2.9. Lomljeni konzolni štap okruglog poprečnog presjeka se nalazi u horizontalnoj ravnini, a u vertikalnoj je opterećen koncentriranom silom P kako je prikazano crtežom. Potrebno je:

a) odrediti dijagrame momenta savijanja, momenta torzije i poprečnih sila na nosaču
b) dimenzionirati nosač koristeći 5. teoriju čvrstoće

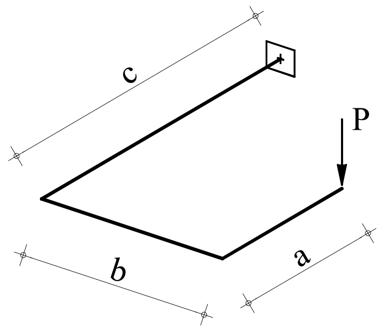
$P = 20.0\,kN$

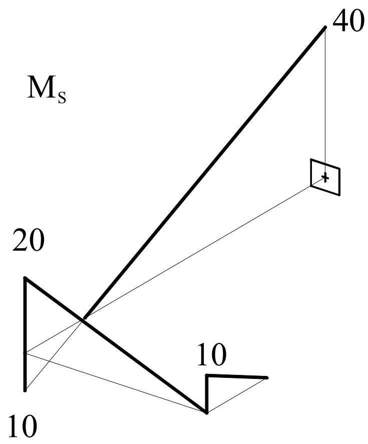
$a = 0.5\,m$

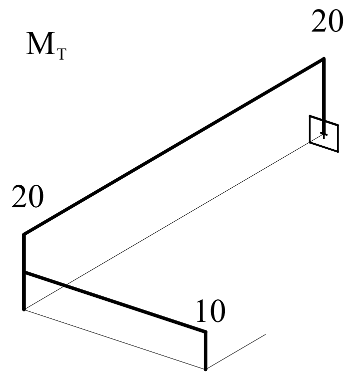
$b = 1.0\,m$

$c = 2.5\,m$

$\sigma_{dop} = 12\,\frac{kN}{cm^2}$




Kritični presjek je na mjestu upetosti.

$M_S = 40\,kNm$

$M_T = 20\,kNm$

Prema 5.teoriji čvrstoće: $\sigma_{ekv} = \sqrt{\sigma^2 + 3\tau^2}$

$$\sigma = \frac{M_S}{W} = \frac{M_S}{\frac{d^3\pi}{32}}$$

$$\tau = \frac{M_T}{W_P} = \frac{M_S}{\frac{d^3\pi}{16}}$$

$$\sigma_{ekv} = \sqrt{(\frac{M_S}{W})^2 + 3(\frac{M_T}{W_P})^2} = \sqrt{(\frac{M_S}{W})^2 + 3(\frac{M_T}{2W})^2} = \frac{\sqrt{4{M_S}^2 + 3{M_T}^2}}{2W} \leq \sigma_{dop}$$

$$W = \frac{d^3\pi}{32} \geq \frac{\sqrt{4{M_S}^2 + 3{M_T}^2}}{2\sigma_{dop}} \Rightarrow d \geq \sqrt[3]{\frac{32\sqrt{4{M_S}^2 + 3{M_T}^2}}{2\sigma_{dop} \cdot \pi}}$$

