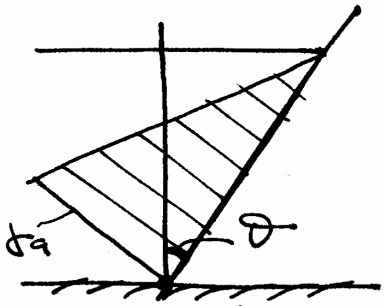
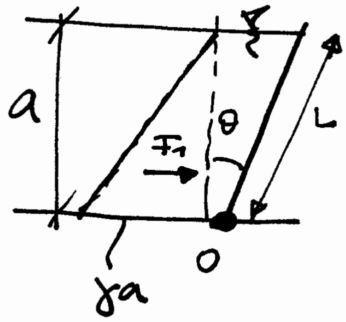
ESAME MECCANICA FLUIDI 1

22 GENNAIO 2008

ESERCIZIO 1

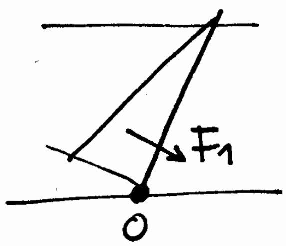


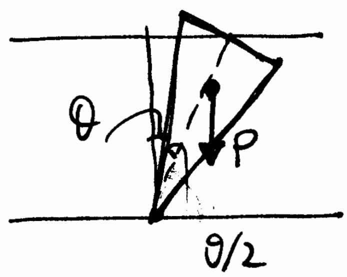


$$L = \frac{a}{\cos\theta} = \frac{3}{\sqrt{3}/2} = 3.46\,m$$

$$P_0 = \gamma \cdot a = 1030 \cdot 3 \cdot 9.81 = 30313\ N/m^2$$

$$M_{F_1} = \gamma \cdot a \cdot \frac{L}{2} \cdot \frac{L}{3} = 1030 \cdot 9.81 \cdot 3 \cdot \frac{3.46}{2} \cdot \frac{3.46}{3} = 60626\,Nm$$



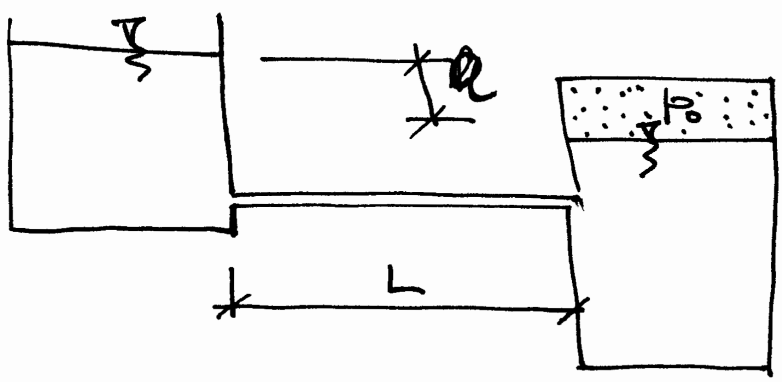


$$X_p = \frac{2h}{3} \cdot \cos\left(\theta + \frac{\theta}{2}\right) = \frac{16}{3} \cdot \frac{\sqrt{2}}{2} = 3.77\,m$$

$$M_p = P g \cdot X_p = 100 \cdot 9.81 \cdot 3.77 = 3698\ Nm$$

$$M_{tot} = M_{F_1} + M_p = 60626 + 3698 = 64324\ Nm$$

ESERCIZIO 2



$$\begin{cases} \dfrac{p_0}{\gamma} = a + \dfrac{U^2}{2g}\left[0.5 + \dfrac{\lambda}{D} L + 1\right] \\ Q = U \cdot \dfrac{\pi D^2}{4} \end{cases}$$

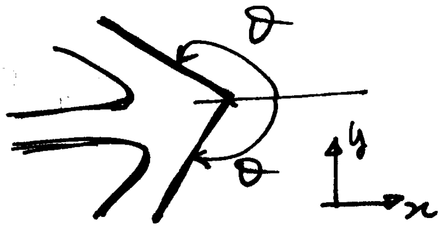
$$\Rightarrow \frac{p_0}{\gamma} = a + \frac{16\,Q^2}{\pi^2 D^4}\left[0.5 + \frac{\lambda L}{D} + 1\right]$$

$$\frac{p_0}{\gamma} - a = \frac{21500}{1000 \cdot 9.81} - 1 = 1.19\ m$$

Bisogna fare in modo che le perdite siano = 1.19m

D	Ω [m^2]	U [m/s]	Re	ε	λ		Perdite
0,010	0,00007854	12,732	127324	0,02500	0,05329	0,000026	893,003
0,020	0,00031416	3,183	63662	0,01250	0,04170	0,000598	22,308
0,030	0,00070686	1,415	42441	0,00833	0,03718	0,000479	2,681
0,035	0,00096211	1,039	36378	0,00714	0,03586	0,000545	1,211
0,04	0,00125664	0,796	31831	0,00625	0,03490	-0,000032	0,612

