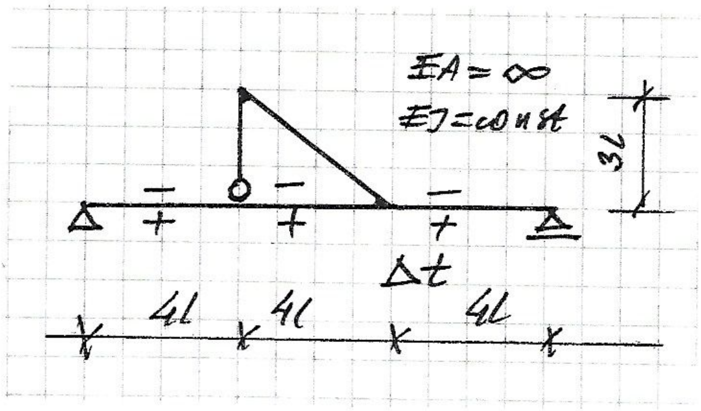
Egzamin pisemny z Mechaniki Konstrukcji I, 05 IV 2017 r.

NAZWISKO imię				
Grupa	Data zaliczenia ćwiczeń		Numer albumu	
Ocena zadania 1	Ocena zadania 2	Ocena zadania 3	Ocena z egzaminu	Ocena łączna Data

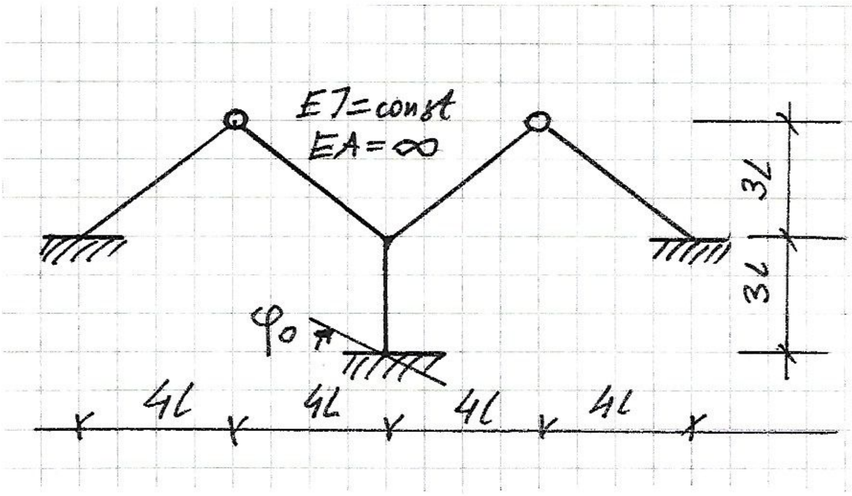
Zadanie 1
Dana jest rama płaska obciążona jak na rysunku. Sporządzić wykres M metodą sił.

(For the given frame construct the diagram of the bending moments by the force method.)

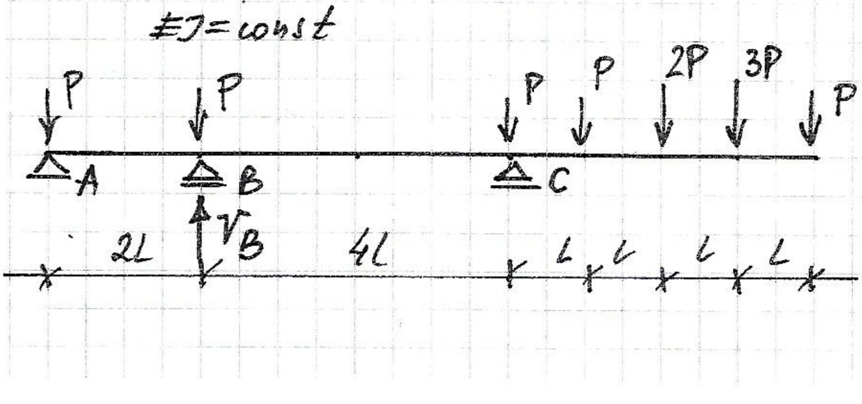


Zadanie 2
Dana jest rama płaska obciążona jak na rysunku. Sporządzić wykres M metodą przemieszczeń.

(For the given frame construct the diagram of the bending moments by the stiffness method.)

