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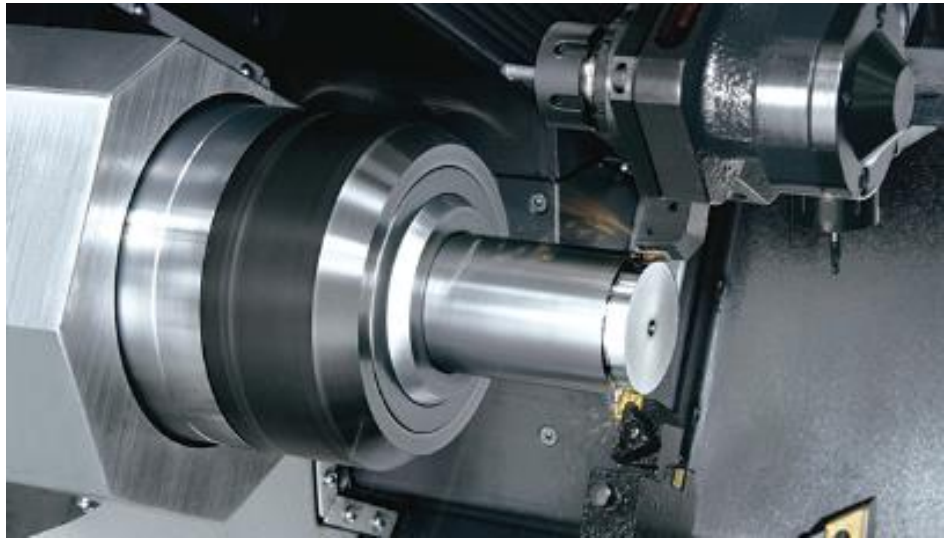
Tool geometry

A cutting tool has one or more sharp cutting edge.

cutting tools classified into two categories

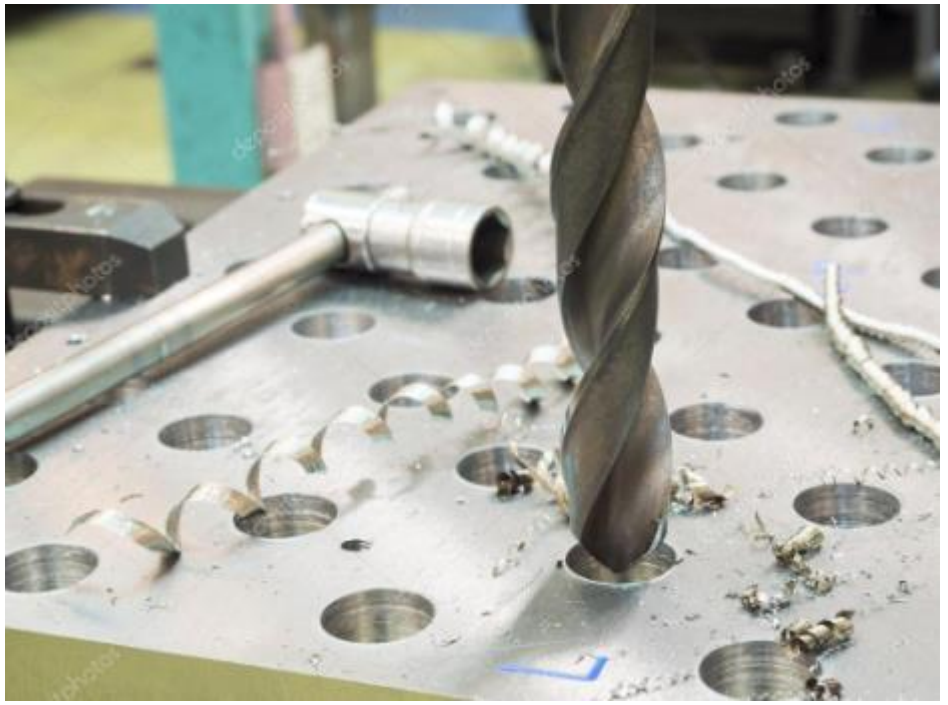
(1) Single point cutting tool

- Single point cutting tools contain only one main cutting edge in the cutter body.
- single point cutting tool, **only one main cutting edge** continuously remains in contact with workpiece
- Example turning tool ,shaping tool, planing tool, slotting tool ,boring tool.
- Its **cutting edge prepared by grinding**.
- Low MRR.
- Low productivity.
- **Simple in design and fabrication**.
- Comparatively **low in cost.**



(2) Multi point cutting tool

- Multi point cutting tools contain more than one (even up to hundreds) cutting edges in the cutter body.
- Sometime, cutters with two cutting edges (more than one) are also considered multi-point cutting tools (instead of considering it as a double point cutter).
- Example ,milling cutter, drills, reamers, saw etc
- **High MRR**.
- Complicated in design and fabrication.
- Costlier
- **High productivity.**



- Tool and workpiece interaction given a depth of cut and relative of motion between tool and workpiece result in chipping.
- Cutting action involves shear deformation of work material to form a chip ,as chip is removed ,new surface is exposed.

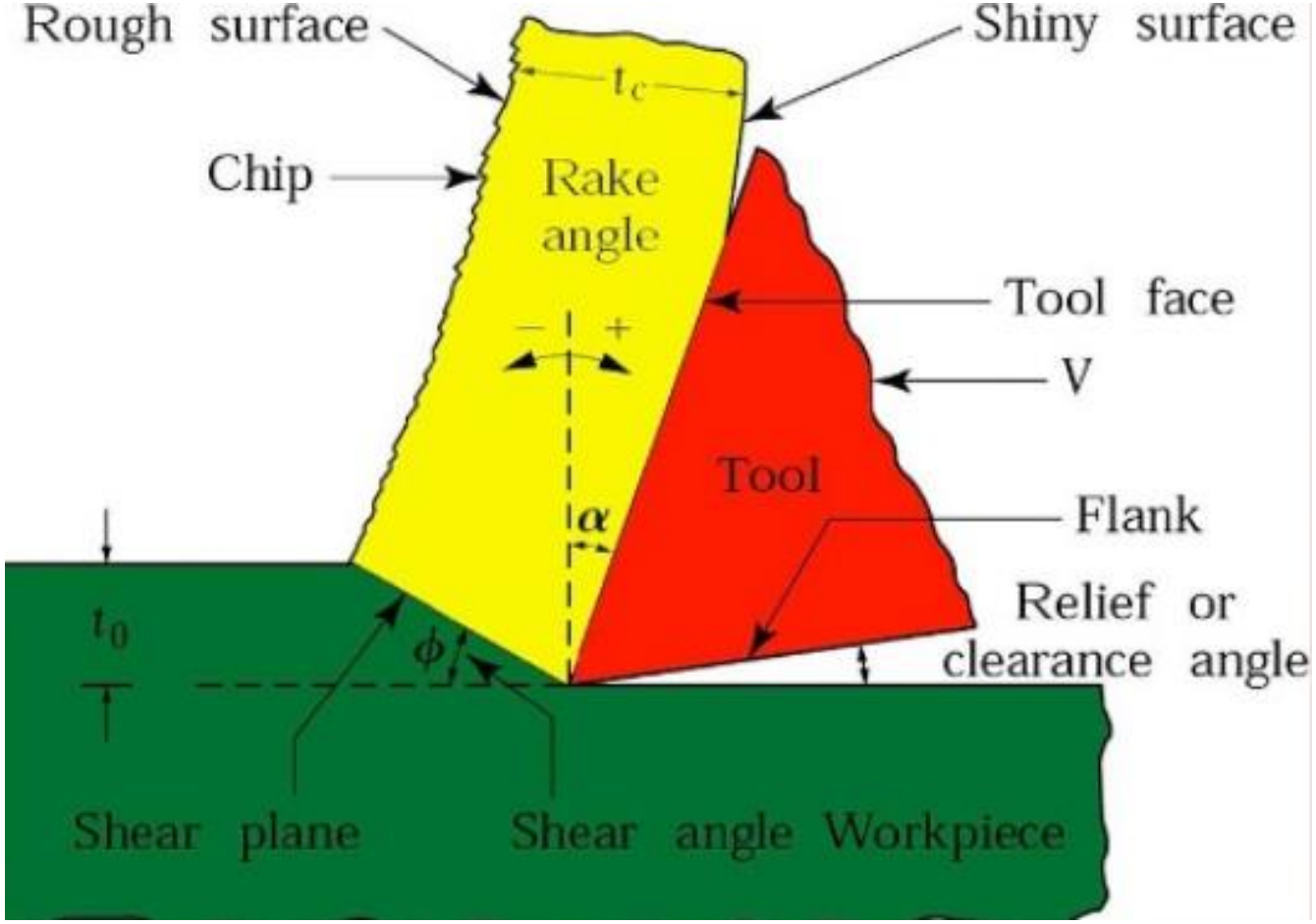
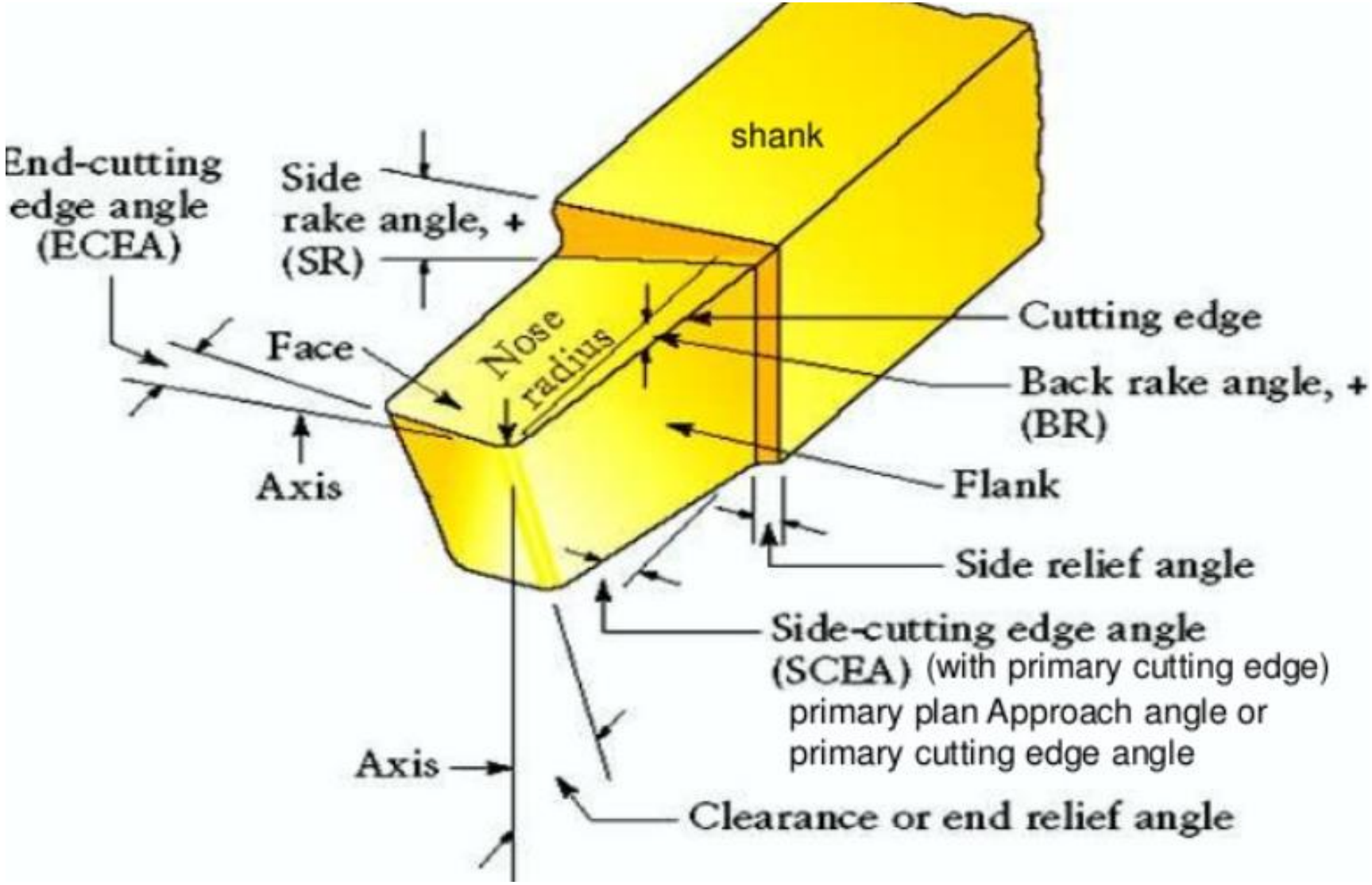


Fig. Element of metal cutting

Geometry of single point cutting tool
or
Terminology of turning tool



Single Point Cutting Tool Material:
This tool can be made from several materials like:

- *High carbon steel*
- *High-speed steel*
- *Ceramics*
- *Diamonds*
- *Cemented carbide*
- *CBN (Cubic boron nitrite)*

High speed steel single point cutting tool

Single Point Cutting Tool Geometry / Nomenclature:

(1) Shank (The main body of the tool is known as shank. It is the backward part of tool which is hold by tool post)

(2) Flank (The surface or surface below and adjacent to the cutting edge is called flank of the tool)

(3) Face (The top surface tool on which chips passes after cutting is known as face. It is the horizontal surface adjacent of cutting edges.)

(4) Nose (The point where both cutting edge meets known as cutting point or nose.)

(5) Cutting Edges

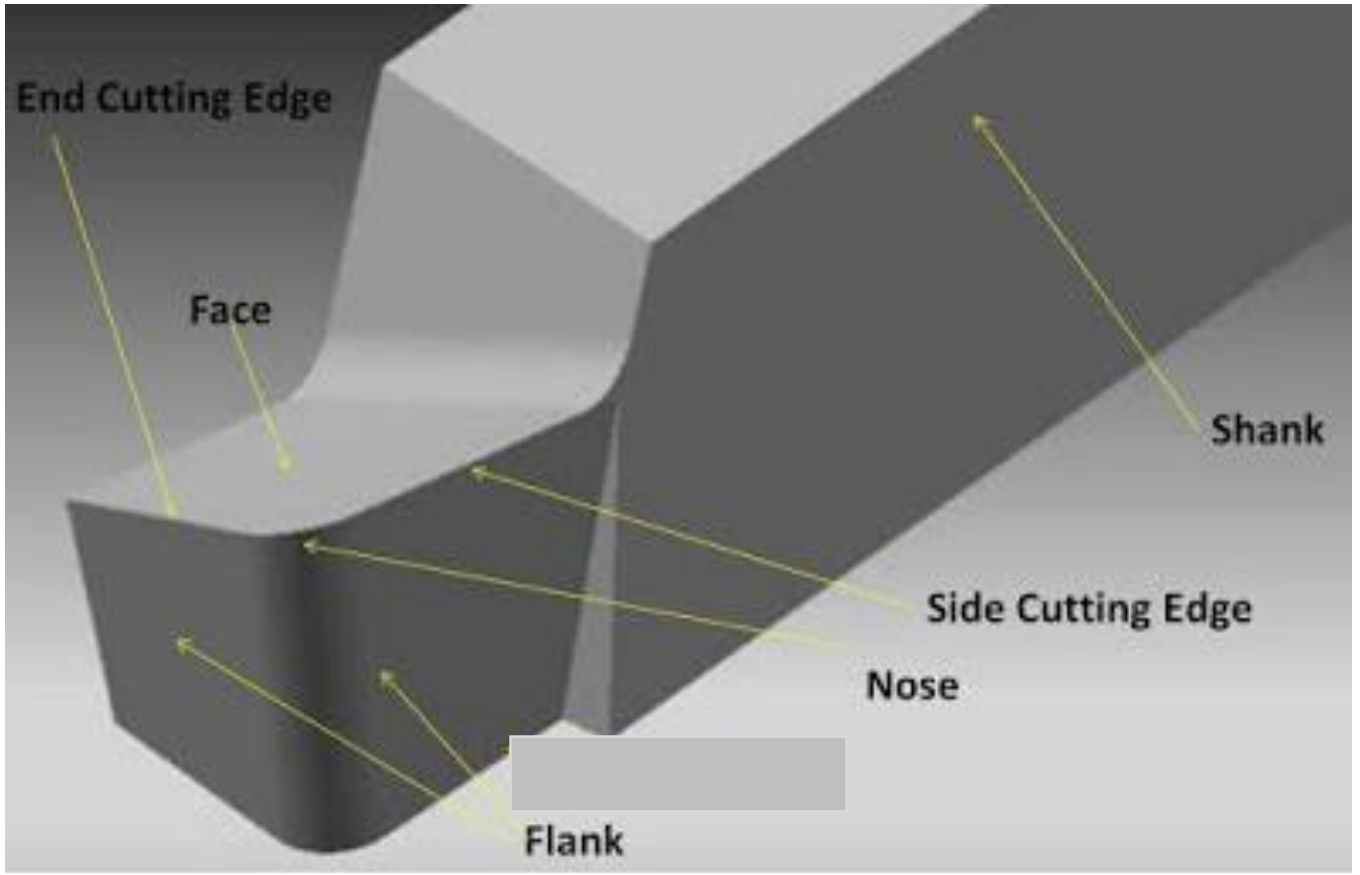
Angle:

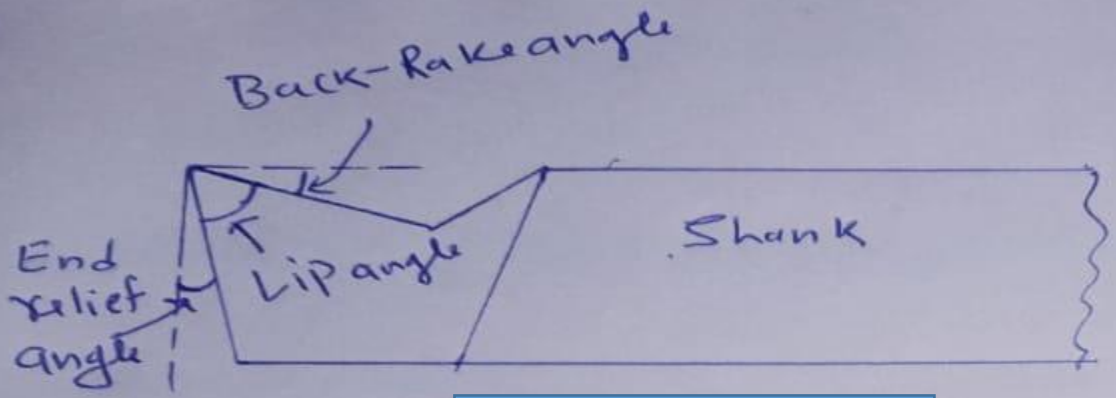
(1) Clearance angle

(2) Rake angle

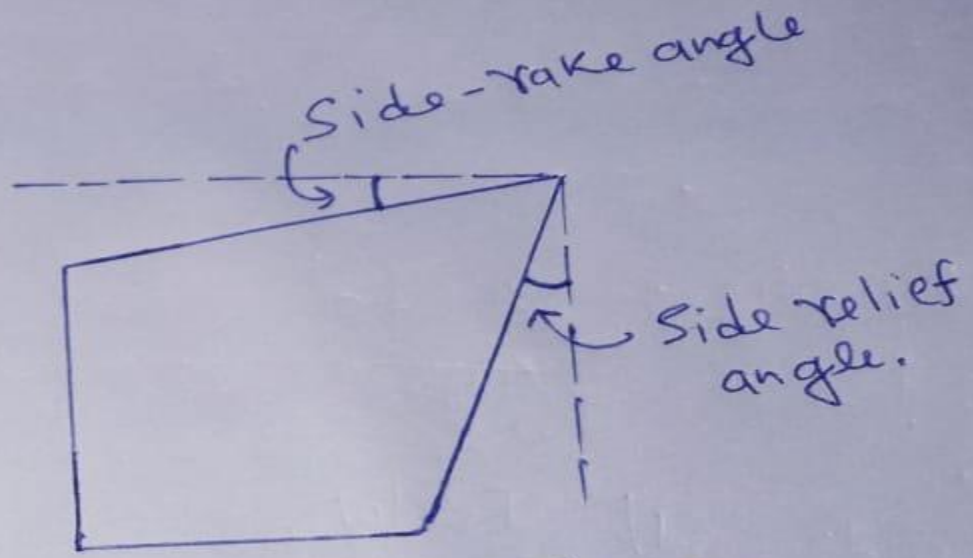
(3) Side Cutting edge angle

(4) End cutting edge angle

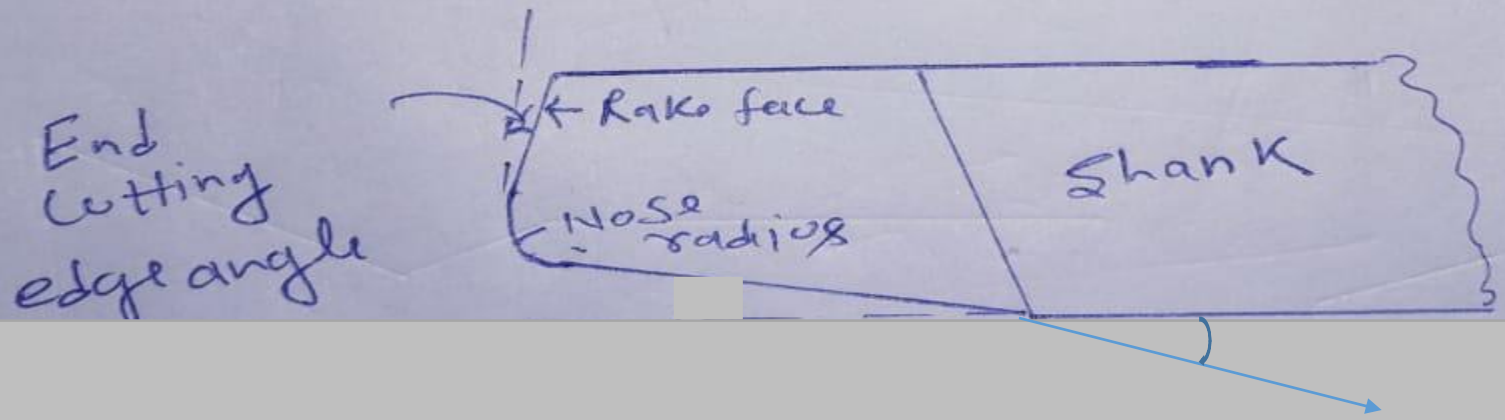




Front view



Side view



Top view

Side cutting edge angle

(1) Clearance angle:

- This is the angle between the machined surface and the underside of the tool called the flank face.
- The clearance angle is provided such that the tool will not rub or spoil the machined surface but at the same time will increase the cutting force.
- A very large clearance angle reduces the strength of the tool tip, hence an angle of the order of 5-6 ^{o} is generally used.

(a) Side relief angle:

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

(b) End relief angle:

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

(2) Rake angle:

- It is the angle between the face of the tool called the rake face and the normal to the machining direction.
- Higher the rake angle better is the cutting and less is the cutting force
- Increasing the rake angle reduces the strength of the tool tip as well as the heat dissipation through the tool.
- There is a maximum limit to the rake angle and is generally of the order of 15^{o} for high speed steel tool cutting mild steel.

