EGZAMIN MK (MK 3, MoS 3) KB studia mgr stacj. dnia 20 VI 2018 r.

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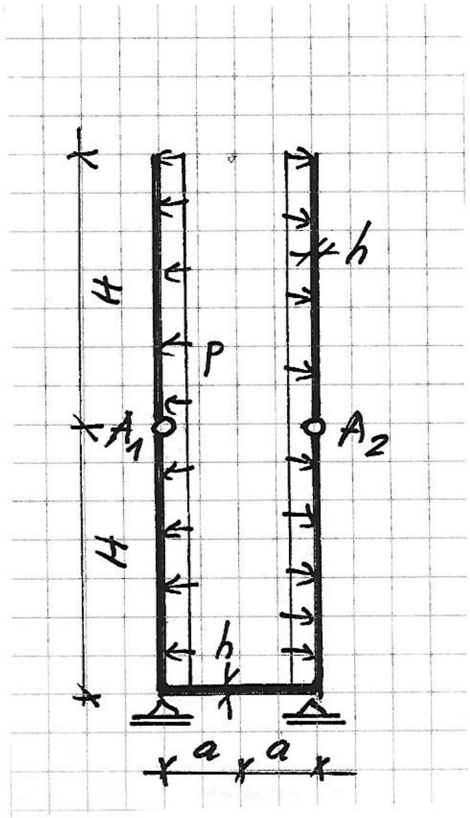
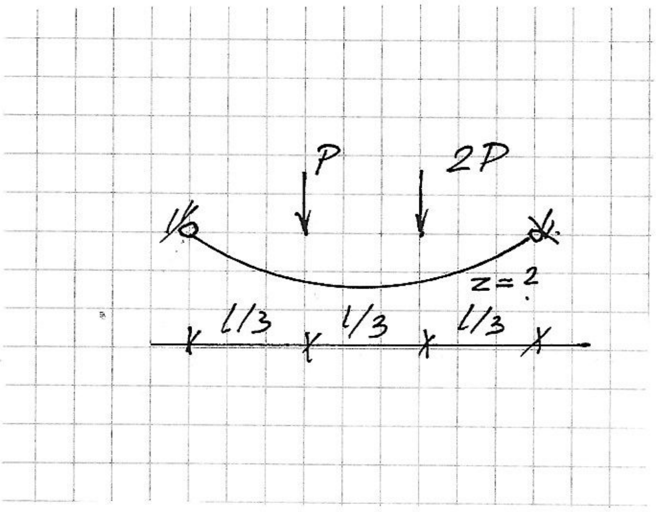
Zadanie 1.
Dany jest wysoki zbiornik walcowy z kołową płytą denną obciążony jak na rysunku.
Znaleźć
a) zmianę średnicy obwodu wzdłuż połączenia przegubowego (spoina A_1A_2)
b) momenty zginające w płycie dennej
Dane: *a*, *h=a/10*, *p*, *H*, *E*=30GPa, współczynnik Poissona =0.2.

(Given is the cylindrical vessel with the circular bottom plate loaded as in the figure.
Compute
a) change of diameter of the circumference along the hinge joint (along: A_1A_2)
b) bending moments in the bottom plate
Data: a, h=a/10, p, H, E=30GPa, Poisson's ratio=0.2)

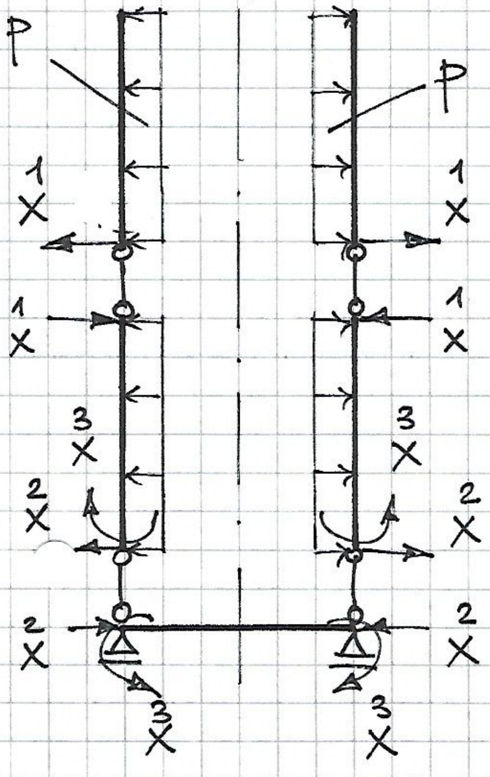


Zadanie 2.
Dane jest cięgno nierozciągliwe obciążone jak na rysunku.
Obliczyć rzędną krzywej zwisu w środku cięgna.
Dane $L_0= 1.07\, l$.
(The given inextensible cable is loaded as in the figure.
Compute the ordinate of the sag function at the middle point of the cable.
Given: $L_0= 1.07\, l$. *)*

