

LIK

LABORATORIJA ZA
ISPITIVANJE
KONSTRUKCIJA

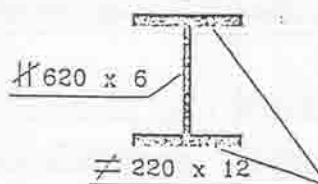
IMK

INSTITUT ZA
MATERIJALE I
KONSTRUKCIJE



Ispitivanje konstrukcija - OKTOBAR-aps.- 2003. -25.10.2003... pismeni deo ispita

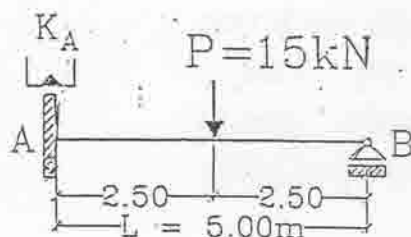
1. Na čeličnoj gredi, poprečnog preseka prema skici, merena je promena krivine u merodavnom preseku. Rezultati merenja dati su u tablici, a merenje je izvršeno standardnim mehaničkim krivinomerom ($U_s=100$). Odrediti presečnu silu koja odgovara ovoj deformaciji. Koliko bi čitanje \check{C}_p bilo na ugobomeru da je upotrebljen ugibomer uvećanja $U_u=1000$.



stanje	U_1
0	0236
P	0238

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2. Za nosač prema skici dati su podaci merenja u tablici. Odrediti stepen i momenat elastičnog uklještenja u osloncu A.



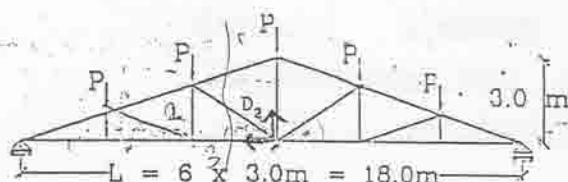
stanje	K_A
0	0 + 073
P	0 + 237
0	0 + 071

$$E_a = 2.1 \times 10^4 \text{ kN/cm}^2$$

$$I_{220} = J = 3060 \text{ cm}^4$$

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3. Na štapu D_2 čelične krovne rešetke pri probnom opterećenju mereno je deformacijsko stanje merenim trakama. Odredit: a/ Sve presečne sile u štapu b/ Odrediti veličnu probnog opterećenja P. ($k_1=2.00$, $k_2=2.15$).

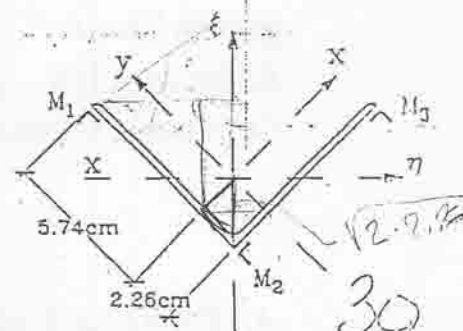


$$L 80 \times 80 \times 8 \dots E_s = 2.1 \times 10^4 \text{ kN/cm}^2$$

$$J_x = J_y = 72.3 \text{ cm}^4 \quad J_z = 115.0 \text{ cm}^4$$

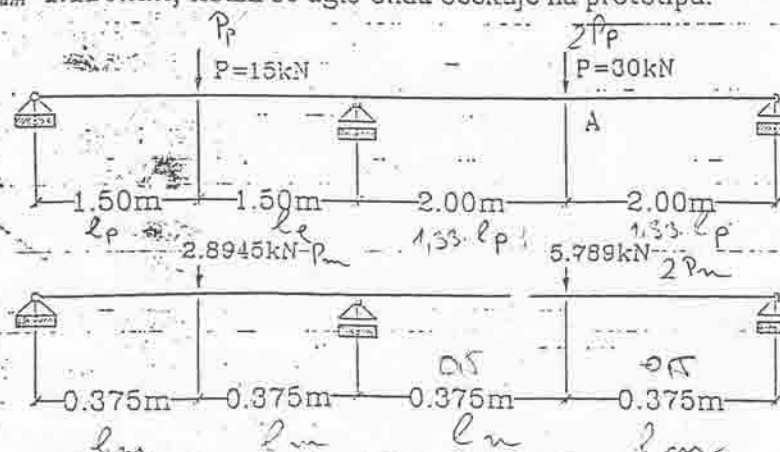
$$J_\eta = 29.6 \text{ cm}^4 \quad A = 12.3 \text{ cm}^2$$

stanje	M_1	M_2	M_3
0	11920	9130	8750
P	11646	8914	8476
0	11922	9130	8752



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4. Dati su prototip i model. Odrediti: a/ Koja sličnost je u pitanju i obrazložiti zašto; b/ Odrediti razmeru za ugibe preko jednačine predviđanja za ugib tačke A. Ako je izmereno na modelu $v_{am}=1.120 \text{ mm}$, koliki se ugib onda očekuje na prototipu.



