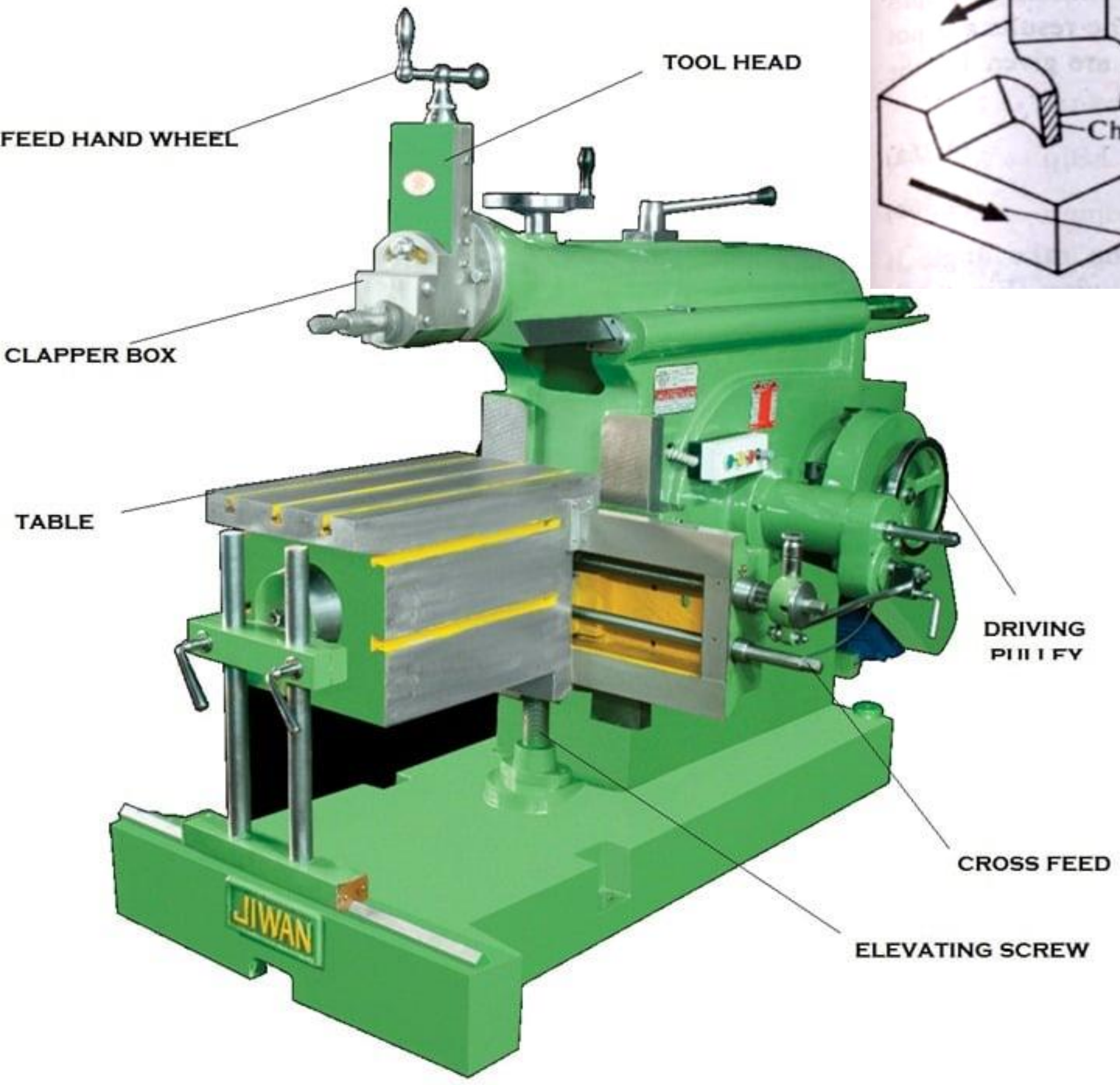
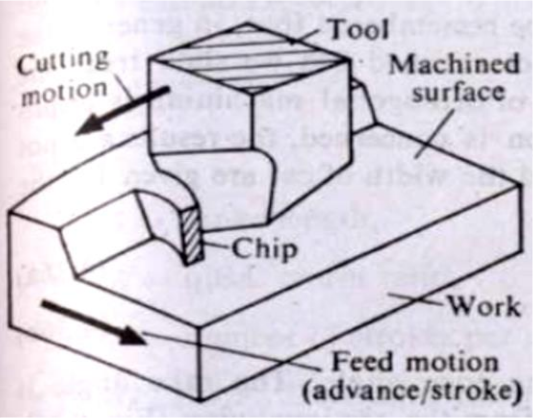
