

SOL. L.:

LETNIK:

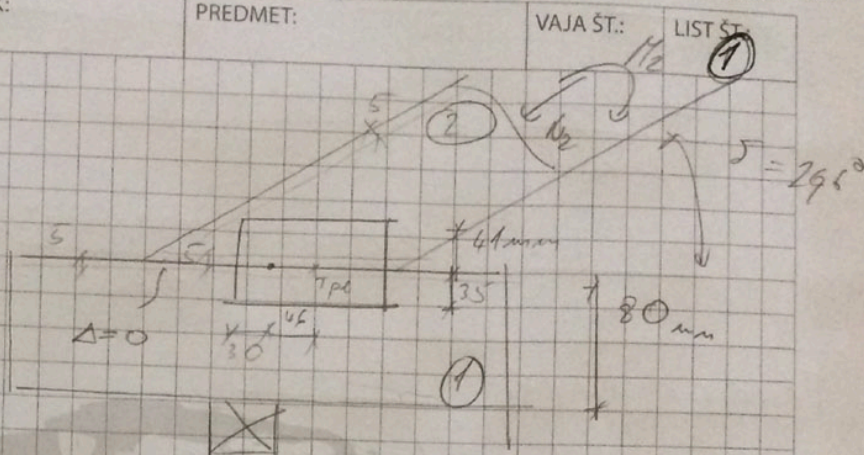
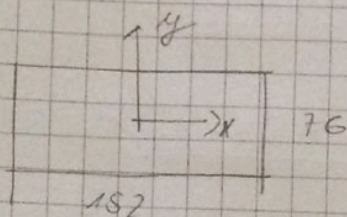
IME IN PRIIMEK:

PREDMET:

VAJA ŠT.:

LIST ŠT. 1

1. NALOGA



$$b_1/b_2 = 80/80 \text{ mm}$$

$$b_2/b_2 = 80/100 \text{ mm}$$

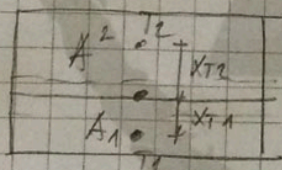
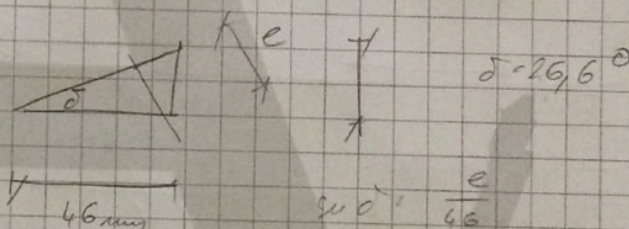
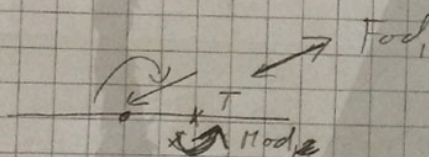
$$N_{2,ed} = 10 \text{ kN}$$

$$H_{2,ed} = 35 \text{ kN/cm}$$

→ Obremenitve na ploščo in keramični plošč

$$F_{ed} = \frac{N_{ed}}{2} = 5 \text{ kN}$$

$$M_{ed} = \frac{H_{ed}}{2} = e \cdot \frac{N_{ed}}{2} = 7,2 \text{ kNcm}$$



$$e = 20,6 \text{ mm}$$

$$A_{eff,1} = 15,2 \text{ cm} \cdot (3,5 - 0,5) \text{ cm} = 45,6 \text{ cm}^2$$

$$A_{eff,2} = 15,2 \text{ cm} \cdot (4,1 - 0,5) \text{ cm} = 54,72 \text{ cm}^2$$

$$x_{T,2} = 0; y_{T,2} = 2,3 \text{ cm}; x_{T,1} = 0; y_{T,1} = -2,0 \text{ cm}$$

$$y_{T,2} = 0,5 + (4,1 - 0,5) \cdot \frac{1}{2}$$

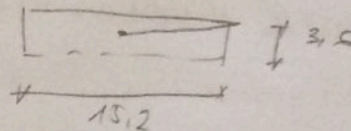
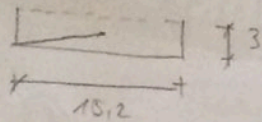
$$y_{T,1} = -0,5 - \frac{3,5 - 0,5}{2}$$

