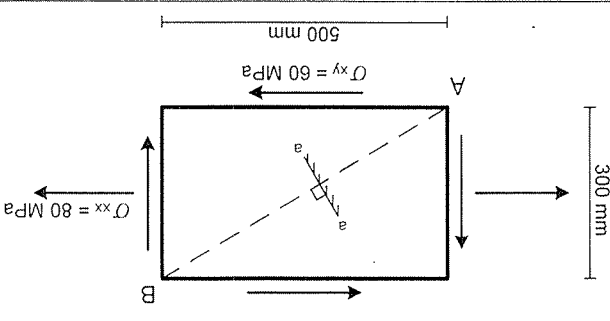
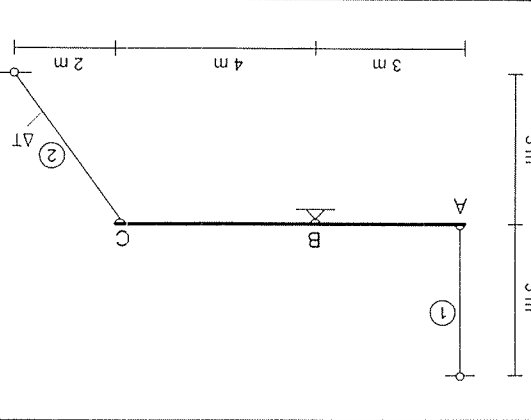
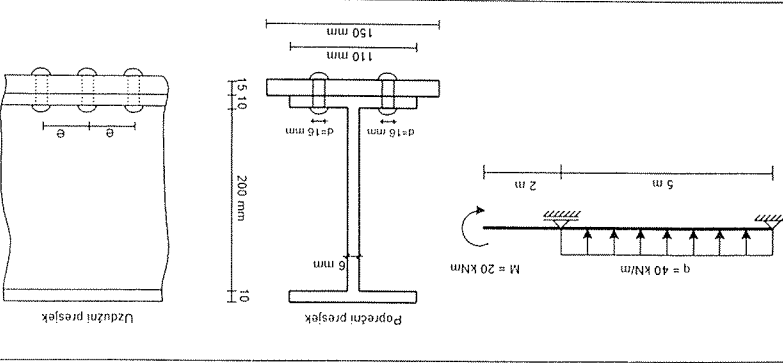
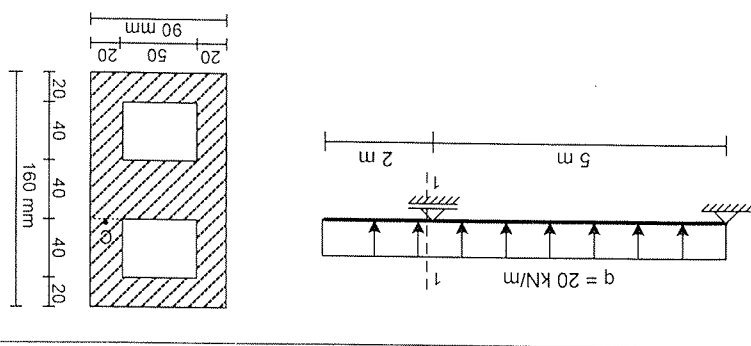
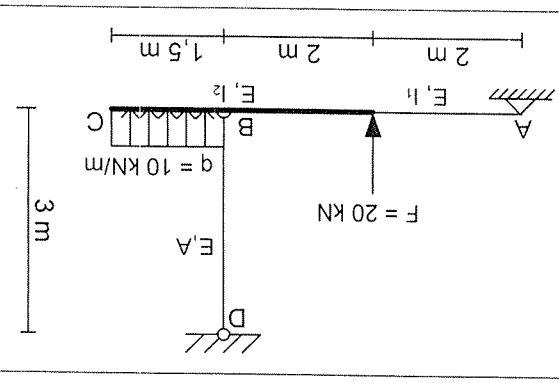
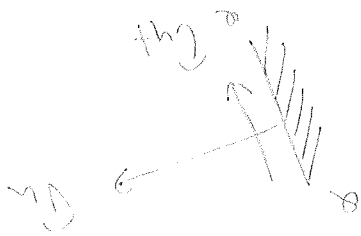


