the press machine. Make sure it is aligned with the die and properly seated. The punch should fit snugly and not wobble or move during operation.
- **Adjust the press machine**: Set the appropriate stroke length, press speed, and pressure for the desired operation. Refer to the press machine's manual for specific instructions on adjusting these parameters.
- **Test the setup**: Before running production, perform a test run to ensure that the die and punch are properly aligned and functioning correctly. Check for any misalignment or interference that may cause issues during production.

- **Adjust the setup:** If necessary, make any adjustments to the die and punch alignment or press machine settings to achieve the desired results. This may include adjusting the die height, punch penetration depth, or press speed.
- **Safety precautions**: Always follow proper safety precautions when working with press machines. Wear appropriate personal protective equipment (PPE), such as safety glasses and gloves. Keep your hands clear of the die and punch area during operation.

It's important to note that the specific setup process may vary depending on the type and model of the press machine you are using.

2.7. Press Ram Adjustment

Adjusting the press ram is an important step in setting up a press machine. The ram adjustment ensures that the proper stroke length and position are achieved during operation. Here's a general guide on how to adjust the press ram:

- **Safety precautions**: Before making any adjustments, ensure that the press machine is turned off and that all energy sources are locked out. Wear appropriate personal protective equipment (PPE) such as safety glasses and gloves.
- **Reference the machine manual:** Consult the press machine's manual for specific instructions on how to adjust the ram. Different press machines may have varying mechanisms for ram adjustment.
- **Locate the ram adjustment mechanism:** Identify the mechanism responsible for adjusting the ram position. It could be a hand wheel, a control panel, or another type of adjustment mechanism. The location of the mechanism will vary depending on the design of the press machine.
- **Set the desired stroke length:** Determine the required stroke length for your operation. Stroke length refers to the distance the ram travels from its uppermost position to its lowermost position. Adjust the ram mechanism to set the desired stroke length.
- **Position the ram:** Adjust the ram position to ensure that it is aligned with the die and punch set. This alignment is crucial for proper operation and to avoid any misalignment or interference.

- **Test the adjustment:** After making the ram adjustment, perform a test run to ensure that the stroke length and ram position are accurate. Check for any issues such as misalignment, interference, or inadequate stroke length.
- **Fine-tune the adjustment:** If necessary, make further adjustments to achieve the desired stroke length and ram position. Refer to the machine manual for specific instructions on fine-tuning the adjustment.
- **Verify safety features:** Ensure that any safety features associated with the ram, such as emergency stop mechanisms or safety guards, are properly functioning after the adjustment.

Remember, the process of adjusting the press ram may vary depending on the specific press machine you are working with.

Self-Check 2

Instruction: Answer all the questions listed below.

Part-I: Choose the correct answer from the given alternatives

1. _____ is the thick plate mounted on the base.
   A. Bolster plate
   B. Stripers
   C. Punch
   D. Crank shaft
2. Which one is receives energy from the electric motor
   A. Cluck
   B. Flywheel
   C. crank shaft
   D. Ram
3. _____is a tool to produce compressive force by means of fluid.
   A. Power Press
   B. Pneumatic Press
   C. Hydraulic press
   D. Gap Press
4. It is main operating part of the press which works directly during processing of a work piece.
   A. Frame
   B. Punch
   C. Die
   D. Base
5. _____ are very urgent in any mobile system.
   A. Brake
   B. Bolster Plate
   C. Flywheel
   D. Pitman
6. It is also known by its other name upper shoe of die set
   A. Punch
   B. Punch Holder
   C. Die Holder
   D. Bottom stop

Part II: Matching

Column A	Column B
_____1. Discard the work piece outside the press	A. Elasticity
_____2. Type of stripper that used in case of inverted dies	B. Mass production
_____3. Permanent deformation of materials without cracking	C. Knockouts
_____4. Materials regain its initial shape and size after removal of load	D. Stripper
_____5. Purpose of setting up of press machine	E. Plasticity

Part-III: Answer the following questions accordingly.

1. List down the material used for press working operations?
2. How will you select the proper material for press tools?
3. List out the press working terminology used in die set?
4. List the two categories of sheet metal press working operations?
5. Mention the three different ways of working sheet metal in presses?

Operation Sheet 2.1

Operation Title: Setting up the press machine

Purpose: To arranged the press machine for operations like punching ,stamping etc.

Conditions for the operations:

- Safe working area
- Properly operated tools and equipment
- Appropriate working cloths fit with the body

Equipment Tools and Materials:

- Press machine, Stock of metal plate, Die Accessories

Quality Criteria: Assured performing of all the activities according to the procedures

Precautions:

- Wearing proper clothes, eye glass, glove
- Make working area hazard free
- Read and interpret manual which guide you how to use tools and equipment

Steps in doing the task

1. Safety Precautions: includes wearing (PPE), familiarize yourself with the machine's emergency stop controls and ensure they are easily accessible.
2. Machine Inspection and Maintenance (Check for loose connections, damaged wires, or faulty components and safety guards functionality
3. Install the appropriate tooling or dies required for the specific forming operation.
4. Adjust Press Parameters: includes setting the press force, stroke length, speed, and dwell time.
5. Apply the appropriate lubricant to the tooling surfaces and the material being formed.
6. Material Handling: Prepare the material to be formed and ensure it is properly positioned and aligned within the press machine.
7. Test Run and Adjustment: Perform a test run with a small batch of parts to verify the setup and make any necessary adjustments.
8. Ongoing Monitoring: continuously monitor the forming process and inspect the formed parts at regular intervals.

Operation Sheet 2.2

Operation Title: Setting Die set and press punch for operation

Purpose: To make sure the die opening is aligned with the punch or piston.

Conditions or situations for the operations:

- Safe working area
- Properly operated tools and equipment
- Appropriate working cloths fit with the body

Equipment Tools and Materials:

- Press Machine with punch and die set
- Wrenches, Allen wrench

Quality Criteria: Assured performing of all the activities according to the procedures

Precautions:

- Wearing proper clothes, eye glass, glove
- Make working area hazard free
- Read and interpret manual which guide you how to use tools and equipment

Steps in doing the task

1. Prepare the press machine (clean, lubricated, and in good working condition).
2. Choose the appropriate die and punch set (Select a die and punch set that matches the desired shape and size for your application)
3. Secure the die: Place the die onto the die holder or bolster plate of the press machine.
4. Mount the punch: Insert the punch into the ram of the press machine. Make sure it is aligned with the die and properly seated.
5. Adjust the press machine: Set the appropriate stroke length, press speed, and pressure for the desired operation.
6. Test the setup: perform a test run to ensure that the die and punch are properly aligned and functioning correctly.
7. Adjust the setup: include adjusting the die height, punch penetration depth, or press speed.
8. Safety precautions: Wear appropriate personal protective equipment (PPE), such as safety glasses and gloves.

Operation sheet 2.3

Operation Title: Adjusting Press Ram with press opening

Purpose: To Determine How press ram work the press operation safely

Conditions or situations for the operations:

- Safe working area
- Properly operated tools and equipment
- Appropriate working cloths fit with the body

Equipment Tools and Materials:

- Hydraulic Press Machine

Quality Criteria: Assured performing of all the activities according to the procedures

Precautions:

- Wearing proper clothes, eye glass, glove
- Make working area hazard free
- Read and interpret manual which guide you how to use tools and equipment

Steps in doing the task

1. Wear appropriate personal protective equipment (PPE) such as safety glasses and gloves.
2. Refer the press machine's manual for specific instructions on how to adjust the ram..
3. Identify the mechanism responsible for adjusting the ram position, by hand wheel, a control panel, or another type of adjustment mechanism.
4. Determine the required stroke length for your operation and set the desired stroke length.
5. Adjust the ram position to ensure that it is aligned with the die and punch set. This alignment is crucial for proper operation and to avoid any misalignment or interference.
6. Test the adjustment, perform a test run to ensure that the stroke length and ram position are accurate.
7. Fine-tune the adjustment: make further adjustments to achieve the desired stroke length and ram position.
8. Verify safety features: Ensure that any safety features associated with the ram, such as emergency stop mechanisms or safety guards, are properly functioning after the adjustment.

LAP Test

Practical Demonstration

Name: _____ **Date: _____**

Time started: _____ **Time finished: _____**

Instruction: Perform the following tasks

Task 1: Set up Press Machine for punching, bending, drawing and trimming

Task 2: Set up Die set and press punch for operation

Task 3: adjust Press Ram with press opening

Unit Three: Die and Mould Parts

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Die and Mould holes Manufacturing
- Types of Strippers
- Stripper plate and die fit
- Mould and Core cavity
- Die and mould Fit

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Manufacture Die and Mould holes to template size and required angle clearance
- Identify Strippers and types of Strippers
- Fit Stripper plate openings
- Identify Mould Cavity and Core cavity
- Fit die and mould parts

3.1. Die and Mould holes manufacturing

Molding is one of the five core processes involved in rubber and plastic manufacturing, alongside casting, forming, machining, and additive manufacturing.

A molding process uses pressure and heat to fill the cavity of a mold, a rigid frame also known as a matrix. The raw material, typically a pliable one like plastic, glass, or ceramic, is kept under pressure until it solidifies or vulcanizes (i.e., begins to harden). Advantages of molding include greater accuracy, versatility, and efficiency.

Molding is different from casting, which is when a liquid or melted polymer is poured into a mold and solidifies to form the part. No pressure other than gravity is used to fill the mold and form the part. The advantages of casting include durability and a greater complexity of design – however, it may not be possible to cast large parts.

There are different kinds of dies and molds, which can be grouped in the following principal types: forging dies, stamping (pressing) dies, die casting dies and molds for plastics.

In manufacturing a die or mold, the shape and the sizes are the main factors of the degree of difficulty for machining:

- Low degree in case of plane areas, simple shapes, shallow cavities etc.
- Medium, when the shape becomes more complicated, the sizes bigger and the cavities deeper; rams have steep walls, etc.
- High degree in the context of very complex shape, narrow and deep cavities, considerable difference between heights, etc.

Also, difficulty in machining is a function of machinability of the die or mold material.

The key to productive and effective die and mold making is the process planning – the choice of technology of the die or mold manufacturing that, in general, includes machining operations, assembly and finishing works.