$$E_p = 2.1 \times 10^4 \text{ kN/cm}^2 \quad a_p = 8$$

$$d = 60 \text{ mm}$$

$$b = 50 \text{ mm}$$

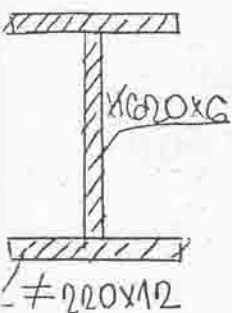
$$E_m = 0.7 \times 10^4 \text{ kN/cm}^2$$

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1.

OKLOBAR, auc. 1003
25.10.2003

Крутиломер $U_u = 100$

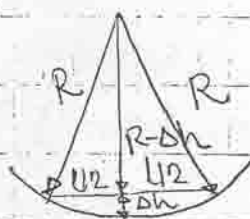
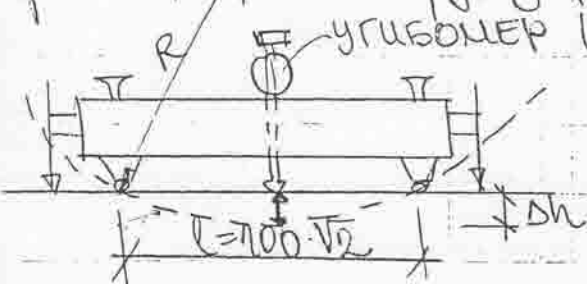


	u_1
0	0236
P	0238
Δ	2
ϵ	0,02 $\Rightarrow \Delta h$ [mm]

$$\epsilon = \Delta \cdot p_u$$

$$p_u = \frac{1}{U_u} = \frac{1}{100}$$

Крутиломер - конструкция и погрешность



$$R^2 = (R - \Delta h)^2 + \left(\frac{l}{2}\right)^2$$

$$R^2 = R^2 - 2R\Delta h + \frac{200^2 \cdot 2}{4}$$

$$\Rightarrow R = \frac{10^4}{\Delta h} \quad \Delta h \text{ [mm]}$$

$$\mathcal{K} = \frac{1}{R} = -\frac{M}{EI} - \text{кривизна}$$

$$E = 2,1 \cdot 10^4 \text{ kN/cm}^2$$

$$I = \frac{1}{12} \cdot 0,6 \cdot 62^3 + 2 \cdot \frac{1}{12} \cdot 1,23 \cdot 22^3 + 2 \cdot 22 \cdot 1,2 \cdot 31,6^2 = 64646,7 \text{ cm}^4$$

$$EI = 2,1 \cdot 10^4 \cdot 64646,7 = 135758,08 \cdot 10^4 \text{ kN/cm}^2$$

$$\Delta h = 0,02 \quad \Delta h = (238 - 236) \cdot \frac{1}{100} = 0,02 \text{ mm} = 2 \cdot 10^{-3} \text{ cm}$$

$$R = \frac{10^4}{\Delta h} = \frac{10^4}{0,02} = 50 \cdot 10^4 = 500 \text{ m}$$

$$\mathcal{K} = \frac{1}{R} = \frac{1}{500} = 0,002 \frac{1}{m}$$

Пресечне силе:

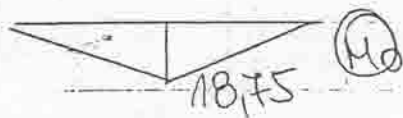
$$\mathcal{K} = -\frac{M}{EI} \Rightarrow M = -\mathcal{K} \cdot EI = 0,002 \cdot 135758,08 = -271,52 \text{ kNm}$$