<p>1. Za element na slici treba odrediti promjenu dužine dijagonale AB. Odrediti vektor punog naprezanja u ravni a - a.</p> <p>$\sigma_{xx} = 80 \text{ MPa}$ $\sigma_{xy} = -60 \text{ MPa}$ $E = 2 \cdot 10^5 \text{ MPa}$ $\nu = 0.3$</p> 	<p>2. Apolutno kruta greda ABC zglobno je pričvršćena u točki B i pridržana s dva štapa u točkama A i C. Treba odrediti naprezanja u štapovima 1 i 2 ako se temperatura štapa 2 promijeni za $\Delta T = +40 \text{ K}$.</p> <p>$A_1 = 400 \text{ mm}^2$ $A_2 = 300 \text{ mm}^2$ $E = 2 \cdot 10^5 \text{ MPa}$ $\alpha_T = 1.5 \cdot 10^{-5} \text{ 1/K}$</p> 	<p>3. Za sastavljeni nosač na slici treba odrediti potreban razmak spojnih sredstava.</p> <p>$\sigma_{o,op} = 200 \text{ MPa}$ $\tau_{dop} = 100 \text{ MPa}$</p> 	<p>4. Za nosač na slici odredite:</p> <p>a) Maksimalno normalno i posmično naprezanje u kritičnim presjecima! nacrtajte odgovarajuće dijagrame naprezanja</p> <p>b) Inose i smjerove naprezanja u točki C presjeka 1 - 1</p> 	<p>5. Za nosač na slici grafoanalitičkim postupkom odrediti progib u točki C i kut zaokreta u točki A.</p> <p>$E = 2 \cdot 10^5 \text{ MPa}$ $I_1 = 10 \cdot 10^7 \text{ mm}^4$ $I_2 = 20 \cdot 10^7 \text{ mm}^4$ $A = 300 \text{ mm}^2$</p> 
---	---	---	--	--



$$\sigma_n = \sqrt{\sigma_y^2 + \tau_{xy}^2} = 63.8 \text{ MPa}$$

$$\tau_{nt} = \frac{\sigma_x - \sigma_y}{2} \sin 2\psi + \tau_{xy} \cos 2\psi = -63.53 \text{ MPa}$$

$$\sigma_n = \sigma_x \cos^2 \psi + \sigma_y \sin^2 \psi + \tau_{xy} \sin 2\psi = 5.88 \text{ MPa}$$

$$\epsilon_{AB} = \frac{\Delta d}{d} \rightarrow \Delta d = \epsilon_{AB} \cdot d = -0.048 \text{ mm}$$

$$\epsilon_{AB} = \epsilon_{xx} \cdot \cos^2 \psi + \epsilon_{yy} \sin^2 \psi + \gamma_{xy} \sin 2\psi = -8.172 \cdot 10^{-4}$$

$$\epsilon_{xy} = \frac{1+\nu}{E} \tau_{xy} = \frac{1+0.3}{2 \cdot 10^5} (-60) = -3.9 \cdot 10^{-4}$$

