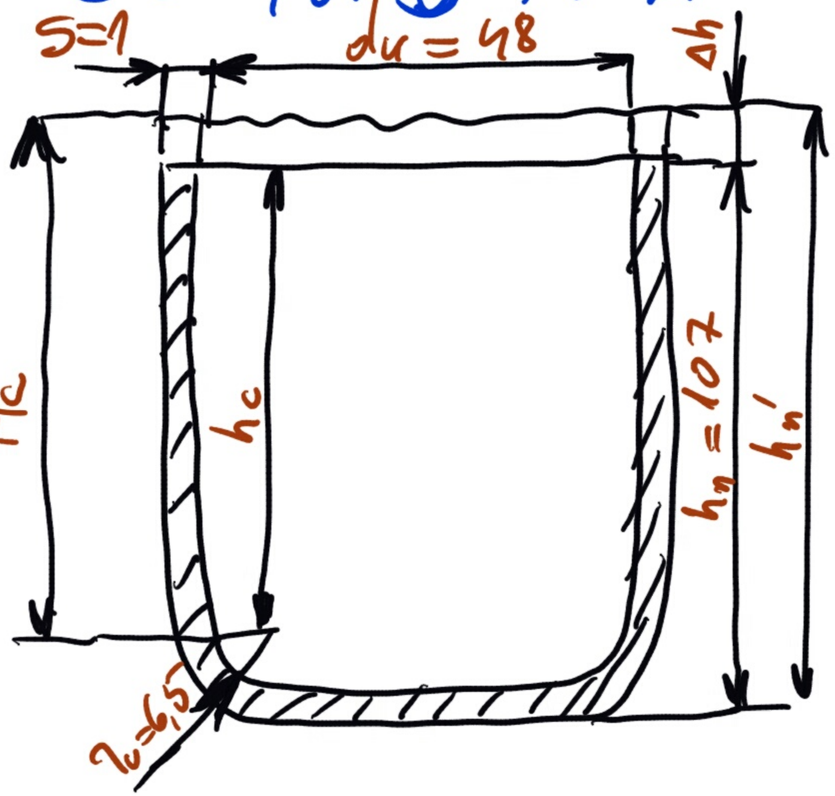
ČOL48PB ; $R_m = 324{,}6\ MPa$; $R_p = 194{,}4\ MPa$; $K = 5407\,\ell^{0{,}19}\ MPa$



a) $D_0 = \sqrt{4 \cdot d_n \cdot H_c + d_0^2 + 2\left(\pi d_d \cdot z_n + 4 z_n^2\right)}$

$s \leq 1$

$d_n = d_u + 2s$

$z_n = z_u + s$

$d_n = 48 + 2 \cdot 1 = 50\ mm$

$z_n = 6{,}5 + 1 = 7{,}5\ mm$

$s > 1$

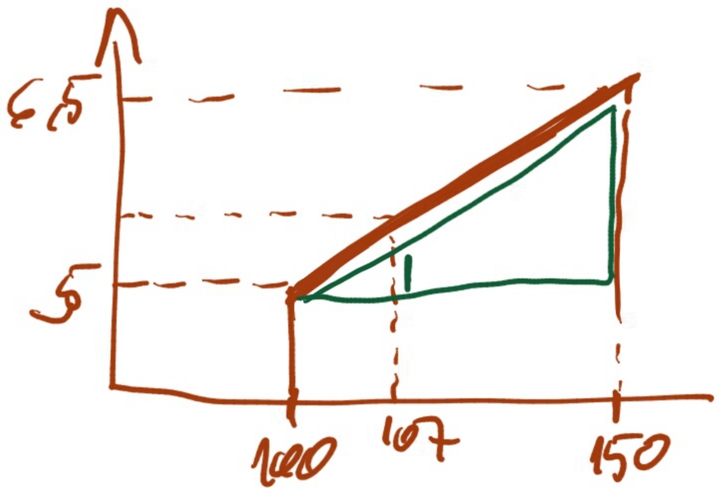
$d_n = d_u + s$

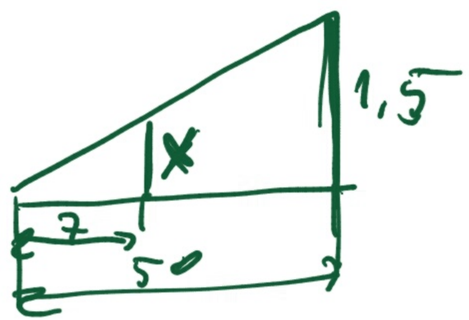
$z_n = z_u + \frac{s}{2}$

DODATAK ZA OPSECANJE $\Delta h = f\left(h_n, \frac{h_n}{d_n}\right) \rightarrow$ TABELA 6

