OTPORNOST MATERIJALA 2
2. kolokvij, 08. travnja 2017.

Ime i prezime: JK

B

1. Za kontinuirani nosač prikazan na slici treba odrediti dijagrame unutarnjih sila primjenom tromomentne jednadžbe.

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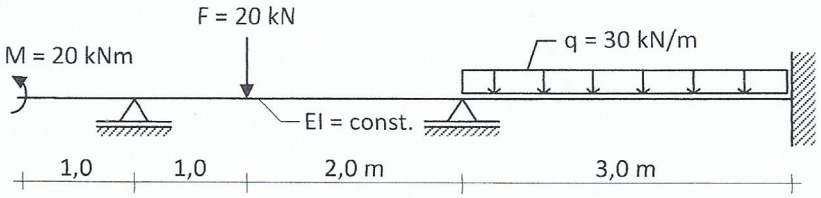

2. Za zadani nosač potrebno je primjenom jezgre poprečnog presjeka odrediti najveća normalna naprezanja i nacrtati njihov dijagram.

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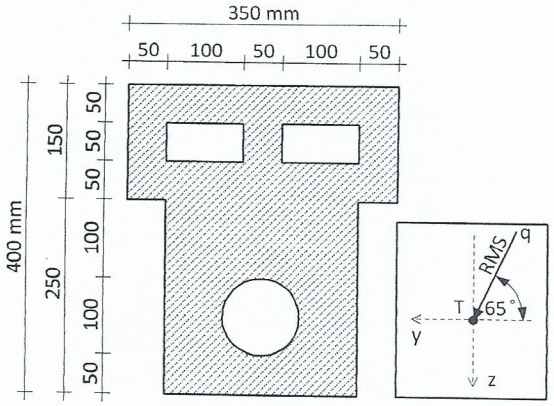

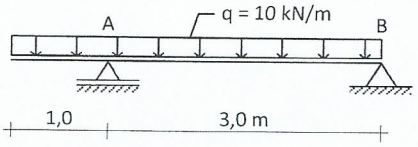

3. Za zadani tankostijeni profil sa slike potrebno je odrediti središte posmika. Debljina stijenke profila je 3 mm.

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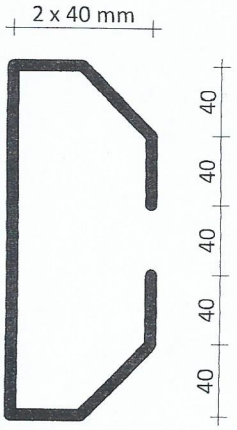
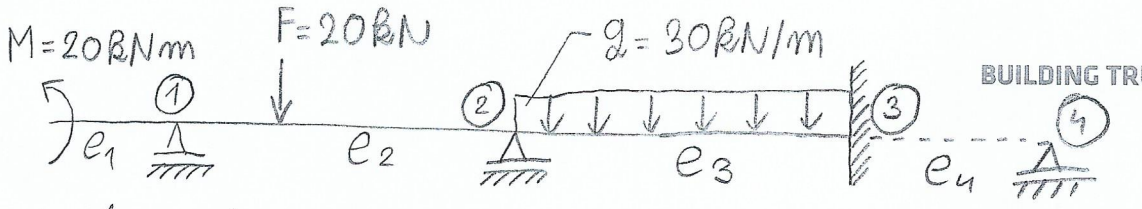
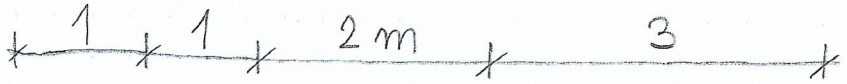
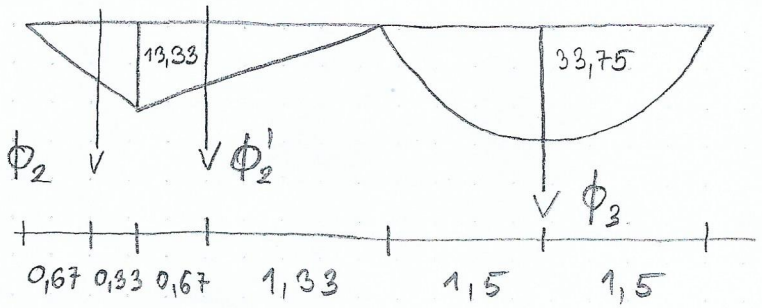


