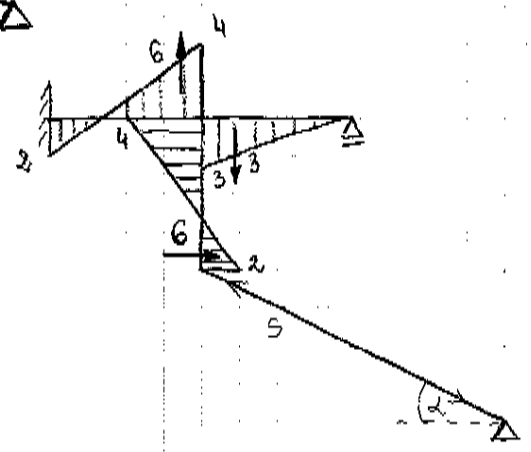
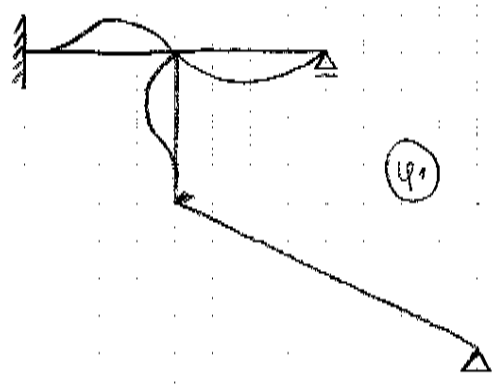
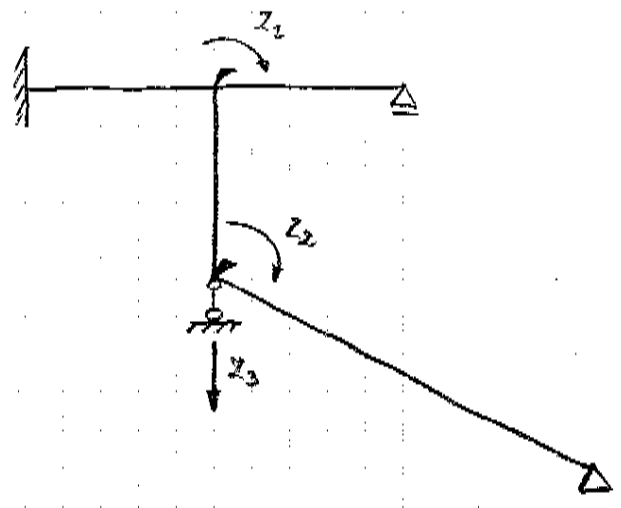
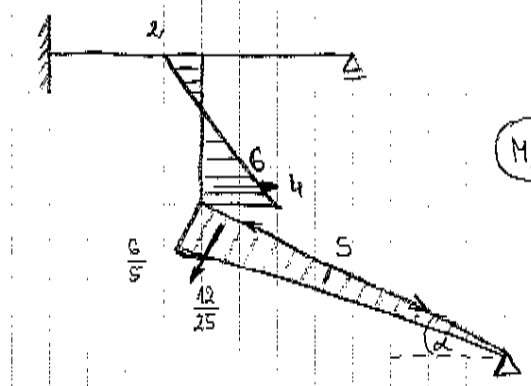
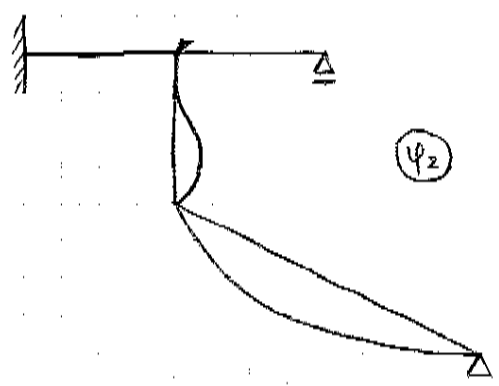


