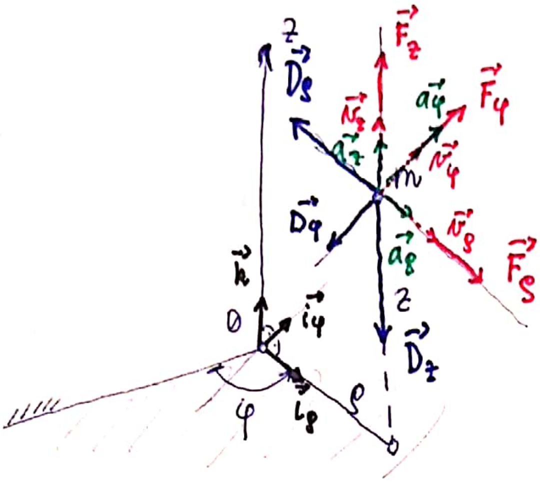
CYLINDRICAL COORDINATE SYSTEM



position: ρ, φ, z

base vectors: $\vec{i}_\rho, \vec{i}_\varphi, \vec{k}$

velocity:

$$\vec{v} = \vec{v}_\rho + \vec{v}_\varphi + \vec{v}_z = v_\rho \vec{i}_\rho + v_\varphi \vec{i}_\varphi + v_z \vec{k}$$

$$v_\rho = \dot{\rho} = \frac{d\rho}{dt}$$

$$v_\varphi = \rho\dot{\varphi} \qquad ; \quad \dot{\varphi} = \frac{d\varphi}{dt}$$

$$v_z = \dot{z}$$

acceleration

$$\vec{a} = \vec{a}_\rho + \vec{a}_\varphi + \vec{a}_z = a_\rho \vec{i}_\rho + a_\varphi \vec{i}_\varphi + a_z \vec{k}$$

$$a_\rho = \ddot{\rho} - \rho\dot{\varphi}^2 \qquad ; \quad \ddot{\rho} = \frac{d^2\rho}{dt^2}$$

$$a_\varphi = \rho\ddot{\varphi} + 2\dot{\rho}\dot{\varphi} \qquad ; \quad \ddot{\varphi} = \frac{d^2\varphi}{dt^2}$$

$$a_z = \ddot{z} \qquad ; \quad \ddot{z} = \frac{d^2 z}{dt^2}$$

Force:

$$\vec{F} = \vec{F}_\rho + \vec{F}_\varphi + \vec{F}_z = $$
$$= F_\rho \vec{i}_\rho + F_\varphi \cdot \vec{i}_\varphi + F_z \cdot \vec{k}$$

d'Alembert force:

$$\vec{D} = \vec{D}_\rho + \vec{D}_\varphi + \vec{D}_z =$$
$$= D_\rho \vec{i}_\rho + D_\varphi \vec{i}_\varphi + D_z \vec{k}$$

$$\vec{D} = -m\vec{a} \longrightarrow D_\rho = m a_\rho$$

$$D_\varphi = m a_\varphi$$

$$D_z = m a_z$$

general eqn. of equilibrium:

$$\sum_{(i)} \vec{F}_i + \vec{D} = \vec{\emptyset}$$

(1) ρ: $\sum_{(i)} F_{i\rho} - D_\rho = \emptyset$

(2) φ: $\sum F_{i\varphi} - D_\varphi = \emptyset$

(3) z: $\sum F_{iz} - D_z = \emptyset$