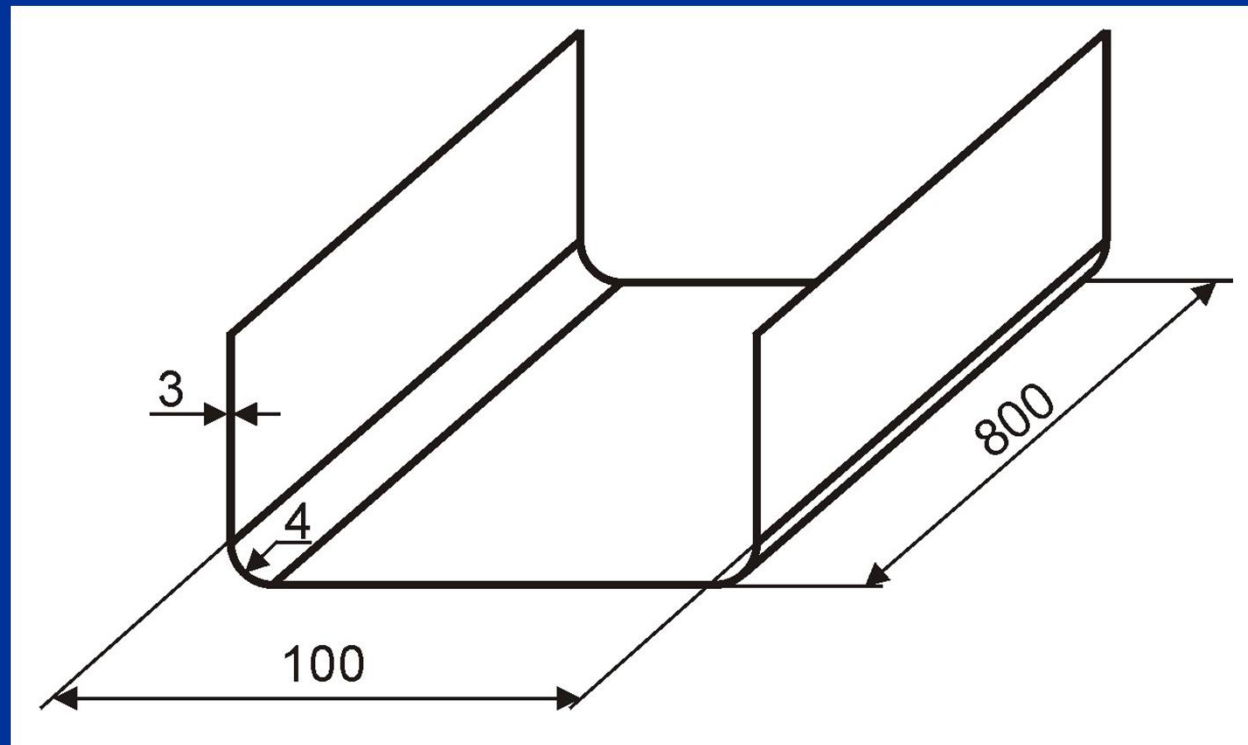# 5. Domaći zadatak - Savijanje

Za slučaj savijanja dijela na slici:
- dati raspored radijalnih i tangecionalnih napona,
- izračunati potrebnu silu za savijanje komada.

Uslovi: $\sigma_T = 600[N/mm^2]$

Slika 5.1.

PRORAČUN:

1. Raspored radijalnih i tangencionalnih napona

$s = 3[mm]$

$r = 4[mm]$

$a = 100[mm]$

$b = 800[mm]$

$\sigma_T = 600[N/mm^2]$

$\rho_n = \sqrt{R \cdot r} = \sqrt{7 \cdot 4} = 5.29[mm]$

ρ_n - poluprečnik krivine neutralne naponske linije,

$R = r + s = 4 + 3 = 7[mm]$

R - spoljni radijus,

$k = \sigma_T = 600[N/mm^2]$

Radijalni naponi u zoni sabijanja (pritiska)

$$\sigma_{\rho_s} = -k \ln \frac{\rho}{r}$$

$\rho_1 = r = 4[mm]$ $\qquad$ $\sigma_{\rho_{s1}} = -600 \ln \frac{4}{4} = 0$

$\rho_2 = 4.5[mm]$ $\qquad$ $\sigma_{\rho_{s2}} = -600 \ln \frac{4.5}{4} = -70.66[N/mm^2]$