Die and Mold Materials

We have already noticed that a die or mould has different movable and stationary parts (clamping elements, springs, pins, bolts, bushings, support pillars, etc.) generally made from different engineering materials, from plastics to cemented carbides.

However, key die or mold parts that act on specific requirements of the die and mold industry usually are from particular materials, which should be emphasized.

Tool Steels

Tool steels relate to a type of steels that, as indicated in its name, is intended first of all for making tools for cutting and forming metals and other materials. Die and mold Manufacturing deal with steel in wide ranges of hardness,

In die and mold manufacturing, there are different machining operations: cutting (milling, drilling, reaming, etc.), abrasive machining (grinding, polishing, honing, etc.) and EDM. Even water jet cutting is used by die and mold makers. However, metal cutting remains to be the predominant method of die and mold production. Dies and molds have different shapes and sizes, varying from small to large. In many cases machining dies and molds requires removing a large amount of material.

3.2. Types of Strippers

Stripper is a plate which is used to strip the metal strip from cutting a non-cutting Punch or die. It may also guide the sheet. The main function of a stripper is to strip the stock material off the punches after each stroke. In addition the stripper may act as a guide for the punches, as well as hold the strip flat and tight while the strip is being worked on.

Strippers can be classified into two groups, **fixed strippers and traveling strippers**. Fixed strippers are simple and easier to make than traveling strippers. Fewer components are required in the construction of fixed strippers when compared to the equivalent traveling strippers. Therefore fixed strippers are economically desirable as far as die construction cost are concerned.

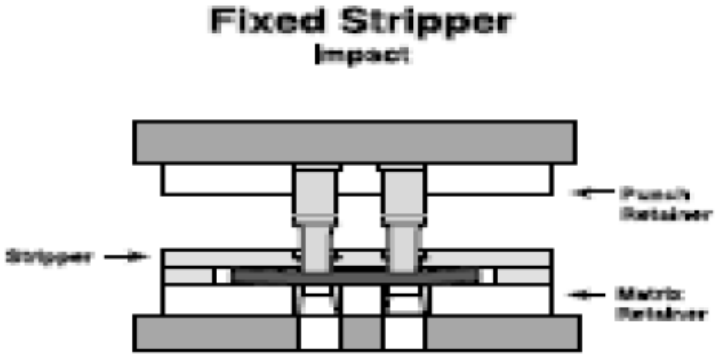


Figure 3.1: Fixed Stripper

A fixed stripper is a steel plate with a clearance slot that allows the part material to pass under it. This plate mounts to the die retainer in a fixed position. Clearance holes cut through the stripper plate let the punches extend through without interference. At withdrawal the part material hits the stripper, preventing it from lifting as punches retract. The part material strips from the end of the punch.

Fixed strippers have several drawbacks. They do not hold the stock strip flat and are unable to absorb impact and snap-thru shock. The result is poor part flatness and premature punch failure

A **spring stripper** is a pressure pad stripper. They are used when it is necessary or desirable to hold the stock material flat (or very nearly flat), or to provide better visibility and access when the tool is mounted in the press. Inverted dies have stationary punches and therefore require traveling pressure pad strippers. Pressure pad strippers are also used for push back applications. There are two main types of spring strippers.

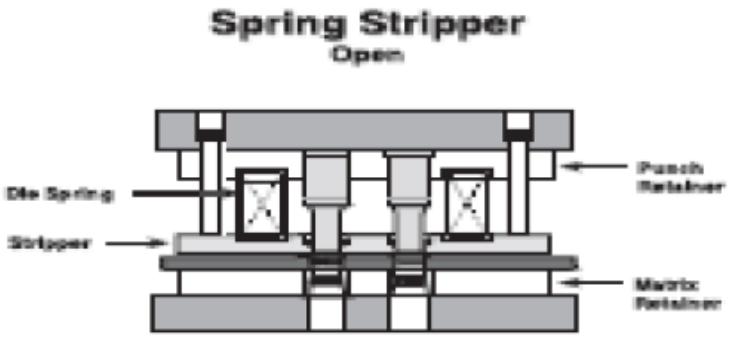


Figure 3.2: Spring stripper

The strip is inserted between die and stripper plate.

3.3. Stripping or Ejection mechanism

Stripping or ejection mechanism is an essential component in various manufacturing processes, such as injection molding, die casting, and stamping. It is responsible for removing the finished part from the mold or tooling after the forming or molding process is complete. The stripping mechanism ensures efficient production and the safe extraction of parts.

The specific design and operation of the stripping or ejection mechanism can vary depending on the manufacturing process, the complexity of the part, and the type of mold or tooling used.

Stripping mechanism is typically comprised of components such as stripper plates, ejector pins, slides, lifters, or other devices that are strategically positioned within the mold or tooling to facilitate the removal of the part.

Stripping force

Stripping force is the force required to eject the strip from the punches, which helps the strip to go forward for the next operation Stripping force will be usually 10 to 20 % of cutting force (CF). For most operations stripping force ranges from 10 to 20% of the cutting force. If the die has more than one punch the stripping force for that die is the sum of stripping forces required for each punch.

Stripping Force for the Blanking and Piercing:

The following factors affect stripping force

- Stock material: Materials, which have high friction, value and materials, which tend to cling, are more difficult to strip.
- Surface conditions of sidewalls: A punch, which has smooth finish on its side, walls strips more easily than a punch, which is not as smooth.
- Distance between punches: More effort is required to strip punches that are close together.
- Area of the stock material to be stripped: Figure shows two piece parts one larger than other.

3.4. Stripper plate and die fit

This plate is also called as stripper plate. In guide plate tool this element is known as guide plate. This plate helps in stripping operation. It not only strips the strip from the punch but the main function of this plate is to guide the punch accurately and maintains the alignment between punch and die. Hence the plate is made with the same care as die. It is mounted on die plate. It is made out of mild steel. In some cases this guide plate is also made out of tool steel. A channel is milled in the plate, which will guide the stock strip.

Stripper is used to discard the work piece out side the press after the completion of cutting or forming operation. After the cutting when punch follows upward stroke the blank is stripped off from the punch cutting edge and prevents it from being lifted along with the punch. This action of prevention is performed by the stripper.

Knockouts

Knockout is also a type of stripper which is used generally in case of inverted dies. After the completion of cutting action, the blank is ejected by the knockout plate out of cutting edge.

3.5. Mould and Core cavity

In press operations, the terms "core cavity" and "mold cavity" refer to different components involved in the manufacturing process, particularly in injection molding and die casting. Let me explain each term::

Core Cavity:- In injection molding or die casting, a core cavity is a part of the mold that creates the internal features or voids of the final product. It shapes the inner dimensions of the product and is typically used to create hollow sections, internal threads, or other complex internal geometries. The core cavity is usually mounted on the core side of the mold and is responsible for forming the interior of the molded or cast part.

Mold Cavity:- The mold cavity, also known as the cavity block, is the part of the mold that forms the external shape of the final product. It defines the outer dimensions, shape, and surface details of the part. The mold cavity is mounted on the cavity side of the mold and is designed to complement the core cavity to create the complete shape of the finished product.

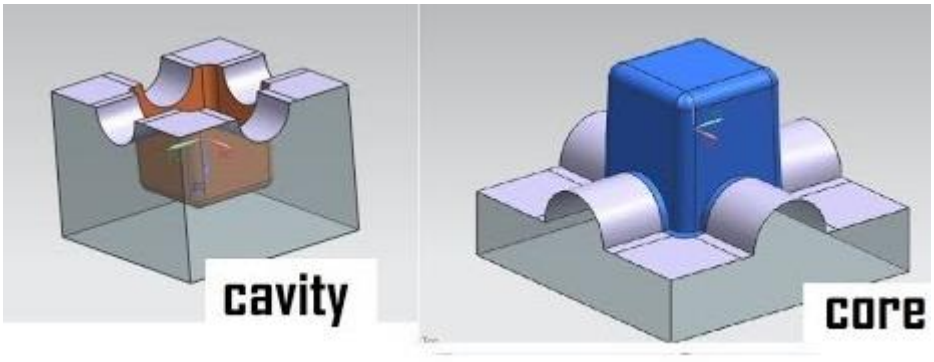


Figure : Core and Mold Cavity

There are several common variations in the design of mold cavities that you should be aware of. These variations are typically based on the specific requirements of the part being manufactured, the material being used, and the production process. Here are a few common variations:

Single Cavity: This is the simplest form of mold cavity design, where a single part is produced in each molding cycle. It is commonly used for low-volume production or when the part is relatively large or complex.

Multiple Cavities: In this design, multiple identical cavities are incorporated into the mold to produce multiple parts simultaneously in each molding cycle. It significantly increases manufacturing efficiency and is suitable for high-volume production.

Family Mold: A family mold consists of multiple cavities that produce different but related parts in a single molding cycle. This design is useful when producing a set of parts that are assembled together or when producing related parts with similar geometries.

Stack Mold: A stack mold is designed with multiple mold cavity layers stacked vertically, allowing for double the production capacity in each molding cycle. It is commonly used for high-volume production of small parts.

Insert Mold: In an insert mold, the mold cavity is designed to include inserts made of a different material or components. These inserts are placed into the mold cavity before the material is injected, resulting in a part with integrated components or features.

Over-molding: Over-molding involves using multiple mold cavities to create a part with multiple layers or materials. The initial mold cavity produces a base part, which is then placed into a secondary mold cavity where additional material is injected to create the over-molded layer.

