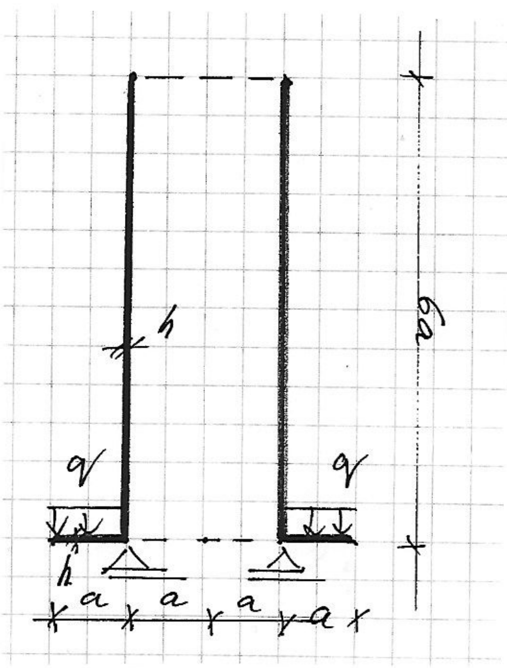
EGZAMIN MK (MK3) KB studia mgr stacj. dnia 4 IX 2016 r.

NAZWISKO Imię		
Nr albumu		Ocena z ćwiczeń projektowych
ocena zadania 1	ocena zadania 2	Ocena z egzaminu po ustnym
		Ocena łączna, data, podpis

Zadanie 1.

Rozważamy pręt o długości l= 1,8 m, profilu dwuteowym I 180 (A=27,9 cm^2 , J_y= 1450 cm^4, J_z= 81,3 cm^4, J_ω=5850 cm^6, J_s=10,4 cm^4) , podparty widełkowo na obu koncach i na obu końcach obciążony momentami zginającymi M_y^0, M_z^0. Przyjąć E=210GPa, współczynnik Poissona = 0.3. Znaleźć obszar bezpieczny zadania zwichrzenia.

Zadanie 2.
Możliwie dokładnie omówić kolejne kroki analizy statycznej wysokiej powłoki walcowej wzmocnionej płytą pierścieniową, obciążoną jak na rysunku.



Dane

```
l = 180(*cm*);(*długość pręta*)
A = 27.9(*cm^2*);
Jy = 1450(*cm^4*);
Jz = 81.3(*cm^4*);
Jω = 5850(*cm^6*);
Js = 10.4(*cm^4*);
EE = 21 000(*kN/cm^2*);(*1GPa=100kN/cm^2*)
v = 0.3;
```

Obszar bezpieczny zadania zwichrzenia

$$E1 = \frac{EE}{1 - v^2} (*kN/cm^2*)$$

23 076.9

$$G = \frac{EE}{2\,(1 + v)} (*kN/cm^2*)$$

8076.92

$$J0 = Jy + Jz (*cm^4*)$$

1531.3

$$ro = \sqrt{\frac{J0}{A}} (*cm*)$$

7.40846

$$Py = \frac{E1 * Jy * \pi^2}{l^2} (*kN*)$$

10 193.

$$Pz = \frac{E1 * Jz * \pi^2}{l^2} (*kN*)$$

571.509

$$Ps = \frac{1}{ro^2} * \left(\frac{E1 * J\omega * \pi^2}{l^2} + G * Js\right) (*kN*)$$