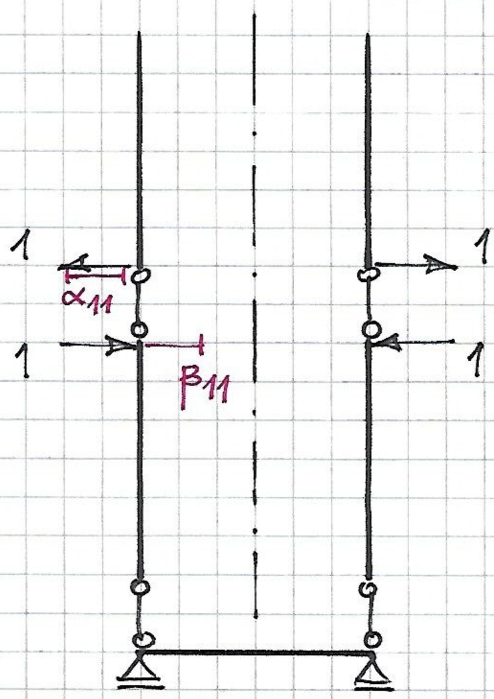


Zadanie 1 / Problem #1

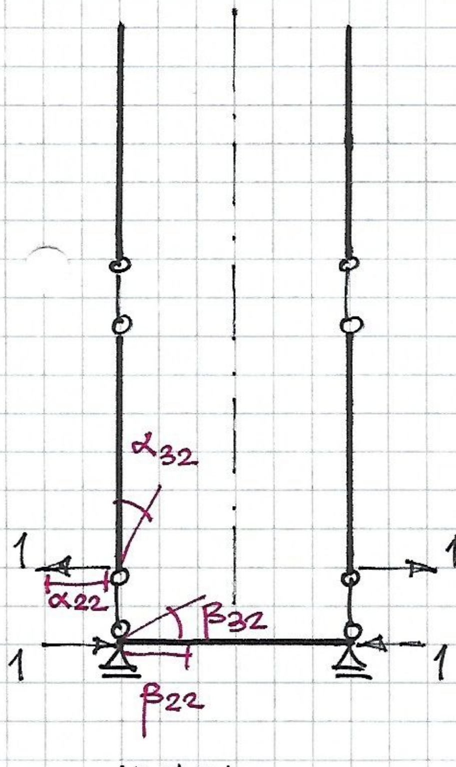
Schemat zastępczy
Primary structure



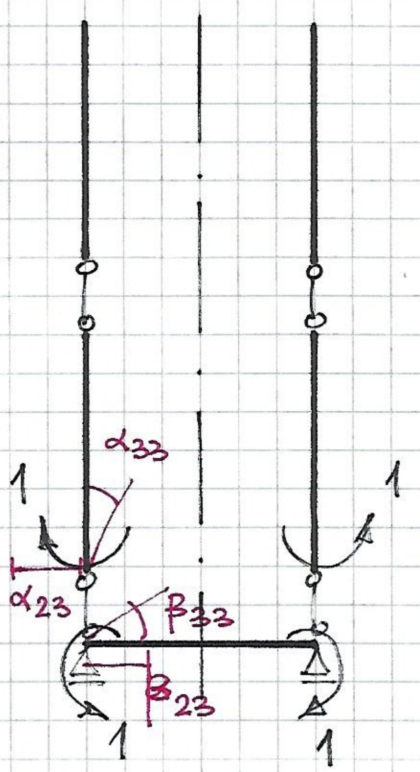
$X_1 = 1$



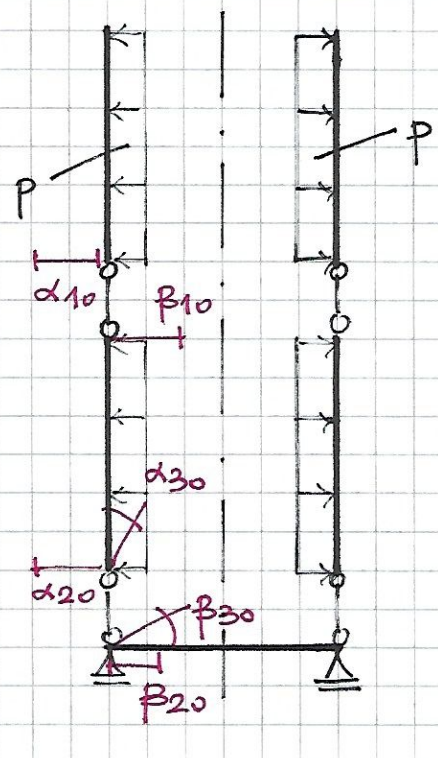
$X_2 = 1$



$X_3 = 1$



"0"



UWAGA:
NOTE:

$\beta_{32} = 0$

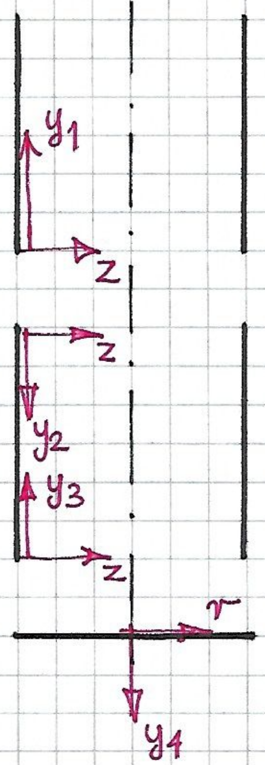
$\beta_{23} = 0$

$\alpha_{30} = 0$

$\beta_{20} = 0$

$\beta_{30} = 0$

Układy współrzędnych
Coordinate systems



Funkcja ugięcia płaszcza
Cylinder deflection function

$$w_c(\xi) = e^{-\lambda\xi}\left[A_1\cos(\lambda\xi) + A_2\sin(\lambda\xi)\right]$$

gdzie
where

$$\lambda^4 = 3(1-\nu^2)\left(\frac{a}{h}\right)^2$$
$$\xi = \frac{y}{a}$$

oraz
and

$$y \equiv y_1 \quad \text{lub/or} \quad y \equiv y_2 \qquad \xi_J = \frac{y_J}{a}$$
$$\text{lub/or} \quad y \equiv y_3 \qquad J = 1,2,3$$

Ponadto
Moreover

$$\chi = \frac{1}{a}\frac{dw_c}{d\xi}$$
$$M_{2c} = -\frac{D}{a^2}\frac{d^2w_c}{d\xi^2} \qquad D = \frac{Eh^3}{12(1-\nu^2)}$$
