Chapter-2 CUTTING TOOL

Cutting tools:

In machining a cutting tool or cutter is any tool which is used to remove the material from the W/P by means of shear difference.Cutting tool must be made of a material harder than the material which is to be cut and the tool must be to withstand the heat generated in the metal cutting process.

The angle of cutting facer is also important, also the tool must have a specific geometry and clearance angles designed so that the cutting edge can contact the W/P surface .

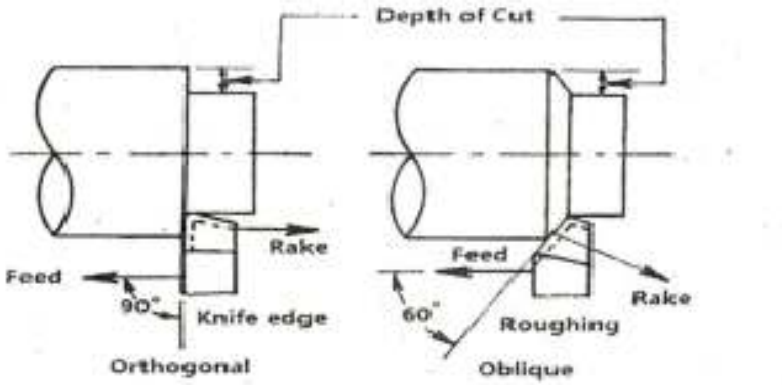

Figure Orthogonal and oblique cutting

Single point cutting tool

This type of cutting tools have only one cutting edge. These used for wide application of lathe, shaper planner, slitter, boring M/C

Multi point cutting tools

This type cutting tools have more than cutting edge. These are employed for wide cutters application in twist drills, milling Reamers, tapes, etc.

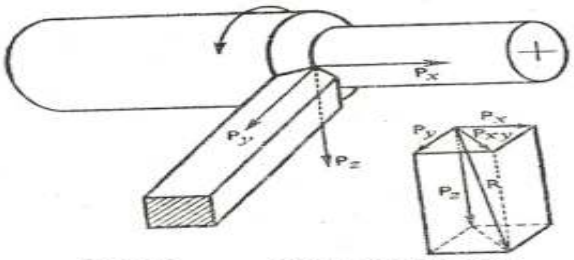

Figure Cutting forces in conventional turning process

Cutting action of hand tools

Chisel:

A chisel is a hand cutting tools which is shaped cutting edge of blade on its end, for carving, cutting a hard material such as wood, stone, metal by hand with the help of mechanical power.

In used the motion. chisels are forced in to the material to

The driving using a

hammer. linear relative forced into the material

may be manually applied by

In industrial use, a hydraulic ram or falling weight drives the chisel into the material to be cut .

Chisel is employed to use in wood work, metal working etc.

In wood & stone working used for carving, shaping,

cutting, shaving trimming.

In metal working process chisel use divided into two categories:

Cold chisel:

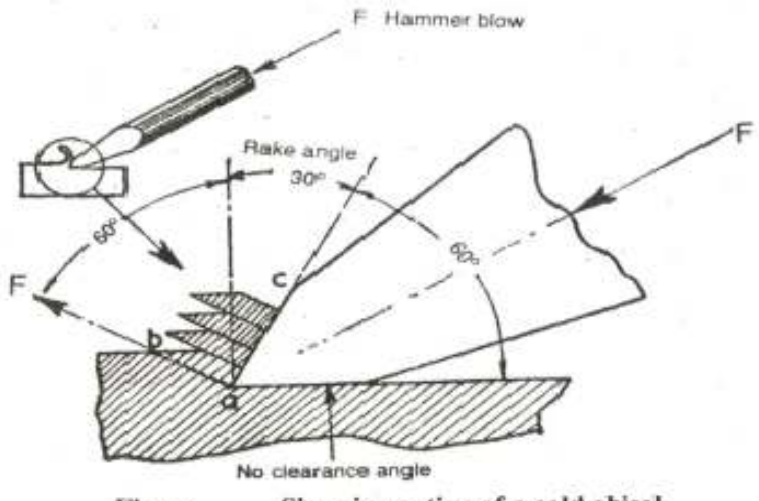

Figure Shearing action of a cold chisel

It is made of from tempered steel. Use forcutting

cold metal.

