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→ **cutting Tool:-**

mechanical instrument used to remove material from the workpiece.

~~Req~~ Types of tool — single cutting tip

1) single point cutting Tool → Lathe, shaping, honing, sizzling etc.
   → MRR is less
2) multi point cutting Tool → milling, grinding, broaching, drilling etc.
   → more than one cutting tip

Properties of cutting tool

→ At least 30 to 50% harder than w/p.
→ high hot hardness temp →
→ High toughness
→ High wear resistance
→ Higher thermal conductivity
→ Easyness in fabrication and cheap.
→ High strength.
→ Low co-efficient of friction (Good surface finish)

cutting tool material

1) **High carbon steel**

C = 0.8 to 1.3%
Si = 0.1 to 0.4%
Mn = 0.1 to 0.4%

→ Hot hardness temp = 250°C
→ very high toughness.
  → hardness upto RC-65
→ method of production = forging
→ Re-grindable
→ used for m/cing of soft metal (Al, Ag, copper, brass etc.) due to higher toughness
  → cutting velocity → 5 m/min
→ chisel are made by ~~(chisel are used~~ using HC steel).

2) <u>High speed steel</u>

Generally used HSS is

18 - 4 - 1

- 18 → Tungsten (for increase in hot hardness temp)
- 4 → Chromium (To increase strength)
- 1 → Vanadium (maintaining to wear Resistance)

& Rest iron.

Rest iron

→ sometimes molibedinum is used in place of Tungsten, low price but wear resistance is low.

→ ~~shouldn't be used in~~

→ Hot hardness temp. 600°c

→ High toughness

→ manufacturing method - forging

→ Regrindable

→ shouldn't be used in cutting is High carbon steel due to iron containing HSS is diffused to the body of the steel

→ <u>uses</u>

→ cutting tool of lathe (turning, ~~plow~~ drill heads, milling cutter

→ shouldn't be used for high carbon steel.

→ cutting velocity - 40 to 50 m/min

(3) <u>stellite</u> → <u>non ferrous cast alloys</u>

→ cobalt - 40 to 50%

Chromium - 27 to 35%

Tungsten - 15 to 22%

Carbon - 2 - 4%

→ manufactured by casting method

→ total body is made up by same metal

→ hot hardness temp. 800°c

→ same as HSS

* Replacement of HSS only ... increase in cutting velocity

~~Carbides~~

(4) ~~Non-ferrous cast Alloys~~ (carbides)

(4) Cemented carbides

(3)
- speed upto 6 to 8 times of HSS.

(2) → Produced by powder mettallurgy technique ~~with sintering at~~ 1000°C.

→ They are very stiff and young modulus is about 3 times of the steel.

(1) → 2 types of carbides

a) Tungsten carbides

b) cemented or centered carbide

(3) can't be regrindable, means ~~throughout~~ throw away type of tool.

→ Hot hardness temp = 1000°C

→ Toughness is less than HSS.

→ maxm cutting velocity 300 m/min – 350 m/min

→ High wear resistance

→ Low co-efficient of thermal expansion

→ High thermal conductivity,

Used : Types

a) P-type - machining of ferrous material & steel. (P10, P20, P30, P40, P50)

b) K-type - machining of non-ferrous non-metals & cast iron. (K10-K50)

c) M-type - Gentle purpose of cutting of cast iron (M10-M50)

→

5) Ceramics

It is
→ Basically Al_2O_3

→ made by powder mettallurgy

→ use for very high speed 500 m/sec.

→ can withstand upto 1200°C.

→ very high Abrasion resistance

→ used for machining CI and plastics

→ Throw away type of tool means not regrindable.

→ highly brittle & lower toughness.

→ can't be used for intermittent operation & only for continuous use

6) Cermets (~~tera~~

→ composition ceramic - 90%

combination of ceramic and metal ~~ceramal~~

& produced by powder metallurgy

90% ceramic + 10% metal.

→ To reduce brittleness & increase toughness small amount % metal used

→ powder metallurgy method used for manufacturing

→ V_{max} = 400 - 500 m/min

→ Intermittent feed also (replacement of ceramic).

7) Diamond

→ It has extreme hardness

→ Lower thermal expansion

→ Higher thermal conductivity

→ Low co-efficient of friction

→ V_c max = 1500 to 2000 m/min

→ not used for m/cing of ferrous ~~carbon~~ metals due to diffusion of carbon atom.

→ withstand upto 1500°c.

→ made by powder mettallurgy

→ used for turning, boring of tools, milling cutters, grinding wheels, honing tools, grinding wheel.

