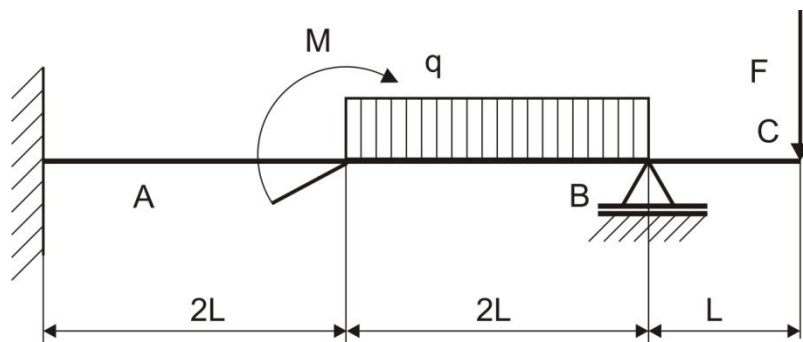


Zadatak 7.3.02.

Za nosač koji je prikazan na slici kvadratnog poprečnog preseka

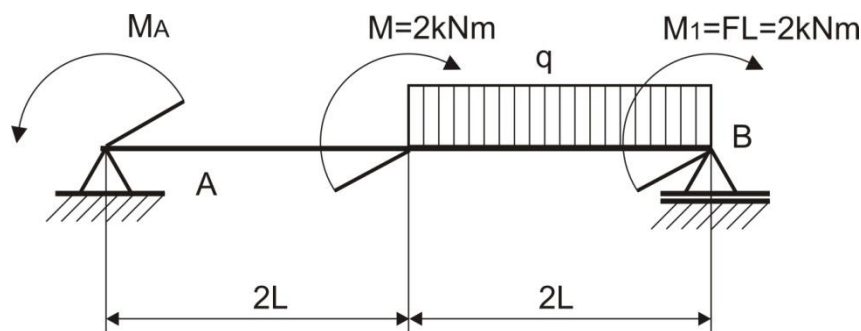
1. Odrediti reakcije veza i nacrtati , dijagrame napadnih momenta, transverzalnih i aksijalnih sila
2. Dimenzionisati nosač ako je po celoj dužini konstantnog poprečnog preseka i ako dozvoljeni napon $\sigma_{df} = 100 MPa$,
3. Izračinati ugib u tački C, ako je $E = 2 \cdot 10^5 MPa$.



$F=2kN, M=2kNm, q=1kN/m, L=1m$

Vidi se da je statički neodređena konzola koja se može rešavati na više načina ali se u startu sila sa prepusta premesti u oslonac B i doda odgovarajući moment

1. Da se umesto konzole uvede moment uklještenja na sada gredi a moment se određuje iz uslova nagiba kod uklještenja, odnosno oslonca A, da je jednak nuli $\alpha=0$.
2. Uvođenjem vertikalne sile F_B u osloncu B i istu odrediti iz uslova da je ugib kraja konzole jednak nuli



$F_q = q \cdot 2L = 2 \text{ kN} = 2 F, \quad M_1 = F L = 2 \text{ kNm}$

Nagib kod oslonca A nastaje kao posledica $\alpha = \alpha_1 + \alpha_2 + \alpha_3 + \alpha_4 = 0$

momenta od uklještenja M_A α_1 tablica 3b slučaj b $\alpha_1 = -\frac{M_A \cdot 4L}{3 \cdot B} = -\frac{M_A \cdot 4 \cdot 1}{24 \cdot B} = -\frac{4 \cdot M_A}{3 \cdot B}$

kontinualnog opterećenja α_2 tablica 7d ali se očitava za β sa suprotnim znakom

$\alpha_2 = -\beta_2 = \frac{7 \cdot q \cdot (4L)^3}{384 \cdot B} = \frac{7 \cdot 1 \cdot (4 \cdot 1)^3}{384 \cdot B} = \frac{448}{384 \cdot B}$

momenta M na sredini raspona α_3 tablica 5 sa suprotnim znakom zbog smera momenta

$$\alpha_3 = -\frac{M \cdot 4L}{24 \cdot B} = -\frac{2 \cdot 4 \cdot 1}{24 \cdot B} = -\frac{1}{3 \cdot B}$$

momenta od redukovane sile sa prepusta α_4 tablica 3b slučaj d

$$\alpha_4 = -\frac{M_1 \cdot 4L}{6 \cdot B} = -\frac{2 \cdot 1 \cdot 4 \cdot 1}{6 \cdot B} = -\frac{4}{3 \cdot B}$$

