UNIT 3 PRESS AND PRESS TOOLS

Structure

3.1 INTRODUCTION

Metal forming is one of the manufacturing processes which are almost chipless. 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.

Objectives

After studying this unit, you should be able to understand

- introduction of press tool,
- major components of press working system,
- different criteria of classification of presses,
- different types of presses,
- description of important parts of a press,
- specifications of a press,
- other press working tools, like punch and die,
- components of press working system,
- different types of die sets, and
- design considerations for die set design.

3.2 PRESS

A press is a sheet metal working tool with a stationary bed and a powered ram can be driven towards the bed or away from the bed to apply force or required pressure for various metal forming operations. A line diagram of a typical pres is explained in the Figure 2.1 hydraulic system. The relative positions of bed and ram in the press are decided by the structure of its frame. The punch is generally gripped into the punch

holder and punch holder is attached to ram. A balster steel plate is attached to the bed of the press and die is mounted on the balster steel plate.

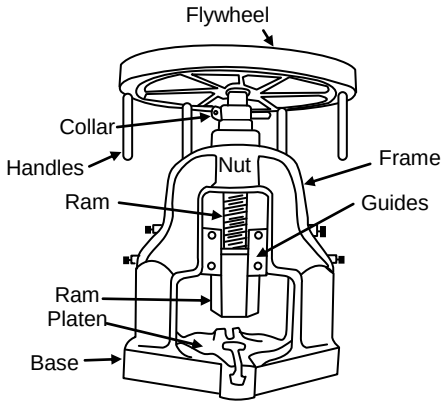

Figure 3.1 : Line Diagram of a Typical Press

Presses are available in a variety of capacities, power systems and frame type. Meaning of capacity of press is its capability to apply the required force to complete the operation.

Power and Drive System

Power systems on presses are either hydraulic presses use a large piston and cylinder to drive the ram. This system is capable to provide longer ram strokes than mechanical dries. It gives a consistent applied load. Its working is comparatively slower. These presses can be single action or double action or so on. Number of actions depends on the number of slides operating independently.

Mechanical presses are used several types of drive mechanisms. These drives includes eccentric, crankshaft, knuckle joint, etc. These drives are used to convert rotational motion given by a motor into linear motion of the ram. A fly wheel is generally used as reservoir of energy for forging operations. These presses are recommended for blanking and punching operations as the involved drives are capable to achieve very high forces at the end of their strokes.

Press working is used in large number of industries like automobile industry, aircraft industry, telecommunication electrical appliance, utensils making industry are major examples.

3.3 TYPES OF PRESSES

There are different criteria of classification of presses into different categories. These criteria, related classifications and their descriptions are discussed below.

According to the Power Source

These power source are categorized as :

Manually Operated or Power Driven

These presses are used to process thin sheet metal working operations where less pressure or force is required. These are operated by manual power. Most of manually operated presses are hand press, ball press or fly press.

Power Presses

Power presses are normally driven by mechanical mechanism or hydraulic system. Power source of these presses may be electric motor or engine.

According to the Type and Design of Frame

The type and design of frame depending on the design of frame these are classified as inclinable, straight side, adjustable bed, gap frame, horning and open end.

Inclinable Frame Press

Its frame is called inclinable due to its capability to tilt back upto some angle. It can be locked into nay of its inclined position as shown in Figure 3.2. Its back is open to exit the scrap so it is also called open back inclinable press.

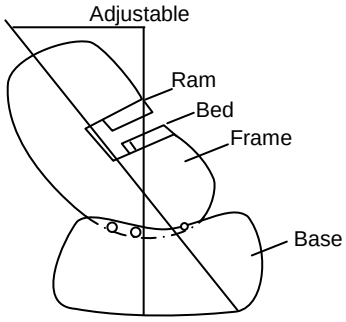

Figure 3.2 : Inclinable Frame Press

Gap Frame Press

These presses have larger frame openings, that means a wide gap between its base and ram to accommodate larger workpieces. It also has longer beds, as shown in Figure 3.3.