8) CBN – cubic boron nitride

→ composition :- consist of Atoms of nitrogen & ~~pod~~ boron and produced by powder mettallurgy

→ used as substitute ~~for~~ diamond during m/cing of ~~st~~ steel.

→ used as grinding wheel on HSS tools

→ Excellent surface finish obtained.

9) UCON

→ Developed by union Carbide in USA

→ consist of colombium 50%, Titanium 30%, tungsten 20%.

→ made by

10) Sialon (Si - Al - O - N)

→ made by powder mettallurgy with milled powder of Silicon, Nitrogen, Aluminium and oxygen

→ more toughness than ceramics, so c/t can used by intermittent cut

→ Cutting speed - 2 to 3 times to Ceramics

→ used in m/cing of Aerospace Alloys Nickel based gas turbine blade with a cutting speed of 3 to 5 m/sec

Elements properties

- Tungsten - Increase hot hardness
  Hard carbides formed, Improving abrasion Resistance

molybdenum - Increasing hot hardness
  Hard carbides formed, Improving Abrasion Resistance.

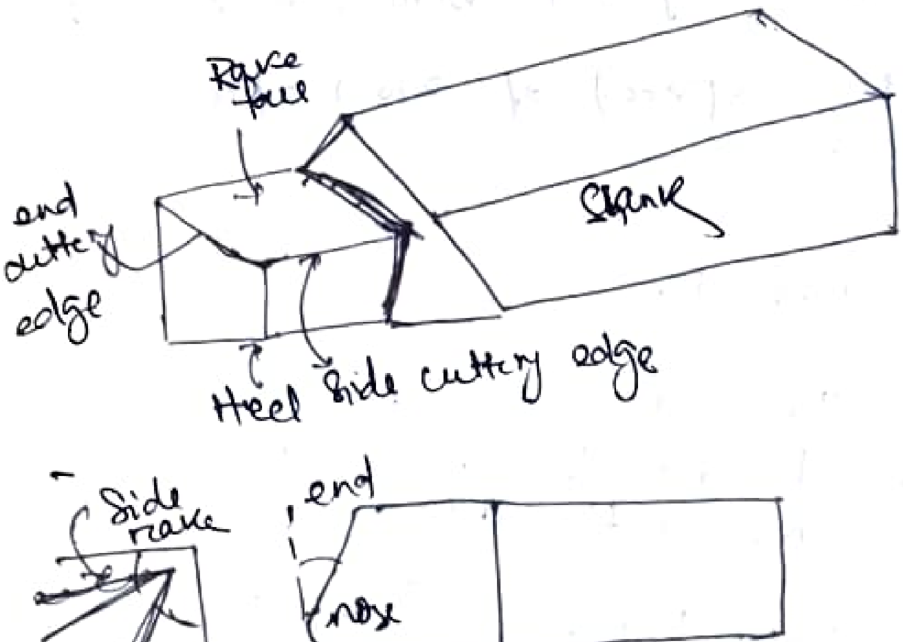
__Chromium__ :- Depth hardenability of using heat treat hard carbides, formed, Improving abrasion Resistance some corrosion Resistance

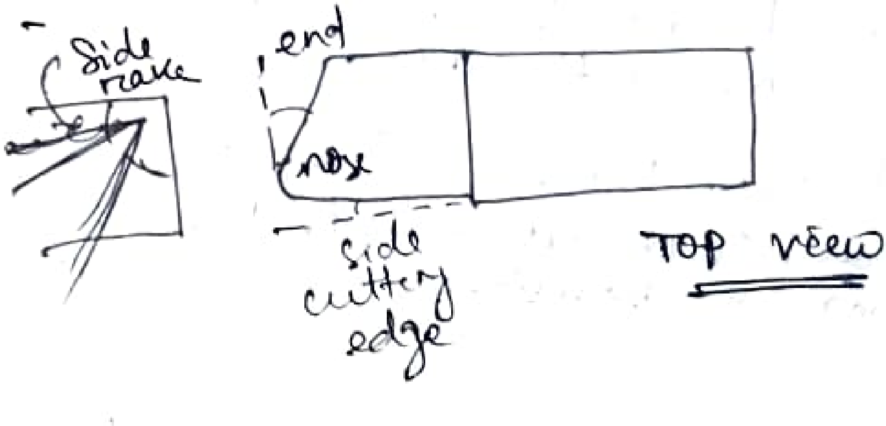
~~Vanad~~.
__Vanadium__. combines with carbon for wear resistance retards grain growth for better toughness.