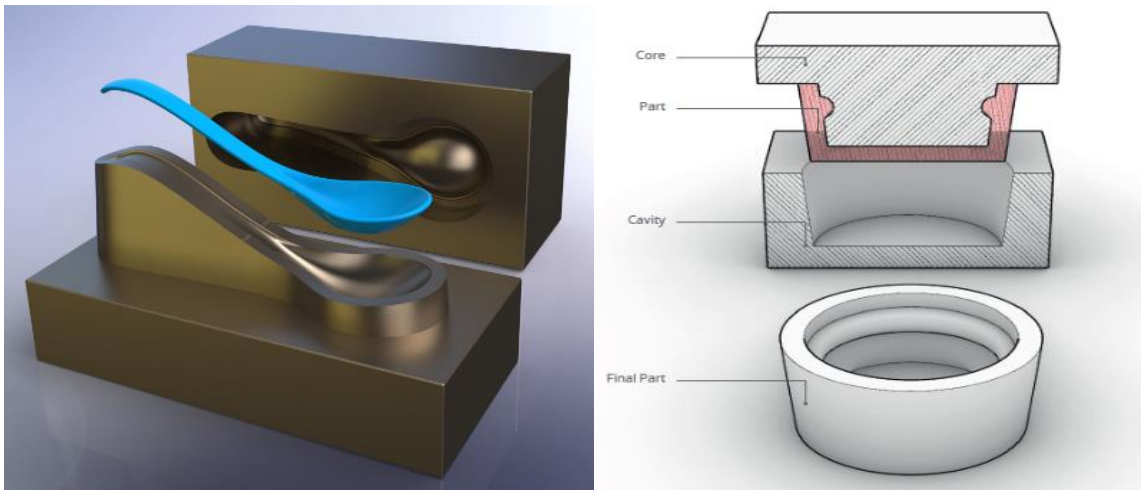


Figure 3.3: Mold cavity and core cavity products

3.6. Die and mould Fit

Fitting a die and mold involves the process of aligning and assembling the various components to ensure proper functionality and precision in the manufacturing process. Here's a general overview of how to fit a die and mold:

Prepare the components: Ensure that all die and mold components are clean and free from any debris, dust, or contaminants. This helps to maintain accuracy during the fitting process.

Review the design and specifications: Familiarize yourself with the design drawings, specifications, and assembly instructions provided for the die and mold components. Understand the intended fit and alignment requirements.

Check for proper mating surfaces: Inspect the mating surfaces of the die and mold components to ensure they are smooth, flat, and free from any damage or irregularities. Any roughness or imperfections can affect the fit and functionality.

Perform initial alignment: Begin by aligning the main components of the die and mold, such as the core and cavity. Use alignment features such as dowel pins, alignment holes, or guiding surfaces to achieve the initial positioning.

Fine-tune the fit: Gradually fit and align the remaining components, such as inserts, slides, and ejector systems, using the specified assembly sequence. Pay attention to the mating surfaces, ensuring they align properly and have the intended clearance or interference fit.

Apply lubrication or release agents: Depending on the materials and process, it may be necessary to apply lubrication or release agents on the mating surfaces to facilitate assembly and prevent sticking or binding.

Perform functional tests: Once the die and mold components are assembled, perform functional tests to ensure smooth operation, proper alignment, and the desired level of precision. This may involve checking for any binding, excessive play, or misalignment.

Make adjustments if needed: If any issues or discrepancies are identified during the functional tests, make necessary adjustments to achieve the desired fit and functionality. This may involve disassembling and reassembling specific components or making minor modifications.

Finalize the assembly: Once the die and mold components are properly fitted and aligned, secure them in place using appropriate fasteners, such as screws or bolts. Ensure that all fasteners are tightened to the specified torque values.

Remember that the fitting process may vary depending on the specific die and mold design, the manufacturing process, and the materials involved. It's important to follow the instructions provided by the die and mold manufacturers and consult with experienced professionals if needed.

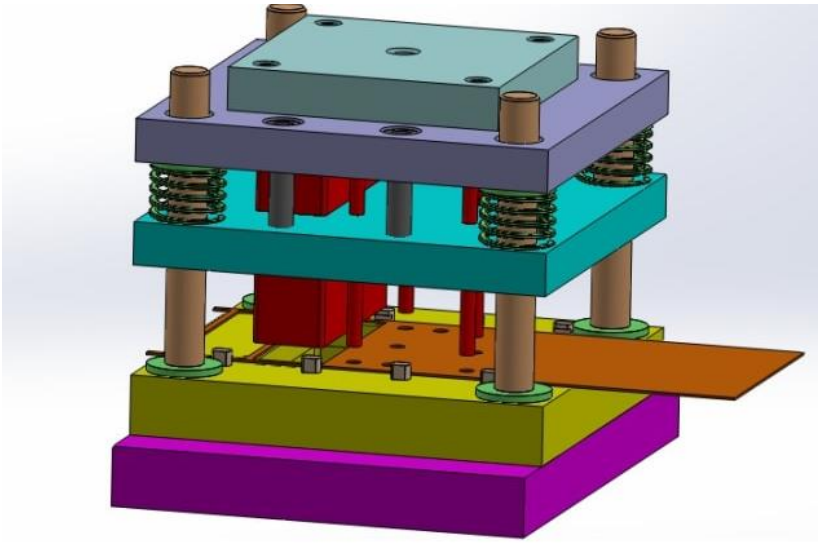


Figure: Mold Assembly and Fitting

Self-Check 3

Instruction: Answer the following questions accordingly

Part I: Choose the correct answer from the given alternative

1. Which one is not types of die and mold groups?
   A. Forging die
   B. Mold for plastics
   C. Die casting die
   D. Welding die
2. In die manufacturing, we can use machining process of:
   A. Milling
   B. Drilling
   C. EDM
   D. All
3. The type of design of mold cavities that produce different but related parts in a single molding cycle.
   A. Single Cavity
   B. multiple cavity
   C. Family cavity
   D. Insert cavity
4. Which one is an example of mould materials?
   A. Aluminum
   B. Brass
   C. Steels
   D. Tools steels
5. Paying attention to the mating surfaces, ensuring they align properly and have the intended clearance or interference fit.
   A. Fine-tune fit
   B. Tune-box fit
   C. Measure-tune fit
   D. Modify-tune fit

Part II: Matching

	Column A	Column B
_____1	Plate which is used to cut product from Punch or die	A. Knockouts
_____2	Ensures efficient production and safe extraction of parts	B. Core Cavity(male)
_____3.	type of stripper which is used generally in case of inverted dies	C. Stripper
		D. Boosters
_____4	internal features or voids of the final product	E. Mold Cavity(female)
_____5	forms the external shape of the final product	F. stripping mechanism

Part III: Write short answer for the following questions

1. List the factors affect stripping force
2. List types of strippers?
3. Write at least four steps fitting the die and mold?

Unit Four: Set up of Mould and Moulding Machines

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Movable and Fixed half of Mould alignment
- Ejector Systems and adjustment
- Punch and die clearances Angle and applications
- Maximum mould opening
- Cycle time and Temperature

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Clamp Movable and Fixed half of Mould Based onMachine Operations
- Ejector Systems and adjustment
- Punch and die clearances Angle and applications
- Adjust the Maximum Mould opening
- Adjust Cycle time and Temperature

4.1. Movable and Fixed half of Mould alignment

Alignment refers to the way the fixed half and moving half of a mold are locked together. Interlocking makes use of angled surfaces on both halves of the mold which engage when the mold is closed.

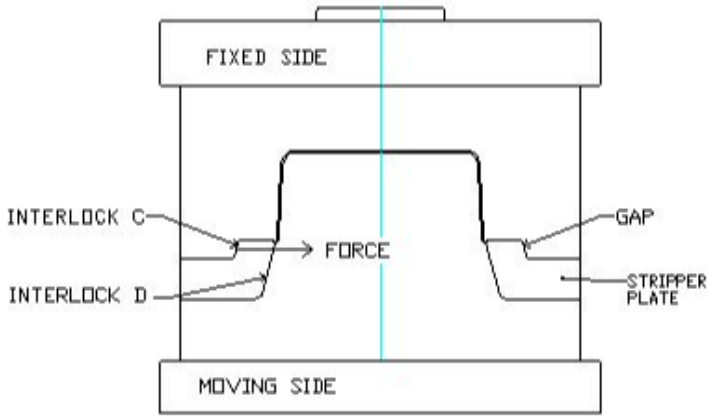


Figure 4.1: Moving and Fixed half of mould

4.2. Ejector Systems and adjustment

Facilities are provided on the injection machine for automatic actuation of ejector system and this is situated behind the moving platen. Because of this, the mould's ejector system will be most effectively operated if placed in the moving half of the mould. There by the core always most satisfactorily is locatled in the moving half.

The ejector system consists of

- Ejector grid
- Ejector plate assembly
- Ejector.

a) Ejector grid

The ejector grid is that part of the mould which supports the mould plate and provides a space in to which the ejector plate assembly can be fitted and operated. The grid normally consists of a back or bottom plate on to which a number of conveniently shaped support blocks are mounted

b) Ejector plate assembly

The ejector plate assembly is that part of the mould to which the ejector element is attached. The assembly is contained in a pocket formed by the ejector grid, directly behind the mould plate.

The assembly consists of an ejector plate, a retainer plate, and an ejector rod. One end of the ejector rood is threaded and it is screwed in to the ejector plate. The ejector rod is guided in an ejector bush fitted in the back plate. Now in new machines, the rods are directly connected to the machine itself. The back plate is relieved in place of bush.

The moving half or ejector half of the mould is mounted on the moving platen of the machine. The actuating rod can be adjusted for various alternative ejector strokes. When the mould opens, as the ejector rod as some point of the stroke, strikes the actuating rod. The entire ejector assembly continue to move to left until the opening stroke is complete. This relative movement between the ejector plate assembly and the mould plate is necessary to operate the ejector element. In normal arrangement for smaller type of ejection system, the machine's actuator rod passes through the center of the moving platen. On larger machines, several actuator rods are used so that a balanced force can be applied to the ejector plate. In this case, the actuator rods push directly on to the ejector plate. A separate method of guiding and supporting the ejector plate assembly is necessary when ejector rod bush are not incorporated.

c) Ejectors

The basic ejection techniques are as follows.