Читање \check{c}_p за $U_u = 1000$

$$\Delta h = (\check{c}_p - \bar{c}_0) \cdot \frac{1}{U_u} \Rightarrow \check{c}_p = \Delta h \cdot U_u + \bar{c}_0$$

$$= 0,02 \cdot 100 + 236 = 256 = 0256$$

Степень и момент эластичного упрочнения


$$E_C = 2.1 \times 10^4 \text{ kN/cm}^2$$

$$I_{220} : I = 3060 \text{ a.u.}^4$$

меней шайалот укештен

$$\delta_{11}x_1 + \delta_{10} = 0$$

$$\Rightarrow x_1 = -\frac{\delta_{10}}{\delta_{11}}$$

$$EI\delta_{11} = \frac{5}{3} \cdot 10^2 = \frac{5}{3}$$

$$EI \delta_{10} = -\frac{5}{8} \cdot \frac{3}{2} \cdot 1 \cdot 18,75 - \frac{5}{3} \cdot 14,062$$

$$M_A = -\frac{\delta_{10}}{\delta_{11}} = 14,062 \text{ kNm}$$

определенная жесткость

$$EI = 2.1 \cdot 10^4 \cdot 3060 = 6426 \cdot 10^4 \text{ kNm}^2 = 6426 \text{ kNm}^2$$

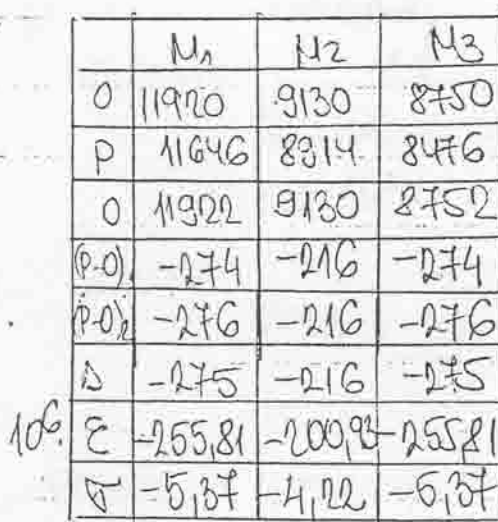
$$M_{A,el} = -\frac{3EI}{l} \cdot \theta_d + M_A = -\frac{3 \cdot 0,426}{5} \cdot 8,475 \cdot 10^{-4} + 14,0625 = 10,795 \text{ kNm}$$

Задан ел. уквештења

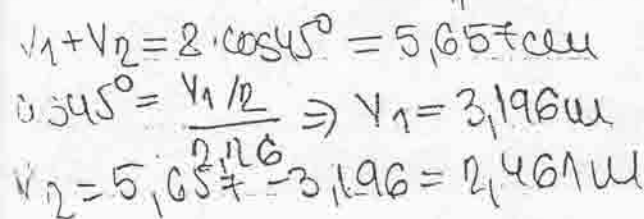
$$\Delta L_{\text{max}} = \Delta L_{\text{max, spez}} \cdot \sigma_{\text{spez}} = \frac{1}{EI} \cdot \frac{5}{3} \cdot M_A = \frac{1}{6400} \cdot \frac{5}{3} \cdot 14,0825 = 36,473 \cdot 10^{-4}$$

$$\eta_A = \left(\frac{1 - \lambda_{A, \text{men}}}{\lambda_{A, \text{rac}}} \right) \cdot 100 = \left(1 - \frac{8.475}{36.473} \right) \cdot 100 = 76.76\%$$

Решетка - пресечение силе и величина притока отсречено


$$\rho = 1 \cdot 10^{-6} \frac{\text{mm}}{\text{mm}}$$

Пресеците сине:

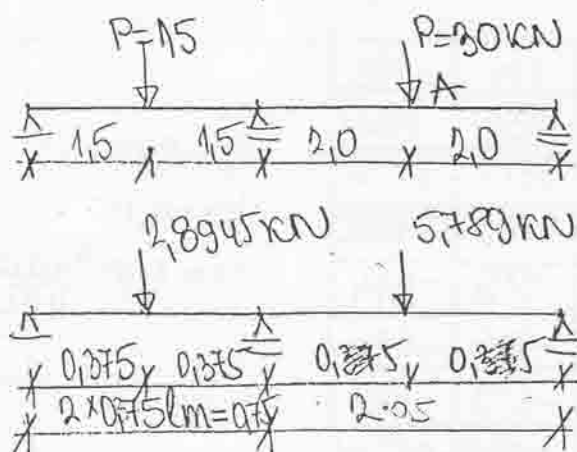


$$\eta = \frac{I_2}{V_1} = 0,65 \cdot \frac{29,6}{3,196} = 6,02 \text{ KWH/KWH}$$