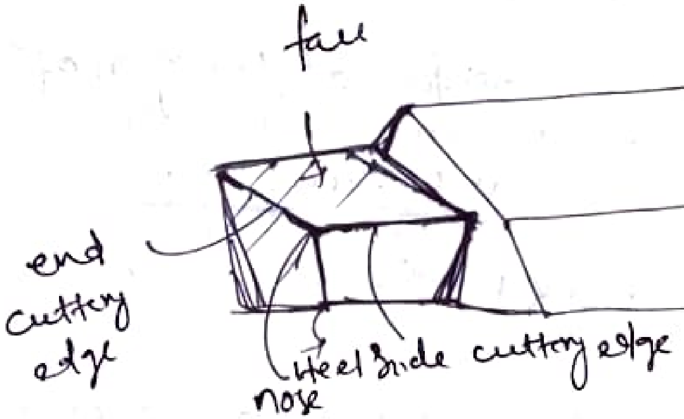
__Cobalt__ :- Increase hot hardness, toughness

Carbon :- Hardening element forms carbides

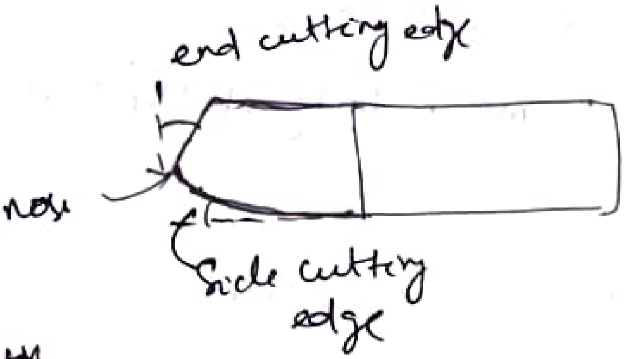
→ movement of tool over the surface ~~along the length~~ of w/p per unit time.

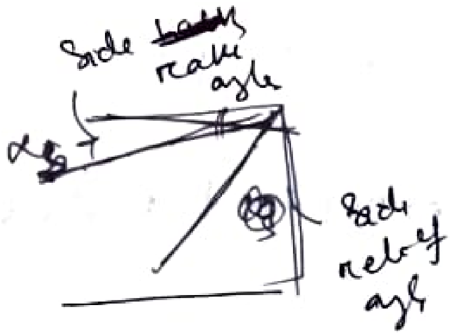




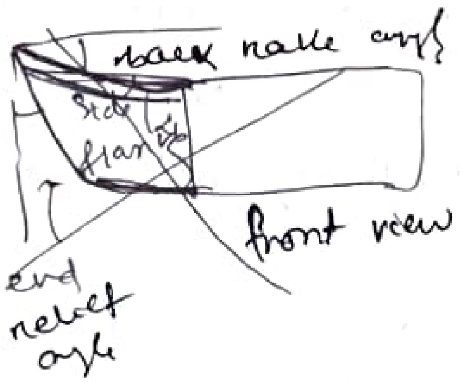


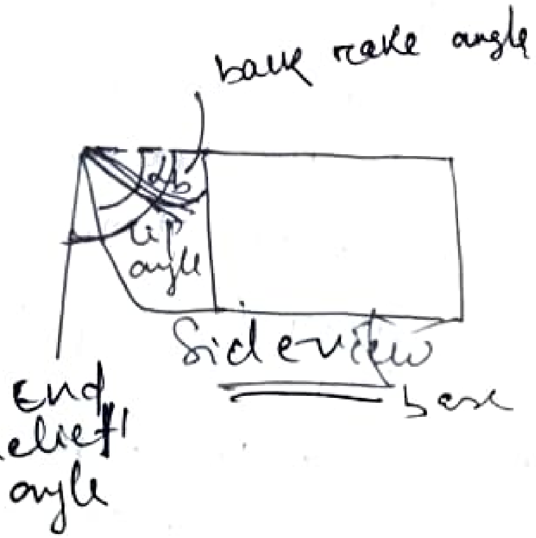
Top view





front view





face :- Through which chip flows.

cutting edges :- Edges that carries out cutting

nose :- Corner, Are on chamfer at Junction of major and minor cutting edge

- flank :- Surface ~~below~~ which faces ~~cutting edge~~ work piece.

Tool angles

Angle that influence tool performance to a considerable extent and therefore proper selection is necessary

shank :- main body of the tool.