Used to remove waste metal in the situation where a smooth finish is not necessary or when other tools such as file, hacksaws cannot be used .

Hot chisel:

A hot chisel is used to cut metal that has been heated in a force to sustain the metal.

Used to smooth the metals.

Hacksaw blade

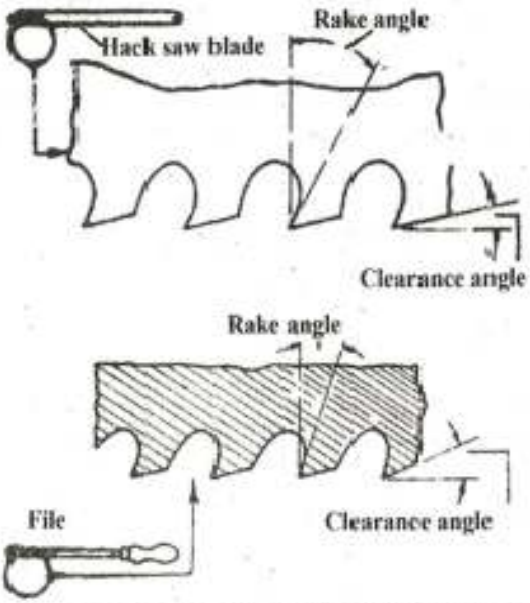

Figure Rake and clearance angles on hack saw blade and file

Hacksaw bled is a fine toothed saw, originally principally for cutting metal.

They can also cut various other materials such as plastic &wood. There are head saw various & power various

When attached to a C-shaped frame which holds a blade under tension. The frames may be adjustable to accommodate blades of different sizes. Blades are available in standardized lengths, usually 10^{11} or 12^{11} for a standard hand hack-saw.

The pitch of the teeth can be anywhere from 14 to 32 per inch for a handblade & for large power hack saw blade there are 3 tpi
As hack-saw teeth are so small, they are set in a wave set.
As the blades are normally quite brittle, so proper care should be taken to prevent fracture of the blade.Blades are made of carbon steel or low alloy steel.But for several decades now, hack-saw blades have used HSS for their teeth, giving great improved cutting & tooth life.On hack-saw the blade can be mounted with the teeth facing toward or away from the handle Resulting and cutting action on either pushes or pull stroke.

In normal use, cutting vertically downwards with work held in a bench, vice, the saw blade Should be set to be face forward.

<u>Die</u>:

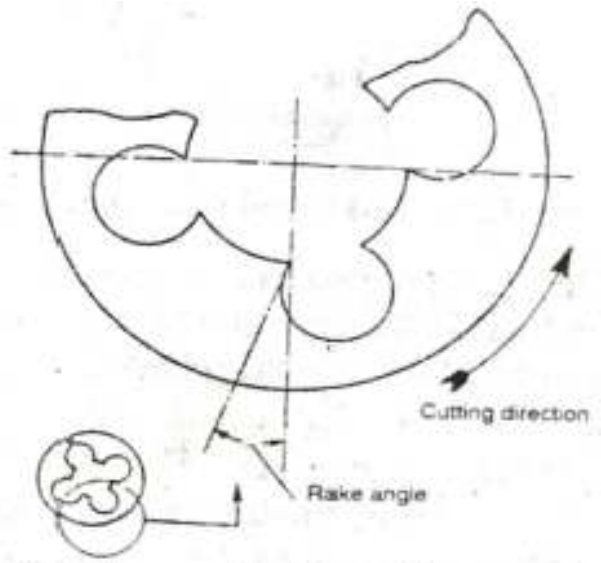

Figure Rake angle on a die

Die cutting is the posses of using die to shear weds of low strength material such as rudder, tidier, cloth, plastic, sheet metal etc.

Die cutting can be done on either flat bed or by rotary process .Rotary dry cutting is die cutting using a cylindrical die or a rotary processes .Dies are used to cut the external thread or the rod or pipe end. Dies are made of high carbon steel or HSS .The process of cutting external thread by dies is called dieing .Sharing is also known as die cutting, is a process which cuts stock without formation of chips or the off during or melting.The die cutting action can be controlled by electric, hydraulic, pressurized or manual surfaces.