2279.72

$$a = ro * \sqrt{Ps * Pz} (*kN*cm*)$$

8456.31

$$b = ro * \sqrt{Ps * Py} (*kN*cm*)$$

35 712.4

```
Plot[My /. Solve[(My / a) ^2 + (Mz / b) ^2 == 1], {Mz, -b * 1.1, b * 1.1},
 AspectRatio → Automatic, AxesLabel → {"Mz[kNcm]", "My[kNcm]"}, ImageSize → 600]
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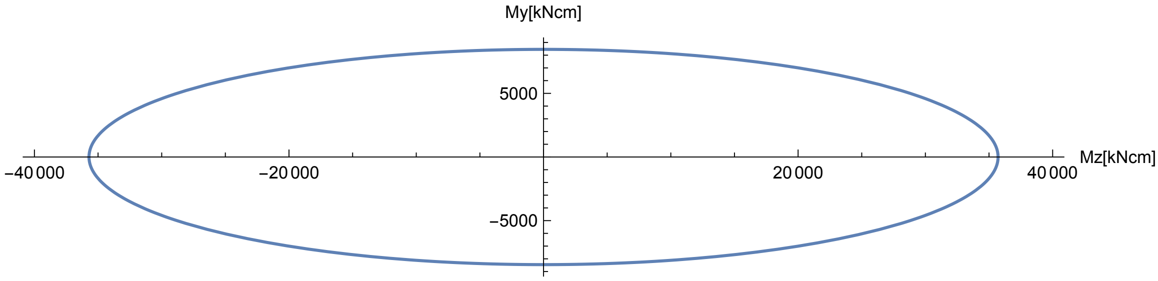
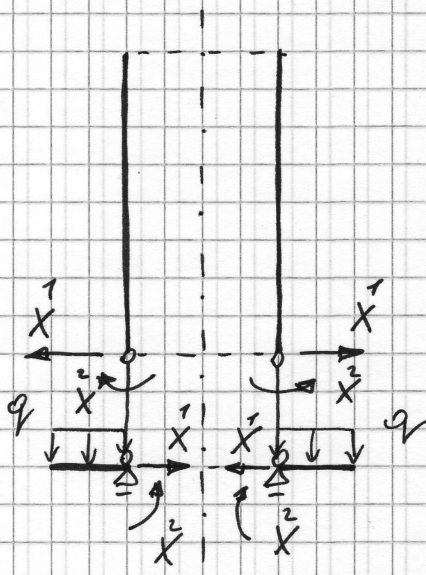


Zadanie 2

Schemat zastępczy



$$C = \frac{Eh}{1-\nu^2}$$

$$D = \frac{Eh^3}{12(1-\nu^2)}$$

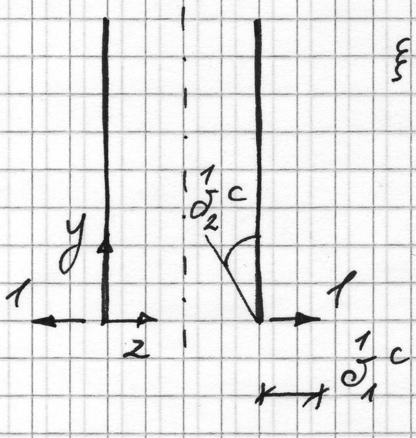
$$\lambda^4 = 3(1-\nu^2)\left(\frac{a}{h}\right)^2$$

WALEC

→ brak obciążeń w stanie bezmomentowym „0"

$$\overset{0}{\delta}{}_1^{c} = \overset{0}{\delta}{}_2^{c} = 0$$

→ obciążenie $\overset{1}{X} = 1$



$$\xi = y/a$$

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

war. brzeg.:

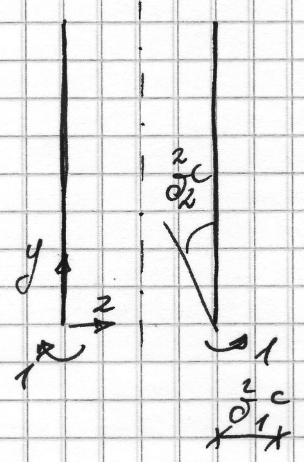
$Q_2(0) = 1 \qquad M_2(0) = 0 \quad \Rightarrow A_1, A_2$

stąd:

$$\overset{1}{\delta}{}_1^{c} = -w(0) = \frac{2a\lambda}{Eh}$$

$$\overset{1}{\delta}{}_2^{c} = \chi_2(0) = \frac{2\lambda^2}{Eh} = \overset{2}{\delta}{}_1^{c}$$

→ zaburzenie $\overset{2}{X} = 1$



ξ, $w(\xi)$ jak w poprzednim punkcie

war. brzeg.:

$Q_2(0) = 0 \qquad M_2(0) = 1 \qquad \Rightarrow \quad A_1,\ A_2$

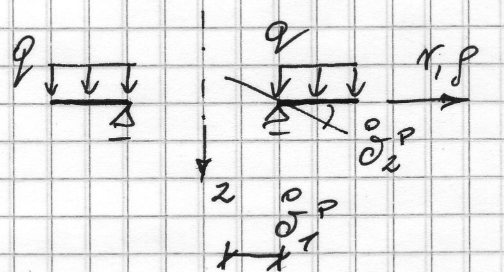
stąd:

$$\overset{2}{\delta}{}_1^c = -w(0) = \frac{2\lambda^2}{Eh} = \overset{1}{\delta}{}_2^c$$

$$\overset{2}{\delta}{}_2^c = \chi_2(0) = \frac{4\lambda^3}{Eha}$$

PŁYTA PIERŚCIENIOWA

→ stan „0"



$\rho = \frac{r}{2a} \qquad \alpha = \frac{a}{2a} = \frac{1}{2}$

$$w(\rho) = A_1 + A_2\rho^2 + A_3 \ln\rho + A_4\rho^2\ln\rho + \frac{q(2a)^4}{64D}\rho^4$$

war. brzeg.:

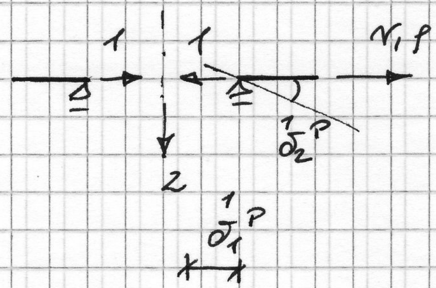
$$\left.\begin{array}{ll} w(\tfrac{1}{2}) = 0 & M_2(1) = 0 \\ M_2(\tfrac{1}{2}) = 0 & Q_2(1) = 0 \end{array}\right\} \Rightarrow A_1,\ A_2,\ A_3,\ A_4$$

