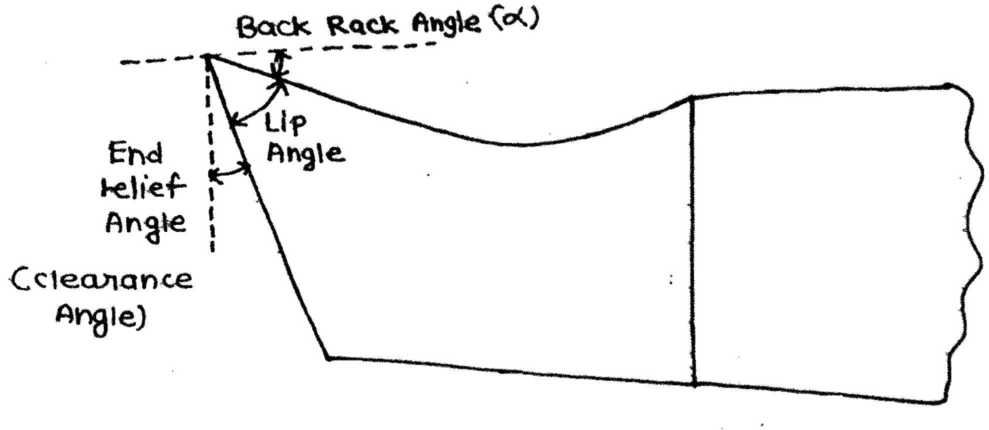
MADE EASY

Mechanical Engineering

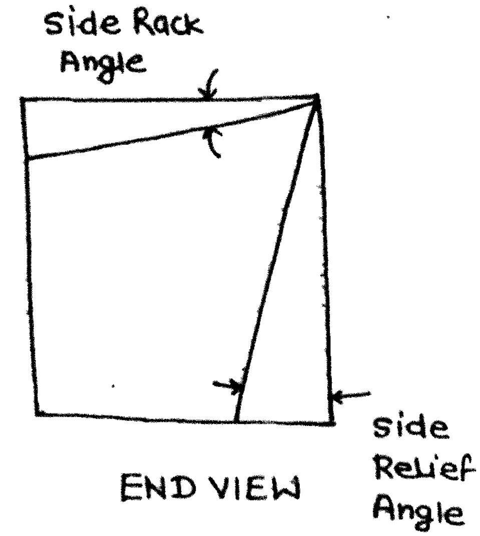
Toppers Handwritten Notes

METAL CUTTING

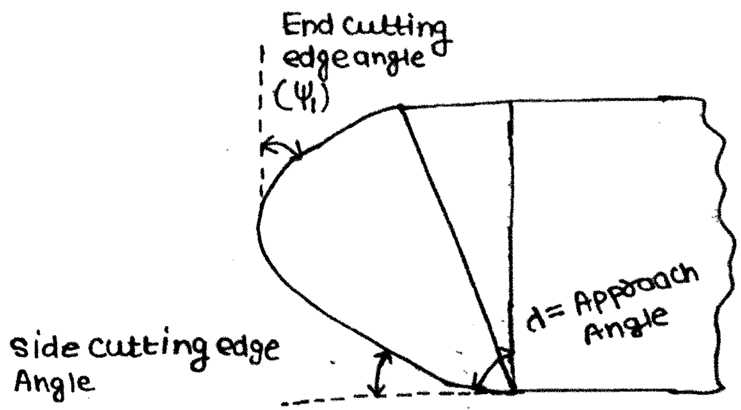
By-Swadesh Sir



ELEVATION



END VIEW

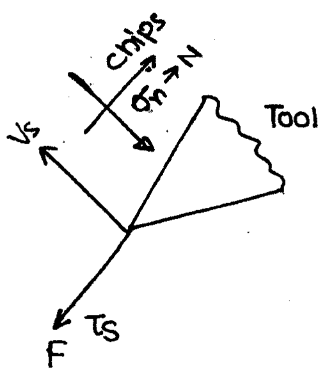


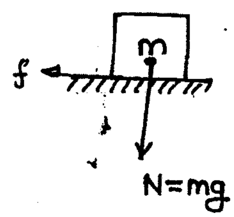
PLAN

- Back Rack Angle

A Line is drawn Parallel to the tool Axis Passing through the tip of the tool, the angle this Line makes with the Rack Face is called Back Rack Angle.

This Angle is measured in a Plane parallel to the tool Axis Perpendicular to the base Plane.