Rake face

→ Allows flow of chip convient direction

- Gives sharpness to cutting edge

→ Increase tool life.

→ Reducing cutting forces required to shear

Back rake angle

st to ~~[illegible]~~

→ Angle made by the rake face of the tool with respect to the horizontal plane measured in the length direction

→ It allows the chip to flow in convient direction

→ It reduce the cutting force required to shear the metal. ~~and increase~~ therefore it increases the tool life.

+ve rake angle used when

→ m/cing of work hardening component

→ m/cing of Low strength ferrous and non-ferrous material.

→ Turning long shaft of small diameter

-ve rake angle used when

→ used with tool material which are very weak in tension like carbide tools.

→ m/cing of high strength alloys

→ Intercepted cuts and heavy feed rates are to be used.

→ ~~m/cing~~

Side rake angle

→ Angle made by the rake face with respect to the horizontal plane measured in the width direction.

→ It guides the direction of the chip away from the w/p.

End cutting edge angle

→ Angle betn face of the tool and plane perpendicular to the side of the ~~shank~~. flank.

→ It acts as a relief angle that allows small section of the end cutting edge to contact the interfering machine surface ~~to avoid~~ and prevent chatter and vibration.

Side cutting edge angle

→ It is Angle betw the side cutting edge and the longitudinal axis of the tool.

→ It avoids the formation of BUE, control the direction of chip and distributes the cutting force

- ~~O~~ Advantage of increase in cutting edge angle

→ Increases tool life, for same depth of cut the cutting force distributed on a wider surface.

→ It diminishes the chip thickness for the same amount of feed and permits greater cutting speed.

→ Large cutting edge angles are likely to cause the tool to chatter

Side relief angle

→ - Angle made by the flank of the tool and plane perpendicular to the base ~~[illegible]~~ under the side cutting edge.

→ This angle permits the tool to be fed side way into the job so that it can cut rubbing

End relief angle

→ It is the angle made by the end flank and plane perpendicular to the base. This angle prevents the cutting tool from rubbing against the job.

Nose Radius

- It is provided to increase the surface finish and strength of cutting tip of the tool.
- Small radius produces smooth surface finish and are used ~~on~~ thin cross section of work.
- Large radius strengthen the tool and are used on cast iron and casting
- Too large radius induces chatter.

Rake - side, back

Cutting - side, end

Relief - side, end relief

Relief Angle

~~Cutting using single~~

→

There are basically 2 types of system to designates tool geometry of single point cutting tool

Cutting using single point cutting tool can be affected by ~~the~~ angle of tool and the nose radius of the tool. The arrangement of all these in a particular order is called as single point cutting tool.

$\alpha_b - \alpha_s - \theta_e - \theta_s - C_e - C_s - r$

a) ASA

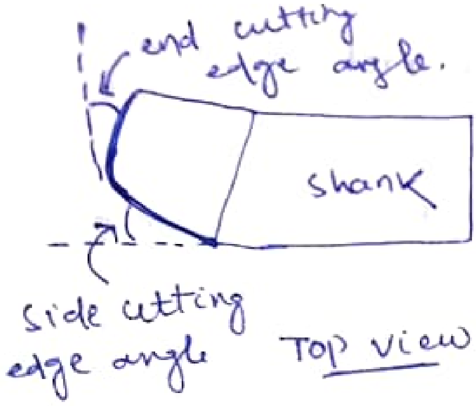
b) ORS

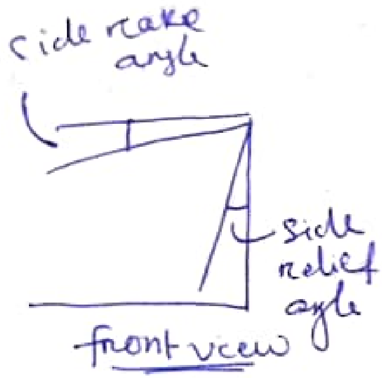
1. Angle are ~~made~~ ~~defined~~ measured w.r.t to
2. perpendicular plane
3.

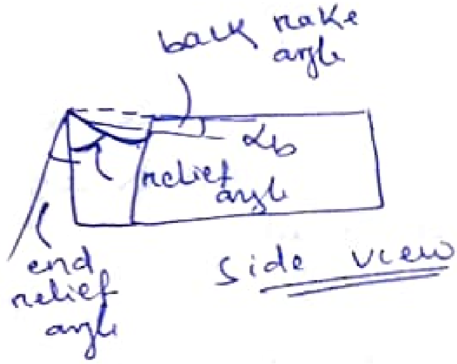
Angles are measured w.r.t ~~to~~ plane containing principal side cutting edge and the plane normal to it.