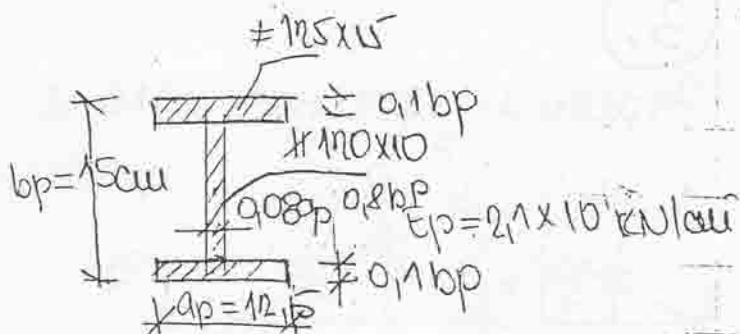
$$\Rightarrow \underline{P = 33,22 \text{ kW}}$$

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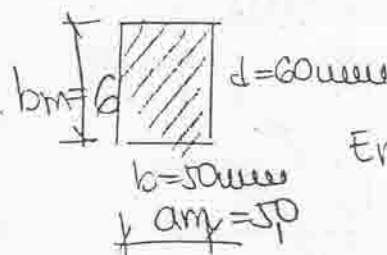
Модел и прототип



прототип



модел



$E_m = 0.7 \times 10^{11} \text{ kN/m}^2$

Која је сличност у типичну и зашто

одлична геометријска сличност \rightarrow различити облик поп. пресека
различити материјал

размере:

размера за гужине:

$l_p = 2.0 \text{ m}$; $l_m = 0.5 \text{ m}$

$r_l = \frac{l_p}{l_m} = \frac{2}{0.5} = 4$

размера за силе

$P_p = 15 \text{ kN}$; $P_m = 2.8945$

$r_p = \frac{P_p}{P_m} = \frac{15}{2.8945} = 5.182$

размера за момент инерције

$I_p = \frac{1}{12} (0.08 a_p \cdot 0.8^3 b_p^3 + 2 \left(\frac{1}{12} a_p \cdot 0.1^3 b_p^3 + 0.45^2 b_p^2 \cdot a_p \cdot 0.1 b_p \right))$
 $= \frac{0.52896}{12} a_p \cdot b_p^3 = c_p \cdot a_p \cdot b_p^3$

$I_m = \frac{1}{12} a_m \cdot b_m^3 = c_m \cdot a_m \cdot b_m^3$

$r_I = \frac{I_p}{I_m} = \frac{c_p a_p \cdot b_p^3}{c_m a_m \cdot b_m^3} = c_I \cdot r_a \cdot r_b^3$

$r_I = c_I \cdot r_{prop}^4$

$\Rightarrow \exists r_l, r_{prop}, r_p$ и $c_I \leq 1 \Rightarrow$ одлична геом. сличност

$r_E = \frac{E_p}{E_m} = \frac{2.1}{0.7} = 3$

$$\begin{aligned} U_A &= \frac{0.58825}{3} \frac{P l^3}{EI} \\ \Rightarrow \text{проп. ј-не: } \frac{U_{AP}}{l_p} &= \frac{0.58825}{3} \frac{P_p}{E_p l_p^2} \frac{l_p^4}{I_p} \\ \frac{U_{AM}}{l_m} &= \frac{0.58825}{3} \frac{P_m}{E_m l_m^2} \frac{l_m^4}{I_m} \\ \Rightarrow \text{ј-не преобликовања} \\ \frac{U_{AP}}{l_p} &= \frac{0.58825}{3} \frac{P_p}{E_p l_p^2} \frac{l_p^4}{I_p} \\ \frac{U_{AM}}{l_m} &= \frac{0.58825}{3} \frac{P_m}{E_m l_m^2} \frac{l_m^4}{I_m} \\ \frac{U_{AP}}{U_{AM}} \cdot \frac{l_m}{l_p} &= \frac{P_p}{P_m} \cdot \frac{E_m}{E_p} \left(\frac{l_m}{l_p} \right)^2 \cdot \left(\frac{l_p}{l_m} \right)^4 \cdot \frac{I_m}{I_p} \\ r_U &= r_p \cdot \frac{1}{r_E} \cdot r_l^3 \cdot \frac{1}{r_I} = \frac{r_p \cdot r_l^3}{c_I \cdot r_{prop}^4 \cdot r_E} = \frac{5.182 \cdot 4^3}{0.52896 \cdot 3^4} = 5.350 \end{aligned}$$

$r_a = \frac{a_p}{a_m} = \frac{12.5}{50} = 2.5$

$r_b = \frac{b_p}{b_m} = \frac{15}{6} = 2.5$

$r_{prop} = r_a = r_b = 2.5$

$c_I = \frac{c_p}{c_m} = 0.52896$