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THEORY OF METAL CUTTING

Ques - Difference b/w production and manufacturing? (INV.

* Manufacturing is a process of converting raw material into finish product by using varies process, machines and energy. It is a narrow term.

* Production is a process of converting inputs into outputs. It is a broader terms.

Example:- Crude Oil is a production not manufacturing.
Movie is a production not manufacturing.

* Manufacturing and production are often used interchangeably.

Classification of Manufacturing Process.

* Shaping or Forming - (zero Process).
* Joining Process - (Positive Process)
* Removal Process - (Negative Process)
* Regenerative Manufacturing.
  ↳ Rapid prototyping.

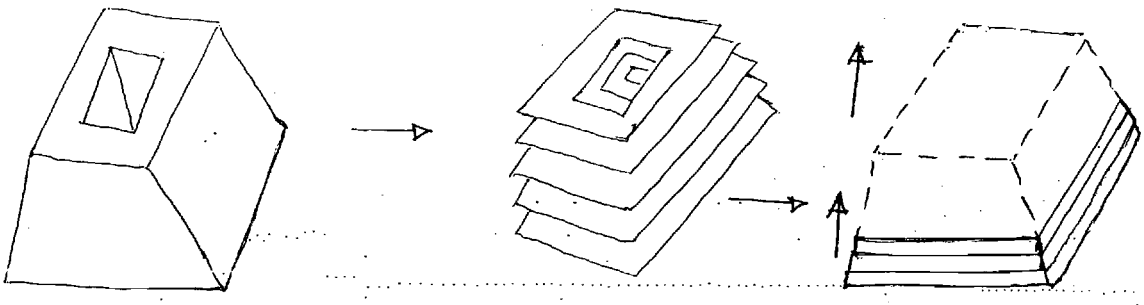
Ques:- What is Regenerative Manufacturing or what is Rapid prototyping or what is 3-D printing?

* Production of solid product in layer by layer from raw materials in different forms.

  Liquid - eg - stereo lithography (Moltean Metal).
  Powder - eg - selective sintering.
  Sheet - eg - LOM (Laminated Object Manufacturing)
  Wire - eg - FDM (Fused Deposition Modeling).

* Very rapid, accurate and used for Rapid prototyping and tooling.

BASIC PRINCIPLE OF REGENERATIVE MFG.



* Size of single layer is in micron. { 1 Micron = 10^{-6} m }

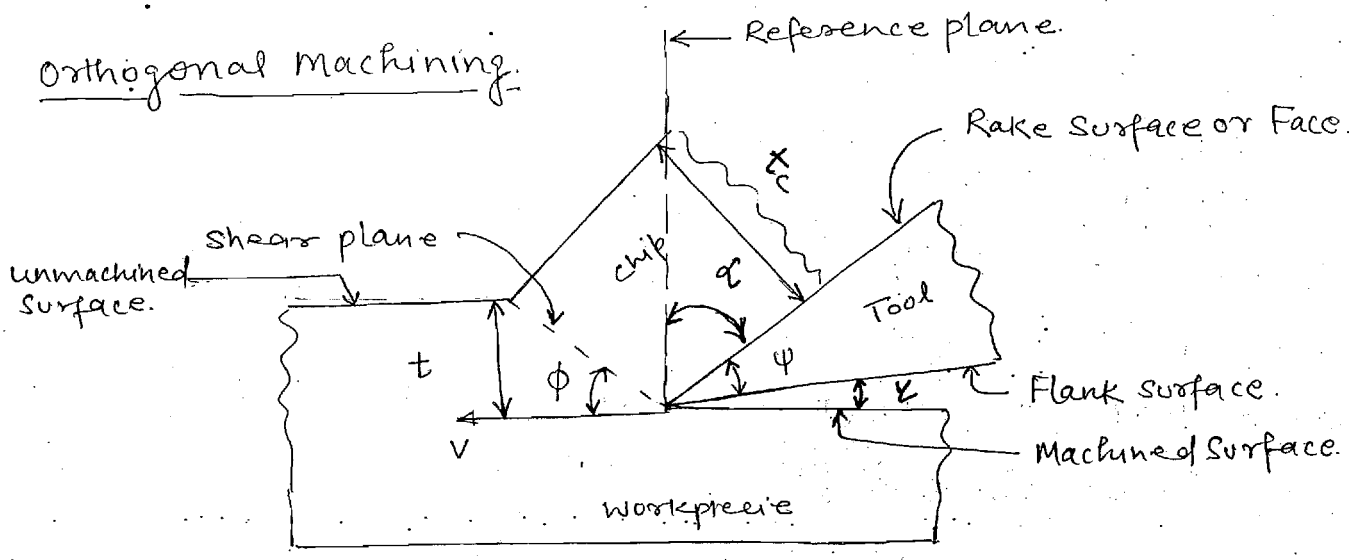
Machining –

Machining is an essential process of finishing by which jobs are produced to the desired dimensions and surface finish by gradually removing the excess material from the preformed blank in the form of chips with the help of cutting tools moved past the work surface.

