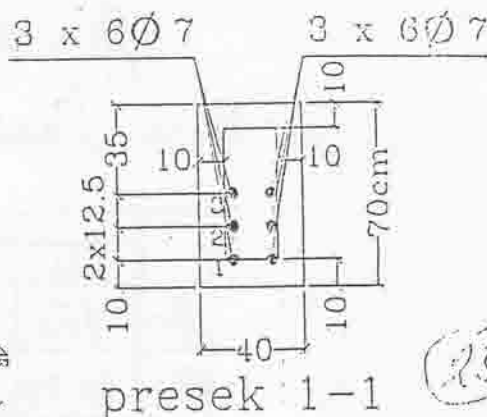
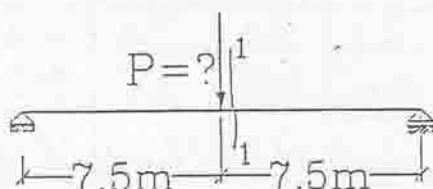


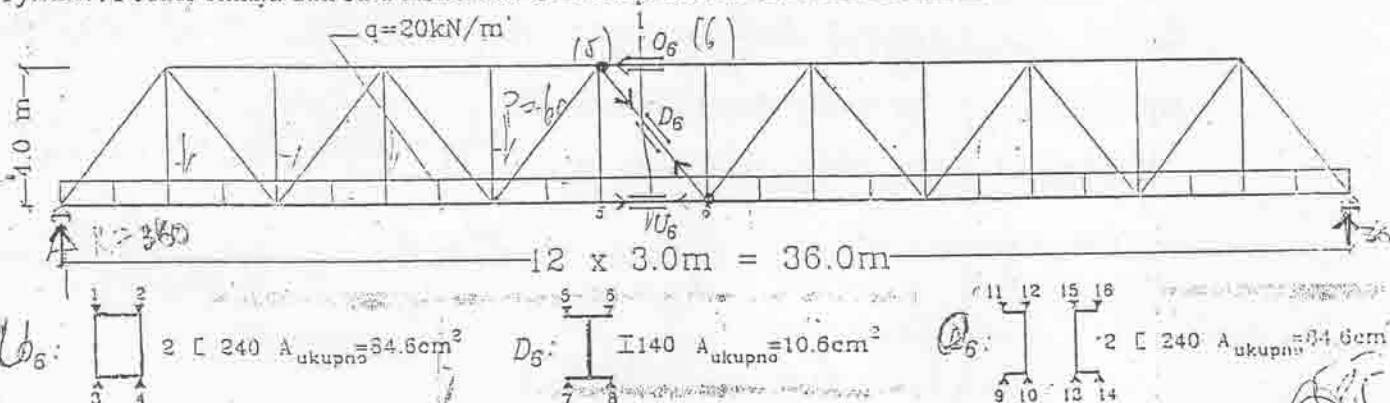
Ispitivanje konstrukcija - SEPTEMBAR-1-2002. 05.09.2002 ... pismeni deo ispita

1. Na prethodno napregnutoj betonskoj gredi pre eksploatacionog opterećenja izmerene su frekvencije žica pri oscilovanju na dužini $l_0 = 90\text{cm}$. Odrediti opterećenje P uz uslov da napon na donjoj ivici preseka bude jednak nuli. Obavezno u obzir uzeti sopstvenu težinu nosača.

Žica	1	2	3
• levo	155	158	149
desno	150	150	145



2. Na rešetkastom nosaču, prema skici, merene su lokalne deformacije metodom opasivanja preseka deformetrom Pfänder. Podaci čitanja dati su u tablicama. Odrediti presečene sile i dati komentar.



Štap U_6 :

sta nje	1	2	3	4
0	0571	0236	0184	0220
q	0613	0279	0223	0265

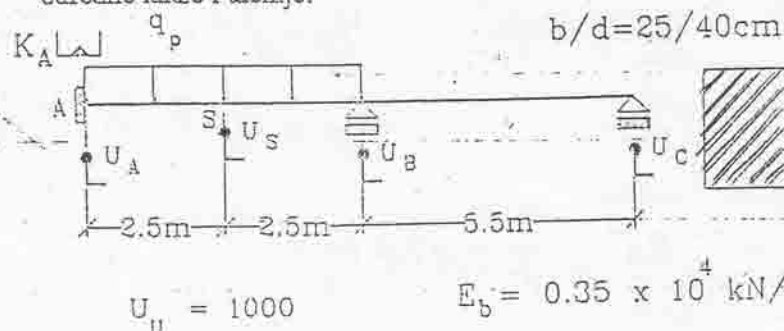
Štap D_6 :