$\rho_3 = 5[mm]$ $\qquad$ $\sigma_{\rho_{s3}} = -600 \ln \frac{5}{4} = -133.88[N/mm^2]$

$\rho_4 = 5.29[mm]$ $\qquad$ $\sigma_{\rho_{s4}} = -600 \ln \frac{5.29}{4} = -167.71[N/mm^2]$

Radijalni naponi u zoni istezanja

$$\sigma_{\rho_i} = -k \ln \frac{R}{\rho}$$

$\rho_5 = 5.29[mm]$ $\qquad$ $\sigma_{\rho_{i5}} = -600 \ln \frac{7}{5.29} = -168.05[N/mm^2]$

$\rho_6 = 6[mm]$ $\qquad$ $\sigma_{\rho_{i6}} = -600 \ln \frac{7}{6} = -92.49[N/mm^2]$

$\rho_7 = 6.5[mm]$ $\qquad$ $\sigma_{\rho_{i7}} = -600 \ln \frac{7}{6.5} = -44.46[N/mm^2]$

$\rho_8 = 7[mm]$ $\qquad$ $\sigma_{\rho_{i8}} = -600 \ln \frac{7}{7} = 0$

Tangencijalni naponi u zoni sabijanja (pritiska)

$$\sigma_\varphi = -k(1 + \ln \frac{\rho}{r})$$

$\rho_1 = r = 4[mm]$ $\sigma_{\varphi s1} = -600(1 + \ln \frac{4}{4}) = -600[N/mm^2]$

$\rho_2 = 4.5[mm]$ $\sigma_{\varphi s2} = -600(1 + \ln \frac{4.5}{4}) = -670.67[N/mm^2]$

$\rho_3 = 5[mm]$ $\sigma_{\varphi s3} = -600(1 + \ln \frac{5}{4}) = -733.89[N/mm^2]$

$\rho_4 = 5.29[mm]$ $\sigma_{\varphi s4} = -600(1 + \ln \frac{5.29}{4}) = -767.71[N/mm^2]$

Tangencijalni naponi u zoni istezanja

$$\sigma_\varphi = k(1 - \ln \frac{R}{\rho})$$

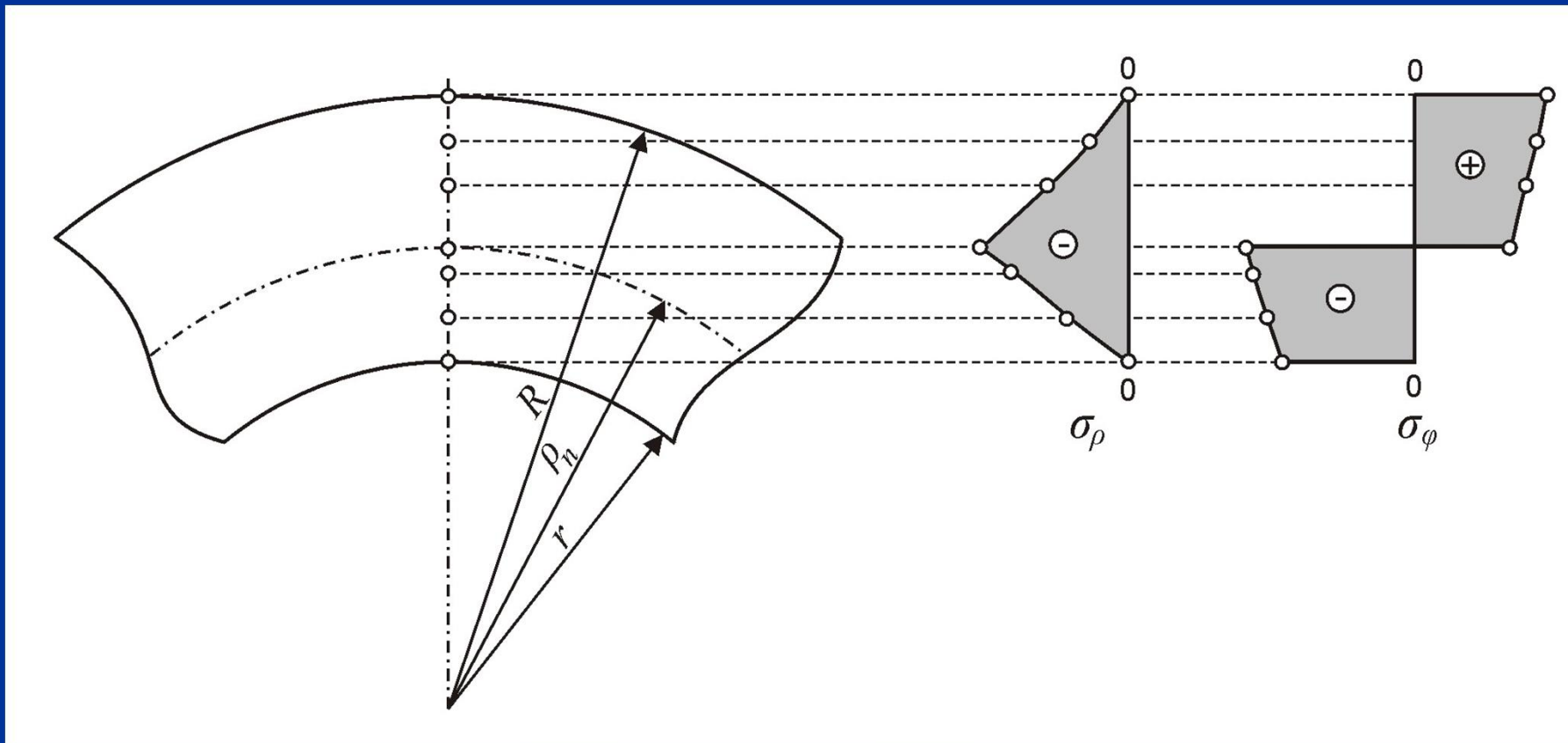$\rho_5 = 5.29[mm]$ $\sigma_{\varphi i5} = 600(1 - \ln \frac{7}{5.29}) = 431.94[N/mm^2]$