$f = \mu N$

Temp. ↑ μ ↑ $\tau_s = \mu \sigma_n$

τ_s ↑ $\tau_s \not> k'$

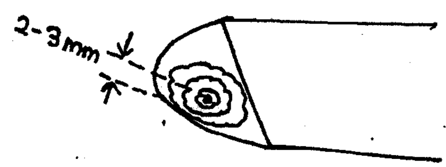
↳ Yield strength in shear

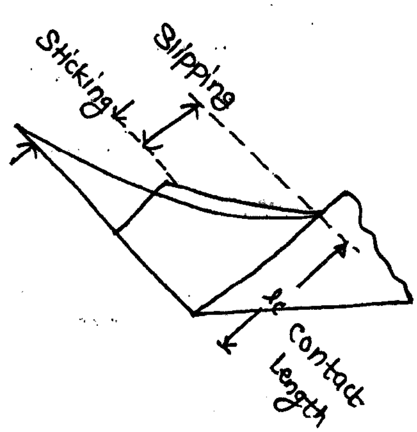
$\tau_s = k'$ sticking

$\tau_s < k' \rightarrow$ slipping

$F_c V = F_s V_s + F V_c$

↓ Cutting energy (Total) ↓ Shear Energy ↓ Friction Energy





α ↑, l_c ↓ A ↓

F ↓

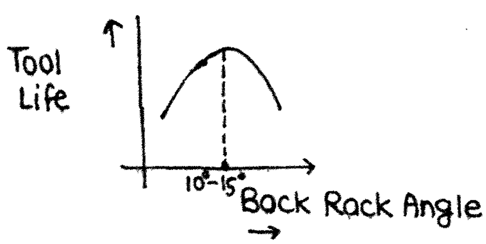
Amonton's Law

$F = \oint_A \tau_s$

$N = \oint_A \sigma_n$

Machining takes Place by breaking the Crystal structure of Work material. The Velocity With Which crack is propogating inside the material is called shear velocity. As the crystals are breaking a Portion of the energy comes out in the form of Heat. Increase in temperature Will increase the Coefficient of friction and when the shear stress becomes equal to the yield strength in shear there will be <u>sticking</u> between the two materials.

> After machining as chips are flowing over the Rack Face there will be sticking between the chip and the Rack Face due to Which chips continues to experience a heavy Drag. So max. temperature over the Rack Face appears 2-3mm away from the cutting edge. By increasing the back Rack Angle there will be decrease in the Contact Length between the chip and the Rack Face. Hence contact Area will decrease, so lesser energy will be required to overcome the friction between Rack Face and the chip. This will decrease the overall Power consumption.
>
> Secondary function of Back Rack Angle to Guide the chip Flow.

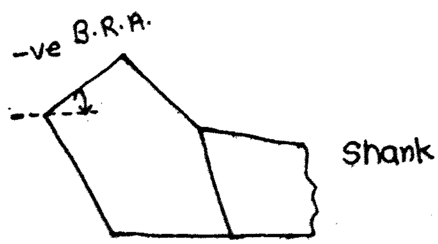


- <u>Select</u>

1> work-strong cu alloys (Brass & Bronze)

2> Threading or Plunge cut
  (i) $\alpha = 0$
  (ii) Aluminium, Pb $\alpha = 5-10°$

3> carbides or Ceramics $\alpha = -ve$

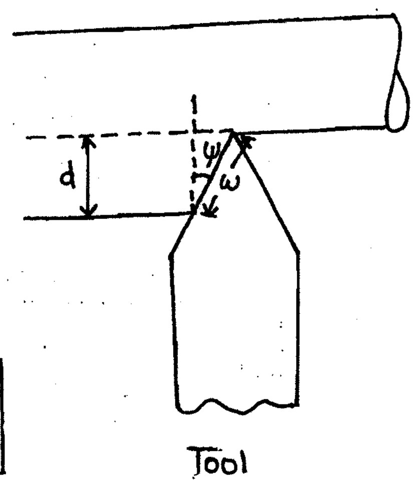


For most of the material when we cutting thread, we will 0° Rack but when we are threading extremly soft material Like Al, Build-up edge will form so we provide 5°–10° Back Rack.

• **Side cutting Edge Angle:→**

It is a Angle between the side cutting edge or Principal cutting edge and the Line extending the Shank. This Angle is measured in a Plane Parallel to Base.