$$\epsilon_{yy} = \frac{1}{E} [-\nu \sigma_{xx}] = -1.2 \cdot 10^{-4}$$

$$\epsilon_{xx} = \frac{\sigma_{xx}}{E} = 4 \cdot 10^{-4}$$

$$d = 583.1 \text{ mm}$$

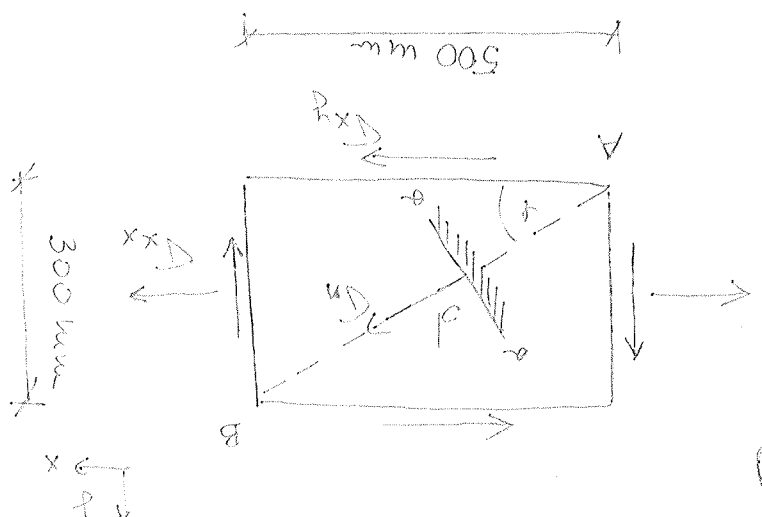
$$\psi = 30.564^\circ$$

$$\nu = 0.3$$

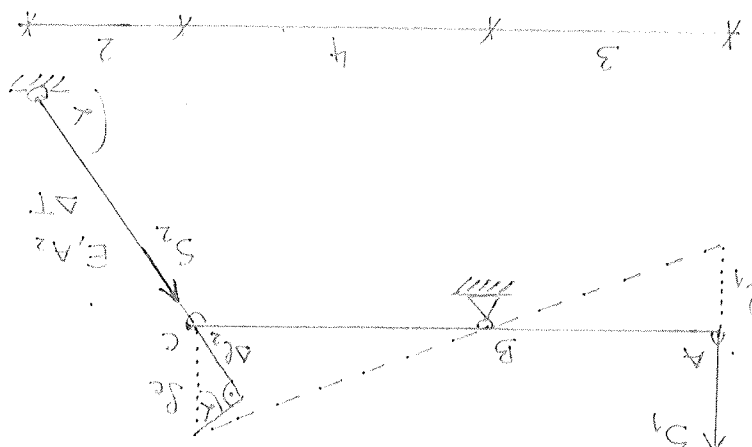
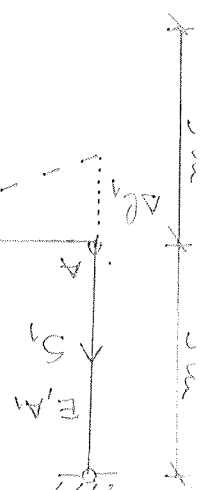
$$E = 2 \cdot 10^5 \text{ MPa}$$

$$\sigma_{xy} = -60 \text{ MPa}$$

$$\sigma_{xx} = 80 \text{ MPa}$$



①



$$\Delta l_1 = \frac{S_1 l_1}{E \cdot A_1}$$

$$\Delta l_2 = \frac{-S_2 \cdot l_2}{E \cdot A_2} + \alpha \cdot \Delta T \cdot l_2$$

$$\delta_{ux} = \frac{\Delta l_2}{\delta_c}$$

[U.D.]

$$\frac{\Delta l_1}{\delta_c} = \frac{3}{4} = \frac{\delta_c}{\Delta l_2}$$

$$\frac{S_1 l_1}{3 E \cdot A_1} = \frac{1}{4} \left(-\frac{S_2 l_2}{E \cdot A_2} + \alpha \cdot \Delta T \cdot l_2 \right)$$

$$S_1 = \frac{3 \cdot E \cdot A_1}{4 l_1 \delta_{ux}} \left(-\frac{S_2 l_2}{E A_2} + \alpha \Delta T \cdot l_2 \right) = -\frac{3}{4} \frac{A_1 l_2}{A_2 l_1} S_2 + \frac{3 E A_1 l_2}{4 \delta_{ux} l_1} \alpha \cdot \Delta T$$

