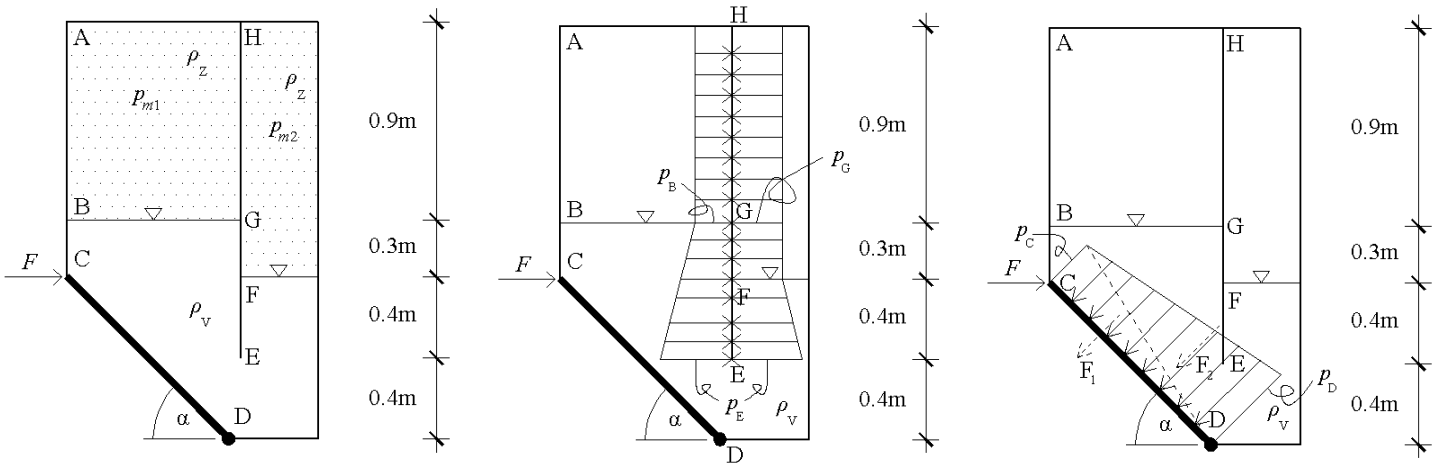
1) Rezervoar je napunjen vodom i zrakom kao što je prikazano na slici. Potrebno je izračunati tlakove u točkama A, B, C, D, E, F, G i H. Nacrtati dijagrame hidrostatskog tlaka na pregradni zid rezervoara E-F-G-H s obje strane te na pravokutni zatvarač C-D. Izračunati vrijednost sile *F* kojom je potrebno djelovati na zatvarač da ne dođe do otvaranja, odnosno rotacije oko osi D. Zadatak je ravninski (računati na 1m širine rezervoara).

(20 bodova)

Zadano je: ρ_V=1000kg/m^3; ρ_Z=0kg/m^3; p_{m2}=8kPa; α=45˚

Zadana slika **Dijagram E-F-G-H** **Dijagram C-D**



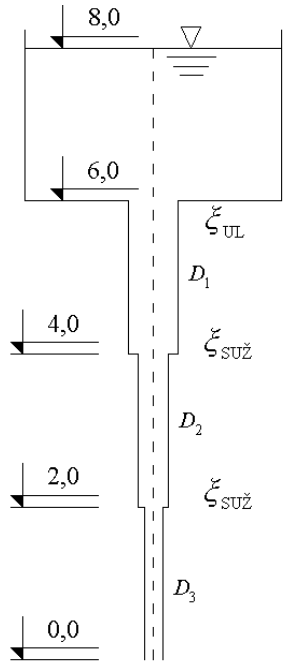
$$p_{m2} = p_H = p_G = p_F = p_C = 8\,kPa$$
$$p_E = p_F + \rho g 0.4 = 8 + 3.92 = 11.92\,kPa$$
$$p_B = p_A = p_C - \rho g 0.3 = 8 - 2.94 = 5.06\,kPa$$
$$p_D = p_E + \rho g 0.4 = 11.92 + 3.92 = 15.84\,kPa$$

$$\sum M_{(D)} = 0$$
$$F \cdot 0.8 = F_1 \cdot \left(0.8\sqrt{2} \cdot \frac{2}{3}\right) + F_2 \cdot \left(0.8\sqrt{2} \cdot \frac{1}{3}\right)$$
$$0.8F = 0.754F_1 + 0.377F_2$$
$$0.8F = 0.754\left(p_C \cdot 1.13 \cdot \frac{1}{2}\right) + 0.377\left(p_D \cdot 1.13 \cdot \frac{1}{2}\right)$$
$$0.8F = 0.754\left(8 \cdot 1.13 \cdot \frac{1}{2}\right) + 0.377\left(15.84 \cdot 1.13 \cdot \frac{1}{2}\right)$$
$$F = 8.48\,kN$$

