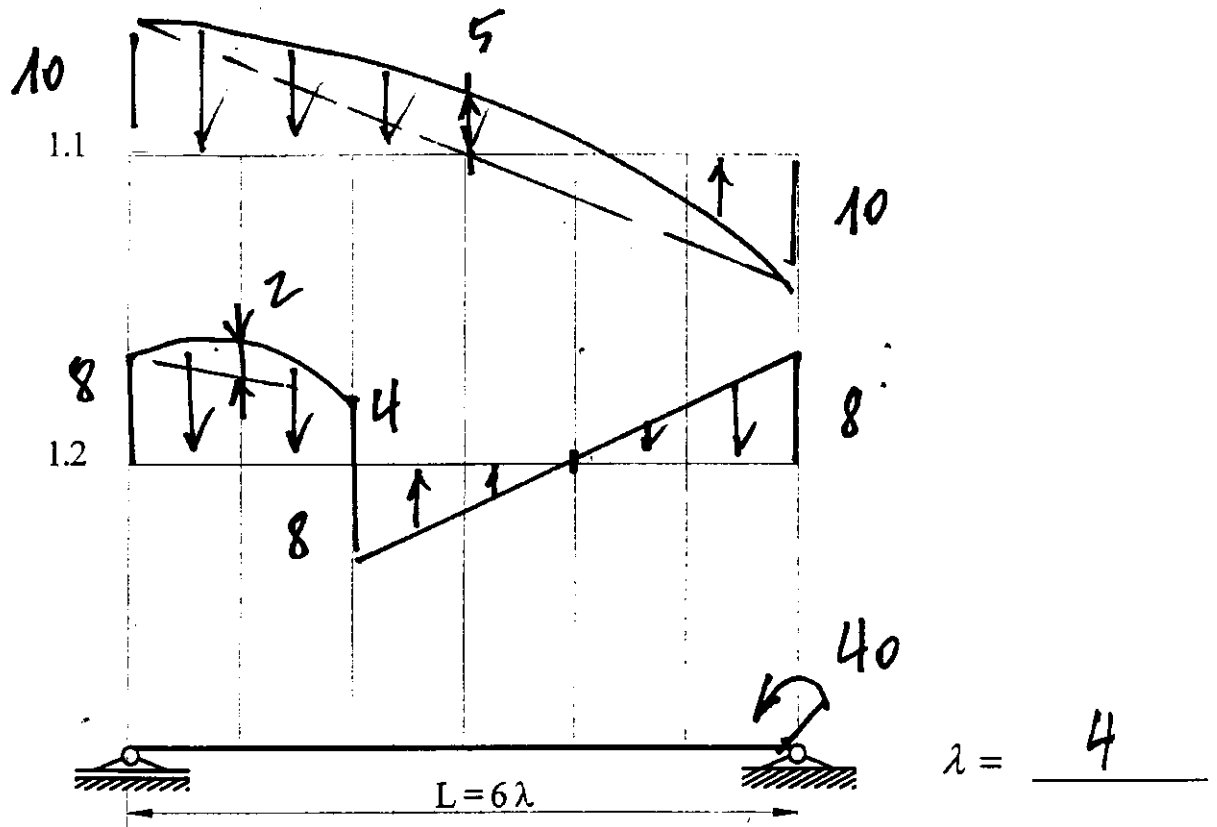


1. ЗАДАТАК

1. За дати носач и оптерећење одредити и нацртати дијаграме M и T користећи :

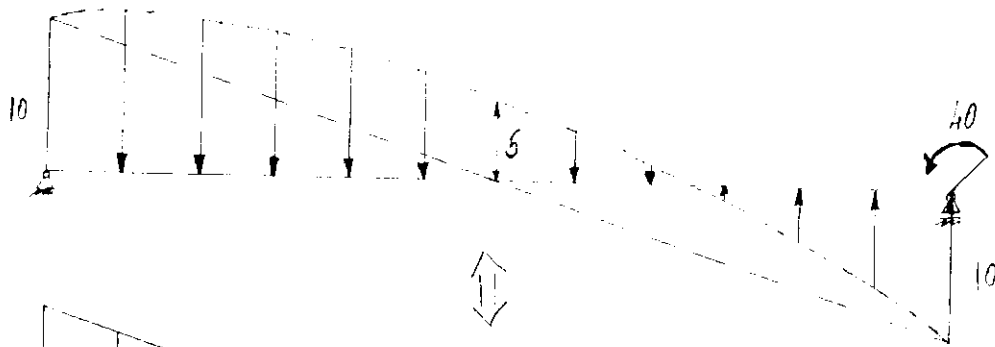
1.1 Аналитичке функције τ_f и ω_f

1.2 Нумерички поступак уз замену расподељеног оптерећења концентрисаним силама.

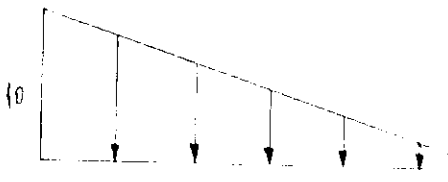


Израда : Марица Земиновић
Издато дана: 25.9.2008.
Оцена: 10 (сесиј)

3. Aufgaben 1.1



(1)



$$A_0^{(1)}$$

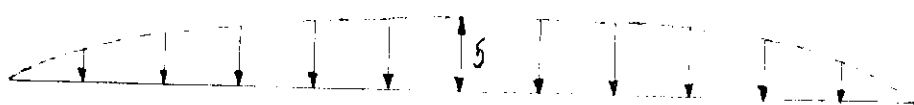
+



$$A_0^{(1)} = \frac{1}{6} \cdot 10 \cdot 24 = 40$$

$$\zeta_F^{(1)} = 1 - 6\zeta + 6\zeta^2$$

$$w_F^{(1)} = \zeta - 3\zeta^2 + 2\zeta^3$$



$$A_0^{(2)}$$

$$A_0^{(2)} = \frac{1}{6} \cdot 5 \cdot 24 = 40$$

$$\zeta_F^{(2)} = 1 - 6\zeta^2 + 4\zeta^3$$

$$w_F^{(2)} = \zeta - 2\zeta^3 + \zeta^4$$

$$\frac{40}{24}$$

$$\frac{40}{24}$$

$$V_0(\zeta) = A_0^{(1)} \zeta_F^{(1)}(\zeta) + A_0^{(2)} \zeta_F^{(2)}(\zeta) + \frac{40}{\ell}$$

$$= 40(1 - 6\zeta + 6\zeta^2) + 40(1 - 6\zeta^2 + 4\zeta^3) + \frac{40}{24}$$

$$= 40 - 240\zeta + 240\zeta^2 + 40 - 240\zeta^2 + 160\zeta^3 + 1,67$$

$$V_0(\zeta) = 81,67 - 240\zeta + 160\zeta^3$$

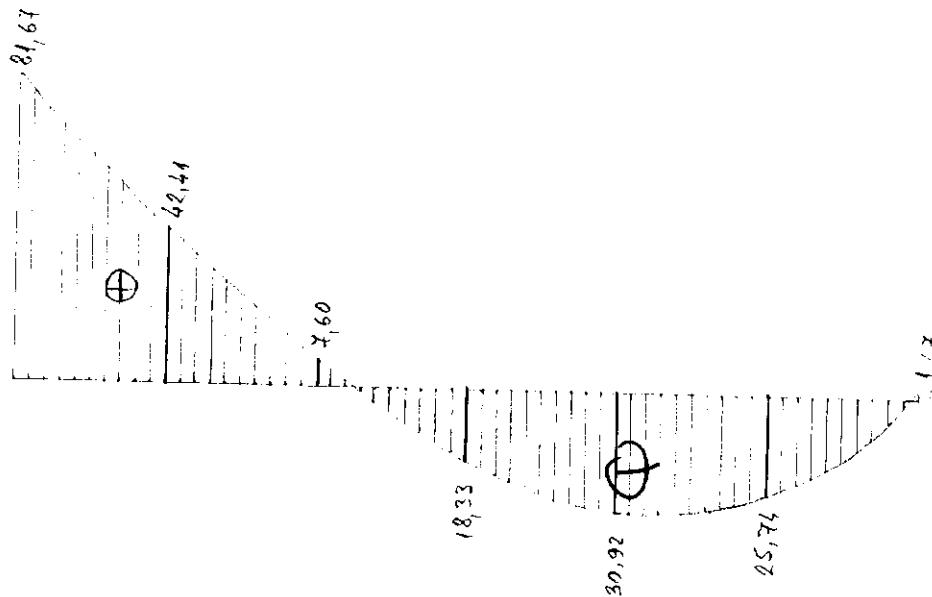
$$M_0(\zeta) = A_0^{(1)} \cdot \ell \cdot w_F^{(1)}(\zeta) + A_0^{(2)} \cdot \ell \cdot w_F^{(2)}(\zeta) + 40\zeta$$

$$= 40 \cdot 24 \cdot (\zeta - 3\zeta^2 + 2\zeta^3) + 40 \cdot 24 \cdot (\zeta - 2\zeta^3 + \zeta^4) + 40\zeta$$

$$M_0(\zeta) = 1960\zeta - 2880\zeta^2 + 960\zeta^4$$

m	0	1	2	3	4	5	6
ξ	0	$\frac{1}{6}$	$\frac{2}{6}$	$\frac{3}{6}$	$\frac{4}{6}$	$\frac{5}{6}$	1
$V_0(\xi)$	81,67	42,41	7,60	-18,33	-30,92	-25,74	1,67
$M_0(\xi)$	0	247,41	345,18	320,00	216,30	96,29	40

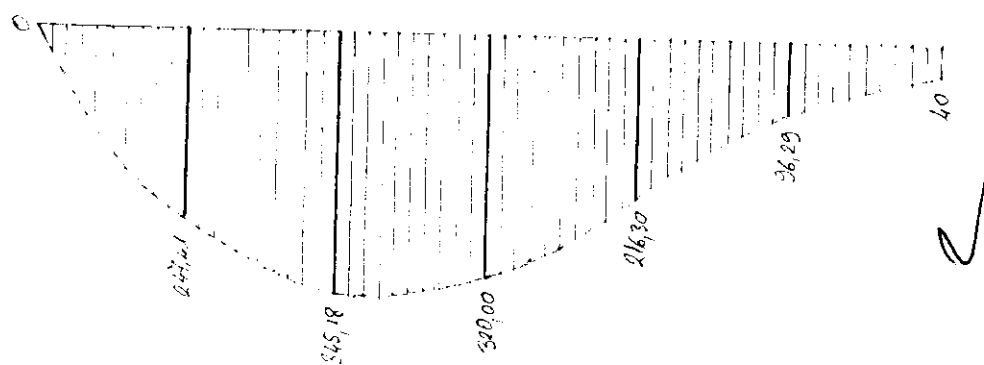
✓
✓



V_0

✓

M_0



✓

m	λ_m	x'_m	P_m^L	P_m	$P_m x'_m$	\bar{V}_{om}	$\bar{V}_{om} \lambda_m$	M_{om}	R_m	V_{om}
	m	m	P_m^d	KN	KN/m	KN	KN/m	KN/m	KN	KN
0	/	24	8	16,67	1,00	37,23	0	0	/	37,23
1	4	20	8	30,67	613,4	20,56	82,24	82,24	33,33	3,9
2	4	16	4 -8	-2	-32	-10,11	-40,44	41,8	25,33	-21,43
3	4	12	-4	-16	-192	-8,11	-32,44	9,36	-24	2,57
4	4	8	0	0	0	7,89	31,56	40,92	-8	10,57
5	4	4	4	16	64	7,89	31,56	72,48	8	2,57
6	4	0	8	13,33		-8,11	-32,44	40	24	-21,43

$$P_0 = \frac{4}{24} (7 \cdot 8 + 6 \cdot 8 - 4) = \frac{58,67}{16,67} = 853,4 - 21,44$$

$$P_1 = \frac{4}{12} (8 + 10 \cdot 8 + 4) = 30,67$$

$$P_2 = \frac{4}{24} (7 \cdot 4 + 6 \cdot 8 - 8) + \frac{4}{6} (2 \cdot (-8) + (-4)) = 11,33 - 13,33 = -2$$

$$P_3 = \frac{4}{6} ((-8) + 4 \cdot (-4) + 0) = -16$$

$$P_4 = \frac{4}{6} ((-4) + 4 \cdot 0 + 4) = 0$$

$$P_5 = \frac{4}{6} (0 + 4 \cdot 4 + 8) = 16$$

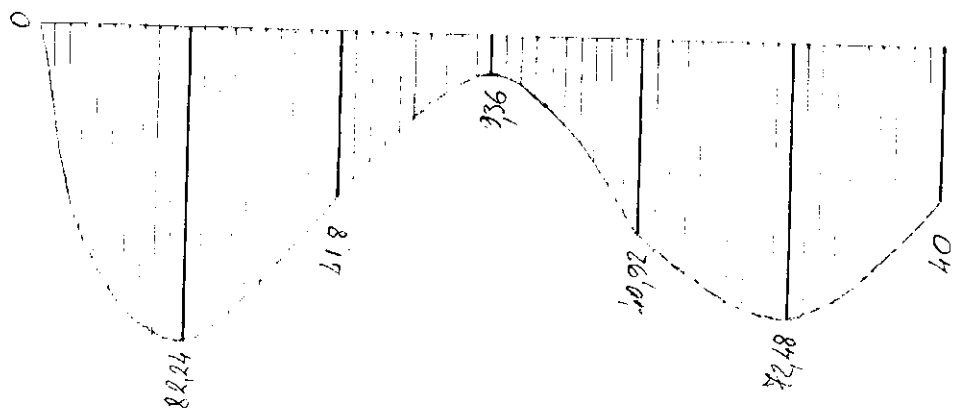
$$P_6 = \frac{4}{6} (2 \cdot 8 + 4) = 13,33$$