$$\sin \alpha = \frac{3}{5}$$

$$\cos \alpha = \frac{4}{5}$$

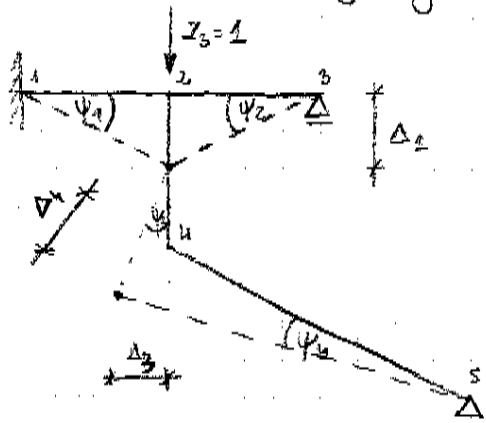


$$M_1 \left[ \frac{EY}{L} \right]$$



$$M_2 \left[ \frac{EY}{L} \right]$$

# Załącznik kinematyczny



$$\Delta_1 = 1$$

$$\psi_1 = \psi_2 = \frac{1}{l}$$

1-2-4-5

$$\sum x \psi_i \cdot l_i = 0$$

$$\psi_1 \cdot l + \psi_4 \cdot 2l = 0$$

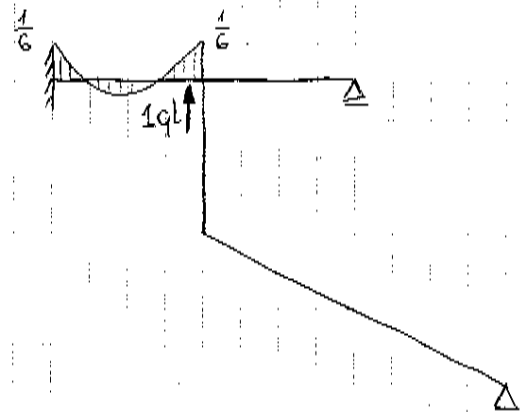
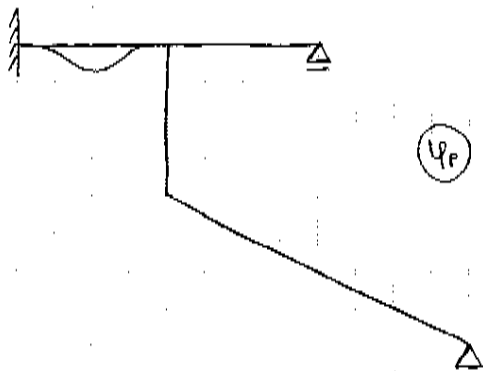
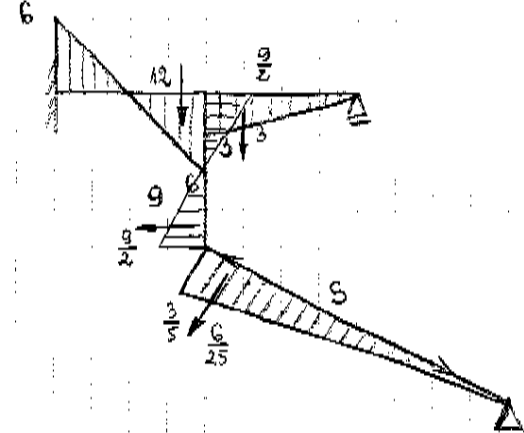
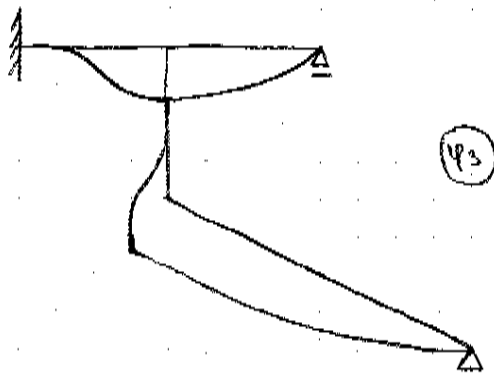
$$\psi_4 = -\frac{1}{2} \psi_1 = -\frac{1}{2l}$$

$$\sum y \psi_i \cdot l_i = 0$$

$$-\psi_3 \cdot l - \psi_4 \cdot \frac{3}{2}l = 0$$

$$\psi_3 = -\frac{3}{2} \psi_4 = \frac{3}{4l}$$

$$\Delta_1 = 1, \quad \Delta_3 = \psi_3 \cdot l = \frac{3}{4}, \quad \Delta_4 = \psi_4 \cdot \frac{5}{2}l = \frac{5}{4}$$



$$K_{11} = (4+4+3) \frac{EJ}{l} = 11 \frac{EJ}{l}$$

$$K_{12} = 2 \frac{EJ}{l}$$

$$K_{13} = (3-6-\frac{9}{2}) \frac{EJ}{l^2} = -\frac{15}{2} \frac{EJ}{l^2}$$

$$K_{31} = 3 \frac{EJ}{l^2} - 6 \frac{EJ}{l^2} - S \sin \alpha = 3 \frac{EJ}{l^2} - 6 \frac{EJ}{l^2} - \frac{18}{2} \frac{EJ}{l^2} \cdot \frac{3}{5} = -\frac{15}{2} \frac{EJ}{l^2}$$