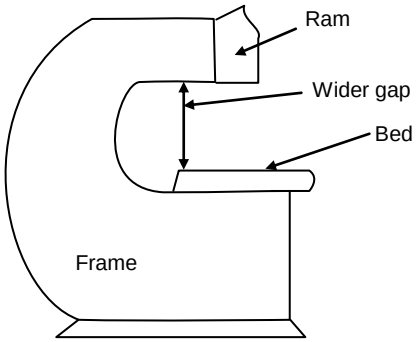

Figure 3.3 : Line Diagram of a Gap Frame Press

Straight Side Press

These presses have straight side type frame which is preferred for presses having larger bed area and high tonnage. This offers greater rigidity and capable of longer strokes. The frame consists of vertical and straight sides so it is called straight side press.

Adjustable Bed Type Press

It is also called column and knee type press because it has a knee type bed supported on its column shaped frame. Its bed (knee) can be adjusted at any desirable height by moving it vertically up or down with the help of power screws. In this structure there is slight lack of rigidity as compared to other structures. It is shown in Figure 3.4.

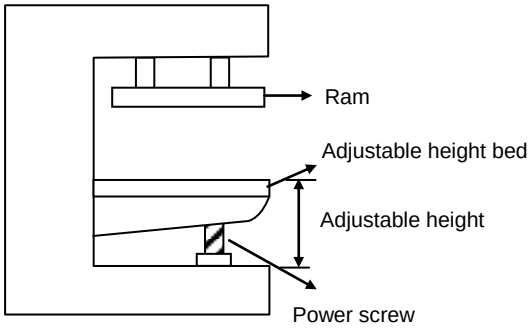

Figure 3.4 : Adjustable Bed Type Press

Open End Press

It has a solid type of vertical frame with all sides open. Driving mechanism is housed at the back and ram controlling mechanism at the front. It is easily to accommodate workpiece and dies in this type of structure. Its is identified as light duty machine.

Horning Press

It consist of a vertical frame, top of which over hangs towards the front. The over hanging portion serves for housing for driving mechanism and ram control. The frame consists of a front face as a work table called horn.

According to the Position of Frame

Presses can also be categorized by the position of frame as described below.

Inclinable Frame

Already described.

Vertical Frame

Vertical frame type of press is already been discussed, it cannot be adjusted like inclinable frame. Gap, adjustable bed, straight side, open end and honing presses are the example of vertical frames.

Horizontal Frame

It has a fixed frame in horizontal position. It provides the facility of auto ejection of produced part and scrap due to gravity.

Inclined Frame

Like inclinable frame, inclined frame press has an inclined frame but fixed, it cannot be adjusted to any other angle.

According to the Actions

According to the number of actions it can be categorized as single action, double action or triple action press. Here number of actions is same as the number of rams on the press.

According to Mechanism Used to Transmit Power to Ram

Crank Press

It consists of crankshaft driven by a flywheel, rotary motion of the crankshaft is converted into reciprocating motion with the help of a connecting rod connected to ram.

Cam Driven Press

In this press, a cam is used to press the ram down words and suitably located springs restore the original position of ram when pressure applied is removed. This mechanism has a limitation of size of the press.

Eccentric Press

In this press, the driving shaft carries an eccentric integral with it. One end of the connecting rod carried an attachment of revolving eccentric and its other end is connected to ram. As the eccentric shaft revolves, the offset between the eccentric centre and the centre of rotation of the shaft provides the required movement.

Knuckle Press

This press is driven with the help of knuckle joint mechanism. The main advantage of this press is partial back thrust is transferred to crankshaft, its major portion is transferred to back crown which is capable to hear. This

enables the application of this press for heavier jobs with high intensity of blows. These presses are recommended for coining, squeezing, extruding and embossing. They have a limitation of shorter stroke lengths.

Toggle Press

These presses work on toggle mechanism and used for double and triple action presses for driving the outer rams. However, crankshaft drive is used for the inner ram. These are used for large draw dies, in which this mechanism actuates the blank holder whereas the punch is operated by the crank driven inner ram.