ZADATAK 1





$M_1 = -20\ kNm$



$\Phi_2 = \frac{1}{2} \cdot 13,33 \cdot 1 = 6,67\ kNm^2$

$\Phi_2' = \frac{1}{2} \cdot 13,33 \cdot 2 = 13,33\ kNm^2$

$\Phi_3 = \frac{2}{3} \cdot 33,75 \cdot 3 = 67,5\ kNm^2$

Ležaj 2 $\rightarrow M_1 \cdot e_2 + 2M_2 \cdot (e_2 + e_3) + M_3 \cdot e_3 = -6 \cdot \left(\Phi_2 \cdot \frac{0,67}{3} + \Phi_2' \cdot \frac{1,67}{3} + \Phi_3 \cdot \frac{1,5}{3}\right)$

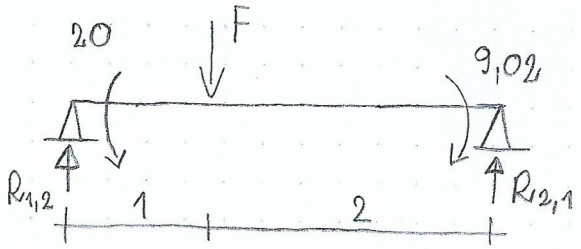
$-60 + 12M_2 + 3M_3 = -255,96 \rightarrow 12M_2 + 3M_3 = -195,96 \quad (1)$

Ležaj 3 $\rightarrow M_2 \cdot e_3 + 2M_3 \cdot (e_3 + e_4) + M_4 \cdot e_4 = -6 \cdot \left(\Phi_3 \cdot \frac{1,5}{3} + \Phi_4 \cdot \frac{e_4}{e_4}\right)$

$3M_2 + 6M_3 = -202,5 \quad (2)$

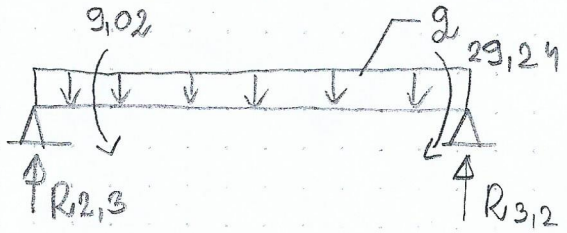
$\Rightarrow$ $M_2 = -9,02\ kNm$

$M_3 = -29,24\ kNm$



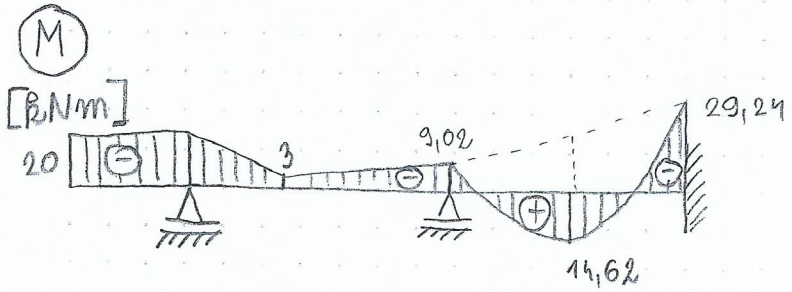
$+20 - R_{1,2} \cdot 3 + F \cdot 2 - 9,02 = 0$

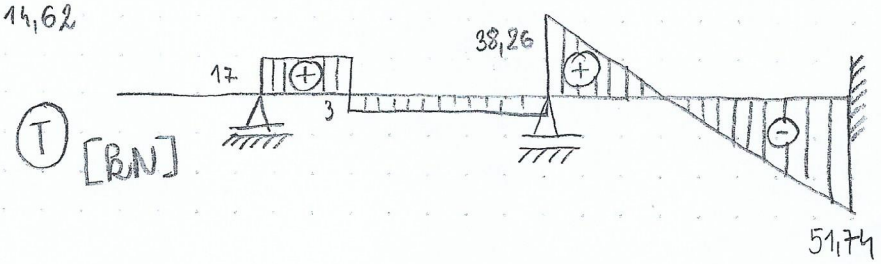
$R_{1,2} = 17\ kN$; $R_{2,1} = 3\ kN$



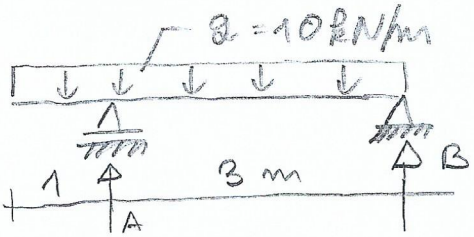
$-R_{2,3} \cdot 3 + 9,02 + \frac{q \cdot 3^2}{2} - 29,24 = 0$

