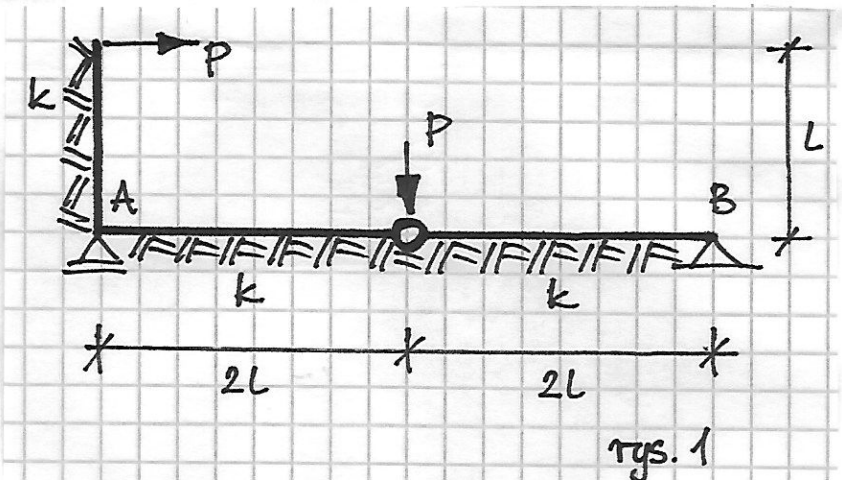
Egzamin z Mechaniki Konstrukcji (MK3 IPB), 3.09.2018
studia stacjonarne

NAZWISKO, Imię				
rok akademicki zaliczenia ćwiczeń		nr albumu	grupa (IPB / BZ)	tryb studiów (ST / NST)
ocena zadania 1	ocena zadania 2	ocena zadania 3	ocena egzaminu	ocena łączna

Zadanie 1.

$EJ = const.$, $\quad k = 0{,}1024\frac{EJ}{l^4}$

Oblicz poziome i pionowe składowe reakcji podpór A (podpora przesuwna) i B (podpora nieprzesuwna) ramy z rys. 1.



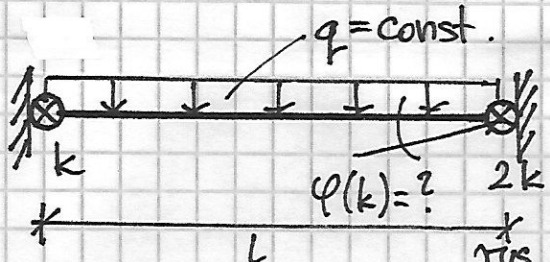
rys. 1

Zadanie 2.

$EJ = const.$

Oblicz wartość $\varphi_A(k)$ w ramie z rys. 2 dla $k = \frac{EJ}{l}$, $k = 5\frac{EJ}{l}$, $k = 20\frac{EJ}{l}$, $k = +\infty$

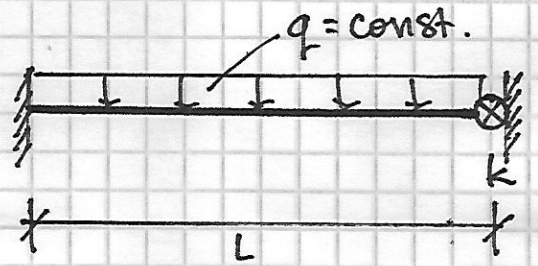
Uwaga: Podpory mają różne współczynniki sprężystości ze względu na obrót.



rys. 2

Zadanie 3.

Wyprowadź równanie linii ugięcia belki z rys. 3.