* objective of machining
  * Surface Finish
  * Dimensional Accuracy.

* Machining is a removal process.

Orthogonal Machining:



- Rake Angle = α
- Clearance Angle or Relief Angle = γ
- Shear Angle = ϕ
- Lip Angle or Wedge angle or Kinfe angle or cutting angle = ψ

Chip thickness = t_c

~~uncut thickness = t~~

uncut chip thickness = t

$t_c > t$

b = width of cut.

* Due to plastic deformation dimension of metal change permanen

* Due to plastic deformation of the metal (shear failure) t_c will be two to three times of t. But due to temperature increase of the chip t_c will increase few microns.

***** Funda.

$t = d$ (orthogonal cutting) ; d = depth of cut.

$\boxed{t = f \sin\lambda}$ (Turning cutting) .....

f = feed

λ = principal cutting.

Shank :- kept inside tool holder.

Rake Surface or Face :- The surface along which the chips moves upward is called 'Rake surface' of tool.

Flank or Relief Surface :- The other surface which is relieved to avoid rubbing with the machined surface is called 'Flank' or Flank Surface.

Rake Angle (α) :- Angle of inclination of rake surface from reference plane i.e normal to the horizontal machined surface.

* It allows chip flow direction.
* It provides keenness (sharpness) to the cutting edge.
* It reduces the cutting force required to shear the metal and reduce the power consumption.
* It improve surface finish.

Ra

Clearance Angle or Relief Angle (α)

Angle of inclination of clearance or flank surface from the finished surface.

* It reduces friction and tool wear.
* It improve tool life.
* Excessive clearance angle weakness the tool.
* It must be positive (3° to 15°).

Turning cutting. (oblique cutting).

Parameter in Turning operation –

Speed, feed, depth of cut.

$V = r \cdot \omega$ V – Tangential Velocity.

$= \frac{D}{2} \cdot \frac{2\pi N}{60}$

$= \frac{\pi DN}{60}$ m/sec. D in m

$= \pi DN$ m/min. D in m.

$= \frac{\pi DN}{1000}$ m/min (D in mm)

f = mm/rev. f = feed.

fN = mm/min.

feed = 0.2 mm/rev

feed = 200 mm/min = $f \cdot N$.

feed = 0.4 m/min

feed = 0.4×1000 mm/min = $f \cdot N$.

Depth of cut (d) = $\frac{D_1 - D_2}{2}$

Ques - Carbide tool is used to machine a 30 mm diameter steel shaft at a spindle speed of 1000 revolutions per minute. The cutting speed of the above turning operation is :- (IES 2013).

$D_1 = 30\,mm$

$N = 1000\ rpm$

$$V = \frac{\pi DN}{1000}\ m/min.$$

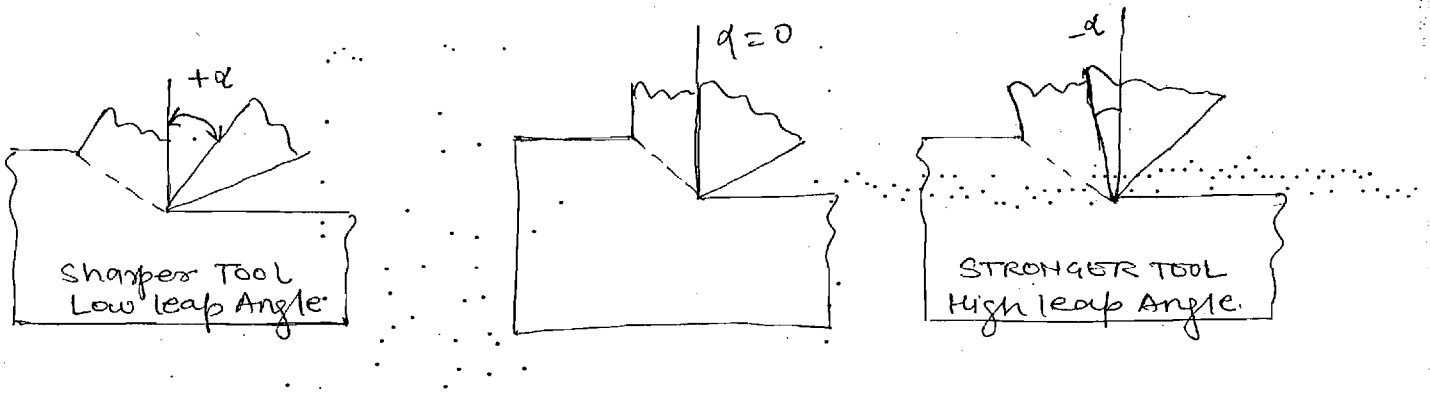
$$V = \frac{\pi \times 30 \times 1000}{1000}\ m/min$$