$$I_{x1} = \frac{15,2 \cdot 3^3}{12} = 34,2 \text{ cm}^4; I_{y1} = \frac{15,2^3 \cdot 3}{12} = 877,95 \text{ cm}^4$$

$$I_{x2} = \frac{15,2 \cdot 3,6^3}{12} = 54,4 \text{ cm}^4; I_{y2} = \frac{15,2^3 \cdot 3,6}{12} = 1053,54 \text{ cm}^4$$

$$r_{max,1} = \sqrt{\left(\frac{2,9}{2}\right)^2 + \left(\frac{15,2}{2}\right)^2} = \underline{7,75 \text{ cm}}$$

$$r_{2,ut} = \sqrt{\left(\frac{2,9}{2}\right)^2 + \left(\frac{15,2}{2}\right)^2} = \underline{7,81 \text{ cm}}$$



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$$W_{y1} = \frac{I_{x1} + I_{y1}}{r_{max,1}} = \frac{34,2 \text{ cm}^4 + 877,75 \text{ cm}^4}{7,75 \text{ cm}} = \underline{117,7 \text{ cm}^3}$$

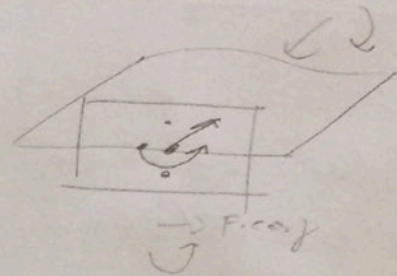
$$W_{y2} = \frac{I_{x2} + I_{y2}}{r_{2,ut}} = \frac{39,1 \text{ cm}^4 + 1053,54 \text{ cm}^4}{7,81 \text{ cm}} = \underline{142,46 \text{ cm}^3}$$

$$F_{A,od,1} = F_{A,od,2} = \underline{5 \text{ kN}}$$

$$M_{A,od,1} = M_{od} - F_{od} \cdot \cos \delta \cdot e_1$$

$$M_{A,od,1} = 7,2 - 5 \cdot \cos(26,6) \cdot \left(9,5 + \frac{3}{2}\right) =$$

$$M_{A,od,1} = \underline{-1,74 \text{ kNcm}}$$



$$M_{A,od,2} = M_{od} + F_{od} \cdot \cos \delta \cdot e_2$$

$$= 7,2 + 5 \cdot \cos(26,6) \cdot \left(10,5 + \frac{3,6}{2}\right) =$$

$$M_{A,od,2} = \underline{17,48 \text{ kNcm}}$$

①		②	
5 kN	$F_{A,od}$	5 kN	
-1,74 kNcm	$M_{A,od}$	17,48 kNcm	
45,6 cm ²	A_{ef}	54,72 cm ²	
117,7 cm ³	W_p	142,46 cm ³	
0,127 (0,1516) $\alpha = 26,6$	$A_{\alpha, \alpha/3, d}$	$\alpha = 26,6$	0,138 (0,1722)
0,185 $\beta = 26,6$	$A_{\alpha, 0, d}$	$\beta = 0$	0,185
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$$A_{\alpha, 0, d} = A_{\alpha, 0, d} \cdot \frac{A_{\alpha, 0, d}}{f_{\alpha}} = 10 \cdot \frac{0,231}{1,13} = \underline{0,185 \text{ kN/cm}^2}$$

$$A_{\alpha, \alpha/3, d} = \max \left\{ \begin{aligned} &A_{\alpha, \alpha/3, d} - (A_{\alpha, \alpha/3, d} - A_{\alpha, 0, d}) \cdot \frac{1}{45} \\ &A_{\alpha, 0, d} - (A_{\alpha, 0, d} - A_{\alpha, \alpha/3, d}) \cdot \sin[\arctan(\alpha, 3)] \end{aligned} \right.$$

