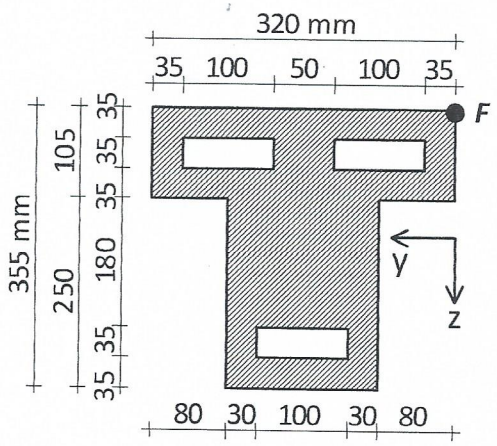
OTPORNOST MATERIJALA 2

1. kolokvij, 4. travnja 2016.

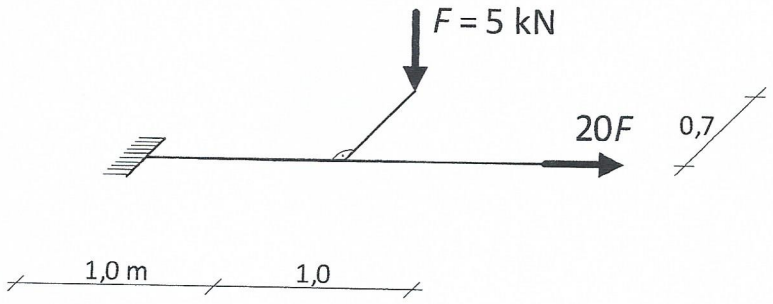
B

Ime i prezime:

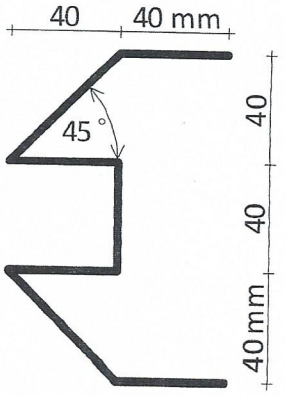
1. Za zadani poprečni presjek opterećen silom F = 700 kN treba nacrtati jezgru te primjenom jezgre odrediti i nacrtati dijagram normalnih naprezanja.



2. Štap prikazan na slici okruglog je poprečnog presjeka i promjera d = 100 mm. Odredite koeficijente sigurnosti u kritičnom presjeku štapa po I i IV teoriji čvrstoće. Dopušteno naprezanje materijala štapa iznosi $\sigma_{dop} = 180\ MPa$, a Poissonov koeficijent je ν = 0,3.



3. Odredite središte posmika tankostijenog otvorenog profila sa slike. Debljina stijenke profila je t = 3 mm.



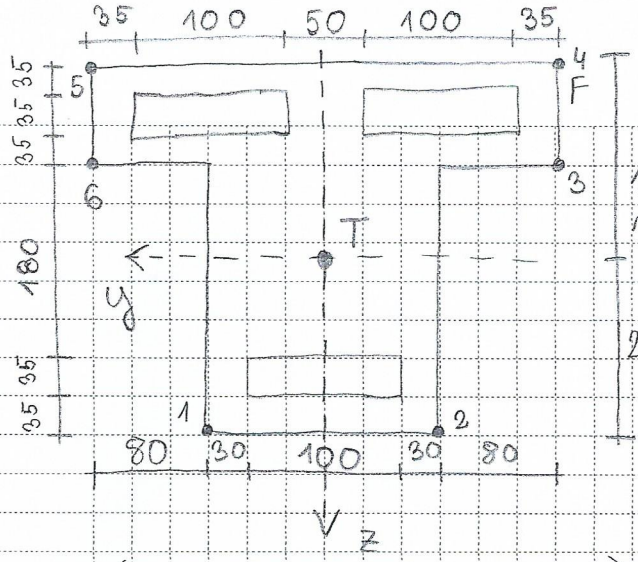
ZADATAK 1

ZAGORJE TEHNOBETON d.d.

