1.30 SHARPNESS OF RESONANCE

The displacement amplitude of a forced oscillator is given by

$$a = \frac{f_0}{\sqrt{4b^2\omega^2 - (\omega^2 - \omega_0^2)^2}}$$

At resonance the frequency of the applied force is equal to the frequency of the oscillator

i.e.

$\omega = \omega_0$ or $(\omega^2 - \omega_0^2) = 0$

$\therefore$ Amplitude of forced vibration at resonance

$= \frac{f_0}{2b\omega}$ where f_0 is the applied force per unit mass, $\frac{\omega}{2\pi}$ the frequency of the applied force and b the damping coefficient.

As the frequency of the applied force ω is increased or decreased from its resonant value ω_0 the value of the amplitude always decreases.

When the amplitude at resonance falls rapidly as the frequency ω of the applied force is changed slightly from its resonant value the resonance is said to be *sharp*.

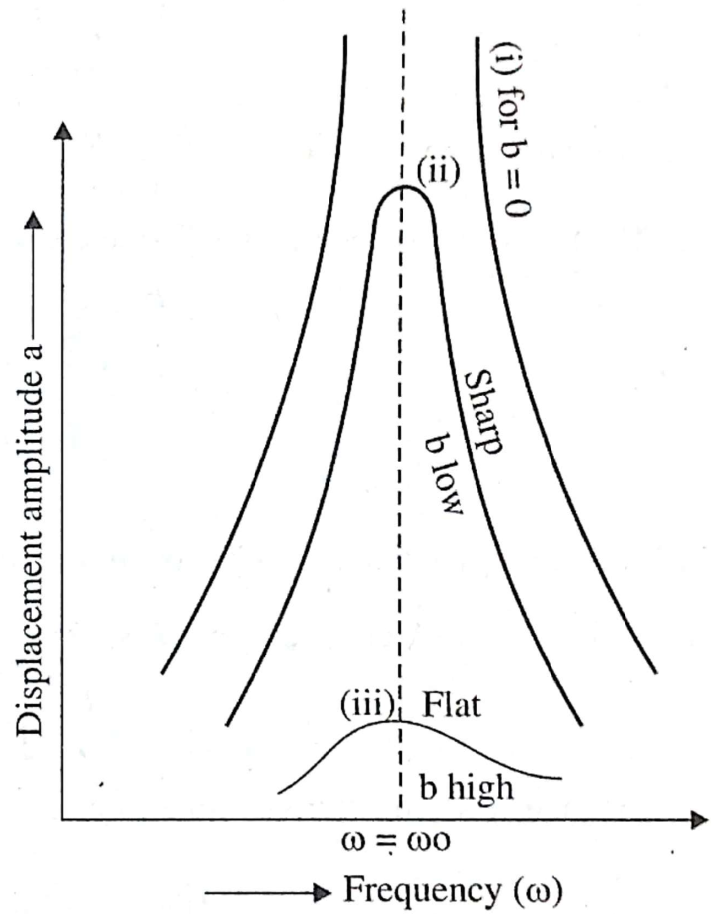

Fig. 1.17

When the amplitude at resonance falls gradually as the frequency ω of the applied force is changed slightly from its resonant value the resonance is said to be flat.

The sharpness of resonance depends upon damping.

Effect of damping on sharpness of resonance.

(*i*) When $b = 0$ *i.e.*, there is no damping, the amplitude at resonance becomes infinite as shown in Fig. 8.12 (*i*).

(*ii*) When damping is low the amplitude is sufficiently large but falls off rapidly as the frequency of the applied force becomes slightly different from the natural frequency of the body as shown in Fig. 8.12 (*ii*). We get a resonance curve

(*iii*) As the value of b is high, we get a flat at resonance as shown in Fig. 8.12 (*iii*). *In other words, when damping is small resonance is sharp and when damping is large resonance is flat.*