Unit-1
Manufacturing Technology-II

① Tool life test in turning yield the following data (1) V=110 m/min, T=20 min; (2) V=85 m/min T=40 min (a) Determine the n and c values in the Taylor tool life equation. Based on the equation, compute (b) the tool life for a speed of 95 m/min and (c) the speed corresponding to a tool life of 30 min.

Given:

$V_1 = 110$ m/min

$T_1 = 20$ min

$V_2 = 85$ m/min

$T_2 = 40$ min

To find:

(i) n & C

(ii) T_{95}

(iii) V_{30}

Soln:

From Taylor's tool life equation

$$V_1 T_1^n = V_2 T_2^n$$

$$110 \times 20^n = 85 \times 40^n$$

$$\frac{110}{85} = \left(\frac{40}{20}\right)^n$$

$$1.294 = 2^n$$

$$\log 1.294 = n \log 2$$

$$n = \frac{\log 1.294}{\log 2}$$

$$n = 0.372$$

$V_1 T_1^{n} = C$

$110 \times 20^{0.372} = C$

$\boxed{C = 335.26}$

for 95 m/min speed.

$95 \times T^{0.372} = 335.26$

$\boxed{T = 29.66 \text{ min}}$

for 30 min life,

$V \times 30^{0.372} = 335.26$

$V = 94.6$ m/min

② The following equation for tool life was obtained for HSS tool $V T^{0.13} f^{0.6} d^{0.3} = C$. A 60 min tool life was obtained using the following cutting condition. $V = 40$ m/min, $f = 0.25$mm, $d = 2$mm. Calculate the effect on tool life if speed, feed and depth of cut are together increased by 25% and also if they are increased individually by 25%. where f = feed, d = depth and v - speed.

Given:

$V T^{0.13} f^{0.6} d^{0.3} = C$

$T = 60$ min, $V = 40$ m/min, $f = 0.25$mm

$d = 2$mm.

To find:

* Effect on tool life

Soln:

$V T^{0.13} f^{0.6} d^{0.3} = C$

$40 \times 60^{0.13}\, 0.25^{0.6}\, 2^{0.3} = C$

$\boxed{C = 36.5}$

when the speed, feed and depth of cut are together increased by 25%.

$V = 50$ m/min, $f = 0.3125$mm, $d = 2.5$mm

$50 \times T^{0.13} \times 0.3125^{0.6} \times 2.5^{0.3} = 36.5$

$\boxed{T = 2.3 \text{ min}}$

when speed is increased by 25%

$V = 50$ m/min, $f = 0.25$mm, $d = 2$mm

$50 \times T^{0.13} \times 0.25^{0.6} \times 2^{0.3} = 36.5$

$\boxed{T = 10.78 \text{ min}}$

when feed is increased by 25%.

