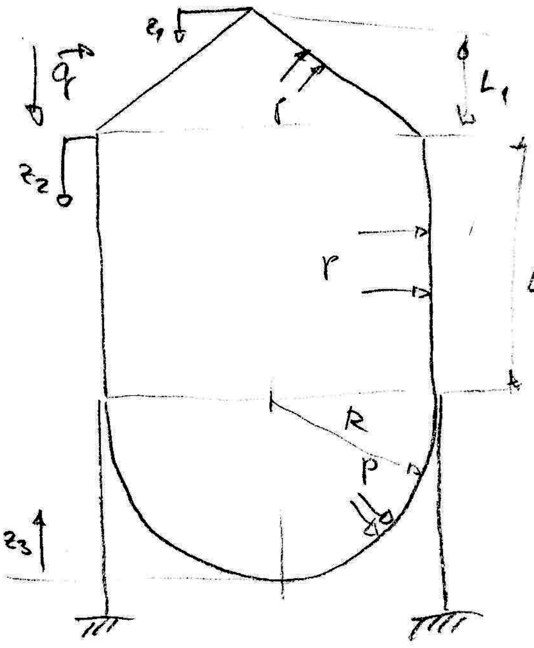
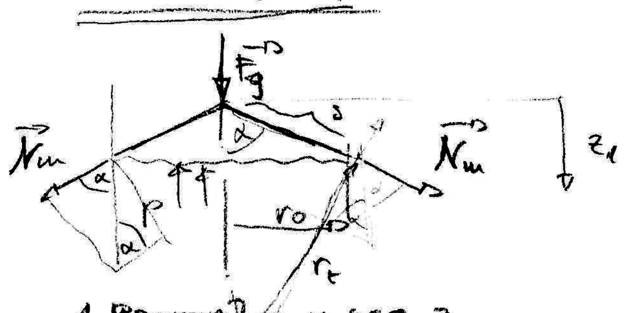


I. Kuželová část



Plocha kužele (pláště)

$S = \pi r s = \pi r \frac{r}{\sin\alpha}$

1. Rovnováha v ose z

$$\tan\alpha = \frac{R}{L_1} \Rightarrow \alpha = \arctan\frac{R}{L_1}$$

$$F_g = \rho g h \pi \frac{r_0^2}{\sin\alpha}$$

$$F_p = p \cdot \pi r_0^2$$

$$F = F_g - F_p = \pi r_0^2 \left(\frac{\rho g h}{\sin\alpha} - p\right)$$

$$\tan\alpha = \frac{r_0}{z} \Rightarrow r_0 = z \cdot \tan\alpha = z\frac{R}{L_1}$$

$$2\pi r_0 N_m \cdot \cos\alpha + F = 0$$

$$\cancel{2\pi} \cdot \cancel{z} \cdot \frac{R}{\cancel{L_1}} \cdot N_m \cos\alpha + \cancel{\pi} z^2 \frac{R^2}{L_1^2}\left(\frac{\rho g h}{\sin\alpha} - p\right) = 0$$

$$N_m = \frac{\left(p - \frac{\rho g h}{\sin\alpha}\right)\frac{zR}{L_1}}{2\cos\alpha} = \frac{(p\sin\alpha - \rho g h)zR}{2L_1 \sin\alpha\cos\alpha} = \frac{(p\sin\alpha - \rho g h)z \cdot R}{L_1 \sin 2\alpha}$$

2. Laplaceova rovnice

$$r_m \to \infty$$

$$\mathrm{tg}\,\alpha = \frac{r_t}{s} \Rightarrow r_t = s \cdot \mathrm{tg}\,\alpha = \frac{r_0}{\cancel{\sin\alpha}} \cdot \frac{\cancel{\sin\alpha}}{\cos\alpha} = \frac{r_0}{\cos\alpha} = \frac{z \cdot R}{L_1 \cos\alpha}$$

$$F_{gn} = F_g \cdot \sin\alpha = \rho g h \pi \frac{r_0^2}{\cancel{\sin\alpha}} \cdot \cancel{\sin\alpha} = \rho g h \pi z^2 \frac{R^2}{L_1^2}$$

$$S = \pi \cdot r_0^2 \frac{1}{\sin\alpha} = \pi \cdot \left(\frac{zR}{L_1}\right)^2 \cdot \frac{1}{\sin\alpha}$$

$$\frac{N_t}{r_t} = \frac{F_n}{S}$$

$$\frac{N_t}{\frac{z \cdot R}{L_1\cos\alpha}} = -\frac{F_g \cdot \sin\alpha}{S} + p \Rightarrow \frac{N_t \cdot L_1\cos\alpha}{z \cdot R} = -\frac{\rho g h \cancel{\pi} \cancel{z^2} \frac{\cancel{R^2}}{\cancel{L_1^2}}}{\cancel{\pi} \frac{\cancel{z^2 R^2}}{\cancel{L_1^2}} \cdot \frac{1}{\sin\alpha}} + p \Rightarrow$$

