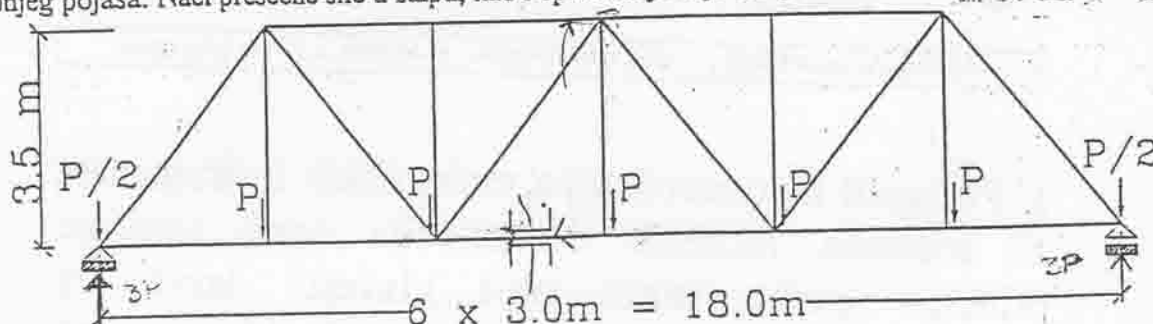




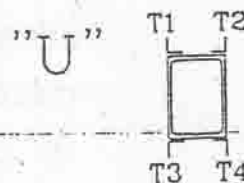
Ispitivanje konstrukcija - OKTOBAR - 2004. 23.10.2004 ... pismeni deo ispita

U čeličnoj rešetki, datoj na skici, putem opasivanja preseka izmerene su lokalne deformacije u označenom štapu donjeg pojasa. Naći presečne sile u štapu, kao i opterećenje koje deluje u čvorovima rešetke.



Stanje	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	T <sub>4</sub>
O	11620	12373	12021	11932
P	12093	12850	12503	12416

U: 2 [ 220  
A=74.8cm<sup>2</sup>  
J=5380cm<sup>4</sup>

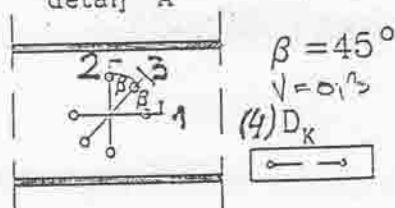


$k_i = k_t$

Na jednom čeličnom elementu putem rozete merene su lokalne deformacije, pri faznom opterećenju, deformetrom Pfender. Podaci merenja su dati tabelarno. Naći deformacijsko i naponsko stanje za oba opterećenja, a zatim naći kvantitativnu i kvalitativnu razliku između faza opterećenja..... $l_{pf}=100mm$

"A"

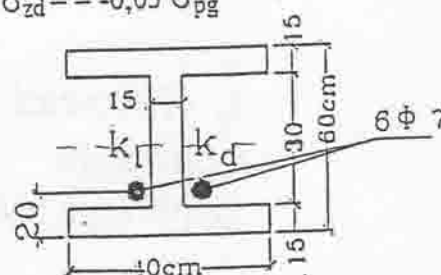
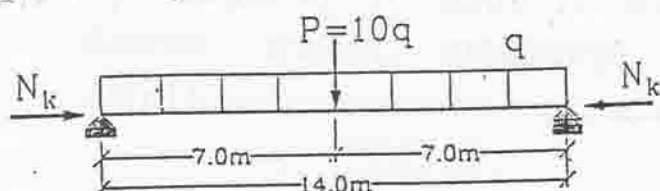
detalj "A"



Stanje	M <sub>1</sub>	M <sub>2</sub>	M <sub>3</sub>	M <sub>4</sub>
0	0462	0328	0193	0611
P <sub>1</sub>	0409	0345	0172	0607
P <sub>2</sub>	0433	0367	0236	0609

3. U prethodnonapregnutom betonskom nosaču, prema skici, izvršeno je merenje frekvencija u kابلu za prethodno naprežanje ( $f_{sr} = 200$  Hz,  $l_i = 100cm$ ). Sopstvena težina je uračunata u opterećenje q. Naći opterećenje P i q za sledeće slučajeve: a) napon zatezanja na donjoj ivici  $\sigma_{zd} = 0$ ;

