① Arithmetic average $= \dfrac{f^2}{R\, 18\sqrt{3}}$

$$R_a = \frac{f^2}{R\,18\sqrt{3}}$$

$$25\times10^{-6} = \frac{f^2}{(0.1\times10^{-3}).18.\sqrt{3}}$$

$$f^2 = 0.2791 \times10^{-3}\ m/rev$$
$$= 0.2791\ mm/rev$$

$$\eta . P_m = u \times MRR$$

$$\eta . P_m\ \cancel{MRR} = 1.5\,W\text{-}s/mm^3 \times MRR$$

$$\frac{0.9 \times 35 . W\times10^3}{1.5\,W\text{-}s/mm^3} = MRR$$

$$\therefore MRR = 21\times10^3\ mm^3/sec$$

$$(\pi D_{avg} N) . d . f = MRR$$

$$\boxed{d = (D_i - D_f)/2 = 1mm}$$

$$\therefore N = \frac{21\times10^3 . mm^3/sec}{\pi \times \left(\frac{73+75}{2}\right) mm \times 1\,mm \times 0.279\ \frac{mm}{rev}}$$

$$= 323.77\ rev/s$$

$$\text{time} = \frac{L}{fN} = \frac{225\ \cancel{mm}}{(0.279)\frac{\cancel{mm}}{\cancel{rev}} \times 324\ \frac{\cancel{rev}}{s}}$$

$$= 2.49\ \text{secs}$$

(2)

$$V_{avg} = \pi D_{avg} N$$

$$D_{avg} = (D_i + D_f)/2 = 24\ mm$$

$$= (\pi \times 24)\frac{mm}{\cancel{rev}} \times \frac{3500}{60} \cdot \frac{\cancel{rev}}{sec} = 4398\ mm/sec$$

$$= 4.398\ m/s$$

$$MRR = V_{avg} \times d \times f$$

$$d = (D_i - D_f)/2$$

$$= \cancel{4398}\ 4398\ mm/s \times 1\ mm \times \underbrace{0.08\ mm}_{\text{uncut chip thickness in turning}}$$

$$= 351.84\ mm^3/sec$$

$$t = \frac{L}{fN} = \frac{400\ mm}{(0.08)\frac{mm}{rev} \times \left(\frac{3500}{60}\right)\frac{rev}{s}}$$

$$t = 85.71\ sec$$

$$P = u \times MRR$$

$$P = 3.5 \times 351.84 = 1231\ W$$

$$F = P/V = \frac{1231\ W}{4.398\ m/s} = 280\ N$$

3

Given

$F_c = 150\ N$

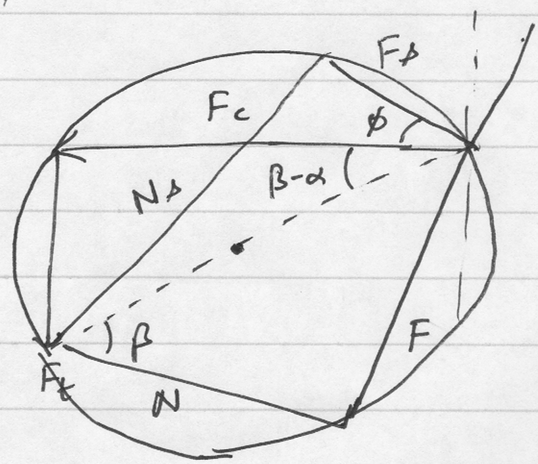
$F_t = 25 N$

$\alpha = 15^\circ$

$t_o = 1mm$

$b = 30mm$

$V = 2\ m/s$



$$\tan(\beta-\alpha) = \frac{F_t}{F_c} = \left(\frac{25}{150}\right) = 0.1666$$

$$\beta-\alpha = 9.462^\circ$$

$$\alpha = 15^\circ$$

$$\therefore \beta = 24.462$$

Merchant's relationship.

$$\phi = 45^\circ - \beta/_2 + \alpha/_2$$

$$\phi = 45^\circ - \frac{9.462^\circ}{2} = 40.269^\circ$$

(b)

$$\frac{t_o}{t_c} = \frac{\sin\phi}{\cos(\phi-\alpha)}$$

$$t_c = \frac{t_o \cdot \cos(\phi-\alpha)}{\sin(\phi)} = \frac{1\,\text{mm} \cos(40.269-15)}{\sin(40.269)}$$

$$= 1.399\ \text{mm}$$

(a)

$$F_s = R \cdot \cos(\phi+\beta-\alpha)$$

$$= \sqrt{150^2+25^2} \cdot \cos(40.269 + 9.462)$$

$$= 152.07\,\text{N} \times \cos(49.37)$$

$$F_s = 152.07 \times 0.646\,\text{N}$$

$$= 98.29\ \text{N}$$

$$\tau_s = \frac{F_s}{A_s} = \frac{F_s}{\frac{b\,t_o}{\sin\phi}} = \frac{98.28\,\text{N} \times \sin(40.269)}{30\,\text{mm} \times 1\,\text{mm}}$$

$$\tau_s = 2.117\ \text{N/mm}^2 \quad \text{or } 2.117\ \text{MPa}$$

(4)

$t_0 = 0.25$

$t_c = 0.75$

$w = 2.5$ mm

$\alpha = 0°$

$F_c = 950$ N

$F_t = 475$ N

From force circle,

(a)

$\mu = \tan\beta$

$$\tan(\beta - \alpha) = \frac{F_t}{F_c}$$

$$= \frac{475}{950} = 0.5$$

$$\beta - \alpha = \tan^{-1}(0.5)$$

$\alpha = 0$

$$\beta = \tan^{-1}(0.5) = 26.56°$$

$$\mu = \tan\beta = 0.5$$

(b)

$$\tau_s = F_s / A_s$$

$$A_s = \frac{w t_0}{\sin\phi} = \frac{2.5 \times 0.25}{\sin\phi}$$

If t_o and t_c are given use chip ratio, Merchant relationship is an approximate one and is used only when t_o and t_c are not available.

$$\phi = \tan^{-1}\left(\frac{r\cos\alpha}{1 - r\sin\alpha}\right) = \tan^{-1}(1/3)$$

$$\phi = 18.4^\circ$$

$$\therefore A_s = 0.25 \times 2.5 / \sin 18.4^\circ \ \text{mm}^2 = 1.98 \ \text{mm}^2$$

$$F_s = R\cos(\phi + \beta - \alpha)$$

$$= \sqrt{950^2 + 475^2} \ \text{N} \cdot \cos(18.4 + 26.56 - 0)$$

$$= 751.5 \ \text{N}$$

$$\tau_s = \frac{F_s}{A_s} = \frac{751.5}{1.98} \ \text{N/mm}^2$$

$$= 379.54 \ \text{N/mm}^2 \text{ or MPa}$$