$$\Rightarrow N_t = (-\rho g h \sin\alpha + p)\frac{z \cdot R}{L_1 \cos\alpha}$$

II. Válcová část

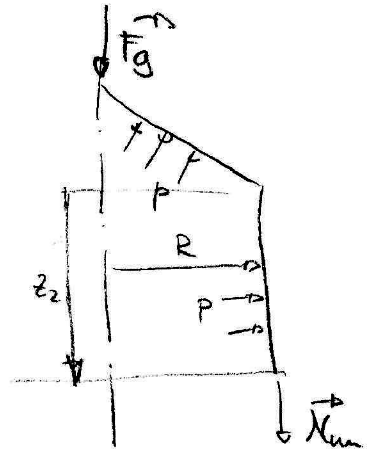
1. Rovnováha v ose z

$$r_0 = R, \quad F_g = \rho g h \pi \cdot \frac{R^2}{\sin\alpha} + \pi R \cdot z_2 \cdot h \cdot \rho g = \pi R \rho g h \left(\frac{R}{\sin\alpha} + z_2\right), \quad F_p = p\pi \cdot R^2$$

$$2\pi R \cdot N_m + (F_g - F_p) = 0$$

$$2\cancel{\pi}\cancel{R} N_m = p\cancel{\pi}R^{\cancel{2}} - \cancel{\pi}\cancel{R}\rho g h\left(\frac{R}{\sin\alpha}+z_2\right)$$

$$N_m = \frac{pR^2\sin\alpha - \rho g h(R+z\sin\alpha)}{2\cdot\sin\alpha}$$



2. Laplaceova rovnice

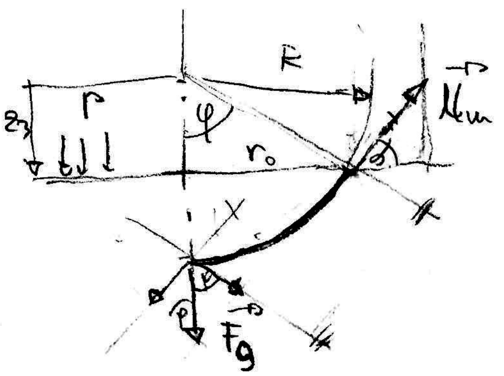
$r_m \to \infty$

$r_t = R$

$F_{gn} = 0$

$$\frac{N_t}{r_t} = p \Rightarrow N_t = p\cdot R$$

III. kulová část



1. Rovnováha v ose z

$$\cos\varphi = \frac{z_3}{R} \Rightarrow \sin\varphi = \sqrt{1-\cos^2\varphi} = \sqrt{1-\left(\frac{z_3}{R}\right)^2}$$

$$r_0 = R\cdot\sin\varphi = R\cdot\sqrt{1-\left(\frac{z_3}{R}\right)^2}$$

$$F_g = h\rho g\int_0^{\varphi} 2\pi R^2\sin\varphi'\,d\varphi' = 2\pi h\rho g R^2\left[1-\cos\varphi\right] =$$
$$= 2\pi h\rho g R^2\left[1-\frac{z_3}{R}\right]$$

$$F_p = p\cdot\pi\cdot r_0^2 = p\cdot\pi\cdot R^2\sin^2\varphi = p\cdot\pi\cdot R^2\left(1-\left(\frac{z_3}{R}\right)^2\right)$$

$$2\pi r_0\cdot N_m\sin\varphi + (-F_p - F_g) = 0$$

$$2\cancel{\pi}\cdot\cancel{R}\sqrt{1-\left(\frac{z_3}{R}\right)^2}\cdot N_m\cdot\sqrt{1-\left(\frac{z_3}{R}\right)^2} + \left(-p\cancel{\pi}R^{\cancel{2}}\left(1-\left(\frac{z_3}{R}\right)^2\right) - 2\cancel{\pi}h\rho g R^{\cancel{2}}\left(1-\frac{z_3}{R}\right)\right) = 0$$

$$N_m = \frac{pR\cancel{\left(1-\frac{z_3}{R}\right)}\left(1+\frac{z_3}{R}\right) + 2h\rho g R\cancel{\left(1-\frac{z_3}{R}\right)}}{\cancel{\left(1-\frac{z_3}{R}\right)}\left(1+\frac{z_3}{R}\right)} = p\cdot R + \frac{2h\rho g R}{1+\frac{z_3}{R}}$$

2. Laplaceova rovnice

$r_m = r_t = R$

$$F_{gn} = F_g\cdot\cos\varphi = 2\pi h\rho g R^2\left(1-\frac{z_3}{R}\right)\cdot\frac{z_3}{\cancel{R}} = 2\pi h\rho g R\left(1-\frac{z_3}{R}\right)\cdot z_3$$

$$\frac{N_m}{R} + \frac{N_t}{R} = p + \frac{F_{gn}}{S} = p + \frac{\cancel{2\pi}h\rho g\cancel{R}\cancel{\left(1-\frac{z_3}{R}\right)}\cdot z_3}{\cancel{2\pi}\cancel{R^2}\cancel{\left(1-\frac{z_3}{R}\right)}} = p + h\rho g\frac{z_3}{R}$$

$$\frac{p\cdot\cancel{R} + \frac{2h\rho g\cancel{R}}{1+\frac{z_3}{R}}}{\cancel{R}} + \frac{N_t}{R} = p + h\rho g\frac{z_3}{R}$$

$$N_t = R\left(\cancel{p} + h\rho g\frac{z_3}{R} - \left(\cancel{p} + \frac{2h\rho g R}{R+z_3}\right)\right) = R\cdot h\rho g\left(\frac{z_3}{R} - \frac{2R}{R+z_3}\right)$$