2) Potrebno je odrediti protok vode kroz cjevovod u vertikalnoj ravnini te brzine u cijevima 1, 2 i 3. Odrediti vrijednost tlaka u cjevovodu na koti 6.0m, 4.0m i 2.0m neposredno prije i neposredno nakon ulaza, odnosno suženja. Nacrtati energetsku, piezometarsku i geometrijsku liniju u prevaljenom presjeku, od vodnog lica na koti 8.0m do izlaza iz cijevi 3 na koti 0.0m. Za referentnu liniju crtanja uzeti os cjevovoda. Linije crtajte u pogodnom mjerilu. Lokalni gubici su funkcija zadanih koeficijenata i nizvodnih brzina.

(25 bodova)

Zadano je: ξ_{UL}=0.6; $\xi_{SUŽ}$=0.3; λ(Darcyjev koef. trenja)=0.023(za sve cijevi)
D_1=1.4D_2=1.8D_3= 42cm



$$A_1 = \frac{D_1^2\pi}{4} = \frac{0.42^2\pi}{4} = 0.1385\,m^2$$
$$A_2 = \frac{D_2^2\pi}{4} = \frac{0.3^2\pi}{4} = 0.0707\,m^2$$
$$A_3 = \frac{D_3^2\pi}{4} = \frac{0.2333^2\pi}{4} = 0.0427\,m^2$$

$$8 = \frac{Q^2}{2gA_3^2}\left(\xi_{SUŽ} + \lambda\frac{L}{D_3} + 1\right) + \frac{Q^2}{2gA_2^2}\left(\xi_{SUŽ} + \lambda\frac{L}{D_2}\right) + \frac{Q^2}{2gA_1^2}\left(\xi_{UL} + \lambda\frac{L}{D_1}\right)$$

$$8 = \frac{Q^2}{2\cdot g\cdot 0.0427^2}\left(0.3 + 0.023\frac{2}{0.2333} + 1\right) + \frac{Q^2}{2\cdot g\cdot 0.0707^2}\left(0.3 + 0.023\frac{2}{0.3}\right) + \frac{Q^2}{2\cdot g\cdot 0.1385^2}\left(0.6 + 0.023\frac{2}{0.42}\right)$$

$$8 = \frac{Q^2}{0.0358}(1.497) + \frac{Q^2}{0.0981}(0.453) + \frac{Q^2}{0.3764}(0.7095)$$

$$8 = Q^2\left(41.816 + 4.618 + 1.885\right)$$

$$Q = \sqrt{\frac{8}{48.319}} = 0.408\,m^3/s$$

$$v_1 = \frac{Q}{A_1} = \frac{0.408}{0.1385} = 2.946\,m/s \quad \rightarrow \quad \frac{v_1^2}{2g} = 0.442\,m$$

$$v_2 = \frac{Q}{A_2} = \frac{0.408}{0.0707} = 5.771\,m/s \quad \rightarrow \quad \frac{v_2^2}{2g} = 1.697\,m$$

$$v_3 = \frac{Q}{A_3} = \frac{0.408}{0.0427} = 9.555\,m/s \quad \rightarrow \quad \frac{v_3^2}{2g} = 4.653\,m$$

$$8 = 6 + \frac{p_A}{\rho g}$$

$$\frac{p_A}{\rho g} = 2m \qquad \rightarrow \qquad p_A = 19.62\,kPa$$

$$\frac{p_A}{\rho g} = \frac{p_B}{\rho g} + \frac{v_1^2}{2g} + \frac{v_1^2}{2g}\xi_{UL}$$

$$\frac{p_B}{\rho g} = 2 - 0.442 - 0.442 \cdot 0.6 = 1.293\,m \qquad \rightarrow \qquad p_B = 12.68\,kPa$$

$$8 = 4 + \frac{p_C}{\rho g} + \frac{v_1^2}{2g} + \frac{v_1^2}{2g}\left(\xi_{UL} + \lambda\frac{L}{D_1}\right)$$

$$\frac{p_C}{\rho g} = 8 - 4 - 0.442 - 0.442 \cdot 0.7095 = 3.288\,m \qquad \rightarrow \qquad p_C = 32.26\,kPa$$

$$\frac{p_C}{\rho g} + \frac{v_1^2}{2g} = \frac{p_D}{\rho g} + \frac{v_2^2}{2g} + \frac{v_2^2}{2g}\xi_{SUŽ}$$

$$\frac{p_D}{\rho g} = 3.288 + 0.442 - 1.697 - 1.697 \cdot 0.3 = 1.524\,m \qquad \rightarrow \qquad p_D = 14.95\,kPa$$

