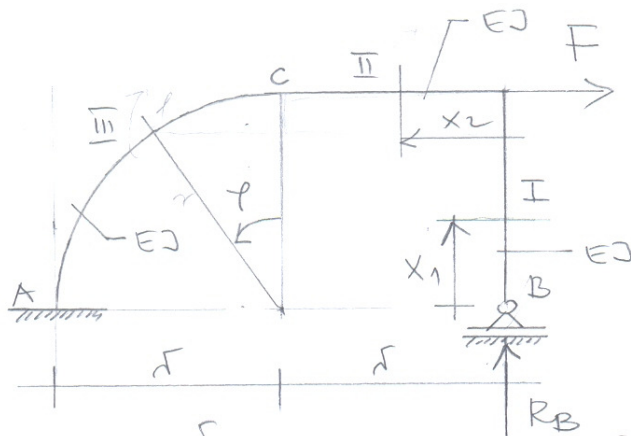


2.A) $EJ = \text{const}$ $M, T, N = ?$
 $F = 50 \text{ kN}$
 $r = 2 \text{ m}$



$$E_p = E_p^I + E_p^{II} + E_p^{III}$$

$$\frac{\partial E_p}{\partial R_B} = 0$$

$$\frac{\partial E_p}{\partial R_B} = \frac{1}{EI} \int_0^r M_{x_1} \frac{\partial M_{x_1}}{\partial R_B} dx + \frac{1}{EI} \int_0^r M_{x_2} \frac{\partial M_{x_2}}{\partial R_B} dx + \frac{1}{EI} \int_0^{\pi/2} M_\varphi \frac{\partial M_\varphi}{\partial R_B} r d\varphi = 0$$

$$M_{x_1} = 0 \quad M_{x_2} = R_B \cdot x_2 \quad M_\varphi = R_B \cdot r \cdot (1 + \sin \varphi) - F \cdot r \cdot (1 - \cos \varphi)$$

$$\frac{\partial M_{x_1}}{\partial R_B} = 0 \quad \frac{\partial M_{x_2}}{\partial R_B} = x_2 \quad \frac{\partial M_\varphi}{\partial R_B} = r (1 + \sin \varphi)$$

$$\int_0^r R_B x_2^2 dx + \int_0^{\pi/2} [R_B \cdot r \cdot (1 + \sin \varphi) - F \cdot r \cdot (1 - \cos \varphi)] r (1 + \sin \varphi) r d\varphi = 0$$

$$R_B \cdot \frac{r^3}{3} + R_B \cdot r^3 \int_0^{\pi/2} (1 + 2 \sin \varphi + \sin^2 \varphi) d\varphi - F \cdot r^3 \int_0^{\pi/2} (1 + \sin \varphi - \cos \varphi - \sin \varphi \cos \varphi) d\varphi = 0$$

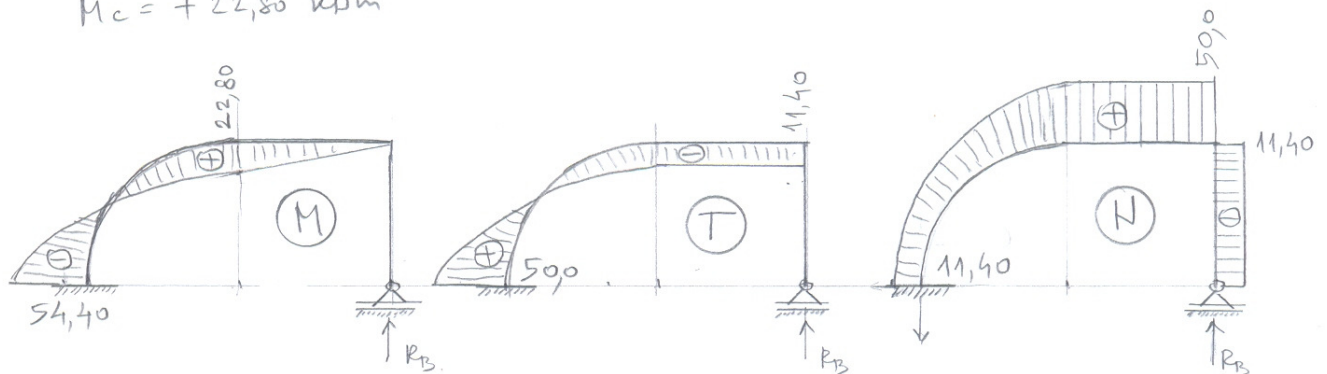
$$\frac{R_B}{3} + R_B \left(\frac{\pi}{2} + 2 \cdot 1 + \frac{\pi}{4} \right) = F \left(\frac{\pi}{2} + 1 - 1 - \frac{1}{2} \right)$$

$$4,6895 \cdot R_B = 1,0708 \cdot F \rightarrow R_B = 0,228 \cdot F$$

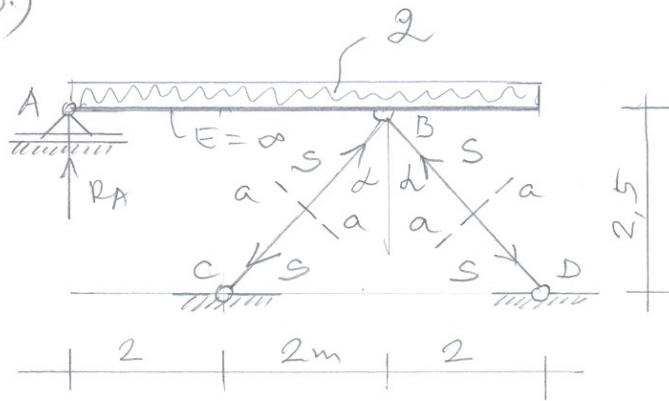
$$R_B = \underline{11,40 \text{ kN}}$$

$$M_A = -54,40 \text{ kNm}$$

$$M_C = +22,80 \text{ kNm}$$



3.)



