Single Point Cutting Tool Geometry

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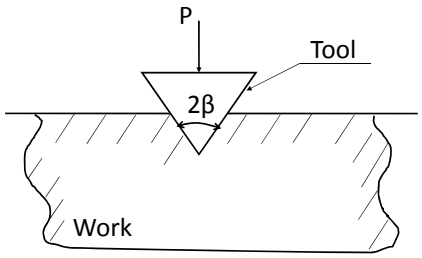
Outline

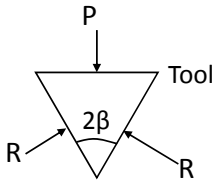
- Tool Geometry, Tool Angles
- Systems for Tool nomenclature
  - ISO System - *ORS/NRS*
  - American Standards System - *ASA*
- Tool Angle Conversion: ISO ⟷ ASA
  - Mathematical Basis

Basic Tool Shape



Wedge angle : 2β

Cutting Efficiency

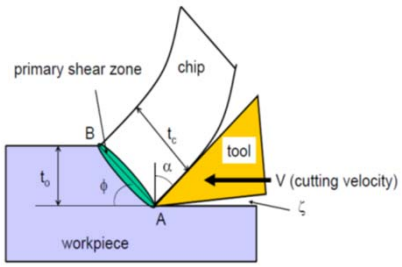


P = 2R sinβ

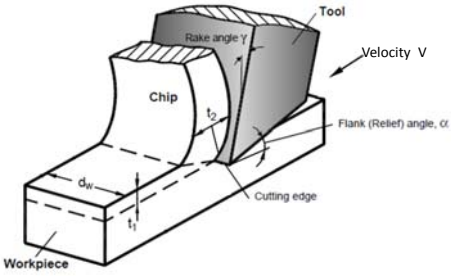
Cutting Efficiency = $\frac{R}{P}$

$$\eta \propto \frac{1}{\sin\beta}$$

Orthogonal Cutting Geometry



Orthogonal Cutting

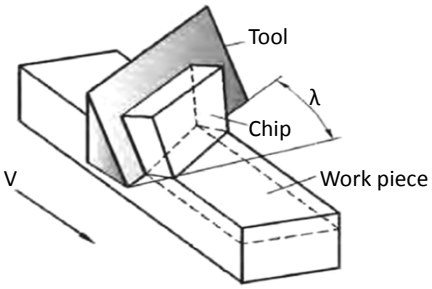


Orthogonal Cutting

Characteristics

- Cutting edge Perpendicular to cutting Velocity Vector
- 2D cutting phenomenon
- No Spread of material across

Oblique Cutting



Oblique Cutting

Characteristics

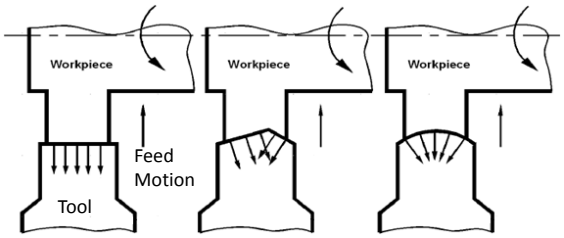
- Cutting edge at an angle(λ) to the normal to velocity vector in the cutting plane
- Inclination angle λ
  - modifies Tool angles
  - governs Direction of chip flow

Stabler's Law for Chip flow

$n_c = k.\lambda$ nc = chip flow angle

K = 0.8 – 1.0

Free and Restricted Cutting



Chip Flow

Free Restricted

Classification of Cutting Tools

- Single Point tools
  - *Turning, Shaping, Boring*
- Two Point tools
  - Twist *Drills, Core drills*
- Multi Point tools
  - *Milling cutters, Taps, Reamers*