- Pin ejection
- Sleeve ejection
- Stripper bar ejection
- Blade ejection
- Valve ejection
- Air ejection
- Stripper ring ejection.
- Stripper plate ejection

4.3. Punch and die clearances Angle and applications

In the context of metal stamping or press operations, the **punch and die clearances** refer to the gap or space between the punch (also known as the upper tool) and the die (also known as the lower tool) during the forming process. The punch and die clearances play a crucial role

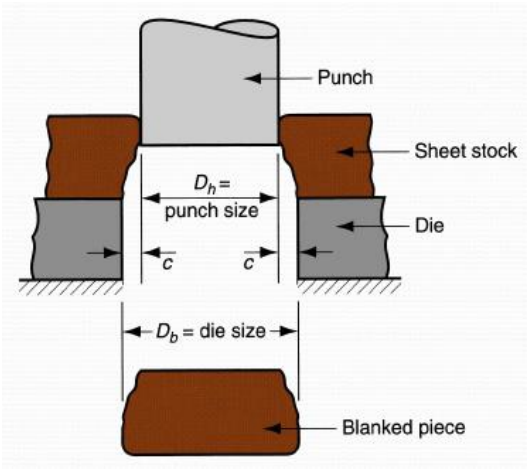
in determining the quality of the formed parts and the overall performance of the stamping operation.

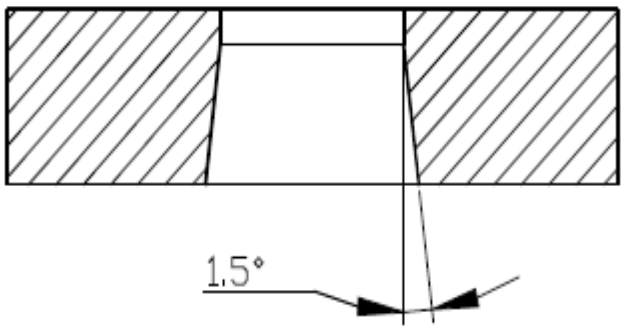
Angle clearance, also known as shear clearance or relief angle, is a specific type of clearance that is applied to the cutting edges of the punch and die. It is the angle formed between the face of the punch or die and a line perpendicular to the direction of the material flow. The angle clearance is designed to reduce friction and prevent galling or sticking of the material during the cutting or shearing process.

Here are some key considerations regarding punch and die clearances and angle clearance:

- **Punch and die clearances:** The punch and die clearances are typically set to ensure proper material flow and prevent issues such as excessive burrs, cracking, or excessive wear of the tools. The clearance is determined based on factors such as the material type, thickness, and hardness, as well as the desired part geometry and tolerances.
- **Clearance calculation:** The clearance between the punch and die is usually expressed as a percentage of the material thickness. The specific clearance values depend on various factors, including the material type and thickness, tooling materials, and the desired part quality. Clearance values are typically provided by tooling manufacturers or can be determined through empirical testing and experience.
- **Angle clearance:** The angle clearance is applied to the cutting edges of the punch and dies to reduce friction and improve the shearing process. The angle clearance is usually between 2 to 5 degrees, but it can vary depending on the material type, thickness, and other factors. It is important to maintain precise and consistent angle clearance to ensure uniform cutting and minimize tool wear.
- **Material considerations:** Different materials may require different clearance values. Softer materials, such as aluminum or plastic, generally require smaller clearances, while harder materials, like stainless steel or hardened steel, may require larger clearances to accommodate their properties

It's important to note that punch and die clearance is just one aspect of the overall stamping process. Other factors such as press tonnage, feed rate, lubrication, and tool sharpness also influence the quality of the formed parts.





Die size determines blank size *Db* Punch size determines hole size *Dh c* = clearance

Importance of Cutting Clearance

Proper punch and die clearance ensures that the material is cleanly cut or formed without excessive force, reducing wear on the tools and minimizing the risk of part defects. Insufficient clearance can cause shearing problems, while excessive clearance can lead to imprecise cuts or bending.

4.4. Maximum mould opening

The maximum mold opening refers to the maximum distance or stroke that the mold can be opened during the operation of an injection molding machine. It determines the size and shape of the parts that can be produced using that particular mold. Here are some key points to understand about the maximum mold opening:

- Part size and geometry
- Machine and mold specifications
- Mold design considerations
- Machine capacity and clamp force
- Part ejection and mold maintenance

4.5. Cycle time and Temperature

In press machine operations, cycle time and temperature are also important parameters that can significantly impact the efficiency and quality of the production process. While the

specific details may vary depending on the type of press machine operation, here are some general considerations regarding cycle time and temperature:

Cycle time in press machine operations refers to the total time required to complete one full cycle of the operation, including the loading, forming, and unloading stages. It determines the production rate and overall efficiency of the process. Minimizing cycle time is essential for maximizing productivity and reducing costs.

Some factors influencing cycle time in press machine operations include:

- **Material and part characteristics:** The type and properties of the material being processed, such as its hardness, thickness, and formability, can impact the cycle time. Additionally, part complexity and size play a role in determining the time required for forming and ejection.
- **Machine setup**: The configuration and setup of the press machine, including the tooling and die arrangement, can affect the cycle time. Efficient tool changes, quick die setups, and proper alignment of the tooling can help reduce cycle time.
- **Process optimization**: Fine-tuning process parameters like press speed, stroke length, dwell time, and dwell pressure can optimize the cycle time. However, it is essential to balance the cycle time with the desired part quality and the limitations of the press machine.

Self-Check 4

Instruction: Answer all the questions listed below.

Part II: Write True if the statement is correct and write False if incorrect

1. Cycle time determines the production rate and overall efficiency of the process
2. Angle clearance between punch and dies increase friction and improve the shearing process
3. Angle clearance, also known as shear clearance or relief angle
4. Ejector plate assembly consists of an ejector plate, a retainer plate, and an ejector rod.

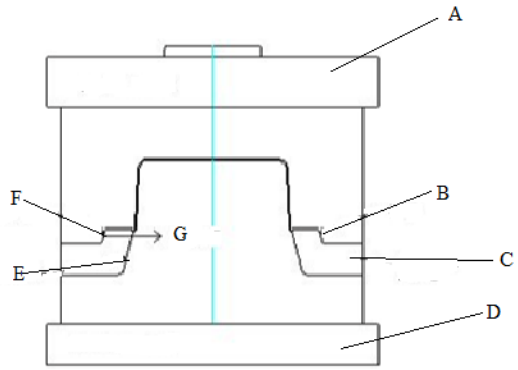
Part II: Matching

	Column A	Column B
_____1	Part of the mould to which the ejector element is attached	G. Ejector grid
_____2	Support the mould plate and provides a space	H. Fine-tuning
_____3.	Ejector technique	I. Mould Opening
_____4	factors influencing cycle time in press	J. Valve Ejection
_____5	Part size and geometry	K. Ejector plate assembly

Part III. Write short Answer for the following questions

1. List Basic ejection techniques?
2. Write the key considerations regarding to punch and die clearance and angle clearance?
3. Mention the importance of cutting clearance calculations?
4. List the key point to be understood about the maximum mould opening?

Part IV: Write the name of mould part that described by Letter A-G on fig bellow?



Operation sheet 4.1

Operation Title: Aligning the movable and fixed halves of a mold

Purpose: to ensures mold assembly, ensuring proper functionality and accurate part production

Conditions or situations for the operations:

- Safe working area
- Properly operated tools and equipment
- Appropriate working cloths fit with the body

Equipment Tools and Materials:

- Moving and Fixed Half of Mold, Wrenches, Bolts, Measuring tools

Quality Criteria: Assured performing of all the activities according to the procedures

Precautions:

- Wearing proper clothes, eye glass, glove
- Make working area hazard free
- Read and interpret manual which guide you how to use tools and equipment

Steps in doing the task

1. Clean the mold halves: (clean and free from any debris, lubricants, or contaminants)
2. Insert alignment features: (include alignment pins, dowel holes, or alignment blocks).
3. Carefully bring the movable half of the mold into alignment with the fixed half and align.
4. Check alignment: visually inspect the alignment to ensure that they are properly aligned.
5. Conduct a fit check by temporarily securing the mold halves together without fully tightening the fasteners.
6. If any misalignment is detected during the fit check, make the necessary adjustments.
7. Finalize the alignment: fully tighten the fasteners, such as bolts or clamps, to secure the movable and fixed halves together
8. Conduct functional tests: check the movement of slides, ejector systems, or any other moving components within the mold.
9. Verify parting line: Double-check the parting line to ensure it is consistently aligned along the entire mold perimeter.

Unit Five: Mould and press machines Operations

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Press Working Processes
- Press Machine start-up and unloading procedures
- Stripping or ejection mechanism
- Calculating Cutting Forces

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Perform Press Working Processes for safe Operations
- Follow the press Machine start-up and unloading procedures
- Fit Stripping/ejection mechanism according to work specification
- Explain Cutting Forces based on press Operations

5.1. Press Working Operations

Press working refers to operations that involve deformation of metal work pieces to the desired size and shape by applying pressure or force. Press working operations are mainly divided into two categories – cutting and forming. These operations can be divided into hot working and **cold working.**

The use of machinery to shape metal provides us with an incredible variety of products, including car body panels, paper clips, cans, etc. As a category, metal forming includes numerous operations.

Press Working Operations or Sheet Metal Operations can be performed on the sheet and they are as follows.

- Punching
- Blanking
- Deep drawing
- Bending
- Notching
- Perforating
- Trimming
- Shaving
- Slitting

Press Working Operations or Sheet Metal Operations:

The physical removal of the material from the sheet, if the required shape of the component is obtained called as Cutting or Shearing operation.

Here, **Punching** operation and **Blanking** operation comes under Cutting or Shearing Operations whereas **Deep drawing** and **bending** operations come under Forming Operations.

Cutting Operations:

The cutting operations which come under Sheet Metal Operations are

Punching Operation

Blanking Operation

For both punching and blanking operations, the punch and die combination will be used as tools.

Punching Operation:

When the force is applied by using the punch on to the sheet, the cutting or shearing action will be taking place in the sheet producing a piece/blank leaving a hole.

