Geometry of Cutting Tools

2.2 Geometry of single-point turning tools

Both material and geometry of the cutting tools play very important roles on their performances in achieving effectiveness, efficiency and overall economy of machining. Cutting tools may be classified according to the number of major cutting edges (points) involved as follows:

2.2.1 General configuration

1.Single point

Single point: e.g., turning tools, shaping, planning and slotting tools and boring tools

2.double point or two points

Double (two) point: e.g., drills

3.multiple (more than two points)

Multipoint (more than two): e.g., milling cutters, broaching tools, hobs, gear shaping cutters etc.

2.2.1.1 Concept of rake and clearance angles of cutting tools

The word tool geometry is basically referred to some specific angles or slope of the salient faces and edges of the tools at their cutting point. Rake angle and clearance angle are the most significant for all the cutting tools. The concept of rake angle and clearance angle will be clear from some simple operations shown in Fig

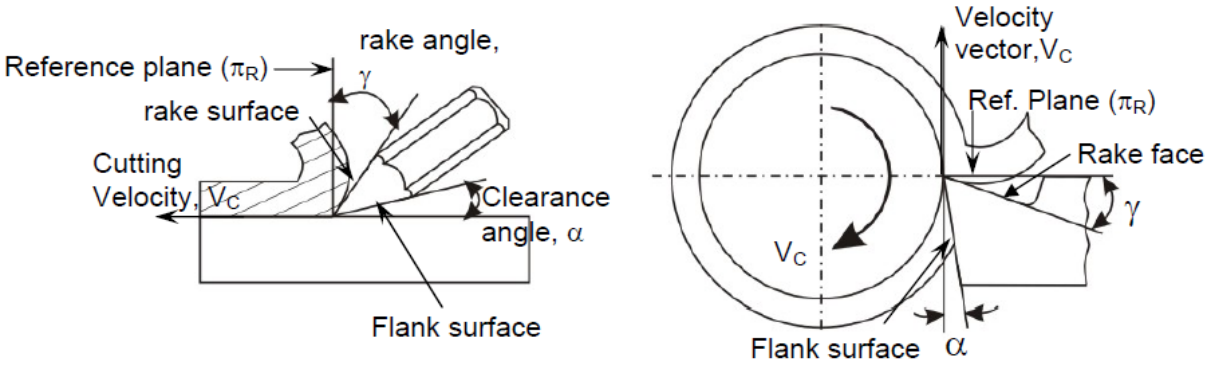


Fig. 3.1 *Rake and clearance angles of cutting tools.*

1.Rake angle

Rake angle (γ): Angle of inclination of rake surface from reference plane

a.Positive rake

• Positive rake – helps reduce cutting force and thus cutting power requirement.

b.Negative rake

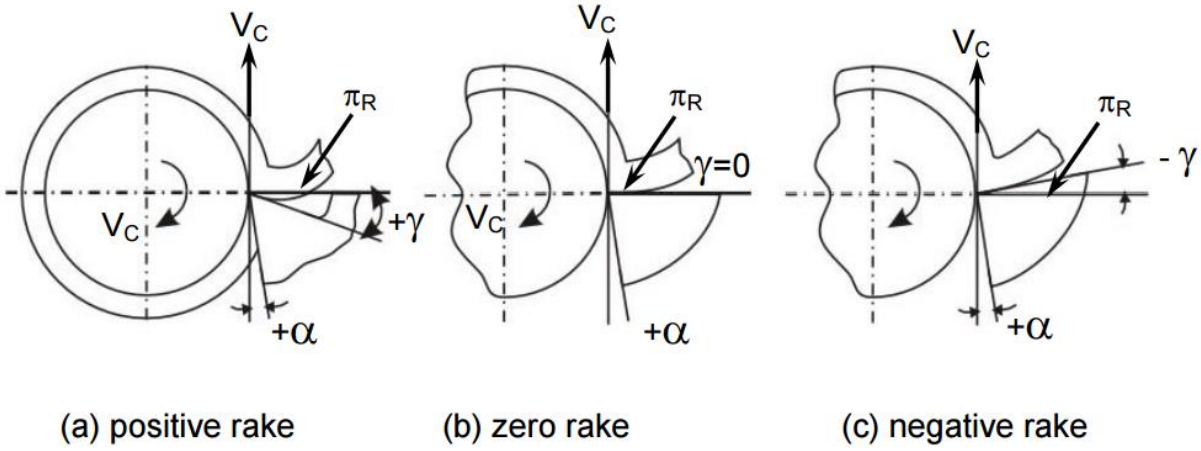
• Negative rake – to increase edge-strength and life of the tool

c.Zero rake

Zero rake – to simplify design and manufacture of the form tools.

