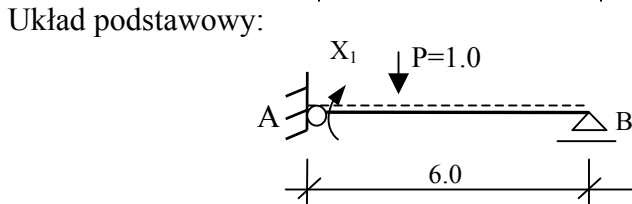
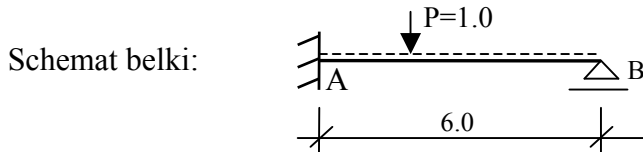
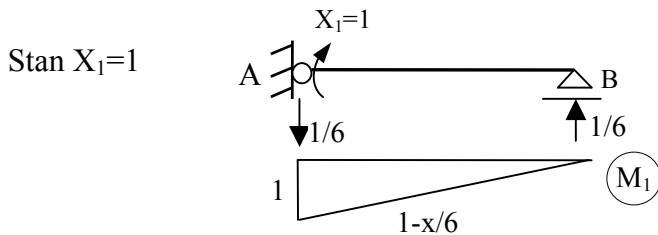


**Zad.1. Wyznaczyć linie wpływu reakcji  $R_B$  dla belki ( $EI=const$ ):**



$$LwR_B = LwR_B^0 + R_B(X_1 = 1)LwX_1$$



$$\delta_{11}LwX_1 + \delta_{1P}(x) = 0$$

$$\delta_{11} = \frac{1}{EI} \left( \frac{1}{2} \cdot 6 \cdot 1 \cdot \frac{2}{3} \cdot 1 \right) = \frac{2}{EI}$$

$$\delta_{1P}(x) = \delta_{P1}(x)$$

$$M(x) = 1 - \frac{x}{6}$$

$$EI \frac{d^2y}{dx^2} = \frac{x}{6} - 1$$

$$EI \frac{dy}{dx} = \frac{x^2}{12} - x = C$$

$$EIy = \frac{x^3}{36} - \frac{x^2}{2} + Cx + D$$

war.brzeg.:

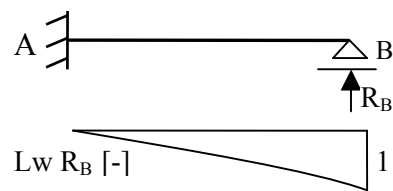
$$x = 0 \rightarrow y = 0 \Rightarrow D = 0$$

$$x = 6 \rightarrow y = 0 \Rightarrow C = 2$$

$$\delta_{P1}(x) = y = \frac{1}{EI} \left( \frac{x^3}{36} - \frac{x^2}{2} + 2x \right)$$

$$LwX_1 = -\frac{\delta_{1P}}{\delta_{11}} = -\frac{x^3}{72} + \frac{x^2}{4} - x$$

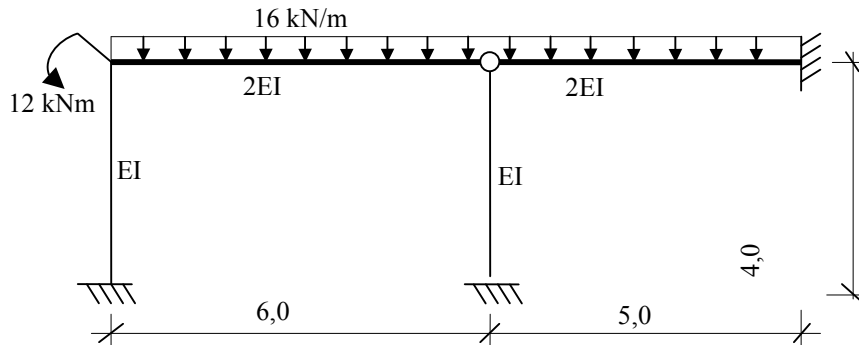
$$LwR_B = \frac{x}{6} + \frac{1}{6} \left( -\frac{x^3}{72} + \frac{x^2}{4} - x \right) = -\frac{x^3}{432} + \frac{x^2}{24}$$