Screw Press

This is known as power screw or percussion press. There is a vertical are like frame, its job forms a nut. There is a flywheel at the top of and engages the ram at its bottom. The flywheel is driven by a friction disc and the rotating screw lowers and raises the ram. The flywheel is accelerated by friction drive. Its total energy is expanded in striking the work, bringing it to a halt. The intensity of blow can be regulated by adjusting the height of the die. Higher the position of the die, lesser the speed of the flywheel and hence lower the intensity of blow. These presses have a limitation that the ram movement is slow so these are recommended for sheet metal work only.

Hydraulic Press

These presses have a piller type construction or carry the hydraulic cylinder at the top of the crown. These presses provide longer stroke than mechanical presses with adjustable intensity of blow. Their stroke length can also be adjusted with full tonnage. These are recommended for deep drawing, extruding and plastic moulding.

Rack and Pinion Press

Rack and pinion driven presses are called rack and pinion presses meant for long strokes. Major advantage is faster operation of this press due to involvement of quick return motion. There are some limitations of this press. Load bearing capability of rack and pinion mechanism is very low so these are light duty machines. Ram movement is slightly slower. These presses have very limited use now-a-days.

According to Number of Drive Gears

Number of drive gears means number of gears attached at the ends of crankshaft, used to drive it. Smaller presses have single drive and larger presses may be double drive crankshafts. Very large presses with longer beds, carry long crankshafts. They have risk of twisting. These crankshafts are provided with one driving gear at each ends, these presses are named as twine drive presses. If a press carries two crankshafts each having a twin drive, such presses are called quadruple drive presses.

According to Number of Crankshaft in a Press

According to the number of crankshafts used in a press, these are directly classified as single crank (having one crankshaft) double crank (having two crankshafts).

Method of transmission of power from Motor to Crankshaft

The method used for transmission of power from motor to crankshaft categorized presses into following categories :

Direct Drive Press

In this case, power is directly transferred through gears pair. Smaller gear is mounted on the motor shaft, called pinion, its mating gear which is larger, mounted on the crankshaft. The larger gear also acts as flywheel. The

flywheel is attached to the crankshaft through clutch and equipped with the facility of disengaging it as per the need. Such presses have shorter strokes and these are light duty presses.

Flywheel Driven Presses

These presses consists no gears so also called "No geared presses". For the transmission of power motor pulley is connected to flywheel driven crankshaft by Vee belt and pulley system. A clutch is used to engage or disengage the flywheel with the crankshaft. These presses are light duty presses providing shorter and quicker strokes.

Single Geared Drive Presses

This press consists of a counter shaft between motor shaft and crankshaft. Flywheel is mounted on the countershaft. Power is transferred from motor to flywheel (countershaft) through 'Vee' belt drive and then from counter shaft to crankshaft through pinion and gear. Clutch is mounted between pinion and flywheel to disengaged the power transmission as per the requirements. In these presses there are two steps for rpm reduction and torque enhancement so these are heavy duty mechanics with longer strokes.

Double Geared Drive Presses

In these type of presses an additional shaft named as intermediate shaft is introduced between the countershaft mounted flywheel and the crankshaft of a single geared drive. Twin drive is possible in this case by having similar gear train on other sides of two shafts. This provides slow stroke with larger power.

According to the Purpose of Use

Some of the operations require low stroke strength and some lager stroke strength. In the same way requirements of stroke length is different for different operations. So depending on power and stroke length presses are classified as given below depending on their suitability of performing different operations.

(a) Shearing press

(b) Seaming press

(c) Straightening press

(d) Punching press

(e) Extruding press

(f) Caining press

(g) Forging press

(h) Rolling press

(i) Bending press.

3.4 MAIN PARTS OF A TYPICAL POWER PRESS

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

Base

The all machine tool, base is the one of the parts of a press. It is main supporting member for workpiece holding dies and different controlling mechanisms of press. Size of the table limits the size of workpiece 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.

Frame

Frame constitute 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.

Ram

This is main operating part of the press which works directly during processing of a workpiece. Ram reciprocates to and fro within its guideways 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 workpiece.

Pitman

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

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.

