4.1 Introduction

Sheet metal work is very useful trade in engineering work and for our day-to-day needs. Many articles (household and engineering) whose production of other methods will be uneconomical and complicated are made from metal sheets. It is necessary to understand the construction and working of hand tools, sheet metal working machines and basic principles of different operations, to attain proficiency in the trade. For successful working in the trade, we must have a good knowledge or projective geometry, development of surfaces and properties of different metals.

4.2 Principle of sheet metal working

Sheet metal working is generally associated with press machines and press working. Press working is a chipless manufacturing process by which various components are produced from sheet metal. The thickness of metal varies from 0.1 mm to 10 mm. Press machine consists of a frame which supports a ram and bed and a mechanism for operating the ram.

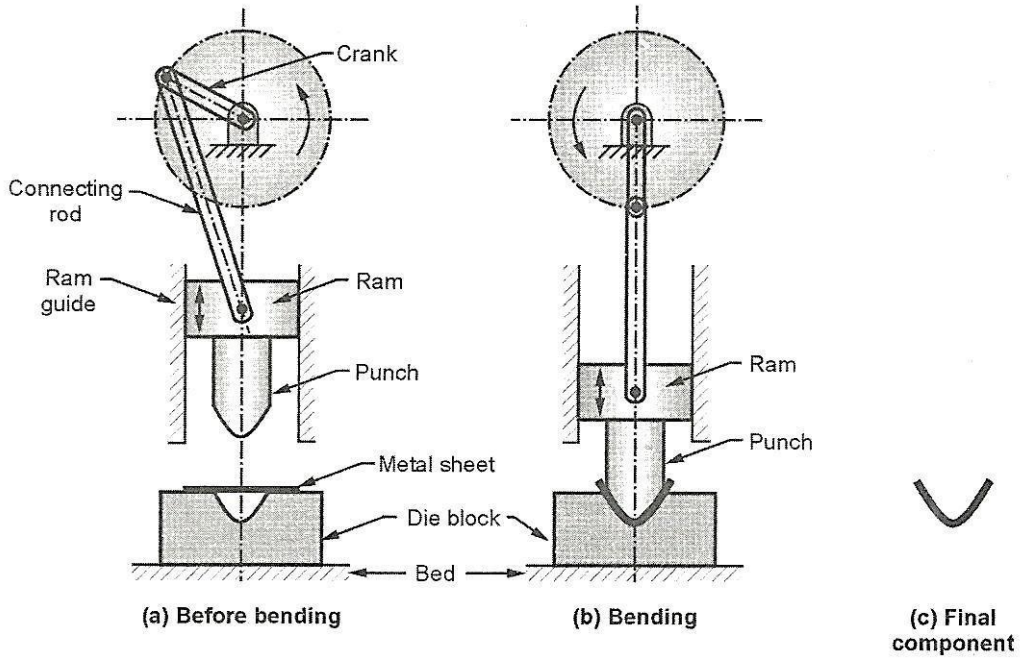

Fig. 4.1 : Sheet metal working

The ram is equipped with punch whereas die block is attached to the bed. The punch and die block assembly is called as die or die-set. Die block is a stationary part which contains die cavity and punch is a moving part which enters in the die cavity. During the operation, metal sheet is kept on the die block and punch moves downward. The punch forces the metal sheet into the die cavity, hence metal sheet will form the shape of the die cavity. There is always some clearance between the punch and die block. On the press machine, various operation can be performed and all the operations are done at the room temperature.

4.2.1 Advantages, disadvantages and Application of Sheet Metal Working:

Advantages

- Sheet metal working is associated with press machine, on which number of operations can be performed.
- Metal sheets of less thickness can be formed into various shapes.
- The components produced by sheet metal working are of low cost.
- Production rate of press machine is very high.
- The process does not require skilled labour.

Disadvantages

- Sheet metal working is only used for mass production.
- The cost of die is very high.
- Initial cost of press machine is also high.
- Metals of thickness more than 10 mm are difficult to form.
- The operation produces more noise and vibrations.

Applications

- The components produced by sheet metal working are as follows:
- Press parts are widely used in automobile (bikes, cars, trucks, buses, etc.) industry. Vehicle parts like doors, roofs, fuel tanks, front guards, etc. can be produced.
- Aircraft industry, radio and telephone industry, electrical parts, etc.