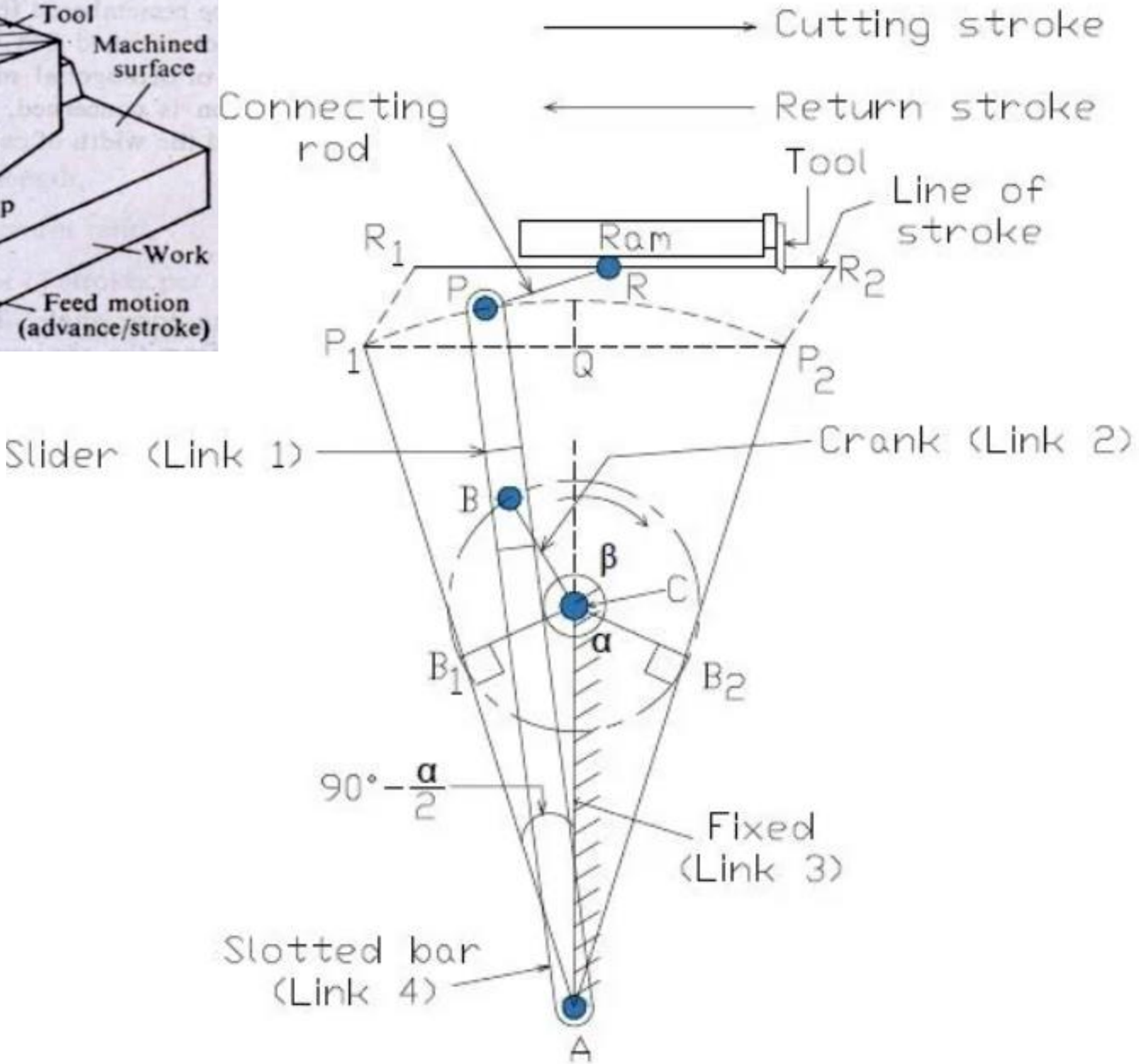
Machining Process – Common Applications

