6. Domaći zadatak - Valjanje

Za hladno valjanje trake:

- naći pritiske po zoni kontakta pretpostavljajući da postoji samo zona klizanja.

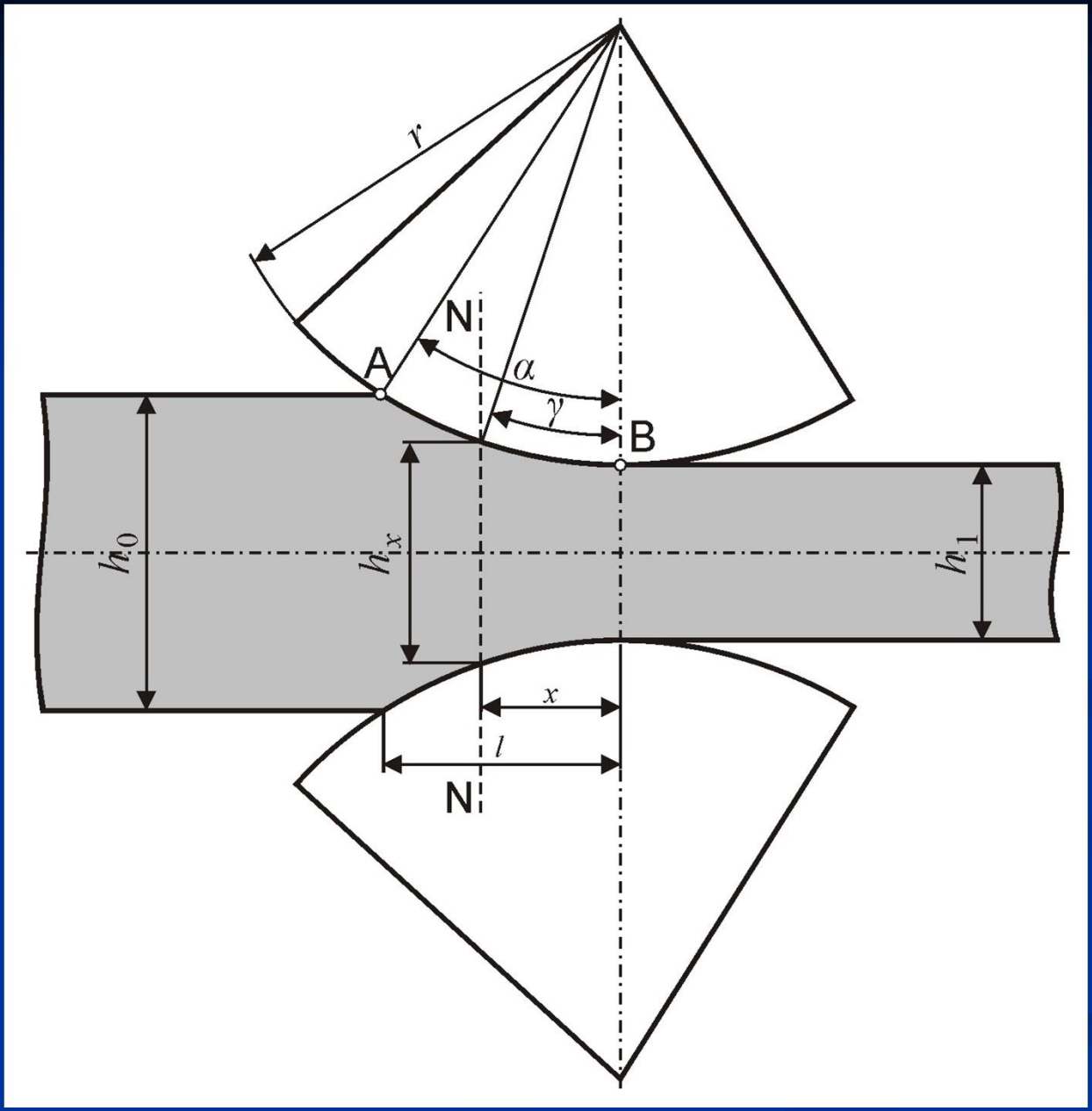
Uslovi: $h_0 = 3.6$ [mm]

$h_1 = 3$ [mm]

$b_0 = 300$ [mm]

$r = 500$ [mm]

$\mu = 0.13$



Slika 6.1.