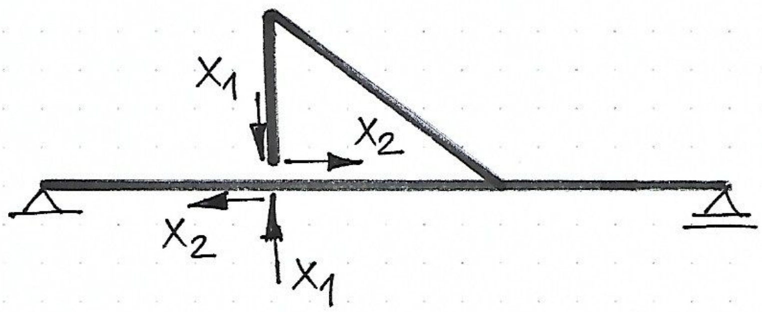


Zadanie 3
Znaleźć reakcję V_B korzystając z twierdzenia Bettiego.
(Find the reaction V_B *by using Betti's theorem)*

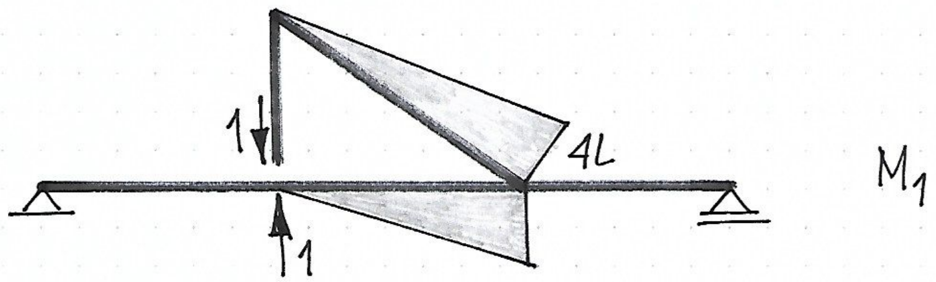


Zadanie 1 / Problem #1

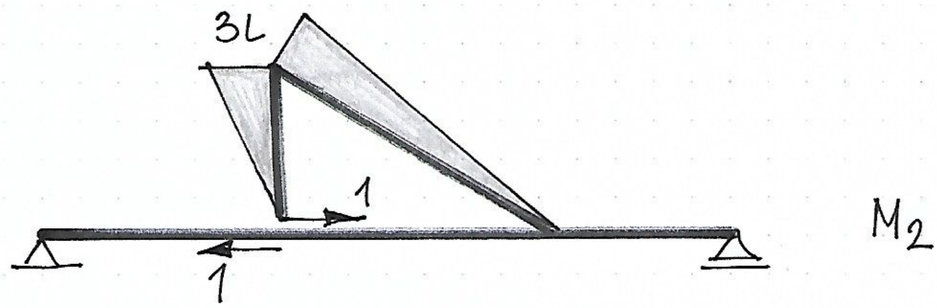
Schemat zastępczy / Primary structure



$X_1 = 1$



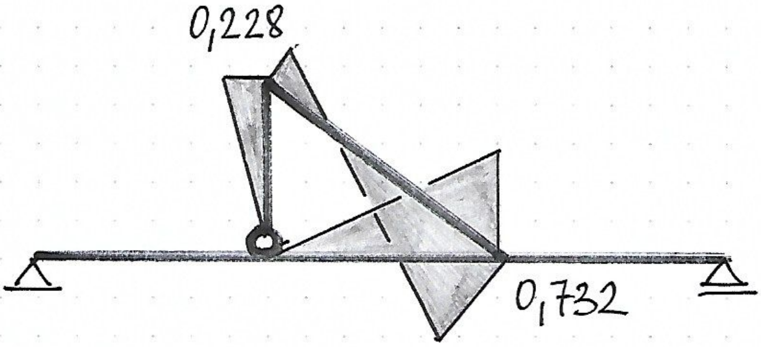
$X_2 = 1$



$\delta_{11} = 48 \frac{l^3}{EJ}$ $\delta_{12} = \delta_{21} = 10 \frac{l^3}{EJ}$ $\delta_{22} = 24 \frac{l^3}{EJ}$