$$Q_{2c} = -\frac{D}{a^3}\frac{d^3w_c}{d\xi^3}$$

Funkcja ugięcia płyty (zginanie)
Plate deflection function (bending)

$$w_p(\rho) = A_1 + A_2\rho^2 \qquad \rho = \frac{r}{a}$$
$$\varphi = \frac{1}{a}\frac{dw_p}{d\rho}$$
$$M_{2p} = -\frac{D}{a^2}\left(\frac{d^2w_p}{d\rho^2} + \frac{\nu}{\rho}\frac{dw_p}{d\rho}\right) \; ; \; M_{1p} = -\frac{D}{a^2}\left(\frac{1}{\rho}\frac{dw_p}{d\rho} + \nu\frac{d^2w_p}{d\rho^2}\right)$$

Funkcja przemieszczenia w płaszczyźnie płyty (stan membranowy)
Displacement in the plane of a plate (the membrane state)

$$u_p(\rho) = B_1\rho$$
$$N_{2p} = C\,\frac{1+\nu}{a}\frac{du_p}{d\rho}$$

Dalej obliczamy
We next calculate

$$\alpha_{11} = -w_c(\xi_1)\Big|_{\xi_1=0} \qquad \delta_{11} = \alpha_{11} + \beta_{11}$$
$$\beta_{11} = w_c(\xi_2)\Big|_{\xi_2=0}$$

assuming that

$M_{2c}(0) = 0$, $Q_{2c} = 1$ for α_{11} calculations

$M_{2c}(0) = 0$, $Q_{2c} = -1$ for β_{11} calculations

Otrzymujemy
We thus obtain

$$\alpha_{11} = \frac{2\lambda a}{Eh} \qquad \beta_{11} = \frac{2\lambda a}{Eh}$$