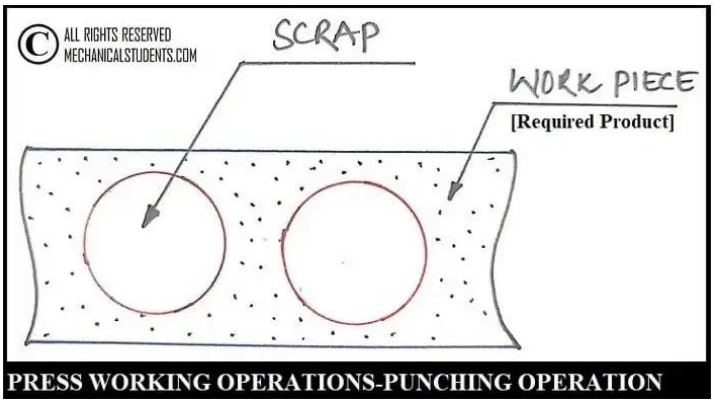


Figure 4.1: Punching Operations

In punch and die working, if the hole produced in the sheet is useful, it is called Punching or Piercing operation. To ensure that the cutting or shearing action is taking place on the sheet, the Punch size is always less than the Die size.

In punching operation, the punch size is made equal to hole size and clearance is provided on the die and also in punching operation, the shear is provided only on the Punch.

Note:

- Punch Size < Die Size(Basic Requirement)
- Punch Size = Hole Size. (Needed)
- Clearance → Die.
- Shear → Punch.

Blanking Operation:

When the force is applied by using the punch on to the sheet, the cutting or shearing action will be taking place in the sheet producing a piece/blank.

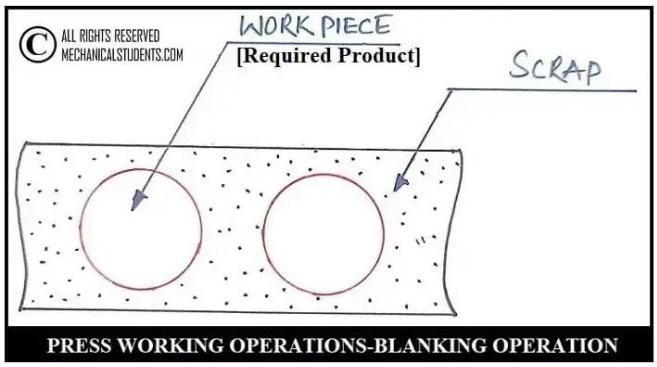


Figure 5.2: Blanking Operation

In punch and die working, if the Piece/blank produced in the sheet is useful, it is called a **Blanking operation.**

In blanking Operation, the die size is made equal to blank size and clearance is provided on the Punch and also the shear is provided on the die.

Note:

- Die Size = blank Size.
- Clearance → Punch.
- Shear → Die.

How Shearing and Tearing is taking place during Cutting Operation?

When the force is applied by using the punch onto the sheet, the elastic **compression** is taking place on the top side of the sheet and **Elastic Elongation** will be taking place at the bottom of the sheet.

Due to the Compression and Elongation, the sheet metal present between the punch and die is experiencing Shear stresses.

Due to the continuous application of the load, the shear stresses induced will become greater than or equal to Ultimate Stress of the sheet metal so that **shearing and cracking** are started taking place at the edges of punch and die and it is propagating in their respective directions and meeting somewhere in the middle cross-section.

Hence the piece will get separated from the sheet leaving a hole in the sheet. From the above, the mechanism by which cutting action taking place is the **Shearing and Tearing.**

Application of Punching and Blanking Operations:

Punching Applications: Electronic Boards Printed Circuit Boards, etc.

Blanking Operations: Coins etc.

Other Applications:

- Automobile industries.
- Kitchen appliances.
- Aerospace industries.
- Mass production of sheet metal components.
- Forming Operations

The Forming operations which come under Press Working Operations are

- Deep Drawing operation
- Bending Operation
- Both of these Forming Operations are explained below.

Deep Drawing Operation:

It is a Sheet Metal forming process in which a sheet metal blank is radially **drawn** into a forming die by the mechanical action of a punch.

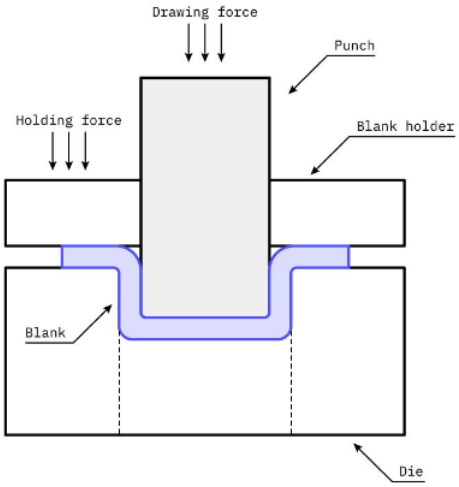


Figure 5.3: Before the application of Punch Force

Deep drawing is mainly used for producing Cup-shaped components.

Example: Most of the utensils used in the kitchen are produced by using Deep Drawing Operation only.

In Deep drawing operation, when the force is applied by using the punch, the sheet is simply pulled into the die without any shearing action and taking the shape and size same as that of the die. But, the edges of the blank will be lifted upwards and produce the folding or wrinkles on the deep drawing component. This will make the appearance of the component very bad. To avoid the lifting of the edges of the blank and minimize drawing force, the optimum amount of the Blank Holder Force(BHF) applied is one-third of the Drawing force. i.e. **BHF = P/3.**

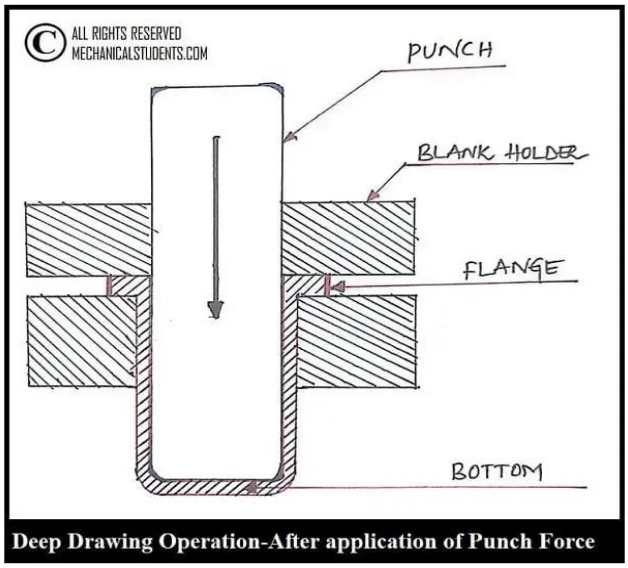


Figure 5.4: After Application of Punch Force

The BHF can be applied by using spring-loaded stripper plate to maintain it until the punch is completely withdrawn from the component so that the component can be always leftover inside the die and it can be removed from the die using ejector pins.

Applications of Deep Drawing Operation:

Cookware, Aluminum cans, and kitchen sinks.

Bending Operation:

It is used for bending the sheet into the required angle.

Types of Bending Operations:

- Edge Bending
- V Bending
- U Bending

Edge Bending:

- Performed with a Wiping die
- These dies are complicated and costly.
- It is for high Production.

Below drawn figure is an example of Edge Bending.

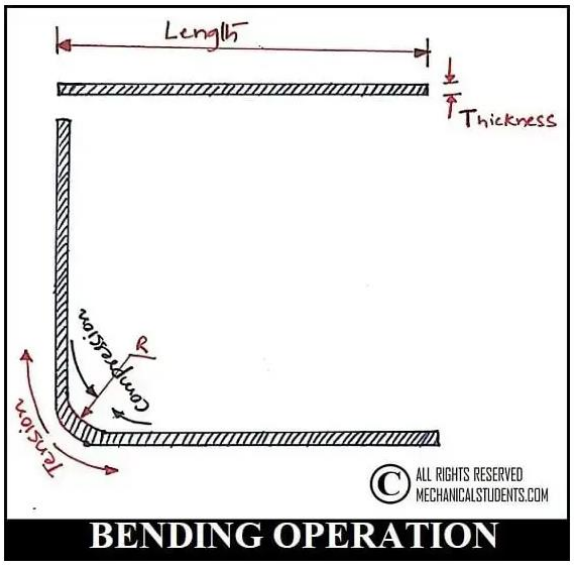


Figure 5.5: Bending Operation illustration

- Straining sheet metal around a straight axis to take a permanent bend is called Bending Process.
- Metal on the inside of a neutral plane is compressed, while metal on the outside of a neutral plane is stretched.

V Bending:

Below is the figure for V shaped Bending.

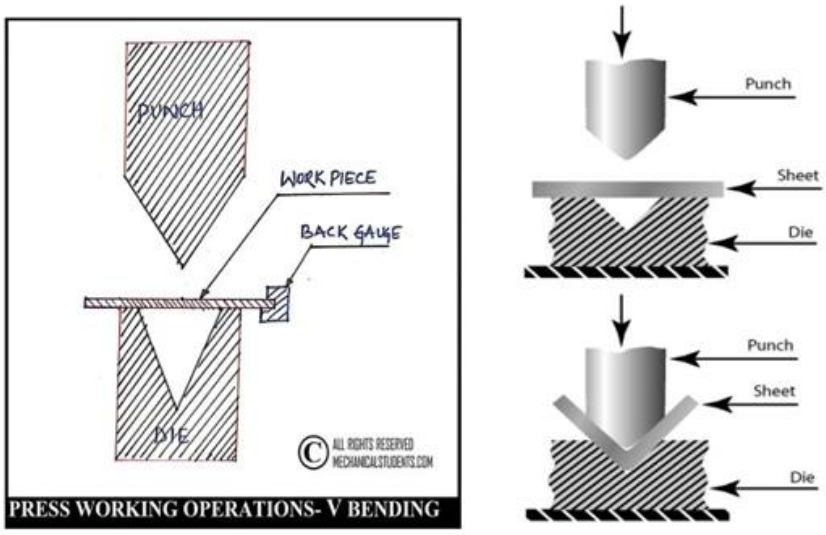


Figure 5.6. V Bending Operation Illustrations

- Performed with a V-shaped die

- V-Dies are simple and Inexpensive
- It is for Low Production

U Bending:

This bending operation is similar to V Bending operation but the V shaped Punch and die are replaced with U shaped punch and die. The similar figure as of above can be drawn by changing V shape to U shape.

Applications of Bending Operation:

The applications of Bending Operation is as follows

- Drawing board clip
- Tube light frame
- Air conditioning duct etc.

Press Working Operations:

Notching Operation:

It is an operation by which metal pieces are cut from the edge of a sheet or blank is called a Notching operation.

