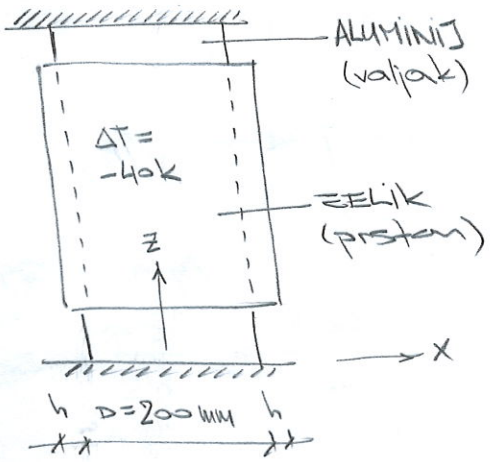
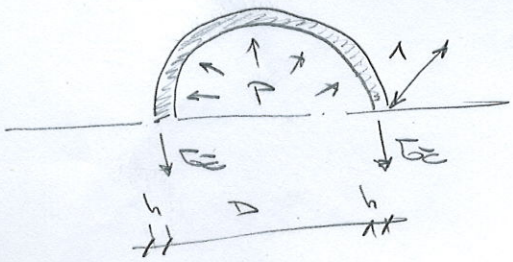
6. ZADATAK: U čeličnom pistonu debljine $h = 20$ mm umetnut je valjak od aluminija. Unutarnji promjer pistona jednak je promjeru valjka. Valjak se nalazi između dvije apsolutno krute stijene. Treba odrediti stanje naprezanja u pistonu i valjku, ako se temperatura pistona promijeni za $\Delta T = -40$ K. Zadano je: $E_{AL} = 0{,}8 \cdot 10^5$ MPa; $E_{\check{C}} = 2{,}0 \cdot 10^5$ MPa; $\nu_{AL} = 0{,}35$; $\alpha_{T\check{C}} = 1{,}7 \cdot 10^{-5}$ 1/K.



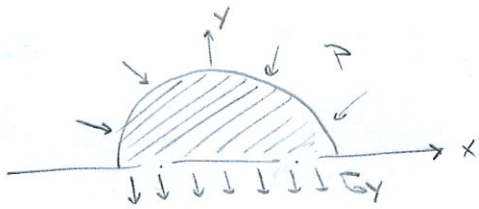
PISTON: (čelik)



$$2\sigma_z \cdot h \cdot 1 = p \cdot D \cdot 1$$

$$\sigma_{\check{C}} = \frac{p \cdot D}{2h}$$

VALJAK: (aluminij)



$$\sigma_y \cdot D \cdot 1 = -p \cdot D \cdot 1$$

$$\sigma_y = \sigma_x = -p$$

$$\sigma_z \neq 0 \longrightarrow \varepsilon_z = 0$$

$$\varepsilon_{zAL} = \frac{1}{E_{AL}} \cdot \left[\sigma_z - \nu_{AL}(\sigma_x + \sigma_y)\right] = 0$$

$$\sigma_z = \nu_{AL} \cdot 2\sigma_x$$

$$\sigma_z = \nu_{AL} \cdot 2p \cdot (-1)$$

$$\sigma_z = -2\nu_{AL} \cdot p$$

UVJET DEFORMACIJE:

$$\varepsilon_z = \varepsilon_{AL} \quad (\times \text{-1 IF R})$$

$$\alpha_T \cdot \Delta T + \frac{\sigma_z}{E_z} = \frac{1}{E_{AL}} \cdot \left[\sigma_x - \nu_{AL}(\sigma_y + \sigma_z)\right]$$

$$\frac{p \cdot D}{2h \cdot E_z} + \underset{(-)}{\alpha_T \cdot \Delta T} = \frac{1}{E_{AL}} \cdot \left[-p - \nu_{AL} \cdot (-p - 2\nu_{AL} \cdot p)\right]$$

$$\longrightarrow p = 2{,}67 \text{ MPa}$$

NAPREZANJA:

$$\sigma_z = \frac{p \cdot D}{2h} = \frac{2{,}67 \cdot 200}{2 \cdot 2} = 133{,}50 \text{ MPa (vlak)}$$

$$\left.\begin{aligned} \sigma_{xAL} = \sigma_{yAL} &= -p = -2{,}67 \text{ MPa} \\ \sigma_{zAL} &= -2\nu_{AL} \cdot p = -2 \cdot 0{,}35 \cdot 2{,}67 = -1{,}87 \text{ MPa} \end{aligned}\right\} \text{tlak}$$