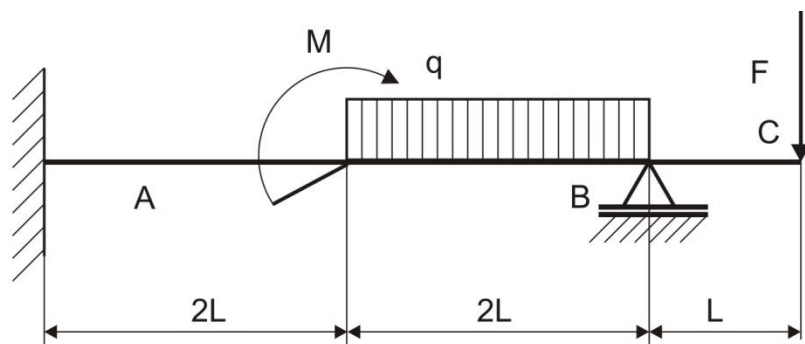
$$-\frac{4 \cdot M_A}{3 \cdot B} + \frac{448}{384 \cdot B} - \frac{1}{3 \cdot B} - \frac{4}{3 \cdot B} = 0$$

$$M_A = \frac{3 \cdot B}{4} \left(\frac{448}{384 \cdot B} - \frac{1}{3 \cdot B} - \frac{4}{3 \cdot B} \right) = \frac{4}{3} \left(\frac{448}{384} - \frac{5}{3} \right) = \frac{-192}{384} \cdot \frac{4}{3} = 0.375 \text{ kNm}$$

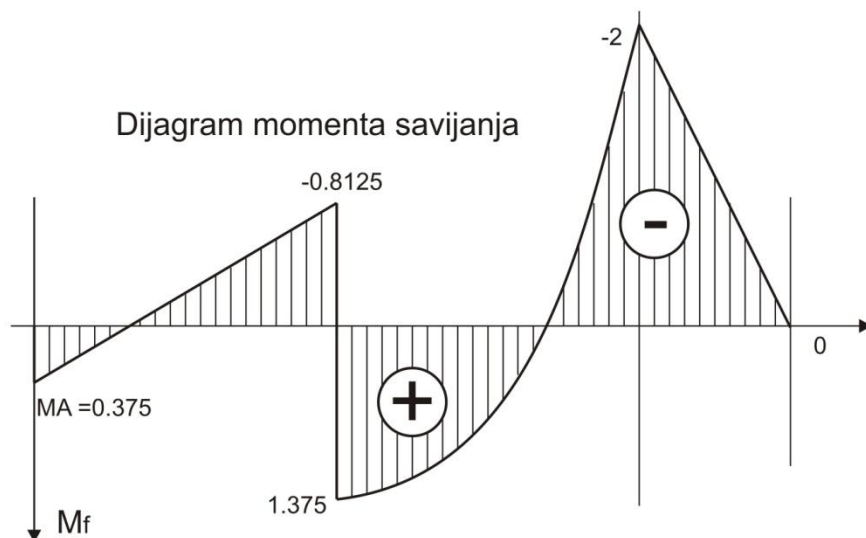
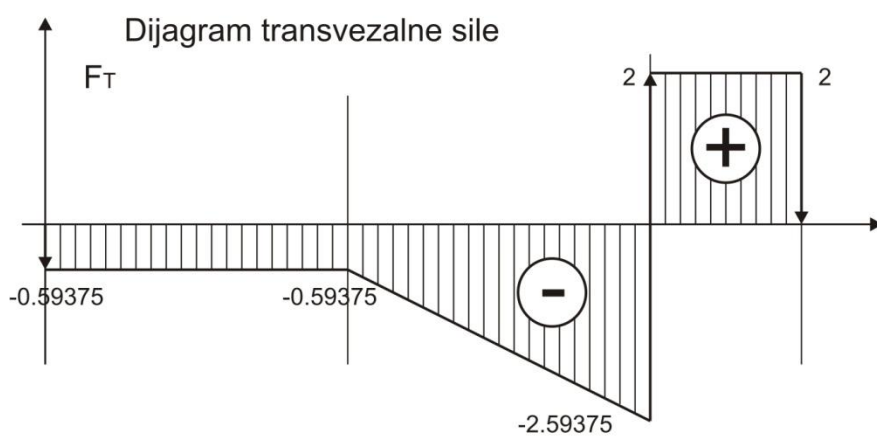
1. $\sum Z_i = Z_A = 0$
2. $\sum Y_i = F_A + F_B - q \cdot 2L = 0$
3. $\sum M_A = M_A + M + F \cdot L + 3L \cdot q \cdot 2L - 4L \cdot Y_B = 0$

$$3) \rightarrow Y_B = \frac{M_A + M + F \cdot 5L + 3L \cdot q \cdot 2L}{4L} = \frac{0.375 + 2 + 10 + 6}{4} = 4.59375 \text{ kN}$$

$$2) \rightarrow F_A = -Y_B + q \cdot 2L + F = -4.59375 + 2 + 2 = -0.59375 \text{ kN}$$