$$V = 94.2\ m/min.$$

(a) 1000 rpm.
(b) 1570 m/min
(c) 94.2 m/min
(d) 47.1 m/min.

DISCUSSION ON RAKE ANGLE.

* Rake angle can be positive, negative, or zero.



Positive Rake :- (5 - 30 degree)

* Reduce cutting force.
* Reduce cutting power.

Positive rake angles are recommended

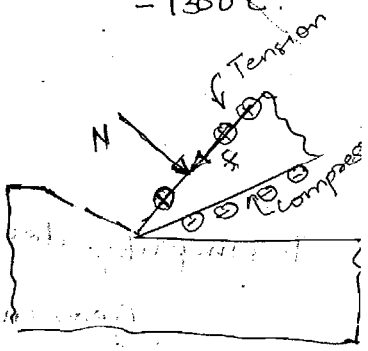
* Machining low strength material.
* Low power machine.
* Long shaft of small diameter. (Low stiffness)
* Set-up lacks strength and rigidity.
* Low cutting speed.
* Cutting tool material : HSS (High Speed steel).

18 - 4 - 1 - HSS.
18% W
4% Cr
1% V

30 m/min — 600°C.

Carbide Tool - 150 m/min - 900°C.

Ceramic Tool - 600 m/min - 1300°C.

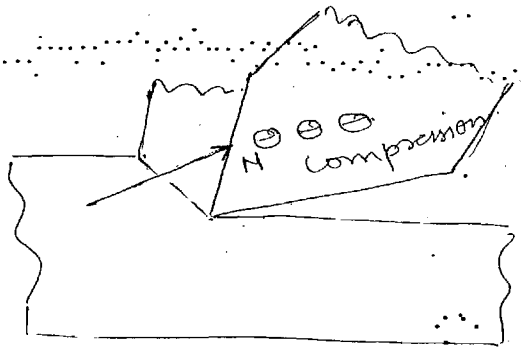


Negative Rake. – (Brittleness)

* Increased edge strength. (Mechanically and Thermally)
* Increase life of tool. ——→ It also increases with inc. clearance angle.
* Increase the cutting force.
* Requires high cutting speeds.
* Requires ample (very) {high} power.
* Heavy Impact Load.

Negative Rake angles are recommended :-

* Machining high strength alloy.
* High speed cutting.
* With rigid set-up.
* Cutting tool Material : Ceramic, Carbide. (Brittle Material).



Toughness ⟶ Insert

Ques. Cutting powers consumption in turning can be

Zero Rake

* To simplify design and manufacturing of the form tools.

ex- Gear cutting in Milling Machine

Thread cutting in lathe Machine.

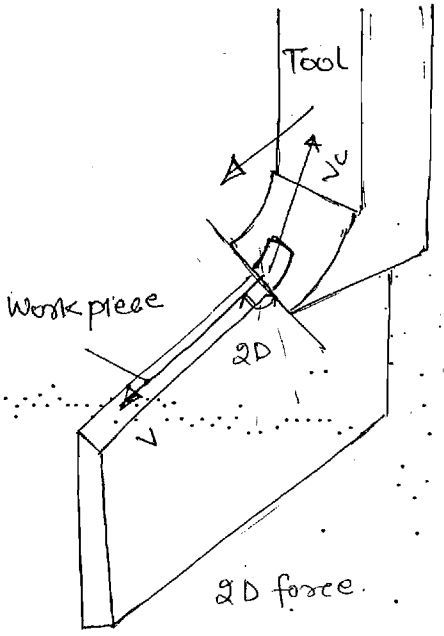
* Increases tool strength.
* Avoids digging of the tool into the work piece.