rys. 3

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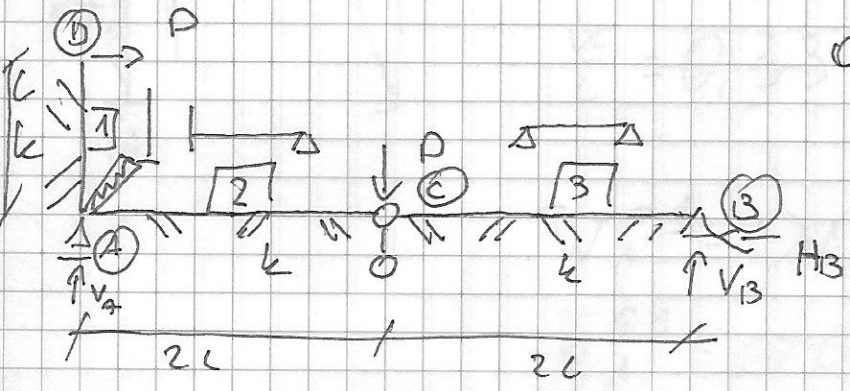
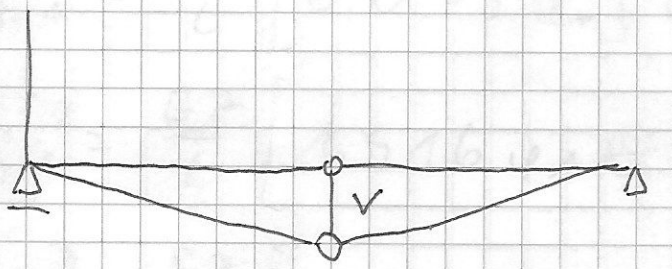
Zadanie 1



$$q_1 = \begin{bmatrix} \varphi_A \\ \frac{v}{l} \end{bmatrix}$$

PP



Pret	$^*w$	w^*	u	↑
1	0	0	0	0,4
2	0	V	0	0,8
3	V	0	0	0,8

RR:

$$\ominus\left(\bar{W}_C^2 \bar{v} + \bar{W}_C^3 \bar{v}\right) + P\bar{v} = 0$$

$$\bar{\Phi}_A^1 + \bar{\Phi}_A^2 = 0$$

$$\frac{EJ}{l}\begin{bmatrix} +1,55 & \ominus 0,734 \\ \ominus 0,734 & 0,491 \end{bmatrix}\begin{bmatrix} \varphi_A \\ \frac{v}{l} \end{bmatrix} = \begin{bmatrix} +0,99 \\ +1 \end{bmatrix} Pl$$

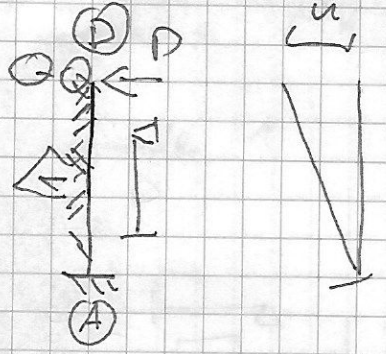
$$\varphi_A = 5,489 \frac{Pl^3}{EJ}$$

$$\frac{v}{l} = 10,242 \frac{Pl^3}{EJ}$$

$$V_A = \ominus \bar{W}_A^2 = 0,757P$$

$$V_{13} = \ominus \bar{W}_{13}^3 = 0,343P$$

$$H_{13} = \ominus \bar{W}_A^1 = 0,707P$$



$$-\left(\underline{\underline{W}}_D^{01}\,\underline{\underline{u}}\right) + P\bar{u} = 0$$

$$\frac{u}{c} = 0{,}331\,\frac{Pc^2}{EJ}$$

$$\bar{W}_A^{01} = \ominus\, 0{,}987P$$

$$\bar{\Phi}_A^{01} = \ominus\, 0{,}99\,Pc$$

$$\bar{\Phi}_A^{1} = \frac{EJ}{c}\left[0{,}034\,\varphi_A\right] \ominus 0{,}99\,Pc$$

$$\bar{\Phi}_A^{2} = \frac{EJ}{c}\left[1{,}516\,\varphi_A \ominus 0{,}734\,\frac{v}{c}\right]$$

$$\bar{W}_C^{2} = \frac{EJ}{c^2}\left[\ominus 0{,}734\,\varphi_A + 0{,}4231\,\frac{v}{c}\right]$$

$$\bar{W}_C^{3} = \frac{EJ}{c^2}\left[0{,}0676\,\frac{v}{c}\right]$$

$$\bar{W}_A^{1} = \frac{EJ}{c^2}\left[0{,}051\,\varphi_A\right] + \bar{W}_A^{01}$$

$$\bar{W}_A^{2} = \frac{EJ}{c^2}\left[0{,}785\,\varphi_A \ominus 0{,}347\,\frac{v}{c}\right]$$