ŠOL. L.: LETNIK: IME IN PRIIMEK: PREDMET: VAJA ŠT.: LIST ŠT.: 2

$$\sigma_{0,0,0,2} = 2,31 \text{ N/mm}^2$$

$$\sigma_{0,90,0,2} = 1,3 \text{ N/mm}^2$$

$$\epsilon_1 = -0,00221 \frac{\text{N}}{\text{mm}^2}, \epsilon_2 = 0,0031 \frac{\text{N}}{\text{mm}^2}; \alpha = 38^\circ$$

$$\sigma_{\alpha,0,0,2} = \sigma_{0,0,0,2} + \epsilon_1 \cdot \alpha$$

$$= 2,31 + (-0,00221) \cdot 26,6 = 1,722 \text{ N/mm}^2$$

$$\sigma_{\alpha,15,2} = \text{med} \begin{cases} 1,722 - (1,722 - 1,3) \cdot \frac{26,6}{45} = 1,473 \\ 2,31 - (2,31 - 1,3) \cdot \sin(26,6) = 1,858 \end{cases}$$

NE STIMA

$$\sigma_{\alpha,15,2} = \left(\frac{(1,81 - 1,52) \cdot (26,6 - 15)}{130 - 15} \right) + 1,81 = 1,586 \text{ N/mm}^2$$

INTERPOLIRAM

KONTROLA

$$\sigma_{0,0,0,d}$$

$$\textcircled{1} \left(\frac{F_{A,od,1}}{A_{d,1} \cdot \sigma_{\alpha,15,2,d}} \right)^2 + \left(\frac{M_{od,1}}{W_{p,1} \cdot \sigma_{0,0,0,d}} \right)^2 =$$

$$\left(\frac{5}{45,6 \cdot 0,127} \right)^2 + \left(\frac{-1,74}{117,7 \cdot 0,185} \right)^2 = 0,752 \leq 1 \quad \checkmark$$

$$\textcircled{2} \left(\frac{5}{36,72 \cdot 0,138} \right)^2 + \left(\frac{11,48}{142,46 \cdot 0,165} \right)^2 = 0,878 \leq 1 \quad \checkmark$$

$$l = 15,2 \text{ cm}$$

$$F_{x,od} = F_{od} \cdot \cos \alpha = 5 \cdot 0,894 = 4,47 \text{ kN}$$

$$F_{y,od} = F_{od} \cdot \sin \alpha + 2 \cdot \frac{M_{od,2}}{l} = 5 \cdot \sin(26,6) + \frac{7,2 - 4}{15,2} = 4,12 \text{ kN}$$

$$F_{x, Rb} = \max \left\{ \begin{array}{l} |f_{n,0,b} \cdot l \cdot \sin(\gamma - \gamma_0 \cdot \sin 2\gamma)| = 0 \\ |f_{v,0,b} \cdot l \cdot \cos \gamma| = 0,106 \cdot 15,2 = \boxed{1,6112 \text{ kN}} \end{array} \right.$$

$$f_{n,0,b} = \begin{cases} f_{t,0,b} & ; F_{x,od} > 0 \\ f_{c,0,b} & ; F_{x,od} < 0 \end{cases}$$

$$F_{x,rd} = \frac{1,61}{1,25} = \underline{\underline{1,29 \text{ kN}}}$$

$$f_{v,0,b} = 0,106 \text{ kN/cm}^2$$

$$F_{y, Rb} = \max \left\{ \begin{array}{l} |f_{n,90,b} \cdot \overset{13,2}{l} \cdot \overset{1}{\cos \gamma}| = 0,151 \cdot 15,2 = \underline{\underline{2,295 \text{ kN}}} \\ \underset{1}{l} \cdot \underset{0}{f_{v,90,b}} \cdot \sin \gamma \cdot l = 0 \end{array} \right.$$

$$F_{y,rd} = \frac{2,3}{1,25} = \underline{\underline{1,84 \text{ kN}}}$$

$$f_{n,90,b} = \begin{cases} f_{t,90,b} & F_{y,od} > 0 \\ f_{c,90,b} & F_{y,od} < 0 \end{cases} = \underline{\underline{0,151 \text{ kN/cm}^2}}$$

$$\left(\frac{F_{x,od}}{F_{x,rd}} \right)^2 + \left(\frac{F_{y,od}}{F_{y,rd}} \right)^2 = \left(\frac{4,47}{1,29} \right)^2 + \left(\frac{4,13}{1,84} \right)^2 = \underline{\underline{0,17 \leq 1}}$$