$\rho_6 = 6[mm]$ $\sigma_{\varphi i6} = 600(1 - \ln \frac{7}{6}) = 507.50[N/mm^2]$

$\rho_7 = 6.5[mm]$ $\sigma_{\varphi i7} = 600(1 - \ln \frac{7}{6.5}) = 555.53[N/mm^2]$

$\rho_8 = 7[mm]$ $\sigma_{\varphi i8} = 600(1 - \ln \frac{7}{7}) = 600[N/mm^2]$

ρ [mm]	4	4.5	5	5.29	6	6.5	7
σ_ρ [N/mm^2]	0	-70.66	-133.88	-167.71 -168.50	-92.49	-44.46	0
σ_φ [N/mm^2]	-600	-670.67	-733.89	-767.71 431.9	507.50	555.53	600

Dijagram rasporeda radijalnih i tangencionalnih napona

2. Proračun sile

$$F = \frac{(1 + \sin \alpha)b \cdot s^2}{2l} \sigma_T$$

$$l = r_1 + r_2 + s = 2r + s = 2 \cdot 4 + 3 = 11 [mm]$$

$$r_1 = r_2 = r$$

r_1 - radijus pritiskivača,

r_2 - radijus matrice,

Za $\alpha = 0^o \Rightarrow \sin \alpha = 0$, $\quad F_{min} = \frac{b \cdot s^2}{2l} \sigma_T = \frac{800 \cdot 3^2}{2 \cdot 11} 600 = 196363.36 [N] = 196.4 [kN]$

Za $\alpha = 90^o \Rightarrow \sin \alpha = 1$, $\quad F_{max} = \frac{2 \cdot b \cdot s^2}{2l} \sigma_T = \frac{800 \cdot 3^2}{11} 600 = 392727.27 [N] = 392.8 [kN]$

Ukupna deformaciona sila

$$F_s = F + F_i + F_r$$

F_i - sila izbacivača, $F_i = 0.3 \cdot F$

F_r - sila ravnjanja, $F_r = p \cdot A$

$A = (a - 2 \cdot r)b = (100 - 2 \cdot 4)800 = 73600 [mm^2]$ - površina ravnjanja,

$$F_s = 1.3 \frac{b \cdot s^2}{l} \sigma_T + p \cdot A = 1.3 \frac{800 \cdot 3^2}{11} 600 + 100 \cdot 73600 = 7870548.45 [N] = 7870.5 [kN]$$