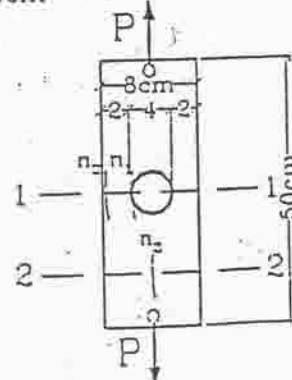
b) napon zatezanja na donjoj ivici  $\sigma_{zd} = -0,05 \sigma_{pg}$



4. Naponsko-optičkom metodom ispitivan je model štapa oslabljen kružnim otvorom. Naći:

- a) Opterećenje P;
- b) Naponsko stanje u presecima 1-1 i 2-2;
- c) Koefficient koncentracije napona u preseku 1-1 na ivici otvora;
- d) Rezultate preneri na prototip od čelika.

$n_1 = 12.1$  red  
 $n_2 = 5.8$  red  
 $n_3 = 5.0$  red  
 $C = 0.115$  kN/cm red  
 $d_m = 0.50$  cm



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Ст.	M1	M2	M3	M4
O	11620	12373	12021	11732
P	12.093	12.850	12.503	12.116
Δ	1773	477	432	704
ε × 10 <sup>4</sup>	473	477	482	484
σ <sub>тн</sub> [кн/см <sup>2</sup> ]	9.93	10.02	10.12	10.16

$$\varepsilon = \frac{\Delta l}{l_0} \cdot P \cdot \Delta \bar{c} = 1 \cdot 1 \cdot 10^{-6} \cdot \Delta \bar{c}$$

$$\sigma = E \cdot \varepsilon \quad E = 2,1 \cdot 10^4 \text{ кн/см}^2$$

$$A = 74.8 \text{ см}^2$$

$$J = 5380 \text{ см}^4 \Rightarrow W = \frac{5380}{22,9} = 234,55 \text{ см}^3$$

а) Пресечите силе:

- бримаре

$$N = \sigma \cdot A = 10.058 \cdot 74.8 = 752,34 \text{ кН} \quad \checkmark$$

- секундарне

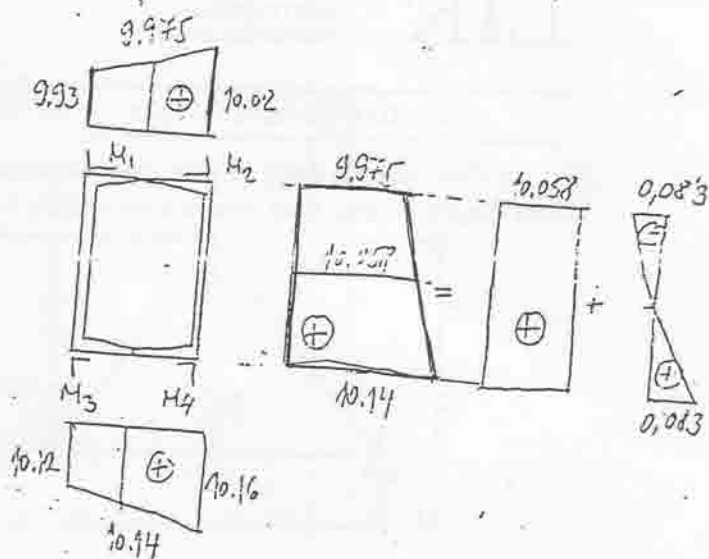
$$M = \Delta \sigma \cdot W = 0,083 \cdot 234,55 \cdot 2 \cdot 10^4 \text{ кн/см} = 0,406 \text{ кНм} \quad \checkmark$$

б) Одиме референс:

$$R = \frac{5}{2} P - 2,5P \Rightarrow M = 2,5P \cdot 3 \cdot 3,0 - P \cdot 3,0(2+1) = 1,5 \cdot P = 13,5P$$

$$U = \frac{M}{R} = \frac{13,5P}{3,5} = N = 752,34$$

$$P = \frac{752,34 \cdot 3,5}{13,5} = 195,05 \text{ кН}$$



2.

