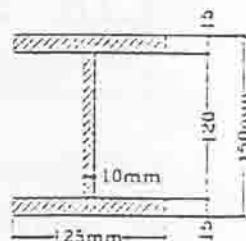
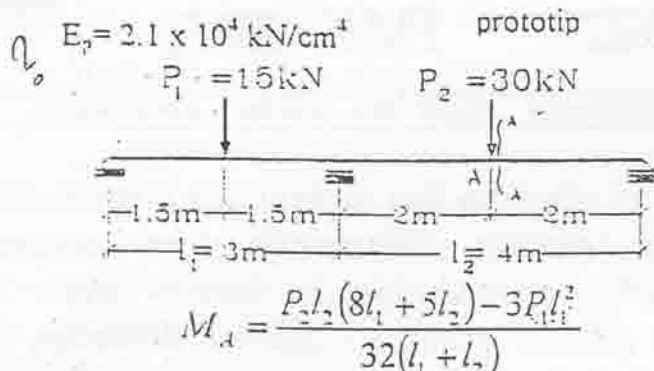




## Ispitivanje konstrukcija - MART -2002. 16.03.2002 ... pismeni deo ispita

3. Za prototip prema skici i poprečni presek modela, konstruisati model i odrediti razmeru za ugiće koristeći jednačinu predviđanja za ugić tačke A i uslov da dilatacija u preseku A-A ne može biti manja od  $\epsilon_{modela}^A = 500 \times 10^{-6} \text{ mm/mm}$ .

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



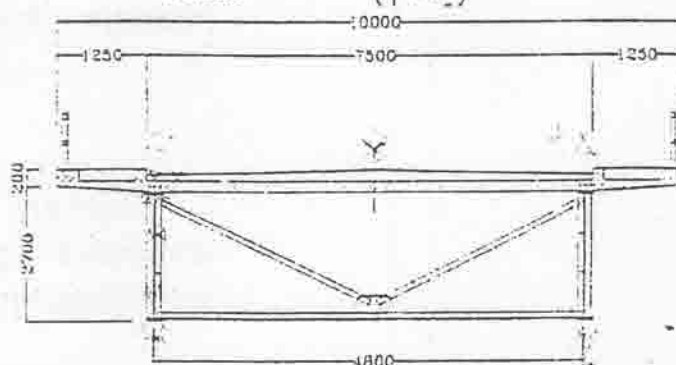
model



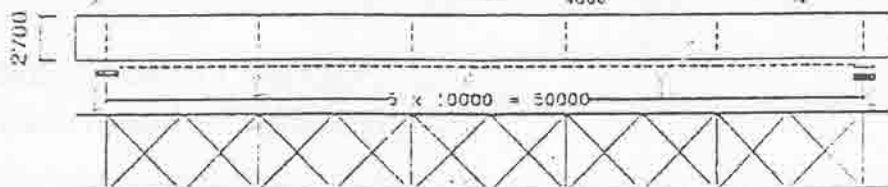
$$v_A = \frac{(l_2)^2}{768EI} \frac{P_2 l_2 (16l_1 + 7l_2) - 9P_1 (l_1)^2}{(l_1 + l_2)}$$

2. Na prikazanoj konstrukciji mosta dati detaljan raspored mernih mesta za merenje opštih i lokalnih deformacija, položaj probnog opterećenja, kao i raspored i broj kompenzacionih mernih mesta.

poprečni presek mosta:



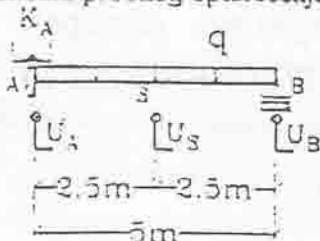
glavni nosač:



spreg za vetar:

3. Na čeličnoj gredi izvršena su merenja prema skici opštih deformacija. Na osnovu tih merenja odrediti veličinu probnog opterećenja  $q$ .

$$p_d = 0.01 \text{ mm}$$



I 200

$$A = 33.4 \text{ cm}^2$$

$$I = 2140 \text{ cm}^4$$

$$W = 214 \text{ cm}^3$$

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

Stanje	U <sub>A</sub>	U <sub>S</sub>	U <sub>B</sub>	K <sub>A</sub>
0	0156	0243	0102	0 + 240
q	0256	0811	0202	0 + 060

2. 4. Na čeličnom stubu ispunjenom betonom merene su statičkim trakama lokalne deformacije, prema skici. Odrediti presične sile u stubu prema rezultatima merenja datim u tablici.