Reamer:

- It is a multiple edge cutting tools.
- The process of enlarging the hole is called reaming.
- There are many different types reamer and there may be designed for used as a hand tool or in a M/C tool such as milling M/C or drill press.
- A typical reamer consists of a set of parallel straight or helical cutting edge along the length of a cylindrical body
- Each cutting edge is grounded at a slight angle and with slight undercut below the cutting edge
- This may be used to remove small amount of material.
- Reamers are made of high Carbon or Plain Carbon Steel

Reamers ar of two types

- Hard Reamers
- Machine Reamers

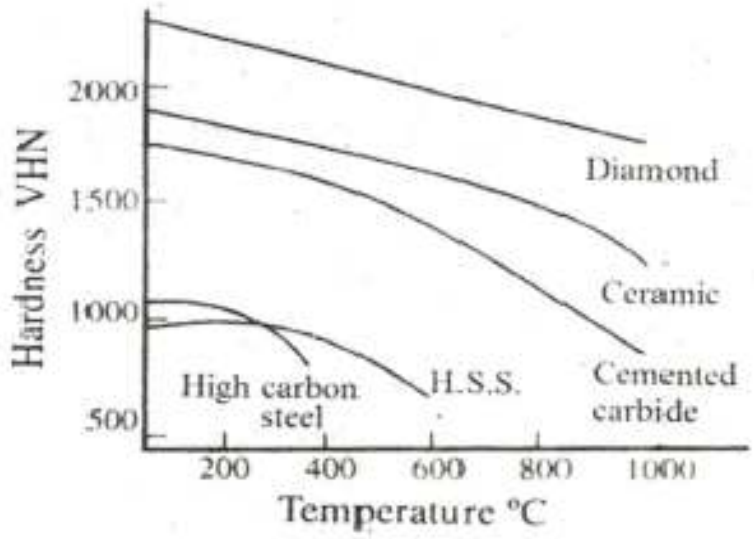

Figure Hardness profiles of cutting tool materials

Machining Process Parameters:

Factors affecting tool life:

The life of a tool is affected by many factors such as: cutting speed, feed, depth of cut, chip thickness tool geometry, material of cutting fluid, and rigidity of the machine

Cutting Speed:

The cutting speed can be defined as the relative surface speed between the tool and the job or the amount of length that will pass the cutting edge of the tool per unit of time.

It may be defined as the speed which the cutting edge pass over the material. It is expressed in meters per min (mpm).

Feed:

It is defined as the relation by small movement per cycl e ofthecutting tool, relative to the workpiece in a direction which is usually to the cutting speed direction.

Or

It is he distances the tools advances into or along the work piece. Each time the tool point passes a certain position in its travel over the surface. It is expressed as mm\tooth.

Depth of cut:

The depth of cut is the thickness of the layer of metal removed in one cut or pass, measured in a direction perpendicular to the machined surface.

It is the vertical distance the tool advances into the work piece during one revolution of job it is expressed in mm.

Selection of cutting speed, feed & depth of cut:

- Hard and strong materials require a lower cutting speed, soft & ductile materials require higher cutting speeds.
- For light finishing cut – fine feed & higher speed roughing cut – low feed & lower cutting speed.
- Large depth of cut – roughing operation
- Small depth of cut – finishing operation
- Cemented carbide, ceramics, satellite &
- Hss – high cutting speed tool
- Alloy or carbon steel tools – lower cutting speed.

Coolants & lubricants:

Cutting fixed sometimes referred to at lubricants or coolants are liquids and gases applied to the tool and work piece to assist in the cutting operations.

Purpose of cutting fixed:

- ➢ To cool the tool
- ➢ To cool the work piece
- ➢ To lubricate and reduce friction
- ➢ To improve surface finish
- ➢ To protect the finished surface from corrosion
- ➢ To cause chips break up into small parts
- ➢ To wash the chips away from the tool

Properties of cutting fluids:

1. High heat absorption for readily absorbing heat developed.
2. Good lubricating qualities to produce low-coefficient of friction.
3. High flash point so as to eliminate the hazard of fire
4. Stability so as not to oxide in the air
5. Neutral so as not to react chemically
6. Colorless so as not to produce any bad smell even when heated.
7. Harmless to the bearings.
8. Harmless to the skin of the operators
9. Non-corrosive to the work or the machine
10. Transparency so that the cutting action of the tool may be observed.
11. Low viscosity to permit flow of the liquid
12. Low priced to minimize production cost.