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$q = ?$

MSN, MSU zamenjamo

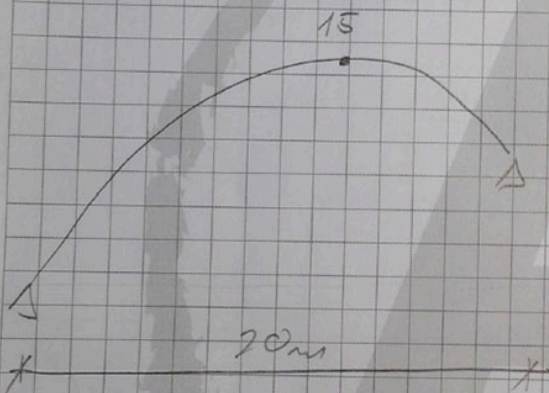
breed "H" = 0,8

$z(x) = ax^3 + bx^2 + cx$

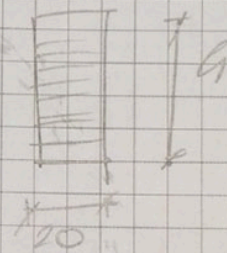
$a = -0,002$; $b = -0,04906$; $c = 1,210332$

$b = 23,68 \text{ m}$

$\frac{1}{r} = \frac{z'''}{(1+(z')^2)^{3/2}}$



$\times 4,14$
 $\times 2,92$



$z' = 3ax^2 + 2bx + c$; $z'' = 6ax + 2b$

$z' = 3 \cdot (-0,0002)x^2 + 2 \cdot (-0,04906) \cdot x + 1,210332$

$z'' = 6 \cdot (-0,0002) \cdot x + 2 \cdot (-0,04906)$

$M_{min} = -83,4 \text{ kNm}$; $V_{paip} = -25 \text{ kN}$; $N_{paip} = -148,6 \text{ kN}$

$M_{max} = 89,7 \text{ kNm}$; $V_{paip} = -0,7 \text{ kN}$; $N_{paip} = -157,3 \text{ kN}$

Ventrikular upogibna napetost:

$\sigma_{m,d} = \sigma_k \cdot \frac{M_{ap,d}}{\frac{1}{6} b h_{ap}^2} \leq \sigma_{cr} \cdot I_{m,d}$

$\sigma_{ap} = \phi$

$\sigma_{cr} = \sigma_1 + \sigma_2 \cdot \left(\frac{h_{ap}}{x}\right)^2 + \sigma_3 \cdot \left(\frac{h_{ap}}{x}\right)^2 + \sigma_4 \cdot \left(\frac{h_{ap}}{x}\right)^3$

$$r_7 = ?$$

$$r_{18} = ?$$

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$$\frac{H_{ap,d}}{\frac{b \cdot h_{ap}^2}{6}} \leq \frac{H_{ap,d}}{b \cdot b_{brov} \cdot h_{m,d}} \rightarrow h_{ap} \geq \sqrt{\frac{6 \cdot H_{ap,d}}{b \cdot b_{brov} \cdot h_{m,d}}}$$

Kontrola tlač 7

$$h_{ap} \geq \sqrt{\frac{6 \cdot 8770}{20 \cdot 0,8 \cdot \frac{2,8}{1,25}}} = 38,3$$

preto $h_{ap} = 50 \text{ cm}$

$$b_l = ?$$

$$x_2 = 4,38 \text{ m}$$

$$\frac{1}{r_7} = \frac{-12 \cdot 10^{-3} \cdot x_2^2 - 0,09812}{\sqrt{\left(1 + \left(-6 \cdot 10^{-4} \cdot x_2^2 - 0,09812 \cdot x_2 + 1,210331\right)^2\right)^{3/2}}}$$

$$\frac{1}{r_7} = -0,05149 \rightarrow \underline{x_2 = 19,42 \text{ m}}$$

$$x_{18} = 14,95 \text{ m}$$

$$\frac{1}{r_{18}} = \frac{-12 \cdot 10^{-3} \cdot 14,95^2 - 0,09812}{\sqrt{\left(1 + \left(-6 \cdot 10^{-4} \cdot 14,95^2 - 0,09812 \cdot 14,95 + 1,210331\right)^2\right)^{3/2}}}$$