$$A = \frac{1}{24} \cdot 853,4 + \frac{40}{24} = 37,23$$

$$R = 58,67 - 37,23 = 21,44$$

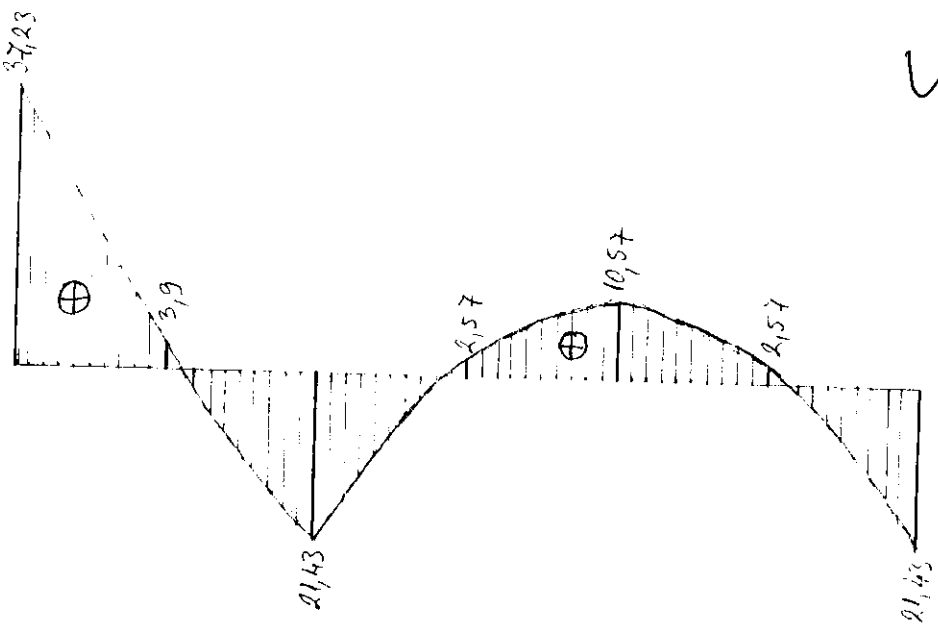


N.



✓

V.



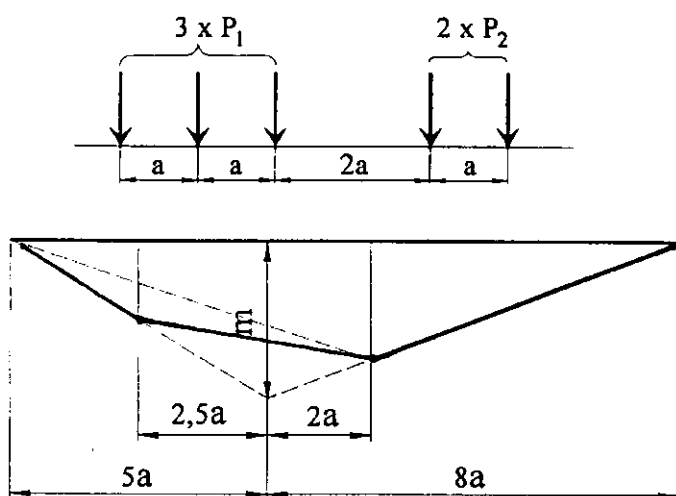
✓

25.9.2008.
получено!

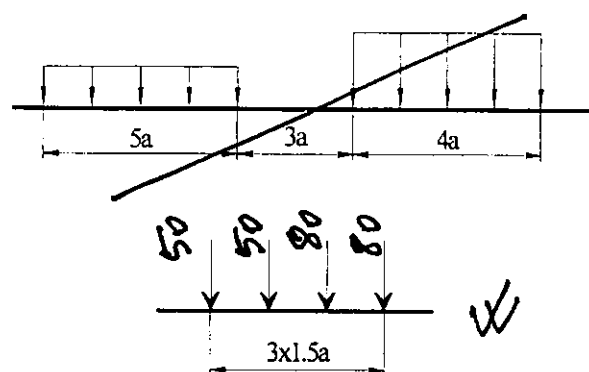
2. ЗАДАТАК

1. Одредити екстремне вредности утицаја $Z(s,u)$ услед задатих случајева оптерећења која се крећу у оба поретка.

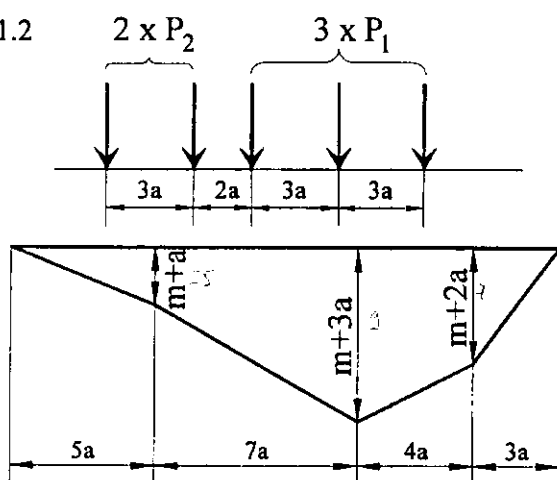
1.1



$$1.3 \quad Z(s,u) = 5 \left[\frac{u}{l} - \left(\frac{u}{l} \right)^3 \right], \quad l = 20a$$



1.2



$$P_1 = \underline{25} \quad a = \underline{2}$$

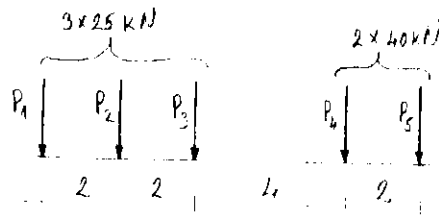
$$P_2 = \underline{40} \quad m = \underline{3}$$

Издао: Марина Желитовић

Издато дана: 16.10.2008.

Оцена: 10 (десет)

Задание 21.



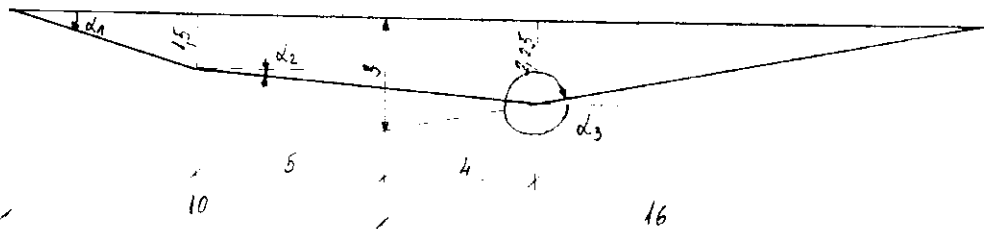
$$\tan \alpha_1 = 0,300$$

$$\tan \alpha_2 = 0,083$$

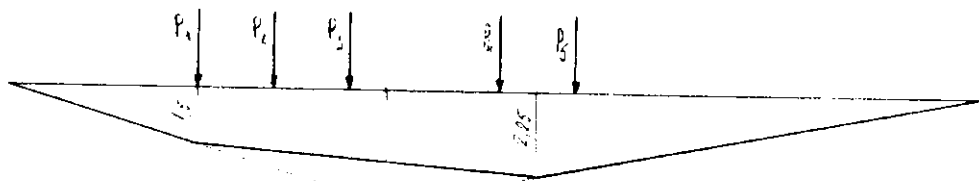
$$\tan \alpha_3 = -0,188$$

$$R = 3 \cdot 25 + 2 \cdot 40 = 155 \text{ kN}$$

$$\frac{R}{C} = \frac{155}{26} = 5,96$$



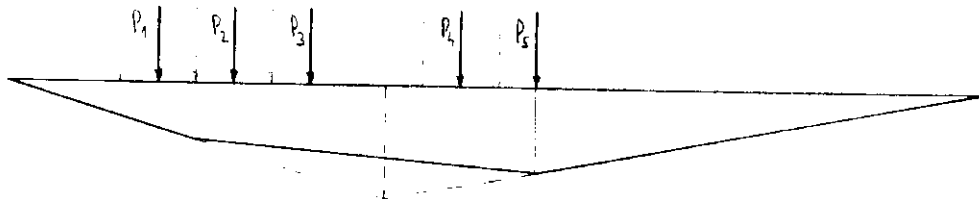
Положение А



$$R_L = 0 \quad R_S = 90 \quad R_D = 40$$

$$\left. \begin{aligned} \frac{0 + 90 \cdot \frac{5}{9}}{10} &= 5 \\ \frac{40 + 90 \cdot \frac{4}{9}}{16} &= 5 \end{aligned} \right\} < \frac{R}{C}$$

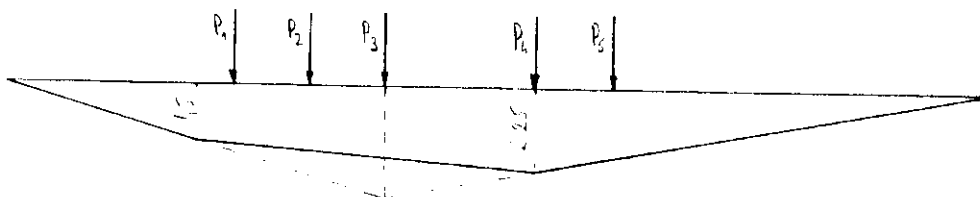
Положение б



$$R_L = 25 \quad R_S = 90 \quad R_D = 0$$

$$\left. \begin{aligned} \frac{25 + 90 \cdot \frac{5}{9}}{10} &= 7,5 \\ \frac{0 + 90 \cdot \frac{4}{9}}{16} &= 2,50 \end{aligned} \right\} > \frac{R}{C}$$

Положение В



$$R_L = 0 \quad R_S = 75 \quad R_D = 40$$

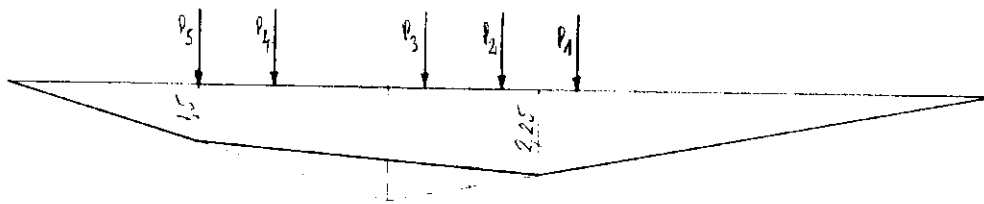
$$\left. \begin{aligned} \frac{0 + 75 \cdot \frac{5}{9}}{10} &= 4,17 \\ \frac{40 + 75 \cdot \frac{4}{9}}{16} &= 4,58 \end{aligned} \right\} < \frac{R}{C}$$

$$Z_A = 25 \cdot 1,5 + 2 \cdot 25 \cdot (1,5 + 3 \cdot 0,083) + 40 \cdot (1,5 + 2 \cdot 0,083) + 40 \cdot (2,25 - 1 \cdot 0,188) = 294,01 \text{ kN}$$

$$Z_E = 3 \cdot 25 \cdot (1,5 + 3 \cdot 0,083) + 40 \cdot 2,25 + 40 \cdot (2,25 - 2 \cdot 0,188) = 296,18 \text{ kN}$$

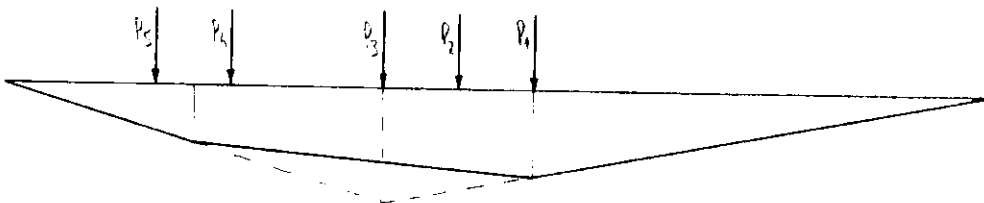
ОБРАТНУ ПОРЕДАК

ПОЛОЖАЈ А'