sta nje	5	6	7	8
0	0184	0221	0385	0232
q	0199	0240	0403	0252

Štap O_6 :

sta nje	9	10	11	12	13	14	15	16	K
0	0632	0335	0386	0223	0189	0732	0812	0711	0185
q	0595	0346	0346	0180	0150	0693	0768	0660	0187

3. Nosač prema skici ispitivan je probnim opterećenjem. Rezultati ispitivanja dati su u tablici. Potrebno je odrediti:
a/ Veličinu probnog opterećenja q ;
b/ Momenat elastičnog uklještenja M_A i stepen uklještenja;
c/ Koji mereni podatak nedostaje da bi se tražene veličine odredile lakše i tačnije.



sta nje	U_A	U_S	U_B	U_C	K_A
0	0464	0461	0237	0359	0 + 245
q	0464	0804	0237	0359	0 + 010

$U_u = 1000$

$E_b = 0.35 \times 10^4 \text{ kN/cm}^2$

3. Na modelu ploče opterećene upravno na srednju ravan dobijene su Moare linije za X i Y osu. Naći u tački A momente M_x i M_y . Interpretirati te podatke na odgovarajući prototip. (Skica je data na poledini zadatka)

1.

- сечение балки $174 - 100 \times 100$:

$$A_b = 0,4 \cdot 0,7 - 0,2 \cdot 0,5 = 0,18 \text{ м}^2; \quad I_b = 25,0 \text{ см}^4$$

$$q = 0,18 \cdot 25,0 = 4,5 \text{ кН/м}^2$$

- сила притяжения к поверхности - q - 100×100 мм

	1л	2л	3л	4л	5л	6л
F_{ki}	155	156	149	150	150	145
G_{ki}	62,27	63,08	57,54	58,32	58,32	54,50
E_{ki}	25	12,5	0	25	12,5	0
N_{ki}	143,84	145,71	132,92	134,72	134,72	125,90

$$\sigma_{ki} = \frac{F_{ki}}{A_b}$$

$$I_0 = 90 \text{ см}^4$$

$$M_{ki} = A_{ki} \cdot \sigma_{ki}$$

$$A_{ki} = 6 \cdot 0,7 \cdot 7$$

сила притяжения к поверхности: $N_k = \sum N_{ki} = 817,81 \text{ кН}$

моменты (у откоса на балку)

пресекать ось симметрии

$$M_k = \sum M_{ki} = 104,69 \text{ кНм}$$

$$\sigma_{b,kl} = \frac{N_k}{A_b} = - \frac{817,81}{0,18} = -4543,39 \frac{\text{кН}}{\text{см}^2} = -0,454 \frac{\text{кН}}{\text{см}^2}$$

(- приращение)

$$\sigma_{b,k} = \pm \frac{M_k}{W_b} = \pm \frac{104,69 \cdot 100}{26714,3} = \pm 0,392 \frac{\text{кН}}{\text{см}^2}$$

$$J_b = \frac{1}{12} (40 \cdot 70^3 - 20 \cdot 50^3) = 935000 \text{ см}^4 \quad W_b = \frac{J_b}{35} = 26714,3 \text{ см}^3$$

$$\sigma_{b,g}^k = -0,454 + 0,392 = -0,062 \frac{\text{кН}}{\text{см}^2}$$

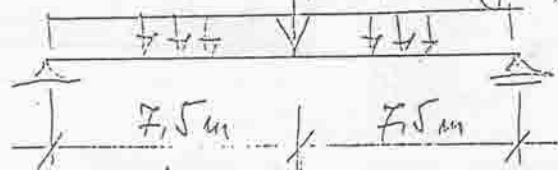
$$\sigma_{b,d}^k = -0,454 - 0,392 = -0,846 \frac{\text{кН}}{\text{см}^2}$$