ZA $\frac{h_n}{d_n} = \frac{107}{50} = 2{,}14$

RADI SE LINEARNA INTERPOLACIJA IZ TABELE 6





$$50 : 1,5 = 7 : x$$

$$x = \frac{7 \cdot 1,5}{50}$$

$$x = 0,21$$

$$\Delta h = 5 + 0,21 = 5,21$$

$$h_n' = h_n + \Delta h = 107 + 5,21 = 112,21 \text{ mm}$$

$$h_c = h_n - (7_n + 5) = 107 - (6,5 + 1) = 99,5 \text{ mm}$$

$$H_c = h_c + \Delta h = 99,5 + 5,21 = 104,71 \text{ mm}$$

$$d_d = d_n - 7_n = 48 - 2 \cdot 6,5 = 35 \text{ mm}$$

$$D_o = \sqrt{4 \cdot 50 \cdot 104,71 + 35^2 + 2(3,14 \cdot 35 \cdot 7,5 + 4 \cdot 7,5^2} = 155,7765 \text{ mm}$$

UZIMA SE PRV VEĆI BROJ $D_o = 156$ mm

RAZVIJENO STANJE $\phi 156 \times 1,0$

b) $F = L \cdot S \cdot \tau_{sm}$

$\tau_{sm} = 0{,}8 \cdot R_m = 0{,}8 \cdot 324{,}6 = 259{,}68 MPa$

$L = \pi \cdot D_0 = \pi \cdot 156 = 490{,}088 mm$

$F = 490{,}088 \cdot 1 \cdot 259{,}68 = 127266{,}17 N$

$F_{MAŠ} = 1{,}3 \cdot F = 1{,}3 \cdot 127266{,}17 = 165446{,}021 N \simeq 165{,}45 kN$

c) $S_r = \frac{S}{D_0} \cdot 100 = \frac{1}{156} \cdot 100 = 0{,}641\% \rightarrow m = f(S_r) \rightarrow$ TABELA BR 5 INTERPOLACIJOM

INTERPOLACIJA NA SLEDEĆEM SLAJDU

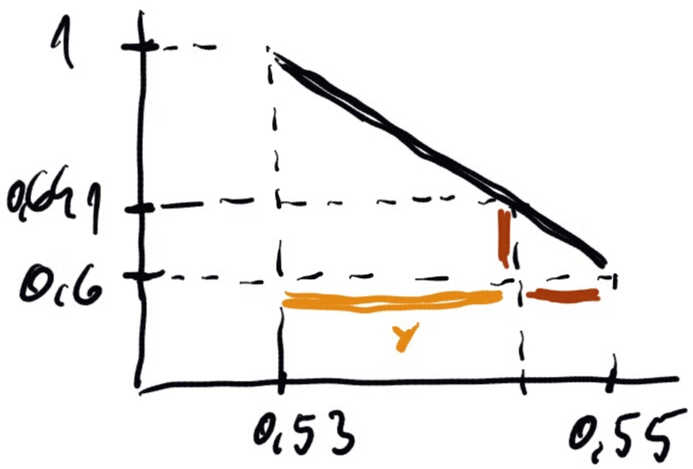
$m_1 = 0{,}54795 \rightarrow d_1 = m_1 \cdot D_0 = 0{,}548 \cdot 156 = 85{,}49 \rightarrow d_1 = 86 mm$

$m_2 = 0{,}77795 \rightarrow d_2 = m_2 \cdot d_1 = 0{,}778 \cdot 86 = 66{,}9 \rightarrow d_2 = 67 mm$

$m_3 = 0{,}80795 \rightarrow d_3 = m_3 \cdot d_2 = 0{,}808 \cdot 67 = 54{,}13 \rightarrow d_3 = 55 mm$

$m_4 = 0{,}81897 \rightarrow d_4 = m_4 \cdot d_3 = 0{,}819 \cdot 55 = 45{,}04 \rightarrow d_4 = 46 mm$