$V = 40$ m/min, $f = 0.3125$mm, $d = 2$mm

$40 \times T^{0.13} \times 0.3125^{0.6} \times 2^{0.3} = 36.5$

$\boxed{T = 21.42 \text{ min}}$

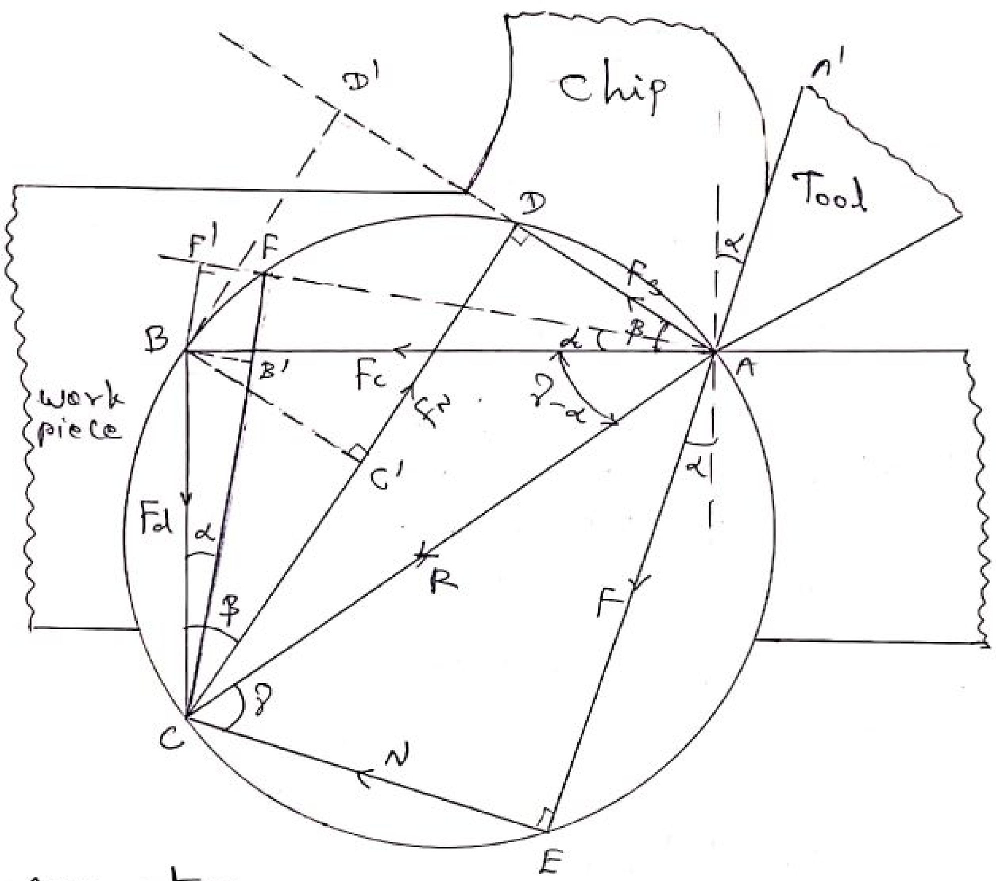
when depth of cut is increased by 25%.

$V = 40$ m/min, $f = 0.25$mm, $d = 2.5$mm

$40 \times T^{0.13} \times 0.25^{0.6} \times 2.5^{0.3} = 36.5$

$\boxed{T = 35.85 \text{ min}}$

③ Draw & Explain merchant's circle to calculate the various forces on Tool.



Assumptions

* The tool is perfectly sharp and has no contact along the clearance face.
* The surface, where shear is occuring is a plane
* The cutting edge is a straight line extending perpendicular to the direction of motion and generates a plane surface as the work moves past it.
* Uncut chip thickness is constant
* Width of the tool is greater than the width of the work.
* A continuous chip is produced without any BUE.
* work moves with a uniform velocity
* The stresses on the shear plane are uniformly distributed.

F_H – Cutting force – F_c

F_V – Thrust force – F_d

F_s – Force along the shear plane

F_n – Force normal to the shear plane

R – Resultant force

F – Frictional force along the rake face

N – Normal force perpendicular to the rake face.

α – Rake angle, β – shear angle,

γ – friction angle

From the above diagram

$$F_s = AD = AD' - DD' \qquad DD' = BC'$$

$$= AD' - BC'$$

from $\Delta ABD'$

$$\cos\beta = \frac{AD'}{AB} = \frac{AD'}{F_c}$$

$AD' = F_c \cos\beta$

From $\Delta BCC'$

$$\sin\beta = \frac{BC'}{BC} = \frac{BC'}{F_d}$$

$$BC' = F_d \times \sin\beta$$

$$\boxed{F_s = F_c \cos\beta - F_d \sin\beta} \quad \text{--- (1)}$$

$$F_N = CD = CC' + C'D \qquad C'D = BD'$$

$$= CC' + BD'$$

from $\Delta BCC'$

$$\cos\beta = \frac{CC'}{BC} = \frac{CC'}{F_d}$$

$$CC' = F_d \cos\beta$$

from $\Delta ABD'$

$$\sin\beta = \frac{BD'}{F_c}$$

$$BD' = F_c \times \sin\beta$$

$$\boxed{F_N = F_d \cos\beta + F_c \sin\beta} \quad \text{--- (2)}$$

from ΔABC

$$\cos(\gamma - \alpha) = \frac{F_c}{R}$$

$$\boxed{F_c = R \cdot \cos(\gamma - \alpha)} \quad \text{--- (3)}$$

from ADC

$$\cos(\beta + \gamma - \alpha) = \frac{F_s}{R}$$

$$\boxed{F_s = R \cdot \cos(\beta + \gamma - \alpha)} \quad \text{--- (4)}$$

$$R = \frac{F_s}{\cos(\beta + \gamma - \alpha)} \quad \text{--- (5)}$$

(5) in (3)

$$F_c = \frac{F_s}{\cos(\beta + \gamma - \alpha)} \times \cos(\gamma - \alpha)$$

$$F_c = F_s \frac{\cos(\gamma - \alpha)}{\cos(\beta + \gamma - \alpha)} \quad \text{--- (6)}$$

$$F_s = F_c \frac{\cos(\beta + \gamma - \alpha)}{\cos(\gamma - \alpha)} \quad \text{--- (7)}$$

from Diagram.