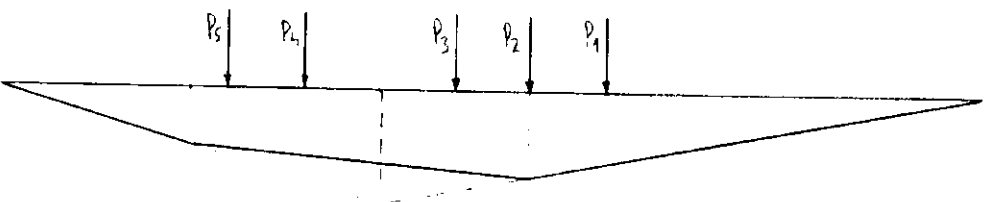
$$\left. \begin{array}{l} R_L = 0 \quad R_S = 90 \quad R_D = 25 \\ \frac{0 + 90 \cdot \frac{5}{9}}{10} = 5 \\ \frac{25 + 90 \cdot \frac{4}{9}}{16} = 4,06 \end{array} \right\} < \frac{R}{e}$$

ПОЛОЖАЈ Б'



$$\left. \begin{array}{l} R_L = 40 \quad R_S = 90 \quad R_D = 0 \\ \frac{40 + 90 \cdot \frac{5}{9}}{10} = 3 \\ \frac{0 + 90 \cdot \frac{4}{9}}{16} = 2,5 \end{array} \right\} > \frac{R}{e}$$

ПОЛОЖАЈ В'



$$\left. \begin{array}{l} R_L = 0 \quad R_S = 105 \quad R_D = 25 \\ \frac{0 + 105 \cdot \frac{5}{9}}{10} = 5,83 \\ \frac{25 + 105 \cdot \frac{4}{9}}{16} = 4,48 \end{array} \right\} < \frac{R}{e}$$

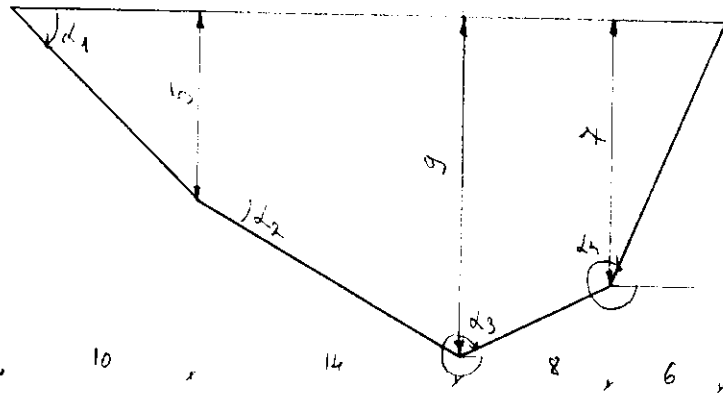
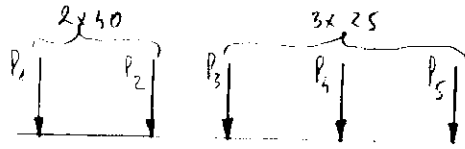
$$Z_{A'} = 2 \cdot 40 \cdot (1,5 + 1 \cdot 0,083) + 2 \cdot 25 \cdot (2,25 - 2 \cdot 0,083) + 25 \cdot (2,25 - 1 \cdot 0,188) = 282,39 \text{ kN}$$

$$Z_{B'} = 2 \cdot 40 \cdot (1,5 + 2 \cdot 0,083) + 2 \cdot 25 \cdot (2,25 - 1 \cdot 0,083) + 25 \cdot (2,25 - 2 \cdot 0,188) = 288,48 \text{ kN}$$

$$\max Z = \max(Z_A, Z_B, Z_{A'}, Z_{B'}) = Z_B = 296,18 \text{ kN}$$



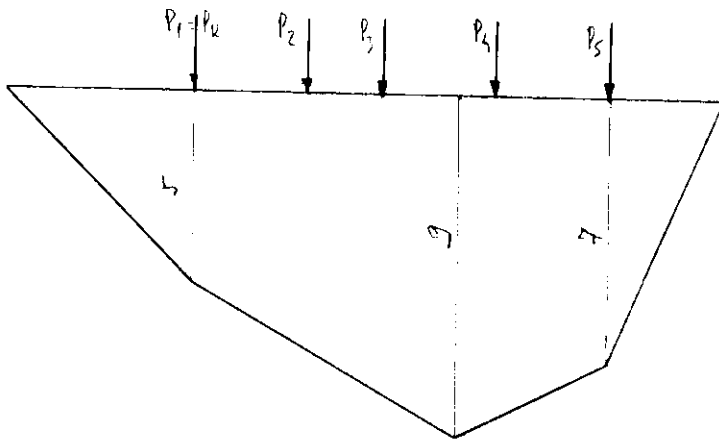
Задание 22.



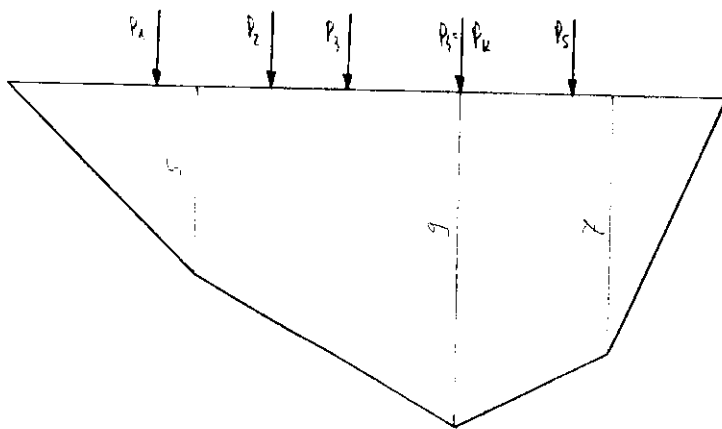
$$\begin{aligned} \operatorname{tg} \alpha_1 &= 0,5 \\ \operatorname{tg} \alpha_3 &= -0,25 \end{aligned}$$

$$\begin{aligned} \operatorname{tg} \alpha_2 &= 0,286 \\ \operatorname{tg} \alpha_4 &= -1,167 \end{aligned}$$

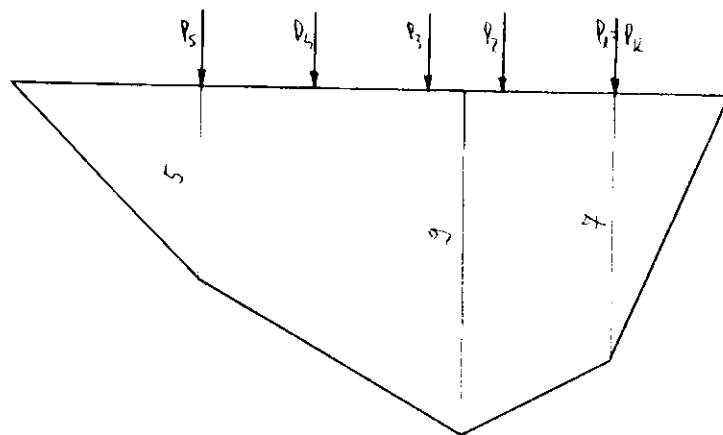
После А



После Б



Положения B (основных порядков)



		A				B				B			
m	$\lg dm$	\vec{P}_m	$\vec{P}_m \lg dm$	\vec{P}_m	$\vec{P}_m \lg dm$	\vec{P}_m	$\vec{P}_m \lg dm$	\vec{P}_m	$\vec{P}_m \lg dm$	\vec{P}_m	$\vec{P}_m \lg dm$	\vec{P}_m	$\vec{P}_m \lg dm$
1	0,5	0	0	40	20	40	20	25	12,5	0	0	25	12,5
2	0,286	105	30,03	65	18,59	65	18,59	50	14,3	75	21,45	50	14,3
3	-0,25	25	-6,25	50	-12,5	50	-12,5	80	-20	40	-10	80	-10
4	-1,167	25	-29,18	0	0	0	0	0	0	40	-46,68	0	0
		-5,4		26,09		26,09		6,8		-35,23		6,8	

$$Z_A = 2 \cdot 40 \cdot (5 + 3 \cdot 0,286) + 25 (9 - 4 \cdot 0,286) + (2 \cdot 25) (9 - 5 \cdot 0,25) = 1052,54$$

$$Z_B = 3 \cdot 25 \cdot (5 + 6 \cdot 0,286) + 2 \cdot 40 \cdot (9 - 5 \cdot 0,25) = 1123,7$$

$$\max Z = \max (Z_A, Z_B) = Z_B = 1123,7$$



ЗАДАЧА 23.

$$Z(s, u) = 5 \cdot \left[\frac{u}{c} - \left(\frac{u}{c} \right)^3 \right] \quad c = 40 \text{ м}$$

$$0 \leq u \leq 40$$

$$\xi = \frac{u}{c}$$

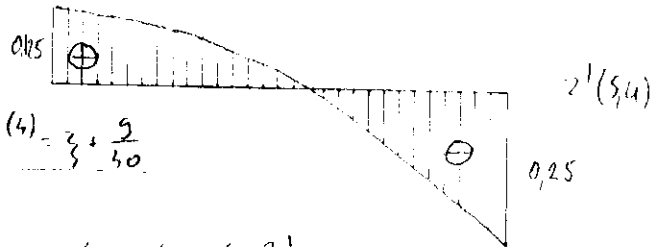
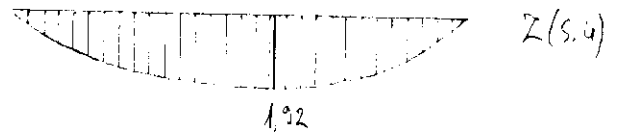
$$Z(s, u) = Z(s, \xi c) = 5 (\xi - \xi^3) \quad \xi = 0, \xi = 1$$

$$Z'(s, u) = \frac{dZ}{du} = \frac{1}{c} \frac{dZ}{d\xi} = \frac{1}{40} \cdot 5 \cdot (1 - 3\xi^2) = 0,125 - 0,375 \xi^2 = 0 \quad \xi = \sqrt{\frac{1}{3}} = 0,577$$

$$Z''(s, u) = -2 \cdot 0,375 \xi \cdot \frac{1}{40} = -0,019 \xi$$

* КОДИТЕРУИМ ЗА НЕПОДАВАНА ПОЛОСКА:

$$\sum_{n=1}^4 p_n Z'(s, u_n) = 0$$



$$\xi^{(1)} = \xi \quad \xi^{(2)} = \xi + \frac{3}{40} \quad \xi^{(3)} = \xi + \frac{6}{40} \quad \xi^{(4)} = \xi + \frac{9}{40}$$

$$50 \cdot 0,125 (1 - 3\xi^2) + 50 \cdot 0,125 (1 - 3(\xi + \frac{3}{40})^2) + 80 \cdot 0,125 (1 - 3(\xi + \frac{6}{40})^2) + 80 \cdot 0,125 (1 - 3(\xi + \frac{9}{40})^2) = 0$$

$$6,25 (1 - 3\xi^2) + 6,25 (1 - 3(\xi^2 + \frac{6}{40} \xi + \frac{9}{1600})) + 10 (1 - 3(\xi^2 + \frac{12}{40} \xi + \frac{36}{1600})) + 10 (1 - 3(\xi^2 + \frac{18}{40} \xi + \frac{81}{1600})) = 0$$

$$6,25 - 18,75 \xi^2 + 6,25 - 18,75 \xi^2 - \frac{112,5 \xi}{40} - \frac{16,875}{1600} + 10 - 30 \xi^2 - \frac{360 \xi}{40} - \frac{1080}{1600} + 10 - 30 \xi^2 - \frac{540 \xi}{40} - \frac{2430}{1600} = 0$$

$$-97,5 \xi^2 - 25,31 \xi + 30,2 = 0 \quad \Rightarrow \quad \xi = 0,44$$

$$\xi^{(1)} = 0,440 \rightarrow u_1 = 17,6 \quad Z(s, u_1) = 1,774$$

$$\xi^{(2)} = 0,515 \rightarrow u_2 = 20,6 \quad Z(s, u_2) = 1,892$$

$$\xi^{(3)} = 0,590 \rightarrow u_3 = 23,6 \quad Z(s, u_3) = 1,923$$

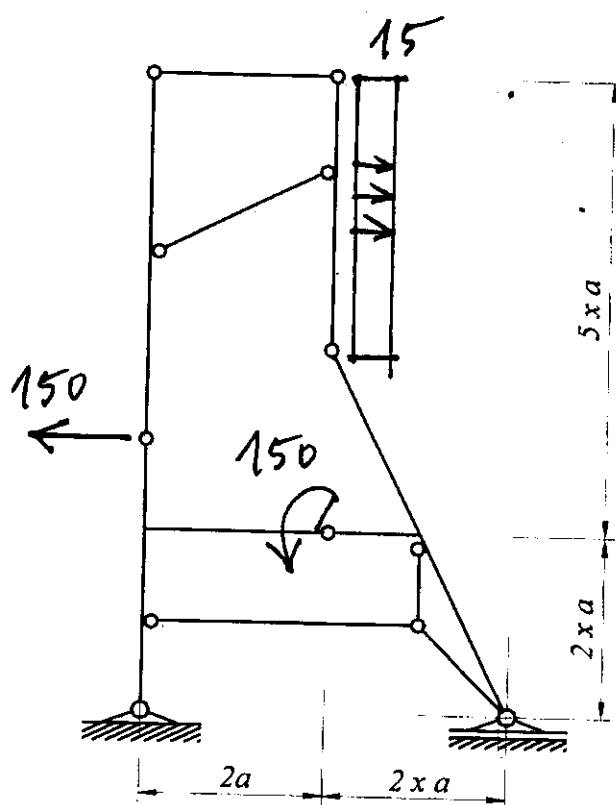
$$\xi^{(4)} = 0,665 \rightarrow u_4 = 26,6 \quad Z(s, u_4) = 1,855$$

$$\max Z_s = \sum_{n=1}^4 p_n \cdot Z(s, u_n) = 485,54$$

✓
10 (9 points)

3. ЗАДАТАК

1. За носач на слици, услед задатог оптерећења, нацртати дијаграме сила у пресецима.