Perforating Operation:

It is an operation by which multiples holes of smaller size are made in sheet metal called perforating operation.

Trimming Operation:

It is a process of removing unwanted material from the surface of the workpiece called a Trimming operation.

Shaving Operation:

The process of removing a thin strip of metal from the blanked part is called as shaving. It can be done after trimming only so that the strips which are not removed by the trimming process are removed by the shaving process.

It is an operation of making incomplete holes in a workpiece called as slitting operation.

Curling Operations

Curling tools curl the edges of a drawn shell to provide strength and rigidity. The curl may be applied over a wire ring for increased strength. You may have seen the tops of the sheet metal piece curled in this manner. Flat parts may be curled also. A good example would be a hinge in which both members are curled to provide a hole for the hinge pin.



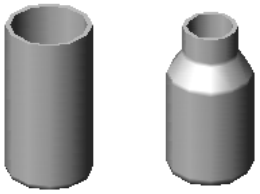
Bulging operations

Bulging tools expand the bottom of the previously drawn shells. The bulged bottoms of some types of coffee pots are formed in bulging tools.



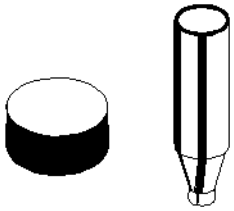
Swaging operations

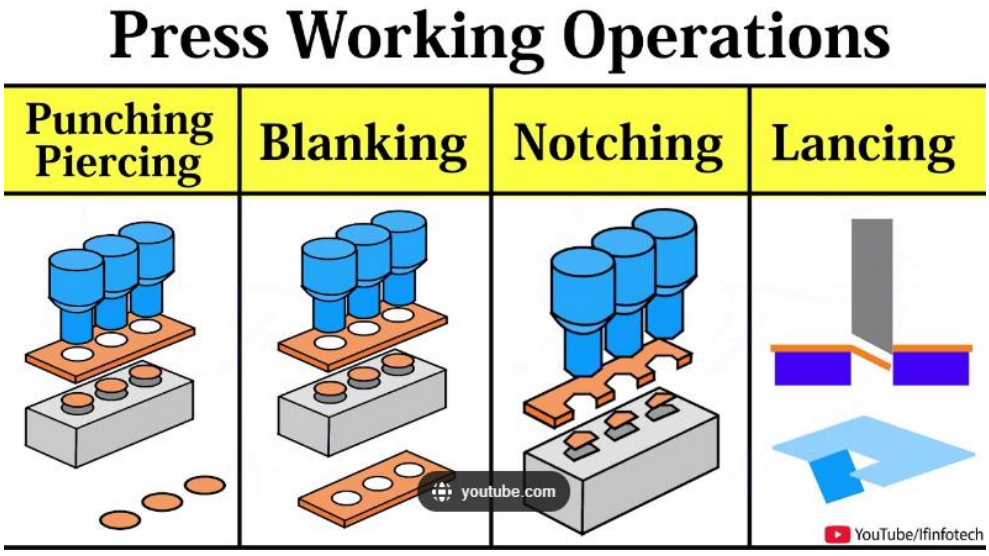
In swaging operations, drawn shells or tubes are reduced in diameter for a portion of their lengths.



Extruding operations

Extruding tools cause metal to be extruded or squeezed out, much as toothpaste is extruded from its tube when pressure is applied. Figure shows a collapsible tool formed and extruded from a solid slug of metal.





5.2. Calculating Cutting Forces

Cutting force is the force which has to act on the on the stock material in order to cut out the blank or slug. This determines the capacity of the press to be used for particular tool. The first step in establishing the cutting force is to determine the cut length area. The area to be cut is found by multiplying the length of cut by stock thickness.

Formula for calculating the cutting force:

$$Cutting\ Force = LxSxTmax$$

L = Length of periphery to be cut in mm

S = Sheet thickness in mm

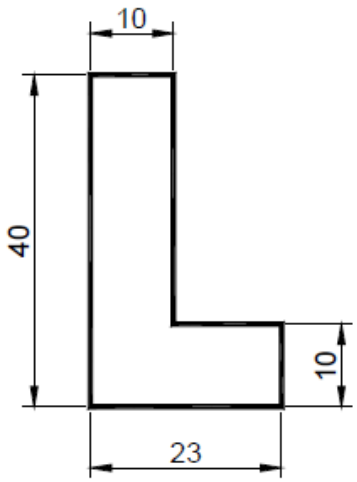
T_{max} = Shear strength in N/ mm2. , (taken from table)

= 80% of tensile strength (σ max)

Example:- Calculate the press force required to produce the following component.

Sheet Thickness 2mm.

Material is brass



Solution

Cutting force = l x s x T max
= 126 x 2 x 400
= 100800 N
= 100.8 KN

Press force = Cutting force + stripping force
= 100800 + 20% 100800
= 120960 N
= 120.960 KN.

5.3. Punching force calculation

The formula below is commonly used to estimate cutting forces in a press machine especialy for punching: $Fc = Kc \times Ae \times Ap$

Where:

Fc is the cutting force
Kc is the specific cutting force (a material property)
Ae is the effective chip area
Ap is the unreformed chip cross-sectional area

Example Calculation:

Let's consider an example where you want to calculate the cutting force for a punching operation in a press machine. Here are the given parameters:

Material: Mild Steel
Specific Cutting Force (Kc): 400 MPa
Punch Diameter (D): 20 mm
Material Thickness (t): 3 mm

Step 1: Calculate the unreformed chip cross-sectional area (Ap):

$Ap = \pi \times (D/2)^2$
$= 3.14 \times (20/2)^2$
$= 314\ mm^2$

Step 2: Calculate the effective chip area (Ae):

$Ae = Ap \times (t / (t + 0.5 \times D))$
$= 314 \times (3 / (3 + 0.5 \times 20))$
$= 251.2$ mm2

Step 3: Calculate the cutting force (Fc):

$Fc = Kc \times Ae \times Ap$
$= 400 \times 251.2 \times 314$
$= 31{,}523.2$ N (or 31.5 kN)

Let's say we have a sheet metal component with the following dimensions and material properties:

Material: Mild Steel
Tensile Strength (σ): 300 MPa
Yield Strength (σy): 250 MPa
Sheet Metal Thickness (t): 2 mm
Component Length (L): 100 mm
Component Width (W): 50 mm
Bend Radius (R): 5 mm

To calculate the bending force required to form this component, we'll use the formula:

$Fb = K \times \sigma \times t \times (L - R)$

Step 1: Calculate the Bending Force:

We need to determine the value of the factor K. For a typical V-bending operation, K is often assumed to be around 0.33.

$K = 0.33$
$Fb = 0.33 \times 300\ MPa \times 2\ mm \times (100\ mm - 5\ mm)$
$= 19.8$ kN

Self-Check 5

Directions: Answer all the questions listed below.

Part-I: Choose the correct answer from the given alternatives

1. Which of the following help in obtaining correct alignment of the punch holder with the die shoe?
   a. Guide posts
   b. Stops
   c. Pilot
   d. None of the above
2. The following helps in freeing the punch from the scrap in the return stroke?
   a. Knock out pins
   b. Stripper
   c. Pilot
   d. Punch plate
3. Following is not a shearing operation.
   a. Blanking
   b. Piercing
   c. Punching
   d. Forming
4. Which of the following is a drawing operation?
   b. Embossing
   c. Curling
   d. Trimming
   e. All of the above

Part II: Write True if the statement is correct and write False if incorrect.

1. Piercing punch always equal to Pierced hole size
2. The size of Die is usually equal hole size plus total clearance.
3. Blanking punch size sometimes equals Blank size minus total clearance
4. Die size is determined as the equal size of Blank size

Part III: Write Short Answer for the following Questions

1. Categorize sheet metal cutting operations under Forming and Cutting operations?
2. List the types of Bending Operations?
3. White the applications of Bending Operations?
4. Write application of punching and blanking Operations?

Operation Sheet 5.1

Operation Title: Performing punching, deep drawing and trimming operations

Purpose: To determine the piercing operation skill by using hydraulic press machine safely

Conditions for the operations:

- Safe working area, wear PPE, Appropriate working cloths fit with the body

Equipment Tools and Materials:

- Press machine , Stock of plate materials
- Die Accessories, Clamps, Bolts and Nuts
- Mild steel Plate thickness 5mm - 100mm

Quality Criteria: Assured performing of all the activities according to the procedures

Precautions:

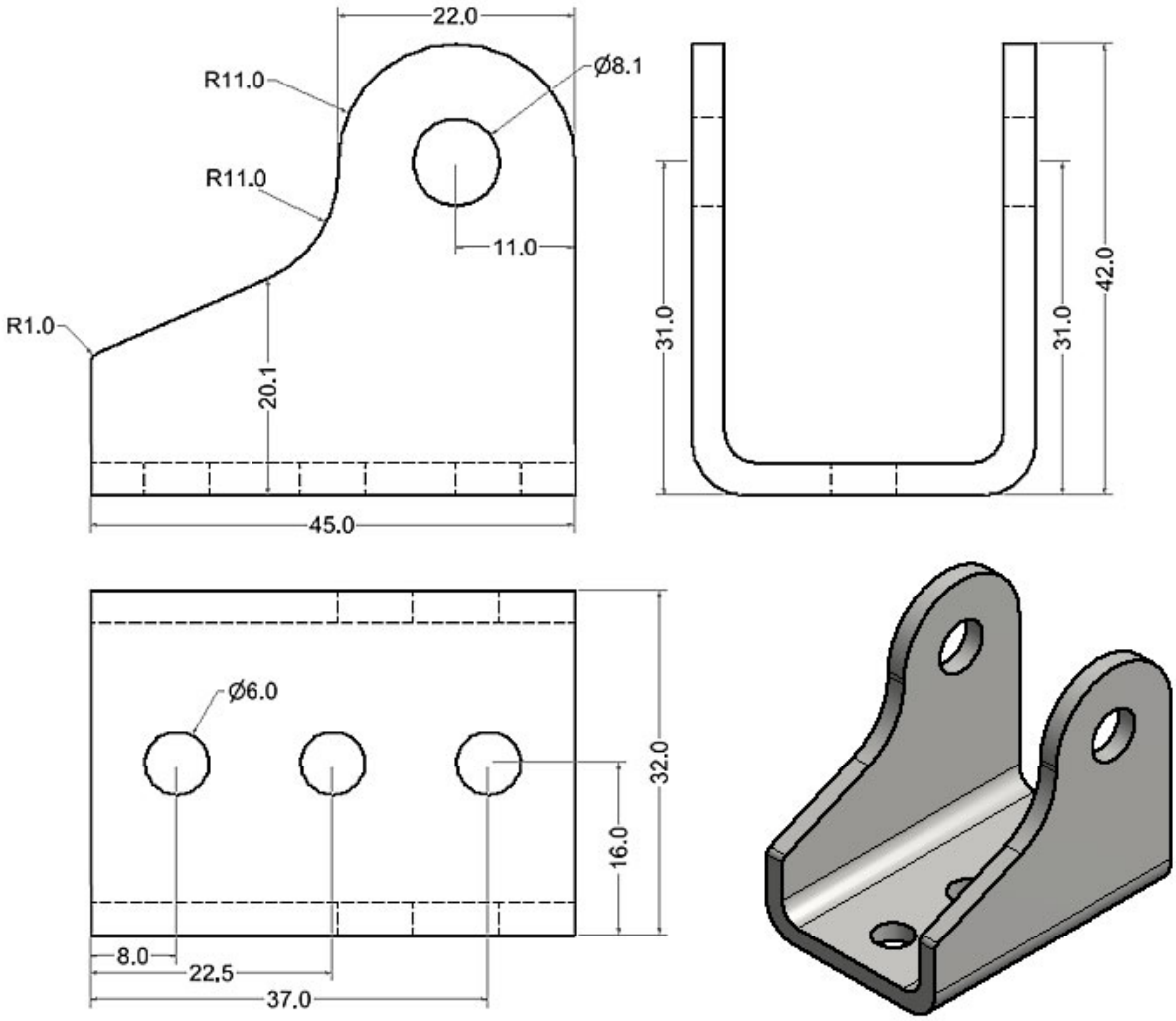
- Wearing proper PPE, Make working area hazard free
- The die should be properly clamped to the bed of the machine and it is not disturbed during the process, The punch is properly fixed to the ram of the machine.
- The load should be applied uniformly on the bar, The bar should be held properly on the die block

Procedures in doing the of the punching, Blacking drawing and bending process

1. Material preparation: cutting the material into the desired size and shape, removing any burrs or sharp edges, and ensuring it is clean and free from contaminants.
2. Tooling setup: Install the appropriate punch and die set into the press machine.
3. Material positioning the material to be punched on the press machine's work surface, aligning it with the punch and die set and clamping
4. Adjust the press machine's settings according to the material type, thickness, and desired punching result, such as press speed, stroke length, dwell time, and dwell pressure
5. Perform a trial run to ensure proper alignment, positioning, and functionality of the tooling..
6. Punching, balking, drawing and bending operation: apply the force through the punch/ram, which penetrates the material and creates the desired hole or shape.
7. Ejection: the press machine's mechanism or the operator manually retracts the punch from the material.

8. Inspection and quality control: Check for any defects, dimensional variations, or other issues that may impact the part's functionality
9. Repeat process: If multiple punches are required on the same part or if there are additional parts to be punched, repeat the process by repositioning the material and initiating the punching operation again.

Component to be produced:



Operation Sheet 5.2

Operation Title: Performing Piercing Operations by hydraulic press machine

Purpose: To determine the piercing operation skill by using hydraulic press machine safely

Conditions for the operations:

- Safe working area
- Properly operated tools and equipment
- Appropriate working cloths fit with the body

Equipment Tools and Materials:

- Press machine , Stock of plate materials
- Die Accessories, Clamps, Bolts and Nuts

Quality Criteria: Assured performing of all the activities according to the procedures

Precautions:

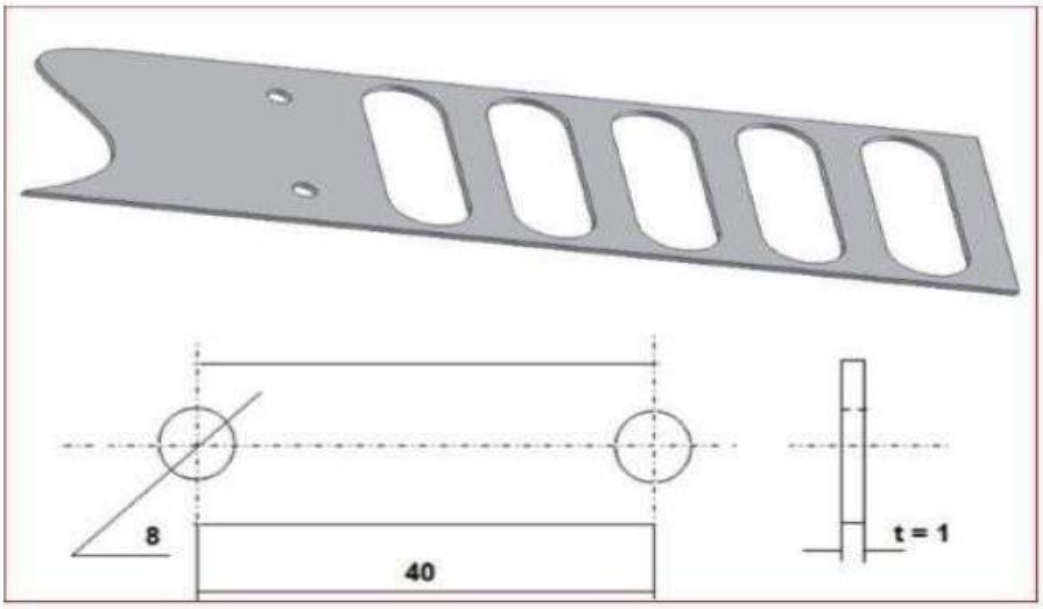
- Wearing proper PPE
- Make working area hazard free
- The die should be properly clamped to the bed of the machine and it is not disturbed during the process.
- The punch is properly fixed to the ram of the machine.
- The load should be applied uniformly on the bar.
- The bar should be held properly on the die block.

Procedures in doing the task

1. Fix the punch to the ram of the press.
2. Fix the die on the bed of the machine using clamps, bolts and nuts.
3. Place the blank of required size between the die and punch.
4. Apply pressure hydraulically on the blank through the punch so that piercing will takes place at the first station.
5. Note down the reading of the pressure gauge which directly gives the force required to perform the piercing operation.
6. Move the blank in forward direction until it touches the stopper on the die.

7. Again apply pressure hydraulically on the blank so that piercing punch blanks out a portion of the metal in which already two holes had been pierced. At the same time piercing operation takes place at the first station.
8. Note down the reading of the pressure gauge which directly gives the force required to perform the piercing and blanking operations.
9. Difference of the two readings gives the force required to perform blanking operation.
10. Compare the values with the theoretically obtained values.
11. The process may be repeated to produce the components in mass production.

Component to be produced:



LAP Test

Practical Demonstration

Name: _____ **Date: _____**

Time started: _____ **Time finished: _____**

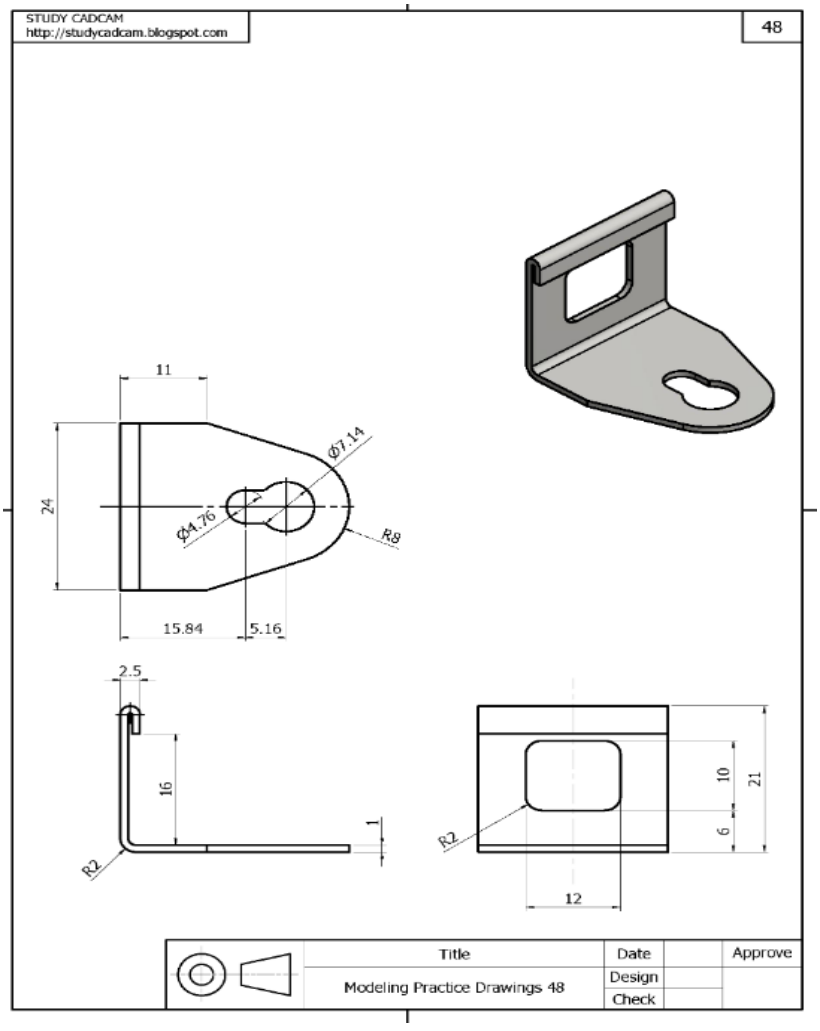
Instruction: Perform the following tasks

Task 1: Perform Trimming Operations

Task 2: Perform Punching or piercing Operations

Task 3: Perform Bending Operations

Task 4: Perform Curling Operations



Unit Six: Product Quality

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Products Inspection mechanism
- Deviations and Faults

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Perform Products Inspection mechanism
- Explain Deviations and faults in press operation