2.Clearance

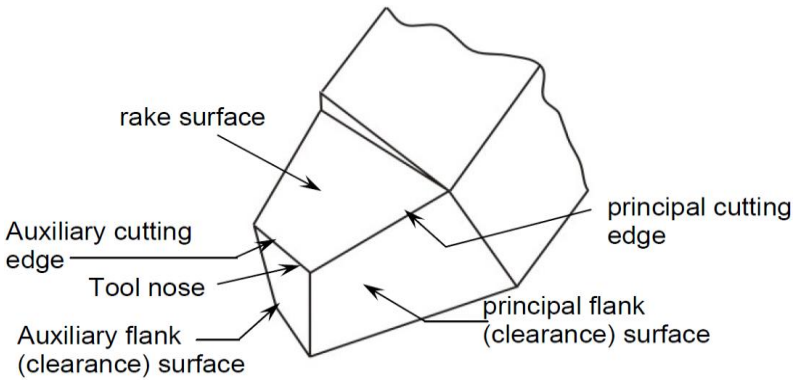
Clearance angle is essentially provided to avoid rubbing of the tool (flank) with the machined surface which causes loss of energy and damages of both the tool and the job surface. Hence, clearance angle is a must and must be positive (3o ~ 15o depending upon tool-work materials and type of the machining operations like turning, drilling, boring etc.)



(a) positive rake (b) zero rake (c) negative rake

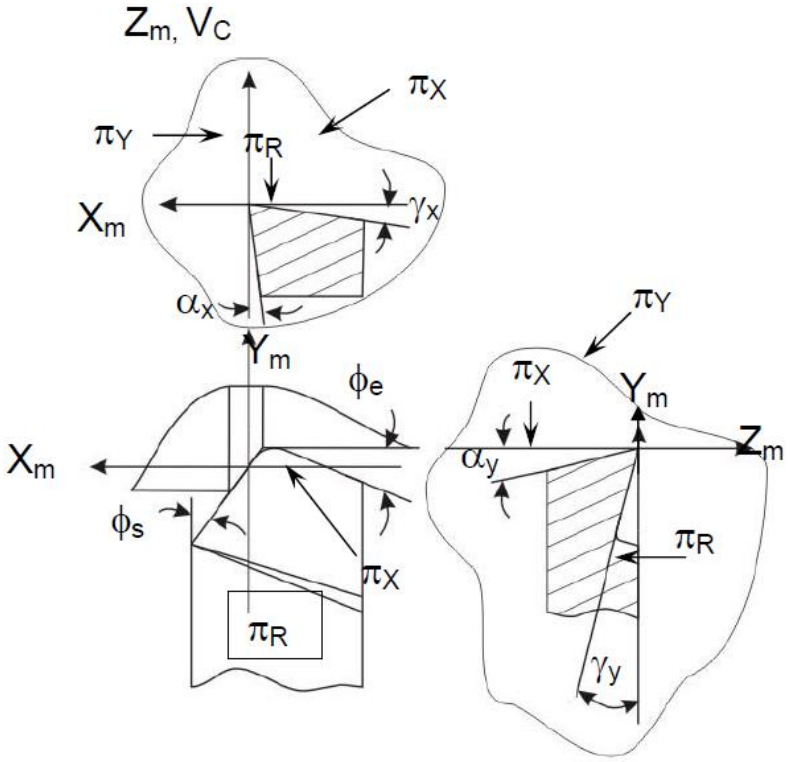
2.2.2.1 Designation of tool geometry in the machine reference system

This system is also called ASA system; ASA stands for American Standards Association. Geometry of a cutting tool refers mainly to its several angles or slope of its salient working surfaces and cutting edges. Those angles are expressed w.r.t. some planes of reference. In Machine Reference System (ASA), the three planes of reference and the coordinates are chosen based on the configuration and axes of the machine tool concerned. The planes and axes used for expressing tool geometry in ASA system for turning operation are shown in Fig



The planes of reference and the coordinates used in ASA system for tool geometry are : πR - πX - πY and Xm – Ym - Zm where, πR = Reference plane; plane perpendicular to the velocity vector πX = Machine longitudinal plane; plane perpendicular to πR and taken in the direction of assumed longitudinal feed πY = Machine Transverse plane; plane perpendicular to both πR and πX [This plane is taken in the direction of assumed cross feed] The axes Xm, Ym and Zm are in

the direction of longitudinal feed, cross feed and cutting velocity (vector) respectively. The main geometrical features and angles of single point tools in ASA systems and their definitions will be clear from Fig



1.Rake angle

• Rake angles: [Fig. 3.5] in ASA system γx = side (axial rake: angle of inclination of the rake surface from the reference plane (πR) and measured on Machine Ref. Plane, πX. γy = back rake: angle of inclination of the rake surface from the reference plane and measured on Machine Transverse plane, πY.

2.clearance angle

• Clearance angles: [Fig. 3.5] αx = side clearance: angle of inclination of the principal flank from the machined surface (or VC) and measured on πX plane. αy = back clearance: same as αx but measured on πY plane.

3.Cutting angle

Cutting angles: [Fig. 3.5] φs = approach angle: angle between the principal cutting edge (its projection on πR) and πY and measured on πR φe = end cutting edge angle: angle between the end cutting edge (its projection on πR) from πX and measured on πR

4. Nose radius

Nose radius, r (in inch) r = nose radius : curvature of the tool tip. It provides strengthening of the tool nose and better surface finish.