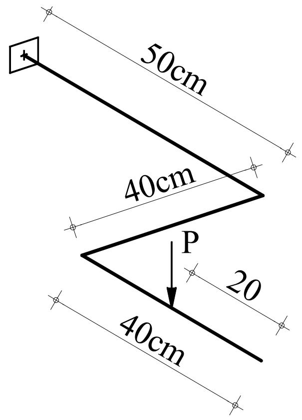
$d \geq 15.47\,cm$

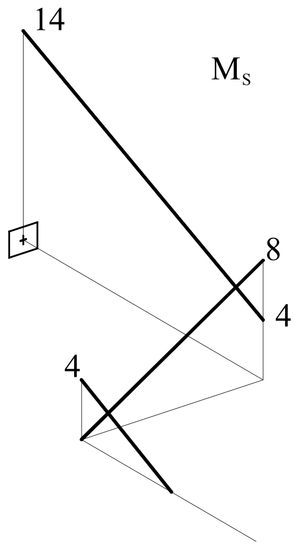
Odabrano d=16 cm

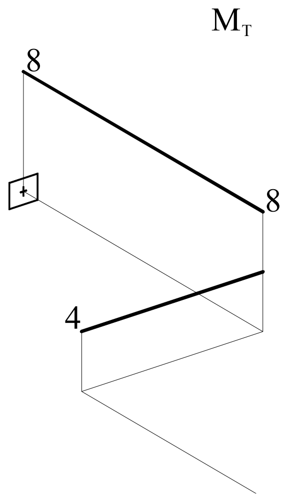
2.10. Lomljeni konzolni štap okruglog poprečnog presjeka se nalazi u horizontalnoj ravnini, a u vertikalnoj je opterećen koncentriranom silom P kako je prikazano crtežom. Primjenom teorije najvećih posmičnih naprezanja dimenzionirati štap ako je:

$P = 20\,kN$

$\sigma_{dop} = 150 \dfrac{N}{mm^2}$




Kritični presjek je na mjestu upetosti.

$M_S = 14\,kNm$

$M_T = 8\,kNm$

Prema 3.teoriji čvrstoće: $\sigma_{ekv} = \sqrt{\sigma^2 + 4\tau^2}$

$$\sigma = \frac{M_S}{W} = \frac{M_S}{\frac{d^3\pi}{32}}$$

$$\tau = \frac{M_T}{W_P} = \frac{M_S}{\frac{d^3\pi}{16}}$$

$$\sigma_{ekv} = \sqrt{(\frac{M_S}{W})^2 + 4(\frac{M_T}{W_P})^2} = \sqrt{(\frac{M_S}{W})^2 + 4(\frac{M_T}{2W})^2} = \frac{\sqrt{{M_S}^2 + {M_T}^2}}{W} \le \sigma_{dop}$$

$$W = \frac{d^3\pi}{32} \ge \frac{\sqrt{{M_S}^2 + {M_T}^2}}{\sigma_{dop}} \Rightarrow d \ge \sqrt[3]{\frac{32\sqrt{{M_S}^2 + {M_T}^2}}{\pi \cdot \sigma_{dop}}}$$

$d \ge 10.306\,cm$

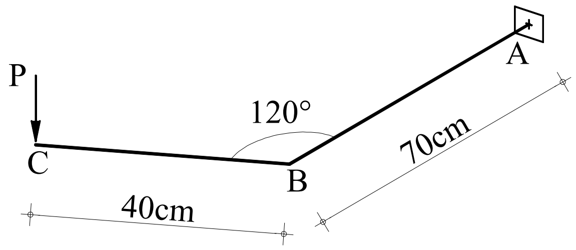
Odabrano d=11 cm

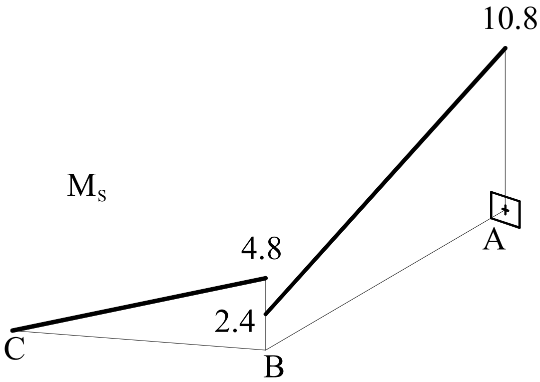
2.11. Lomljeni konzolni štap okruglog poprečnog presjeka se nalazi u horizontalnoj ravnini, a u vertikalnoj je opterećen koncentriranom silom P kako je prikazano crtežom. Potrebno je:

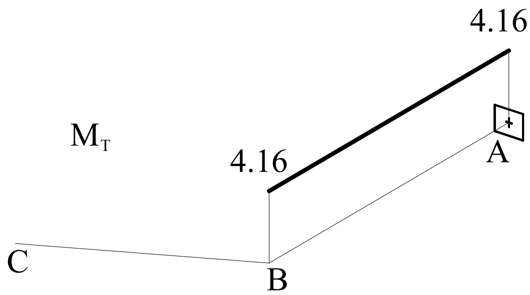
a) odrediti dijagrame momenta savijanja, momenta torzije i poprečnih sila na nosaču
b) za najviše naprezani element štapa naći položaj i veličinu glavnih naprezanja
c) dimenzionirati nosač koristeći potencijalne energije promjene oblika

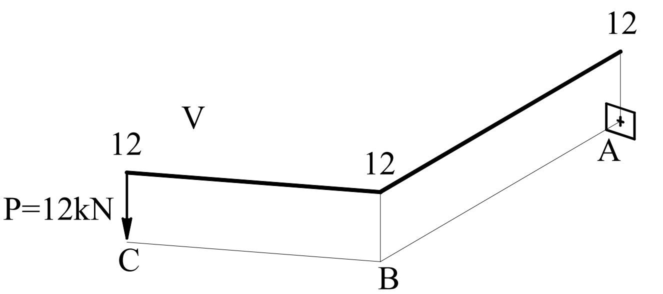
$P = 12.0\,kN$

$\sigma_{dop} = 12 \frac{kN}{cm^2}$




Kritično stanje naprezanje je u presjeku A-A

$M_S = 10.8\,kNm$

$M_T = 4.16\,kNm$

$V = 12\,kN$

Potrebno je dimenzionirati presjek, te za odabrane dimenzije naći glavna naprezanja u presjek A-A.

Prema 5.teoriji čvrstoće: $\sigma_{ekv} = \sqrt{\sigma^2 + 3\tau^2}$

$$\sigma = \frac{M_S}{W} = \frac{M_S}{\frac{d^3\pi}{32}}$$

$$\tau = \frac{M_T}{W_P} = \frac{M_S}{\frac{d^3\pi}{16}}$$

Zašto nismo uzeli u obzir posmično naprezanje od poprečne sile?

$$\sigma_{ekv} = \sqrt{(\frac{M_S}{W})^2 + 3(\frac{M_T}{W_P})^2} = \sqrt{(\frac{M_S}{W})^2 + 3(\frac{M_T}{2W})^2} = \frac{\sqrt{4M_S{}^2 + 3M_T{}^2}}{2W} \leq \sigma_{dop}$$

$$W = \frac{d^3\pi}{32} \geq \frac{\sqrt{4M_S{}^2 + 3M_T{}^2}}{2\sigma_{dop}} \Rightarrow d \geq \sqrt[3]{\frac{32\sqrt{4M_S{}^2 + 3M_T{}^2}}{2\sigma_{dop} \cdot \pi}}$$

$$d \geq 9.98\,cm$$

Odabrano d=10 cm

Položaj i veličina glavnih naprezanja:

$$\sigma = \frac{M_S}{W} = \frac{M_S}{\frac{d^3\pi}{32}} = 10.98\frac{kN}{cm^2}$$

$$\tau = \frac{M_T}{W_P} = \frac{M_S}{\frac{d^3\pi}{16}} = 2.18\frac{kN}{cm^2}$$

$$\sigma_{1,2} = \frac{\sigma_x + \sigma_y}{2} \pm \frac{1}{2}\sqrt{(\sigma_x - \sigma_y)^2 + 4\tau^2} = \frac{\sigma}{2} \pm \frac{1}{2}\sqrt{\sigma^2 + 4\tau^2}$$

$$\sigma_1 = 11.38\frac{kN}{cm^2}$$

$$\sigma_2 = -0.40\frac{kN}{cm^2}$$

$$tg2\alpha = \frac{2\tau}{\sigma_x - \sigma_y} = \frac{2\tau}{\sigma} \Rightarrow \alpha = 10.53° = 10°32'$$