$R_{2,3} = 38,26\ kN$; $R_{3,2} = 51,74\ kN$





ZADATAK 2



$R_A = 26{,}67\,kN$

$R_B = 13{,}33\,kN$

$M_A = \frac{-qe^2}{2}$

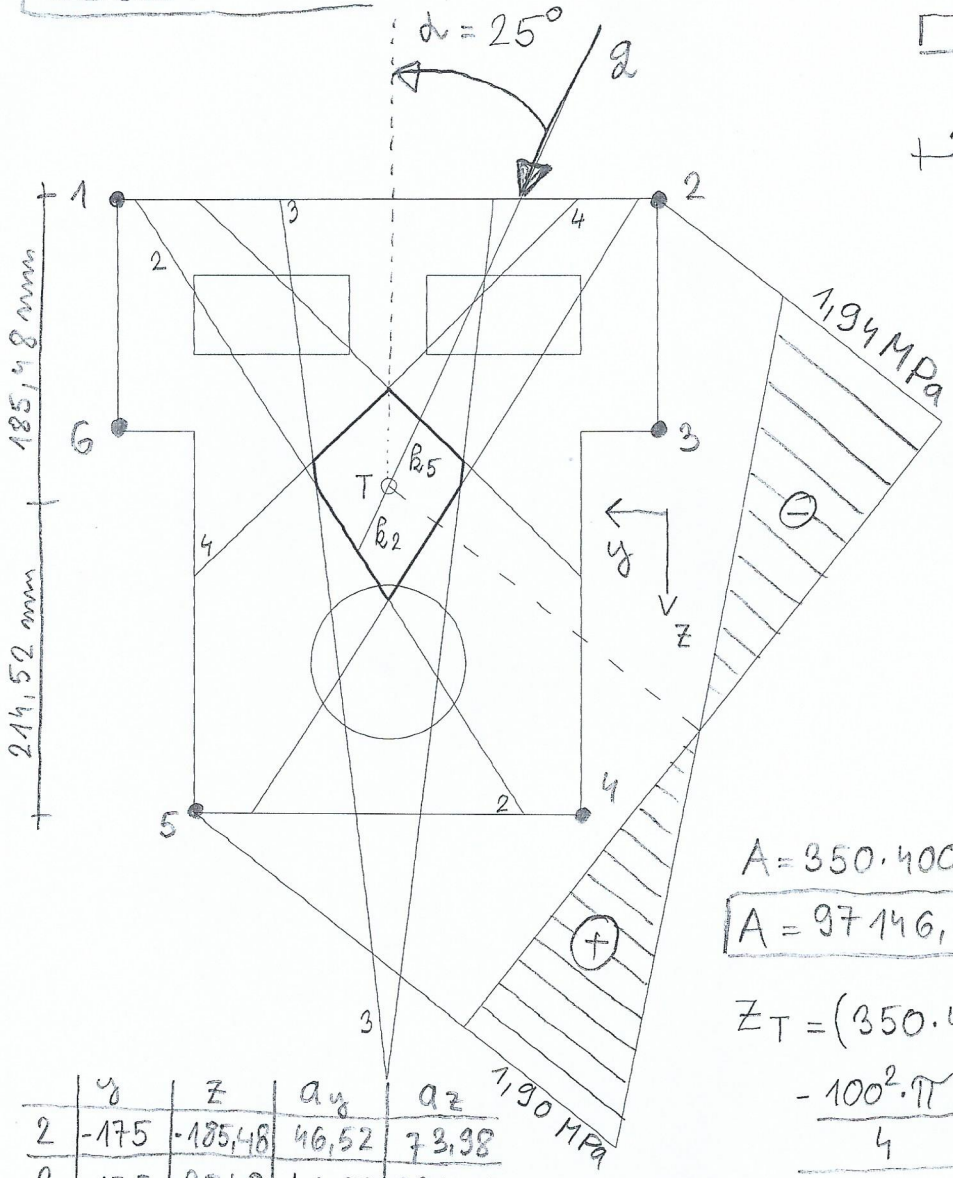
$M_A = -5\,kNm$

$q \cdot x - R_B = 0$

$x = 1{,}33\,m$

$M_x = 8{,}88\,kNm$

$\boxed{M_{MAX} = 8{,}88\,kNm}$



	y	z	a_y	a_z
2	-175	-185,48	46,52	73,98
3	-175	-35,48	46,52	386,74
4	-125	214,52	65,14	-63,96