Ст.	0	P <sub>1</sub>	P <sub>2</sub>	P <sub>1-0</sub>	P <sub>2-0</sub>	Δ <sub>1</sub> -Δ <sub>K1</sub>	Δ <sub>2</sub> -Δ <sub>K2</sub>	ε · 10 <sup>6</sup>	ε <sub>2</sub> · 10 <sup>6</sup>
1-1	0462	0409	0433	-53	-29	-49	-27	-490	-270
2-2	0328	0345	0367	17	39	21	41	210	410
3-3	0193	0172	0236	-21	43	-17	45	-170	450
K	0611	0607	0609	-4	-2				

ℓ = 100 мм ⇒ ρ<sub>pf</sub> = 10 · 10<sup>-6</sup>  $\frac{\text{мм}}{\text{мм}}$  + замяззаве

ε<sub>0</sub> = ε<sub>3-3</sub>    ε<sub>+45</sub> = ε<sub>2-2</sub>    ε<sub>-45</sub> = ε<sub>1-1</sub>

СТАВЪ 1:    ε<sub>+45</sub> = 210 · 10<sup>-6</sup>  $\frac{\text{мм}}{\text{мм}}$     ε<sub>0</sub> = -170 · 10<sup>-6</sup>  $\frac{\text{мм}}{\text{мм}}$     ε<sub>-45</sub> = -490 · 10<sup>-6</sup>  $\frac{\text{мм}}{\text{мм}}$

ε<sub>1,2</sub> · 10<sup>6</sup> =  $\frac{210 - 490}{2} \pm \frac{1}{2} \sqrt{(-2 \cdot 170 - 210 + 490)^2 + (-490 - 210)^2}$

ε<sub>1,2</sub> · 10<sup>6</sup> = -140 ±  $\frac{1}{2} \sqrt{(-60)^2 + (-700)^2}$  = -140 ± 351,283

ε<sub>1</sub> = 211,283 · 10<sup>-6</sup>  $\frac{\text{мм}}{\text{мм}}$     ε<sub>2</sub> = -491,283 · 10<sup>-6</sup>  $\frac{\text{мм}}{\text{мм}}$

tg 2α\* =  $\left| \frac{-700}{-60} \right| = 11,667 \Rightarrow \alpha_0^* = 42,55^\circ$   
α<sub>0</sub> = 90° - α<sub>0</sub>\* = 47,45° ↙

σ<sub>1</sub> =  $\frac{21 \cdot 10^4}{1 - 0,3^2} (211,283 - 0,3 \cdot 491,283) \cdot 10^{-6} = 1,4 \text{ тн/см}^2$

σ<sub>2</sub> =  $\frac{21 \cdot 10^4}{1 - 0,3^2} (-491,283 + 0,3 \cdot 211,283) \cdot 10^{-6} = -9,87 \text{ тн/см}^2$  ✓

СТАВЪ 2:    ε<sub>+45</sub> = 410 · 10<sup>-6</sup>    ε<sub>0</sub> = 450 · 10<sup>-6</sup>    ε<sub>-45</sub> = -270 · 10<sup>-6</sup>

ε<sub>1,2</sub> · 10<sup>6</sup> =  $\frac{410 - 270}{2} \pm \frac{1}{2} \sqrt{(2 \cdot 450 - 410 + 270)^2 + (-270 - 410)^2}$

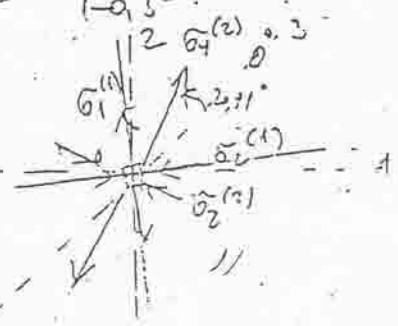
ε<sub>1,2</sub> · 10<sup>6</sup> = 70 ±  $\frac{1}{2} \sqrt{(760)^2 + (-680)^2}$  = 70 ± 509,902

ε<sub>1</sub> = 579,902 · 10<sup>-6</sup>  $\frac{\text{мм}}{\text{мм}}$     ε<sub>2</sub> = -439,902 · 10<sup>-6</sup>  $\frac{\text{мм}}{\text{мм}}$

tg 2α\* =  $\left| \frac{-680}{760} \right| = 0,8947 \Rightarrow \alpha_0^* = 20,91^\circ = \alpha_0$  ↘

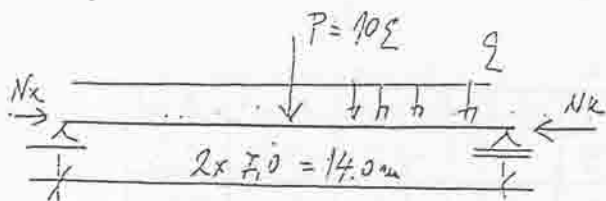
σ<sub>1</sub> =  $\frac{21 \cdot 10^4}{1 - 0,3^2} (579,902 - 0,3 \cdot 439,902) \cdot 10^{-6} = 10,34 \text{ тн/см}^2$