4.3 Metals used in sheet metal working

There are different types of metals used in sheet metal work in the form of sheets and plates. The specifications of metal sheets are given in terms of their gauge numbers, length and width. Gauge number represents a thickness of metal sheets. The higher the gauge number, the smaller the thickness. Some of the important sheet metals are as follows:

1. Black iron

Black iron or uncoated sheet carries no artificial coating on its surface, but is cheaper than other types of metal sheets. Components made from this type of metal are pans, tanks, cabinets, almirahs, stove, pipes, etc.

2. Galvanised iron

It is soft iron sheet carries zinc coating on its surface which make the surface good looking and rust resistant. Components made from this type of metal are storage tanks, buckets, heating ducts, furnaces, gutters, pans, trunks, etc.

3. Aluminium sheets

Due to low strength of aluminium sheets they are not used in their pure form, hence suitable amount of silicon manganese, copper and iron are added. It offers high resistance to corrosion and abrasion. They are used in the manufacture of aeroplane bodies, kitchenware and cabinets, doors, windows and building work, electrical appliances, etc.

4. Copper sheets

Copper sheets are costlier but offers good resistance to corrosion and relatively good in appearance. They are reddish in colour, highly ductile and malleable. They are used in applications like radiators of automobiles, heating appliance, gutters, hoods and components in chemical plants.

5. Stainless steel

Stainless steel offers high resistance to corrosion and exhibits a bight surface. It is used in the manufacture of food containing equipments, dairy equipments, food processing plant, chemical plant, etc.

6. Tin plates

Tin plates are used for those iron sheets which are coated with pure tin. Tin plates are used for making good containers, containers for cooking oils and ghee, cans, etc.

4.4 Sheet-metal characteristics

After a blank is cut from a larger sheet, it is formed into various shapes. Basically, all sheet forming process employ various dies and tooling to stretch and bend the sheet.

Before we consider these processes, however, certain characteristics of sheet metals must be reviewed, because of their important effects on the overall operation.

Characteristics metals important in sheet forming

Characteristic	Importance
Anisotropy (Planar)	Exhibits different behaviour in different planar directions present in cold-roiled sheets because of preferred orientation or mechanical fibering; causes earing in drawing; can be reduced or eliminated by an nearling but at lowereed strength.
Elongation	Determines the capability of the sheet metal to stretch without necking and failure; high strain-hardening exponent (n) and strain-rate sensitivity exponent (m) desirable.
Grain size	Determines surface roughness or stretched sheet metal; the coarser the grain, the roughter the appearance (orange peel); also affects material strength.
Springback	Caused by elastic recovery of the plastically deformed sheet after unloading causes distortion of part and loss of dimensional accuracy; can be controlled by techniques such as overbending and bottoming of the punch.
Residual stresses	Caused by nonuniform recovery of the plastically deformed sheet after unloading causes distortion when sectioned and can lead to stress – corrosion cracking; reduced or eliminated by stress relieving.
Wrinking	Caused by compressive stresses in the plane of the sheet; can be objectionable or can be useful in imparting stiffness to parts; can be controlled by proper tool and die design.
Surface condition of sheet	Depends on rolling practice; important in sheet forming as it can cause learning and poor surface quality.
Quality of sheared edges	Depends on process used; edges can be rough, not square, and contain cracks, residual stresses, and a work-hardened layer, which are all detrimental to the formability of the sheet; quality can be improved by control of clearance, tool and die design, fine blanking, shaving, and lubrication.
Yield-point elongation	Observed with mild-steel sheets; also called Lueder's bands and stretcher strains causes flamelike depressions on the sheet surfaces; can be eliminated by temper rolling, but sheet must be formed within a certain time after rolling.

4.5 Types of Sheet Metal Working

Press operations may be grouped into two categories i.e. *cutting operations and forming operations.* In cutting operations, the sheet metal is stressed beyond its ultimate strength whereas, in forming operations the stresses are below the ultimate strength of the metal.