stąd:

$$\overset{0}{\delta}{}_1^p = 0$$

$$\overset{0}{\delta}{}_2^p = -\chi_2(\alpha), \quad \text{gdzie} \quad \chi_2(\rho) = -\frac{1}{2a}\left[2A_2\rho + \frac{A_3}{\rho} + A_4\rho(2\ln\rho + 1) + \frac{q(2a)^4}{16D}\rho^3\right]$$

→ zaburzenie $\overset{1}{X} = 1$



ρ, α jak w poprzednim punkcie

$$u(\rho) = A_1 \rho + \frac{A_2}{\rho}$$

war. brzeg.:

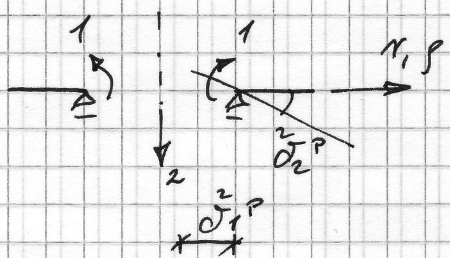
$$N_2\left(\tfrac{1}{2}\right) = 1 \qquad N_2(1) = 0 \quad \Rightarrow A_1, A_2$$

stąd:

$$\overset{1}{\delta}{}_1^{\rho} = -u\left(\tfrac{1}{2}\right)$$

$$\overset{1}{\delta}{}_2^{\rho} = 0 = \overset{2}{\delta}{}_1^{\rho}$$

→ zaburzenie $\overset{2}{X} = 1$



ρ, α jak w poprzednim punkcie

$$w(\rho) = A_1 + A_2 \rho^2 + A_3 \ln\rho + A_4 \rho^2 \ln\rho$$

war. brzeg.:

$$\left.\begin{matrix} w\left(\tfrac{1}{2}\right) = 0 & M_2(1) = 0 \\ M_2\left(\tfrac{1}{2}\right) = 1 & Q_2(1) = 0 \end{matrix}\right\} \Rightarrow A_1, A_2, A_3, A_4$$

stąd:

$$\overset{2}{\delta}{}_1^{\rho} = 0 \qquad \overset{2}{\delta}{}_2^{\rho} = -X_2\left(\tfrac{1}{2}\right), \quad \text{gdzie } X_2(\rho) = -\frac{1}{2D}\left[2A_2\rho + \frac{A_3}{\rho} + A_4\rho\left(2\ln\rho + 1\right)\right]$$

OBLICZENIE NADLICZBOWYCH $\overset{1}{X}, \overset{2}{X}$

→ układ równań

$$\begin{cases} \overset{1}{\delta}_1 \overset{1}{X} + \overset{2}{\delta}_1 \overset{2}{X} + \overset{0}{\delta}_1 = 0 \\ \overset{1}{\delta}_2 \overset{1}{X} + \overset{2}{\delta}_2 \overset{2}{X} + \overset{0}{\delta}_2 = 0 \end{cases}$$

→ wartości δ

$$\overset{1}{\delta}_1 = \overset{1}{\delta}_1^{\,c} + \overset{1}{\delta}_1^{\,p} \qquad \overset{2}{\delta}_1 = \overset{1}{\delta}_2 = \overset{2}{\delta}_1^{\,c}$$

$$\overset{2}{\delta}_2 = \overset{2}{\delta}_2^{\,c} + \overset{2}{\delta}_2^{\,p} \qquad \overset{0}{\delta}_1 = 0 \qquad \overset{0}{\delta}_2 = \overset{0}{\delta}_2^{\,p}$$