$$K_{21} = 2 \frac{EJ}{l}$$

$$K_{22} = (4+\frac{6}{5}) \frac{EJ}{l} = \frac{26}{5} \frac{EJ}{l}$$

$$K_{23} = (\frac{3}{5}-\frac{9}{2}) \frac{EJ}{l^2} = -\frac{39}{10} \frac{EJ}{l^2}$$

$$R_{1P} = \frac{1}{6} ql^2$$

$$R_{2P} = 0$$

$$R_{3P} = -ql$$



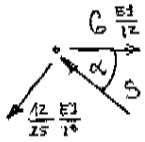
$$\sum x = 0$$

$$6 \frac{EJ}{l^2} - S \cos \alpha = 0$$

$$6 - S \cdot \frac{4}{5} = 0$$

$$S = 6 \cdot \frac{5}{4} = \frac{15}{2} \frac{EJ}{l^2}$$

$$N_{32} = \frac{12}{25} \frac{EJ}{l^2} \cos \alpha - S \cdot \sin \alpha = \frac{12}{25} \cdot \frac{4}{5} - \frac{357}{50} \cdot \frac{3}{5} = \frac{96}{250} - \frac{1071}{250} = -\frac{975}{250} = -\frac{39}{10} \frac{EJ}{l^2}$$



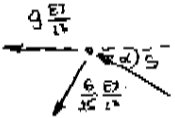
$$\sum X = 0$$

$$6 \frac{EJ}{l^2} - S \cdot \cos \alpha - \frac{12}{25} \frac{EJ}{l^2} \cdot \sin \alpha = 0$$

$$6 - S \cdot \frac{4}{5} - \frac{12}{25} \cdot \frac{3}{5} = 0$$

$$S = \frac{750}{125} = \frac{36}{5} = \frac{357}{50} \frac{EJ}{l^2}$$

$$N_{23} = 12 \frac{EJ}{l^2} + 3 \frac{EJ}{l^2} + \frac{6}{25} \frac{EJ}{l^2} \cdot \cos \alpha - S \cdot \sin \alpha = 15 + \frac{6}{25} \cdot \frac{4}{5} + \frac{1143}{100} \cdot \frac{3}{5} = \frac{441}{20} \frac{EJ}{l^2}$$



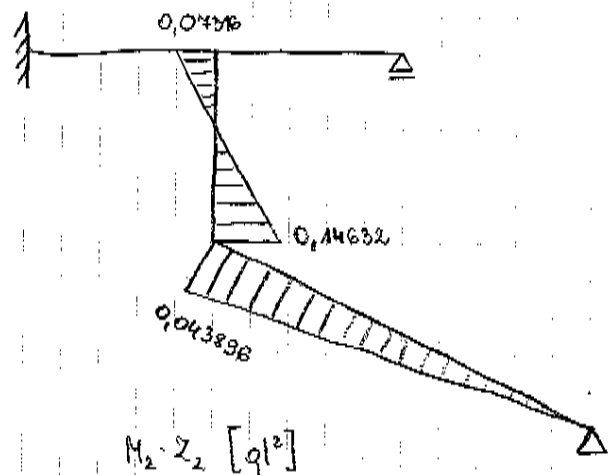
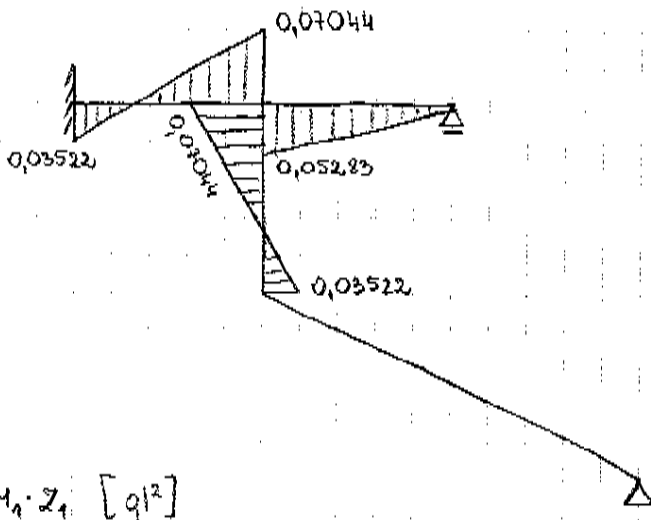
$$\sum X = 0$$

$$-9 \frac{EJ}{l^2} - S \cdot \cos \alpha - \frac{6}{25} \frac{EJ}{l^2} \cdot \sin \alpha = 0$$