- нагрузка со стороны откоса:

$$P = ? \quad q = 4,5 \text{ кН/м}^2$$

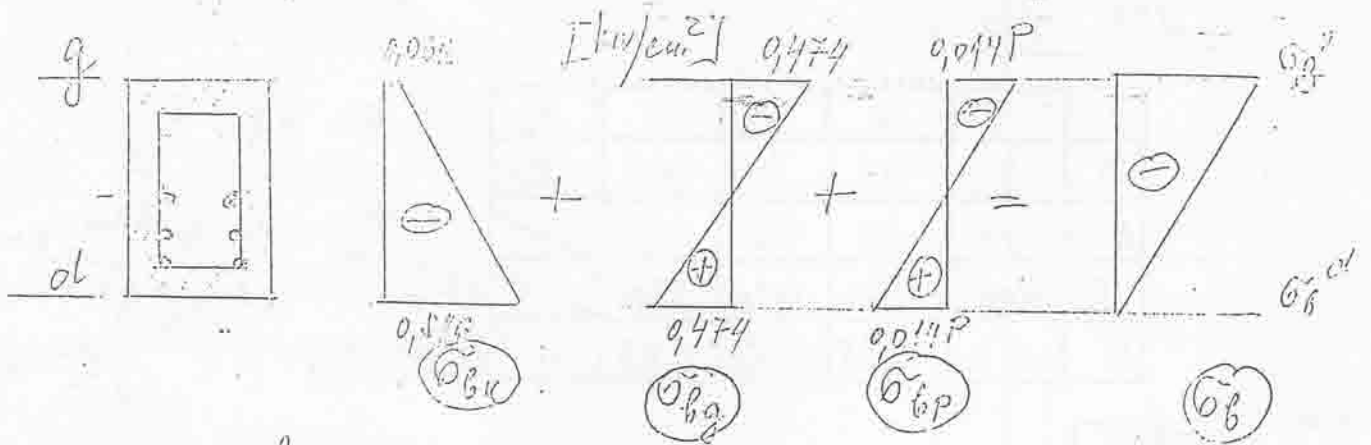
$$M_g = \frac{1}{8} \cdot 4,5 \cdot 15^2 = 126,5625 \text{ кНм}$$

$$M_p = \frac{1}{4} \cdot P \cdot 15 = 3,75 P \text{ кНм}$$



$$\sigma_{b,g}^d = - \frac{126,5625}{26714,3} = -0,474 \frac{\text{кН}}{\text{см}^2}$$

$$\sigma_{b,d}^d = - \frac{3,75 \cdot 600}{26714,3} = -0,0474 \frac{\text{кН}}{\text{см}^2}$$



new condition: $\sigma_{bd} = 0$

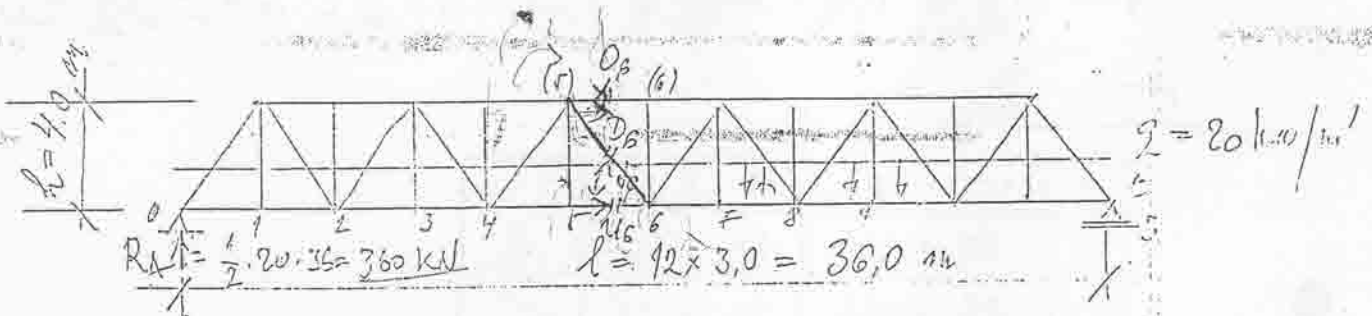
$$\sigma_{bk} + \sigma_{bg} + \sigma_{bp} = -0,846 + 0,474 + 0,014P = 0$$

$$P = \frac{0,372}{0,014} = 26,57 \text{ kN}$$

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2.