$\delta_{10} = 8 \frac{\alpha_t \Delta t \, l^2}{h}$ $\delta_{20} = 0$

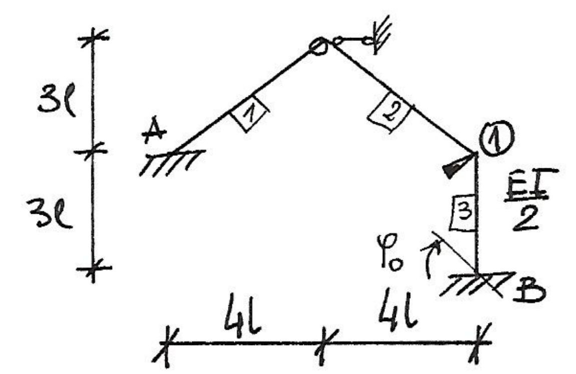
$$\begin{cases} \delta_{11} X_1 + \delta_{12} X_2 + \delta_{10} = 0 \\ \delta_{21} X_1 + \delta_{22} X_2 + \delta_{20} = 0 \end{cases} \longrightarrow \quad X_1 = -0{,}183 \, \frac{EJ\alpha_t \Delta t}{hL}, \quad X_2 = 0{,}076 \, \frac{EJ\alpha_t \Delta t}{hL}$$

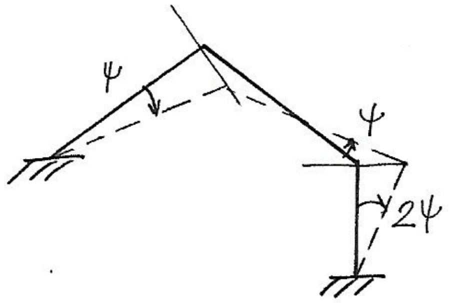


$M \left[\frac{EJ\alpha_t \Delta t}{hL}\right]$

opracował:
G. Dzierżanowski

Zadanie 2 / Problem #2





1) $\phi_1^2 + \phi_1^3 = 0$

2) $\phi_A^1 \bar{\Psi} + \phi_1^2(-\bar{\Psi}) + (\phi_1^3 + \phi_B^3)\, 2\bar{\Psi} = 0$

$$\phi_A^1 = \frac{3EI}{5l}(-\psi)$$

$$\phi_1^2 = \frac{3EI}{5l}(\varphi_1 + \psi)$$

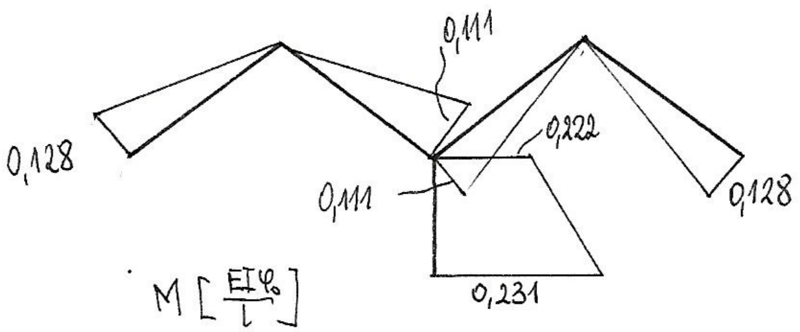
$$\phi_1^3 = \cancel{3}\,\frac{2EI}{2\cdot 3l}(2\varphi_1 - 6\psi) + \frac{2EI}{2\cdot 3l}(\varphi_0)$$

$$\phi_A^3 = \frac{2EI}{2\cdot 3l}(\varphi_1 - 6\psi) + \frac{2EI}{2\cdot 3l}(2\varphi_0)$$

$$\frac{EI}{l}\begin{bmatrix} \frac{19}{25} & -\frac{7}{5} \\ -\frac{7}{5} & \frac{46}{5} \end{bmatrix}\begin{bmatrix} \varphi_1 \\ \psi \end{bmatrix} = \frac{EI\varphi_0}{l}\begin{bmatrix} -\frac{1}{3} \\ 2 \end{bmatrix}$$