$$S_2 = 20'36 \text{ kN (TRAK)}$$

$$S_1 = 22'59 \text{ kN (VLAK)}$$

$$F_1 = \frac{S_1}{A_1} = 56'48 \text{ MPa}$$

$$F_2 = \frac{S_2}{A_2} = -67'87 \text{ MPa}$$

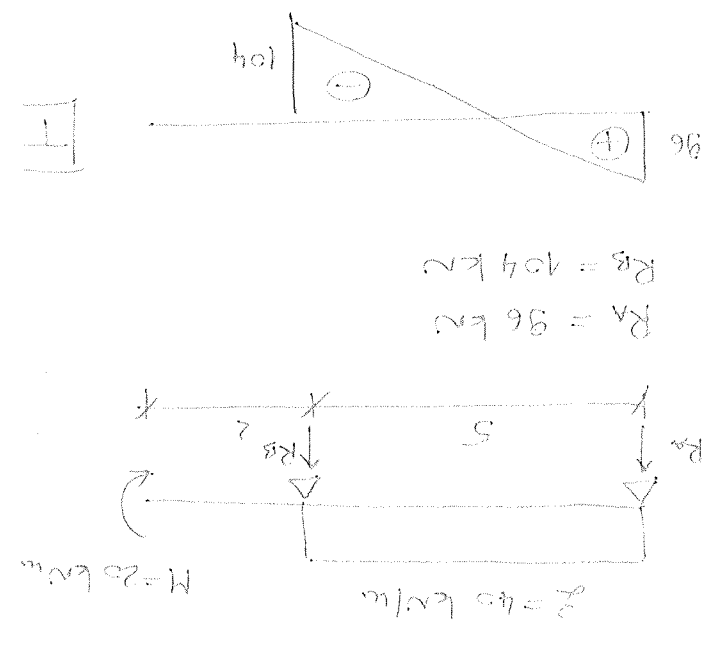
- $A_1 = 400 \text{ mm}^2$
- $A_2 = 300 \text{ mm}^2$
- $\alpha = 1,5 \cdot 10^{-5} \text{ K}^{-1}$
- $l_1 = 3 \text{ m}$
- $l_2 = 3,606 \text{ m}$
- $\alpha = 56,31^\circ$

[U.R.] $\sum M_B = 0$

$$-S_1 \cdot 3 + 4 \cdot S_2 \cdot \cos 33,63^\circ = 0$$

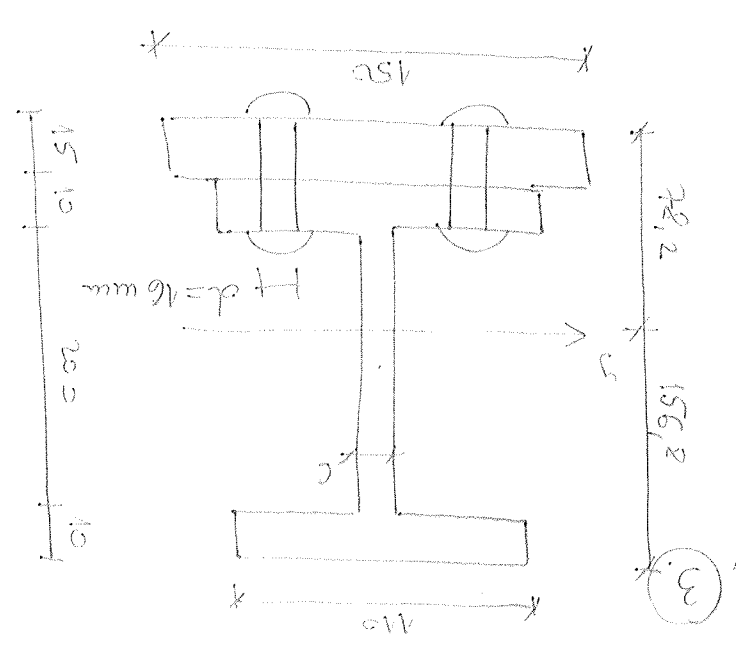
$$S_2 = 0,9014 S_1$$

$$S_1 = 1,1094 S_2$$



$$A = 3400 + 180 \cdot 15 = 5650 \text{ mm}^2$$

$$z_T = \frac{3400 \cdot 125 + 2250 \cdot 75}{5650} = 78,2 \text{ mm}$$



$$I_y = \left(\frac{110 \cdot 10^3}{12} + 110 \cdot 10 \cdot 58,2^2 \right) + \left(\frac{150 \cdot 15^3}{12} + 150 \cdot 15 \cdot 79,7^2 \right) + \left(\frac{6 \cdot 200^3}{12} + 6 \cdot 200 \cdot 46,8^2 \right) = 47 \cdot 10^6 \text{ mm}^4$$

