Designation of Cutting Tools

By designation or nomenclature of a cutting tool is meant the designation of the shape of the cutting part of the tool. The following systems to designate the cutting tool shape which are widely used are:

- Tool in Hand System
- Machine Reference System or American Standard Association (ASA) System
- Tool Reference System
  - Orthogonal Rake System (ORS)
  - Normal Rake System (NRS)
- Maximum Rake System (MRS)
- Work Reference System (WRS)

Tool Reference System

The references from which the tool angles are specified are the

- Reference plane (π_R)
- Machine longitudinal plane (π_x)
- Machine transverse plane (π_y)
- Principal cutting plane (π_c)
- Orthogonal plane (π_o) and
- Normal plane (π_n)

The reference plane (π_R) is the plane perpendicular to the cutting velocity (V_c). The machine longitudinal plane (π_x) is the plane perpendicular to π_R and taken in the direction of feed (longitudinal feed). The machine transverse plane (πy) is the plane perpendicular to both π_R and π_x or plane perpendicular to π_R and taken in the direction of cross feed. The principal cutting plane (π_c) is the plane perpendicular to π_R and containing the principal cutting edge. The orthogonal plane (π_o) is the plane perpendicular to π_R and π_c. The normal plane (π_n) is perpendicular to the principal cutting edge.

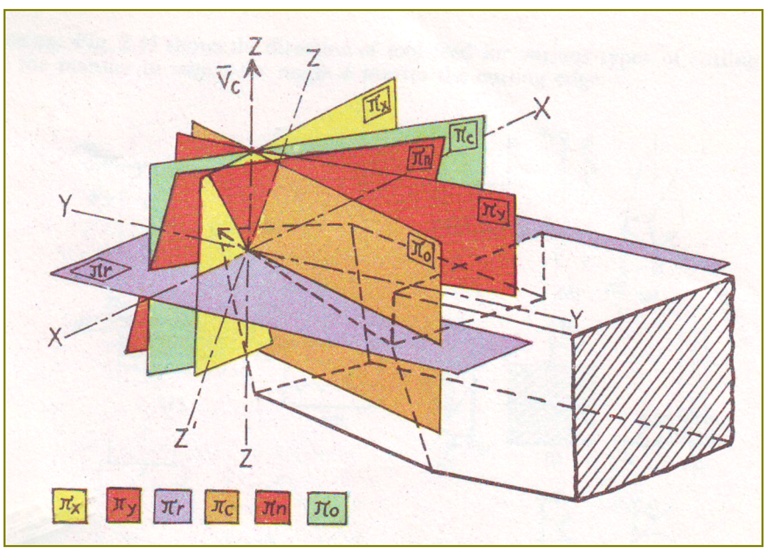
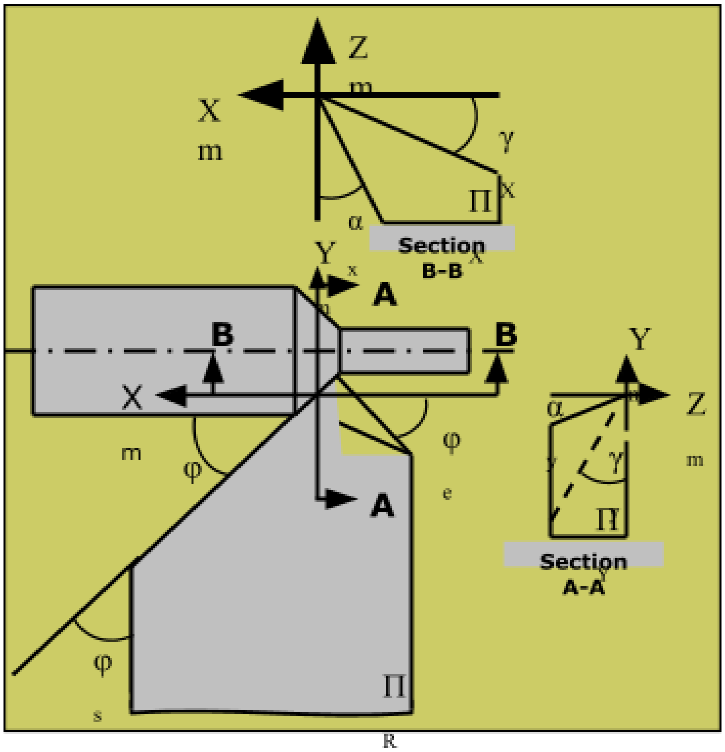