Stanje	M <sub>1</sub>	M <sub>2</sub>	M <sub>3</sub>	M <sub>4</sub>
0	11375	10220	9967	10122
P	11350	10189	9938	10099
0	11372	10216	9970	10125

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

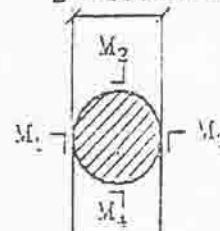
$$E_c = 2.10 \times 10^4 \text{ kN/cm}^2$$

$$v_b = 0.18 \text{ cm}^2 \quad v_s = 0.30$$

$$k_1 = 2.10 \quad k_2 = 1.90$$

$$J_0 = D^4 \pi \cdot 64$$

$$D = 406.4 \text{ mm}$$



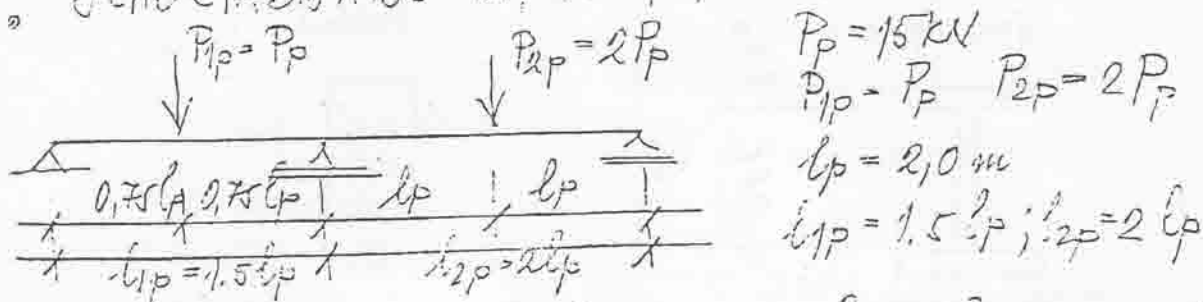
$$\delta = 3 \text{ mm}$$

$$D_0 = D - 2\delta$$



1. Prikazati tri osnovna tipa mehaničkih instrumenata za merenje lokalnih deformacija (dati osnovne principe rada, postavljanja,...). Izvesti izraz za određivanje glavnih pravaca i glavnih dilatacija pri merenju lokalnih deformacija rezetom  $0^\circ, +\beta^\circ, -\beta^\circ$ .....(40%)
2. Objasniti i prikazati izbor šeme opterećenja i izvođenje ispitivanja kod statičkog ispitivanja ploča sa odgovarajućim dijagramima i skicama.....(25%)
3. Prikazati i objasniti metode apliciranja dinamičkog opterećenja na konstrukcije.....(20%)
4. Prikazati aparaturu i objasniti postupak pri ispitivanju modela primenom *moare metode*.....(15%)

1. УПОСТАВЉАЊЕ ПАРАМЕТРА КОЈ ОБЛИКА;



$$V_{Ap} = \frac{l_{2p}^2}{32 E_p I_p} \frac{P_{2p} l_{2p} (16 l_{1p} + 5 l_{2p}) - 3 P_{1p} (l_{1p})^2}{(l_{1p} + l_{2p})} = \frac{4 l_p^2}{32 E_p I_p} \frac{131,75 P_p l_p^2}{3,5 l_p}$$

$$V_{Ap} = 0,196 \frac{P_p l_p^3}{E_p I_p} \quad V_{Am} = 0,196 \frac{P_m l_m^3}{E_m I_m}$$

$$M_{Ap} = \frac{P_{2p} l_{2p} (2 l_{1p} + 5 l_{2p}) - 3 P_{1p} l_{1p}^2}{32 (l_{1p} + l_{2p})} = \frac{81,25 P_p l_p^2}{16 l_p} = 0,725 P_p l_p$$

$$M_{Am} = 0,725 P_m l_m$$

$$\epsilon_{Ap} = \frac{M_{Ap}}{E_p W_p} \quad \epsilon_{Am} = \frac{M_{Am}}{E_m W_m}$$