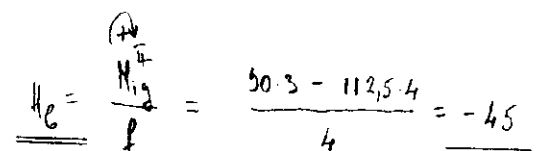
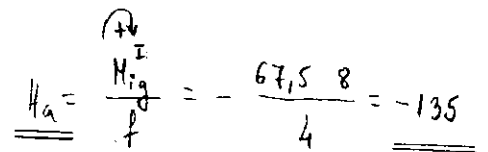
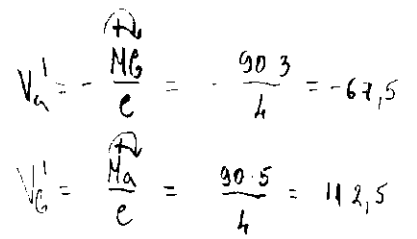


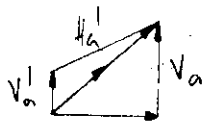
$a = 2$

Издала(о): Марина Зеткович

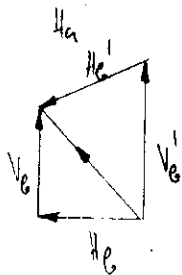
Издато дана: 30.10.2008.

Оцена: 10 (десет)



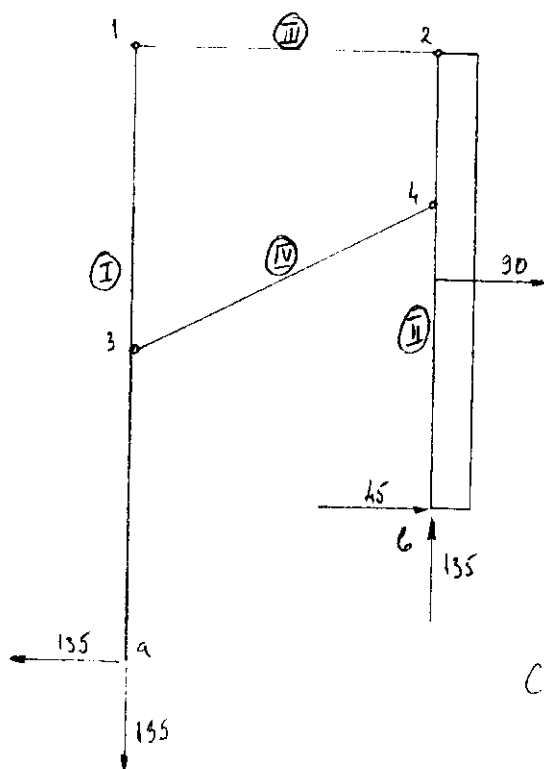


$$V_a = V_a' + H_a' \tan \alpha_0 = -67,5 + (-135) \cdot \frac{2}{4} = -135$$



$$V_b = V_b' - H_b' \tan \alpha_0 = 112,5 - (-45) \cdot \frac{2}{4} = 135$$

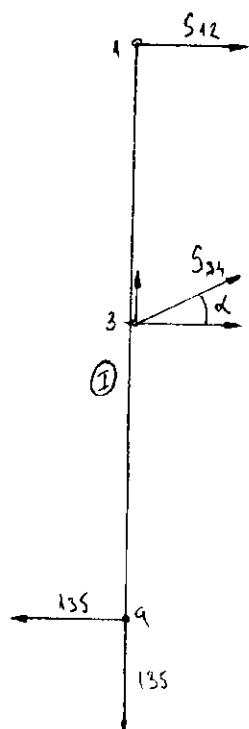
КОНТРОЛЬ РЕАКЦИЙ В ОСЛОТНАЦА У ТИЧКАМА а и б



$$\sum X = 0 \quad -135 + 90 + 45 = 0 \quad T$$

$$\sum Y = 0 \quad -135 + 135 = 0 \quad T$$

ОПРЕДЕЛЕНИЕ СИЛ S_{12} И S_{34}

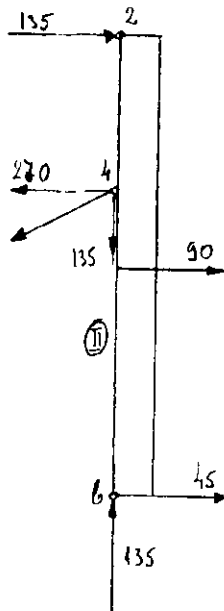


$$\sum X = 0 \quad S_{12} + \cos \alpha S_{34} = 135$$

$$\sum Y = 0 \quad \sin \alpha S_{34} = 135$$

$$\underline{\underline{S_{34} = 300}}$$

$$\underline{\underline{S_{12} = -135}}$$



$$\sum X = 0$$

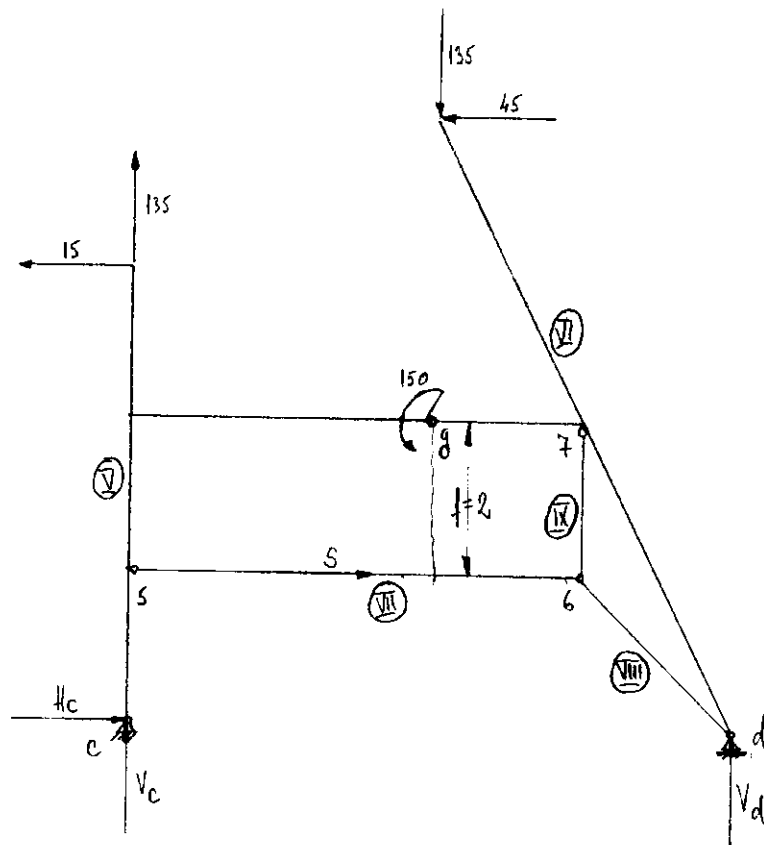
$$135 - 270 + 45 + 90 = 0$$

T

$$\sum Y = 0$$

$$135 - 135 = 0$$

T

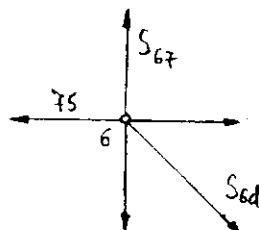


$$\sum M_d = 0 \quad V_c \cdot 8 + 135 \cdot 8 - 15 \cdot 6 - 135 \cdot 4 - 45 \cdot 8 - 150 = 0 \Rightarrow \underline{V_c = 7,5}$$

$$\sum X = 0 \quad H_c - 15 - 45 = 0 \Rightarrow \underline{H_c = 60}$$

$$\sum Y = 0 \quad V_c + V_d + 135 - 135 = 0 \Rightarrow \underline{V_d = -7,5}$$

$$\underline{S = \frac{M_g}{f} = \frac{7,5 \cdot 4 + 135 \cdot 4 - 15 \cdot 2 - 60 \cdot 4 - 150}{2} = 75}$$