Fig 3.6

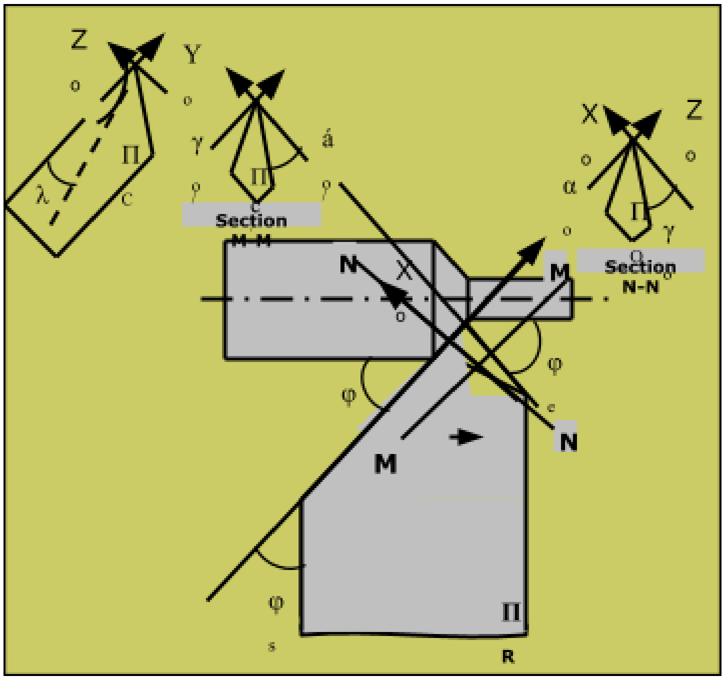
American Standard Association System



Tool Character						
γ_v	γ_x	α_v	α_x	φ_e	φ_s	r
5^0	10^0	7^0	8^0	20^0	30^0	1/32

γ_v	Back rake angle
γ_x	Side rake angle
α_v	Back or end clearance angle
α_x	Side clearance angle
φ_e	Auxiliary or End cutting edge angle
φ_s	Side cutting edge angle (90o-φ)
r	Nose radius (inch)

Orthogonal Rake System (ORS)



Tool Character						
λ	γ_0	α_0	$\alpha_0^{/}$	φ_e	φ	r
5^0	10^0	7^0	8^0	20^0	30^0	0.8 mm

λ	Inclination angle
γ_0	Orthogonal rake angle
α_0	Orthogonal clearance angle
$\alpha_0^{/}$	Auxiliary orthogonal clearance angle
φ_e	Auxiliary or End cutting edge angle
φ	Principal cutting edge angle ($90-\varphi_s$)
r	Nose radius (mm)

Interconversion Between ASA and ORS

Interrelations can be established between ASA and ORS and vice versa. Various methods are used for developing such interrelationships such as

- Method of projection
- Method of slopes
- Method of master line
- Circle diagram
- Vector methods, etc.