BR OPERACIJA $n = 4$



$0,4 : 0,02 = 0,041 : x$

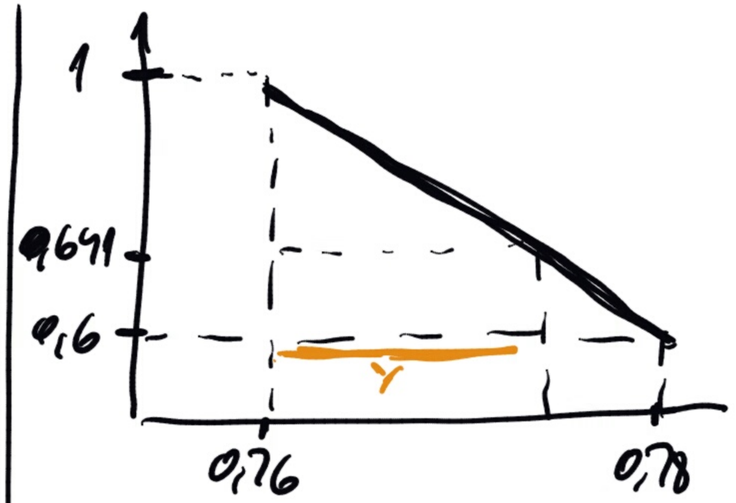
$x = 0,00205$

$y = 0,02 - 0,00205 = 0,01795$

$m_1 = 0,53 + x$

$m_1 = 0,53 + 0,01795$

$m_1 = 0,54795$



$0,4 : 0,02 = 0,041 : x$

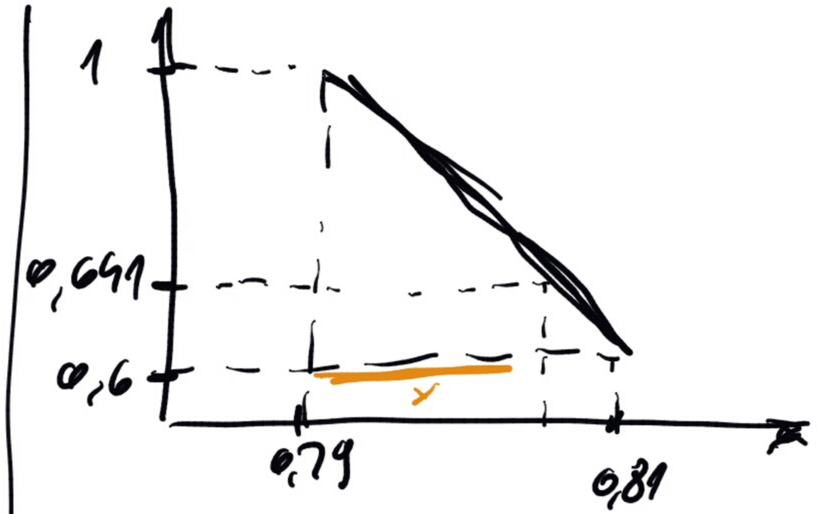
$x = 0,00205$

$y = 0,02 - 0,00205 = 0,01795$

$m_2 = 0,76 + y$

$m_2 = 0,76 + 0,01795$

$m_2 = 0,77795$



$0,4 : 0,02 = 0,041 : x$

$x = 0,00205$

$y = 0,02 - 0,00205 = 0,01795$

$m_3 = 0,79 + x$

$m_3 = 0,79 + 0,01795$

$m_3 = 0,80795$

PROVERA BROJA OPERACIJA:

$$n = 1 + \frac{\ln d_n - \ln(m_1 \cdot D_0)}{\ln \bar{m}}$$

$$\bar{m} = \frac{m_2 + m_3 + \dots + m_n}{n-1}$$

$$\bar{m} = \frac{m_2 + m_3 + m_4}{n-1} = \frac{0{,}778 + 0{,}868 + 0{,}819}{3} = 0{,}7987$$

$$n = 1 + \frac{\ln 50 - \ln(0{,}548 \cdot 156)}{\ln 0{,}7987} = 3{,}386 \rightarrow n = 4$$

RADIJUSI DNA PO OPERACIJAMA:

$r_i = \frac{d_i - d_{i+1}}{2}$ AKO JE $r_i < r_n$ USVAJA SE $r_i = r_n$

$r_1 = \frac{d_1 - d_2}{2} = \frac{86-67}{2} = 9{,}5\,mm$

$r_2 = \frac{d_2 - d_3}{2} = \frac{67-54}{2} = 6{,}5\,mm < 7{,}5\,mm$

USVAJA SE $r_2 = r_3 = r_4 = 7{,}5\,mm$

VISINE KOMADA PO OPERACIJAMA

$h_i = 0{,}25\left(\frac{D_0^2}{d_i} - d_i\right) + 0{,}43\frac{r_i}{d_i}\left(d_i + 0{,}32 \cdot r_i\right)$