6.1. Products Inspection mechanism

The quality of the produced components is influenced by several factors related to the press machine, tooling, process parameters, and material characteristics. Here are some key considerations for achieving good product quality in press operations:

- **Machine Capability**: The press machine should have the required capacity, rigidity, and precision to ensure accurate and consistent forming of components. Regular maintenance and calibration of the machine are important to maintain its performance.
- **Tooling Design and Maintenance:** Proper tooling design is crucial for achieving the desired component shape and dimensions. The tooling should be designed to minimize deflection and wear. Regular inspection and maintenance of the tooling, including sharpening or replacement of worn parts, are essential to maintain product quality.
- M**aterial Selection and Preparation:** The material used for forming should be of suitable quality and meet the required specifications. Proper handling, storage, and preparation of the material, including cleaning and lubrication, can contribute to better product quality.
- **Process Parameters Optimization:** The process parameters, such as press force, speed, and dwell time, should be optimized to ensure consistent and controlled forming. Understanding the material behavior and conducting trials to determine the optimal parameters can help achieve better product quality.
- **Quality Control and Inspection**: Implementing quality control measures, such as in-process inspections and final product checks, can help identify and rectify any deviations or defects during the press operation. This may involve visual inspection, dimensional checks, or non-destructive testing techniques.
- **Monitoring and Feedback**: Monitoring process variables, such as force, displacement, or strain, can provide real-time feedback on the forming process. This information can be used to adjust parameters or detect any issues that may affect product quality.
- **Operator Training and Skill:** Proper training and skill development for operators involved in press operations are crucial. Operators should be familiar with the machine,

tooling, and quality requirements. They should also be trained to identify and address any issues that may impact product quality.

- **Continuous Improvement:** Implementing a culture of continuous improvement can help identify opportunities for enhancing product quality. Analyzing process data, collecting feedback from operators, and conducting root cause analysis for any quality issues can lead to process optimization and better product outcomes

6.1.1. Product inspection mechanisms

In press machine operations, product inspection mechanisms play a vital role in ensuring the quality of the produced components. These mechanisms involve various techniques and tools to inspect and verify the dimensions, integrity, and other quality parameters of the formed parts. Product inspection mechanism in this context:

Visual Inspection: inspect the formed parts for any visible defects such as cracks, scratches, dents, or deformations and compare the stamped parts against quality standards to ensure they meet the required appearance and surface finish.

Dimensional Inspection: by using calipers, micrometers, or gauges to check critical dimensions, hole sizes, or distances between features. Coordinate measuring machines (CMMs) may also be used to capture detailed dimensional data for complex parts.

Functional Testing: This can involve assembling the stamped components into the final product or fitting them with other parts to assess their functionality, proper fit, or movement.

Non-Destructive Testing (NDT): To inspect the integrity of the formed parts without causing any damage. This includes visual inspection with the aid of magnification tools, dye penetrant testing, magnetic particle inspection, or ultrasonic testing. These techniques help detect internal or surface defects, cracks, or material inconsistencies.

Statistical Process Control (SPC): Statistical process control involves monitoring and analyzing process variables to ensure consistent quality. In press machine operations, SPC can be applied by using sensors or measurement devices to collect data on parameters such as press force, displacement, or strain. The collected data is then analyzed statistically to identify any variations or trends that may affect product quality. SPC helps in real-time process monitoring and enables proactive quality control.

Automated Vision Systems: Automated vision systems utilize cameras and image processing algorithms to inspect stamped parts for various quality aspects. These systems can quickly detect defects, measure dimensions, or verify the presence of specific features. They are particularly useful for high-speed production lines where manual inspection may not be feasible or efficient.

6.2. Deviations and Faults

In pressing, the material is shaped as desired through the application of pressure through various methods, generally with a mould called a die and punch. Typical pressing types are as follows:

- Shearing: The material is processed (cut) through the application of force exceeding its fracture limit.
- Bending: The material is bent through the application of tensile force on one side and of compression force on its other side.
- Deep drawing: The material is processed through the application of tensile stress.
- Compression: The material is processed through the application of compression force.

This section explains typical pressing defects and their causes and countermeasures. It is difficult to completely and continuously eliminate all defects due to factors such as the properties of the material, the design, and processing principles. However, it is important to improve the yield rate as much as possible by reducing the frequency of defects through various countermeasures.

a) Spring back

Cause: After bending, the residual compressive stress and tensile stress in the material act in opposition to each other, causing the processed part to bend back toward its original shape.

Countermeasures: Bend to a deeper angle than intended or add a striker plate or a notched groove to the punch.

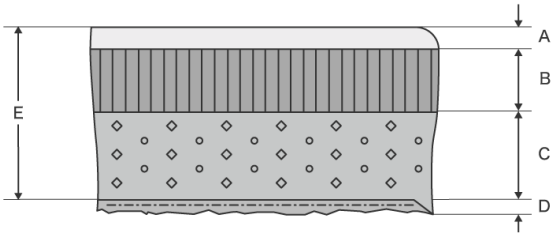
b) Burrs

Cause: This defect occurs because, for example, the ***gap (clearance)*** between the punch and die is too large during shearing.

Countermeasure: Ensure that 1/2 to 1/3 of the plate thickness is the sheared surface and that this status is uniform.

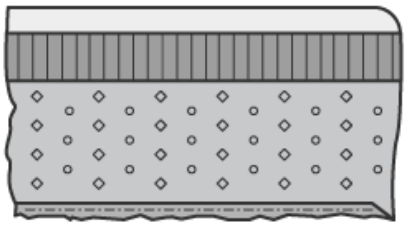
Structural images of the cross-sections of the material after shearing with various ***clearance*** conditions are shown below with explanations of the names and characteristics of the parts.

Appropriate clearance

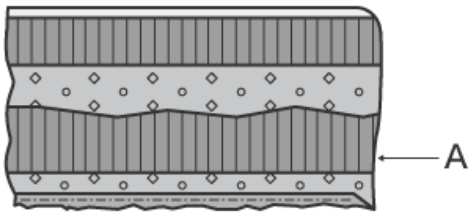


A. Shear droop: Smooth surface caused by the surface of the material being pulled.
B. Sheared surface: Glossy surface with vertical stripes. There are subtle scratches caused by the punch cutting during shearing and due to the friction between the deposited metal and the material.
C. Fracture surface: Compared to the sheared surface, this is a rougher surface that has been torn away, making the surface extremely uneven.
D. Burr: A jagged protrusion from the material. Large burrs can lead to defective products due to insufficient fit accuracy between parts and safety problems such as injuries caused by sharp burr tips.
E. Plate thickness

Too much clearance



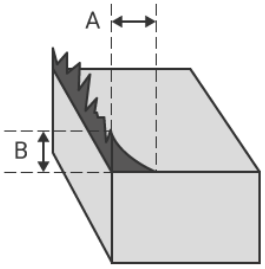
Too little clearance



When the clearance of passes appropriate amount, the larger the clearance, the larger the burr. Also, the shape and dimension accuracies decrease due to problems such as warping

caused by the extraction pressure. On the other hand, too little clearance causes a secondary sheared surface (A in the figure on the right) on the other side of the fracture surface to occur, resulting in whisker-shaped burrs.

The size of a burr is expressed as the thickness of its base (A in this figure) or as its height (B in this figure).



c) Wrinkles

Cause: This happens when compression force is applied to the flange during deep drawing.

Countermeasure: Use wrinkle suppression via the deep drawing conditions to apply a uniform load to the material. In addition to fixed wrinkle suppression, there is also moveable wrinkle suppression that uses the force of a spring or a die cushion.

d) Cracks

Cause: Cracks form in the material when the tensile force exceeds the fracture limit during deep drawing.

During bending, cracks, splits, and tears may occur in the bent part due to the rolling direction of the material or the bend width dimension.

Countermeasures: In deep drawing, reduce the wrinkle suppression pressure or make the curve of the die smooth to lower the deformation resistance. In bending, ensure that the bending line and the rolling direction of the material are perpendicular or set the bend width to at least eight times the plate thickness.

e) Scrap buildup (the cause of dents and scratches)

Cause: This is a phenomenon where scrap (which should be removed from the mould) affixes to the punch due to factors such as vacuum pressure, oil films, and magnetism after extraction processing. Scrap buildup is the cause of defects such as dents and scratches on the material surface and may also damage the mould.

Countermeasures: Install a kicker pin on the punch to establish a physical gap between the scrap and the punch. Other methods include discharging air from the tip of the punch, cutting a groove in the punch and inserting air there, and suctioning the scrap from below. It may also be possible to reduce the degree to which scrap affixes to the punch by lowering the viscosity of the oil used or by cutting a groove in the punch to reduce the contact area of the oil.

6.2.1. Cause of Parallelism Error: Spring-back

The parallelism of the press machine bolster and slide surface as well as parallelism of the formed product is extremely important in pressing. When parallelism of the bolster and slide surface is not correct, the bend angle and drawing blank holder will be affected even when the slide moves vertically. This reduces the service life of the die. Parallelism failures of formed products after pressing occur primarily as a result of residual stress (internal stress) that exists inside of the formed product. This deformation is called spring-back, and it is a reason why maintaining the required dimensional accuracy during pressing is difficult.

Self-Check 6

Instruction: Answer all the questions stated bellow

Part I: Write True if the statement is Correct and Write False if it is incorrect

1. Wrinkling is a defect that can occur during press working operations, characterized by folds or creases on the surface of the formed part.
2. The strength of the material being formed does not affect the selection of press parameters in press working operations.
3. Press working operations can be performed using hydraulic presses, mechanical presses, or pneumatic presses.
4. Misalignment is a press defect that can occur when the features or components of the formed part are not properly aligned or positioned.
5. In press working operations, the choice of lubricant can significantly affect the material flow and reduce friction between the material and the tooling surfaces.

Part II: Matching

	Column A	**Column B**
_____1	defect occurs because of ***gap (clearance)***	A. Scrap buildup
_____2	Defect due tensile force exceeds the fracture limit	B. Wrinkling
_____3.	when compression force is applied to the flange during deep drawing	C. Burrs
_____4	Affixes to the punch due after extraction processing.	D. Cracks

Reference

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