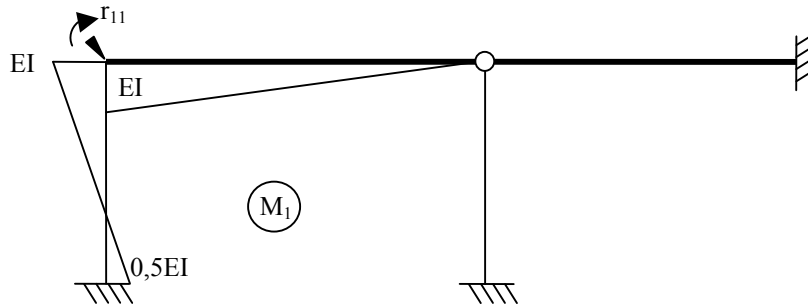
**Zad.2. Wyznaczyć siły wewnętrzne N, M, T wywołane zadaniem obciążeniem zewnętrznym, korzystając z metody przemieszczeń:**

Schemat układu:

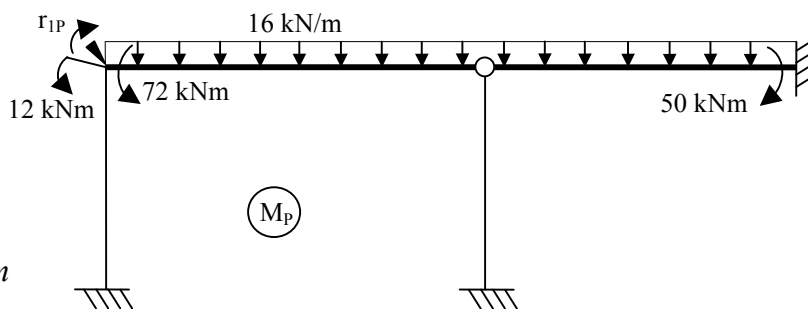
SGN=1 ( $\varphi_1$ )



Stan  $\varphi_1=1$



Stan „P”

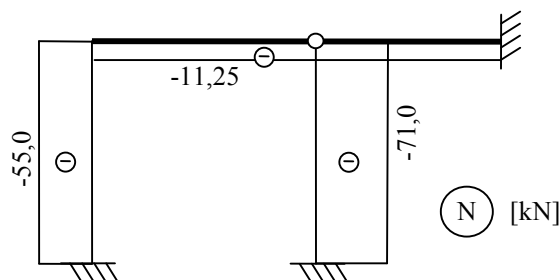
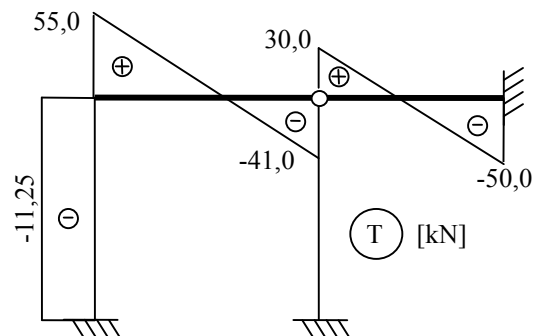
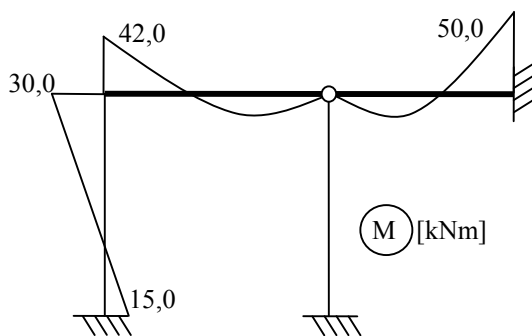


$$r_{11} = 2EI$$

$$r_{1P} = 12 - 72 = -60 \text{ kNm}$$

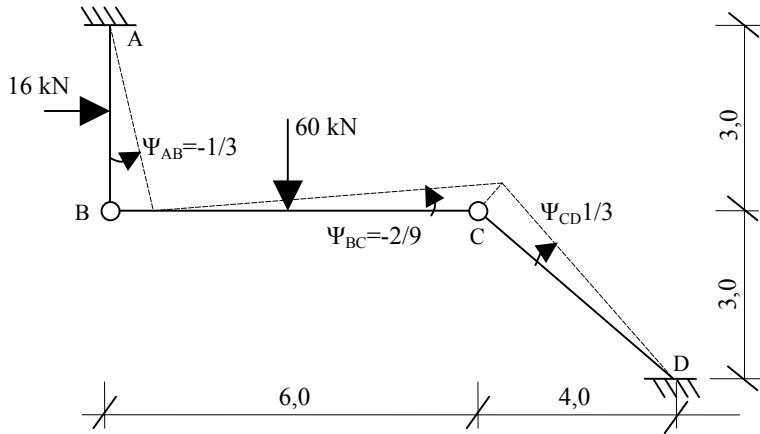
$$\varphi_1 = -\frac{r_{1P}}{r_{11}} = \frac{30}{EI}$$