$h_1 = 0{,}25\left(\frac{D_0^2}{d_1} - d_1\right) + 0{,}43\frac{r_1}{d_1}\left(d_1 + 0{,}32 \cdot r_1\right)$

$$h_1 = 0{,}25\left(\frac{156^2}{86} - 86\right) + 0{,}43\,\frac{9{,}5}{86}\left(86 + 0{,}32 \cdot 9{,}5\right) = 53{,}27 \text{ mm}$$

$$h_2 = 0{,}25\left(\frac{156^2}{67} - 67\right) + 0{,}43\,\frac{7{,}5}{67}\left(67 + 0{,}32 \cdot 7{,}5\right) = 77{,}14 \text{ mm}$$

$$h_3 = 0{,}25\left(\frac{156^2}{54} - 54\right) + 0{,}43\,\frac{7{,}5}{54}\left(54 + 0{,}32 \cdot 7{,}5\right) = 102{,}21 \text{ mm}$$

$$h_4 = 0{,}25\left(\frac{156^2}{50} - 50\right) + 0{,}43\,\frac{7{,}5}{50}\left(50 + 0{,}32 \cdot 7{,}5\right) = 112{,}56 \text{ mm}$$

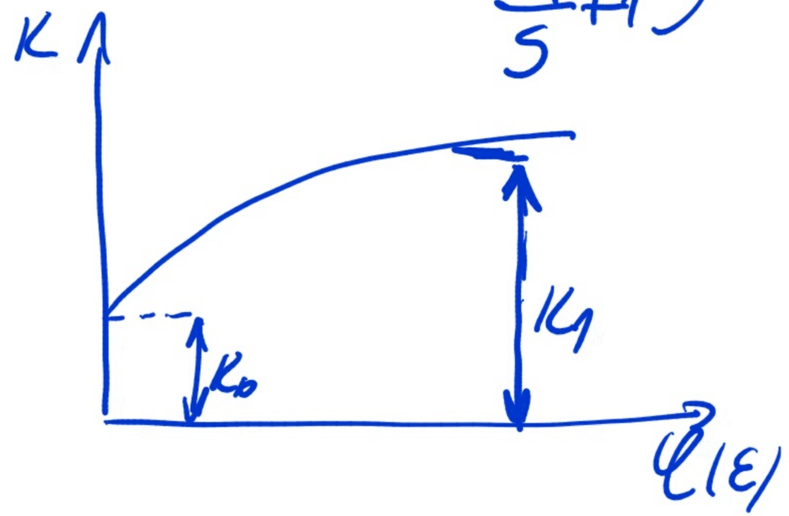
TREBA DA JE ISPUNJEN USLOV $h_{n} > h_{n'}$

$h_4 > h_3$ $\quad 112{,}56 > 112{,}21$ mm

d) $F_1 = d_1 \pi \cdot S \left\{ \left[C_{1,1} \cdot \bar{K} \cdot \ln \frac{D_0}{d_1} + \frac{2 f F_0}{d_1 \cdot \pi \cdot S} \right] e^{f\alpha} + \frac{R_m}{\frac{2 z_1}{5} + 1} \right\}$

$d_1 = 86$ mm

$\ell_1 = \ln \frac{D_0}{d_1} = \ln \frac{156}{86} = 0{,}5955$



$K_0 = R_p = 194{,}4$ MPa

$K_1 = 5497 \cdot \ell_1^{0,19} = 540{,}7 \cdot 0{,}5955^{0,19} = 490$ MPa

$\bar{K} = \frac{K_0 + K_1}{2} = \frac{194{,}4 + 490}{2} = 342{,}2$ MPa

$f = 0{,}1 - 0{,}15 \rightarrow \boxed{f = 0{,}1}$

- ZA $S_R = 2 - 1\ \%$ $\Rightarrow T_m = (6-8) \cdot S$
- ZA $S_R = 1 - 0{,}3\ \%$ $\Rightarrow T_m = (8-10) \cdot S$
- ZA $S_R = 0{,}3 - 0{,}1\ \%$ $\Rightarrow T_m = (10-15) S$

ZA $S_R = 0{,}641 \Rightarrow T_m = (8-10) S$ $\quad T_m = 9 \cdot S = 9 \cdot 1 = 9\ mm$