σ<sub>2</sub> =  $\frac{21 \cdot 10^4}{1 - 0,3^2} (-439,902 + 0,3 \cdot 579,902) \cdot 10^{-6} = -6,14 \text{ тн/см}^2$



- Постоян и квадратична и квадратична разликата и то ва е за р<sub>1</sub> и р<sub>2</sub> тиску и се определя само по дефиниции и не е нужно да се намира.

B.



$$q = 2 \text{ [кН/м]}$$

$$P = 102 \text{ [кН]}$$

$$\max M = \frac{P l}{4} + \frac{1}{8} q l^2 =$$

$$= 14 \frac{102}{4} + \frac{1}{8} 2 \cdot 14^2 = 357 + 245 =$$

$$\max M = 59,5 \text{ [кНм]}$$

$q$  - безразмерный параметр

Сила  $\gamma$  кабу:

$$A_{\bar{x}(1)} = 0,7 \frac{2\pi}{4} = 0,385 \text{ см}^2 \quad A_k = 2 \times 6 \times A_{\bar{x}(1)} = 4,62 \text{ см}^2$$

$$\bar{\sigma}_x = C \cdot l^2 \cdot l^2 = 3,2 \cdot 10^{-7} \cdot 200^2 \cdot 100^2 = 128 \text{ кН/см}^2$$

$$N_k = \bar{\sigma}_x \cdot A_k = 128 \cdot 4,62 = 591,36 \text{ кН}$$

$$e_k = \frac{60}{2} - 20 = 10 \text{ см}$$

$$M_k = N_k \cdot e_k = 591,36 \cdot 10 = 5913,6 \text{ кНсм}$$

+ замязание

$$A_g = 60 \cdot 40 - 2 \cdot 12,5 \cdot 30 = 1650 \text{ см}^2$$

$$J_g = \frac{1}{12} (60^3 \cdot 40 - 2 \cdot 12,5 \cdot 30^3) = 663750 \text{ см}^4$$

$$W_g = \frac{J_g}{30} = 22125 \text{ см}^3$$

Напоми ої претходног напрезата:

$$\bar{\sigma}_g^{\text{dol}} = - \frac{591,36}{1650} \pm \frac{5913,6}{22125} = -0,358 \pm 0,267$$

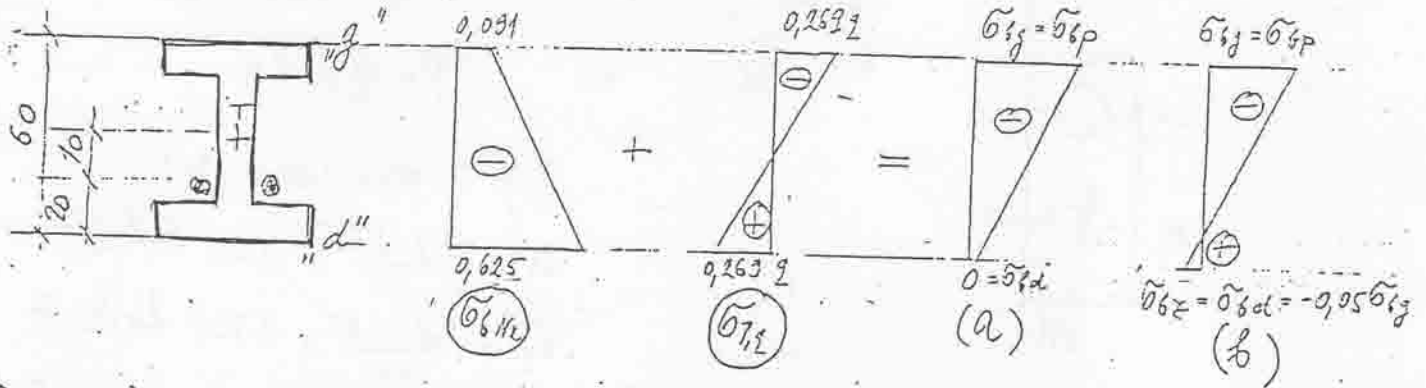
$$\bar{\sigma}_g^g = -0,358 + 0,267 = -0,091 \text{ кН/см}^2$$