Width of chip:→



$$\frac{d}{\omega} = \cos\psi$$

$$\boxed{\omega = \frac{d}{\cos\psi}}$$

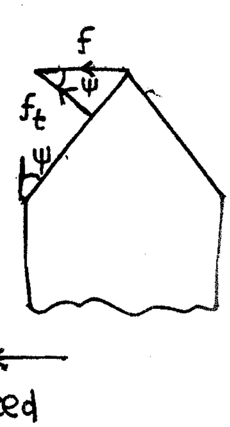
In any machining operation Width of chip is Length of Side-cutting edge covered by the chips.

In any machining operation uncut chip thickness is feed per Cutting edge expressed Normal to the cutting edge.

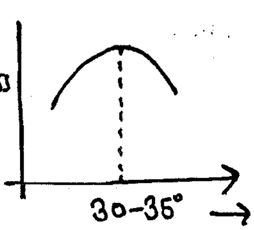
f = mm/rev.

f_t = True feed = t_1

$$\boxed{t_1 = f_t = f\cos\psi}$$



diffusion wear → Crator



As it can be seen from the derivation that by increasing the side cutting edge angle chips becomes thinner & wider.

As discussed Previously, that the max. temp. over the Rack Face Appears 2-3mm away from the Cutting edge.

Higher is the temperature more Predominant the diffussion Phenomenon i.e. Hard Particals from the tools start diffusing into the chip making the tool Weaker & Weaker in this region. After some time chips takes away a small Portion of tool material Produces Crator. This Phenomenon is called as diffusion wear. By Increasing the Side- cutting edge angle, chips becomes wider i.e. Contact Area between the chip and the Rack Face will increase ⟷ So Heat is distributed over the larger Area and this will decrease the Peak temp. over the Rack Face. And Hence diffusion wear decreases and tool Life will increase.

Optimum value of side- cutting edge angle is between 30–35° and when this Angle beyond this value drag between chip & the rake face increase suddenly which leads to tool Breakdown.

अगर परीक्षा में

Principal cutting Angle Value → $<35^\circ$ Side cutting edge Angle

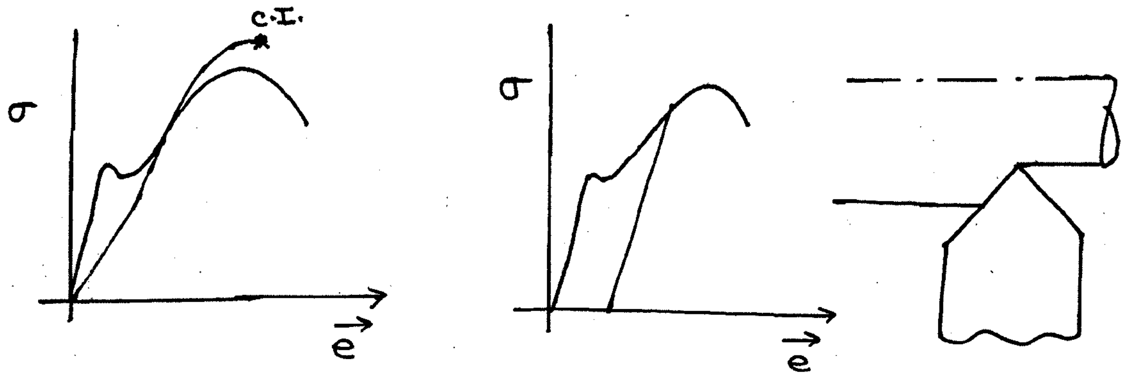
Principal cutting Angle Value → $90-\alpha=\psi$ → Approach Angle

छोटी वैल्यू → अनकट चीप thickness

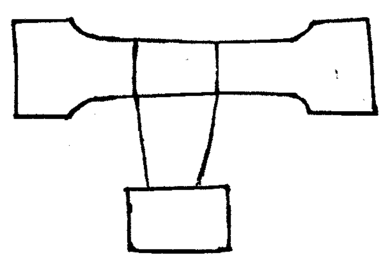
बड़ी वैल्यू → Width of chip

End Relief angle

A Line is drawn Passing through the tip of the tool Perpendicular to the tool Axis, the angle this Line with the end Flank is called End Relief Angle. This Angle is measured in a Plane Parallel to the tool Axes and Perpendicular to the base Plane.

