

$$1) \sum \vec{F} - \cancel{\rho \vec{v} \cdot \vec{n} dV} = \frac{d}{dt} \cancel{\rho \vec{v} \cdot \vec{n} dV} + \cancel{\rho \vec{v} \cdot \vec{n} dS}$$

$$\sum F = \int_S \rho u_x \vec{v} \cdot \vec{n} dS$$

$$- \mu M g = \rho (V_j - u) [-(V_j - u)] S$$

$$(V_j - u) = \sqrt{\frac{\mu M g}{\rho S}}$$

$$= \sqrt{\frac{0.5 (75 \text{ kg}) (9.81 \text{ m/s}^2)}{(1000 \text{ kg/m}^3) (0.005 \text{ m}^2)}}$$

$$= 8.58 \text{ m/s}$$

$$u = V_j - 8.58 \text{ m/s}$$

$$\boxed{= 21.42 \text{ m/s}}$$

2)



$$\sum \vec{F} - \iiint_V \rho \vec{a} dV = \frac{d}{dt} \iiint_V \rho \vec{v} dV + \iint_S \rho \vec{v} \vec{v} \cdot \vec{n} dS$$

$$-M a_x = -\rho (V_j - u)^2 S - \rho (V_j - u)^2 \cos \theta S$$

$$-M \frac{du}{dt} = -\frac{3}{2} \rho (V_j - u)^2 S$$

$$\frac{du}{dt} = \frac{3 \rho S}{2 M} (V_j - u)^2$$

$$\int_0^u \frac{du}{(V_j - u)^2} = \int_0^t \frac{3 \rho S}{2 M} dt$$

$$\left[\frac{1}{V_j - u} \right]_0^u = \frac{3 \rho S}{2 M} t$$

$$\frac{1}{V_j - u} - \frac{1}{V_j} = \frac{3}{2} \frac{g s}{M} +$$

$$u = V_j \left[\frac{+}{+ + \frac{2M}{3g s V_j}} \right]$$

$$u = 20 \text{ m/s} \left[\frac{+}{+ + \left(\frac{1}{3} \right) s} \right]$$

$$3) \sum F_x - \iiint_V \rho a_x dV = \frac{d}{dt} \iiint_V \rho u_x dV + \iint_S \rho u_x \vec{v} \cdot \vec{n} dS$$

$$-Mg\mu - Ma_x = \rho (v_j - u) [-(v_j - u)] S$$

$$Mg\mu + M \frac{du}{dt} = \rho (v_j - u)^2 S$$

$$\frac{du}{dt} = \mu g \left[\frac{\rho S}{M\mu g} (v_j - u)^2 - 1 \right]$$

$$\frac{du}{dt} = -\mu g \left[1 - \frac{\rho S}{M\mu g} (v_j - u)^2 \right]$$

$$\frac{du}{1 - \frac{\rho S}{M\mu g} (v_j - u)^2} = -\mu g dt$$

define $A = \sqrt{\frac{\rho S}{M\mu g}} (v_j - u)$

$$dA = -\sqrt{\frac{\rho S}{M\mu g}} du$$

$$\int_{A_0}^{A_1} \frac{dA}{1-A^2} = \int_0^+ \sqrt{\frac{gs\mu g}{M}} dt$$

$$\operatorname{arctanh}(A_1) - \operatorname{arctanh}(A_0) = \sqrt{\frac{gs\mu g}{M}} t$$

$$@ t=0 \quad u=0 \quad \& \quad A = \sqrt{\frac{gs}{M\mu g}} v_j$$

$$\operatorname{arctanh}(A_1) = \sqrt{\frac{gs\mu g}{M}} t + \operatorname{arctanh}\left(\sqrt{\frac{gs}{M\mu g}} v_j\right)$$

$$A_1 = \tanh\left[\sqrt{\frac{gs\mu g}{M}} t + \operatorname{arctanh}\left(\sqrt{\frac{gs}{M\mu g}} v_j\right)\right]$$

$$\sqrt{\frac{gs}{M\mu g}} (v_j - u) = \tanh\left[\sqrt{\frac{gs\mu g}{M}} t + \operatorname{arctanh}\left(\sqrt{\frac{gs}{M\mu g}} v_j\right)\right]$$

$$u = V_j - \sqrt{\frac{M_{ug}}{ss}} \left\{ \tanh \left[\sqrt{\frac{ss_{ug}}{M}} + \operatorname{arctanh} \left(\sqrt{\frac{ss}{M_{ug}}} V_j \right) \right] \right\}$$

simple