- ПРОЈЕКТИРАЊЕ ЧЕЉАЧНИХ:

$$\frac{V_{Ap}}{l_p} = 0,196 \frac{P_p}{E_p l_p^2} \cdot \frac{l_p^4}{I_p}$$

$$\frac{V_{Am}}{l_m} = 0,196 \frac{P_m}{E_m l_m^2} \cdot \frac{l_m^4}{I_m}$$

$$\epsilon_{Ap} = 0,725 \frac{P_p}{E_p l_p^2} \cdot \frac{l_p^3}{W_p}$$

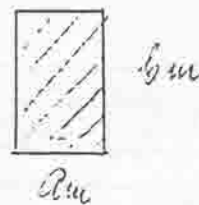
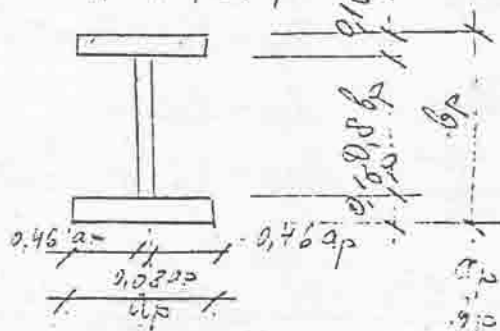
$$\epsilon_{Am} = 0,725 \frac{P_m}{E_m l_m^2} \cdot \frac{l_m^3}{W_m}$$

- ЧЕЉАЧНИХ ПРЕДЗУПРАКА;

$$\frac{V_{Ap}}{l_p} = \frac{0,196 \frac{P_p}{E_p l_p^2} \cdot \frac{l_p^4}{I_p}}{0,196 \frac{P_m}{E_m l_m^2} \cdot \frac{l_m^4}{I_m}} \quad (1)$$

$$\frac{\epsilon_{Ap}}{\epsilon_{Am}} = \frac{0,725 \frac{P_p}{E_p l_p^2} \cdot \frac{l_p^3}{W_p}}{0,725 \frac{P_m}{E_m l_m^2} \cdot \frac{l_m^3}{W_m}} \quad (2)$$

— ГЕОМЕТРИЧКЕ ВЕЏЕ (РАЗМЕРЕ ЗА I, W) ;  
ПРОТОТИП ; МОДЕЛ ;



$$a_p = 125 \text{ mm} \\ b_p = 150 \text{ mm}$$

$$a_m = 50 \text{ mm} \\ b_m = 60 \text{ mm}$$

$$J_p = \frac{1}{12} (a_p b_p^3 - 2 \cdot 0.46 a_p \cdot 0.8^3 b_p^3) = 904408 \text{ mm}^4 \quad J_m = \frac{1}{12} a_m b_m^3$$

$$\lambda_J = \frac{J_p}{J_m} = \frac{0.04408 \cdot a_p b_p^3}{\frac{1}{12} a_m b_m^3} = 0.529 \frac{a_p}{a_m} \left( \frac{b_p}{b_m} \right)^3 = C_J \cdot \lambda_{prop}^3$$

$$\lambda_a = \frac{125}{50} = 2.5 \quad \lambda_b = \frac{150}{60} = 2.5$$

$$\lambda_{prop} = \lambda_a = \lambda_b = 2.5 \quad C_J = 0.529$$

$$I_{p0} = \frac{0.04408 \cdot a_p^3}{\lambda_a^3} = 0.02216 a_p^3 \quad (= 24000 \text{ mm}^4)$$

$$W_{p0} = \frac{1}{6} a_m b_m^2$$

$$\lambda_{Wp} = \frac{0.02216 a_p^3}{\frac{1}{6} a_m b_m^2} = 0.529 \frac{a_p}{a_m} \left( \frac{b_p}{b_m} \right)^2 = C_{Wp} \cdot \lambda_{prop}^2 \quad (5)$$

— ОДНОСТРАЊИТЕ РАЗМЕРЕ ;

$$\lambda_{L0} = \frac{L_{p0}}{I_{p0}} = \frac{2176.5}{24000} = 0.0907 \frac{1}{\text{mm}^2} \quad \lambda_{Lp} = \frac{2222}{2176.5} = 1.021 \frac{1}{\text{mm}^2}$$

$$\text{УПОЗНАЈА : } \lambda_{Lm} \geq 370 \cdot 10^{-6} \frac{1}{\text{mm}^2}$$

$$\lambda_E \leq \frac{\lambda_{Lp}}{\lambda_{Lm}} = \frac{1.021}{370} = 0.00276$$

$$\lambda_E = 0.00276$$

$$\lambda_E = \frac{F_p}{F_m} \cdot \frac{a_m}{a_p} \cdot \left( \frac{b_m}{b_p} \right)^2 \cdot \frac{a_m}{W_p} \cdot \left( \frac{b_p}{b_m} \right)^2$$

$$\lambda_E = \lambda_p \cdot \frac{1}{\lambda_E} \cdot \lambda_E \cdot \frac{1}{\lambda_W} \Rightarrow$$

$$\Rightarrow \lambda_p = \lambda_E \cdot \lambda_E \cdot \frac{\lambda_{Wp}}{\lambda_L}$$

$$\epsilon = \frac{\Xi_{\Sigma}}{\Xi_m} = \frac{2,1 \cdot 10^{-4}}{0,7 \cdot 10^{-4}} = 3$$