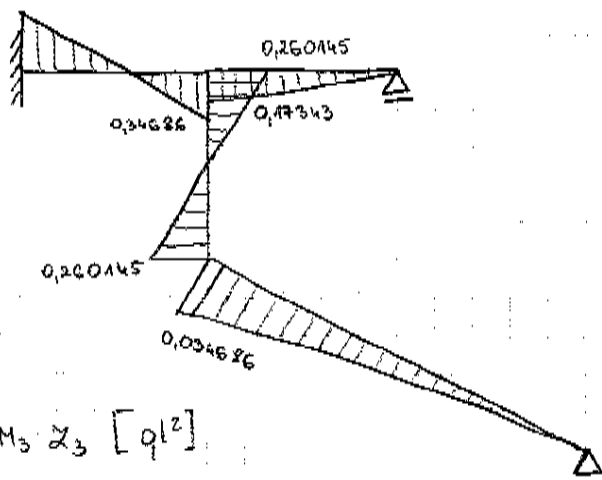
$$-9 - S \cdot \frac{4}{5} - \frac{6}{25} \cdot \frac{3}{5} = 0 \Rightarrow S = -\frac{1143}{100} \frac{EJ}{l^2}$$

$$\begin{cases} N_{11} \cdot Z_1 + N_{12} \cdot Z_2 + N_{13} \cdot Z_3 + R_{1P} = 0 \\ N_{21} \cdot Z_1 + N_{22} \cdot Z_2 + N_{23} \cdot Z_3 + R_{2P} = 0 \\ N_{31} \cdot Z_1 + N_{32} \cdot Z_2 + N_{33} \cdot Z_3 + R_{3P} = 0 \\ 11 \frac{EJ}{l} \cdot Z_1 + 2 \frac{EJ}{l} \cdot Z_2 - \frac{15}{2} \frac{EJ}{l^2} \cdot Z_3 + \frac{1}{6} q l^2 = 0 \\ 2 \frac{EJ}{l} \cdot Z_1 + \frac{20}{5} \frac{EJ}{l} \cdot Z_2 - \frac{39}{10} \frac{EJ}{l^2} \cdot Z_3 = 0 \\ -\frac{15}{2} \frac{EJ}{l^2} \cdot Z_1 - \frac{39}{10} \frac{EJ}{l^2} \cdot Z_2 + \frac{441}{20} \frac{EJ}{l^2} \cdot Z_3 - q l = 0 \end{cases}$$

$$\begin{cases} Z_1 = 0,01761 \frac{q l^2}{EJ} \\ Z_2 = 0,03658 \frac{q l^2}{EJ} \\ Z_3 = 0,05781 \frac{q l^2}{EJ} \end{cases}$$