Podobnie
Similarly,

- warunki brzegowe
  boundary conditions

$$\left.\begin{array}{l} M_{2c}(\xi_3)\big|_{\xi_3=0} = 0 \\ Q_{2c}(\xi_3)\big|_{\xi_3=0} = 1 \end{array}\right| \longmapsto w_c(\xi_3) \longmapsto \begin{array}{l} \alpha_{22} = w_c(\xi_3)\big|_{\xi_3=0} \\ \alpha_{32} = \chi_2(\xi_3)\big|_{\xi_3=0} \end{array}$$

$$N_{2p}(\varsigma)\big|_{\varsigma=1} = -1 \longmapsto u_p(\varsigma) \longmapsto \beta_{22} = u_p(\varsigma)\big|_{\varsigma=1}$$

$$\left.\begin{array}{l} M_{2p}(\varsigma)\big|_{\varsigma=1} = -1 \\ w_p(\varsigma)\big|_{\varsigma=1} = 0 \end{array}\right| \longmapsto w_p(\varsigma) \longmapsto \beta_{33} = -\varphi(\varsigma)\big|_{\varsigma=1}$$

$$\left.\begin{array}{l} M_{2c}(\xi_3)\big|_{\xi_3=0} = 1 \\ Q_{2c}(\xi_3)\big|_{\xi_3=0} = 0 \end{array}\right| \longmapsto w_c(\xi_3) \longmapsto \begin{array}{l} \alpha_{33} = \chi_2(\xi_3)\big|_{\xi_3=0} \\ \alpha_{23} = \alpha_{32} \end{array}$$

Stąd
Hence,

$$\alpha_{22} = \frac{2\lambda a}{Eh} \qquad \alpha_{32} = -\frac{2\lambda^2}{Eh}$$

$$\beta_{22} = \frac{(1-\nu)a}{Eh}$$

$$\beta_{33} = \frac{12\,a(1-\nu)}{Eh^3}$$

$$\alpha_{33} = \frac{4\lambda^3}{ahE}$$

$$\delta_{22} = \alpha_{22} + \beta_{22}$$

$$\delta_{32} = \alpha_{32} + \beta_{32}$$

$$\delta_{23} = \delta_{32}$$

$$\delta_{33} = \alpha_{33} + \beta_{33}$$

W stanie "0"
From the "0"-th state:

$$\alpha_{10} = \frac{pa^2}{Eh} \qquad \beta_{10} = -\frac{pa^2}{Eh} \qquad \delta_{10} = \alpha_{10} + \beta_{10}$$

$$\alpha_{20} = \frac{pa^2}{Eh} \qquad \delta_{20} = \alpha_{20}$$

$$\delta_{30} = 0$$

Dalej obliczamy
We next calculate

$$\delta_{11} X_1 + \delta_{10} = 0 \longrightarrow X_1 = 0$$

$$\begin{cases} \delta_{22} X_2 + \delta_{23} X_3 + \delta_{20} = 0 \\ \delta_{32} X_2 + \delta_{33} X_3 + \delta_{30} = 0 \end{cases} \longrightarrow \begin{aligned} X_2 &= 0{,}123\ pa \\ X_3 &= 0{,}003\ pa^2 \end{aligned}$$

Zatem
Hence

$$d_{AB} = \frac{pa^2}{Eh}$$

$$M_{1p}(\xi)\big|_{\xi=0} = X_3$$

$$M_{2p}(\xi)\big|_{\xi=0} = X_3$$

Zadanie 2 / Problem #2

$$\lambda_0 = 0{,}935$$

$$Q^2 = \frac{14}{9} P^2 \longrightarrow Q = 1{,}247 P$$

$$H = 3{,}333 P$$

$$z_{mid} = \frac{1}{2} \frac{PL}{H} = 0{,}15 L$$

Opracował
G. Dzierżanowski