- It is possible to have rake angle as zero or negative. These are generally used in the case of highly brittle tool materials suchg as carbide or diamond for giving extra strength to the tool tip.

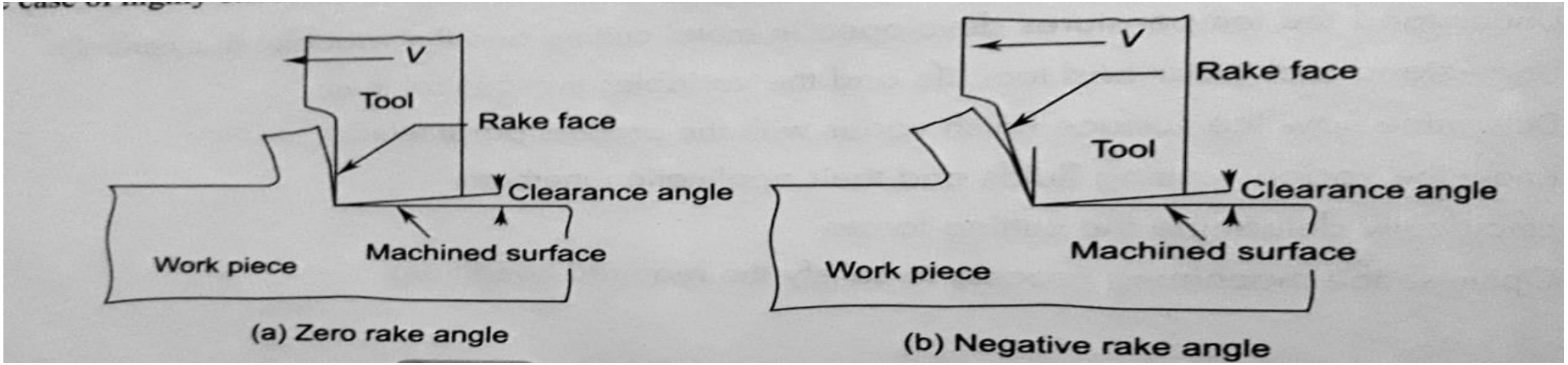


Fig. Tool cutting at different rake angle

(a) Back rake angle :

It is the angle between the tool face and a line parallel to the base of the tool and measured in a plane perpendicular through the side cutting edge.

(b) 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 plane perpendicular to the base and the side cutting edge.

(3) Side cutting edge angle :

This angle **also is known as the lead angle**. This is the angle between the side cutting edge and side of the tool shank.

(4) End cutting edge angle:

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

Tool nomenclature systems:

(1) ASA system

(2) ORS system or international orthogonal

Tool designation or Tool Signature in (ASA) System

This is the order in ASA Sys

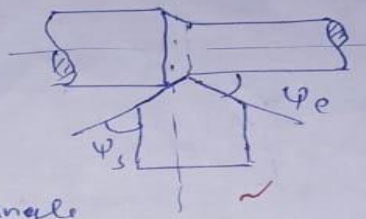
$$\alpha_b - \alpha_s - \gamma_e - \gamma_s - \psi_e - \psi_s - r$$

To remember easily follow the rule.

→ Rake, relief ; cutting edge

→ Side will come last

→ finish with nose radius (inch)



α_b = back rack angle

α_s = Side rack angle

γ_e = end relief / clearance Angle

γ_s = Side relief / clearance Angle

ψ_e = End cutting edge angle

ψ_s = Side cutting Edge Angle

r = Nose radius

Tool designation or tool Signature in ORS System.

$$i - \alpha - \gamma - \gamma_1 - \psi_e - A - r$$

$90° = \psi_s + A$

$A = 90 - \psi_s$

i = inclination angle

α = orthogonal Rake angle

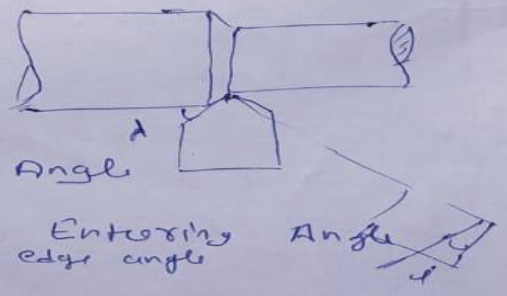
γ = Side relief angle

γ_1 = End relief angle

ψ_e = End cutting edge Angle

A = Approach angle or Entering Angle or Principle cutting edge angle

r = nose Radius.