ESERCIZIO 3



Applico il principio della Quantità di Moto lungo l'asse x

$$F_x = -\Pi_x$$

$$M_{ix} = Q \cdot U = 18 \cdot 250 = 4500 \ kg\, m/s^2$$

$$M_{ux} = Q \cdot U \cdot \cos\vartheta$$

$$\Pi_x = QU(1-\cos\vartheta) = 4500 - 4500\cos\vartheta$$

$$\cos\vartheta = -\frac{3000}{4500} = -0.67 \rightsquigarrow \vartheta \simeq 132°$$

ESERCIZIO 5

Calcoliamo la vorticità $\quad \omega_z = -\frac{\partial u}{\partial y} + \frac{\partial v}{\partial x} = -\frac{1}{2m}\frac{\partial P}{\partial x}(2y-h) + 0 \neq 0$

Il moto è rotazionale

$$\mathbb{E} = \begin{bmatrix} \frac{\partial u}{\partial x} & \frac{1}{2}\left(\frac{\partial u}{\partial y} + \frac{\partial v}{\partial x}\right) \\ \frac{1}{2}\left(\frac{\partial u}{\partial y} + \frac{\partial v}{\partial x}\right) & \frac{\partial v}{\partial y} \end{bmatrix} = \begin{bmatrix} \frac{1}{2m}\frac{\partial^2 P}{\partial x^2}(y^2 - hy) & \frac{1}{4m}\frac{\partial P}{\partial x}(2y-h) \\ \frac{1}{4m}\frac{\partial P}{\partial x}(2y-h) & 0 \end{bmatrix}$$

ESERCIZIO 6

$$[\rho] = \frac{M}{L^3} \quad [U] = \frac{L}{T} \quad [D] = L \quad [f] = \frac{1}{T}$$

$$M^{\alpha} L^{-3\alpha} L^{\beta} T^{-\beta} L^{\gamma} = T^{-1} \Rightarrow \begin{cases} \alpha = 0 \\ -3\alpha + \beta + \gamma = 0 \\ -\beta = -1 \end{cases}$$

$$\Rightarrow \begin{cases} \alpha = 0 \\ \beta = 1 \\ \gamma = -1 \end{cases} \qquad \Pi_0 = \frac{f}{U/D}$$

ESERCIZIO 7

Modello similitudine di Reynolds

acqua $\nu_m = 10^{-6}$ m^2/s ; aria $\nu_p = 17 \cdot 10^{-6}$

$\lambda = 0.1$

$$Re = \frac{UD}{\nu} \qquad \frac{U_m D_m}{\nu_m} = \frac{U_p D_p}{\nu_p} \qquad \frac{U_m}{U_p} = \frac{D_p}{D_m}\frac{\nu_m}{\nu_p} = \frac{1}{\lambda}\frac{1}{17} = \frac{10}{17}$$

La scala delle velocità è il rapporto tra la scala delle viscosità e quella delle lunghezze $u = \frac{\nu}{\lambda} = 0.588$

Scala delle forze $\varphi = \frac{\rho_m U_m^2 D_m^2}{\rho_p U_p^2 D_p^2} = \frac{1000}{1}\frac{10^2}{17^2} \cdot \frac{1}{10^2} = 3.46$

$$\varphi = \frac{F_m}{F_p} \rightsquigarrow F_p = \frac{F_m}{\varphi} = \frac{175\ N}{3.46} = 50.6\ N$$

ESERCIZIO 8

Applicando il teorema di Bernoulli tra il p.to 1 e il p.to 2 si ottiene

$$H_1 = H_2 \qquad z_1 + \frac{p_1}{\gamma} + \frac{U_1^2}{2g} = z_2 + \frac{p_2}{\gamma} + \frac{U_2^2}{2g}$$

$$Q = U_1 \frac{\pi D_1^2}{4} = U_2 \frac{\pi D_2^2}{4} \qquad U_2 = U_1 \frac{D_1^2}{D_2^2} \qquad U_1 = \frac{0.03\ 4}{\pi D_1^2} = 0.425 m/s$$

$$P_2 = P_1 + \frac{\rho}{2}(U_1^2 - U_2^2) + \gamma(z_1 - z_2) = P_1 + \rho U_1^2 \left[1 - \frac{D_1^2}{D_2^2}\right] - \Delta\gamma$$

$$= 10\,000 + 1000 \cdot 0.425^2 \left[1 - \frac{0.3^2}{0.15^2}\right] - 0{,}5\ 9810 = 4555\ Pa$$