Shaping and Planing

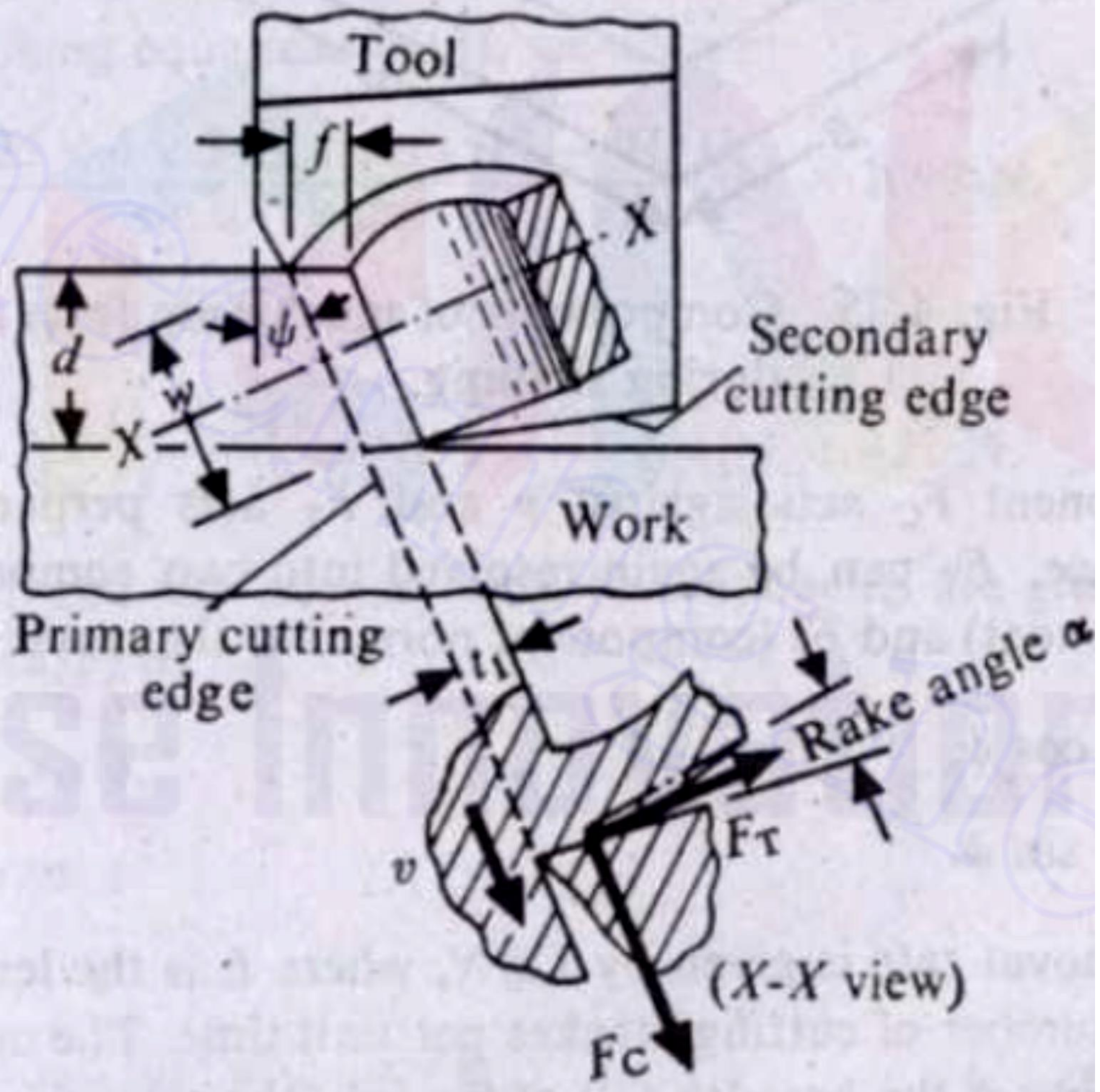


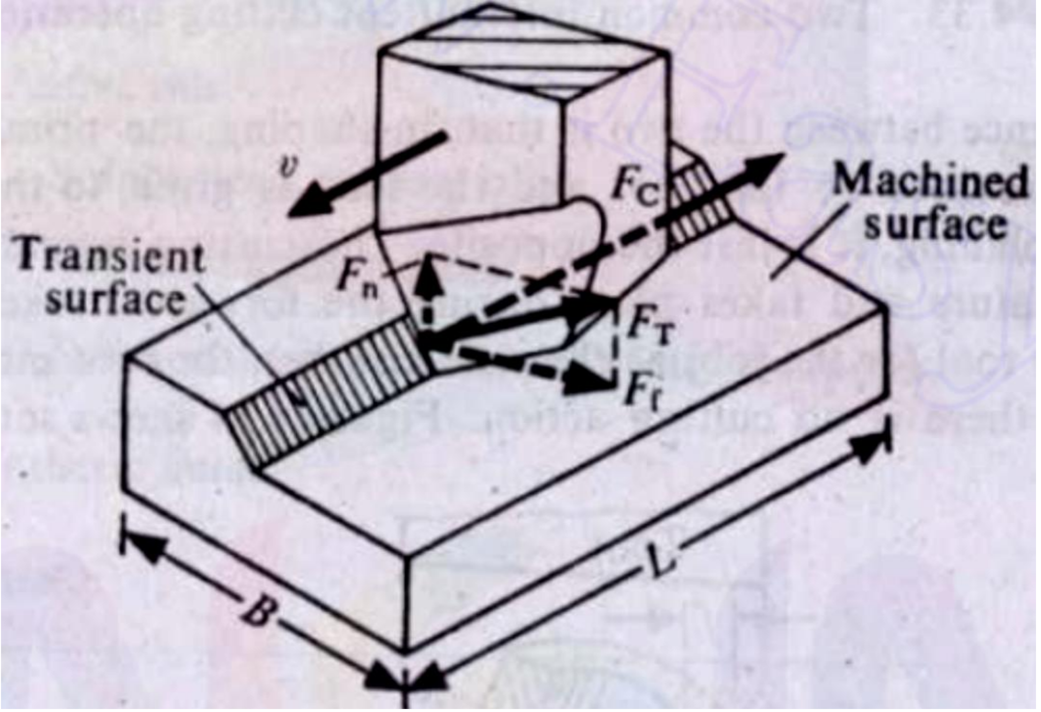
PARTS OF SHAPER MACHINE





Whitworth Quick Return Mechanism





$F_f = F_T \cos \psi$

$F_n = F_T \sin \psi$

$t_1 = f \cos \psi$

$w = d/\cos \psi$

ψ = principal cutting edge angle

Major parameters:

- No. of cutting strokes/time (N)
- Length of the job (L)
- Breadth of the job (B)
- Total depth of metal removal (H)
- Depth of cut (d)
- Feed (f)

Metal removal rate = L d f N

Cutting time,

$$T_c = \frac{H}{d} \times \frac{B}{f} \times \frac{1}{N}$$

Average Cutting Speed,

$$v = \frac{NS(1+R)}{2}$$

S = stroke length

R = quick return ratio

EXAMPLE 4.9 Determine the three components of the machining force when shaping a cast iron block with depth of cut = 4 mm, feed = 0.25 mm/stroke, normal rake angle of tool = 10°, principal cutting edge angle = 30°, coefficient of friction between chip and tool = 0.6, and ultimate shear stress of cast iron = 340 N/mm².

SOLUTION We shall use Lee's and Shaffer's shear angle relationship

$$\phi + \lambda - \alpha = 45°.$$

In the present case, $\lambda = \tan^{-1}(0.6) \approx 31°$. Hence,

$$\phi = 45° + 10° - 31° = 24°.$$

The uncut thickness and width of cut are $0.25 \cos 30°$ mm and $4/\cos 30°$ mm, respectively.

$$F_S = \frac{w t_1 \tau_s}{\sin\phi} \quad \text{and} \quad F_C = \frac{F_S \cos(\lambda - \alpha)}{\cos(\phi + \lambda - \alpha)}$$