Single Point Cutting Tool

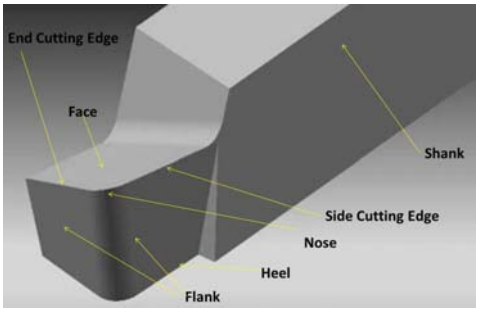
Tool Inserts

Insert Shapes

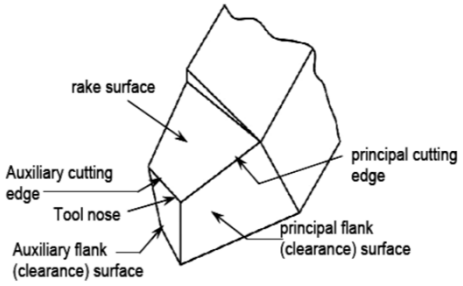
Twist Drills and End Mills

Multipoint Tools – Milling Cutters

Single Point Cutting Tool - Nomenclature



Single Point Tool Geometry



Tool Nomenclature Systems

Tool in Hand

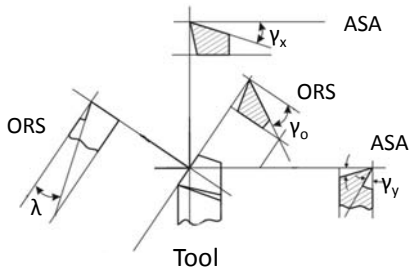
- ISO System : *ORS/ NRS*
  - Orthogonal/ Normal Reference System
- American Standards Association (ASA) system

Tool in Machine

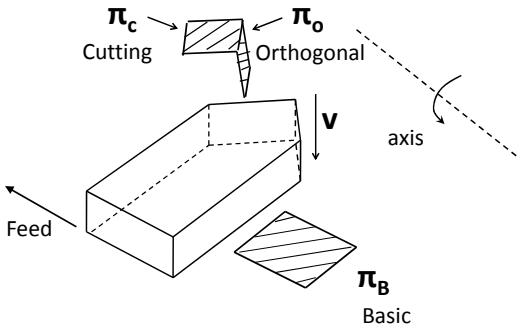
- Tool /Insert setting in fixture

Tool Angle Reference Systems

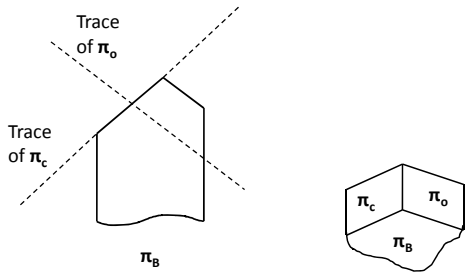
(ORS and ASA)