$i - \alpha' - \theta' - \theta_e' - C_e - \psi - r$

i → inclination angle; α' → side rake; C_e → end cutting edge; ψ → approach / principal cutting edge angle







Effect of Tool Geometry on machining

Back rake angle

→ ~~It is the angle betn the face of the tool and a~~

→ With increase in back rake angle the chip is getting curling and moving away from somewhere in the middle of the rake face. hence the length of contact betn chip and rake face will be shorter, frictional energy losses are reducing and therefore forces and power consumption reducing

→ Even though strength of tool is reduced with the increase in rake angle, if at all tool is failuring because of strength, it is considered as abnormal failure of the tool ~~body~~ only.

But the increase in rake angle when the forces and machining are reducing the tool wear reducing and hence force same tool can be used for longer duration

~~and therefore~~

hence the tool life is increased.

→ The contact area betn tool tip and work piece is called as wear land.

→ with increase in back rake angle tool the length of the tool, b/w wear out for enduring the required amount time will be longer therefore the time taken for longer length of the tool to be worn out is longer. hence the tool life is increased.

→ max^m back rake angle used is only 45° because beyond 45° increase in back rake angle will cause the drastic reduction in the strength of the tool.

→ Zero back angle used when machining of brass work piece. and also on thread cutting operation.

→ Generally back rake angle not affecting the surface finish produced on the work piece but during m/cing of brass w/p by keeping all other parameters remains constant with changing in back rake angle it is found that surface finish changing and it is found that at zero rake angle it is producing better surface finish.

② Side rake angle

$\alpha_s \uparrow$

strength ↓

force ↓

power ↓

Tool ↑

↳ With increase in side rake angle amount of chip bending in width line strain reducing.

α_s = ~~..~~ 5 to 45°

③ Relief angle

→ With zero relief angle of the tool cannot penetrate into the work piece and the tool is simply rubbing on the work piece without doing any machining.

→ θ_e = 5 to 15°

θ_s = 5 to 15°

④ cutting edge (C_e, C_s)

→ If the end cutting angle increases nose radius decreases, therefore surface finish produced ~~with the~~

→ ~~with increase~~ in

on the machined surface is ~~reduced~~ ~~increased~~ reduced.

→ with increase in side cutting edge angle, the nose radius increased therefore the surface finish produced on the machined surface is reduced.

C_e = 8 to 20°

C_s = 0 to 90° (65° to 90° preferable)

⑤ Nose Radius

→ As the nose radius increasing the surface finish produced on the machined surface ~~reduced~~. producing is better but on the other hand with increase in nose radius the surface contact betn tool and w/p increases therefore the vibration induced during machining will be increasing

→ Due to increase in vibration, the chattering start, and chattering mark is produced which damages the surface finish

→ The optimum nose radius which gives better surface finish 0.2 to 1.2 mm

cutting speed

→ cutting speed of cutting tool can be defined as the rate at which its cutting edge passes over the surface of the w/p in unit time

→ It is normally expressed in terms of surface speed in meters per minute.

→ If it is too high the tool will be ~~fail~~ get over heated and its cutting edge may fail.

→ If it is too low, the time consumed in machining and full cutting capacities of the tool and machine are not utilized which results in lowering of productivity and increases the production cost.

feed

→ It is defined as the distance travelled along or into the work piece for each pass of the point through a particular ~~cut line~~. position

→ for single point
→ ~~Eg: In lathe~~

Eg: In turning operation on a lathe it is equal to the advancement of tool corresponding to each revolution of work. (mm/rev)

(ii) In milling, the feed is basically considered per tooth of the cutter which is (feed/rev)

(iii) In planning, it is the work fed and not the tool.

Depth of Cut :-

→ It is the penetration of the cutting edge of the tool into the w/p material in each pass, measured ~~parallel~~ perpendicular to the machined surface.

→ It determines the thickness of metal layer removed by the cutting tool in one pass.

cutting fluid

cutting fluid sometimes referred as lubricants or coolants are liquid and gases applied to the tool and w/p to assist the cutting operation

Purpose of cutting fluid

(1) TO cool the tool

cooling is necessary to prevent mettallurgical damage and to assist in decreasing friction at the tool chip interface

(ii) TO cool the work piece

(iii) TO lubricate and reduce friction

(iv) TO improve surface finish

(v) TO cause chips breaks up into smaller parts

(vi) TO wash the chip away from the tool

(vii) It prevents corrosion of chips and machine

properties of cutting fluid

→ Highly heat absorption capacity

→ It should posses good lubricating properties

→ It should be non-corrosive to work piece and machine

→ Low viscosity to permit free flow of the liquid.