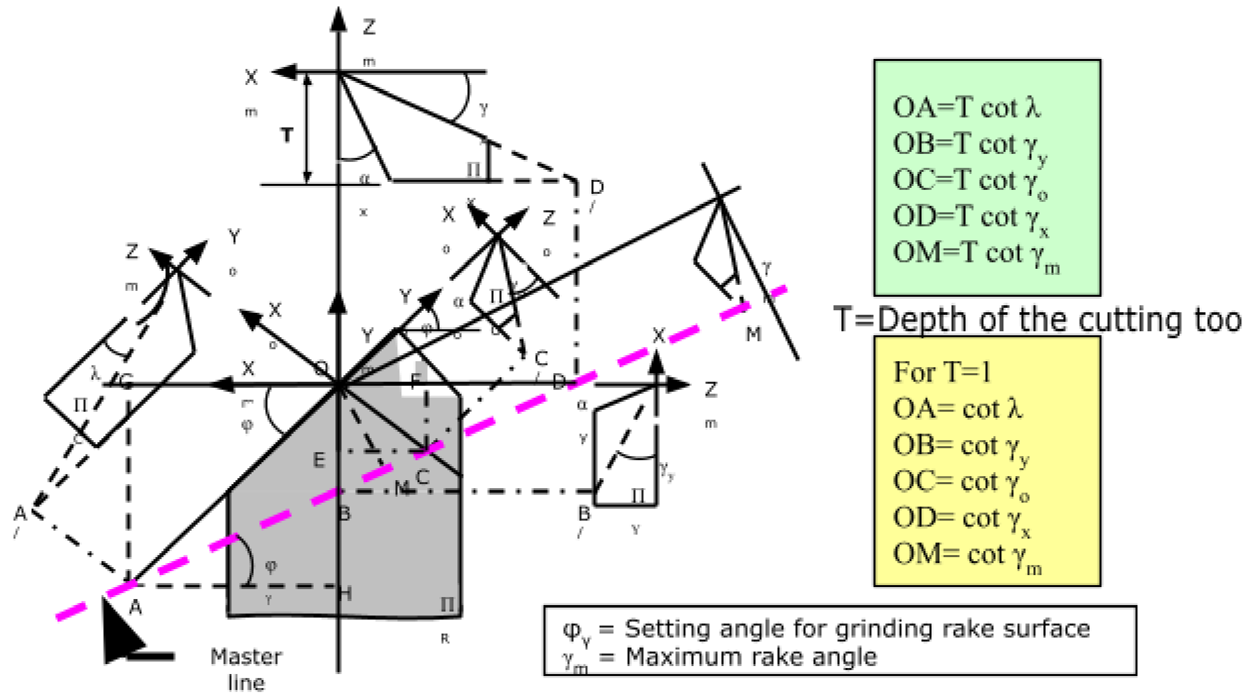


Fig 3.6

- Prove the followings by master line methods for a single point cutting tool.

(i) $\tan\gamma_o = \tan\gamma_x \sin\varphi + \tan\gamma_y \cos\varphi$

(ii) $\tan\lambda = -\tan\gamma_x \cos\varphi + \tan\gamma_y \sin\varphi$

(iii) $\tan\gamma_x = \tan\gamma_o \sin\varphi - \tan\lambda \cos\varphi$

(iv) $\tan\gamma_y = \tan\gamma_o \cos\varphi + \tan\lambda \sin\varphi$

(v) $\tan\gamma_m = \sqrt{\tan^2\gamma_o + \tan^2\lambda}$

(vi) $\varphi_\gamma = \varphi - \tan^{-1}\left(\frac{\tan\lambda}{\tan\gamma_o}\right)$