parabolic hyperbolic curve of the beam:



$$M_5 = M(5) = 360 \cdot 5 \cdot 3 - 20 \cdot \frac{(5 \cdot 3)^2}{2} = 3150 \text{ kNm}$$

$$M_6 = M(6) = 360 \cdot 6 \cdot 3 - 20 \cdot \frac{1}{2} (6 \cdot 3)^2 = 3240 \text{ kNm}$$

$$\text{sec } \gamma_{D6} = 1,6$$

$$h_5 = h_6 = 4,0 \text{ m}$$

$$\sigma_6 = - \frac{M_6}{h_6} = - \frac{3240}{4} = - 810 \text{ kN/m}$$

$$u_6 = \frac{M(5)}{h_5} = \frac{3150}{4} = 787,5 \text{ kN}$$

$$D_6 = \left(\frac{M_6}{h_6} - \frac{M(5)}{h_5} \right) \text{sec } \gamma_{D6} = (810 - 787,5) \cdot 1,6 = 37,50 \text{ kN}$$

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— мереже: општегласни чина и симболирања;

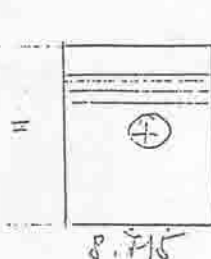
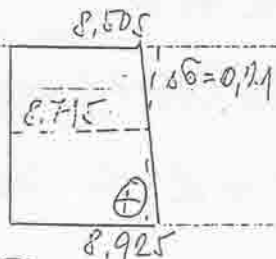
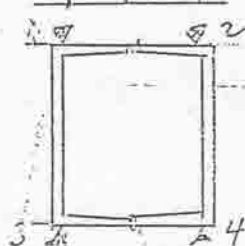
штап U_6 :

ст.	1	2	3	4	K
Δ	42	43	44	45	2
$\Delta-\Delta$	40	41	42	43	
E	400	410	420	430	
G	8.4	8.61	8.82	9.03	

$$E = \Delta \sigma \cdot p$$

$$p_{pf} = 10 \cdot 10^{-6} \text{ mm/mm} \quad (+ 3 \text{ A} \cdot 10^{-6} \text{ A} \cdot 10^{-6})$$

$$\frac{E}{\Delta \sigma} = \frac{E}{\Delta \sigma} \cdot E \quad (E = 2,1 \cdot 10^4)$$



$$G \text{ [kN/cm}^2]$$

$$\sigma_{\text{R}} = 8.715$$

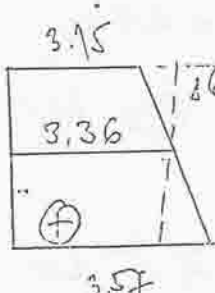
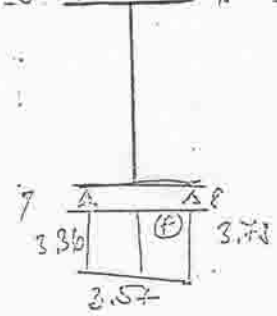
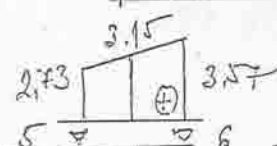
$$\Delta \sigma = 0.21$$

$$N - U_{G, \text{нр}} = \sigma_{\text{R}} \cdot A_{UG} = 8.715 \cdot 84.6 = 737.29 \text{ kN}$$

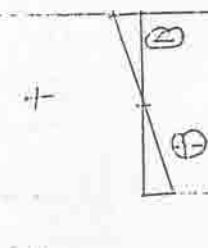
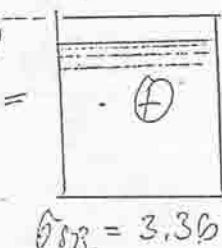
штап D_6 :