$$\frac{1}{r_{18}} = -0,0938 \rightarrow \underline{x_{18} = 10,66 \text{ m}}$$

$$r_{1m} = r - 0,25 \text{ m} \rightarrow r_{1m}^7 = 19,17 \text{ m}$$

$$r_{1m}^{18} = 10,41 \text{ m}$$

$$b_{el} = b_1 + b_2 \left(\frac{h_{ap}}{r}\right) + b_3 \left(\frac{h_{ap}}{r}\right)^2 + b_4 \left(\frac{h_{ap}}{r}\right)^3$$

$$b_1 = 1$$

$$b_2 = 0,35$$

$$b_3 = 0,6$$

$$b_4 = 0$$

$$b_{el}^{(7)} = 1 + 0,35 \cdot \left(\frac{0,5}{19,42}\right) + 0,6 \cdot \left(\frac{0,5}{19,42}\right)^2 = \underline{\underline{1,0094}}$$

$$b_{el}^{(18)} = \underline{\underline{1,018}}$$

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$$b_r = \begin{cases} 1 & \text{if } \frac{v_{lim}}{t} \geq 240 \\ 0,76 + 0,001 \frac{v_{lim}}{t} & \text{if } \frac{v_{lim}}{t} < 240 \end{cases}$$

Tablica limita 4cm

$$\frac{v_{lim}}{t} = \frac{19,12}{0,04} = 480 > 240 \rightarrow b_r = 1$$

$$\frac{v_{lim}}{t} = \frac{10,41}{0,04} = 260,3 > 240 \rightarrow b_r = 1$$

$$\left(\frac{N_{ed}}{A \cdot f_{cd,d}} \right)^2 + \frac{k_{ed} \cdot M_{ed}}{W \cdot b_r \cdot f_{td,d}} \leq 1$$

$$\left(\frac{157,3}{2050 \cdot 1,696} \right)^2 + \frac{10074 \cdot 2560}{\frac{2050^3}{6} \cdot 1 \cdot 1,792} = 0,601 \leq 1$$

$$f_{cd,d} = \frac{2,65}{1,25} \cdot 0,8 = 1,696 \text{ MPa}$$

$$f_{td,d} = 0,8 \cdot \frac{2,8}{1,25} = 1,792 \text{ kN/cm}^2$$

→ Najbolj + na voljo + zlog

$$\frac{\sigma_d}{f_{td,d}} + \frac{b_{dis} \cdot b_{vol} \cdot f_{cd,d}}{b_{dis} \cdot b_{vol} \cdot f_{cd,d}} \leq 1$$

$$b_{td,d} = 0,8 \cdot \frac{0,32}{1,25} = 0,2048 \text{ kN/cm}^2$$

$$b_{dis} = 1,4$$

$$b_{vol} = \left(\frac{0,01}{\frac{2}{3} \cdot 0,1 \cdot 0,5 \cdot 23,65} \right)^{0,12} = 0,363$$

$$f_{td,d} = 0,8 \cdot \frac{0,045}{1,25} = 0,0288 \text{ kN/cm}^2$$

100m ⑦

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$$b_p = 0,25 \cdot \left(\frac{0,5}{17,42} \right) = 6,44 \cdot 10^{-3}$$

$$U_{t,90,d} = 6,44 \cdot 10^{-3} \cdot \frac{8770}{\frac{20 \cdot 50}{6}} = 6,777 \cdot 10^{-3}$$

$$\chi_d = \frac{+V_{od}}{\frac{4}{9} \cdot b \cdot h_{ay}} = \frac{-0,7}{\frac{4}{9} \cdot 20 \cdot 50} = -1,05 \cdot 10^{-3}$$

$$\frac{-1,05 \cdot 10^{-3}}{0,2048} + \frac{6,777 \cdot 10^{-3}}{114 \cdot 0,35 \cdot 0,0288} = 0,458$$

Merodajni je točka ⑦, kjer je tudi $0,458 \leq 1$