$$S_y = 150 \cdot 15 \cdot (78,2 - 7,5) = 15907,5 \text{ mm}^3$$

$$R_x = \frac{I_y}{I_{max} \cdot S_y} \cdot c = \frac{47 \cdot 10^6}{104 \cdot 10^3 \cdot 15907,5} \cdot c = 352 \text{ c}$$

$$z = \frac{R_x}{2 \cdot d \cdot \pi} \leq I_{dop} \Rightarrow 352 \text{ c} \leq \frac{16^2 \pi}{2} \cdot 100$$

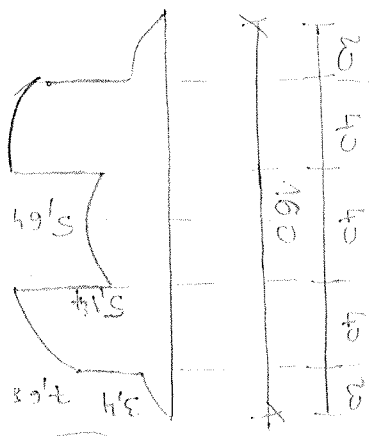
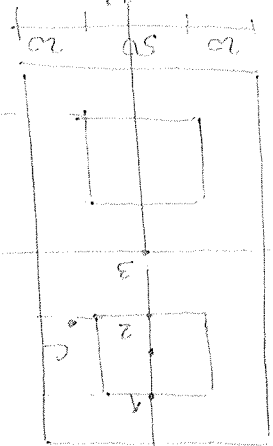
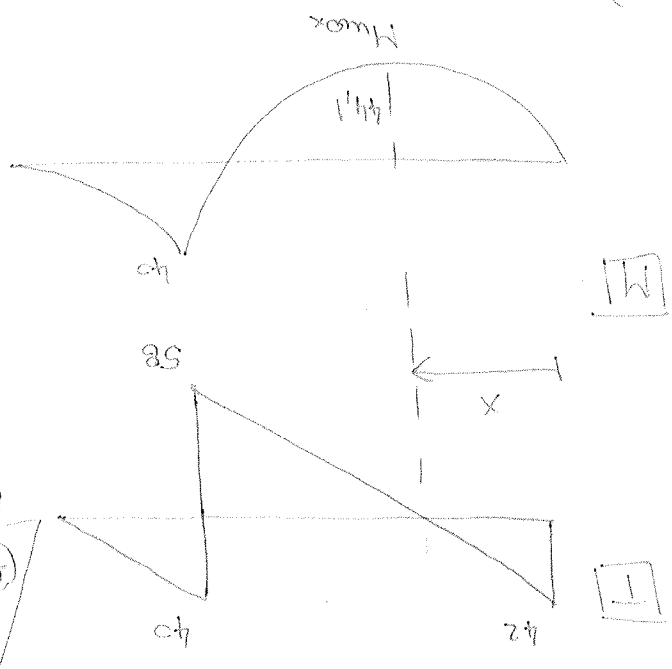
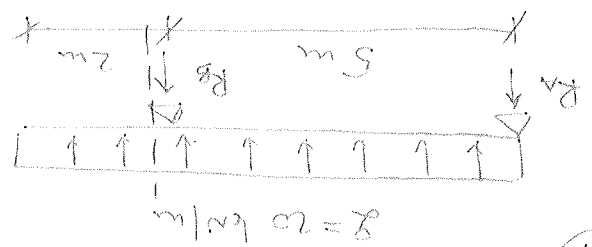
$$c \leq 114,2 \text{ mm}$$

my'bedevus

$$v = \frac{R_x}{2d \cdot \pi} \leq I_{dop} \Rightarrow 352 \text{ c} \leq 2 \cdot 16 \cdot 10 \cdot 200$$

$$c \leq 181,8 \text{ mm}$$

4.