Choice of cutting fluids:

1. Type of operation
2. The rate of metal removal
3. Material of the work piece
4. Material of the tool
5. Surface finish requirements
6. Cost of cutting fluid.

Type of cutting fluids:

Water:

Pure water is the best cutting fluid available because of its highest heat carrying capacity. But water corrodes the material very quickly so water containing alkali, salt or water-soluble additive but little or no oil or soap are some times used as coolant.

Soluble oils:

These are emulsions composed of around 80% or more water, soap & mineral oil. The soap acts as an emulsifying agent which breaks the oil into minute particles to dispose them throughout the water. The water increase the cooling effect and the oil provide the lubricating properties.

Straight oils:

The straight oils may be

a) Straight mineral oils, kerosene, low-viscosity petroleum fraction such as mineral seal, or higher viscosity mineral oils
b) Straight fixed or fatty oils consisting animal, vegetable or synthetic equivalent, lard oil etc.
c) They have both cooling and lubricating properties

Mixed oils:

This is a combination of strength mineral and strength fatty oil. This makes oil excellent lubricant and coolant for anosmatic screw-machine work.

Chemical additive oil: straight oil or mixed oil when mixed- up with sulphur or chorine is known as chemical additive oil. Sulphur and chloral are used to increase both lubricating and cooling qualities. These oils used for machining tough, stivgy7 low carbon steels.

Chemical compounds: these compounds consists mainly of a rust inhibitor, such as sodium nitrate, mixed with a high percentage of water.

Solid lubricants: stick waxes. And bar soaps are sometimes used as lubricants.

Metal cutting and cutting tools : in the metal working industry the various working processes fall into groups.

Not-cutting shaping – forgery, pressing, drawing Cutting

shaping – turning, drilling, milling.

Cutting tools

A cutting tool may be used either for cutting a part or for removing chips.

Cutting tools are mainly divided into two groups.

- ➢ Single point cutting tool
- ➢ Multipoint cutting tool

A single point cutting tool consists of a sharpened cutting part called its point.
Ex: lathes, slotting machines
Multipoint cutting tools have arrangement of two or more single point tools as a unit.
Ex – milling cutting, broaching tool,twist drill.

Cutting tool nomenclature:

It means schematic naming of the various parts and angles of a cutting tool.

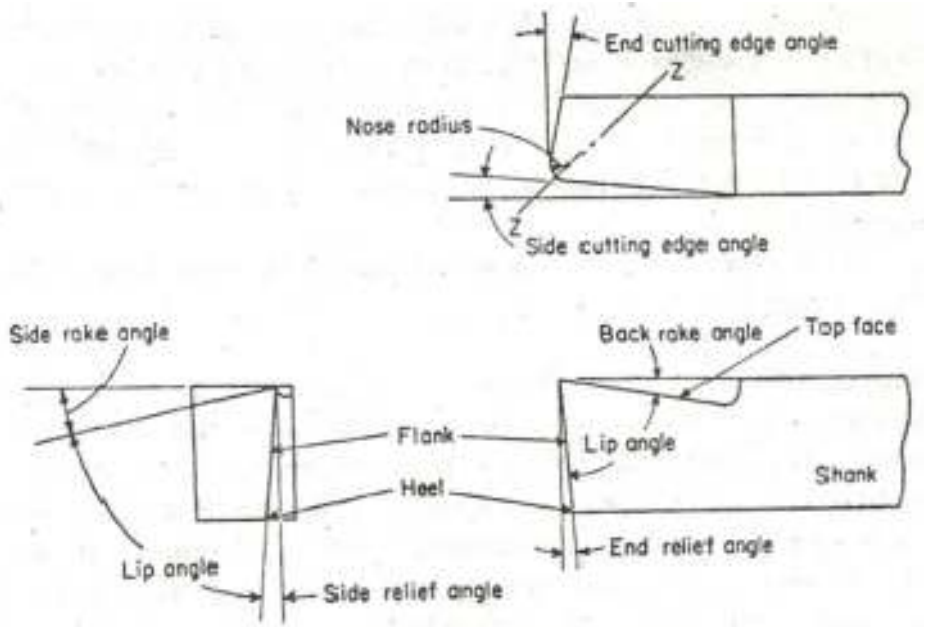

Figure Tool nomenclature and tool angles

Shank:

It is the main body of the tool.