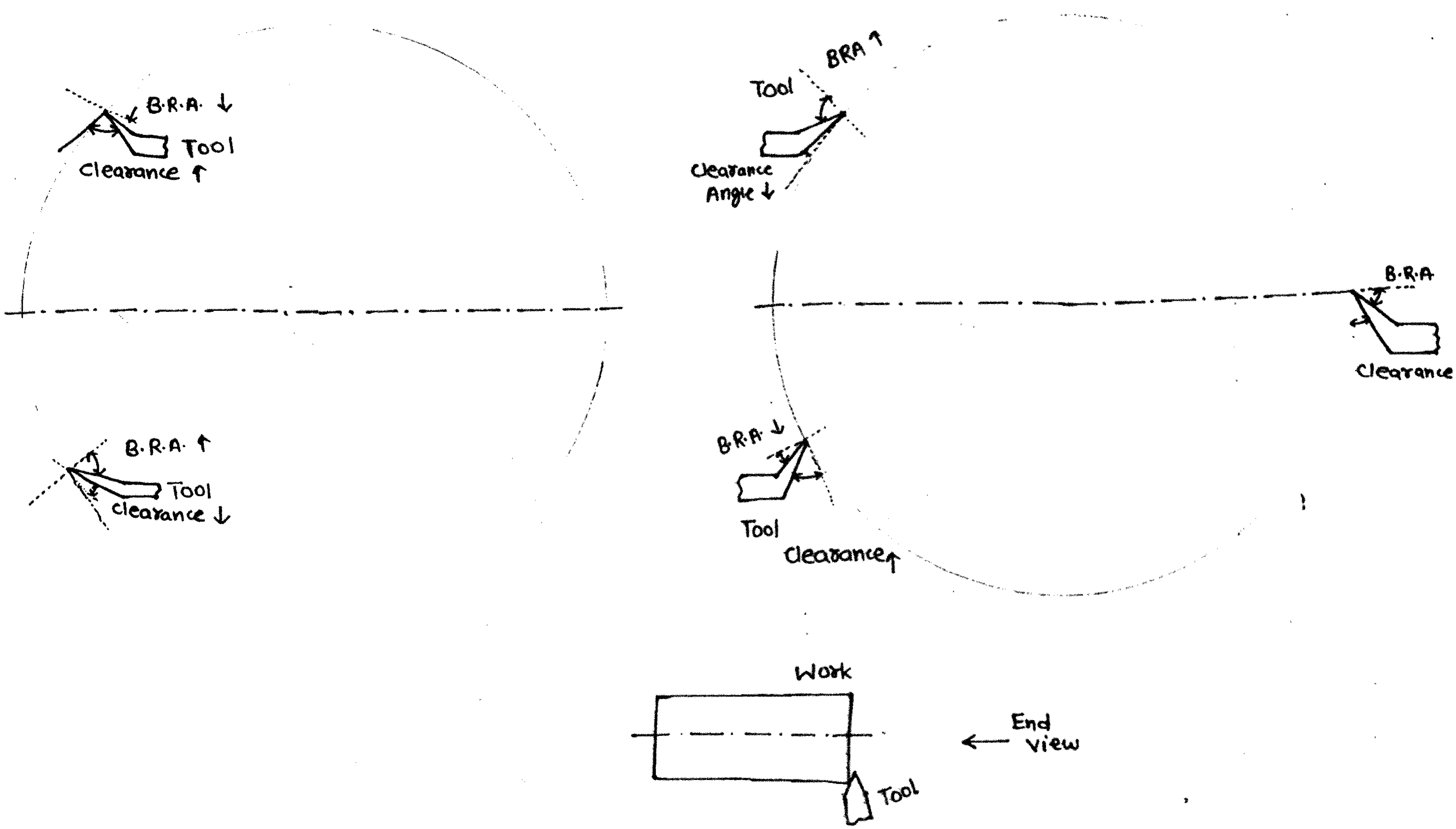


Extensometer



After machining finished Part of the work. There will be some elastic Recovery due to which it will try to hit the end flank. To Avoid that Rubbing clearance angle is Provided to the tool.

Larger is the elastic Recovery exhibited by the work material larger should be the clearance angle over the tool.