$R_A = 42 \text{ kN}$
 $R_B = 98 \text{ kN}$
 $R_A - 20 \cdot x = 0 \Rightarrow x = 2,1 \text{ m}$
 $M_{max} = 42 \cdot 2,1 - 20 \cdot \frac{2,1^2}{2} = 44,1 \text{ kNm}$

$I_y = \frac{90 \cdot 160^3}{12} - 2 \left(\frac{50 \cdot 40^3}{12} + 50 \cdot 40 \cdot 40^2 \right)$
 $= 23,786 \cdot 10^6 \text{ mm}^4$

$\sigma_x = \frac{M_{max}}{I_y} z = \frac{44,1 \cdot 10^6}{23,786 \cdot 10^6} \cdot 80 = 148,32 \text{ MPa}$

$S_{y1} = 90 \cdot 20 \cdot 70 = 126000$
 $S_{y2} = 90 \cdot 60 \cdot 50 - 50 \cdot 40 \cdot 40 = 190000$
 $S_{y3} = 90 \cdot 80 \cdot 40 - 50 \cdot 40 \cdot 40 = 208000$

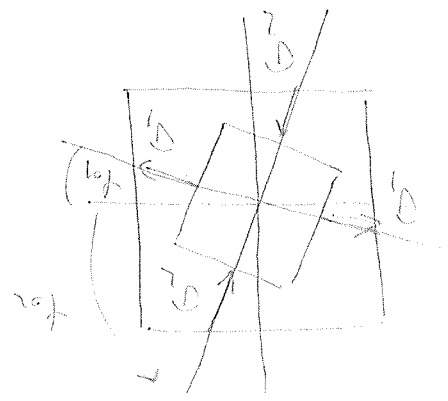
$I_{y_{poc}} = \frac{58 \cdot 10^3 \cdot 126000}{23,786 \cdot 10^6} = 3,41 \text{ MPa}$
 $I_{y_{poc}} = 11,58 \text{ MPa}$
 $I_{y_{poc}} = 5,14 \text{ MPa}$
 $I_3 = 5,64$

$I_{x2} = T \cdot S_y$

$\sigma_x = \frac{-40 \cdot 10^6}{23,786 \cdot 10^6} \cdot (-20) = +33,63 \text{ MPa}$
 $\sigma_{x2} = \frac{40 \cdot 10^3 \cdot 130000}{23,786 \cdot 10^6} = 7,982 \text{ MPa}$

$\sigma_{12} = \frac{\sigma_x}{2} \pm \frac{1}{2} \sqrt{\sigma_x^2 + 4 \cdot \tau_{xy}^2} = 16,82 \pm 18,62$

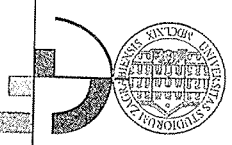
$\sigma_1 = 35,44 \text{ MPa}$
 $\sigma_2 = -1,8 \text{ MPa}$



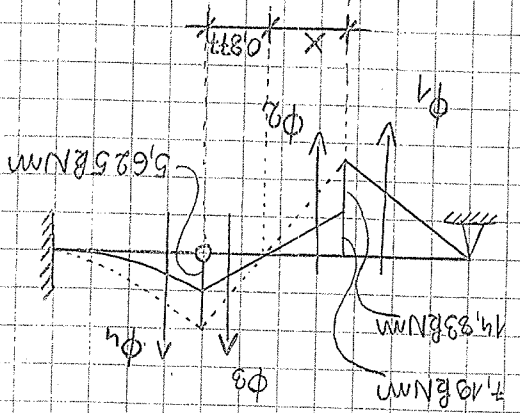
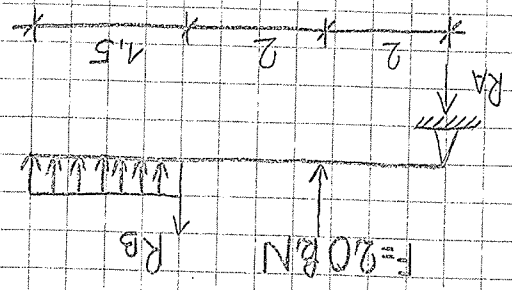
$\phi_{01} = \frac{1}{2} \arctan \frac{2 \tau_{xy}}{\sigma_x} = \frac{1}{2} \arctan \frac{2 \cdot 18,62}{-33,63} = -12,7^\circ$
 $\phi_{02} = \frac{90^\circ}{2} - \phi_{01} = 77,3^\circ$

