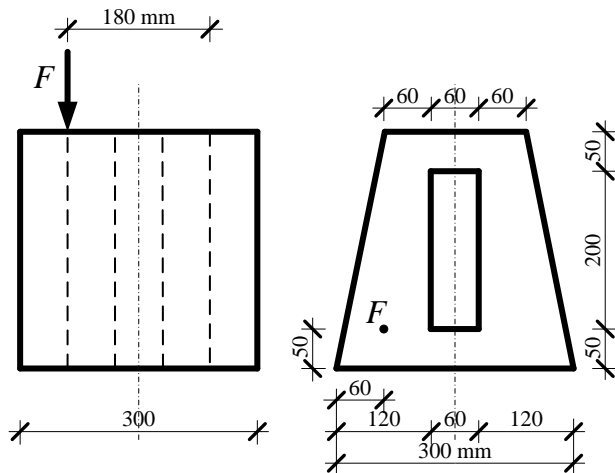


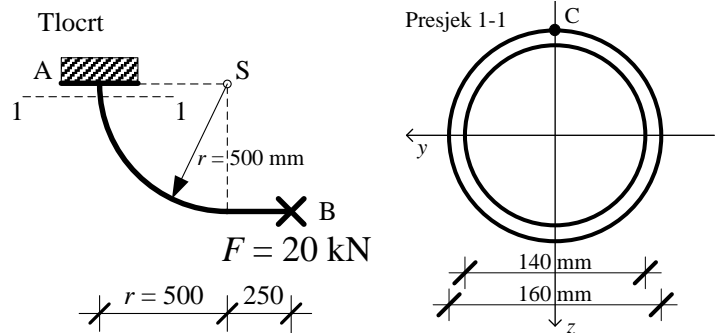
1. klazurni rad, 14. 04. 2008.

Ime i prezime :

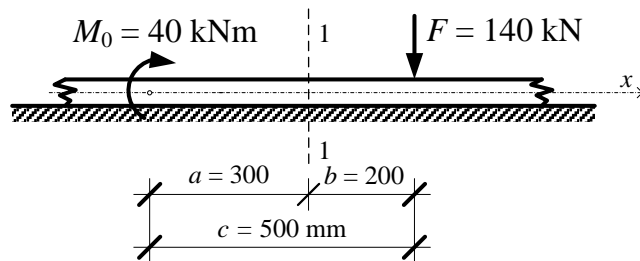
1. Štap zadanog presjeka opterećen je tlačnom ekscentričnom silom  $F = -700\text{kN}$ . Treba odrediti jezgru poprečnog presjeka, te pomoću jezgre odrediti ekstremna normalna naprezanja i nacrtati dijagram naprezanja u najviše napregnutom presjeku.



2. Štap AB leži u horizontalnoj ravnini i opterećen je vertikalnom silom  $F = 20,0\text{ kN}$ . Treba odrediti koeficijent sigurnosti u točki C u presjeku 1-1 pomoću V. teorije čvrstoće, ako je granica popuštanja materijala  $\sigma_T = 240\text{ MPa}$ .



3. U točki «C» presjeka 1-1 beskonačno dugog nosača na elastičnoj podlozi opterećenog prema slici, treba odrediti normalna i posmična naprezanja, nacrtati dijagrame  $\sigma$  i  $\tau$  te nacrtati element oko točke «C» s pripadnim komponentama naprezanja.

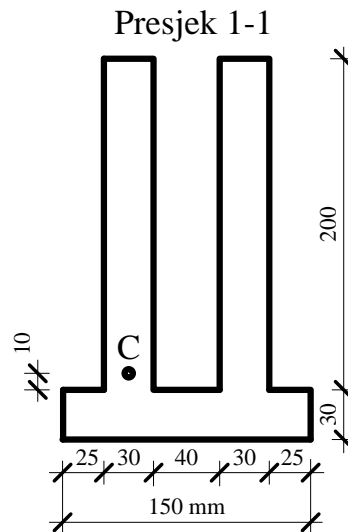


Modul elastičnosti:  $E = 2,1 \cdot 10^5\text{ MPa}$

Koeficijent podloge:  $k = 500\text{ MPa}$

$$w_F = \frac{F}{8E\alpha^3} \cdot e^{-\alpha x} \cdot (\cos \alpha x + \sin \alpha x); x \geq 0$$