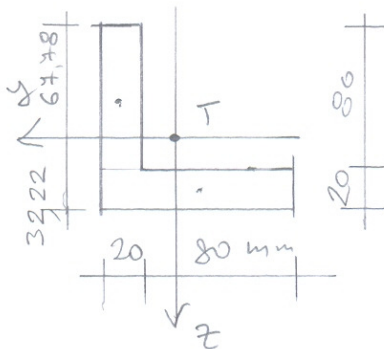
$$q = 7 \text{ kN/m} \quad k_i = ?$$

$$\sigma_p = 210 \text{ MPa}$$

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

$$\alpha = 38,66^\circ$$

$$R_A = 10,5 \text{ kN}$$



$$A = 3600 \text{ mm}^2$$

$$z_T = y_T = 32,22 \text{ mm}$$

$$J_y = J_z = \frac{100 \cdot 20^3}{12} + 100 \cdot 20 \cdot 22,22^2 + \frac{20 \cdot 80^3}{12} + 20 \cdot 80 \cdot 27,78^2 = 3,142 \cdot 10^6 \text{ mm}^4$$

$$J_{yz} = 100 \cdot 20 (+22,22)(-27,78) + 80 \cdot 20 (-27,78)(+22,22)$$

$$J_{yz} = -1,778 \cdot 10^6 \text{ mm}^4$$

$$J_{\min} = J_y - |J_{yz}| = 1,364 \cdot 10^6 \text{ mm}^4$$

$$S_{\text{krit}} = \frac{\pi^2 \cdot E \cdot J_{\min}}{l_i^2} = \underline{\underline{262,67 \text{ kN}}}$$

$$l_i = l = \sqrt{2^2 + 2,5^2} = 3,2016 \text{ m}$$

$$\sum M_A = 0 \quad q \cdot 6 \cdot 3 = S \cdot \cos \alpha \cdot 2 \cdot 4 \rightarrow \underline{\underline{S = 20,14 \text{ kN}}}$$

$$k_i = \frac{S_{\text{krit}}}{S} = \underline{\underline{13,02}}$$

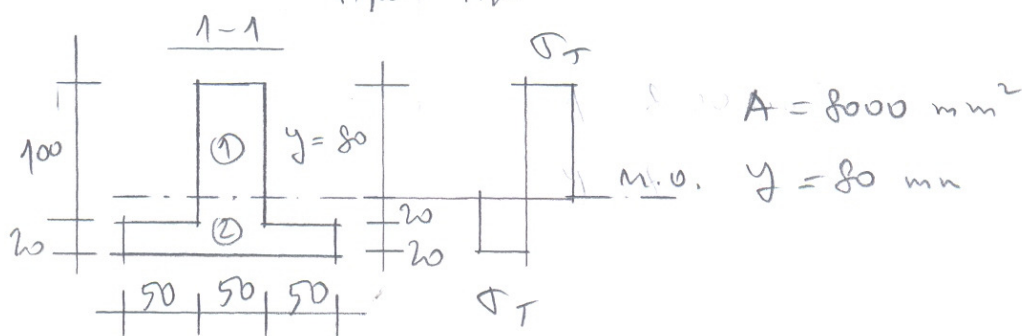
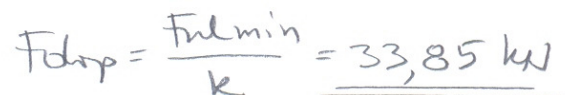
$$\lambda_{\min} = \sqrt{\frac{J_{\min}}{A}} = 19,46 \text{ mm}$$

$$\lambda = \frac{l_i}{\lambda_{\min}} = 164,5$$

$$\lambda_p = \sqrt{\frac{\pi^2 \cdot E}{\sigma_p}} = 97$$

$$\lambda > \lambda_p$$

$$k = 1,6$$



$$W_{pl} = 26 \cdot 10^4 \text{ mm}^3$$

$$M_{ul} = W_{ul} \cdot \sigma_T = 65 \text{ kNm}$$

$$p_1 \cdot 1,5 = p_2 \cdot 5$$

$$F_{ul} \cdot 0,3 \cdot 3 = M_{ul}$$

$$\tau_2 = 0,3 \cdot \tau_1$$

$$F_{ul} = \frac{M_{ul}}{0,9} = \underline{\underline{72,22 \text{ kN}}}$$

$$\tau_{1,2} = \tau_{2,3}$$

$$F_{\text{rel } 2} = M_{\text{rel}} + M_{\text{rel}} \frac{2}{3}$$

$$\varphi_2 = \frac{2}{3} \varphi_1$$

$$F_{ul} = \frac{1,667 \cdot M_{ul}}{2} = \frac{M_{ul}}{1,2} = \underline{\underline{54,17 \text{ kN}}} = F_{ul \text{ min}}$$