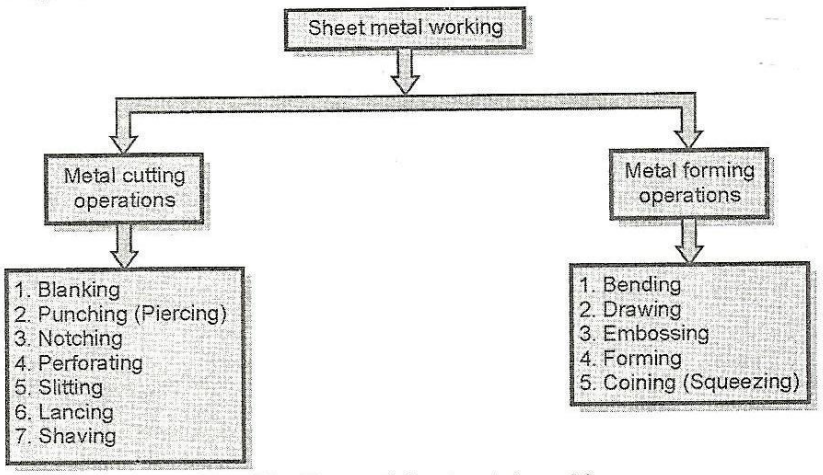

Fig. 4.2 : Types of sheet metal working

4.5.1 Metal Cutting Operations

In sheet metal cutting operations, the metal gets sheared hence these operations are also called as shearing operations. In these operations, the metal sheet is stressed beyond its ultimate strength. Metal cutting operations include following operations:

1. Blanking	2. Punching (Piercing)	3. Notching
4. Perforating	5. Slitting	6. Lancing
7. Shaving	8. Shearing	9. Nibbling

1. Blanking

Blanking is the cutting operation of a flat metal sheet and the article punched out is known as blank. Blank is the required product of the operation and the metal left behind is considered as a waste.

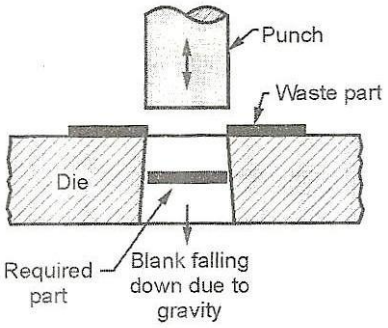

Fig. 4.3 : Blanking

2. Punching (Piercing)

It is the cutting operation with the help of which holes of various shapes are produced in the sheet metal. It is similar to blanking; only the main difference is that, the hole is the required product and the material punched out to form a hole is considered as a waste.

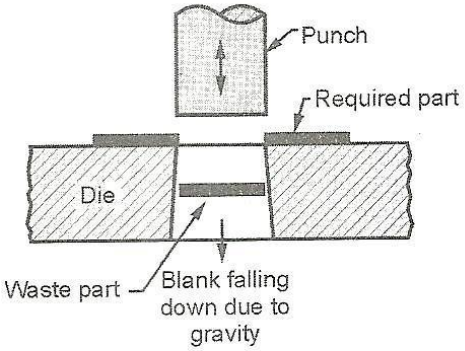

Fig. 4.4 : Punching (Piercing)

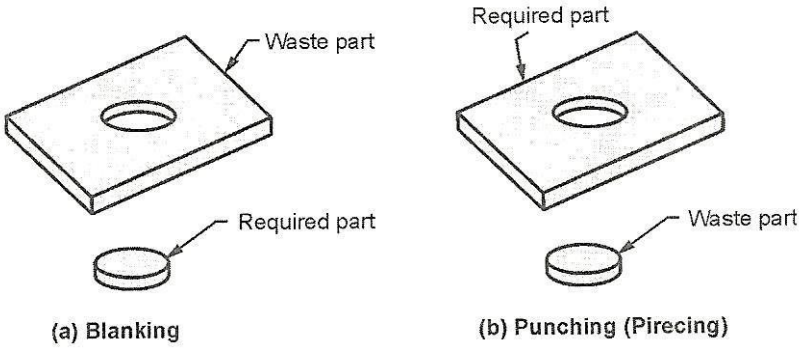

Fig. 4.5 : Blanking and punching (piercing)

3. Notching

It is similar to blanking operation, but in this full surface of punch does not cut the metal. In this operation, metal pieces are cut from the edges of a sheet.

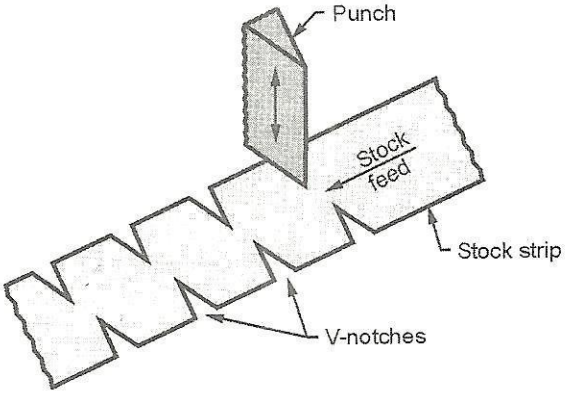

Fig. 4.6 : Notching

4. Perforating

It is similar to piercing but the difference is that, to produce holes the punch is not of round shape. In this process, multiple holes which are very small and close together are cut in the sheet metal.