$$w_M = \frac{M_0}{4E\alpha^2} e^{-\alpha x} \cdot \sin \alpha x; x \geq 0$$



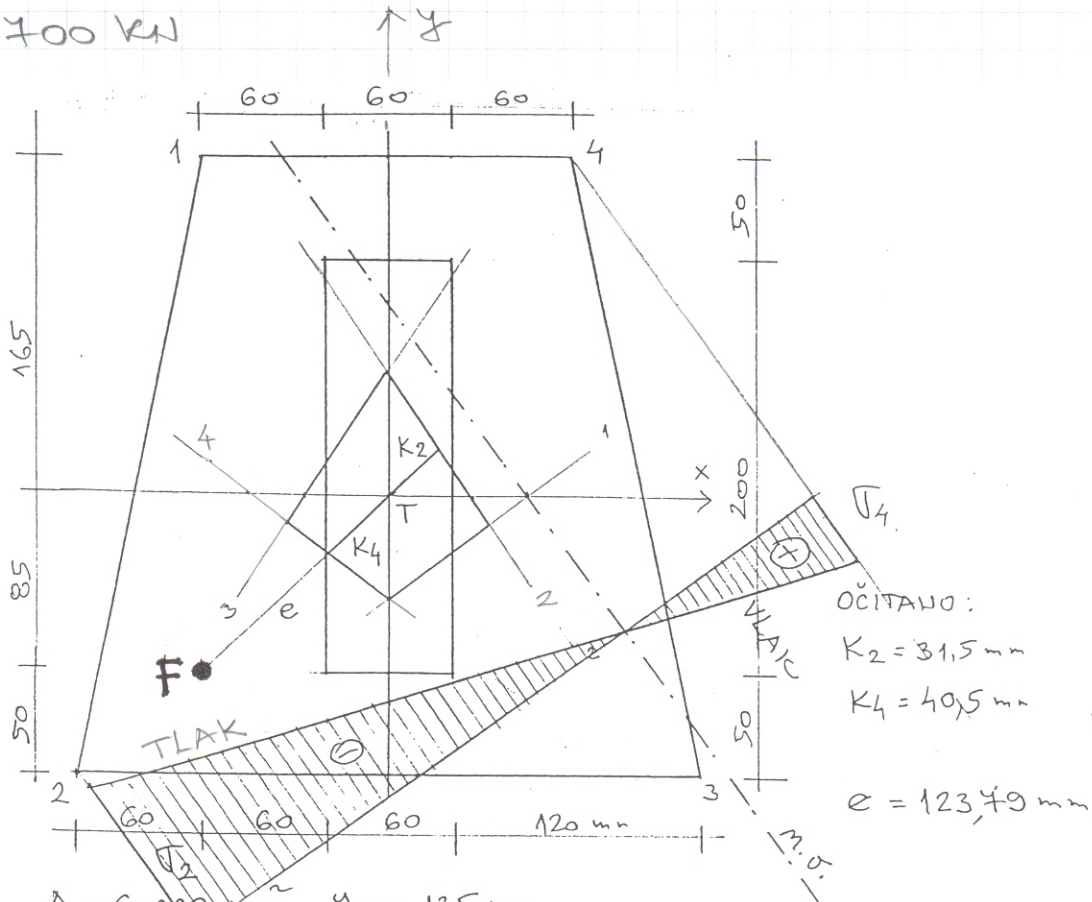


OTPORNOST MATERIJALA 2

1. KOLOKVIJ - GRUPA (B)

1. ZADATAK

$F = -700 \text{ kN}$



OČITANO:  
 $K_2 = 31,5 \text{ mm}$   
 $K_4 = 40,5 \text{ mm}$   
 $e = 123,79 \text{ mm}$