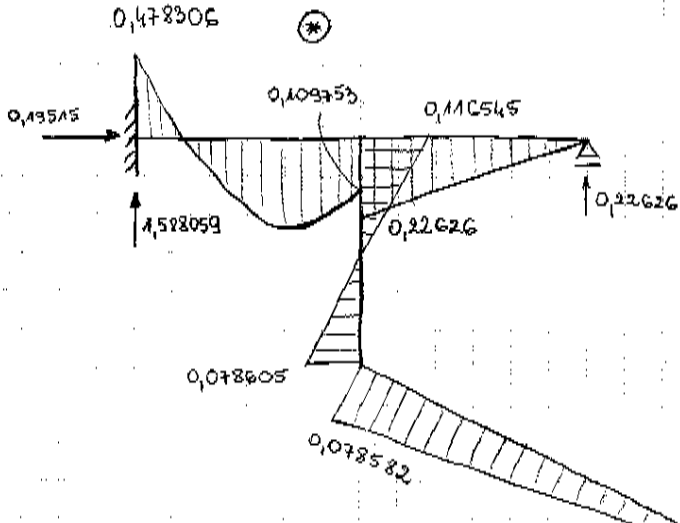


0,34686

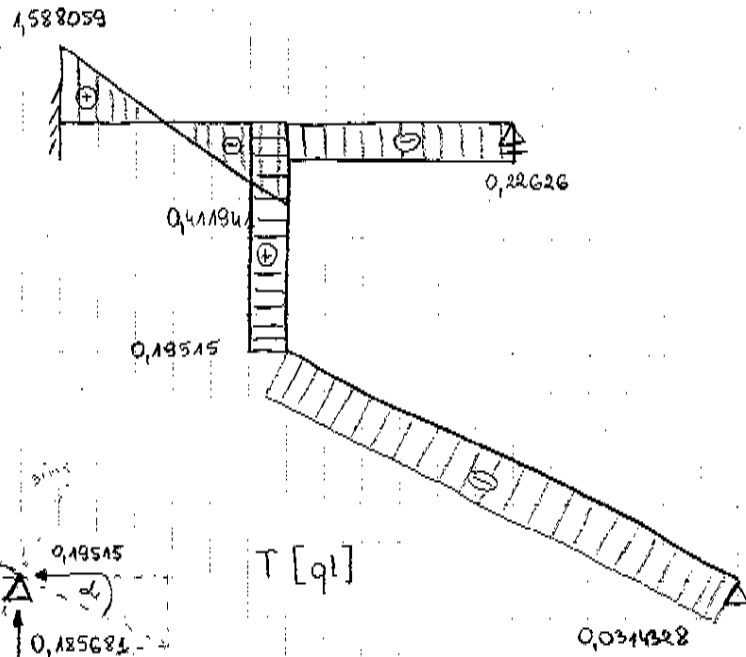


$M_3 z_3 [q l^2]$

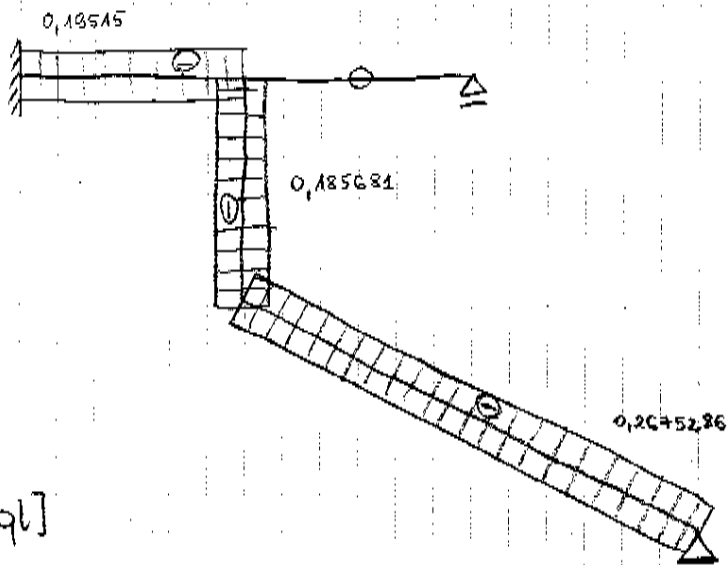
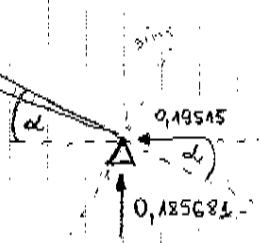
$$M = M_1 \cdot z_1 + M_2 \cdot z_2 + M_3 \cdot z_3 + M_p$$



$H [q l]$

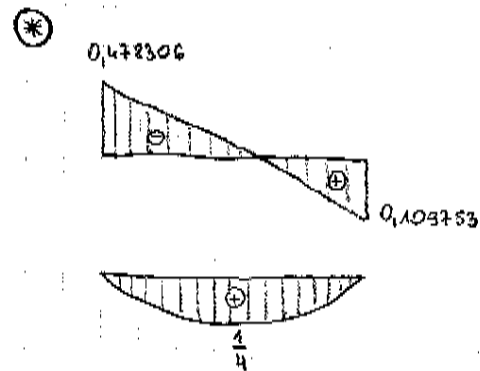
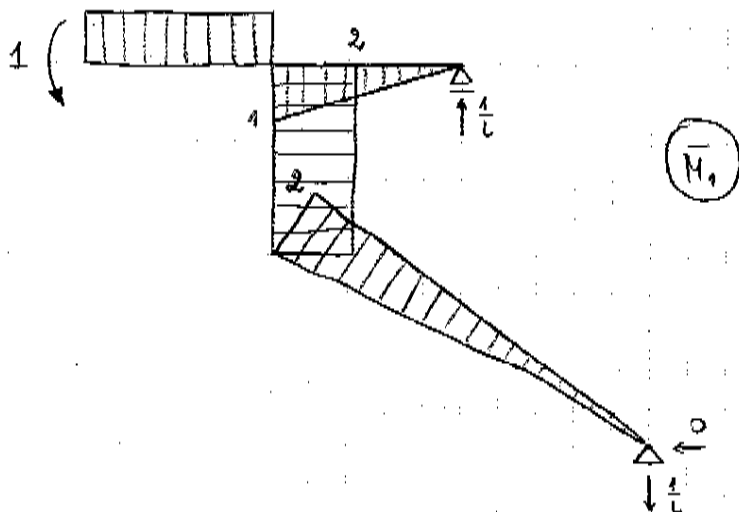