b) DOKA C

Datum: _____



ZADATK 3



$$\sum M_A = 0, R_B = 27,81 \text{ kN}$$

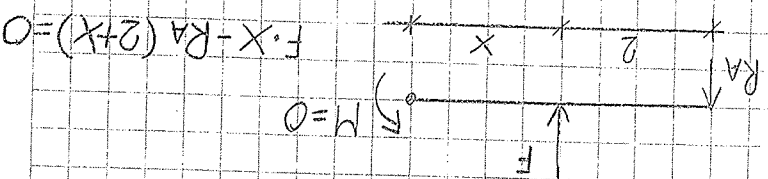
$$\sum M_B = 0, R_A = 7,19 \text{ kN}$$

$$M_{rod.F} = R_A \cdot 2 = 14,38 \text{ kNm}$$

$$M_{ramzola} = 9,22 = 11,25 \text{ kNm}$$

$$M_{rod.F}^* = 7,19 \text{ kNm}$$

$$M_{ramzola}^* = 5,625 \text{ kNm}$$



$$\phi_1 = 14,38 \cdot \frac{2}{2} = 14,38 \text{ kNm}^2$$

$$\phi_2 = 7,19 \cdot 1,128 = 4,04 \text{ kNm}^2$$

$$\phi_3 = 5,625 \cdot 0,877 = 2,47 \text{ kNm}^2$$

$$\phi_4 = \frac{1}{3} \cdot 5,625 \cdot 1,5 = 2,81 \text{ kNm}^2$$

$$\Delta E = \frac{R_B \cdot E}{E \cdot A} = 1,40 \text{ mm}$$

$$\Delta E = \frac{R_A \cdot E}{E \cdot A} = 1,98 \text{ mm}$$

$$P_A'' = \frac{1,40}{4000}, P_A'' = 0,00035 \text{ rad}$$

$$\sum M_A = 0$$

$$R \cdot 4 + \phi_3 \cdot 3,11 - \phi_2 \cdot 2,37 - \phi_1 \cdot 1,33 = 0$$

$$R = 4,88 \text{ kNm}^2$$

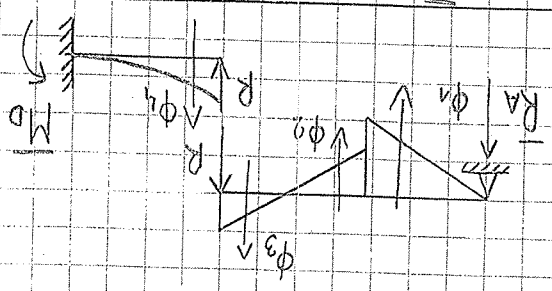
$$\sum M_D = 0$$

$$M_D + R \cdot 1,5 - \phi_4 \cdot 1,125 = 0, M_D = -4,16 \text{ kNm}^2$$

$$\sum M_{otro\ zglobila} = 0$$

$$-R \cdot 4 + \phi_1 \cdot 2,67 + \phi_2 \cdot 1,63 - \phi_3 \cdot 0,292 = 0$$

$$R_A = 11,06 \text{ kNm}^2 = F_A$$



$$\frac{M_D}{E \cdot I_D} = \frac{F_A}{E \cdot I_A} = -0,21 \text{ mm}$$

$$P_A = \frac{F_A}{E \cdot I_A} = 5,53 \cdot 10^{-4} \text{ rad}$$

$$\frac{M_D}{E \cdot I_D} = \frac{M_D + M_D'}{E \cdot I_D} = 1,19 \text{ mm}$$

$$P_A' = P_A + P_A'' = 9,03 \cdot 10^{-4} \text{ rad}$$