2.2 Verify the geometrical elements for Circular channel

Top width of water T

$$\left(\frac{T}{2}\right)^2 = \left(y - \frac{d_o}{2}\right)^2 = r^2$$

or $$\frac{T^2}{4} = r^2 - \left(y - \frac{d_o}{2}\right)^2$$

$$T = 2\sqrt{\left(\frac{d_0}{2}\right)^2 - \left(y - \frac{d_o}{2}\right)^2}$$

$$T = 2\sqrt{\frac{d_o^2}{4} - \left(y^2 + \frac{d_o^2}{4} - 2y\frac{d_o}{2}\right)}$$

$$= 2\sqrt{\frac{d_o^2}{4} - y^2 - \frac{d_o^2}{4} + \frac{2yd_o}{2}}$$

$$T = 2\sqrt{y(-y + d_o)} \quad or \quad T = 2\sqrt{y(d_o - y)}$$

$$\sin\left(180 - \frac{\theta}{2}\right) = \frac{T}{2}r$$

or $$\boxed{T = d_o \sin\left(180 - \frac{\theta}{2}\right) = d_o \sin\frac{\theta}{2}}$$

Area of flow = Area of circle - Area above the chord

$$\text{Area of triangle} = \frac{T}{2} x \left(y - \frac{d_o}{2}\right)$$

$$= \frac{d_o}{2}\sin\left(180 - \frac{\theta}{2}\right)\left(y - \frac{d_o}{2}\right)$$

$$\left[\cos\left(180 - \frac{\theta}{2}\right) = \frac{y - \frac{d_o}{2}}{r} \text{ or } y - \frac{d_o}{2} = \frac{d_o}{2}\cos\left(180 - \frac{\theta}{2}\right) = -\frac{d_o}{2}\cos\frac{\theta}{2}\right]$$

$$\text{Area for } \theta = \frac{\text{Area of full circle}}{2\pi} x\theta$$

$$= \frac{\pi d_o^2}{4.2\pi}\theta = \frac{d_o^2}{8}\theta$$

$$\frac{d_o^2}{8}\theta - \sin\theta\frac{d_o^2}{8}$$

$$\boxed{\text{Area of flow} = \frac{d_o^2}{8}(\theta - \sin\theta)}$$

$$\boxed{P = 2\pi \frac{d_o}{2} \text{ x } \frac{1}{2A}\theta = \frac{d_o\theta}{2}}$$

$$R = \frac{A}{P} = \frac{\frac{1}{8}(\theta - \sin\theta)d_o^2}{\frac{d_o^2}{2}} = \frac{d_o}{4}\left(\frac{\theta}{\theta} - \frac{\sin\theta}{\theta}\right)$$

$$\boxed{R = \frac{d_o}{4}\left(1 - \frac{\sin\theta}{\theta}\right)}$$

$$Z = A\sqrt{D} = A\sqrt{A/T}$$

$$D = \frac{A}{T} = \frac{\frac{1}{8}(\theta - \sin\theta)d_o^2}{d_o \sin\frac{\theta}{2}}$$

$$D = \frac{A}{T} = \frac{d_o}{8}\left(\frac{\theta - \sin\theta}{\sin\frac{\theta}{2}}\right)$$

$$D = \frac{d_o}{8}\left(\frac{\theta - \sin\theta}{\sin\frac{\theta}{2}}\right)$$

$$Z = \frac{1}{8}(\theta - \sin\theta)d_o^2\sqrt{\frac{d_o}{8}\left(\frac{\theta - \sin\theta}{\sin\frac{\theta}{2}}\right)}$$

$$\boxed{Z = \frac{\sqrt{2}}{32}\frac{(\theta - \sin\theta)^{1.5}}{\left(\sin\frac{\theta}{2}\right)^{0.5}}d_0^{5/2}}$$