$T [q l]$



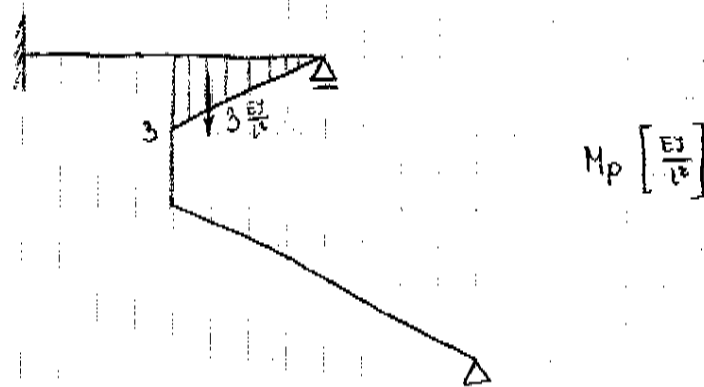
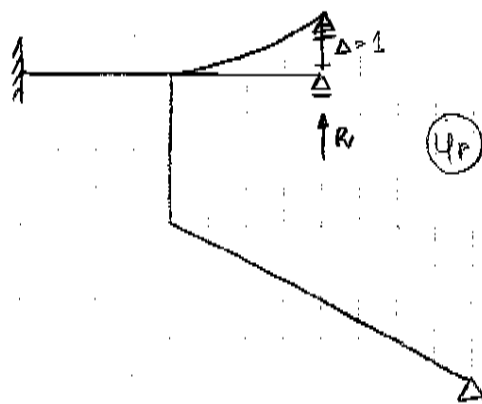
$N [q l]$

# Sprawdzanie



$$f = \frac{1}{EJ} \left[ \frac{1}{2} \cdot 0,472306 \cdot ql^2 \cdot l \cdot 1 + \frac{1}{2} \cdot 0,109753 \cdot ql^2 \cdot l \cdot (-1) + \frac{2}{3} \cdot \frac{1}{4} \cdot ql^2 \cdot l \cdot (-1) + \frac{1}{2} \cdot 0,22626 \cdot ql^2 \cdot l \cdot \left(\frac{2}{3} \cdot 1\right) + \frac{1}{2} \cdot 0,166545 \cdot ql^2 \cdot l \cdot 2 + \frac{1}{2} \cdot 0,078605 \cdot ql^2 \cdot l \cdot (-2) + \frac{1}{2} \cdot 0,078582 \cdot ql^2 \cdot \frac{5}{2}l \cdot \left(-\frac{2}{3} \cdot 2\right) \right] = -0,000000017$$