— ПАЗМЕРТА ЗА ЧУЛЪТ;

$$\boxed{R_P = R_E \cdot R_{\Sigma} \cdot C_W \frac{R_{\text{доп}}^3}{R_L}} \quad \text{--- (5)}$$

$$R_E = 0,836 \quad R_{\Sigma} = 3 \quad C_W = 0,529 \quad R_{\text{доп}} = 2,5 \quad R_L = 4 \quad (R_{\text{доп}} = 40)$$

$$R_P = 5,182$$

— ПАЗМЕРТА ЗА ВЪЗДЪХЪТ;

$$R_W \Rightarrow R_W \cdot \frac{1}{R_L} = R_P \cdot \frac{1}{R_{\Sigma}} \cdot \frac{1}{R_L^2} \cdot \frac{R_L^4}{R_J}$$

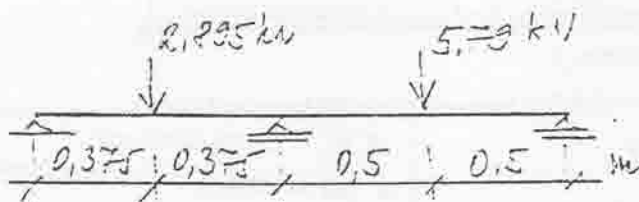
$$R_W = R_P \cdot \frac{R_L^3}{R_{\Sigma} \cdot R_J} = R_E \cdot R_{\Sigma} \cdot C_W \cdot \frac{R_{\text{доп}}^3}{R_J} \cdot \frac{R_L^3}{R_{\Sigma} \cdot R_J}$$

$$\boxed{R_W = \frac{C_W}{C_J} \cdot R_E \cdot \frac{R_L^2}{R_{\text{доп}}}} \quad \text{--- (5)}$$

$$R_W = 0,836 \cdot \frac{4^2}{2,5} = 5,3504$$

— ЧУЛЪТЪТ;

$$L_{\text{доп}} = \frac{L_P}{R_E} = \frac{2}{4} = 0,5 \text{ m}$$



$$P_{1m} = \frac{15}{5,182} = 2,895 \text{ kN}$$

$$P_{2m} = \frac{30}{5,182} = 5,79 \text{ kN}$$

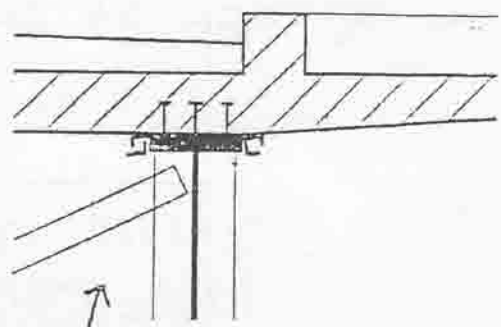
--- (5)

Σ (30)