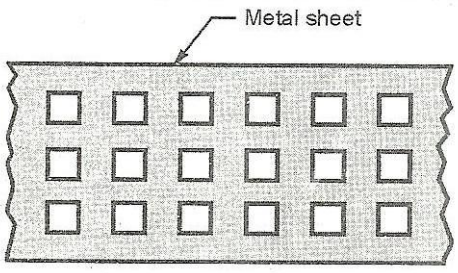

Fig. 4.7 : Perforating

5. Slitting

It is the operation of making an unfinished cut through a limited length only.

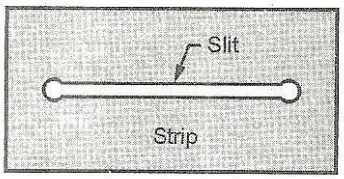

Fig. 4.8 : Slitting

6. Lancing

In this operation, there is a cutting of sheet metal through a small length and bending this small cut portion downwards.

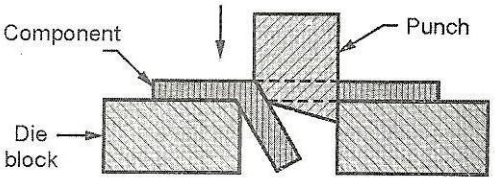

Fig. 4.9 : Lancing

7. Shaving

This operation is used for cutting unwanted excess material from the periphery of a previously formed workpiece. In this process very small amount of material is removed.

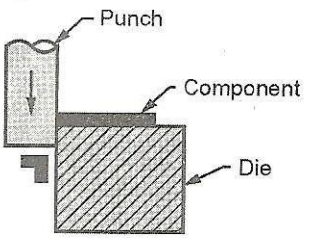

Fig. 4.10 : Shaving

8. Shearing

It is a process of cutting a straight line across a strip, sheet or bar. Shearing process has three important stages:

i) Plastic deformation ii) Fracture (Crack propagation) iii) Shear

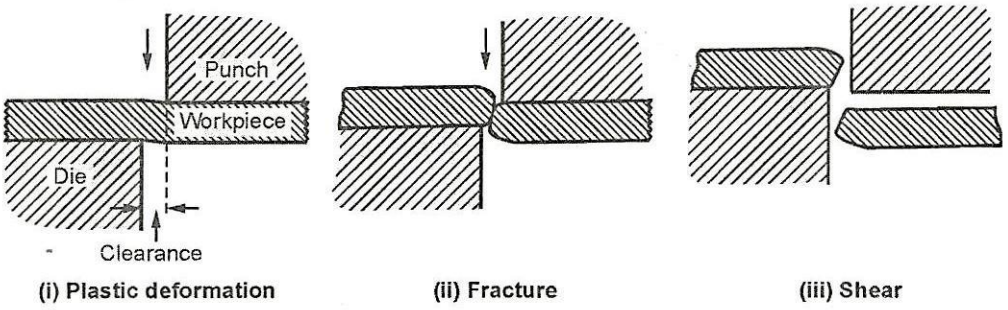

Fig. 4.11 : Steps in shearing process

When the metal is placed between upper and lower blades of the shear and pressure is applied, plastic deformation of metal takes place. As the pressure is continued, the fracture or crack start at the cutting edge of the blade. As the blade descends further, the small fractures meet and the metal is then sheared. Shearing is performed either by using hand or by using machines also.

9. Nibbling

This operation is generally substituted for blanking. It is designed for cutting out flat parts from sheet metal. The flat parts range from simple to complex contours. It is used only for small quantities of components.

4.5.2 Metal forming operations

In metal forming operations, the sheet metal is stressed below the ultimate strength of the metal. In these operations, no material is removed hence there is no wastage. Metal forming operations include following operations:

1. Bending 2. Drawing 3. Embossing
4. Forming 5. Coining (Squeezing)

1. Bending

It is a metal forming operation in which the straight metal sheet is transformed into a curved form. In bending operations, the sheet metal is subjected to both tensile and compressive stresses. During the operation, plastic deformation of material takes place beyond its elastic limit but below its ultimate strength.

The bending methods which are commonly used are as follows:

a) U-bending b) V-bending c) Angle bending
d) Curling e) Roll bending f) Bending in a 4-slide machine