## Linia wpływu



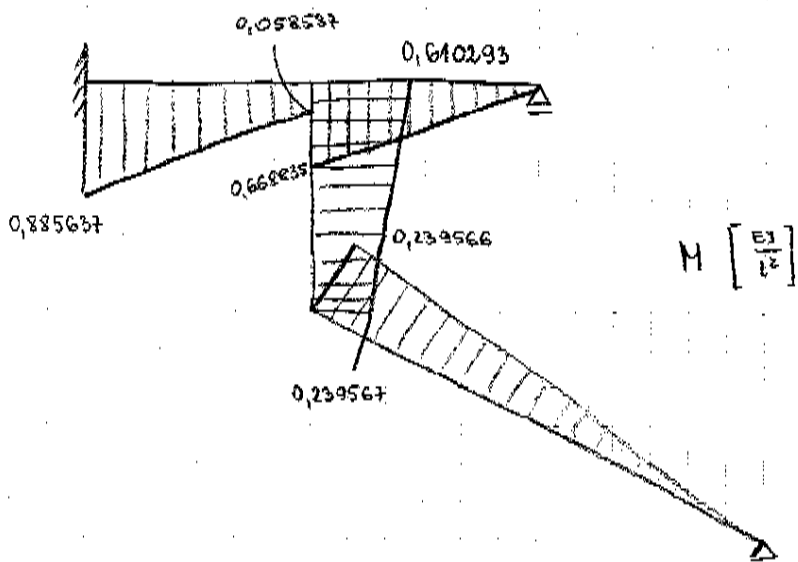
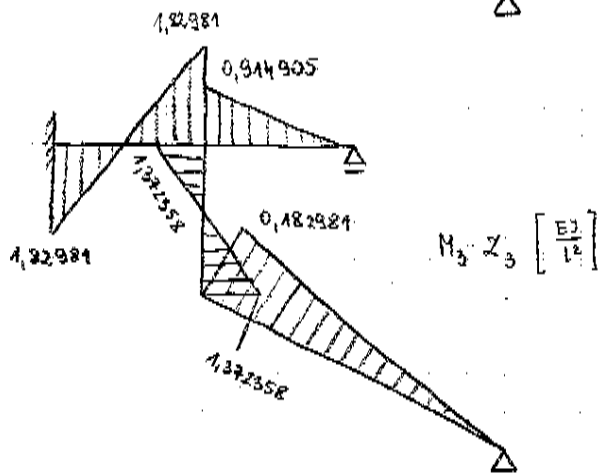
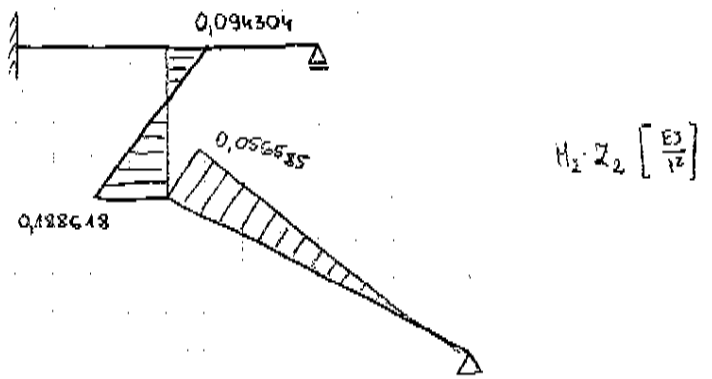
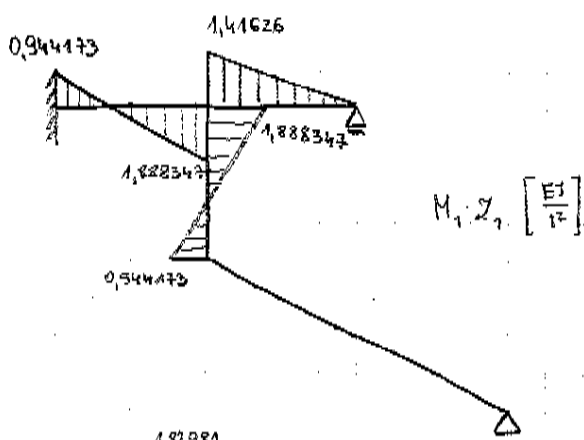
$$R_{1p} = +3 \frac{EJ}{l^2}$$

$$R_{2p} = 0$$

$$R_{3p} = 3 \frac{EJ}{l^2}$$

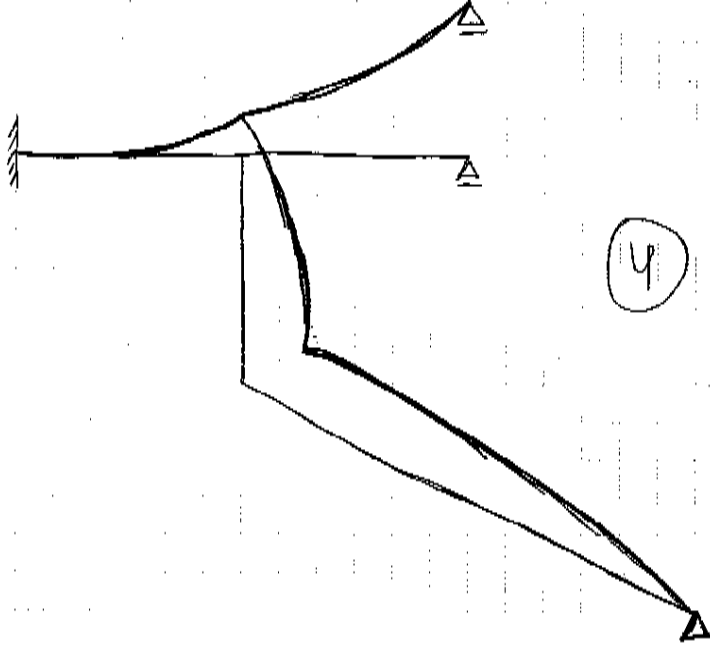
$$\begin{cases} M \frac{EJ}{l} \cdot z_1 + 2 \frac{EJ}{l} \cdot z_2 - \frac{15}{2} \frac{EJ}{l^2} \cdot z_3 + 3 \frac{EJ}{l^2} = 0 \\ 2 \frac{EJ}{l} \cdot z_1 + \frac{26}{5} \frac{EJ}{l} \cdot z_2 - \frac{39}{10} \frac{EJ}{l^2} \cdot z_3 = 0 \\ -\frac{15}{2} \frac{EJ}{l^2} \cdot z_1 - \frac{39}{10} \frac{EJ}{l^2} \cdot z_2 + \frac{44}{20} \frac{EJ}{l^2} \cdot z_3 + 3 \frac{EJ}{l^2} = 0 \end{cases}$$

$$\begin{cases} z_1 = -0,472087 \frac{1}{l} \\ z_2 = -0,047154 \frac{1}{l} \\ z_3 = -0,304968 \end{cases}$$

