Acceleration of Piston :-

A = change in velocity w.r.t. time.

$$a = \frac{dv}{dt}$$

$$= \frac{dv}{d\theta} \cdot \frac{d\theta}{dt}$$

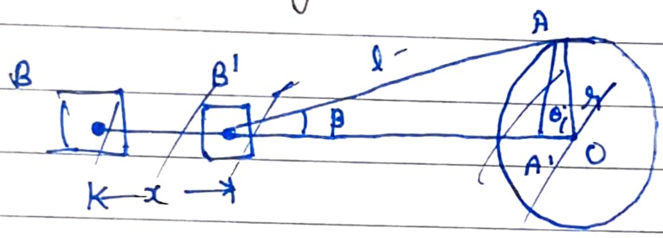
$$= \frac{d}{d\theta}\, \omega r \left(\sin\theta + \frac{\sin 2\theta}{2n} \right) \frac{d\theta}{dt}$$

$$= \omega r \left[\cos\theta + \frac{1}{2}\frac{d}{d\theta} \frac{\sin 2\theta}{n} \right] \omega$$

$$= \omega^2 r \left[\cos\theta + \frac{1}{2n} \cos 2\theta \cdot 2 \right]$$

$$\boxed{a = \omega^2 r \left[\cos\theta + \frac{\cos 2\theta}{n} \right]}$$

Angular velocity & angular acceleration of connecting rod:-



In $\Delta AA'B$

$$\sin\beta = \frac{y}{l}$$

$$y = l\sin\beta$$

$$BB' = OB - OB'$$

$$x = (l+r) - (OA' + A'B')$$

$$x = (l+r) - (r\cos\theta + l\cos\beta)$$

$$x = (l+r) - r\cos\theta - l\cos\beta \quad (\because n = l/r)$$

$$x = nr + r - r\cos\theta - nr\cos\beta$$

$$x - n + 1$$

$$\Delta AA'O = \sin\theta = \frac{y}{r}$$

$$y = r\sin\theta$$

$$l\sin\beta = r\sin\theta$$

$$\sin\beta = \frac{r}{l}\sin\theta$$

$$\sin\beta = \frac{\sin\theta}{n} \quad \text{——} (1)$$

$$\cos\beta \frac{d\beta}{dt} = \frac{\cos\theta}{n}\frac{d\theta}{dt}$$

$$\cos\beta\, \omega_c = \frac{\cos\theta}{n}\frac{d\theta}{dt}$$

$$\cos\beta\, \omega_c = \frac{\cos\theta}{n}\,\omega$$

$$\sqrt{1 - \frac{\sin^2\theta}{n^2}} \times \omega_c = \frac{\cos\theta}{n}\,\omega$$

$$\left\{ \cos\beta = \sqrt{1 - \frac{\sin^2\theta}{n^2}} \right.$$

$$W_c = \frac{\omega\cos\theta}{\frac{n}{n}\sqrt{n^2 - \sin^2\theta}}$$

$$\boxed{\omega_c = \frac{\omega\cos\theta}{\sqrt{n^2 - \sin^2\theta}}}$$