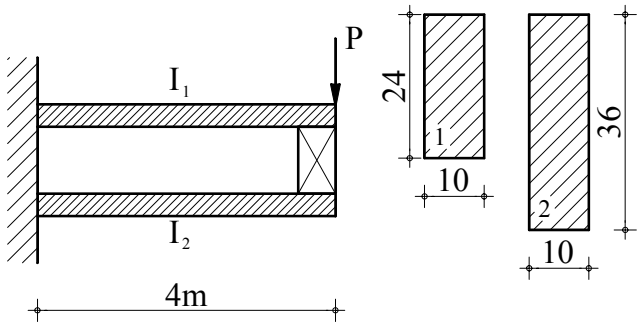
1.11. Za sustav i opterećenje prikazano na crtežu odrediti maksimalna normalna i posmična naprezanja, ako je zadano:

$P = 100\text{kN}$

$E = 2 \cdot 10^6 \frac{\text{kN}}{\text{cm}^2}$

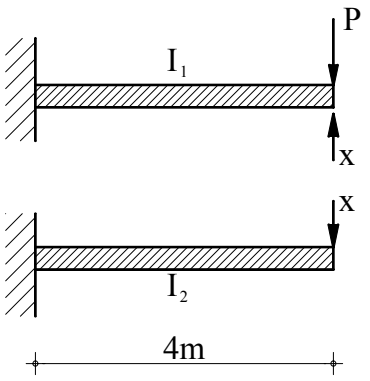


$I_1 = \frac{10 \cdot 24^3}{12} = 11520\text{cm}^4$

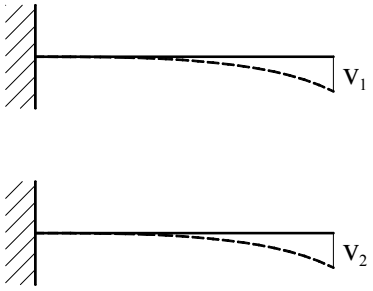
$I_2 = \frac{10 \cdot 36^3}{12} = 38880\text{cm}^4$

Uvjet deformacija

Naš statički neodređen sustav ćemo prikazati kao dva statički određena, a utjecaj jednog nosača na drugi ćemo zamijeniti silom "x".



Potrebna nam je još jedna jednadžba, a kako progibi krajeva nosača moraju biti isti, dobivamo:



Uvjet deformacija: $v_1 = v_2$

$$v_1 = \frac{(P - x) \cdot L^3}{3EI_1} \qquad v_2 = \frac{x \cdot L^3}{3EI_2}$$

$$v_1 = v_2$$

$$\frac{(P - x) \cdot L^3}{3EI_1} = \frac{x \cdot L^3}{3EI_2}$$

$$\frac{P}{I_1} = \frac{x}{I_1} + \frac{x}{I_2}$$

$$\frac{P}{I_1} = x\left(\frac{1}{I_1} + \frac{1}{I_2}\right)$$

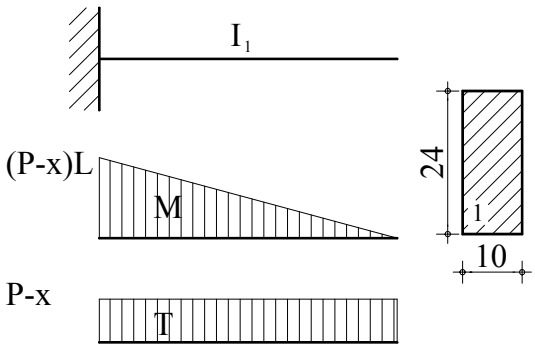
$$\frac{P}{I_1} = x\frac{I_1 + I_2}{I_1 \cdot I_2}$$

$$x = \frac{I_2 \cdot P}{I_1 + I_2}$$

$$x = 77.14\text{kN}$$

Određivanje stanja normalnih i posmičnih naprezanja u nosačima

Konzola 1:



Normalna naprezanja

$$M_{1max} = (P - x) \cdot L = (100 - 77.14) \cdot 4 = 91.43\text{kNm}$$

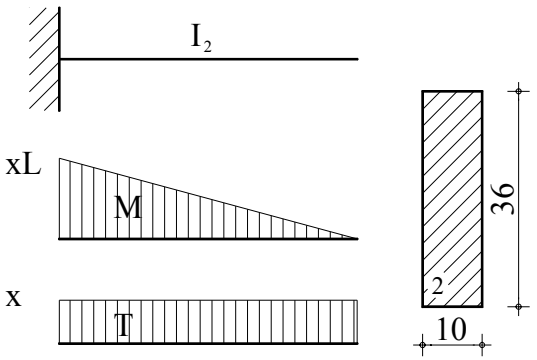
$$\sigma_{1max} = \frac{M_{1max}}{W_1} = \frac{92.43\text{kNm}}{\frac{10 \cdot 24^2\text{cm}^3}{6}} = 9.52\frac{\text{kN}}{\text{cm}^2}$$

Posmična naprezanja:

$$T_{1max} = (P - x) = 22.86\text{kN}$$

$$\tau_{1max} = \frac{T_{1max} \cdot S_{x1}}{I_1 \cdot b_1} = \frac{22.86\text{kN} \cdot 12 \cdot 10 \cdot 6\text{cm}^3}{11520\text{cm}^4 \cdot 10\text{cm}} = 0.14\frac{\text{kN}}{\text{cm}^2}$$

Konzola 2:



Normalna naprezanja

$$M_{2max} = x \cdot L = 77.14 \cdot 4 = 308.56kNm$$

$$\sigma_{2max} = \frac{M_{2max}}{W_2} = \frac{308.56kNm}{\frac{10 \cdot 36^2 cm^3}{6}} = 14.29 \frac{kN}{cm^2}$$

Posmična naprezanja:

$$T_{2max} = x = 77.14kN$$

$$\tau_{2max} = \frac{T_{2max} \cdot S_{x2}}{I_2 \cdot b_2} = \frac{77.14kN \cdot 18 \cdot 10 \cdot 9cm^3}{38880cm^4 \cdot 10cm} = 0.32 \frac{kN}{cm^2}$$