$$N = CE = AF$$

$$AF = AF' - FF'$$

$$N = AF' - BB'$$

from $\Delta ABF'$

$$\cos\alpha = \frac{AF'}{AB} = \frac{AF'}{F_c}$$

$$AF' = F_c \cos\alpha$$

from $\Delta BB'C$

$$\sin\alpha = \frac{BB'}{BC} = \frac{BB'}{F_d}$$

$$BB' = F_d \sin\alpha$$

$$\boxed{N = F_c \cos\alpha - F_d \sin\alpha} \quad \text{—— (8)}$$

From Diagram.

$$F = AE = CF$$

$$CF = CB' + B'F$$

$$F = CF = CB' + BF'$$

From $\Delta BB'C$

$$\cos\alpha = \frac{CB'}{BC} = \frac{CB'}{F_d}$$

$$CB' = F_d \cdot \cos\alpha$$

From $\Delta ABF'$

$$\sin\alpha = \frac{BF'}{AB} = \frac{BF'}{F_c}$$

$$BF' = F_c \times \sin\alpha$$

$$F = CB' + BF'$$

$$\boxed{F = F_d \cos\alpha + F_c \sin\alpha} \quad \text{—— (9)}$$

μ - Coefficient of friction

$$F = \mu \cdot N$$

$$\mu = F/N$$

$$\mu = \frac{F_c \sin\alpha + F_d \cos\alpha}{F_c \cos\alpha - F_d \sin\alpha} \quad \text{—— (10)}$$

$$= \frac{\cos\alpha \left[F_c \frac{\sin\alpha}{\cos\alpha} + F_d\right]}{\cos\alpha \left[F_c - F_d \frac{\sin\alpha}{\cos\alpha}\right]}$$

$$\boxed{\mu = \frac{F_c \tan\alpha + F_d}{F_c - F_d \tan\alpha}} \quad \text{—— (11)}$$

(4) In an orthogonal cutting test with a tool of rake angle $10°$, the following observations were made:

chip thickness ratio = 0.3

Horizontal component of the cutting force } = 1290 N

vertical component of the cutting force } = 1650 N

From merchant's theory, Calculate the various components of the cutting forces, and the co-efficient of friction at the chip tool interface.

Given:

Chip thickness ratio = 0.3

Horizontal force $F_c = 1290\,N$

vertical force $F_d = 1650\,N$

Rake angle $\alpha = 10°$

To find:

* various components of the cutting forces
* co-efficient of friction

Solution:

(i) Shear angle

$$\tan\beta = \frac{r\cos\alpha}{1 - r\sin\alpha}$$

$$= \frac{0.3\cos 10^\circ}{1 - 0.3\sin 10^\circ}$$

$$\tan\beta = 0.311679$$

$$\beta = \tan^{-1}(0.311679)$$

$$\boxed{\beta = 17.31^\circ}$$

(ii) Frictional force

$$F = F_c\sin\alpha + F_v\cos\alpha$$

$$= 1290\sin 10^\circ + 1650\cos 10^\circ$$

$$\boxed{F = 1848.94\,N}$$

(iii) Normal force

$$N = F_c\cos\alpha - F_v\sin\alpha$$

$$= 1290\cos 10^\circ - 1650\sin 10^\circ$$

$$N = 983.88\,N$$

(iv) Co-efficient of friction μ

$$\mu = F/N = \frac{1848.94}{983.88} = 1.8792$$

$$\boxed{\mu = 1.8792}$$

(v) Friction angle

$$\tan\rho = \mu;\ \rho = \tan^{-1}\mu$$

$$\rho = \tan^{-1}(1.8792)$$

$$\boxed{\rho = 62^\circ}$$

(vi) Resultant cutting force

$$R = \sqrt{F_c^2 + F_d^2}$$

$$= \sqrt{1290^2 + 1650^2}$$

$$\boxed{R = 2094.42\,N}$$

(vii) Shear force

$$F_s = F_c\cos\beta - F_d\sin\beta$$

$$= 1290\cos 17.31 - 1650\sin 17.31$$

$$\boxed{F_s = 740.63\,N}$$

(viii) Normal force

$$N_s = F_d\cos\beta + F_c\sin\beta$$

$$= 1650\cos 17.31^\circ + 1290\sin 17.31^\circ$$

$$\boxed{N_s = 1959.10\,N}$$

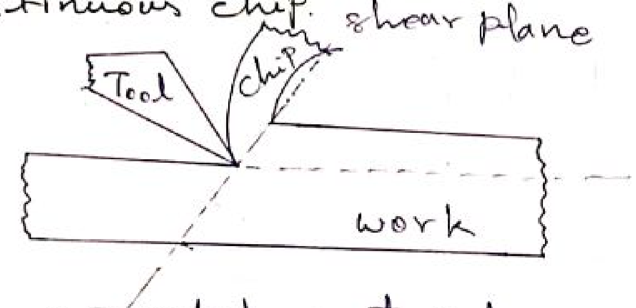
⑤ Explain the types of chips and chip Breaker with neat sketch.

Types of chips

Depends upon the machining condition and material to be cut.

(i) Continuous chip
(ii) Discontinuous chip
(iii) Continuous chip with build-up edge.

Continuous chip.



* Ductile material
* A continuous ribbon-like chip
* long coil
* same thickness throughout the length

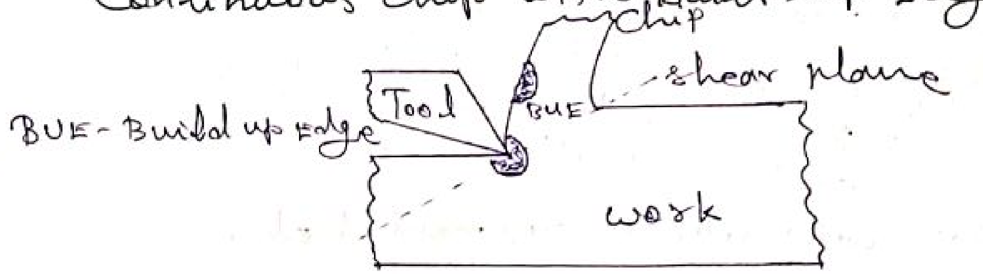
Benefits:

* Good surface finish
* Improving the tool life
* Less power consumption

Condition for discontinuous chips

* Machining of brittle material
* small rake angle
* Higher depth of cut
* Low Cutting speed.
* cutting ductile material at very low feeds with small rake angle of the tool.

Continuous chip with Built-up Edge



* High temperature & high pressure during cutting process
* High friction b/w tool-chip interface.
* Chip material to weld itself
* poor surface finish
* Increased tool life.

Conditions for Continuous chips with built-up edge.

* Low cutting speed
* Small rake angle
* coarse feed

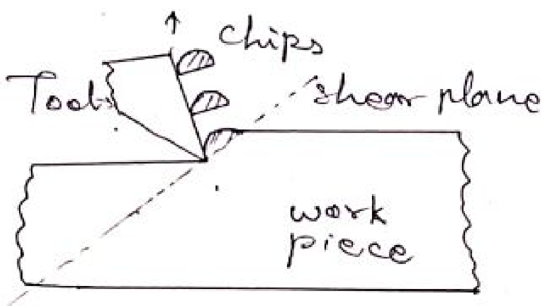
Draw backs

* chip disposal is not easy
* Surface finish gets affected

Condition for continuous chips

* Ductile material.
* Smaller depth of cut
* High cutting speed
* Large rake angle
* sharp cutting edge
* proper cutting fluid
* Low friction b/w tool face and chip interface

D) Discontinuous or segmental chip



* Brittle materials
* Low cutting speed
* No fluid
* Friction exists
* Easily disposed
* not spoil the finished work

* Strong adhesion between chip and tool interface.
* Insufficient cutting fluid
* Large uncut thickness.

Chip Breakers

* Long and continuous chips formed at high cutting speed will affect the machining process.
* It will spoil the tool, work and machine. These chips are hard, sharp and hot
* It will be difficult to remove the metal and also it is dangerous
* chip breakers are used to break the chips into small pieces for easy removal.

Types of chip breakers

(i) Step type (ii) Groove type (iii) clamp type