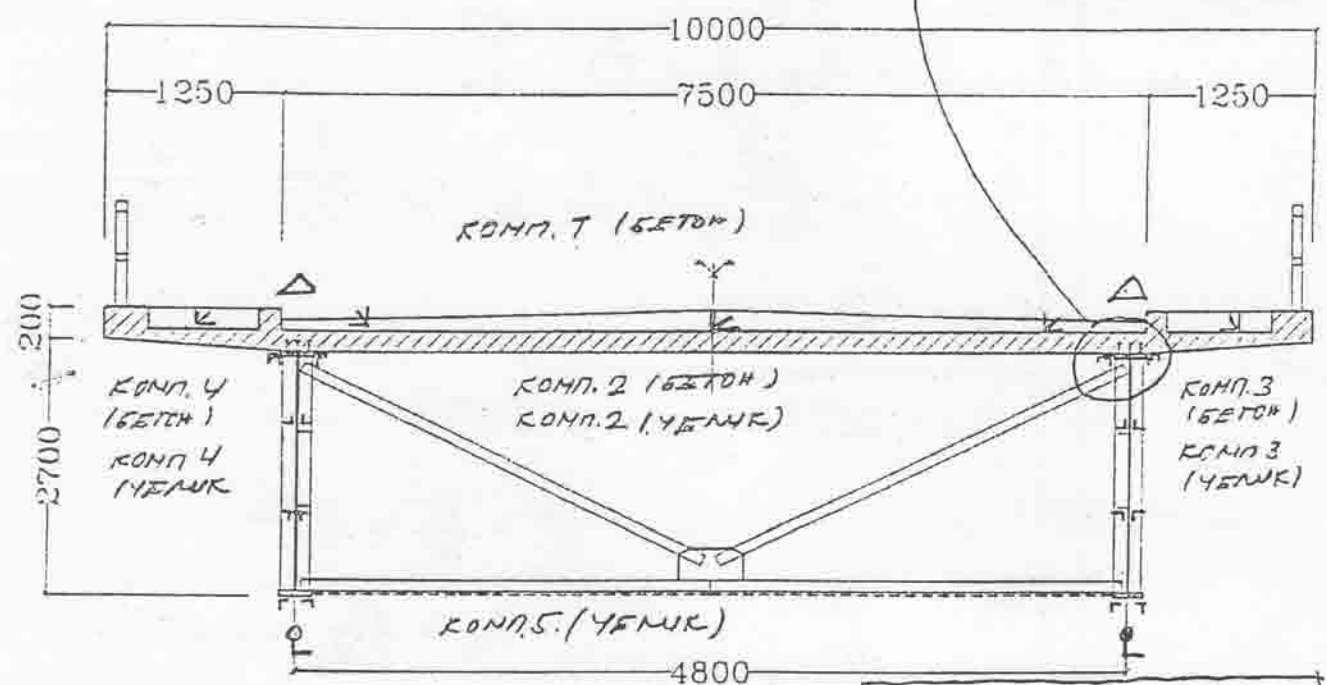
2.

2. Na prikazanoj konstrukciji mosta dati detaljan raspored mernih mesta za merenje opštih i lokalnih deformacija, položaj probnog opterećenja, kao i raspored i broj kompenzacionih mernih mesta.

ОПШТЕ ДЕФ. 5 УГЛУБЉ (УГЛУБЉЕЊИ)  
 ЛОКАЛНЕ ДЕФ. 10 ДИСТАНЦИЈЕ (МЕРНЕ ТРАКЕ)  
 КОМПЕНЗАЦ. 5  
 ОПТЕРЕЋ 5  
 25



poprečni presek mosta:

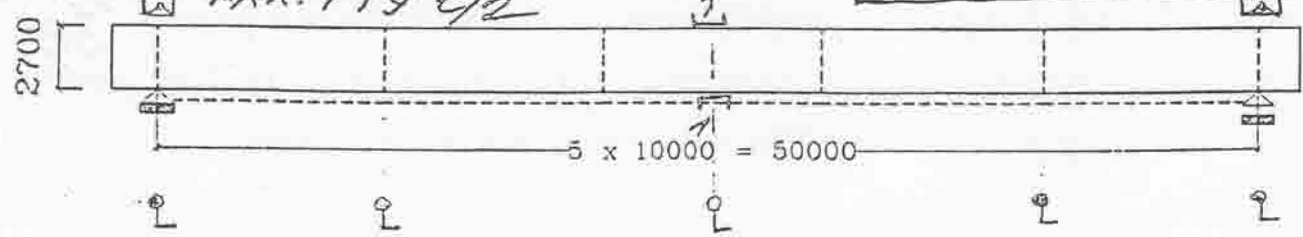


1-1

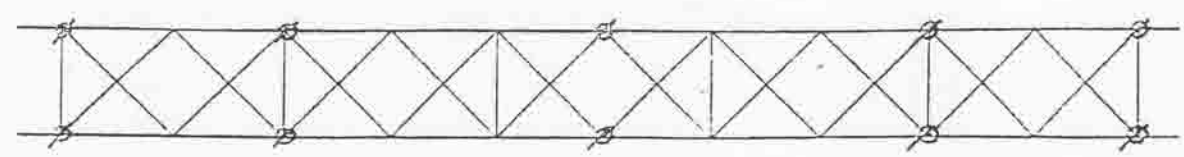
glavni nosač:

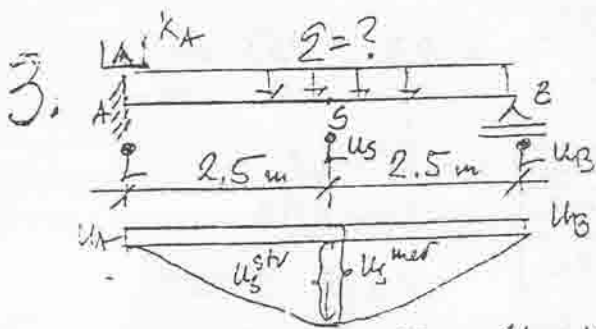
ВОЗУЛА ПОСТРЕБИТУ  
 ПРЕНА УПЛУ.  
 МИНУЖА ЗА  
 МАХ. МУ 1/2

Ø Ø - УГЛУБОМЕР  
 Δ Δ - КЛУЧОМЕТКА  
 L L - МЕРНА ТРАКА  
 V - РОЗЕТА

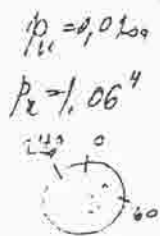


спрег за ветар:





	$u_A$	$u_S$	$u_B$	$K_A$
0	0156	0243	0102	01240
2	0256	0811	0202	07060
2-0	100	568	100	70
YT	1,0	5,68	1mm	74,2"



$$u_S^{st} = u_S^{mer} - \frac{u_A + u_B}{2} = 5,68 - 1 = 4,68 \text{ mm}$$

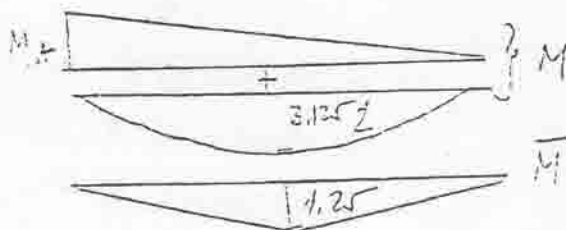
$$\frac{1}{\rho} \Delta x = 0,000360$$

МОМЕНТ ЭЛАСТИЧНОСТИ В КРОЕВЫХ Точках:

$$M_A = - \frac{3EI}{l} \frac{1}{\rho} \Delta x + \frac{q l^2}{8} = -3 \cdot \frac{2,1 \cdot 10^9 \cdot 2140 \cdot 10^{-8}}{5} \cdot 0,00036 + 2 \cdot \frac{5}{8}$$

$$M_A = 3,125 \cdot 2 - 0,971 \text{ W}$$

ОПРЕДЕЛЕНИЕ ОПРЕДЕЛЕНИЯ:



$$E \Delta u_S = \int M \bar{u}_S ds =$$

$$= - \frac{5}{6} (3,125 \cdot 2 - 0,971) \cdot 1,25 \cdot \frac{3}{2} + \frac{5}{3} \cdot 1,25 \cdot 3,125 \cdot 2 \cdot \frac{5}{4} = 3,255 \cdot 2 + 1,517$$

$$E \Delta u_S = 2,1 \cdot 2140 \cdot 4,68 \cdot 10^{-2} = 21,032 \approx 3,255 \cdot 2 + 1,517$$

$$\Rightarrow q = 6,00 \text{ kN/m}$$

4. - ГЕОМЕТРИЧЕСКИЕ ХАРАКТЕРИСТИКИ ПРЕСЕК:

$$A_{oi} = A_o + \frac{E_o}{E_b} \cdot A_c \quad J_{oi} = J_o + \frac{E_o}{E_b} J_c$$

$$D = 40,64 \text{ cm} \quad D_o = D - 2\delta = 40,64 - 2 \cdot 0,8 = 39,04 \text{ cm}$$

$$A_o = \frac{D_o^2 \pi}{4} = \frac{39,04^2 \cdot \pi}{4} = 1197,04 \text{ cm}^2 \quad A_c = (D^2 - D_o^2) \frac{\pi}{4} = 100,129 \text{ cm}^2$$

$$J_o = \frac{D_o^4 \pi}{64} = \frac{39,04^4 \cdot \pi}{64} = 114027,377 \text{ cm}^4$$

$$J_c = (D^4 - D_o^4) \frac{\pi}{64} = 19873,833 \text{ cm}^4$$

$$A_i = 1197,04 + \frac{2,1}{0,35} \cdot 100,129 = 1797,814 \text{ cm}^2$$

$$J_i = 114027,377 + \frac{2,1}{0,35} \cdot 19873,833 = 233270,735 \text{ cm}^4$$