$$\sum X = 0$$

$$S_{6d} \cos 45^\circ = 75$$

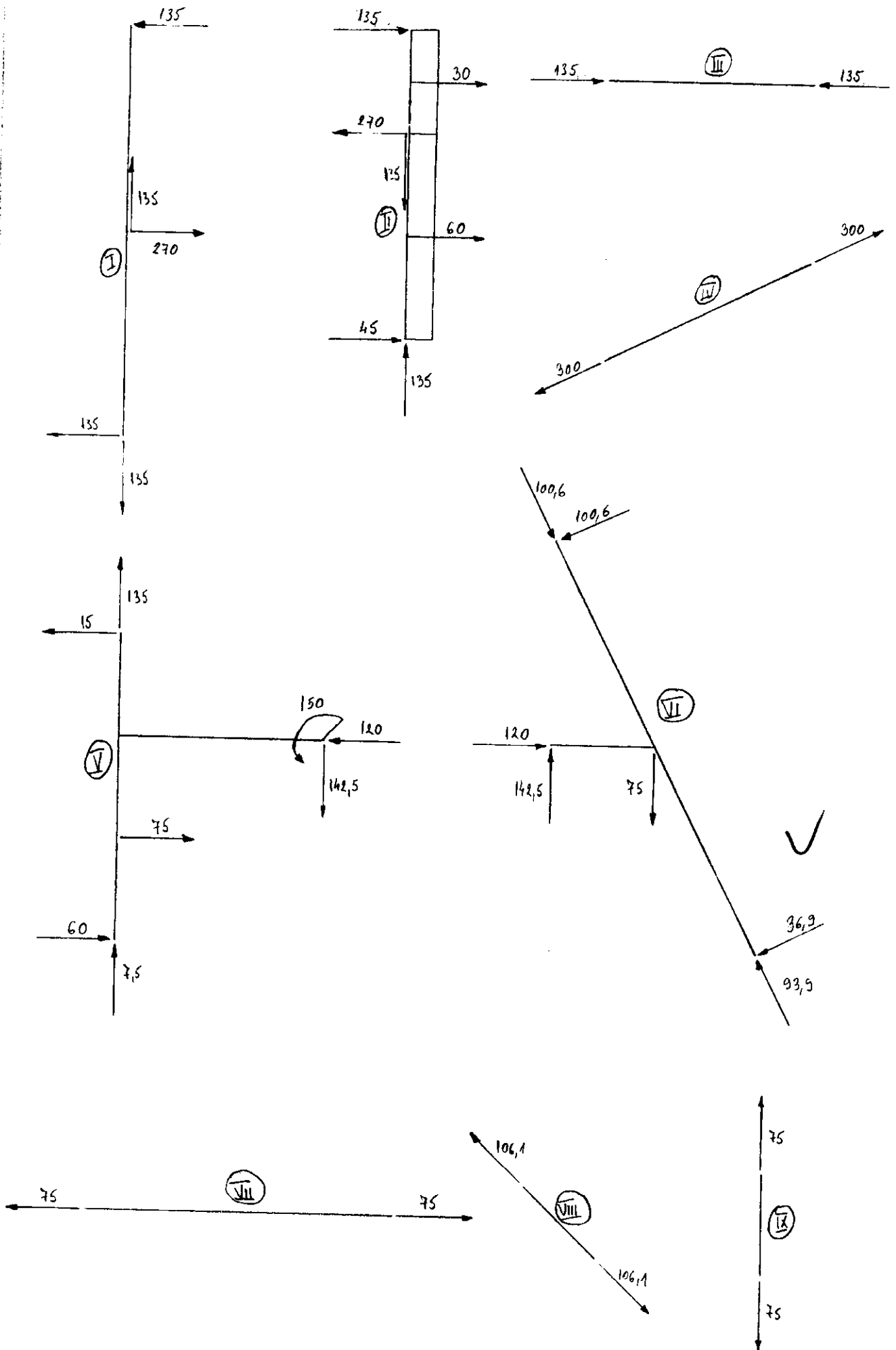
$$\sum Y = 0$$

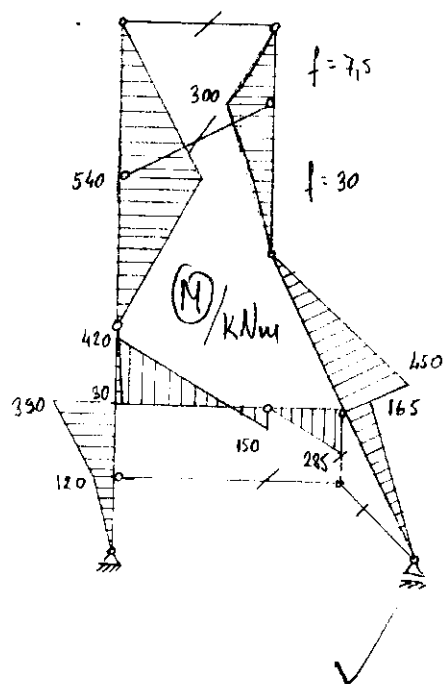
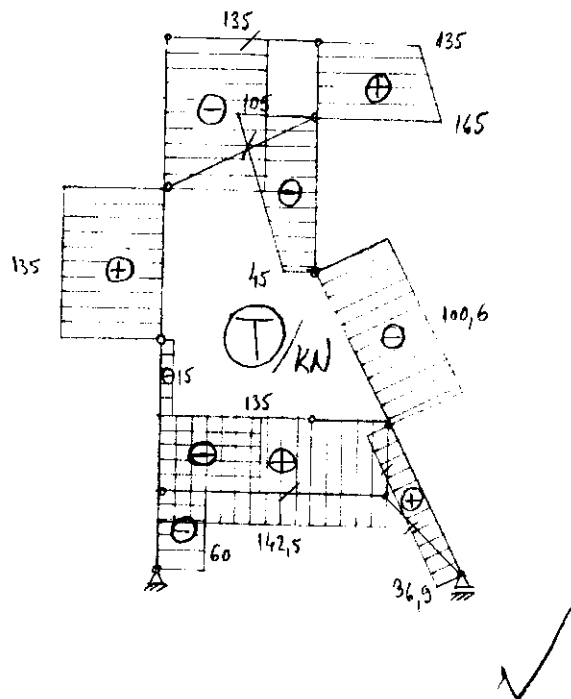
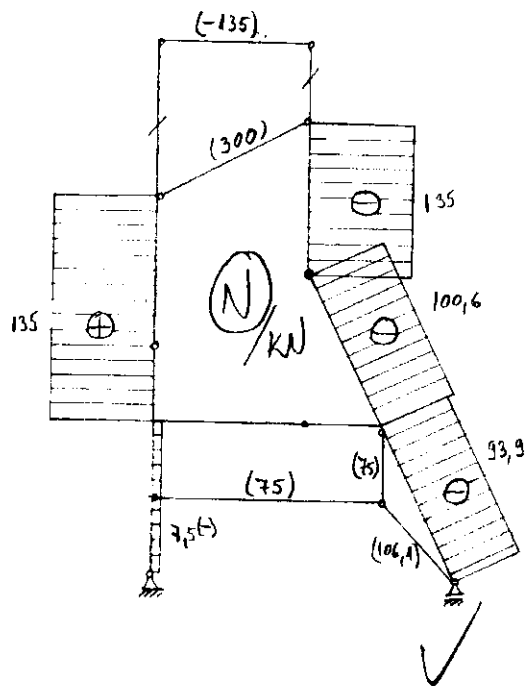
$$S_{67} = S_{6d} \cdot \sin 45^\circ$$

$$\underline{S_{6d} = 106,1}$$

$$\underline{S_{67} = 75}$$

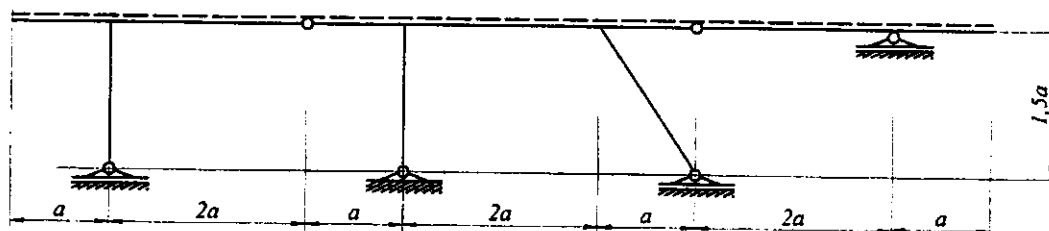
$$P = 15$$





4. ЗАДАТАК

1. Услед једнако подељеног покретног оптерећења $p = \underline{11}$, срачунати и нацртати дијаграме екстремних вредности сила у пресецима

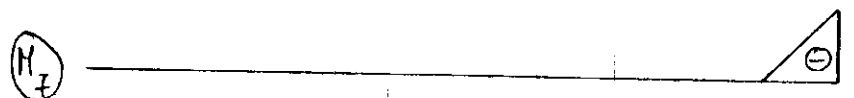
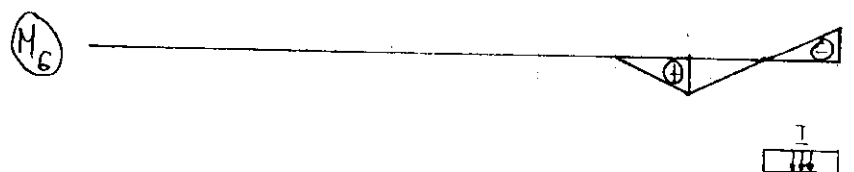
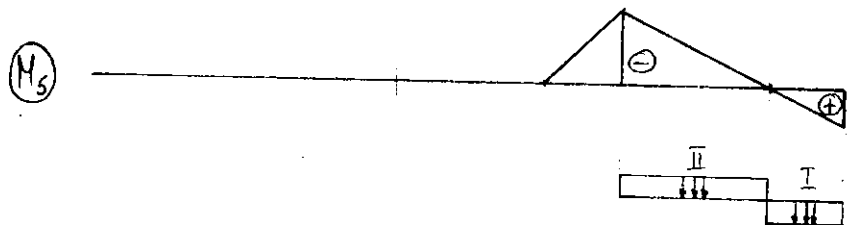
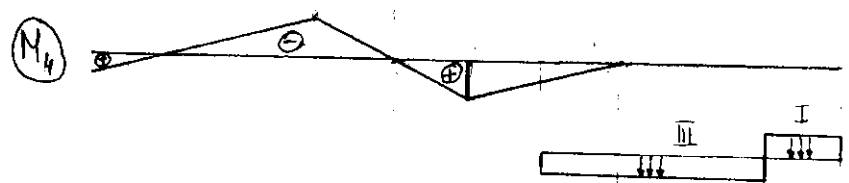
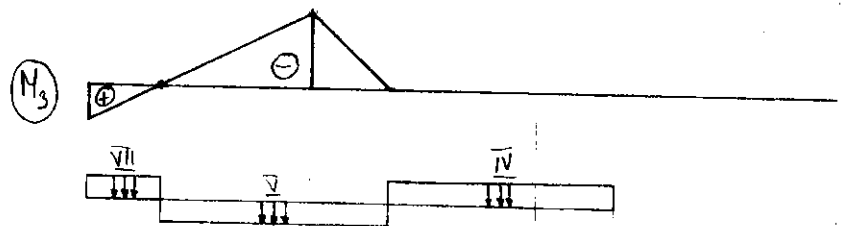
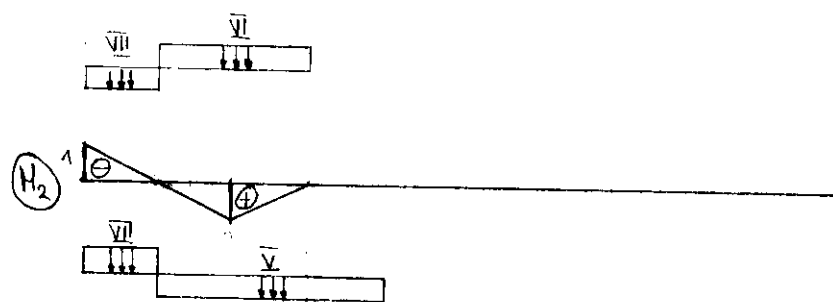
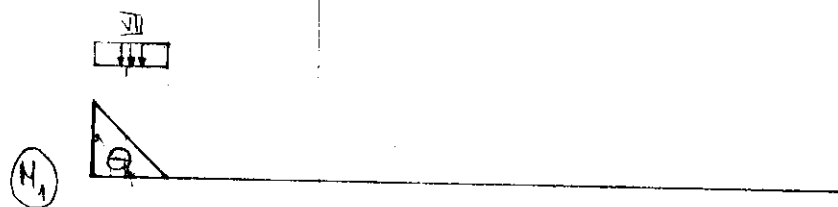
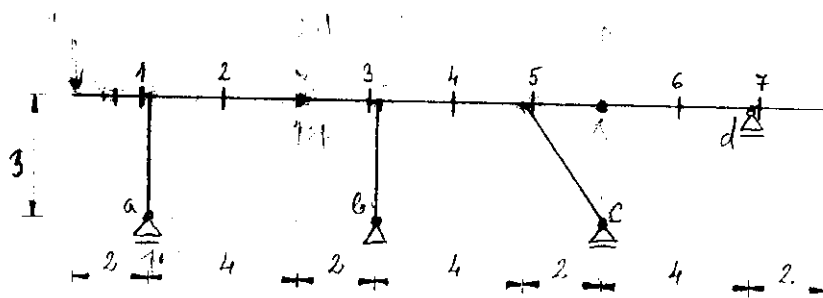


$$a = \underline{2}$$

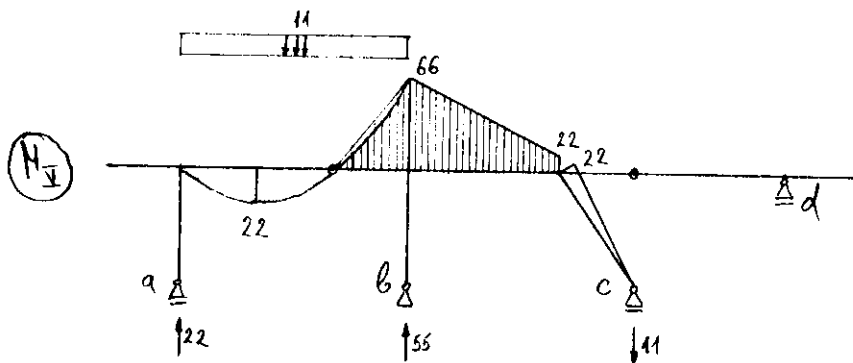
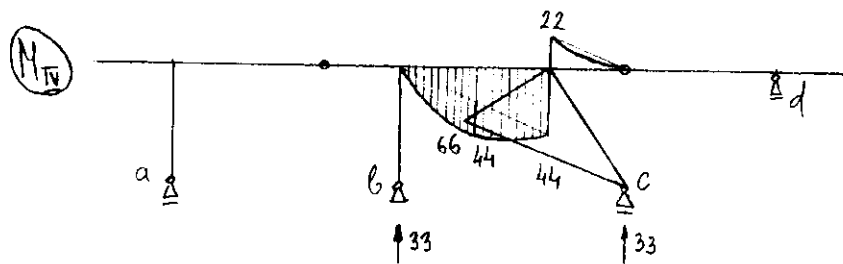
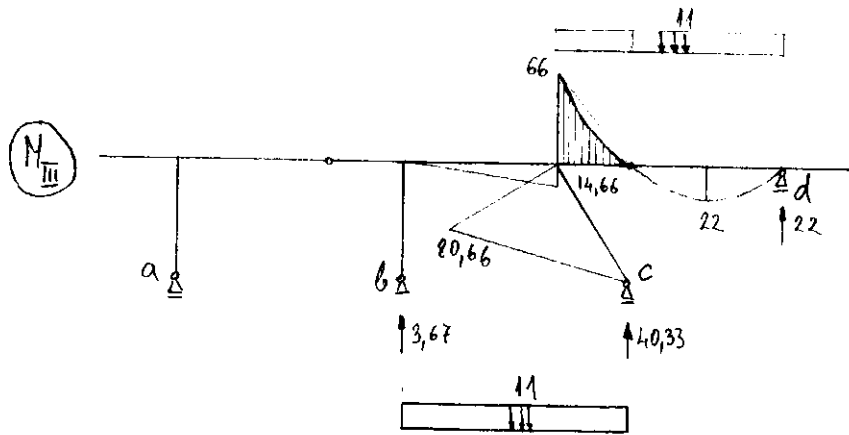
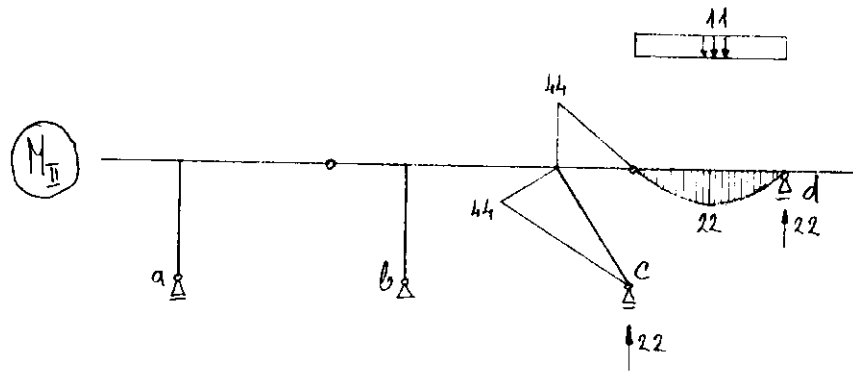
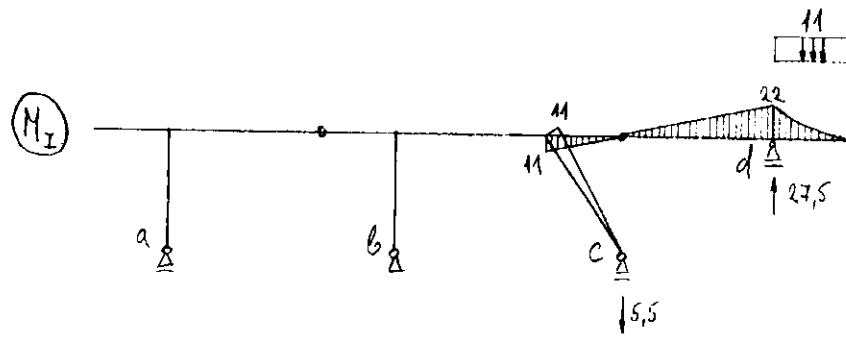
Израдила(о): Марица Златковић

Издато дана: 13.11.2008.