$$\varphi_1 = -0{,}028\ \varphi_0$$

$$\psi = 0{,}213\ \varphi_0$$

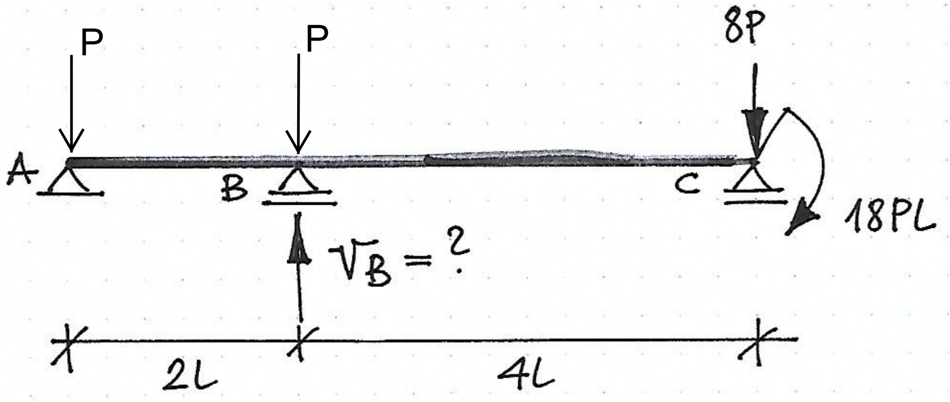


$M\left[\frac{EI\varphi_0}{l}\right]$

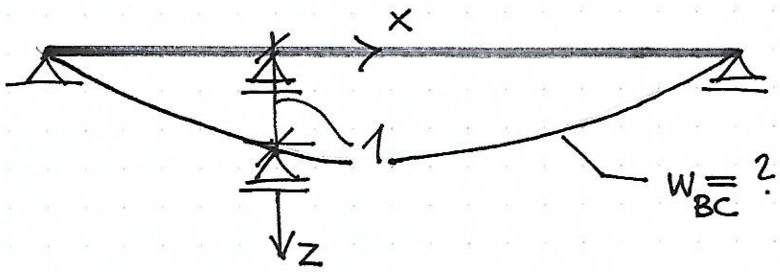
opracował:
J. Pełczyński

Zadanie 3 / Problem #3

Zadanie upraszczamy do postaci poniżej.
We reduce the problem to the following form:



Formułujemy zadanie stowarzyszone:
We formulate the auxiliary problem:



Z twierdzenia Bettiego wynika, że
From Betti's Theorem it follows that

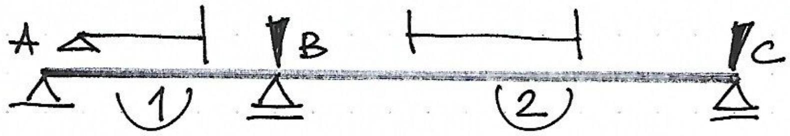
$$V_B = 18PL \cdot \varphi_C + P, \quad \varphi_C = \left.\frac{dw_{BC}}{dx}\right|_{x=4L}$$

Kąt obrotu φ_C można wyznaczyć jako wartość pochodnej $w_{BC} = w_{BC}(x)$ w punkcie C, lub korzystając z metody przemieszczeń.

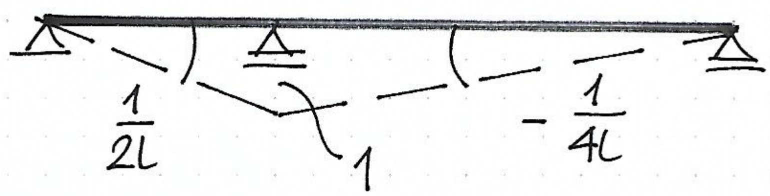
The angle φ_C can be determined by calculating the derivative of $w_{BC} = w_{BC}(x)$ at C, or by the displacement method.

<u>Wyznaczenie φ_C metodą przemieszczeń.</u>
<u>Calculating φ_C by the displacement method.</u>

Schemat zastępczy
Primary structure



$$q = \begin{bmatrix} \varphi_B \\ \varphi_C \end{bmatrix}$$



$$\begin{cases} \Phi_B^{(1)} + \Phi_C^{(1)} = 0 \\ \Phi_C^{(2)} = 0 \end{cases}$$

$$\Phi_B^{(1)} = \frac{3EJ}{2L}\left[\varphi_B\right] + \frac{3EJ}{2L}\left[-\frac{1}{2L}\right]$$

$$\Phi_B^{(2)} = \frac{2EJ}{4L}\left[2\varphi_B + \varphi_C\right] + \frac{2EJ}{4L}\left[3 \cdot \frac{1}{4L}\right]$$

$$\Phi_C^{(2)} = \frac{2EJ}{4L}\left[\varphi_B + 2\varphi_C\right] + \frac{2EJ}{4L}\left[3 \cdot \frac{1}{4L}\right]$$

Kąty obrotu:
Rotation angles:

$$\varphi_B = \frac{1}{4L}$$
$$\varphi_C = -\frac{1}{2L}$$

Rozwiązanie:
Solution:

$$V_B = 18PL \cdot \left(-\frac{1}{2L}\right) + P = -8P$$

opracował:
G. Dzierżanowski