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 provides reliable and accurate control with automation.

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 workpiece. Flywheel is placed in the driving mechanism just before the clutch is sequence of power transmission.

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.

Balster 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 workpiece. 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.

3.5 SPECIFICATIONS OF A PRESS

Expressing size of a machine (press) includes expressing each of the parameters pertaining to it quantitatively in appropriate units. Expressing size in the above mentioned way is the specifications of press. The following parameters are expressed as specifications of a press.

(a) **Maximum Force :** Maximum force that its ram can exert on the workpiece, this is expressed in tones and called tonnage. It varies from 5 to 4000 tonnes for mechanical press. It may be up to 50,000 tonnes by hydraulic press.

(b) **Maximum Stroke Length :** Maximum distance traveled by the ram from its top most position to extreme down position. It is expressed in mm. the stroke length is adjustable so different values that can be obtained between minimum and maximum of stroke length, these are also the part of specifications.

(c) **Die Space :** Total (maximum) surface area, along with ($b \times d$), of bed, base, ram base. This the area in which die can be maintained.

(d) **Shut Height :** Total opening between the ram and base when ram is at its extreme down position. This is the minimum height of the processed workpiece.

(e) **Press Adjustments :** Different stroke lengths (already covered in point number 2). Different tonnage that can be set as per the requirement.

(f) **Ram Speed :** It is expressed as number of strokes per minute. Generally it can be 5 to 5000 strokes per minute.

3.6 PRESS TOOL

Commonly used tools which are major components of press working are punches and dies. Punch is an important part of the system which is fastened to the ram and forced into the die where workpiece to be processed is supported. Die is a work holding device, designed specifically for a particular design of a product. Die is rigidly held on the base of the press. Die carries an opening which ϕ is perfectly aligned with the punch and its movement. Both die and punch work together as a unit and this is called a die set. Punch and die both are made of high speed steel. Die is the part where strength and wear resistant both properties are required. So normally working surface of the die is made of satellite or cemented carbide. Details of the die set are described below.

Punch

Lower end of the ram holds punch holder which is equipped with the punch plate. Punch plate is generally made of stainless steel or HSS. The punch plate holds the punch rigidly and accurately. Different ways of holding the punch are described below :

(a) Punch can be fastened by forcing it to punch plate, top end of the punch is flattened to fit in the countersunk recess as shown in Figure 3.5.

(b) Punch can be clamped to the punch plate by a set screw. The correct position of the punch is located by cutting a slot into the punch plate as shown in Figure 3.5.

(c) Shank of the punch is forced into the punch plate top end of the punch is made flat to fit into the countersunk recess as shown in Figure 3.5.

(d) Punch can be tightly secured to the punch plate with the help of grubs screws as shown in Figure 3.5.

(e) Set screws are used to fastened the punch to the punch plate as shown in Figure 3.5.

(f) Fastening of punch with the help of a set screw and it is located during fastening with the help of two dowel pins shown in Figure 3.5.

(g) Flange end of the punch is secured to the punch plate by set screws from the punch end as shown in Figure 3.5.