Flank:

The surface or surfaces below and adjacent to the cutting edge is called flank of the tool.

Heel:

It is the intersection of the flank and the base of the tool.

Nose:

It is the point where the side cutting edge and end cutting edge intersection.

Cutting edge :

It is the edge on the face of the tool which removes the metarial from the work piece. The total cutting edge consists edge (major), end cutting edge (minor) and the nose.

Face:

The surface against which the chip slides upward.

Base:

Tt is the undersice of the shank.

Rake:

It is the slope of the tap away from the cutting edge. Larger the rake angle, the cutting force and power reduce.

Designation of cutting tools: there are two system to designate the tool shape

1. **American standards association system** (ASA)

   Or

   American national standards institute (ANSI)

2. **Orthogonal rake system**.

   (ORS) The various tool

   angles are:

1.Side cutting edge angle (Cs): (Lead angle)

The angle between the side cutting edge and side of the toolshank

2.End cutting edge angle (Ce):

This is the angle between the end cutting edge and a line normal to the tool shank

Side relief angle:

It is the angle between the portion of the side flank immediately below the side cutting edge and a line perpendicular top the base of the tool measured at right angle to the side flank.

End relief angle

It is the angle between the portion of the end flank immediately below the side cutting edge and a line perpendicular to the base of the tool measured at right angle to the end flank.

Back rake angle:

It is the angle between the face of the tool and s line parallel to the base of the tool and measured in a plane perpendicular to the side of the cutting edge. The angle is +ve – If side cutting edge slopes downwards from the point towards the shank.-ve – if the slope of the side cutting edge is reverse.

Side rake angle :

It is the angle between the tool face and a line parallel to the base of the tool and measured in a planer perpendicular to the base and side cutting edge. This angle gives slope of the face of the top from the cutting edge.

The angle is – ve – if the slope is towards the cutting edge+ve - If the slope is away from the cutting edge

Purpose of tool angles

Cs – It is the angle which prevents interface as the tool enters the work material. This angle affects tool life and surface finish 150 top 300 is kept for general machining.

Ce – It provides a clearance or relief to the trailing end of the cutting edge to prevent rubbing or drag between the mechanical surface and the non cutting part of the cutting edge 8 to 150 is satisfactory.

These angles are provided so that the flank of the tool clears the workpiece surface and there is no rubbing between them 5 to 15^0 is given.

Larger the rake angle smaller the cutting angle and lower the cutting force and power

The rake angle is small for cutting har4d materials and large for cutting soft ductile materials. It may be – ve or zero.

A flat cold chisel is a single point tool used at the branch and the point is considered as wedge.

For mild steel a rake angle of 300 and wedge angle of 60^0 are recommended

Using a cold chisel with no clearance angle, the loss through friction is small as are cutting point is in contact with the metal

The force hammer below F is transmitted at approximately 90^0 to the cutting face ac and these sets up shear stress across the shear plane ab.

If the hammer blow is heavy as , the metal will shear across the shear plane and move up to the face ac as continuous chip.

The energy required to shear the metal will be the shearing force along the shear plane and this force is proportional to the length of the shear force is propotional to the length of the shear plane and the greater the energy required to the shear of metal

A hack saw blade is a multi-point tool and has a very large number of wedges like points each with its own rake and clearance angle.

The rake is necessary but too much rake makes the tooth weak
A large amount of energy would be lost in overcoming the frictional forces set up if there is clearance.

The hollow space between each tool is sloped more sharply to give the form if this would be tooShallow it would be closed with chips of the metal being cut.

Taps are used for cutting internal threads on work materials. it consists of a no of teeth arranged uniformly across the whole die body when it rotates in a particular direction i.e clockwise or anticlockwise .

The rake angle is provided to reduce the shear forces during cutting & less torque will be required to shear the metal. There is no provision for clearance angle in the die.

It is a multi point cutting tool used for enlarging or finishing a previously drilled or bore hole to give a good finish and accurate dimension. It removes very small.