ст.	5	6	7	8	K
Δ	15	19	18	20	2
$\Delta-\Delta$	13	17	16	18	
E	130	170	160	180	
G	2.73	3.57	3.36	3.78	

$$\times 10^{-6} \text{ mm/mm}$$



$$G \text{ [kN/cm}^2]$$

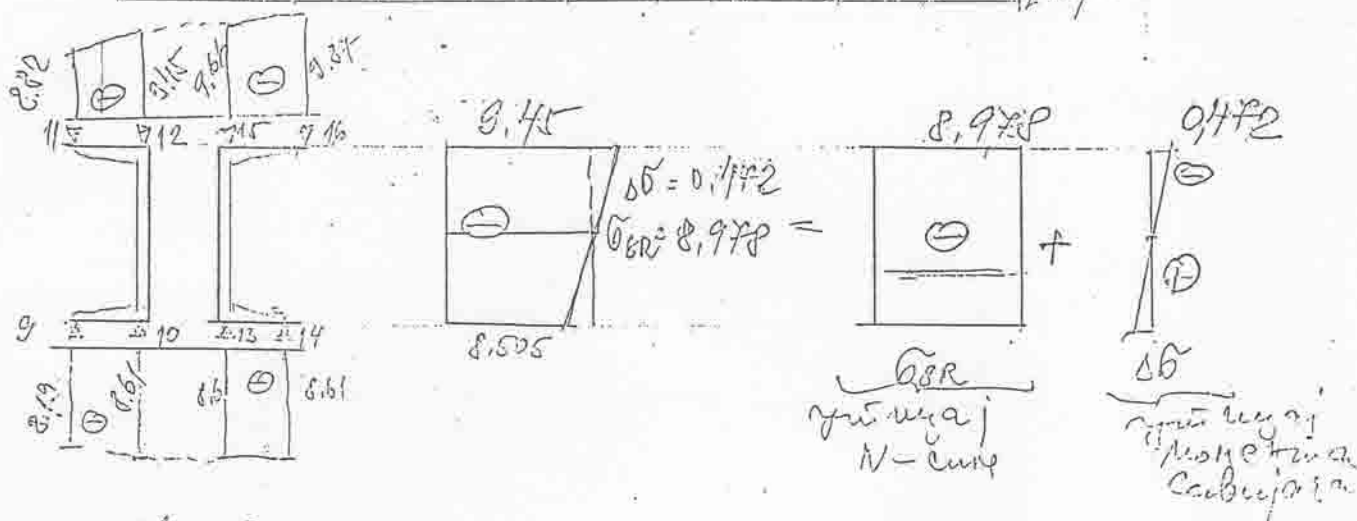


$$\Delta \sigma = 0.21$$

$$N - D_{6, \text{нр}} = \sigma_{\text{R}} \cdot A_{D6} = 3.36 \cdot 10.6 = 35.62 \text{ kN}$$

Ст.	5	10	14	12	13	14	15	16	K
Δ	-37	-39	-40	-43	-39	-39	-44	-45	2
b-ΔK	-39	-41	-42	-45	-41	-41	-46	-47	—
ε	-390	-410	-420	-450	-410	-410	-460	-470	—
σ	-8.19	-8.61	-8.32	-9.45	-8.61	-8.61	-9.66	-9.87	—

$\times 10^{-6} \frac{\text{mm}}{\text{mm}}$
 mm^2



$$N = \sigma_{\delta, \text{мер.}} = \sigma_{\delta} \cdot A_{\delta} = -8.978 \cdot 84.6 = -759.50 \text{ kN}$$

— коментари /

Грешке од нормалне силе су примарни резултат а грешке од моментна сабијања су секундарни. С обзиром да су мерење не само на ерозивним деловима од С.Т.

$$\Delta u_6 = \frac{u_{6, \text{рал}} - u_{6, \text{мер.}}}{u_{6, \text{рал}}} \cdot 100 = \frac{787.5 - 737.29}{787.5} \cdot 100 = 6.38\%$$

$$\Delta D_6 = \frac{37.50 - 35.62}{37.50} \cdot 100 = 5.01\%$$

$$\Delta \sigma_6 = \frac{|-8.19| - |-759.50|}{|-8.19|} \cdot 100 = 6.23\%$$

Грешке су изобилаженим триугао (до 10%) мерење је добро. Грешке одбацили због идеализације релативног модела.

3.