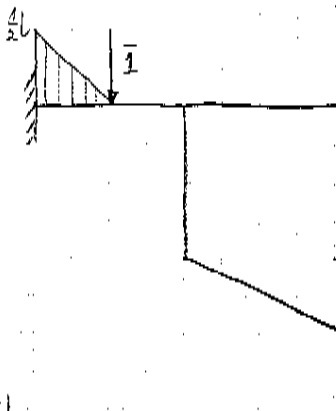


Sprawdzenie ( wykres jednostkowy z wcześniejszej strony )

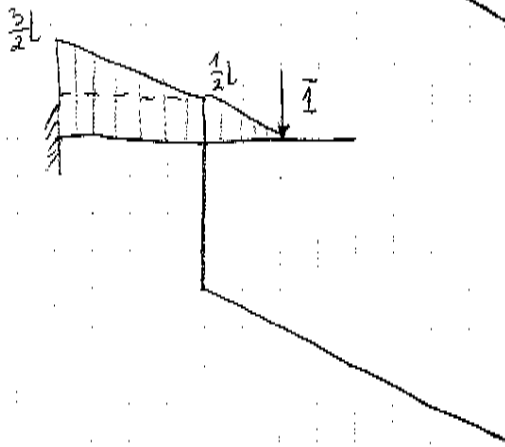
$$\begin{aligned}
 \frac{P}{F} = \frac{1}{EJ} & \left[ \frac{1}{2} \cdot (0,885637 + 0,058537) \frac{EJ}{l^2} \cdot l \cdot (-1) + \frac{1}{2} \cdot 0,668835 \frac{EJ}{l^2} \cdot l \cdot \frac{2}{3} + \frac{1}{2} \cdot (0,239567 + 0,610293) \frac{EJ}{l^2} \right. \\
 & \left. \cdot l \cdot 2 + \frac{1}{2} \cdot 0,239567 \frac{EJ}{l^2} \cdot \frac{5}{2} \cdot \left[ \frac{2}{3} \cdot 2 \right] \right] - \frac{1}{l} = 0,9999968 \frac{1}{l} - \frac{1}{l} = -0,0000037
 \end{aligned}$$



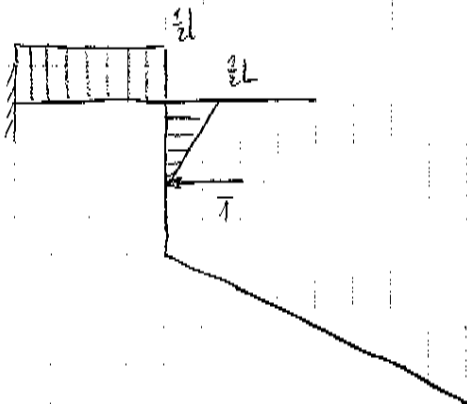
Rządnie linii wpływowej



$$\eta_1 = - \left[ 0,41355 \cdot \frac{1}{2} \cdot \left(-\frac{1}{4}\right) + \frac{1}{2} \cdot (0,825637 - 0,41355) \cdot \frac{1}{2} \cdot \left(-\frac{2 \cdot 1}{3 \cdot 2}\right) \right] = 0,0931$$



$$\eta_2 = - \left[ 0,3344175 \cdot \frac{1}{2} \cdot \left(-\frac{1}{4}\right) + 0,058537 \cdot 1 \cdot (-1) + \frac{1}{2} \cdot 0,8271 \cdot 1 \cdot \left(-\frac{1}{2} - \frac{2}{3} \cdot 1\right) \right] = 0,5828$$



$$\eta_3 = - \left[ \frac{1}{2} \cdot (0,058537 + 0,825637) \cdot 1 \cdot \left(-\frac{1}{2}\right) + 0,42493 \cdot \frac{1}{2} \cdot \frac{1}{4} + \frac{1}{2} \cdot 0,185363 \cdot \frac{1}{2} \cdot \frac{2}{3} \cdot \frac{1}{2} \right] = 0,1645$$