$A = 350 \cdot 400 - 2 \cdot (100 \cdot 50 + 250 \cdot 50) - \frac{100^2 \cdot \pi}{4}$

$\boxed{A = 97146{,}02\,mm^2}$

$z_T = (350 \cdot 400 \cdot 200 - 2 \cdot 100 \cdot 50 \cdot 325 - \frac{100^2 \cdot \pi}{4} \cdot 100 - 2 \cdot 250 \cdot 50 \cdot 125)$ / 97146,02

$\boxed{z_T = 214{,}52\,mm}$

$J_y = \frac{350 \cdot 400^3}{12} + 350 \cdot 400 \cdot 14{,}52^2 - 2 \cdot \left(\frac{100 \cdot 50^3}{12} + 100 \cdot 50 \cdot 110{,}48^2\right) - 2 \cdot \left(\frac{50 \cdot 250^3}{12} + 50 \cdot 250 \cdot 89{,}52^2\right) - \left(\frac{100^4 \pi}{64} + \frac{100^2 \pi}{4} \cdot 114{,}52^2\right) =$

$J_y = 18{,}96 \cdot 10^8 - 1{,}24 \cdot 10^8 - 3{,}31 \cdot 10^8 - 1{,}08 \cdot 10^8 \Rightarrow \boxed{J_y = 13{,}33 \cdot 10^8\,mm^4}$

$J_z = \frac{400 \cdot 350^3}{12} - \frac{100^4 \pi}{64} - 2 \cdot \left(\frac{250 \cdot 50^3}{12} + 250 \cdot 50 \cdot 150^2\right) - 2 \cdot \left(\frac{50 \cdot 100^3}{12} + 50 \cdot 100 \cdot 75^2\right)$

$J_z = 10^8 \cdot (14{,}24 - 5{,}68 - 0{,}65) \Rightarrow \boxed{J_z = 7{,}91 \cdot 10^8\,mm^4}$

$\boxed{i_y^2 = 13721{,}61\,mm^2 \; ; \; i_z^2 = 8142{,}38\,mm^2}$

$\operatorname{tg} \rho = -\frac{J_y}{J_z} \cdot \operatorname{tg} \alpha^{25°} \Rightarrow \underline{\rho = -38{,}16°}$

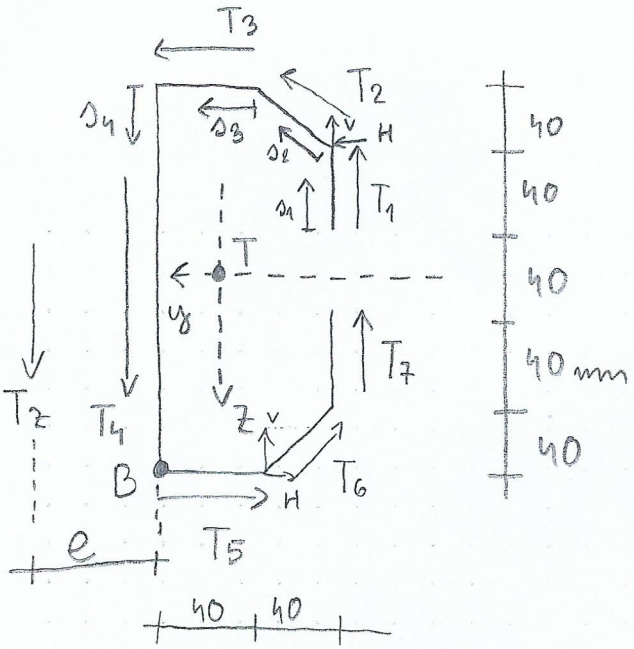
OČITANO: $R_2 = 47\,mm$, $R_5 = 48\,mm$

$\sigma_{min} = \sigma_2 = \frac{M_{MAX}}{R_2 \cdot A} = \underline{-1{,}94\,MPa}$

$\sigma_{max} = \sigma_5 = \frac{M_{MAX}}{R_5 \cdot A} = \underline{1{,}90\,MPa}$