φ_γ = Setting angle for grinding rake surface
γ_m = Maximum rake angle

$\tan \gamma_o = \tan \gamma_x \sin \varphi + \tan \gamma_y \cos \varphi$

From **Figure** ΔOBD=ΔOBC+ΔOCD

½OB.OD=½OB.CE + ½OD.CF

½OB.OD=½OB.OC sin φ + ½OD.OC. cos φ

Dividing on both sides by ½OB.OC.OD

$$\frac{1}{OC} = \frac{\sin\varphi}{OD} + \frac{\cos\varphi}{OB}$$

$\tan \gamma_o = \tan \gamma_x \sin \varphi + \tan \gamma_y \cos \varphi$

$\tan \lambda = -\tan \gamma_x \cos \varphi + \tan \gamma_y \sin \varphi$

From **Figure** ΔOAD = ΔOAB +ΔOBD

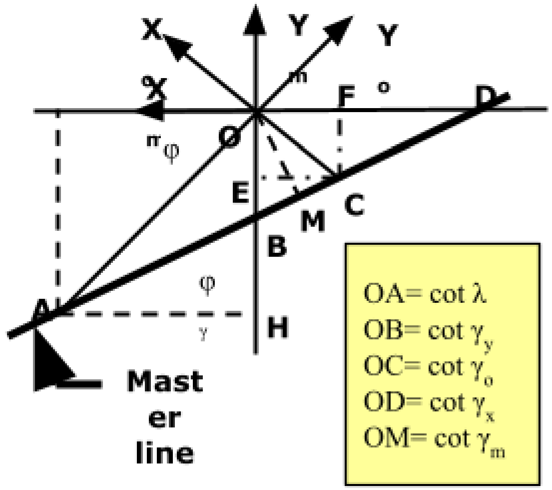
½ OD. AG = ½ OB. AH + ½ OB.OD

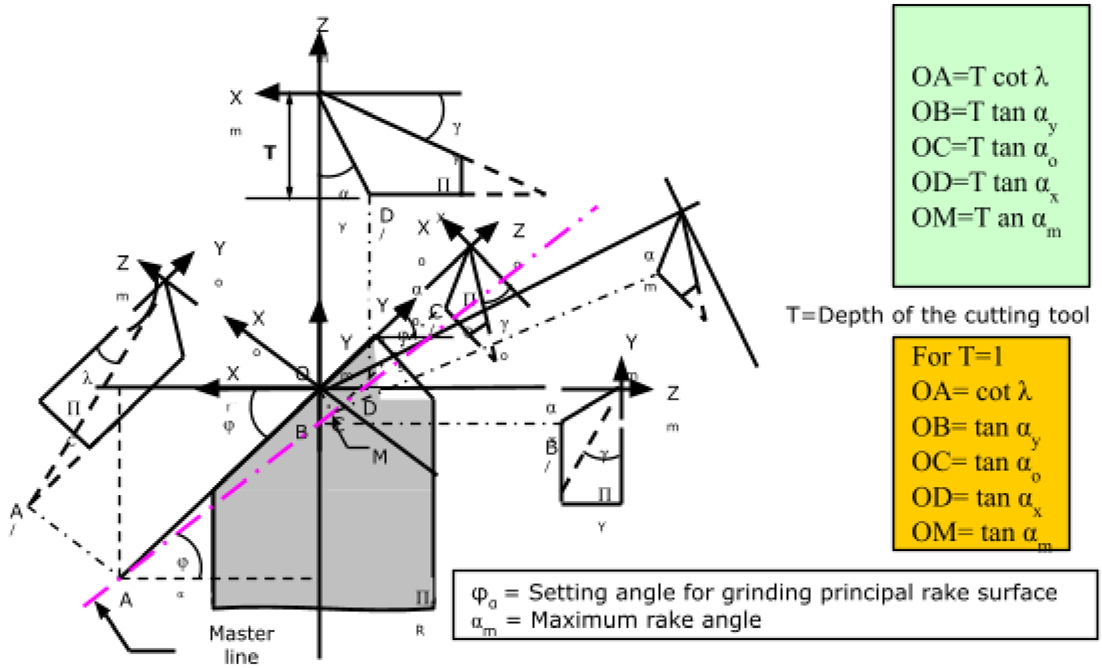
½ OD. OA. sin φ=½OB.OA COS φ + OB.OD

Dividing on both sides by ½OA.OB.OD

$$\frac{\sin\varphi}{OB} = \frac{\cos\varphi}{OD} + \frac{1}{OA}$$

$\tan \lambda = -\tan \gamma_x \cos \varphi + \tan \gamma_y \sin \varphi$





- **Prove the followings by master line methods for a single point cutting tool.**

(i) $\cot \alpha_o = \cot \alpha_x \sin \varphi + \cot \alpha_y \cos \varphi$

(ii) $\tan \lambda = -\cot \alpha_x \cos \varphi + \cot \alpha_y \sin \varphi$

(iii) $\cot \alpha_x = \cot \alpha_o \sin \varphi - \tan \lambda \cos \varphi$

(iv) $\cot \alpha_y = \cot \alpha_o \cos \varphi + \tan \lambda \sin \varphi$

(v) $\cot \alpha_m = \sqrt{\cot^2 \alpha_o + \tan^2 \lambda}$

(vi) $\varphi_\alpha = \varphi - \tan^{-1}\left(\dfrac{\tan \alpha_o}{\cot\lambda}\right)$