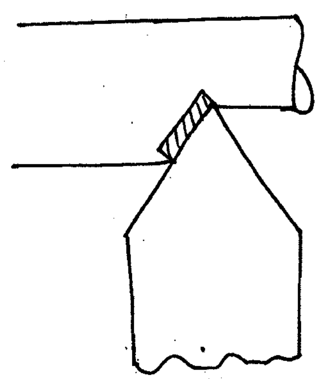

B.R.A. ↓
Tool
Clearance ↑
B.R.A. ↑
Tool
Clearance ↓
Tool
BRA ↑
Clearance Angle ↓
B.R.A
Clearance
B.R.A. ↓
Tool
Clearance ↑
Work
End View
Tool

- ## Side Relief Angle:→

A Line is drawn Perpendicular to tool Axis Passing through the Tip, the Angle this Line with the side flank is called Side Relief Angle.

This Angle is measured in a Plane Perpendicular to the tool Axis.

The workpiece material i.e is going to be removed in the next revolution of the work is trying to hit side flank. To avoid that rubbing we Provide Side relief angle.



- ## Side Rack Angle→

A Line is drawn Perpendicular to the tool Axis Passing through the Tip of the tool, the angle this Line make with the Rack face is called Side Rack and the angle is a measured in a Plane Perpendicular to tool Axis.

This angle Partly guide the chip flow and Partly Avoid the Rubbing. but incase of Plunge cut & threading this is one of the measure cutting angle.

- **End cutting edge Angle →**

A Line is drawn Perpendicular to the tool Axis Passing through the tip, the angle this Line makes with the end cutting edge is called end cutting edge angle. The angle is measured in a Plane Parallel to Base.

Range : 8° to 15°

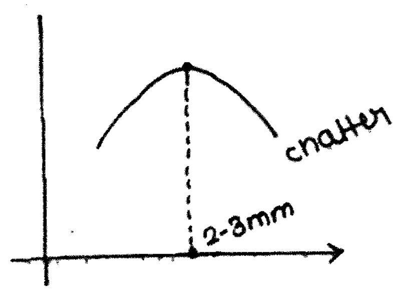
~~Ese~~

- **Angle of Inclination →**

Angle of Inclination and Back Rack Angle are in different Plane.

→ Side Plane में Back Flank से बनाने वाला Angle.

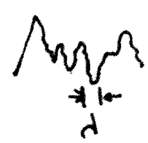
- **Nose Radius :→**



NOSE Radius is Provided to make the Cutting edge slightly — Curve so that cutting forces appears on the Area rather than Line.

Surface finish

Roughness



Peak to vally height

$$H_{max} = \frac{f^2}{8R}$$

$$H_{max} = \frac{f}{\tan\psi + \cot\psi_1}$$

centre Line Avg value

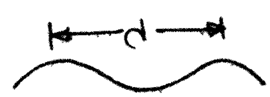
$$CLA \approx \frac{H_{max}}{4}$$

Waviness ↑

→ chatter

→ machine Vibration

→ Error in lead Screw



- **ASA (American System)**

Tool signature :→

Rake		Relief		Cutting edge		Nose Radius
BRA —	SRA	ERA —	SRA	ECEA —	SCEA —	R
α				ψ_1	ψ	

As Per ASA System, Merchant Analysis whenever there is a Rake Angle if we keep Back Rack Angle cutting forces Pridiction will be close to experimental data.

- **British ~~Rack~~ Rake**

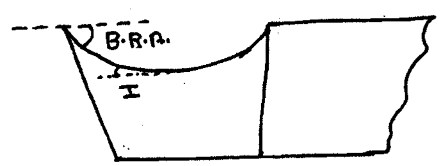
It is the max. Rack observed on the rack face. A Line is drawn Passing through the tip of the tool and this line shifted in the horizontal Plane only, the max. angle any one of line makes with the Rack face is called British Rack.

- **Orthogonal ~~Rack~~ Rake and Normal Rake**

Orthogonal Rake

Stabler

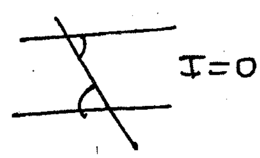
(i) chip flow direction



$\xi = C I$ ↳ Angle of Inclination

↓ Stabler Constant

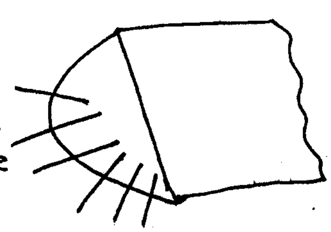
∼ 0.9 – 1



$\tan \xi = \tan I \tan \alpha_n$

↳ Normal rake angle

Orthogonal Rake Angle>



multiple Lines are drawn Perpendicular to the side cutting edge and all this line Should be lies on Horizontal Plane, the max. angle any one of this lines makes with the Rake is Called Orthogonal Rake.