от.	u _A	u _B	u _C	u _D	K _K
Б	0	343	0	0	15
гид.	0	0,343 мм	0	0	15,9"

$$u_u = 1000$$

$$P_{av} = 900 / \text{mm}$$

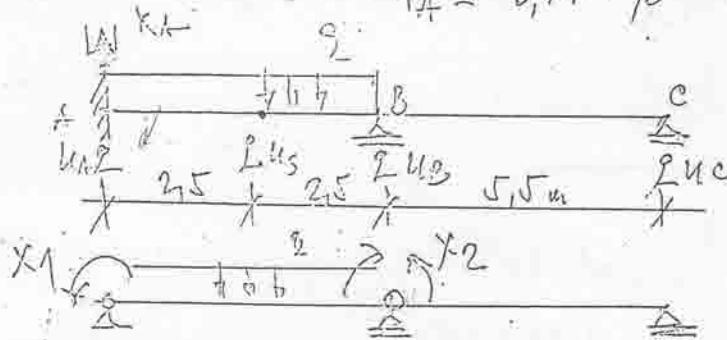
$$P_K = 1,06''$$

$$u_B = 0,343 \text{ мм}$$

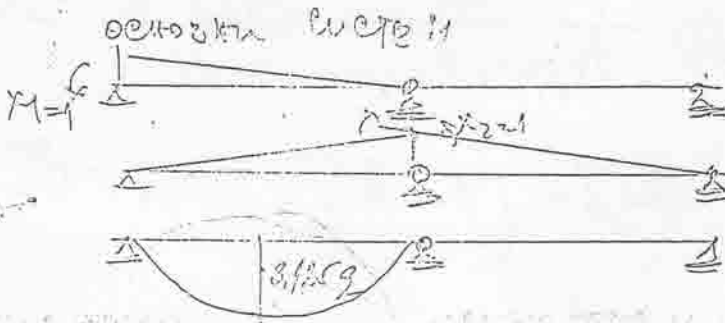
$$\varphi_A = 0,77 \cdot 10^{-4} \text{ рад}$$

$$J_B = \frac{1}{12} \cdot 9250 \cdot 1^3 = 9250 \text{ см}^4$$

$$E J_B = 46666,6 \text{ МПа} \cdot \text{см}^4$$



Р₁ } отсюда
2 } в уравнении



$$E J \delta_{11} = \frac{5}{3} \cdot 1^2$$

$$E J \delta_{12} = \frac{5}{6} \cdot 1^2$$

$$E J \delta_{22} = \frac{10,5}{3}$$

$$M_0 E J \delta_{10} = \int M_1 M_0 ds = E J \int \varphi_1 \varphi_0$$

$$E J \delta_{10} = - \frac{5}{3} \cdot 1 \cdot 3,125 \cdot 2 = -46666,6 \cdot (-1 \cdot 0,77 \cdot 10^{-4}) = - \frac{15,625}{3} \cdot 2 + 3,593$$

$$E J \delta_{20} = - \frac{5}{3} \cdot 1 \cdot 3,125 \cdot 2 = - \frac{15,625}{3} \cdot 2$$

$$\frac{5}{3} X_1 + \frac{5}{6} X_2 = \frac{15,625}{3} \cdot 2 \quad 3,593 \quad / \cdot 6$$

$$\frac{5}{6} X_1 + \frac{10,5}{3} X_2 = \frac{15,625}{3} \cdot 2$$

$$10 X_1 + 5 X_2 = 31,25 \cdot 2 = 21,578$$

$$5 X_1 + 21 X_2 = 31,25 \cdot 2$$

$$\left. \begin{aligned} &+ \Rightarrow -37 X_2 = -31,25 \\ &- 21,578 \end{aligned} \right\} (1-2) \cdot 2$$

$$X_2 = 0,845 \cdot 2 + 0,583$$

$$X_1 = 2,701 \cdot 2 = 2,449$$

a) сдвиги



(M)

$$E J u_3 = \int M u_3 ds = \int M (M_0 + X_1 M_1 + X_2 M_2)$$

$$E J u_3 = \frac{5}{3} \cdot 1,25 \cdot 3,125 \cdot 2 \cdot \frac{5}{4} - \frac{5}{6} \cdot 2 \cdot 1,25 \cdot 1 (0,845 \cdot 2$$

$$+ 0,583 + 2,701 \cdot 2 - 2,449) = \frac{0,77 \cdot 66625}{12} \cdot 2 - 1,5625 (3,576 \cdot 2 - 1,8)$$