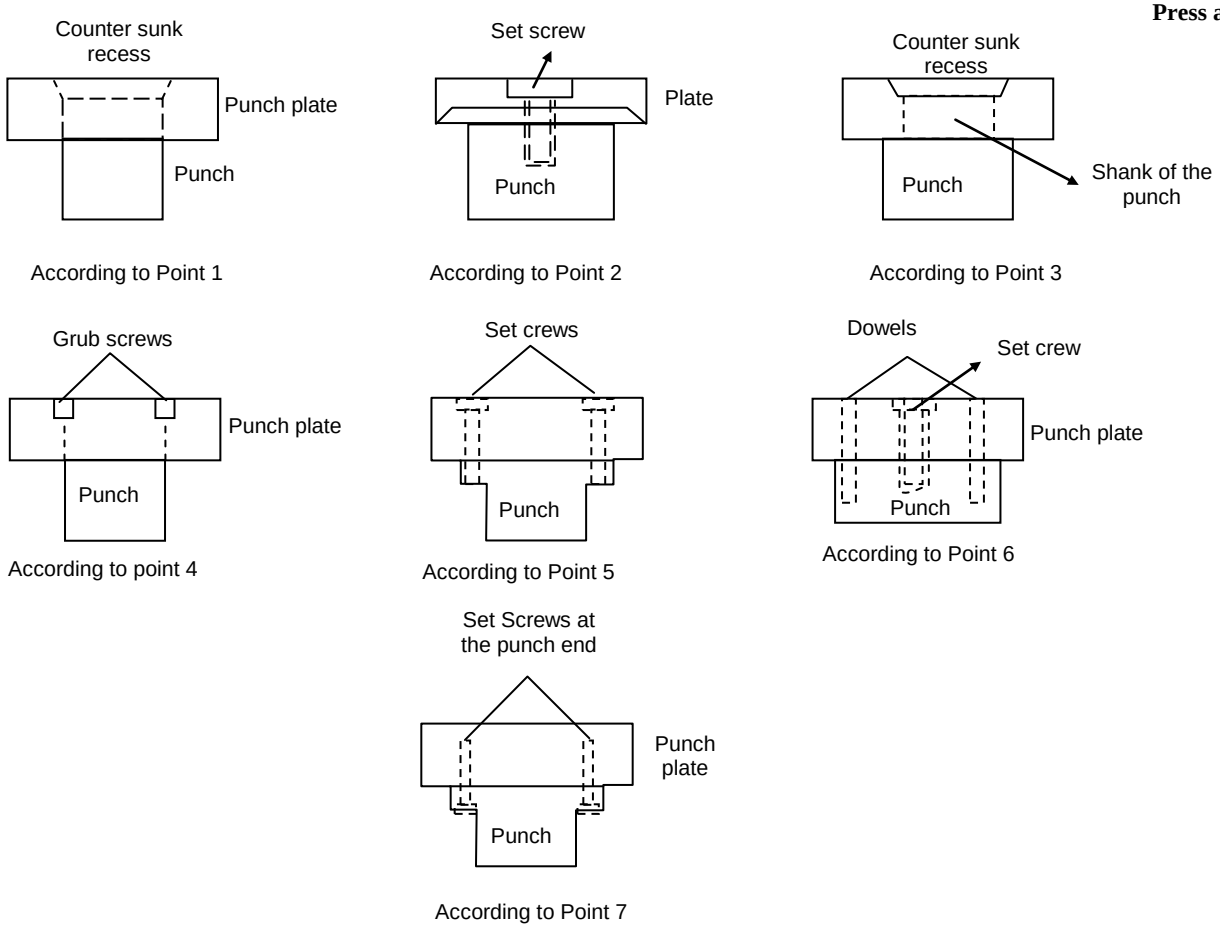

Figure 3.5 : Different Ways of Holding a Punch

3.7 DIE SET AND ITS DETAILS

The complete die set consists of a punch, die and some other accessories which are described in this section later. 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 the finished parts, removal of waste. The die accessories are shown in Figure 3.6. These are described as below.

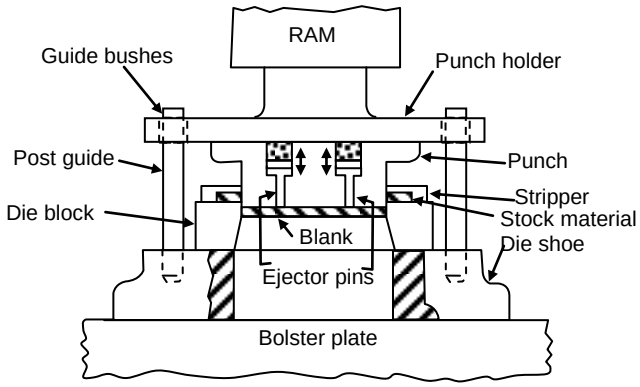

Figure 3.6 : Die Accessories

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.

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.

Die Holder

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

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.

Bottom Top

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.

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.

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.

Strippers

Stripper is used to discard the workpiece 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 invarted dies. After the completion of cutting action, the blank is ejected by the knockout plate out of cutting edge.