* Brass is turned with zero rake angle. (Due to chip flow)
* Cast Iron uses zero rake angle. (Due to high impact load).

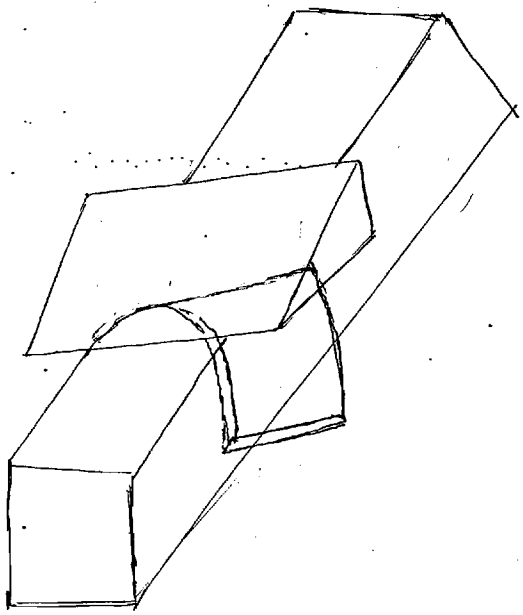
HSS – Highly tough.

Clearance Angle.

* Provided to avoid rubbing of the tool (flank) with machined surface.
* Reduce tool wear.
* Must be positive.



ORTHOGONAL CUTTING



OBLIQUE CUTTING.

ORTHOGONAL CUTTING

* Cutting edge of the tool is perpendicular to the direction of cutting velocity.
* The cutting edge is wider than the workpiece width and extends beyond the workpiece on either side. Also the width of the workpiece is much greater than the depth of cut.
* The chip generated flows on the rake face of the tool with chip velocity perpendicular to the cutting edge.
* The cutting forces act along two directions only.

NOTE :- During metal cutting, an increase in cutting speed (IES 12) causes cutting forces to remain unaffected or sadly reduced. But cutting power, heat production and temperature will increase.

sadly reduced is more appropriate answer.

GEOMETRY OF SINGLE POINT TURNING TOOL. (OBLIQUE CUTTING)

Classification of tool.

According to the no. of major cutting edges (points) involved.

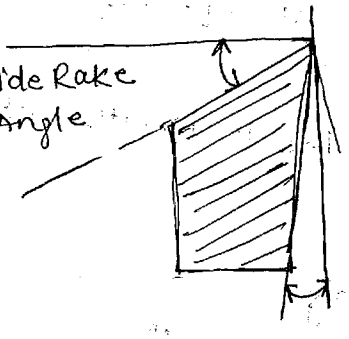
* Single point – Turning tool, shaping tool, planning tool, slotting tool, Parting tools. etc.
* Double point – Drilling tools.
* Multi-point – hobbing tool, milling tool, broaching, saw, grinding wheel etc.

SYSTEM OF DISCRIPTION OF TOOL GEOMETRY.

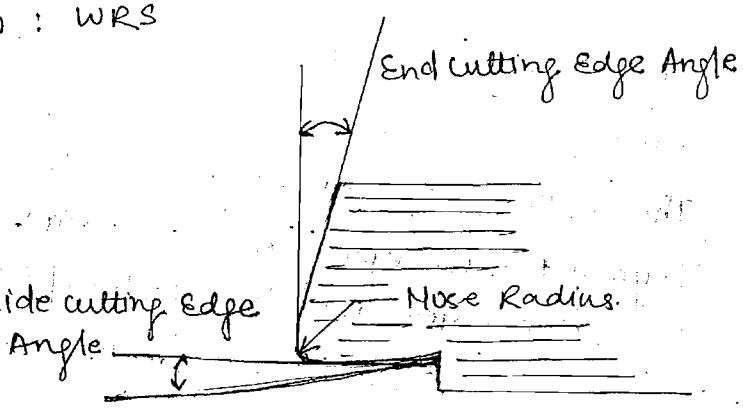
1- Machine reference system : ASA or ANSI. (Discription of tool is easy)
(ASA – American standard Association / ANSI – American National standard Institute)

2- Tool reference system : ORS and NRS. (Calculation is easy)

3- Work reference system : WRS



Parallel to width
Section for base



Section parallel to base.