SPECIFIČNI PRITISAK OREZAČA: $q = (2 \div 2{,}5) \frac{N}{mm^2} \rightarrow \boxed{q = 2{,}5\ MPa}$

↓ TABELA 4

SILA OREZANJA:

$F_O = q \cdot A_O$; $A_d = \frac{\pi D_o^2 - d_1^2}{4} = \pi \frac{156^2 - 86^2}{4} = 13304{,}6\ mm^2$

$F_O = 2{,}5 \cdot 13304{,}6 = 33261{,}6\ N$

$$F_1 = 86\pi \cdot 1 \left\{ [1,1 \cdot 342,2 \cdot \ln \frac{156}{86} + \frac{2 \cdot 0,1 \cdot 33261,6}{86\pi \cdot 1}] e^{0,1\frac{\pi}{2}} + \frac{3246}{2 \cdot \frac{9}{1} + 1} \right\} =$$

$$= 83262,9\ N \quad \approx 83,3\ kN$$

$$F_{1max} = 1,3 \cdot F_1 = 1,3 \cdot 83262,9 = 108241,8\ N \approx 108,2\ kN$$

DEFORMACIONI RAD:

$$W_1 = \chi \cdot F_1 \cdot h_1$$

FAKTOR SREDNJE SILE $\chi = f(m_1)$

m_1	0,5	0,55	0,6	0,65	0,7	0,75	0,8
χ	0,83	0,8	0,77	0,74	0,7	0,67	0,64

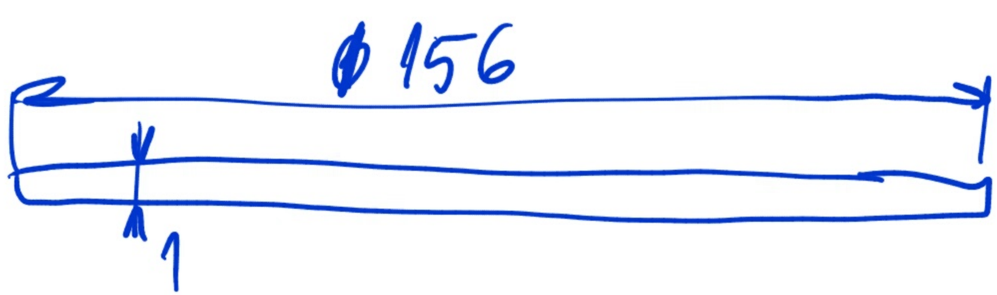
ZA $m_1 = 0,548$

$\chi = 0,8012$ → INTERPOLACIJOM

$W_1 = 0{,}8 \cdot 83262{,}9 \cdot 53{,}27 = 3544990{,}65\,Nmm \approx 3{,}5\,kJ$

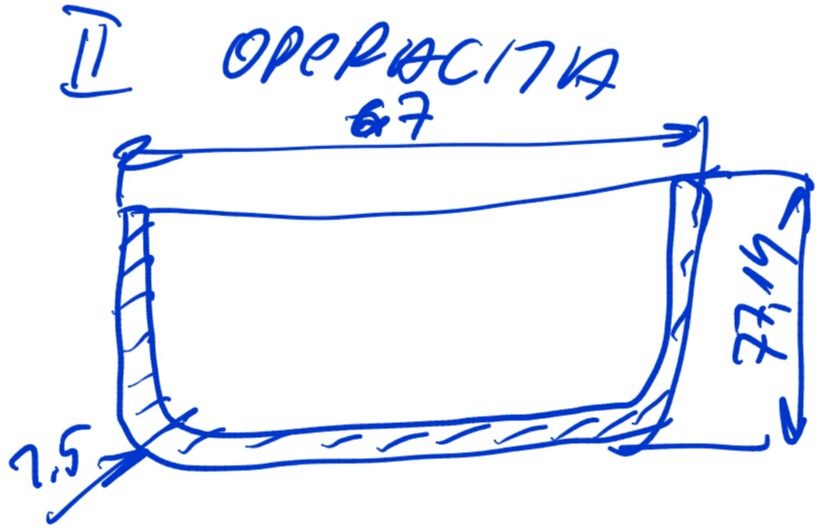
$W_{1maš} = \alpha \cdot F_{1maš} \cdot h_1 = 0{,}8 \cdot 108218\,N \cdot 53{,}27 = 4608572\,Nmm \approx 4{,}6kJ$

e) RAZVRTNO STANJE



I OPERACIJA : Ø86

II OPERACIJA



III OPERACIJA . . . .

IV OPERACIJA . . . .