$\cot \alpha_o = \cot \alpha_x \sin \varphi + \cot \alpha_y \cos \varphi$

From **Figure** $\Delta OBD = \Delta OBC + \Delta OCD$

$\frac{1}{2}OB.OD = \frac{1}{2}OB.CE + \frac{1}{2}OD.CF$

$\frac{1}{2}OB.OD = \frac{1}{2}OB.OC \sin \varphi + \frac{1}{2}OD.OC. \cos \varphi$

Dividing on both sides by $\frac{1}{2}OB.OC.OD$

$$\frac{1}{OC} = \frac{\sin\varphi}{OD} + \frac{\cos\varphi}{OB}$$

$\cot \alpha_o = \cot \alpha_x \sin \varphi + \cot \alpha_y \cos \varphi$

$\tan \lambda = -\cot \alpha_x \cos \varphi + \cot \alpha_y \sin \varphi$

From **Figure** $\Delta OAD = \Delta OAB + \Delta OBD$

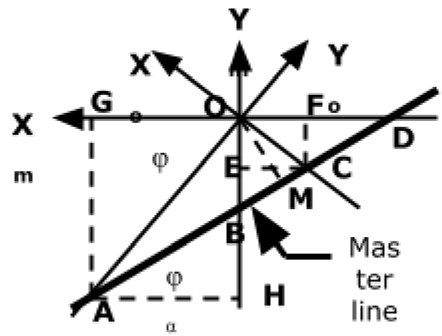
$\frac{1}{2}$ OD. AG = $\frac{1}{2}$ OB. AH + $\frac{1}{2}$ OB.OD

$\frac{1}{2}$ OD. OA. $\sin \varphi = \frac{1}{2}$OB.OA COS φ + $\frac{1}{2}$OB.OD

Dividing on both sides by $\frac{1}{2}$OA.OB.OD

$$\frac{\sin\varphi}{OB} = \frac{\cos\varphi}{OD} + \frac{1}{OA}$$

$\tan \lambda = -\cot \alpha_x \cos \varphi + \cot \alpha_y \sin \varphi$



For T=1

OA= $\cot \lambda$

OB= $\tan \alpha_y$

OC= $\tan \alpha_o$

OD= $\tan \alpha_x$

OM= $\tan \alpha_m$

Assignment-1

- **Prove by Master Line Method**

(i) $\cot \alpha_o = \cot \alpha_x \sin \varphi + \cot \alpha_y \cos \varphi$

(ii) $\tan \lambda = -\cot \alpha_x \cos \varphi + \cot \alpha_y \sin \varphi$

(iii) $\cot \alpha_x = \cot \alpha_o \sin \varphi - \tan \lambda \cos \varphi$

(iv) $\cot \alpha_y = \cot \alpha_o \cos \varphi + \tan \lambda \sin \varphi$

(v) $\cot \alpha_m = \sqrt{\cot^2 \alpha_o + \tan^2 \lambda}$

(vi) $\varphi_\alpha = \varphi - \tan^{-1}\left(\frac{\tan \alpha_o}{\cot \lambda}\right)$

(i) $\tan \gamma_o = \tan \gamma_x \sin \varphi + \tan \gamma_y \cos \varphi$

(ii) $\tan \lambda = -\tan \gamma_x \cos \varphi + \tan \gamma_y \sin \varphi$

(iii) $\tan \gamma_x = \tan \gamma_o \sin \varphi - \tan \lambda \cos \varphi$

(iv) $\tan \gamma_y = \tan \gamma_o \cos \varphi + \tan \lambda \sin \varphi$

(v) $\tan \gamma_m = \sqrt{\tan^2 \gamma_o + \tan^2 \lambda}$

(vi) $\varphi_\gamma = \varphi - \tan^{-1}\left(\frac{\tan\lambda}{\tan\gamma_o}\right)$

Reference:

LM-04-Conversion of tool angles from one system to another.pdf -pages 1-10