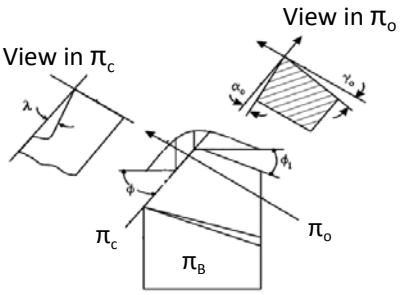
Tool Reference Planes



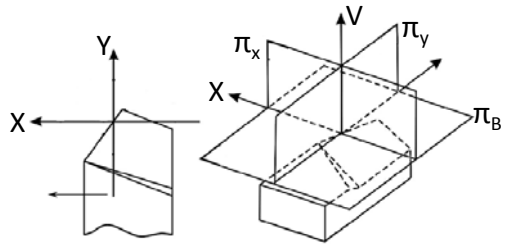
Orthogonal (ORS) Reference Planes



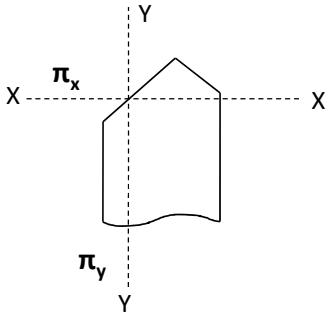
Reference Planes - ORS



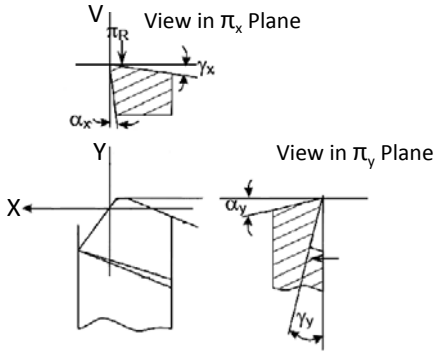
Reference Planes – ASA system



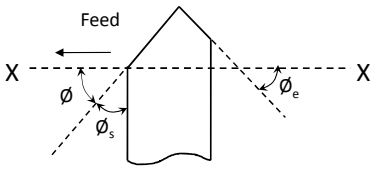
ASA Reference Planes



Tool Angles – ASA System



Tool Angles



Ø = Plan Approach angle
$Ø_s$ = Side cutting Edge angle
$Ø_e$ = End cutting Edge angle

Ø = 90 - $Ø_s$

Tool Designation

ASA System

γ_y , γ_x , α_y , α_x , $Ø_e$, $Ø_s$, r

γ_y	:	Back rake angle
γ_x	:	Side rake angle
α_y	:	Front clearance angle
α_x	:	Side clearance angle
$Ø_e$	:	End cutting Edge angle
$Ø_s$	:	Side cutting Edge angle
r	:	Nose radius (mm)

Tool Angle Conversion

ORS ⟶ **ASA**
(γ_o, λ) (γ_x , γ_y)

$$\begin{bmatrix} tan\gamma_x \\ tan\gamma_y \end{bmatrix} = \begin{bmatrix} sinØ & -cosØ \\ cosØ & sinØ \end{bmatrix} \begin{bmatrix} tan\gamma_o \\ tan\lambda \end{bmatrix}$$

Ø = Plan approach angle

Tool Angle Conversion

ASA ⟶ **ORS**

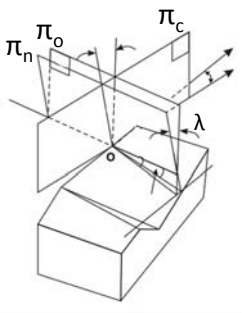
(γ_x , γ_y) (γ_o, λ)

$$\begin{bmatrix} tan\gamma_o \\ tan\lambda \end{bmatrix} = \begin{bmatrix} sin\emptyset & cos\emptyset \\ -cos\emptyset & sin\emptyset \end{bmatrix} \begin{bmatrix} tan\gamma_x \\ tan\gamma_y \end{bmatrix}$$

$\emptyset$ = Plan approach angle

Does Orthogonal Plane π_o represent <u>True</u> rake angle?

Orthogonal and Normal Reference Planes



Tool Angle Conversion

ORS ⟶ NRS

γ_o γ_n

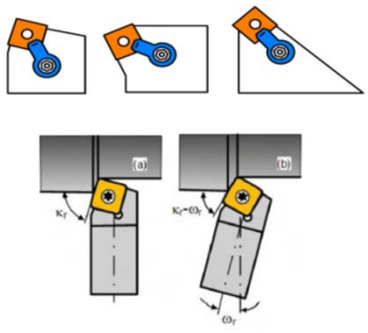
$$tan\gamma_n = tan\gamma_o \, . Cos\lambda$$

Tool in Machine System

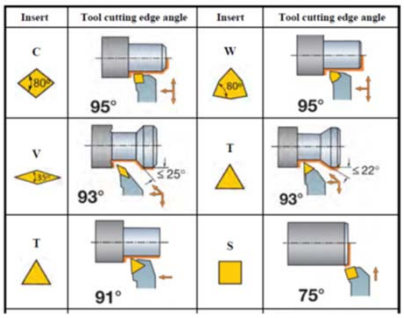
Static angles on Tool/Insert change due to

- Setting in tool Holders/ Fixtures
- Tool/ Work relative motion.

Inserts in Tool Holder



Inserts and Tool Angles



Tool Setup on Machine