**Ostateczne wykresy N, M, T:**

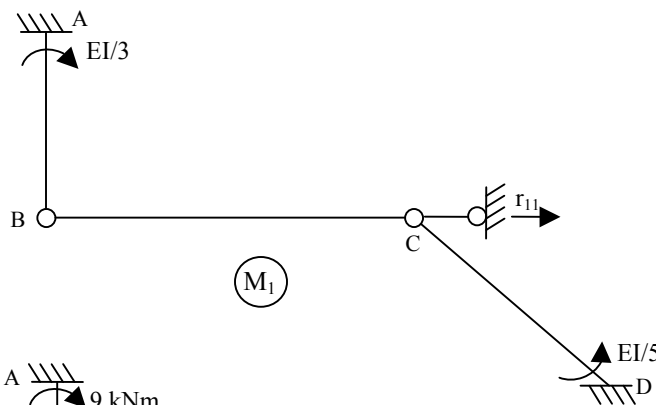


**Zad.3. Korzystając z metody przemieszczeń znaleźć przemieszczenie poziome punktu C wywołane zadaniem obciążeniem zewnętrznym:**

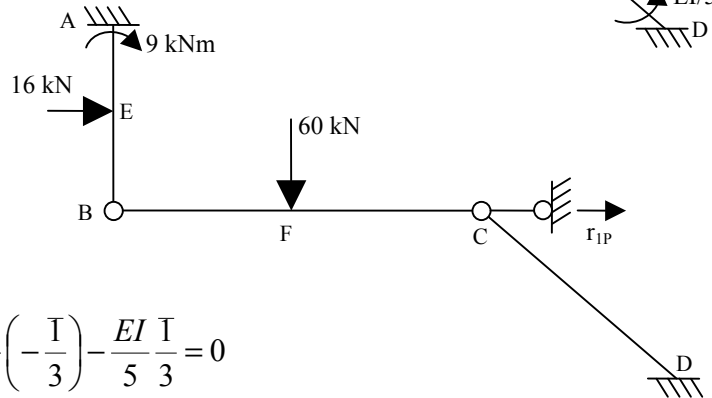
**Dane: I 180:  $I_x=1450 \text{ cm}^4$   
 $E=205 \text{ GPa}$**



Stan  $u_1=1$ :



Stan "P":



$$r_{11} \cdot \bar{I} + \frac{EI}{3} \left( -\frac{\bar{I}}{3} \right) - \frac{EI}{5} \frac{\bar{I}}{3} = 0$$

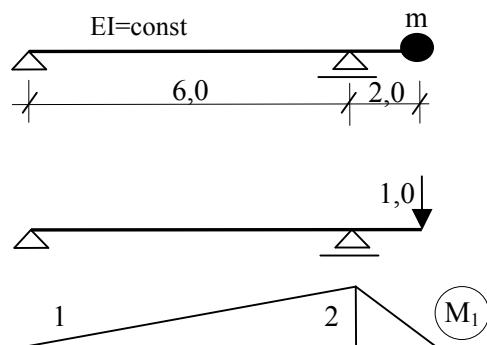
$$r_{11} = \frac{8EI}{45}$$

$$r_{1P} \cdot \bar{I} + 16 \cdot \delta_E + 60 \cdot \delta_F + 9 \left( -\frac{\bar{I}}{3} \right) = 0$$

$$r_{1P} = 35 \text{ kN}$$

$$u_1 = -\frac{r_{1P}}{r_{11}} = \frac{196,875}{EI}$$

$$\text{dla I180: } I_x = 1450 \text{ cm}^4; \quad E = 250 \text{ GPa} \Rightarrow \underline{u_1 = 6,62 \text{ cm}}$$

**Zad.4. Wyznaczyć częstość drgań własnych belki.****Dane:  $m=250$  kg;****I 180:  $I_x=1450$  cm<sup>4</sup>;** **$E=205$  GPa**

$$\delta_{11} = \frac{1}{EI} \left( \frac{1}{2} \cdot 6 \cdot 2 \cdot \frac{2}{3} \cdot 2 + \frac{1}{2} \cdot 2 \cdot 2 \cdot \frac{2}{3} \cdot 2 \right) = \frac{10,667}{EI}$$

$$\omega = \sqrt{\frac{1}{\delta_{11} \cdot m}} = \sqrt{\frac{2972500}{10,667 \cdot 250}} = \underline{\underline{33,387}} \frac{rad}{s}$$