PRORAČUN:

l - dužina kontaktne zone

$$l = \sqrt{r \cdot \Delta h} = \sqrt{500 \cdot 0.6} = 17.32[mm]$$

r - radijus valjka

Δh - visinska razlika pri ulazu i izlazu iz valjaka,

$$\Delta h = h_0 - h_1 = 3.6 - 3 = 0.6[mm]$$

α - ugao zahvata

$$\alpha = \arcsin \frac{l}{r} = \arcsin \frac{17.32}{500} = 1.98°$$

γ - neutralni ugao

$$\chi = \arcsin\left(\frac{\sin \alpha}{2} - \frac{1-\cos \alpha}{2\mu}\right)$$

$$\chi = \arcsin\left(\frac{\sin 1.98}{2} - \frac{1-\cos 1.98}{2 \cdot 0.13}\right) = 0.87°$$

Jednačina tetive kroz tačke A i B je:

$$h_x = h_1 + \frac{\Delta h}{l} \cdot x$$

$$h_x = 3 + \frac{0.6}{17.32} \cdot x = 3 + 0.034 \cdot x$$

h_n - visina u neutralnom presjeku

$$h_n = h_1 \left[\frac{1 + \sqrt{1 + (\delta^2 - 1)\left(\frac{h_0}{h_1}\right)^{\delta}}}{\delta + 1} \right]^{\frac{1}{\delta}} = 3 \left[\frac{1 + \sqrt{1 + (7.5^2 - 1)\left(\frac{3.6}{3}\right)^{7.5}}}{7.5 + 1} \right]^{\frac{1}{7.5}} = 3.25[mm]$$

δ - karakteristika klizanja

$$\delta = \frac{2 \cdot l \cdot \mu}{\Delta h} = \frac{2 \cdot 17.32 \cdot 0.13}{0.6} = 7.5$$

Na osnovu jednačine $h_x = 3 + 0.034 \cdot x$

l_1 - dužina zone preticanja, za $h_x = h_n$

$$x = l_1 = \frac{h_x - 3}{0.034} = \frac{3.25 - 3}{0.034} = 7.35[mm]$$

l_0 - dužina zone zaostajanja

$$l_0 = l - l_1 = 17.32 - 7.35 = 9.97[mm]$$

a) Proračun pritiska

Zona preticanja

$$Px = \frac{k}{\delta}\left[(\delta+1)\left(\frac{h_x}{h_1}\right)^{\delta} - 1\right] \qquad \text{odnosno} \qquad \frac{Px}{k} = \frac{1}{\delta}\left[(\delta+1)\left(\frac{h_x}{h_1}\right)^{\delta} - 1\right]$$

$$x_1 = 0 \Rightarrow h_{x_1} = 3 + 0.034x_1 = 3 \Rightarrow \frac{Px_1}{k} = \frac{1}{7.5}\left[(7.5+1)\left(\frac{3}{3}\right)^{7.5} - 1\right] = 1$$

$$x_2 = 2 \Rightarrow h_{x_2} = 3 + 0.034x_2 = 3.068 \Rightarrow \frac{Px_2}{k} = \frac{1}{7.5}\left[(7.5+1)\left(\frac{3.068}{3}\right)^{7.5} - 1\right] = 1.20$$

$$x_3 = 4 \Rightarrow h_{x_3} = 3 + 0.034x_3 = 3.136 \Rightarrow \frac{Px_3}{k} = \frac{1}{7.5}\left[(7.5+1)\left(\frac{3.136}{3}\right)^{7.5} - 1\right] = 1.45$$

$$x_4 = 6 \Rightarrow h_{x_4} = 3 + 0.034x_4 = 3.204 \Rightarrow \frac{Px_4}{k} = \frac{1}{7.5}\left[(7.5+1)\left(\frac{3.204}{3}\right)^{7.5} - 1\right] = 1.72$$

$$x_5 = 7.35 \Rightarrow h_{x_5} = 3 + 0.034x_5 = 3.249 \Rightarrow \frac{Px_5}{k} = \frac{1}{7.5}\left[(7.5+1)\left(\frac{3.249}{3}\right)^{7.5} - 1\right] = 1.93$$

Zona zaostajanja

$$Px = \frac{k}{\delta}\left[(\delta-1)\left(\frac{h_0}{h_x}\right)^{\delta}+1\right] \qquad \text{odnosno} \qquad \frac{Px}{k} = \frac{1}{\delta}\left[(\delta-1)\left(\frac{h_0}{h_x}\right)^{\delta}+1\right]$$

$$x_6 = 8 \Rightarrow h_{x_6} = 3+0.034x_6 = 3.272 \Rightarrow \frac{Px_6}{k} = \frac{1}{7.5}\left[(7.5-1)\left(\frac{3.6}{3.272}\right)^{7.5}+1\right] = 1.91$$

$$x_7 = 10 \Rightarrow h_{x_7} = 3+0.034x_7 = 3.340 \Rightarrow \frac{Px_7}{k} = \frac{1}{7.5}\left[(7.5-1)\left(\frac{3.6}{3.34}\right)^{7.5}+1\right] = 1.65$$