Conversion between ASA System and ORS

Imp

U have to Learn

$$\tan\alpha = \tan\alpha_s \sin\lambda + \tan\alpha_b \cos\lambda \quad \Big\} \text{GATE}$$

$$\tan\alpha_b = \cos\lambda \tan\alpha + \sin\lambda \tan i$$

$$\tan\alpha_s = \sin\lambda \tan\alpha - \cos\lambda \tan i \quad \Big\} \text{IES}$$

$$\tan i = \tan\alpha_b \sin\lambda - \tan\alpha_s \cos\lambda$$

if $\lambda = 90$

$$\tan\alpha = \tan\alpha_s$$

$$\boxed{\alpha = \alpha_s}$$

$\because \sin 90 = 1$
$\cos 90 = 0$
$\tan 0 = 0$
$\tan 90 = \infty$

* for orthogonal cutting $i = 0$
* for oblique cutting $i \neq 0$
* pure orthogonal cutting $i = 0$ and $\lambda = 90$

27/8/2018
Lecture – 5

Question 1 In ORS system the tool angles are.

Inclination angle (i) = 0°

Orthogonal rake (α) = 10°

Principal cutting edge angle (λ) = 75°

Determine :-

(i) back rake angle

(ii) Side rake angle.

$$\tan\alpha_b = \cos\lambda \tan\alpha + \sin\lambda \tan i$$

$$= \cos 75° \tan 10 + \sin 75° \tan 0°$$

$$\tan\alpha_b = 0.0456$$

$$\alpha_b = \tan^{-1}(0.0456) = 2.61° \text{ Ans.}$$

Ans

$$\tan\alpha_s = \sin d \tan q - \cos d \tan i$$

$$= \sin 75^\circ \tan 10^\circ - \cos 75^\circ \tan 0^\circ$$

$$\tan\alpha_s = 0.1703$$

$$\boxed{\alpha_s = 9.66^\circ}$$ Ans

Question 12 Calculate the inclination angle and orthogonal rake angle ~~and orthogonal rake angle~~. Given side rake $= -5^\circ$ back rake $= -7^\circ$, side cutting edge angle $= 15^\circ$

Soln As per ASA system –

$\alpha_b = -7^\circ$

$\alpha_s = -5^\circ$

$\psi_s = 15^\circ$

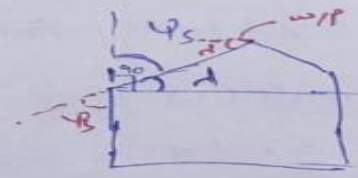
$i = ?$

$\alpha = ?$

$$\tan i = \tan\alpha_b \sin d - \tan\alpha_s \cos d$$

first $d = ?$

d = entering Angle



$90 = \psi_s + d$

$d = 90 - \psi_s$

$d = 90 - 15$

$\boxed{d = 75^\circ}$

$$\tan i = \tan(-7^\circ) \sin 75^\circ - \tan(-5^\circ) \cos 75^\circ$$

$$= -0.09596$$

$$\boxed{i = 5.48^\circ}$$ Ans

(iii) $\tan\phi = \tan\phi_s \sin\delta + \tan\phi_b \cos\delta$

$\tan(-5^\circ)\sin 75^\circ + \tan(-7^\circ)\cos 75^\circ$

$\tan\phi = -0.11629$

$\boxed{\phi = 6.63^\circ}$ Ans

THANKYOU