$$\rightarrow \quad F_C = w t_1 \tau_s \cos(\lambda - \alpha)\left[\frac{1}{\sin\phi \cos(\phi + \lambda - \alpha)}\right].$$

$$F_C = \frac{0.25 \times 4 \times 340 \times \cos(31^\circ - 10^\circ)}{\sin 24^\circ \times \cos 45^\circ}\ \mathrm{N} = 1099\ \mathrm{N}$$

$t_1 = f \cos\psi$
$w = d/\cos\psi$ $\rightarrow$ $t_1 w = f d = 0.25 \mathrm{x} 4$

Also, $F_C = R\cos(\lambda - \alpha)$ and $F_T = R\sin(\lambda - \alpha)$

$$\rightarrow \quad F_T = F_C \frac{\sin(\lambda - \alpha)}{\cos(\lambda - \alpha)} = 1099 \times \frac{\sin 21^\circ}{\cos 21^\circ}\ \mathrm{N} = 422\ \mathrm{N}$$

Finally, $F_f = F_T \cos\psi \quad \rightarrow \quad F_f = 422 \cos 30^\circ\ \mathrm{N} = 365\ \mathrm{N}$

$F_n = F_T \sin\psi \quad \rightarrow \quad F_n = 422 \sin 30^\circ\ \mathrm{N} = 211\ \mathrm{N}$

EXAMPLE 4.10 If the operation in Example 4.9 takes place with 60 strokes/min, what will be the average power consumption if the length of the job is 200 mm ?

SOLUTION Let us assume that the cutting component of F_C remains constant. Thus, the work done during each forward stroke is

$$F_C \times \frac{200}{1000}\ \mathrm{J} = \frac{1099 \times 200}{1000}\ \mathrm{J} = 220\ \mathrm{J}$$

since F_n and F_t do not consume any energy. So, the average power consumption is given by

$$W_{av} = \frac{220 \times 60}{60}\ \mathrm{W} = 220\ \mathrm{W}.$$