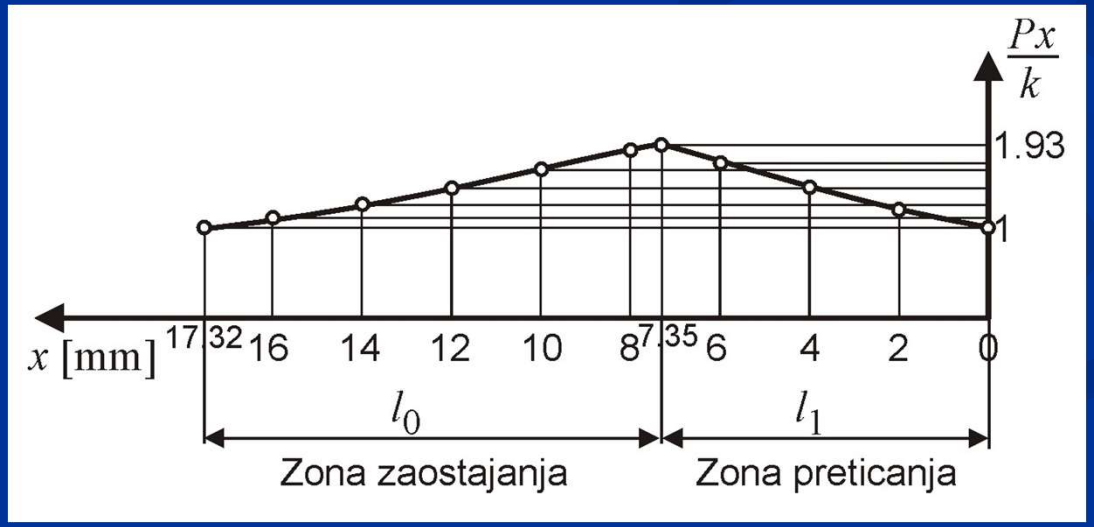
$$x_8 = 12 \Rightarrow h_{x_8} = 3+0.034x_8 = 3.408 \Rightarrow \frac{Px_8}{k} = \frac{1}{7.5}\left[(7.5-1)\left(\frac{3.6}{3.408}\right)^{7.5}+1\right] = 1.44$$

$$x_9 = 14 \Rightarrow h_{x_9} = 3+0.034x_9 = 3.476 \Rightarrow \frac{Px_9}{k} = \frac{1}{7.5}\left[(7.5-1)\left(\frac{3.6}{3.476}\right)^{7.5}+1\right] = 1.26$$

$$x_{10} = 16 \Rightarrow h_{x_{10}} = 3+0.034x_{10} = 3.544 \Rightarrow \frac{Px_{10}}{k} = \frac{1}{7.5}\left[(7.5-1)\left(\frac{3.6}{3.488}\right)^{7.5}+1\right] = 1.11$$

$$x_{11} = 17.32 \Rightarrow h_{x_{11}} = 3+0.034x_{11} = 3.59 \Rightarrow \frac{Px_{11}}{k} = \frac{1}{7.5}\left[(7.5-1)\left(\frac{3.6}{3.59}\right)^{7.5}+1\right] = 1.00$$

Nº	x [mm]	h_x [mm]	$\frac{P_x}{k}$
1.	0	3	1
2.	2	3.068	1.20
3.	4	3.136	1.45
4.	6	3.204	1.72
5.	7.35	3.249	1.93
6.	8	3.272	1.91
7.	10	3.340	1.65
8.	12	3.408	1.44
9.	14	3.476	1.26
10.	16	3.544	1.11
11.	17.32	3.600	1.00

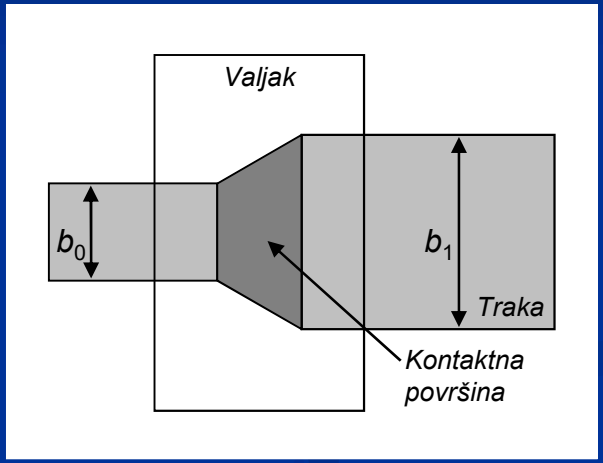


b) Proračun deformacione sile

$$F = A \cdot Psr$$

$$Psr = k\frac{2h_1}{\Delta h(\delta - 1)}\left(\frac{h_n}{h_1}\right)\left[\left(\frac{h_n}{h_1}\right)^{\delta} - 1\right] = k\frac{2 \cdot 3}{0.6(7.5 - 1)}\left(\frac{3.25}{3}\right)\left[\left(\frac{3.25}{3}\right)^{7.5} - 1\right] = 1.37k$$

Pogled na valjak odozgor:



$b_0 = 300$ [mm] - širina trake

$$\Delta b = 0.01 \cdot b_0 = 0.01 \cdot 300 = 3[mm]$$

$$b_1 = b_0 + \Delta b = 300 + 3 = 303[mm]$$

Kontaktna površina je površina trapeza:

$$A = \frac{b_0 + b_1}{2} \cdot l = \frac{300 + 303}{2} 17.32 = 5221.98[mm^2]$$

$$F = 5221.98 \cdot 1.37k = 7154.11 \cdot k$$