→ It should be non-toxic to operating person

→ It should be stable in use and storage

→ It should be safe

→ It should permit clean view of work

→ Low priced to minimize the cost of production

most commonly used cutting fluids are

(i) cast iron:- no cutting fluid is used

(ii) Steel - Lard oil + mineral oil

(iii) Alloy steel:- sulphur base oil + mineral oil

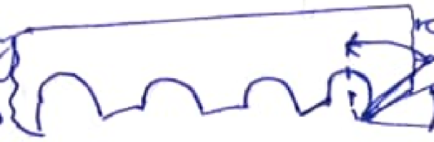
(iv) copper:- soluble oil with 90% to 95% of water

(v) Aluminium - mineral with soluble oil.

Hack-saw Blade

→ A Hacksaw blade is a multi-point cutting tool has a very large number of wedge like points each with its own rake and clearance angle is used to cut steel and other metals.

→ The rake is necessary but too much rake makes the tooth weak.

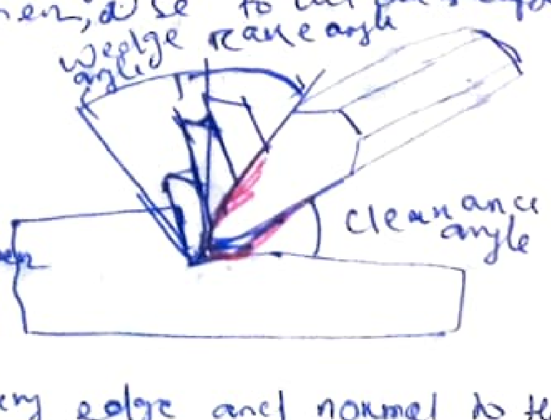


→ It is also necessary to have clearance angle. If there is no clearance angle then a large amount of ~~frictional force~~ energy will be lost to overcoming the frictional force.

→ High speed steel blades are used for cutting of tough, resistant material while high Carbon steel are used for general cutting.

Chisel

→ A chisel is a single point cutting tool ~~used to~~ with a wedge shaped cutting edge and a handle which is struck with a hammer, use to cut ~~or shape~~ metal.

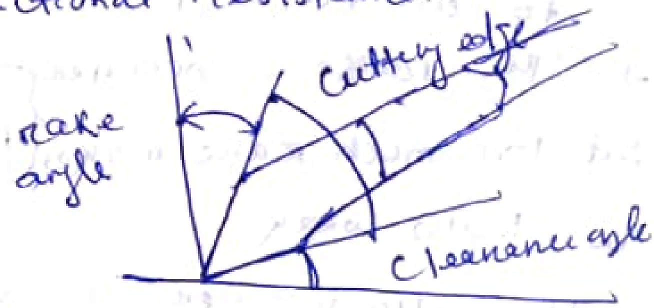


→ Angle between the working surface and lower cutting edge known as clearance angle

→ Angle betn upper cutting edge and normal to the working surface known as rake angle

→ The Chisel is seen flat on the work if there is no clearance angle

→ The clearance angle takes on actual part in the cutting on shearing action, but it is given on a tool to remove the loss of energy caused by the frictional resistance.



→ ~~using cold chisel with no clearance angle~~

Reamers

A reamer is a type of cutting tool used in metalworking to enlarge the size of existing hole. ~~by a small amount with~~

Taps & Dies

Taps & Dies are 2 tools used to create screw threads.

→ A tap is used to form thread on the inner surface of a hole.

→ Dies used to create external thread on cylindrical material such as rod

Lathe

The main function of a lathe is to remove metal from a piece of work to give it required shape and size.

→ This is accomplished by holding the work securely and rigidly on the machine and then turning it against the cutting tool which will remove metal from the work in the form of chips.

→ To cut the material properly the tool should be harder than the material of the work piece should be rigidly held on the machine and should be fed on progressed in a definite way relative to the work.

Description and function of Lathe parts

a) Bed
b) Head stock
c) Tail stock
d) Carriage
e) feed mechanism
f) Screw cutting mechanism

I Bed

→ The Lathe bed forms the base of the machine. The head stock and tail stocks are located either end of the bed and the carriage rest over the lathe bed and slides on it. The lathe bed being the main guiding member of the tool, for accurate my work