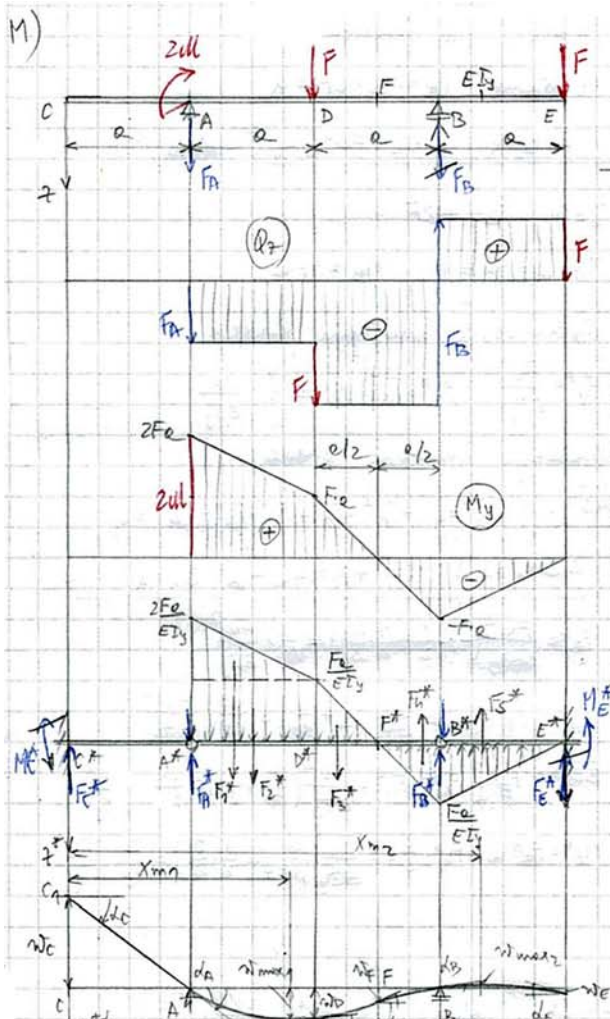


Primjer M: Deformacije ravnog nosača metodom analogne grede

Zadano: $F, a, M = F \cdot a, EI_y = \text{konst.}$



Reakcije u otklonima

$$1. \sum F_z = 0 \Rightarrow F_A + F_B + 2F = 0$$

$$2. \sum M_B = 0 \Rightarrow F_A \cdot 2a - 2M + F \cdot a - F \cdot a = 0 \quad | : 2a$$

$$F_A = \frac{2M}{2a} = \frac{2F \cdot a}{2a} = F, \quad F_B = -2F - F_A = -3F$$

$$M_A = 2M = 2F \cdot a, \quad M_D = 2M - F_A \cdot a = F \cdot a, \quad M_E = 0$$

$$M_B = -F \cdot a, \quad M_C = 0$$

Opterećenje analogne grede:

$$F_1^* = \frac{1 \cdot F \cdot a^2}{2 \cdot EI_y} = F_2^*, \quad F_3^* = \frac{F \cdot a^2}{EI_y}, \quad F_4^* = F_5^* = \frac{1 \cdot F \cdot a^2}{4 \cdot EI_y}$$

Reakcije analogne grede:

$$AB^*: 1. \sum F_z^* = 0 \Rightarrow F_A^* + F_B^* = F_1^* + F_2^* + F_3^* - F_4^*$$

$$2. \sum M_A^* = 0 \Rightarrow F_B^* \cdot 2a + F_3^* \cdot \frac{2}{3}a - F_1^* \cdot \frac{a}{2} - F_2^* \cdot \frac{a}{2} = 0 \quad | : 2a$$

$$F_B^* = \frac{F \cdot a^2}{2 \cdot EI_y} \left(\frac{1}{2} \cdot \frac{1}{3} + 1 \cdot \frac{1}{2} - \frac{1}{2} \cdot \frac{2}{3} \right) = \frac{1}{4} \cdot \frac{F \cdot a^2}{EI_y}$$