$$46666,6 \cdot 0,343 \cdot 10^{-3} = 25972 + 2,516$$

$$|Q = 5,041 \text{ kN/m}^2|$$

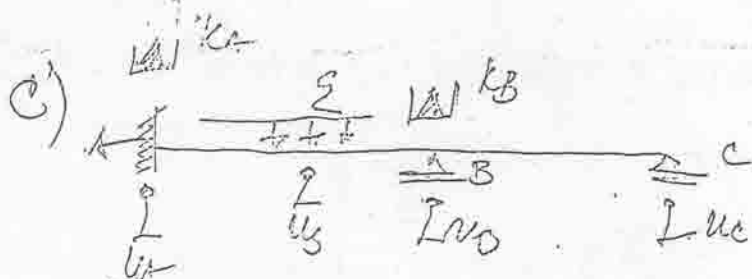
b) $M_A^{el} = X_1 = 2,7012 - 2,449 = 2,701 - 5,041 - 2,449$

$$M_A^{el} = 11.17 \text{ kg/m}$$

$$\varphi_{Amer} = 0,77 \cdot 10^{-4} \text{ rad}$$

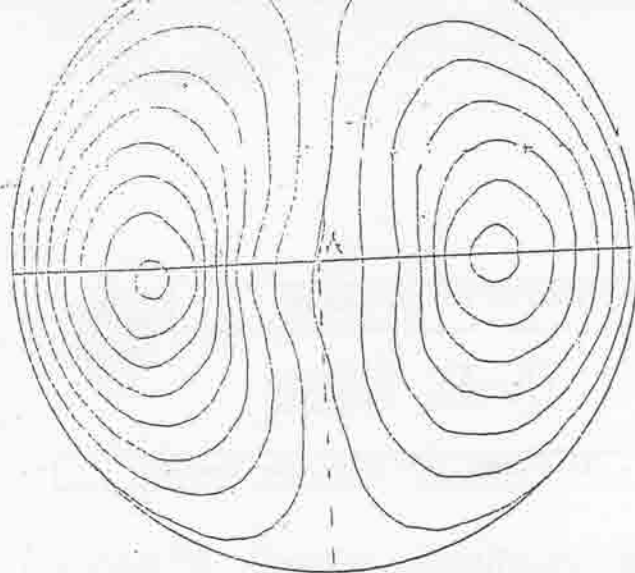
$$\varphi_{\text{Archi}} = \frac{1}{24} \frac{3l^3}{EI} = \frac{1}{24} \cdot \frac{5,041 \cdot 5,0^3}{46666,6} = 5,626 \cdot 10^{-4} \text{ rad}$$

$$\eta_A = \left(1 - \frac{Q_{\text{verlust}}}{Q_{\text{zuer}}}\right) \cdot 100\% = \left(1 - \frac{2,77}{5,026}\right) \cdot 100\% = 45,3\%$$



- употребил кличку майора из основ. 3-го полка
к-е он доказал до полка в Железнодорожном
и Беговом моменте.

15

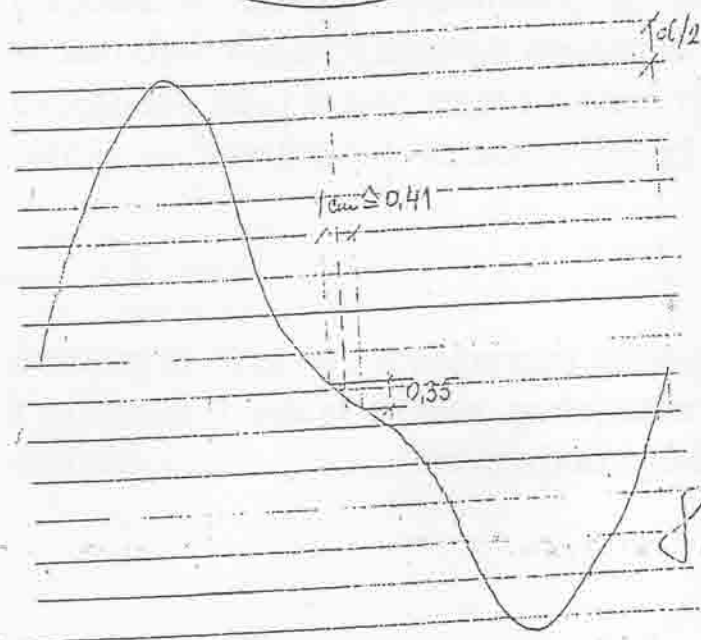


$$\frac{d}{d\theta} = 0.0015$$

$$R_e = \frac{8.12}{20} \Rightarrow 1:0.41$$

$$\begin{aligned} \lambda &= \mu_0 \mu_r \mu_0 \mu_r \mu_0 \\ \nu &= 0.33 \\ \pm &= 300 \text{ KJ/cm}^2 \end{aligned}$$