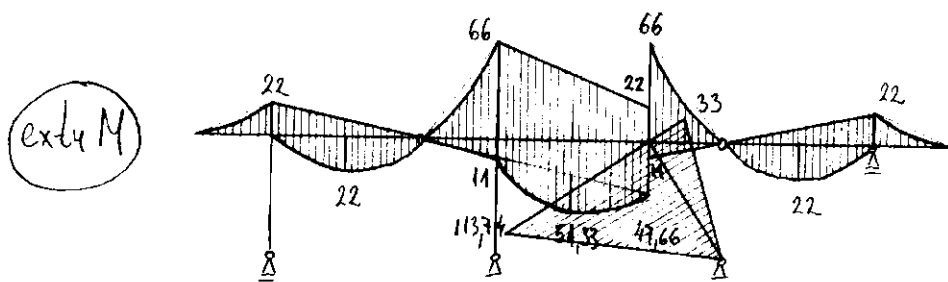
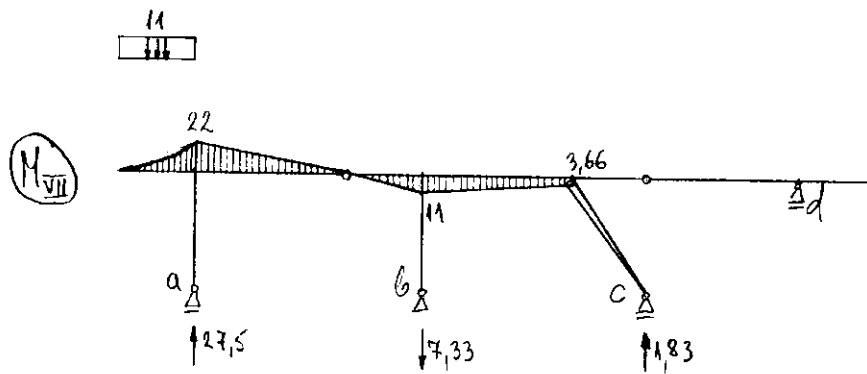
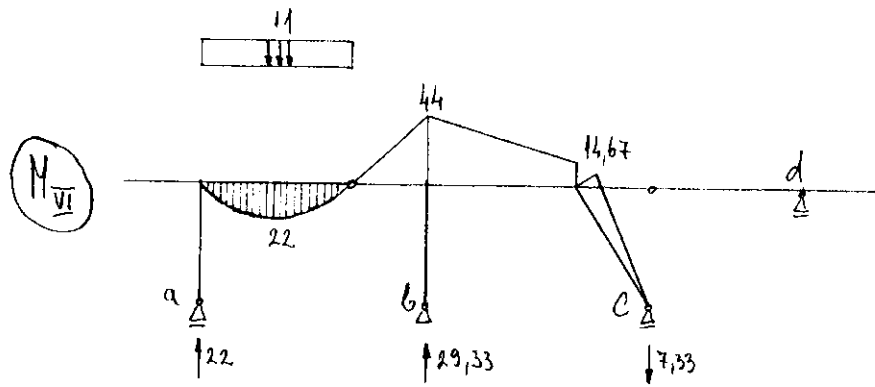
Оцена: 10 (уџиво)



✓

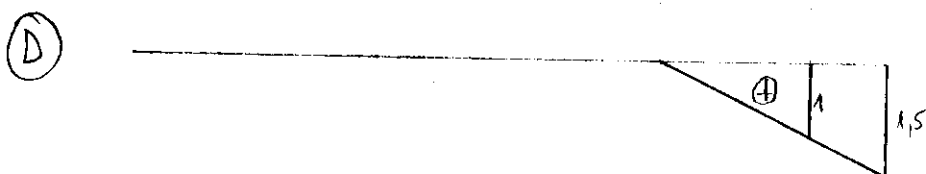
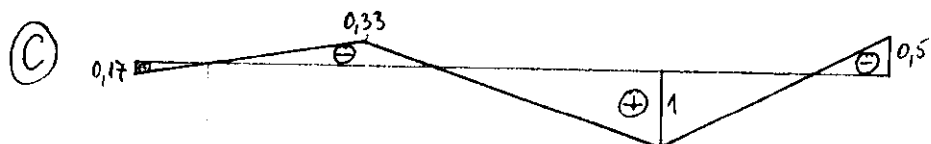
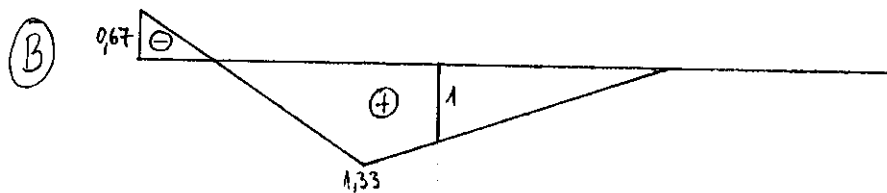
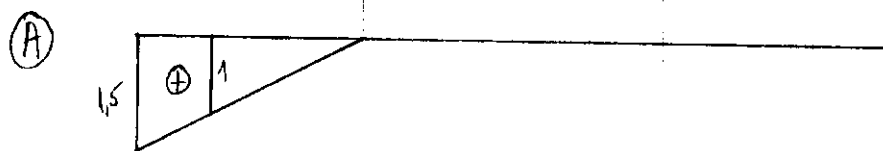


✓



min M

max M



$$\max A = p \cdot F^+ = 11 \cdot \left(\frac{1,5 \cdot 6}{2} \right) = 49,5$$

$$\min A = p \cdot F^- = 0$$

$$\max B = p \cdot F^+ = 11 \cdot \left(\frac{1,33 \cdot 12}{2} \right) = 87,78$$

$$\min B = p \cdot F^- = 11 \cdot \left(\frac{0,67 \cdot 2}{2} \right) = -7,37$$

$$\max C = p \cdot F^+ = 11 \cdot \left(\frac{0,17 \cdot 2}{2} + \frac{1 \cdot 10}{2} \right) = 56,87$$

$$\min C = p \cdot F^- = 11 \cdot \left(\frac{0,33 \cdot 6}{2} + \frac{0,5 \cdot 2}{2} \right) = -16,5$$

$$\max D = p \cdot F^+ = 11 \cdot \left(\frac{1,5 \cdot 6}{2} \right) = 49,5$$

$$\min D = 0$$

$$\max N_c = \max C \cdot 2 = 56,87 \cdot 2 = 113,74$$

$$\min N_c = \min C \cdot 2 = -16,5 \cdot 2 = -33$$

$$\bar{T}_a = 0 \Rightarrow \max \bar{T}_a = 0, \min \bar{T}_a = 0$$

$$N_a = A \Rightarrow \max N_a = 49,5, \min N_a = 0$$

$$\bar{T}_B = 0 \Rightarrow \max \bar{T}_B = 0, \min \bar{T}_B = 0$$

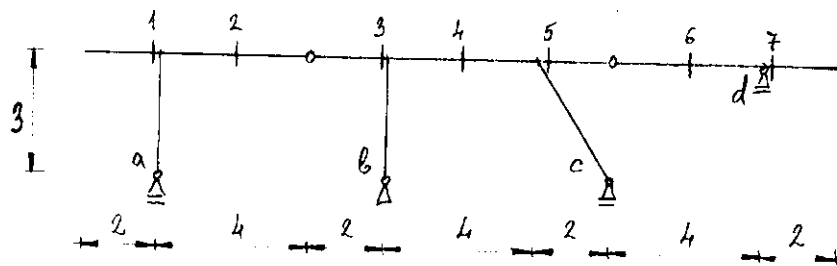
$$N_B = B \Rightarrow \max N_B = 87,78, \min N_B = -7,37$$

$$\bar{T}_C = C \cos \alpha \Rightarrow \max \bar{T}_C = 31,55, \min \bar{T}_C = -9,15$$

$$N_C = C \sin \alpha \Rightarrow \max N_C = 47,32, \min N_C = -13,73$$

D није ушао па нема тангенталну ни нормалну силу (беспошребно)





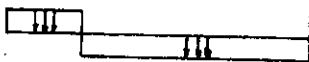
(1)



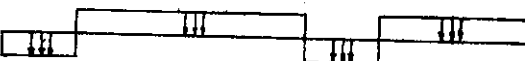
(2)



(3)



(4)



(5)



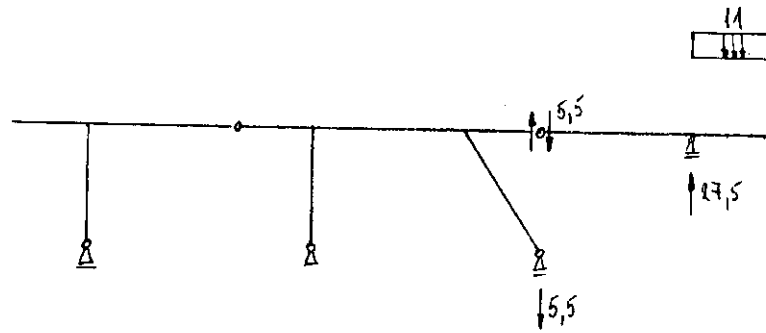
(6)



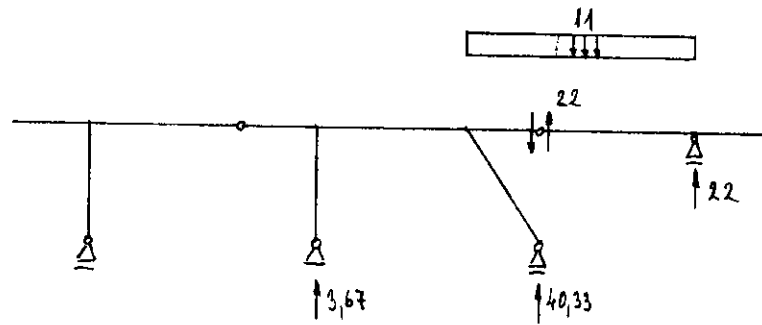
(7)



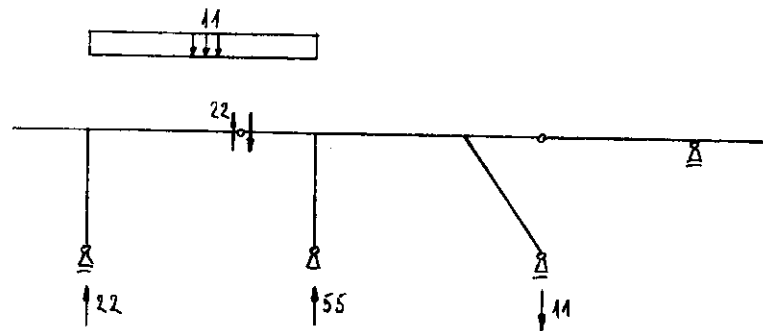
✓



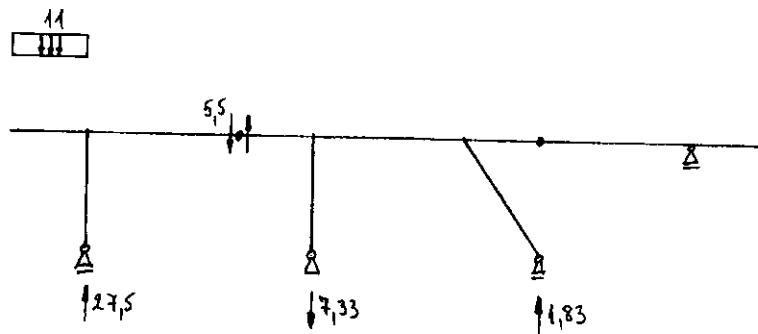
$\max T_7$
 $\text{deo } \min T_6$
 $\min T_5$