$F=2\text{kN}, M=2\text{kNm}, q=1\text{kN/m}, L=1\text{m}$



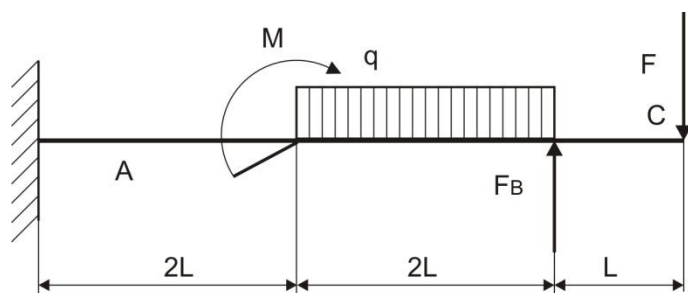
Sa dijagrama $M_{fmax} = 2 \text{ kNm}$

$$\sigma_f = \frac{M_{fmax}}{W_x} \leq \sigma_{df} \rightarrow W_x = \frac{M_{fmax}}{\sigma_{df}} = \frac{2 \cdot 10^3}{100 \cdot 10^6} = 20 \cdot 10^{-6} \text{ m}^3 = 20 \text{ cm}^3$$

Za kvadratni poprečni presek $W_x = \frac{a^3}{6} = 20 \rightarrow a = \sqrt[3]{120} = 4.932 \text{ cm}$ usvaja se 5 cm

$$B = E \cdot I_x = E \cdot \frac{a^4}{12} = 2 \cdot 10^{11} \cdot \frac{625}{12} \cdot 10^{-8} = 104.167 \cdot 10^3 \text{ Nm}^2$$

Ugib u tački C najjednostavnije smatrati gredu kao konzolu sa silom F_B i odrediti ugib na kraju konzole $f = f_1 + f_2 - f_3 + f_4 + f_5$



$$F=2\text{kN}, M=2\text{kNm} \quad q=1\text{kN/m}, L=1\text{m}$$

Moment $M=2$ na $a=2L$, $l=5L$ $z=l=5L$ tab 13

$$f_1 = \frac{M(5L)^2}{2 \cdot B} \cdot \frac{2L}{5L} \cdot \left(2 - \frac{2L}{5L}\right) = \frac{M25L^2}{2 \cdot B} \cdot \frac{2}{5} \cdot \frac{10-2}{5} = \frac{8}{B}$$

Kontinualno opterećenje za celu dužinu dodato q na L $a=2L$, $b=3L$, $s=3.5L$, $l=5L$ tabela 15b

$$f_2 = \frac{q3L(5L)^2}{24 \cdot B} \cdot \left[12 \frac{3.5L}{5L} \frac{5L}{5L} - 4 \left(\frac{5L}{5L}\right)^3 + \frac{5L}{3L} \left(\frac{5L-2L}{5L}\right)^4\right] = \frac{75qL^3}{24 \cdot B} \cdot \left(\frac{42}{5} - 4 + \frac{27}{125}\right) = \frac{427}{40B}$$

Negativno fiktivno dodato q na L $a=4L$, $b=L$, $s=4.5L$, $l=5L$ tabela 15b

$$f_3 = -\frac{qL(5L)^2}{24 \cdot B} \cdot \left[12 \frac{4.5L}{5L} \frac{5L}{5L} - 4 \left(\frac{5L}{5L}\right)^3 + \frac{5L}{L} \left(\frac{5L-4L}{5L}\right)^4\right] = -\frac{25qL^3}{24 \cdot B} \cdot \left(\frac{54}{5} - 4 + \frac{1}{125}\right) = -\frac{851}{120B}$$

Ugib od sile F_B $a=4L$, $l=5L$, $z=5L$ tabela 10

$$f_4 = -\frac{F_B(5L)^2}{6B} \left(\frac{4L}{5L}\right)^2 \left[3 - \left(\frac{4L}{5L}\right)\right] = -\frac{4.59375 \cdot 25}{6B} \cdot \frac{16}{25} \left(3 - \frac{4}{5}\right) = -\frac{404.25}{15B}$$

Ugib od sile F $a=5L$, $l=5L$, $z=5L$ tabela 11

$$f_5 = \frac{F}{3} \cdot \frac{(5L)^2}{B} = \frac{2 \cdot 25}{3B} = \frac{50}{3B}$$

$$f = f_1 + f_2 - f_3 + f_4 + f_5 = \frac{8}{B} + \frac{427}{40B} - \frac{851}{120B} - \frac{404.25}{15B} + \frac{50}{3B} = \frac{960+1281-851-3234+2000}{120B}$$

$$= \frac{156}{120 \cdot 104.167 \cdot 10^3}$$

$$f = 0.000012479\text{m} = 0.012\text{mm}$$