$\frac{\partial W}{\partial x}$



$$\frac{\partial^2 W}{\partial x^2} = \frac{0.35 \cdot \frac{0.0015}{0.5}}{1} = 0.00105$$

ПРЕДСТАВЛЕНИЕ НА ПРОЦЕДУРА
АБ - НАДЪЛЪТ

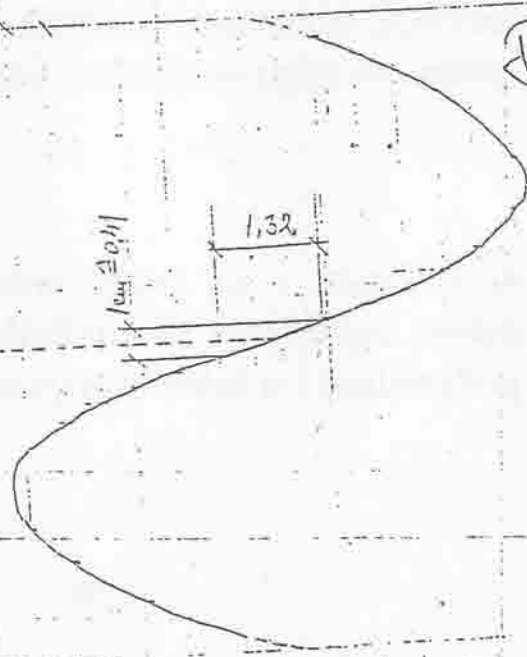
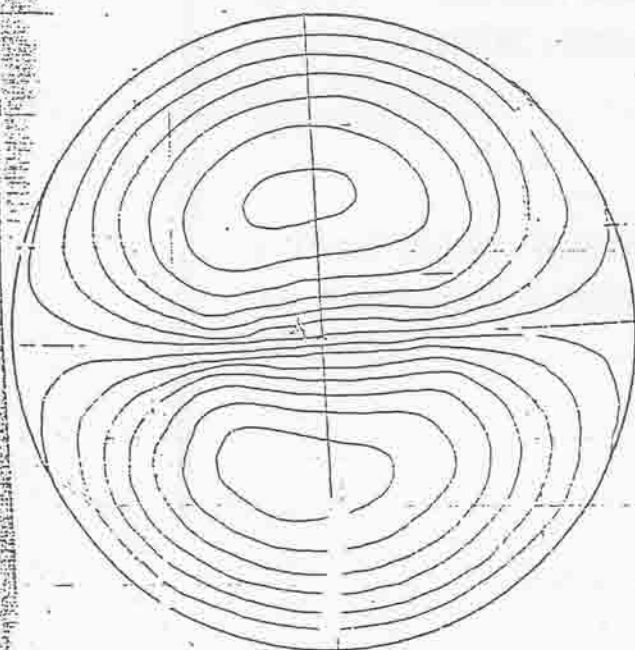
$$\lambda = \frac{3600}{\mu_0} = \mu_0 \Rightarrow \lambda = \mu_0$$

$$\lambda_1 = \lambda \cdot \mu_0 = 12 \cdot 10^7 = 3 \cdot 10^8$$

$$M_{x,A}^P = \lambda_1 \cdot \lambda_2 = -28.7 \cdot 10^4 \text{ KJ/cm}$$

$$M_{y,A}^P = \lambda_1 \cdot \lambda_2 = -57.66 \cdot 10^4 \text{ KJ/cm}$$

$\frac{\partial W}{\partial x}$



$$\frac{\partial^2 W}{\partial x^2} = \frac{1.32 \cdot \frac{0.0015}{0.5}}{1} = 0.00396$$

$$M_{x,A} = -0.4 (0.00105 + 0.33 \cdot 0.00396) = -9.43 \cdot 10^4 \text{ KJ/cm}$$

$$M_{y,A} = -0.4 (0.00308 + 0.33 \cdot 0.00105) = -17.23 \cdot 10^4 \text{ KJ/cm}$$

3

3

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