$$A = 160\cdot250 + 320\cdot105 - 3\cdot100\cdot35 = \underline{63100\ mm^2}$$

$$z_T = \frac{160\cdot250\cdot125 + 320\cdot105\cdot302{,}5 - 2\times100\cdot35\cdot302{,}5 - 100\cdot35\cdot52{,}5}{63100}$$

$$\underline{z_T = 203{,}85\ mm\ (151{,}15\ mm)}$$



Točka	y	z	a_y	a_z
2	-80	203,85	64,17	-51,74
3	-160	-46,15	32,09	228,54
4	-160	-151,15	32,09	69,78

$$a_y = \frac{-i_z^2}{y}\ ;\ a_z = \frac{-i_y^2}{z}$$

$$J_y = \left(\frac{160\cdot250^3}{12} + 160\cdot250\cdot78{,}85^2\right) + \left(\frac{320\cdot105^3}{12} + 320\cdot105\cdot98{,}65^2\right) - \left(\frac{100\cdot35^3}{12} + 100\cdot35\cdot151{,}35^2\right) -$$

$$- 2\cdot\left(\frac{100\cdot35^3}{12} + 100\cdot35\cdot98{,}65^2\right) = 10^6\cdot\left(457{,}03 + 357{,}86 - 80{,}53 - 2\cdot34{,}42\right)$$

$$\underline{J_y = 665{,}52\cdot10^6\ mm^4}$$

$$J_z = \frac{250\cdot160^3}{12} + \frac{105\cdot320^3}{12} - 2\cdot\left(\frac{35\cdot100^3}{12} + 100\cdot35\cdot75^2\right) - \frac{35\cdot100^3}{12}$$