$$\bar{W}_B^{3} = \frac{EJ}{c^2}\left[0{,}0335\,\frac{v}{c}\right]$$

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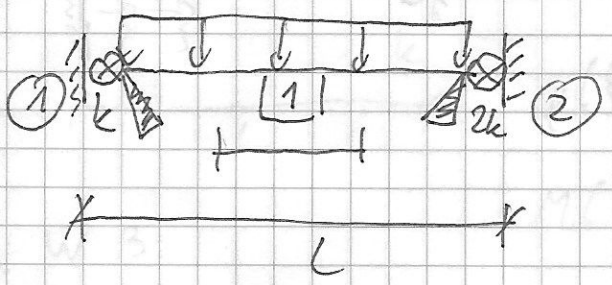
Zadanie 2



$$q_1 = \begin{Bmatrix} \varphi_1 \\ \varphi_2 \end{Bmatrix}$$

$$Q_1 = \varphi_1 k$$

$$Q_2 = \ominus \varphi_2 \cdot 2k$$

RR:

$$\underline{\Phi}_1^1 + Q_1 = 0$$

$$\underline{\Phi}_2^1 \ominus Q_2 = 0$$

$$\underline{\Phi}_1^1 = \frac{EJ}{L}\left[4\varphi_1 + 2\varphi_2\right] \ominus \frac{1}{12} qL^2$$

$$\underline{\Phi}_2^1 = \frac{EJ}{L}\left[2\varphi_1 + 4\varphi_2\right] + \frac{1}{12} qL^2$$

$$\frac{EJ}{L}\begin{bmatrix} 4+k & 2 \\ 2 & 4+2k \end{bmatrix}\begin{bmatrix} \varphi_1 \\ \varphi_2 \end{bmatrix} = \begin{bmatrix} \frac{1}{12} \\ \ominus \frac{1}{12} \end{bmatrix} qL^2$$

$$\varphi_A(k) = \varphi_2 = \ominus \frac{6+k}{24(6+6k+k^2)} \frac{qL^3}{EJ}$$

$$\varphi_A\left(\frac{EJ}{L}\right) = \ominus \frac{7}{312} \frac{qL^3}{EJ}$$

$$\varphi_A\left(5\frac{EJ}{L}\right) = \ominus \frac{11}{1464} \frac{qL^3}{EJ}$$

$$\varphi_A\left(20\frac{EJ}{L}\right) = \ominus \frac{13}{6312} \frac{qL^3}{EJ}$$

$$\varphi_A(\infty) = 0$$

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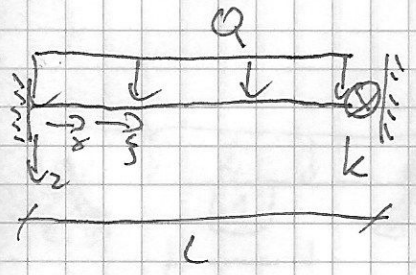
Zadanie 3



$$\xi = \frac{x}{L}$$

$$w(\xi) = C_0 + C_1\xi + C_2\xi^2 + C_3\xi^3 + \frac{qL^4}{24EJ}\xi^4$$

$$\varphi(\xi) = \frac{1}{L}\frac{dw(\xi)}{d\xi} = \frac{1}{L}\left(C_1 + 2C_2\xi + 3C_3\xi^2 + \frac{qL^4}{6EJ}\xi^3\right)$$

$$M(\xi) = -\frac{EJ}{L^2}\frac{d^2w(\xi)}{d\xi^2} = -\frac{EJ}{L^2}\left(2C_2 + 6C_3\xi + \frac{qL^4}{2EJ}\xi^2\right)$$

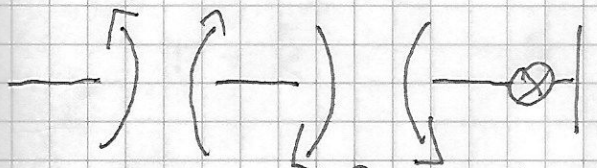
W B:

$w(0) = 0$ $\quad C_0 = 0$

$\varphi(0) = 0$ $\quad C_1 = 0$

$w(1) = 0$ $\Rightarrow$ $\quad C_2 = \frac{qL^4}{24EJ}\left(\frac{6EJ + kL}{4EJ + kL}\right)$

$M(1) = \varphi(1)k$ $\quad C_3 = \ominus\frac{qL^4}{12EJ}\left(\frac{5EJ + kL}{4EJ + kL}\right)$



$$w(\xi) = \frac{qL^4}{24EJ}\left(\frac{6EJ + kL}{4EJ + kL}\xi^2 \ominus 2\,\frac{5EJ + kL}{4EJ + 4L}\xi^3 + \xi^4\right)$$