$A = 60000 \text{ mm}^2 \quad y_T = 135 \text{ mm}$

$J_x = \left( \frac{60 \cdot 300^3}{36} + \frac{60 \cdot 300 \cdot 35^2}{2} \right) \cdot 2 + \frac{180 \cdot 300^3}{12} + 180 \cdot 300 \cdot 15^2 - \frac{60 \cdot 200^3}{12} - 60 \cdot 200 \cdot 15$

$J_x = 486,50 \cdot 10^6 \text{ mm}^4$

$J_y = \left( \frac{300 \cdot 60^3}{36} + \frac{300 \cdot 60 \cdot 110^2}{2} \right) \cdot 2 + \frac{300 \cdot 180^3}{12} - \frac{200 \cdot 60^3}{12} = 363,60 \cdot 10^6 \text{ mm}^4$

$i_x^2 = \frac{J_x}{A} = 8108,33 \text{ mm}^2 \quad i_x = 90,05 \text{ mm} \quad a_x = -\frac{i_y^2}{x}$

$i_y^2 = \frac{J_y}{A} = 6060,0 \text{ mm}^2 \quad i_y = 77,85 \text{ mm} \quad a_y = -\frac{i_x^2}{y}$

VRH	x (mm)	y (mm)	$a_x$ (mm)	$a_y$ (mm)
1	-90,0	+165,0	+67,33	-49,17
2	-150,0	-135,0	+40,40	+60,06
F	-90	-85,0	+67,33	+95,39

$\sigma_2 = -\frac{F}{A} \left( 1 + \frac{e}{K_2} \right) = -11,667 \left( 1 + \frac{123,79}{31,5} \right) = \underline{\underline{-57,52 \text{ MPa}}}$

$\sigma_4 = -\frac{F}{A} \left( 1 - \frac{e}{K_4} \right) = \underline{\underline{+24,00 \text{ MPa}}}$

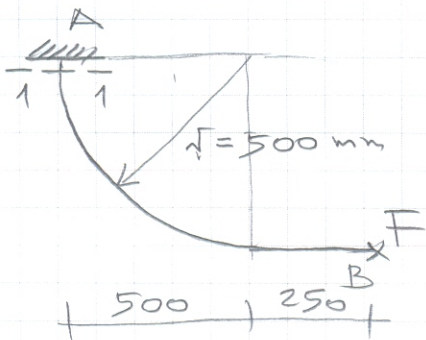
OTPORNOST MATERIJALA 2

1. KOLOKVIJ - GRUPA (B)

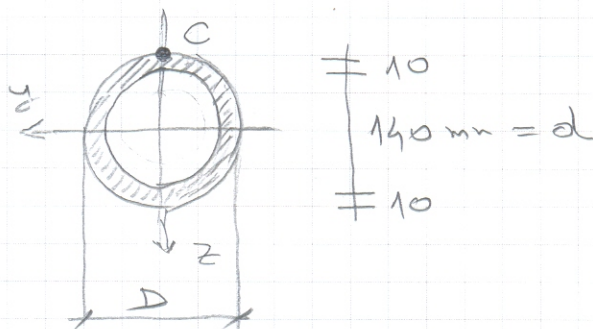
2. ZADATAK

$F = 20 \text{ kN}$

$\sigma_T = 240 \text{ MPa}$



PRESJEK 1-1



$J_p = \frac{\pi}{32} (D^4 - d^4) = 26,625 \cdot 10^6 \text{ mm}^4$

$J_y = J_z = \frac{\pi}{64} (D^4 - d^4) = 13,312 \cdot 10^6 \text{ mm}^4$

$M_s^A = F \cdot r = 10 \text{ kNm}$

$M_E^A = F (r + r/2) = 15 \text{ kNm}$

$\sigma_c = \frac{M_s^A}{J_y} \cdot \frac{D}{2} = 60,12 \text{ MPa}$

$\tau_c = \frac{M_E^A}{J_p} \cdot \frac{D}{2} = 45,09 \text{ MPa}$

$\sigma_{1,2}^c = \frac{\sigma_c}{2} \pm \frac{1}{2} \sqrt{\sigma_c^2 + 4\tau_c^2} \Rightarrow \sigma_1^c = 84,25 \text{ MPa}$