$$\bar{\sigma}_g^d = -0,358 - 0,267 = -0,625 \text{ кН/см}^2$$

- Напомни от опъреженье:

$$\max M = 59,5 \cdot q \text{ kN/m} = 5950 \text{ g kN/cm}$$

$$\tilde{\sigma}_{\delta}^{g,d} = \mp \frac{5950 \text{ g}}{22125} = \mp 0,269 \cdot q \text{ [kN/cm}^2\text{]}$$



a)  $\tilde{\sigma}_{\delta z} = \tilde{\sigma}_{\delta d} = 0 = -0,625 + 0,269 \cdot q$

$$q = \frac{0,625}{0,269} = 2,323$$

опъреженье:  $q = 2,323 \text{ kN/m'}$

$$P = 10q = 23,23 \cdot \text{kN}$$

б)  $\tilde{\sigma}_{\delta z} = \tilde{\sigma}_{\delta d} = -0,05 \cdot \tilde{\sigma}_{\delta g}$

$$0,269 \cdot q - 0,625 = -0,05(-0,091 - 0,269 \cdot q)$$

$$0,269 \cdot q - 0,625 = 0,0046 + 0,0135 \cdot q$$

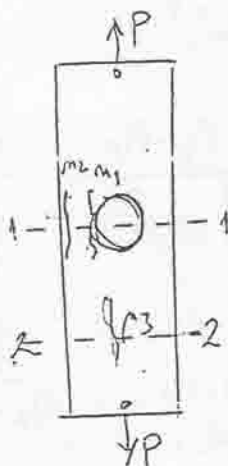
$$0,256 \cdot q = 0,6296$$

$$q = 2,459$$

$$q = 2,459 \text{ kN/m'}$$

$$P = 24,59 \cdot \text{kN}$$

4.



$$m = \frac{d}{c} (\sigma_1 - \sigma_2)$$

$$\sigma_2 = 0$$

$$\sigma_1 = \frac{m \cdot P}{\alpha}$$

a) γ пресека 2-2:

$$\sigma_1 = \frac{P}{A} = \frac{P}{8.05} = \frac{5 \cdot 0.115}{0.5} = 1.15 \frac{\text{kN}}{\text{cm}^2}$$

$$P = 4.6 \text{ kN}$$

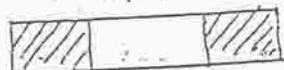
δ) γ пресека 1-1

$$\sigma_1^1 = \frac{12.1 \cdot 0.115}{0.5} = 2.783 \frac{\text{kN}}{\text{cm}^2}$$

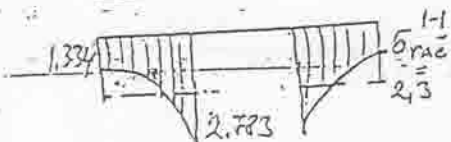
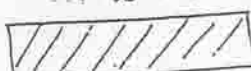
$$\sigma_1^2 = \frac{5.8 \cdot 0.115}{0.5} = 1.334 \frac{\text{kN}}{\text{cm}^2}$$

$$\sigma_{\text{rae}}^1 = \frac{4.6}{0.5 \cdot (2+2)} = 2.3 \frac{\text{kN}}{\text{cm}^2}$$

1-1



2-2



$$b) \alpha = \frac{\sigma_{\text{max}}}{\sigma_{\text{rae}}} = \frac{2.783}{2.3} = 1.21$$

$$\Gamma) \sigma = \sigma_e \cdot \frac{2.1 \cdot 10^4}{200} = \sigma_e \cdot 1 = 70 \Rightarrow$$

$$\sigma_e = \frac{E_e}{E_b}$$

$$\sigma_e = \frac{2.1 \cdot 10^4}{0.13 \cdot 10^4} = \sigma_e \cdot \sigma_e = 7$$

$$\sigma_e = 1.0$$

$$\sigma_{1p} = 2.783 \cdot 7.0 = 19.4 \frac{\text{kN}}{\text{cm}^2}$$

$$\sigma_{2p} = 1.334 \cdot 7 = 9.34 \frac{\text{kN}}{\text{cm}^2}$$

$$\sigma_{3p} = 1.15 \cdot 7 = 8.05 \frac{\text{kN}}{\text{cm}^2}$$