ZNAJDOWANIE PRZEMIESZCZEŃ

→ walec

$$\overset{1}{w}(\xi) = w(\xi) \text{ dla } \overset{1}{X}=1 \qquad \overset{2}{w}(\xi) = w(\xi) \text{ dla } \overset{2}{X}=1$$

$$\overset{1}{\chi}_2(\xi) = \chi_2(\xi) \text{ dla } \overset{1}{X}=1 \qquad \overset{2}{\chi}_2(\xi) = \chi_2(\xi) \text{ dla } \overset{2}{X}=1$$

$$\chi_2(\xi) = \frac{1}{a}\frac{dw}{d\xi}$$

$$w(\xi) = \overset{1}{w}(\xi)\cdot\overset{1}{X} + \overset{2}{w}(\xi)\cdot\overset{2}{X}$$

$$\chi_2(\xi) = \overset{1}{\chi}_2(\xi)\cdot\overset{1}{X} + \overset{2}{\chi}_2(\xi)\cdot\overset{2}{X}$$

→ płyta pierścieniowa

$$\overset{1}{u}(\rho) = u(\rho) \text{ dla } \overset{1}{X}=1 \qquad \overset{2}{u}(\rho) = u(\rho) \text{ dla } \overset{2}{X}=1 \qquad \overset{2}{u}(\rho)=0$$

$$\overset{1}{w}(\rho) = w(\rho) \text{ dla } \overset{1}{X}=1 \qquad \overset{1}{w}(\rho)=0 \qquad \overset{2}{w}(\rho) = w(\rho) \text{ dla } \overset{2}{X}=1$$

$$\overset{0}{w}(\rho) = w(\rho) \text{ dla „0''}$$

$$\chi_2(\rho) = -\frac{1}{2a}\frac{dw}{d\rho}$$

$$u(\rho) = \overset{1}{u}(\rho)\cdot\overset{1}{X}$$

$$w(\rho) = \overset{2}{w}(\rho)\cdot\overset{2}{X} + \overset{0}{w}(\rho)$$

ZNAJDOWANIE SIŁ WEWNĘTRZNYCH

→ walec

$$M_1 = \nu M_2 \qquad M_2 = -\frac{D}{a^2}\frac{d^2w}{d\xi^2} \qquad N_1 = -\frac{Eh}{a}w \qquad Q_2 = -\frac{D}{a^3}\frac{d^3w}{d\xi^3}$$

→ płyta pierścieniowa

$$N_1 = \frac{C}{2a}\left(\frac{u}{\rho} + \nu\frac{du}{d\rho}\right) \qquad N_2 = \frac{C}{2a}\left(\frac{du}{d\rho} + \frac{\nu}{\rho}u\right)$$

$$M_1 = -\frac{D}{(2a)^2}\left[\frac{1}{\rho}\frac{dw}{d\rho} + \nu\frac{d^2w}{d\rho^2}\right] \qquad M_2 = -\frac{D}{(2a)^2}\left[\frac{d^2w}{d\rho^2} + \frac{\nu}{\rho}\frac{dw}{d\rho}\right] \qquad Q_2 = -\frac{D}{(2a)^3}\frac{d}{d\rho}\left[\frac{1}{\rho}\frac{d}{d\rho}\left(\rho\frac{dw}{d\rho}\right)\right]$$