Pressure Pads

Pressure pads are plates which grip the workpiece 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 workpiece plate also serve the same function. The pressure pads do a type of ironing on the sheet metal workpiece.

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.

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 and properly aligned. This makes the replacement of punch quick and correct.

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.

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.

3.8 METHODS OF DIE SUPPORTING

Die is normally held in die holder which is clamped to the balster plate mounted on the table or base of the press. Three different methods of securing die blocks to the die holder are discussed here.

Method 1

The die block is secured to the die holder by four set screws shown in Figure 3.7. Here only one screw is shown. The position of the die is correctly located by dowel pin.

Method 2

The die block is secured by the set screws at the bottom of the die holders shown in Figure 3.7.

Method 3

Die block is secured by an wedge which is clamped to the die holder by set screws, shown in Figure 3.7.

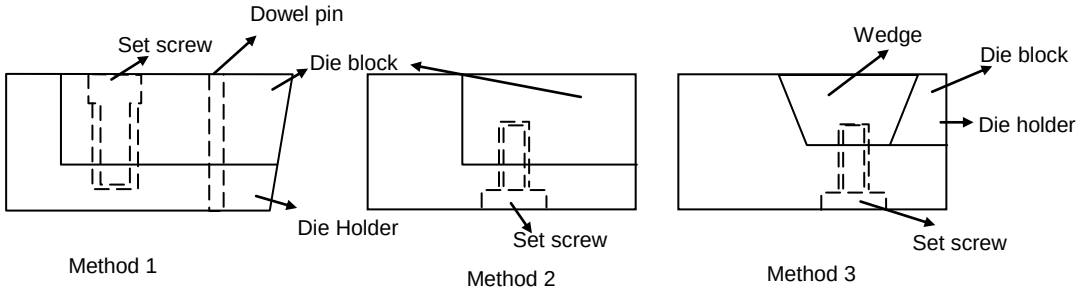

Figure 3.7 : Different Methods of Die Supporting

3.9 CLASSIFICATION OF DIES

There is a broader classification of single operation dies and multi-operation dies.

(a) Single operation dies are designed to perform only a single operation in each stroke of ram.

(b) Multi operation dies are designed to perform more than one operation in each stroke of ram.

Single operation dies are further classified as described below.

Cutting Dies

These dies are meant to cut sheet metal into blanks. The operation performed so is named as blanking operation. These dies and concerned punches are given specific angles to their edges. These are used for operation based on cutting of metal by shearing action.

Forming Dies

These dies are used to change two shape of workpiece material by deforming action. No cutting takes place in these dies. These dies are used to change the shape and size related configuration of metal blanks.

As there is a classification of single operation dies, multi-operation dies are can also be classified (further) as described below.

Compound Dies

In these dies two or more cutting actions (operations) can be executed in a single stroke of the ram.

Combination Dies

As indicated by their names these dies are meant to do combination of two or more operations simultaneously. This may be cutting action followed by forming operation. All the operations are done in a single action of ram.

Progressing Dies

These dies are able to do progressive actions (operations) on the workpiece like one operation followed by another operation and so on. An operation is performed at one point and then workpiece is shifted to another working point in each stroke of ram.

Another classification of dies is also possible on the basis of specific operations that can be performed on them. This classification is described below.

Shearing Operations

These belong to the category of cutting dies. These are used for operations involving shearing action on the workpiece material like blanking, punching, perforating, notch making, slitting, etc.

Drawing Operations

All dies designed for flanging, embossing, bulging and cupping operations fall in the category of drawing operation dies.

Bending Operations

Some of the dies designed for angle bending, curling, forming, folding, plunging, etc. operations fall in the category of dies based on bending operations.

Squeezing Operations

Another category of dies based on squeezing operations are capable to do operations like flattening, planishing, swaging, coining, sizing, extruding and pressing operations.

On the basis of construction, dies can be classified in the following ways :

Cut-off Die

The die designed for cutting off operation is called cut-off die. It provides a vertical surface along which punch slides to cut-off the workpiece by shearing action.