$$F_A^* = F_1^* + F_2^* - F_B^* = \frac{F \cdot a^2}{EI_y} \left(\frac{1}{2} + 1 - \frac{1}{4} \right) = \frac{5}{4} \cdot \frac{F \cdot a^2}{EI_y}$$

$$BE^*: F_E^* = F_B^* - F_3^* = \frac{F \cdot a^2}{EI_y} \left(\frac{1}{4} - \frac{1}{2} \right) = -\frac{1}{4} \cdot \frac{F \cdot a^2}{EI_y}$$

$$M_E^* = -F_B^* \cdot a + F_3^* \cdot \frac{2}{3}a = \frac{F \cdot a^3}{EI_y} \left(-\frac{1}{4} \cdot 1 + \frac{1}{2} \cdot \frac{2}{3} \right) = \frac{1}{12} \cdot \frac{F \cdot a^3}{EI_y}$$

$$AC^*: F_C^* = F_A^* = \frac{5}{4} \cdot \frac{F \cdot a^2}{EI_y}, \quad M_C^* = -F_A^* \cdot a = -\frac{5}{4} \cdot \frac{F \cdot a^3}{EI_y}$$

Negibi tangente na elastičnu liniju grede:

$$\alpha_A = -\alpha_A^* = -F_A^* \cdot a = -\frac{5}{4} \cdot \frac{F \cdot a^2}{EI_y} = -1,250$$

$$\alpha_B = -\alpha_B^* = F_B^* \cdot a = \frac{1}{4} \cdot \frac{F \cdot a^2}{EI_y} = 0,250$$

$$\alpha_C = -\alpha_C^* = -F_C^* \cdot a = -\frac{5}{4} \cdot \frac{F \cdot a^2}{EI_y} = -1,250$$

$$\alpha_E = -\alpha_E^* = -F_E^* \cdot a = \frac{1}{4} \cdot \frac{F \cdot a^2}{EI_y} = 0,250$$

$$\alpha_D = -\alpha_D^* = F_B^* \cdot a - F_3^* \cdot \frac{2}{3}a + F_4^* \cdot \frac{a}{3} = \frac{1}{4} \cdot \frac{F \cdot a^2}{EI_y}$$

$$\alpha_F = -\alpha_F^* = F_B^* \cdot a + F_4^* \cdot \frac{a}{3} = \frac{F \cdot a^2}{EI_y} \left(\frac{1}{4} + \frac{1}{4} \right) = \frac{1}{2} \cdot \frac{F \cdot a^2}{EI_y}$$

Prigrabi grede: $w_A = w_B = 0$

$$w_C = M_C^* = -\frac{5}{4} \cdot \frac{F \cdot a^3}{EI_y} = -1,250$$

$$w_D = M_D^* = F_B^* \cdot a + F_3^* \cdot \frac{2}{3}a = \frac{F \cdot a^3}{EI_y} \left(\frac{1}{4} \cdot 1 + \frac{1}{4} \cdot \frac{2}{3} \right) = \frac{5}{12} \cdot \frac{F \cdot a^3}{EI_y} = 0,416667$$

$$w_E = M_E^* = \frac{1}{12} \cdot \frac{F \cdot a^3}{EI_y} = 0,083333$$

$$w_F = M_F^* = F_B^* \cdot \frac{a}{2} + F_4^* \cdot \frac{a}{3} = \frac{F \cdot a^3}{EI_y} \left(\frac{1}{4} \cdot \frac{1}{2} + \frac{1}{4} \cdot \frac{1}{3} \right) = \frac{5}{24} \cdot \frac{F \cdot a^3}{EI_y} = 0,208333$$

Udaljeni ekstremi:

$$x_{m1} = 1,77525 \cdot a \rightarrow w_{max1} = 0,445706 \cdot \frac{F \cdot a^3}{EI_y}$$

$$x_{m2} = 3,29288 \cdot a \rightarrow w_{max2} = 0,034518 \cdot \frac{F \cdot a^3}{EI_y}$$