$$\underline{J_z = 323{,}93\cdot10^6\ mm^4}$$

- polumjeri tromosti ^ 2 : $i_y^2 = 10547{,}07\ mm^2$

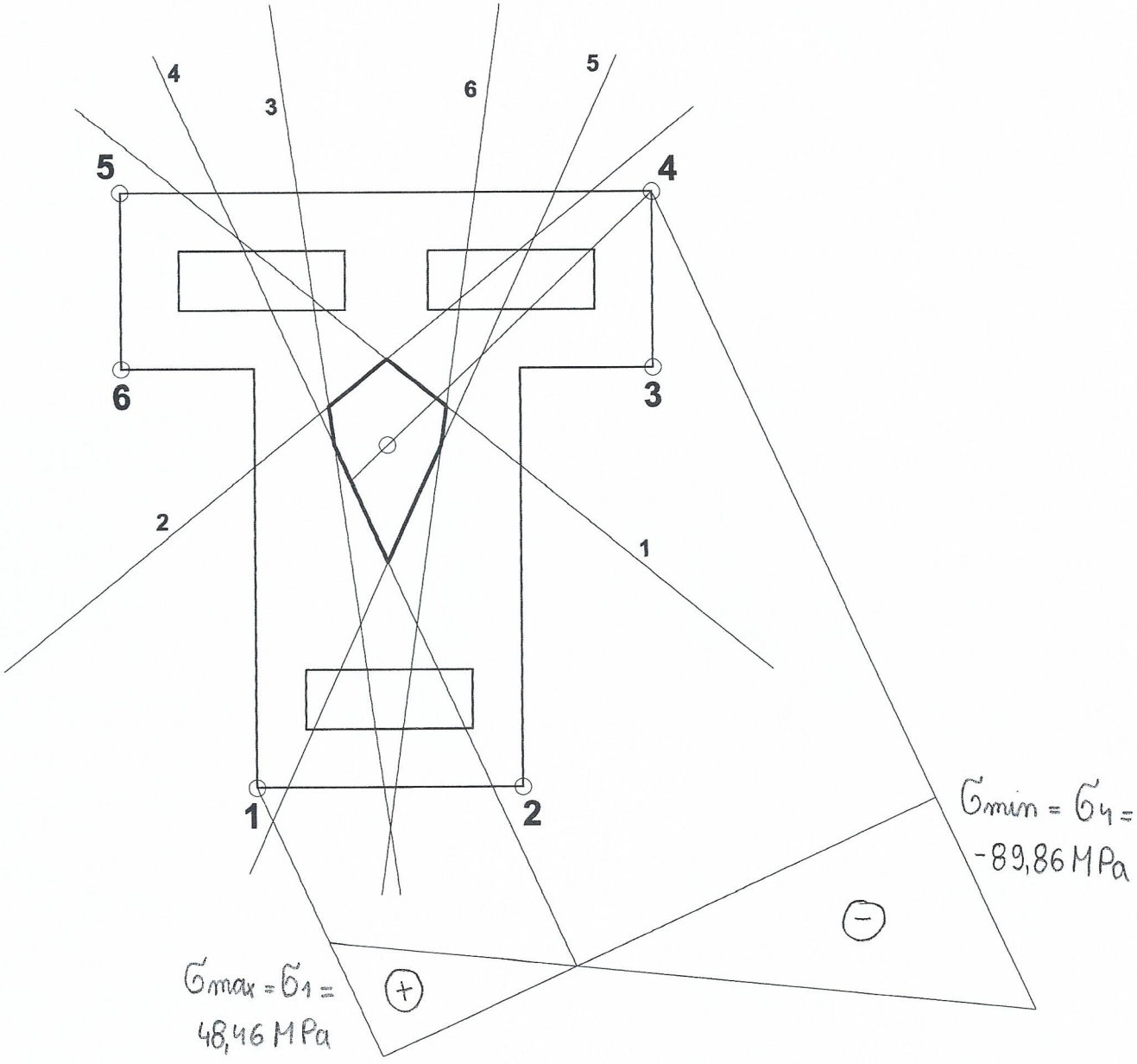
$i_z^2 = 5133{,}60\ mm^2$

- ekscentricitet sile F: $e = \sqrt{160^2 + 151{,}15^2} = 220{,}11\ mm$

- očitano: $R_1 = 41\ mm$; $R_4 = 31\ mm$

$$\underline{\sigma_{min}^4 = \frac{F}{A}\left(1 + \frac{e}{R_4}\right) = \frac{-700\cdot10^3}{63100}\left(1 + \frac{220{,}11}{31}\right) = -89{,}86\ MPa}$$

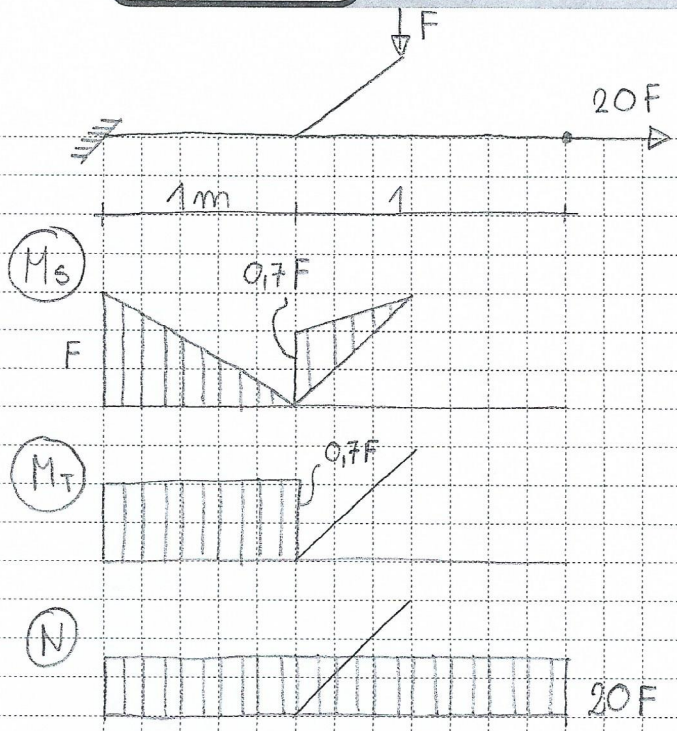
$$\underline{\sigma_{max}^1 = \frac{F}{A}\left(1 - \frac{e}{R_1}\right) = \frac{-700\cdot10^3}{63100}\left(1 - \frac{220{,}11}{41}\right) = 48{,}46\ MPa}$$


4
3
6
5
5
4
6
3
2
1
1
2
σmin = σ4 =
-89,86 MPa
σmax = σ1 =
48,46 MPa
+
−

ZADATAK 2

ZAGORJE TEHNOBETON d.d.

sigurna linija susreta



F = 5 kN

$\nu = 0,3$

$\sigma_{dop} = 180 MPa$

$d = 100\ mm$

$k_I, k_{IV} = ?$

Kritični presjek -> mjesto uvrtanja

$M_S = 5\ kNm$

$M_T = 3,5\ kNm$

$N = 100\ kN$

$A_{štapa} = \frac{d^2\pi}{4} = 7853,98\ mm^2$; $J_y = \frac{d^4\pi}{64} = 49,09 \cdot 10^5\ mm^4$

$J_P = \frac{d^4\pi}{32} = 98,17 \cdot 10^5\ mm^4$

$\sigma = \frac{M_S}{J_y} \cdot z_{max} + \frac{N}{A} = \frac{5 \cdot 10^6}{4,909 \cdot 10^6} \cdot 50 + \frac{100 \cdot 10^3}{7853,98} = 63,66\ MPa$

$\tau = \frac{M_T}{J_P} \cdot \rho = \frac{3,5 \cdot 10^6}{9,817 \cdot 10^6} \cdot 50 = 17,83\ MPa$

$\sigma_{1,2} = \frac{\sigma}{2} \pm \frac{1}{2}\sqrt{\sigma^2 + 4\tau^2}$ -> $\sigma_1 = 68,31\ MPa$; $\sigma_2 = -4,65\ MPa$

I teorija čvrstoće

$\sigma_{ekv} = \sigma_1 = 68,31\ MPa$

$k_I = \frac{\sigma_{dop}}{\sigma_{ekv}}$

$k_I = 2,64$

IV teorija čvrstoće

$\sigma_{ekv} = \sqrt{\sigma_1^2 + \sigma_2^2 - 2\nu\sigma_1\sigma_2}$

$\sigma_{ekv} = 69,85\ MPa$

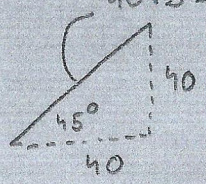
$k_{IV} = 2,58$

ZADATAK 3

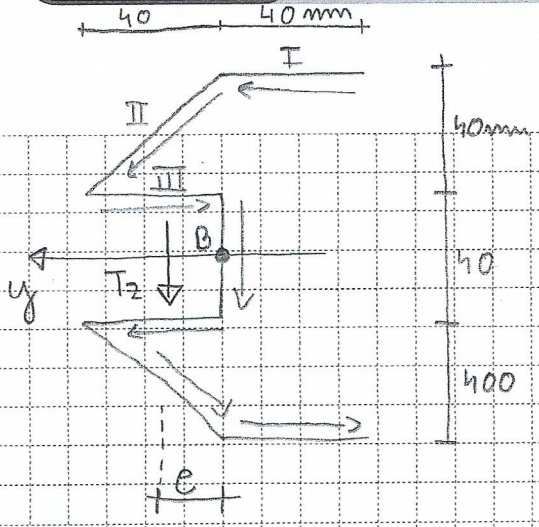
ZAGORJE TEHNOBETON d.d.

sigurna linija susreta

$40\sqrt{2} = 56,57$ mm



debljina stijenke $t = 3$ mm



$$J_y = \frac{3 \cdot 40^3}{12} + 2 \cdot \left(\frac{40 \cdot 3^3}{12} + 40 \cdot 3 \cdot 20^2 \right) +$$
$$+ 2 \cdot \left(\frac{40 \cdot 3^3}{12} + 40 \cdot 3 \cdot 60^2 \right) +$$
$$+ 2 \cdot \left(\frac{1}{12} \frac{3}{\sin 45} \cdot 40^3 + 3 \cdot 40\sqrt{2} \cdot 40^2 \right)$$
$$J_y = 16 \cdot 10^3 + 96,18 \cdot 10^3 + 864,18 \cdot 10^3 + 181,02 \cdot 10^3$$
$$J_y = 1564,69 \cdot 10^3 \text{ mm}^4$$

Dio I

$$S_y = 3 \cdot s_1 \cdot 60 = 180 s_1$$
$$T_1 = \int_0^{40} \frac{T_z}{J_y \cdot t} \cdot 180 s_1 \cdot t \, ds_1 = \frac{T_z}{1564,69 \cdot 10^3} \cdot 180 \cdot \frac{40^2}{2}$$
$$T_1 = 0,092 \, T_z$$

Dio II

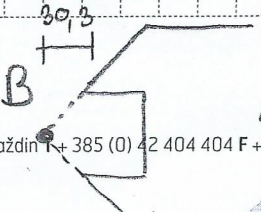
$$S_y = S_{y\,I} + 3 \cdot s_2 \cdot (60 + 1/2 \, s_2 \sin 45°) = 180 \cdot 40 + 3 s_2 (60 - 0,35 s_2)$$
$$S_{y\,II} = 7200 + 180 s_2 - 1,05 s_2^2$$
$$T_2 = \int_0^{40\sqrt{2}} \frac{T_z}{J_y \cdot t} \cdot (7200 + 180 s_2 - 1,05 s_2^2) \cdot t \cdot ds_2 \Rightarrow T_2 = 0,403 \, T_z$$

Dio III

$$S_y = S_{y\,II} + 3 \cdot s_3 \cdot 20 = 7200 + 180 \cdot 56,57 - 1,05 \cdot 56,57^2 + 60 s_3$$
$$S_{y\,III} = 13990,43 + 60 \cdot s_3$$
$$T_3 = \int_0^{20} \frac{T_z}{J_y \cdot t} (11390,43 + 60 \cdot s_3) \cdot t \, ds_3 \Rightarrow T_3 = 0,3883 \cdot T_z$$

$$T_z \cdot e = 2 T_1 \cdot 60 + 2 T_{2V} \cdot 40 + 2 T_{2H} \cdot 20 - 2 T_3 \cdot 20$$

$$e = 29,7 \text{ mm}$$



Druga magičnast!

P. Miškine 49 . 42000 Varaždin . Hrvatska . p.p. 61 . 42001 Varaždin T +385 (0) 42 404 404 F +385 (0) 42 350 693 W www.gpzagorje.hr E tehnobeton@gpzagorje.hr