$\sigma_2^c = -24,13 \text{ MPa}$

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$\sigma_{ck}^c = \sqrt{\sigma_1^2 + \sigma_2^2 - \sigma_1 \cdot \sigma_2} = 98,55 \text{ MPa}$

$k_c = \frac{\sigma_T}{\sigma_{ck}^c} = \underline{\underline{2,435}}$



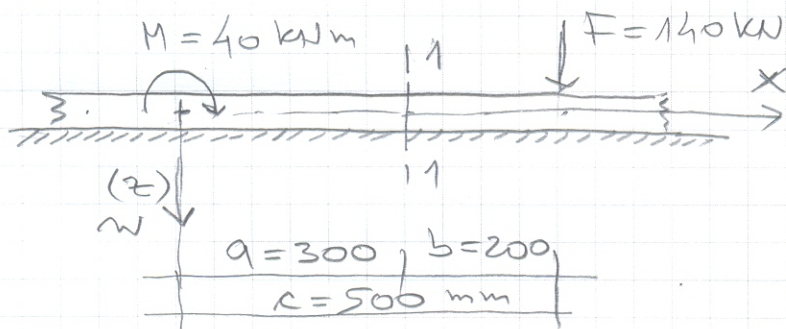
OTPORNOST MATERIJALA 2

1. KOLOKVIJ - GRUPA (B)

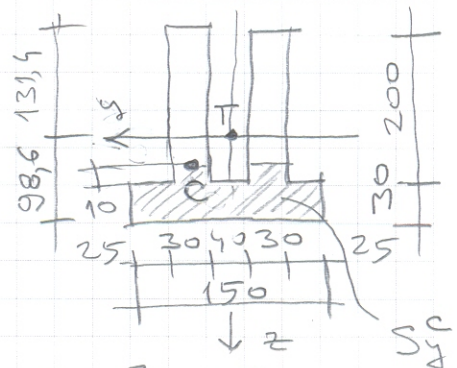
3. ZADATAK

$E = 2,1 \cdot 10^5 \text{ MPa}$

$k = 500 \text{ MPa}$



PRESJEK 1-1



$A = 16500 \text{ mm}^2 \quad z_T = 98,6 \text{ mm}$

$J_y = 8361,93 \cdot 10^4 \text{ mm}^4 \quad S_y^c = 414,36 \cdot 10^3 \text{ mm}^3$

$\alpha = \sqrt[4]{\frac{k}{4EJ_y}} = 1,65 \frac{1}{\text{m}}$

$w = \frac{M_0}{4EJ\alpha^2} \cdot e^{-\alpha x} \sin \alpha x + \frac{F}{8EJ\alpha^3} e^{-\alpha(c-x)} \left[ \cos \alpha(c-x) + \ln \alpha(c-x) \right]$

$M = -EJw'' = \frac{M_0}{2} e^{-\alpha x} \cos \alpha x + \frac{F}{4\alpha} e^{-\alpha(c-x)} \left[ \cos \alpha(c-x) - \sin \alpha(c-x) \right]$

$T = -EJw''' = -\frac{M_0 \cdot \alpha}{2} e^{-\alpha x} (\cos \alpha x + \sin \alpha x) + \frac{F}{2} e^{-\alpha(c-x)} \cdot \cos \alpha(c-x)$

ZA  $x = a = 300 \text{ mm}$  i  $c - x = b = 200 \text{ mm}$

$M_{1-1} = \underline{20,21 \text{ kNm}}$

$T_{1-1} = \underline{20,35 \text{ kN}}$

$\sigma_x^c = \frac{M_{1-1}}{J_y} \cdot z_c = \underline{14,16 \text{ MPa}}$

$\tau_{xz}^c = \frac{T_{1-1} \cdot S_y^c}{J_y \cdot b} = \underline{1,68 \text{ MPa}}$