Drop through Die

As indicated by their names, these dies are made hollow where blank fall down after being cut-off.

Return Type Die

In these dies a knockout plate is incorporated, by which the cut blank returns back to the position at which it was cut before it ejected.

Simple and Compound Dies

These are two different dies, simple dies are those dies, used for single exclusive operation in each stroke of ram. These dies have already been discussed in earlier section. In compound dies two or more operations can be done at a single working point. Initial cost of such dies is more due their complicated design and difficult manufacturing. Their low operating cost makes these very economical as a single compound die is equivalent to two or three simple dies.

There is also reduction of cost of using of two or three presses because multiple operations are accomplished in a single press by a single operator.

Continental Dies

These are similar to other dies but the conceptual difference is, these are meant to do research and development work. These cannot do mass production as they may not be very robust.

Sub-press Die

These are designed by incorporating two punch shoe in the die which is actuated by springs to its starting position.

Follow Die

This is designed to do two operations, one followed by other operation. It is like a progressive die which have already been discussed earlier in this unit.

Transfer Die

It is also like a progressive die having more then one working points. It is different form progressive die as it has feeding fingers in the die which transfer the workpiece from one work station to other. In some cases feeding fingers are attached to press, then the press is called transfer press.

Shuttle Die

This is also a type of progressive die having bars in the die just below the workpiece position at each workstation. After the completion of one operation, lift to bear shifts the workpiece from one station to another.

3.10 IMPORTANT CONSIDERATION FOR DESIGN OF A DIE SET

Important points should be considered while designing a die set are listed below :

(a) Cost of manufacturing depends on the life of die set, so selection of material should be done carefully keeping strength and wear resistant properties in mind.

(b) Die is normally hardened by heat treatment so design should accommodate all precautions and allowances to overcome the ill effects of heat treatment.

(c) Accuracy of production done by a die set directly depends on the accuracy of die set components. Design should be focused on maintaining accurate dimensions and tight tolerances.

(d) Long narrow sections should be replaced by block shaped sections to avoid warpage.

(e) Standardized components should be used as much as possible.

(f) Reinforcing grips should be used as per the requirements of the sections.

(g) Easy maintenance should be considered. Replacement of parts should be easy.

(h) The process should be shock proof, if it is unavoidable, shock resistant properties should also be consider while selecting the material of components of die set.

Along with the important design consideration one should also know about the proper material selection for components of a die set various types of tool steels with their suitability for components of die set.

Material or selected tool steel should be very hard to resist wear and strong to hear load to the same time die set components may have very complicated shape, design and need very accurate sizing. Most of them are manufactured by machining and then finishing operations. Their manufacturing involves processing of tool steel to make these components, then these are hardened by different hardening methods like water hardening, oil hardening, air hardening and hard coatings while selecting a die set component material following factors should be taken in care :

(a) Life of the die set component as required.

(b) Their mobility to be manufactured and accuracy level.

(c) Ability to bear wear, shock and load (type of process subjected).

(d) Their costs, both initial cost and operating costs.

3.11 SUMMARY

Metal forming is one of the chip less manufacturing processes. These operations are performed by the press and press tools. Presses can be classified into different categories depending upon their capacity, capabilities and mechanisms used for their operations. Presses can also be categorized depending upon their construction and frame as straight side, adjustable bed type, open end honing press. Method of transmission of power from the place of its generation to the place of its utilization also serve an important criteria for the classification of presses. In general, a press is described by its main parts like base, frame, ram, pitman, driving mechanism, controlling mechanism, flywheel, brakes, balster plate all these parts along with their functions are described here.

Die and punch are the integral part of a pres tool system. Die and punch are normally fitted to a press tool system. Punch and die can be fitted to a press by different methods as described in the unit. Different types of dies are also described in the unit, which are used for different types of workpieces and operations. Accuracy of the operation largely depends on the accuracy of die and punch. So die and punch should be designed and manufactured very carefully. The important considerations for designing die set and punch for pres tool system are described in details.

3.12 ANSWERS TO SAQs

Refer the preceding text for all the Answers to SAQs.