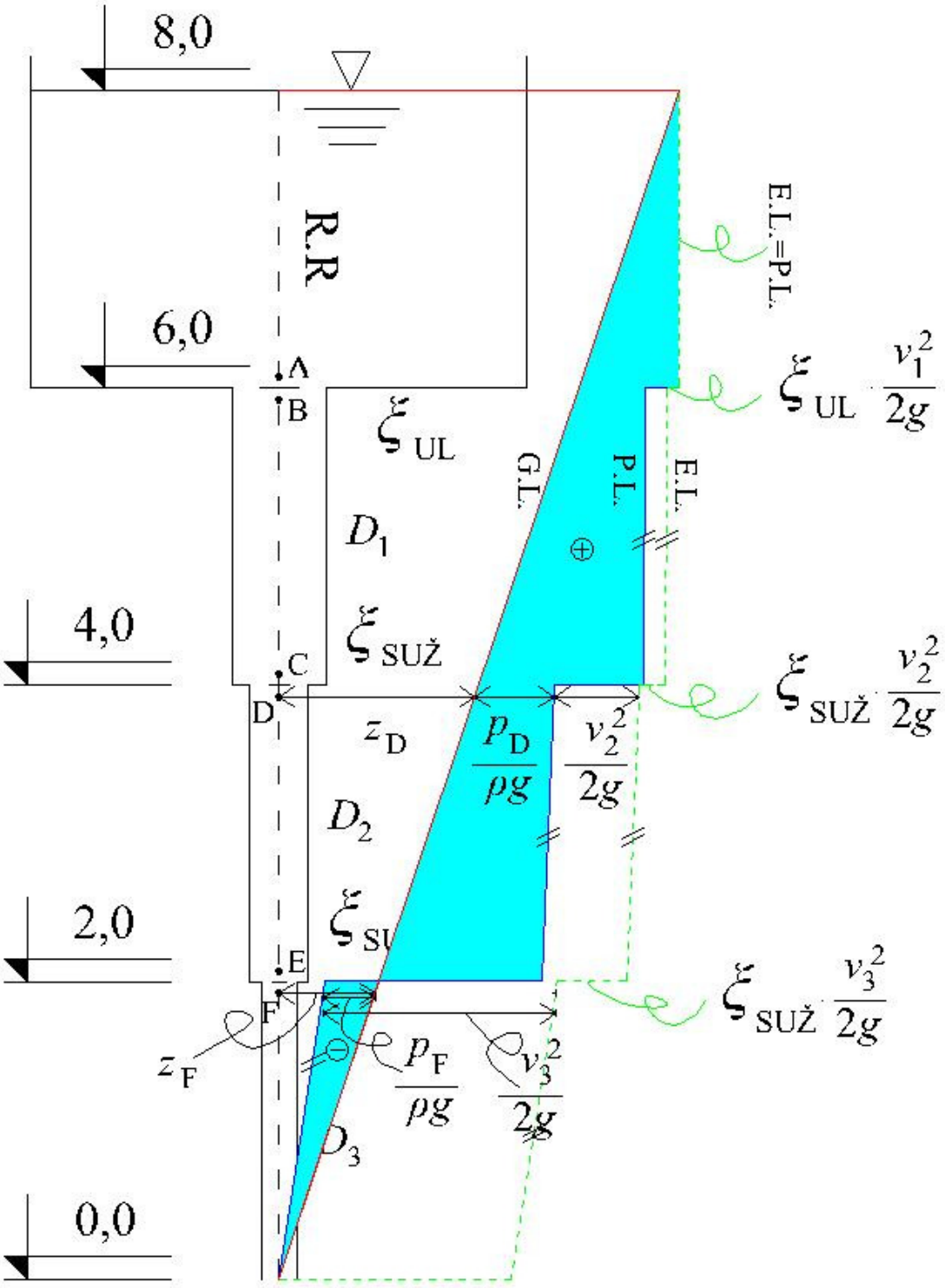
$$4 + \frac{p_D}{\rho g} = 2 + \frac{p_E}{\rho g} + \frac{v_2^2}{2g}\lambda\frac{L}{D_2}$$

$$\frac{p_E}{\rho g} = 4 + 1.524 - 2 - 1.697 \cdot 0.023\frac{2}{0.3} = 3.264\,m \qquad \rightarrow \qquad p_E = 32.02\,kPa$$

$$\frac{p_E}{\rho g} + \frac{v_2^2}{2g} = \frac{p_F}{\rho g} + \frac{v_3^2}{2g} + \frac{v_3^2}{2g}\xi_{SUŽ}$$

$$\frac{p_F}{\rho g} = 3.264 + 1.697 - 4.653 - 4.653 \cdot 0.3 = -1.088\,m \qquad \rightarrow \qquad p_F = -10.67\,kPa$$

Dijagram tlaka i energije, odnosno P.L i E.L. :



U slučaju da se za G.L uzme središnja strujnica cjevovoda, dijagram tlaka i energije, odnosno P.L i E.L. izgledaju ovako: