

Primjer L: Deformacije ravnog nosača metodom analogne grede

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

A)

Reakcije u odnoscima:

$$1. \sum F_z = \phi \quad F_A + F_B + F = \phi$$

$$2. \sum M_B = \phi \quad F_A \cdot 3a - F \cdot a - \phi \cdot a = \phi / 3a$$

$$F_A = F, \quad F_B = -F - F_A = -2F$$

$$M_A = \phi = F \cdot a, \quad M_{D,L} = \phi - F_A \cdot 2a = F \cdot a - F \cdot 2a = -F \cdot a$$

$$M_{D,D} = M_{D,L} + \phi = -F \cdot a + F \cdot a = 0, \quad M_B = -F \cdot a, \quad M_E = 0$$

Opterećenje analogne grede:

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

Reakcije analogne grede:

ABA:

$$1. \sum F_z^* = 0 \quad -F_A^* + F_1^* - F_2^* + F_3^* + F_B^* = 0$$

$$2. \sum M_B^* = \phi \quad -F_A^* \cdot 3a + F_1^* \cdot 4a - F_2^* \cdot 3a = \phi / 3a$$

$$F_A^* = \frac{F \cdot a^2}{3EI_y} \left(\frac{1}{2} \cdot \frac{4}{3} - \frac{1}{2} \cdot \frac{1}{3} \right) = \frac{1}{6} \cdot \frac{F \cdot a^2}{EI_y}$$

$$F_B^* = F_A^* + F_3^* = \frac{F \cdot a^2}{EI_y} \left(\frac{1}{6} + \frac{1}{2} \right) = \frac{4}{6} \cdot \frac{F \cdot a^2}{EI_y} = \frac{2}{3} \cdot \frac{F \cdot a^2}{EI_y}$$

BEA:

$$F_E^* = F_B^* + F_4^* = \frac{F \cdot a^2}{EI_y} \left(\frac{4}{6} + \frac{1}{2} \right) = \frac{7}{6} \cdot \frac{F \cdot a^2}{EI_y}$$

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

Napibi tangente na elastičnom luku grede

$$\alpha_A = -Q_A^* = -F_A^* = -\frac{1}{6} \cdot \frac{F \cdot a^2}{EI_y}, \quad \alpha_B = -Q_B^* = -F_B^* = -\frac{2}{3} \cdot \frac{F \cdot a^2}{EI_y}, \quad \alpha_E = -Q_E^* = -F_E^* = -\frac{7}{6} \cdot \frac{F \cdot a^2}{EI_y}$$

$$\alpha_C = -Q_C^* = -F_A^* + F_1^* = \frac{F \cdot a^2}{EI_y} \left(-\frac{1}{6} + \frac{1}{2} \right) = \frac{1}{3} \cdot \frac{F \cdot a^2}{EI_y}, \quad \alpha_D = -Q_D^* = -F_B^* + F_3^* = \frac{F \cdot a^2}{EI_y} \left(-\frac{2}{3} + \frac{1}{2} \right) = -\frac{1}{6} \cdot \frac{F \cdot a^2}{EI_y}$$

Prigibi grede: $w_A = w_B = 0$

$$w_C = M_C^* = F_A^* \cdot a - F_1^* \cdot \frac{2}{3}a = \frac{F \cdot a^3}{EI_y} \left(\frac{1}{6} \cdot 1 - \frac{1}{2} \cdot \frac{2}{3} \right) = -\frac{1}{6} \cdot \frac{F \cdot a^3}{EI_y}, \quad w_E = M_E^* = 1 \cdot \frac{F \cdot a^3}{EI_y}$$

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

$x_{m1} = 0,18335 \cdot a \rightarrow w_{max1} \approx 0,014777 \cdot \frac{F \cdot a^3}{EI_y}$

$x_{m2} = 1,81665 \cdot a \rightarrow w_{max2} \approx 0,34811 \cdot \frac{F \cdot a^3}{EI_y}$

(U skorijoj budućnosti, svi primjeri analognih greda biti će iscrtani i ispisani uobičajenom tehnikom, a sada se ovdje daju skenirani iz radnog materijala!).