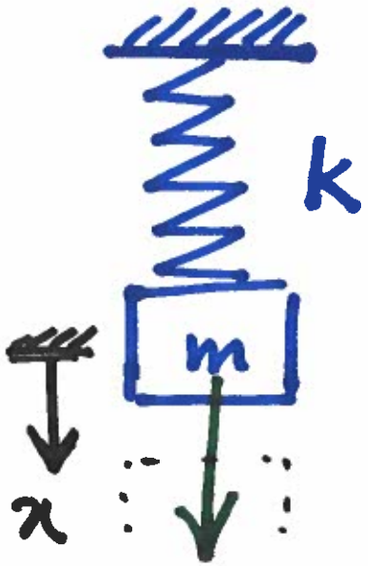
Tools & Vibrations:

Background)

f_n : natural frequency



$\omega_n = 2\pi f_n$ Natural freq.

$\omega_n = \sqrt{k/m}$

excitation freq.

$F(t) = F \sin\omega t$

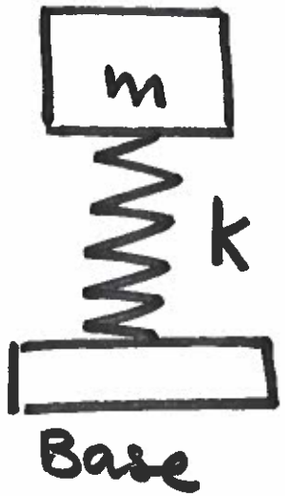
$$x(t) = \left(\frac{(\frac{F}{K})}{1-(\frac{\omega}{\omega_n})^2} \right) \sin\omega t$$

Amp.

$m\ddot{x} + kx = F\sin\omega t$

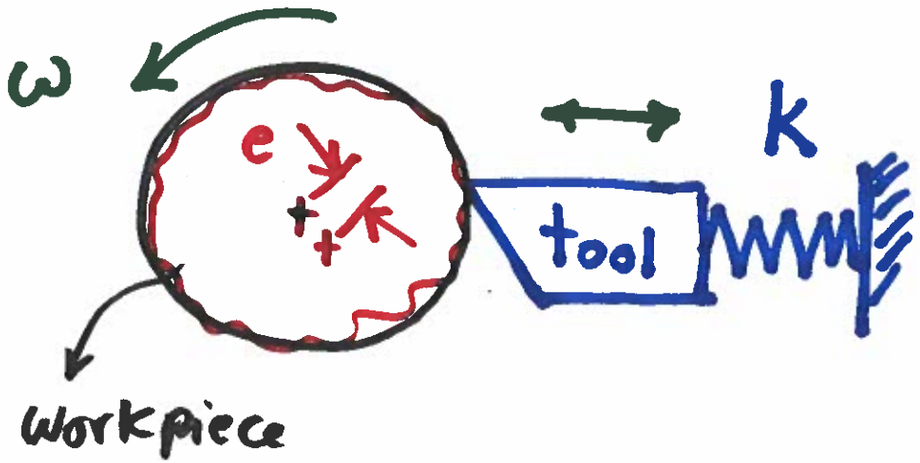
if $\omega = \omega_n \Rightarrow x \to \infty$ Resonance

Displacement as excitation



if $\omega = \omega_n$ ⟶ Resonance ✓

in Turning operation:



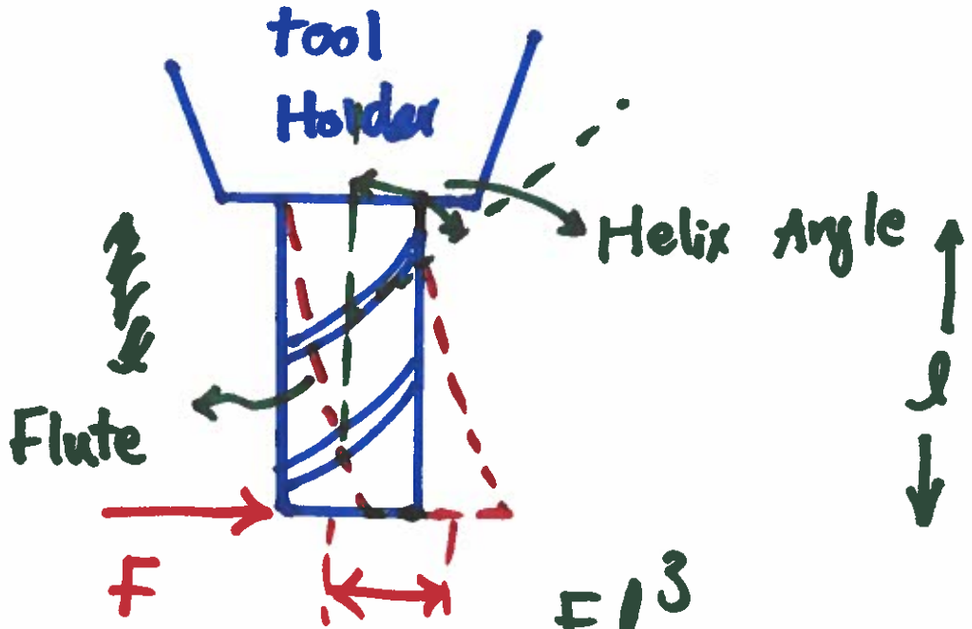
Cascading effect

▶ Video # 1

in cutting there are vibrations with large amplitude.

▶ in class video of Saw Vibration

in milling operation:



$\equiv$

$$\left(K = \frac{3EI}{l^3} \right)$$

$$\delta = \frac{Fl^3}{3EI} \rightarrow I = \frac{\pi}{64} d^4$$

$$F = K\delta$$

Chatter: it is the resonance phenomenon.

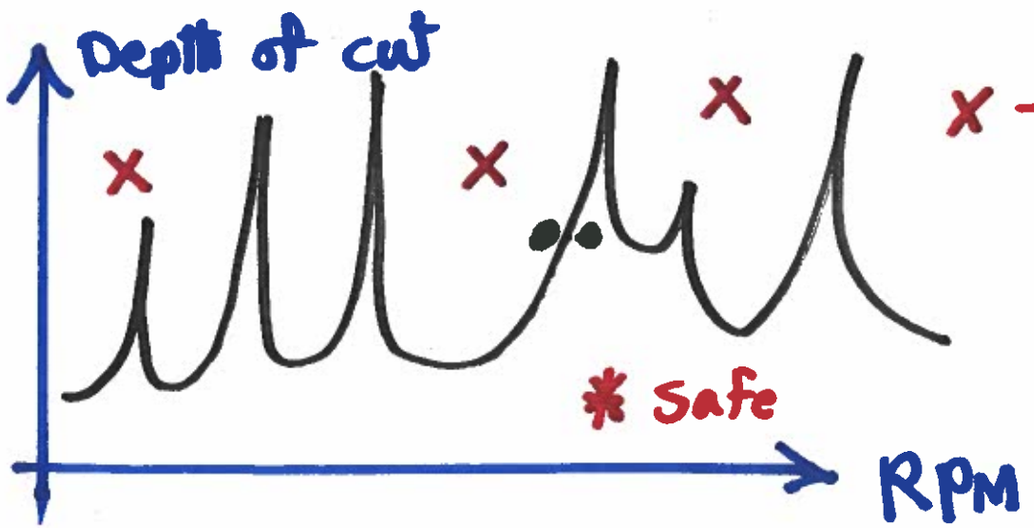
in Machining chatter can be
- heard → noise
  - ▶ Video ≠ 2
- Seen → surface
  - tools
  - life

$\omega = \omega_n$

- excitation (Rotation, ...)
- tool stiffness
  - Machine
  - Geometry

How we can avoid chatter:

- Change the rotation speed
- change the depth of cut



← Stability Lobe Diagram

▶ Video ≠ 3

- Change the tool stiffnen:

$$K = \frac{3EI}{l^3}$$

→ bigger tool diameter

→ shorter tool length

- Use a machine with higher stiffnen.

▶ video #4