ZADATAK 3

$T_2^V = \sin 45° \cdot T_2$ $\quad T_2^H = \cos 45° \cdot T_2$ $\quad (=)$ $\quad T_6^V = \cos 45° \cdot T_6$ $\quad T_6^H = \sin 45° \cdot T_6$



$$J_y = \frac{3 \cdot 200^3}{12} + 2 \cdot \left(\frac{40 \cdot 3^3}{12} + 40 \cdot 3 \cdot 100^2 + \right.$$

$$+ \frac{\frac{t}{\sin 45°} \cdot 40^3}{12} + 56{,}57 \cdot 3 \cdot 80^2 +$$

$$\left. + \frac{3 \cdot 40^3}{12} + 3 \cdot 40 \cdot 40^2 \right) = 2{,}0 \cdot 10^6 +$$

$$+ 2 \cdot \left(1{,}2 \cdot 10^6 + 1{,}11 \cdot 10^6 + 0{,}21 \cdot 10^6 \right) =$$

$$J_y = 7{,}04 \cdot 10^6 \text{ mm}^4$$

$$S_y^{(1)} = 3 \cdot s_1 \cdot \left(20 + \frac{s_1}{2} \right) = 60 s_1 + \frac{3}{2} s_1^2$$

$$T_1 = \int_0^{40} \frac{T_z}{J_y \cdot t} \cdot \left(60 s_1 + \frac{3}{2} s_1^2 \right) \cdot t \, ds_1 = \frac{T_z}{7{,}04 \cdot 10^6} \cdot \left(\frac{60^{30}}{60} \cdot \frac{40^2}{2} + \frac{3}{2} \frac{40^3}{3} \right) =$$

$$T_1 = 0{,}011 \cdot T_z$$

$$S_y^{(2)} = 60 \cdot 40 + \frac{3}{2} \cdot 40^2 + 3 \cdot s_2 \cdot \left(60 + \frac{s_2 \sin 45°}{2} \right) = 4800 + 180 s_2 + 1{,}05 s_2^2$$

$$T_2 = \int_0^{56{,}57} \frac{T_z}{J_y} \cdot \left(4800 + 180 s_2 + 1{,}05 s_2^2 \right) ds_2 = \frac{T_z}{J_y} \cdot \left(4800 \cdot 56{,}57 + 180 \cdot \frac{56{,}57^2}{2} + \right.$$

$$\left. + 1{,}05 \cdot \frac{56{,}57^3}{3} \right) \Rightarrow \quad T_2 = 0{,}088 \cdot T_z$$

$$S_y^{(3)} = 4800 + 180 \cdot 56{,}57 + 1{,}05 \cdot 56{,}57^2 + 3 \cdot s_3 \cdot 100 = 18342{,}77 + 300 s_3$$

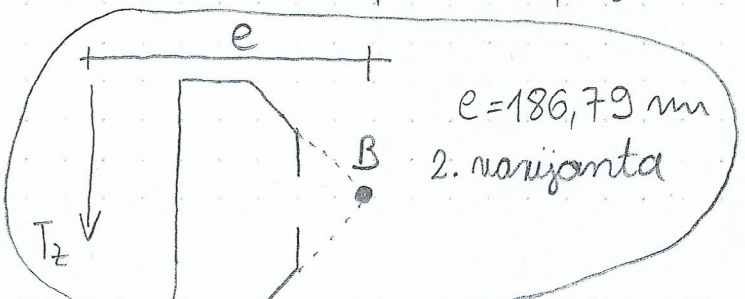
$$T_3 = \frac{T_z}{J_y} \cdot \int_0^{40} (18342{,}77 + 300 s_3) \, ds_3 = \frac{T_z}{J_y} \cdot \left(18342{,}77 \cdot 40 + 300 \frac{40^2}{2} \right)$$

$$T_3 = 0{,}138 \cdot T_z$$

$$T_z \cdot e = (T_1 + T_7) \cdot 80 + T_2^V \cdot 80 + T_2^H \cdot 160 + T_3 \cdot 200 + T_6^V \cdot 40$$

$$T_z \cdot e = 1{,}76 \cdot T_z + 4{,}98 T_z + 9{,}96 T_z + 27{,}6 T_z + 2{,}49 \cdot T_z$$

$$e = 46{,}79 \text{ mm}$$



$T_4 = 1{,}143 \cdot T_z$

$\Sigma F_V = 0 \Rightarrow T_z = T_z$ ✓