$\max T_5$

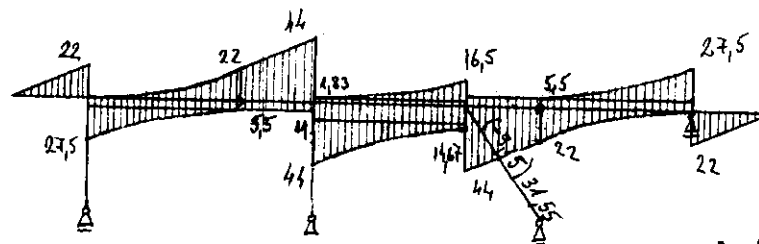


$\text{deo } \max T_4$
 $\min T_3$



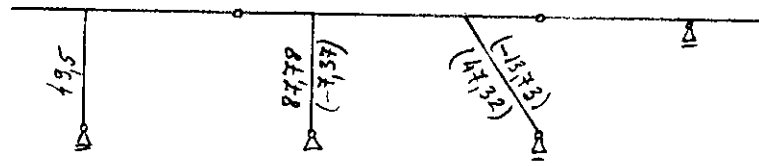
$\text{deo } \min T_1$
 $\max T_3$
 $\text{deo } \max T_2$
 $\min T_4$

ext₄ T



$\uparrow \min T$
 $\downarrow \max T$

ext₄ N



26.11.08.
10/10/08

5. ЗАДАТАК

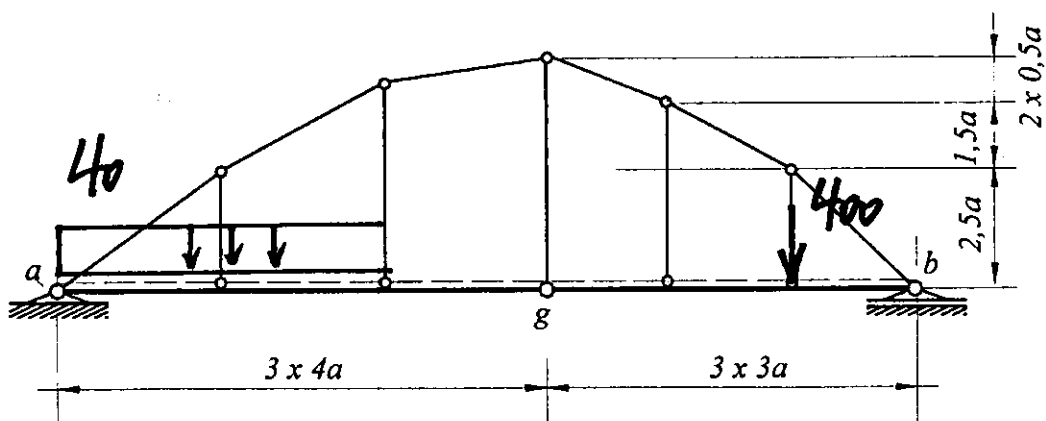
1. За посредно непосредно оптерећен носач срачунати и нацртати:

➤ дијаграме сила у пресецима услед задатог оптерећења.

➤ дијаграме екстремних вредности момената савијања, трансферзалних сила на делу носача a-g, g-b услед једнако подељеног покретног оптерећења p .

$$p = \underline{10} \text{ kN/m}$$

$$a = \underline{1} \text{ m}$$

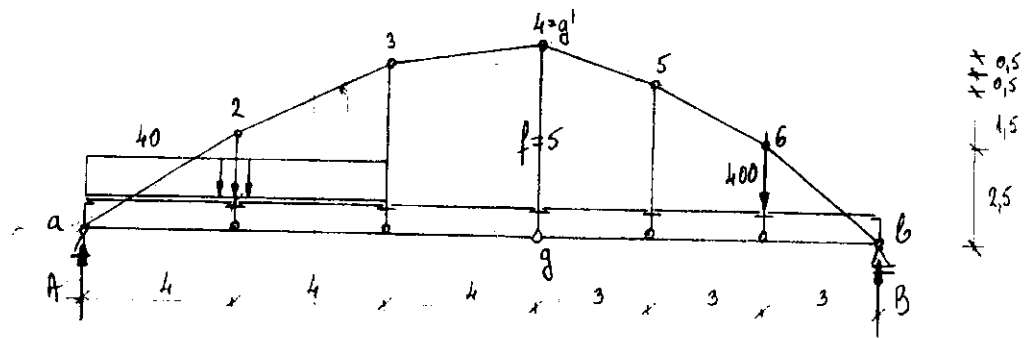


Издао: Марица Зечевић

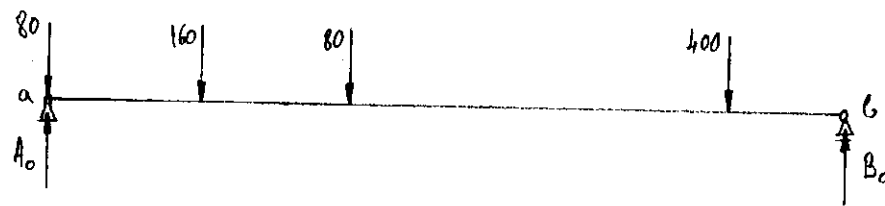
Издато дана: 19.11.2008.

Оцена: 10 (пет)

5.1.



РЕАКЦИИ ОСНОВАНИЯ КОРЕСПОНДЕНТНЕ ПРОСТЕ ГРЕДЕ



$$A_0 = \frac{N_C}{e} = \frac{400 \cdot 3 + 80 \cdot 13 + 160 \cdot 17 + 80 \cdot 21}{21} = 316,19 \text{ kN}$$

$$B_0 = \frac{N_A}{e} = \frac{160 \cdot 4 + 80 \cdot 8 + 400 \cdot 18}{21} = 403,81 \text{ kN}$$

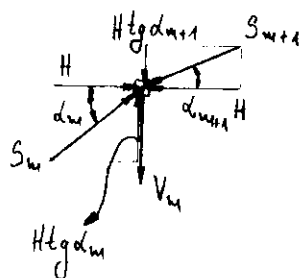
$$A_0 + B_0 = 720 \quad \text{T}$$

$$H = \frac{N_{A0}}{f} = \frac{403,81 \cdot 9 - 400 \cdot 6}{5} = 246,86 \text{ kN}$$

$$A' = B' = 0 \Rightarrow A = A_0 = 316,19 \text{ kN}$$

$$B = B_0 = 403,81 \text{ kN}$$

СИЛА У ШТАПОВИНА ЛАНЦА И ВЕШАЉКИ



$$S_m = \frac{H}{\cos \alpha_m}$$

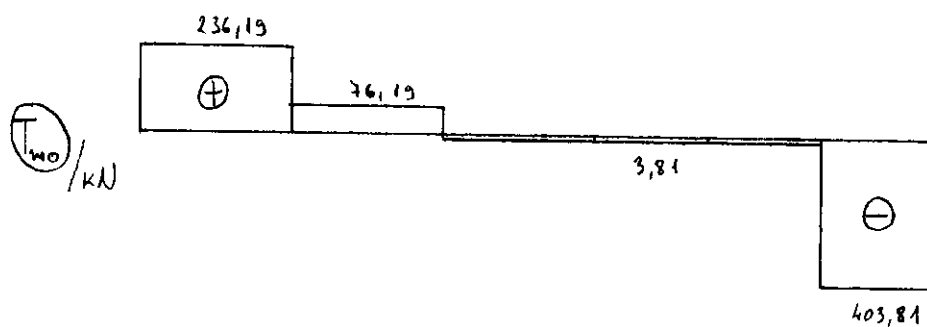
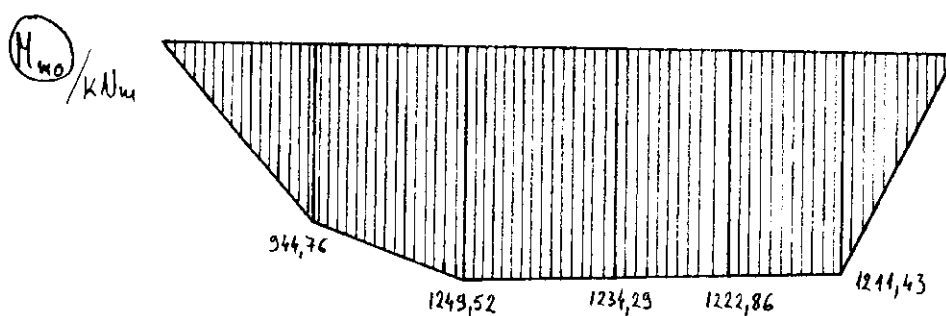
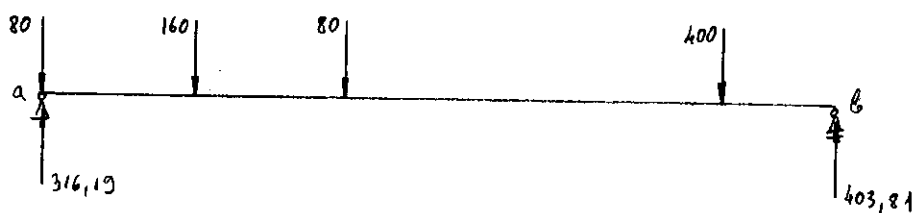
$$V_m = H(\tan \alpha_m - \tan \alpha_{m+1})$$

M	$tg \alpha_m$	$tg \alpha_m - tg \alpha_0$	V_m	$cos \alpha_m$	S_m	
	/	/	kN	/	kN	
2	0,625	0,125	30,86	0,848	291,11	I
3	0,500	0,375	92,57	0,894	276,13	II
4	0,125	0,458	113,06	0,992	248,85	III
5	-0,333	0,167	41,23	0,949	260,13	IV
6	-0,500	0,333	82,20	0,894	276,13	V
6	-0,833	/	/	0,768	321,43	VI

МОМЕНТИ САЗИЈАКА И ТРАНСВЕРЗАЛНЕ СИЛЕ У ГРЕГАНА $a-g$ И $g-b$

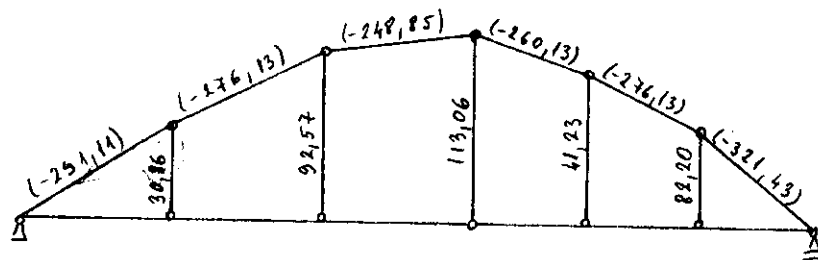
$$M_m = M_{m0} - H y_m$$

$$T_m = T_{m0} - H(tg \alpha_m - tg \alpha_0), \alpha_0 = 0 \Rightarrow T_m = T_{m0} - H tg \alpha_m$$

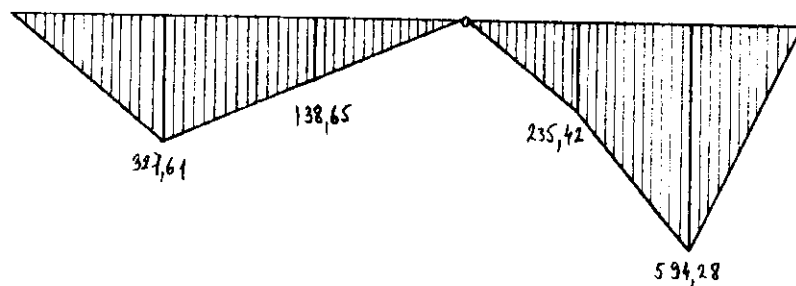


n	H_{no}	H_{ym}	H_m	номе	T_{no}	$Htg\ d_m$	T_m
	кНм	кНм	кНм		кН	кН	кН
a	0	0	0	I	236,19	154,29	81,90
2	944,76	617,15	327,61	II	76,19	123,43	-47,24
3	1249,52	1110,87	138,65	III	-3,81	30,86	-34,67
4	1234,29	1234,29	0	IV	-3,81	-82,20	78,39
5	1222,86	587,44	235,42	V	-3,81	-123,43	119,62
6	1211,43	617,15	594,28	VI	-403,81	-205,63	198,18
b	0	0	0				

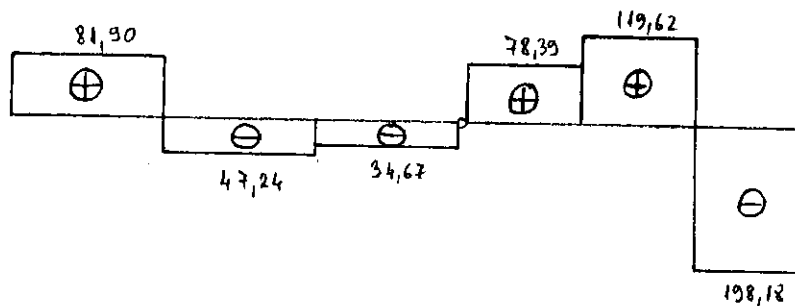
⑤, ⑥ / кН



④ / кНм



⑦ / кНм



5.2.

$$H_c = M_{co} - H y_c, \quad e_H = \frac{l}{1 + \frac{e_1 \cdot y_c}{f \cdot x_c}}$$

ПРЕСЕК 1:

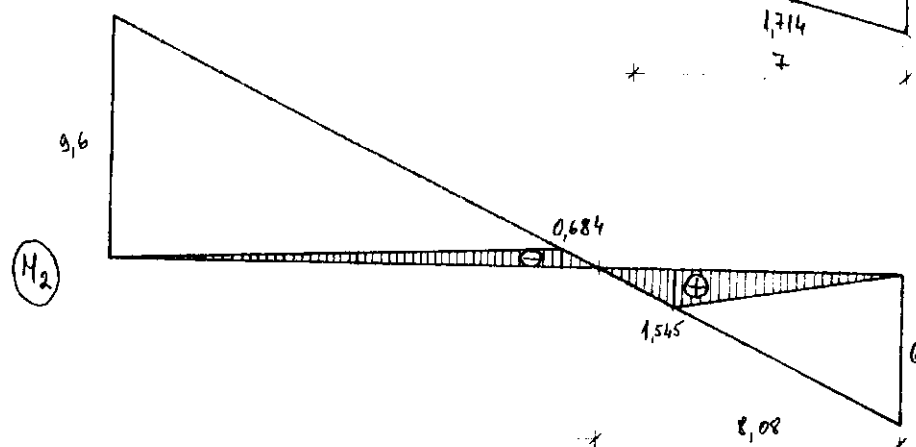
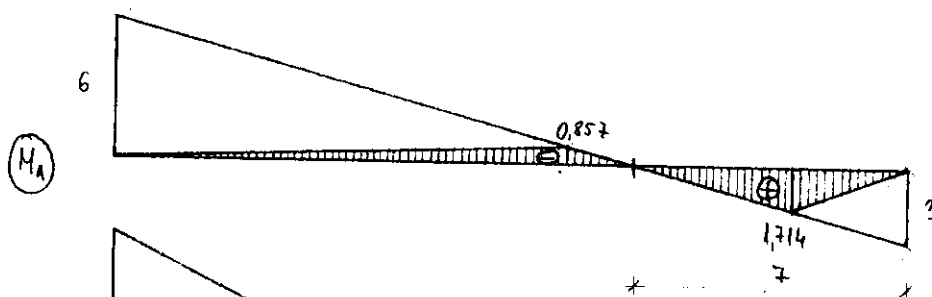
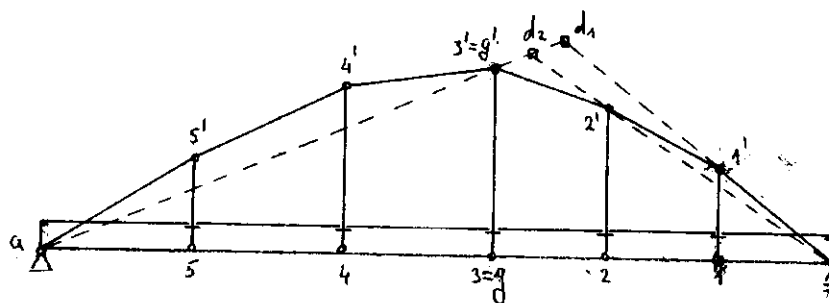
$$M_1 \begin{cases} x_1 = 3 \\ -\frac{e_1}{f} y_1 = -\frac{12}{5} \cdot 2,5 = -6 \end{cases}$$

$$e_{H1} = \frac{21}{1 + \frac{12}{5} \cdot \frac{2,5}{3}} = 7$$

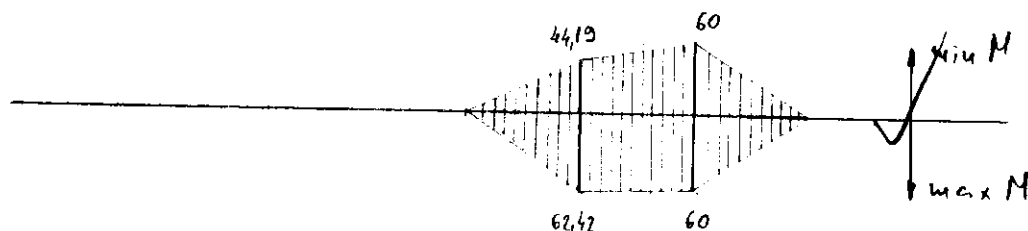
ПРЕСЕК 2:

$$M_2 \begin{cases} x_2 = 6 \\ -\frac{e_1}{f} y_2 = -\frac{12}{5} \cdot 4 = -9,6 \end{cases}$$

$$e_{H2} = \frac{21}{1 + \frac{12}{5} \cdot \frac{4}{6}} = 8,08$$

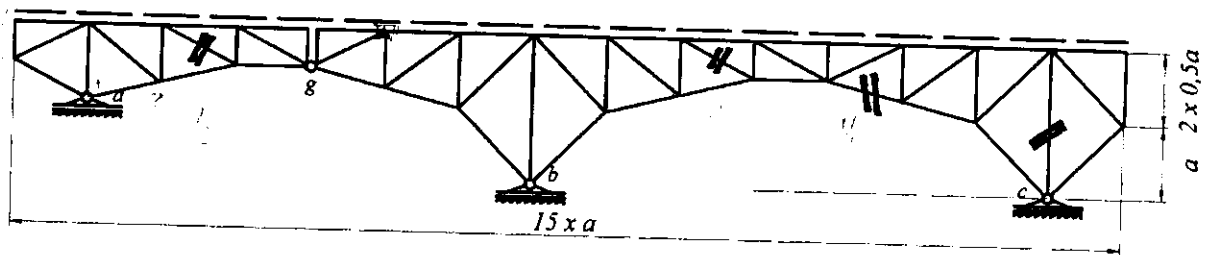


(extr M)



6. ЗАДАЧА

1. За дати носач конструисати утицајне линије за силе у означеним штаповима статичком методом.

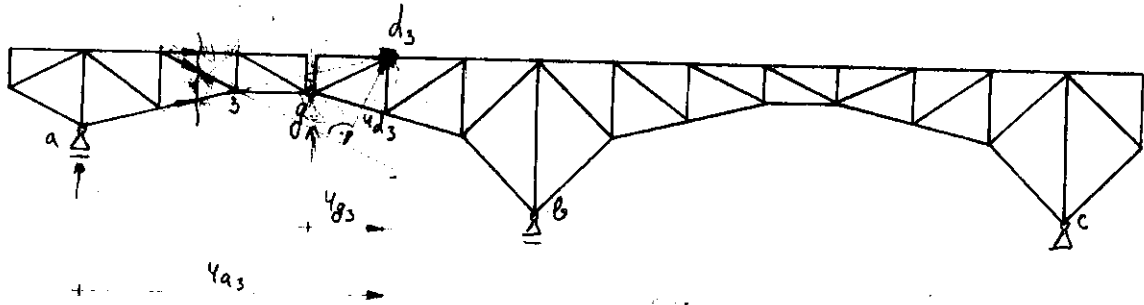


$$a = \underline{2}$$

Издана(о): Мария Захаровна

Издадо дана: 27.11.2008.

Оцена: Добро

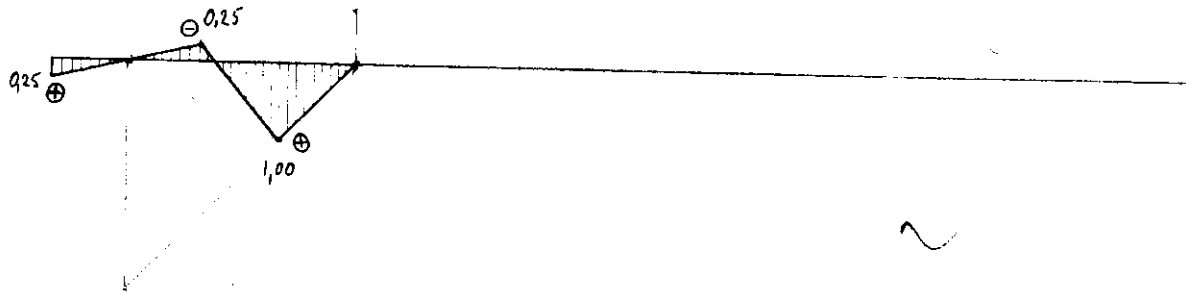


$$D_3 \cdot y_{d3} = H_{d3} \Rightarrow D_3 = H_{d3} / y_{d3} \rightarrow G \cdot y_{g3} / y_{d3} \rightarrow A \cdot y_{a3} / y_{d3}$$

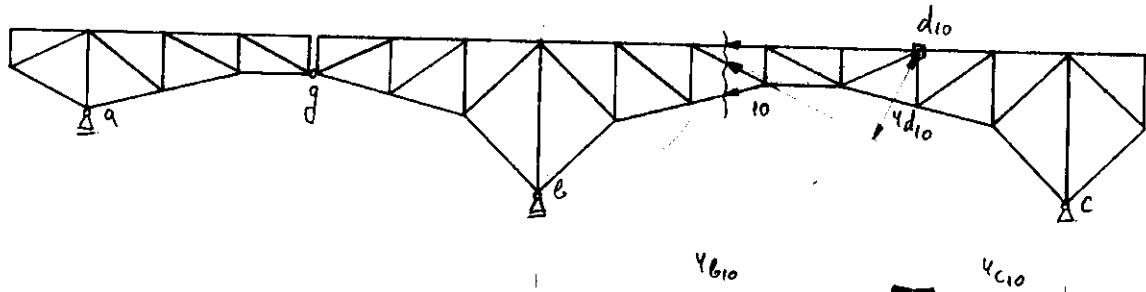
$$y_{g3} = -2$$

$$y_{a3} = 8$$

$$y_{d3} = 2,68$$



(D₃)

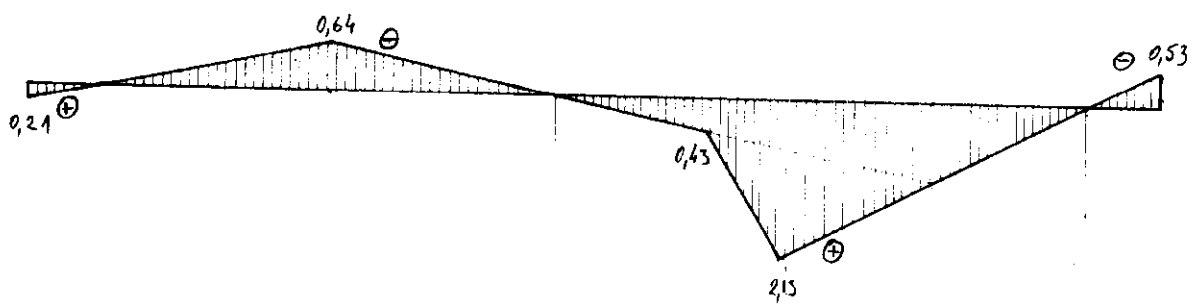


$$D_{10} \cdot y_{d10} = H_{d10} \rightarrow D_{10} = H_{d10} / y_{d10} \rightarrow C \cdot y_{c10} / y_{d10} \rightarrow B \cdot y_{b10} / y_{d10}$$

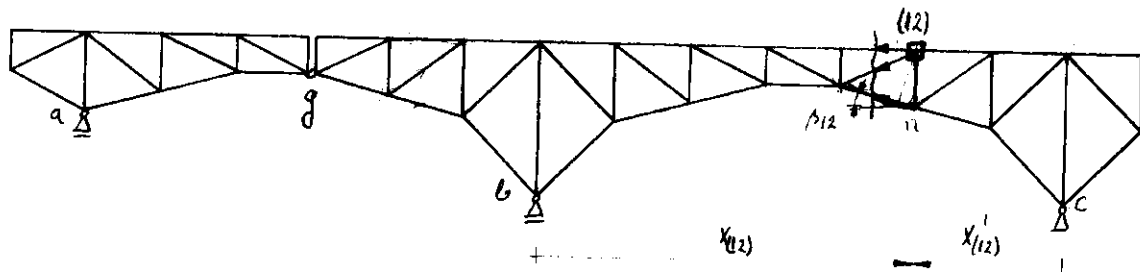
$$y_{c10} = 4$$

$$y_{b10} = 10$$

$$y_{d10} = 2,68$$



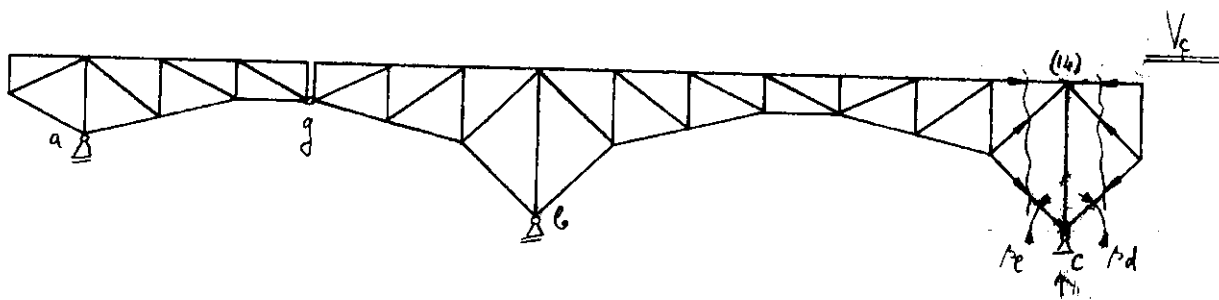
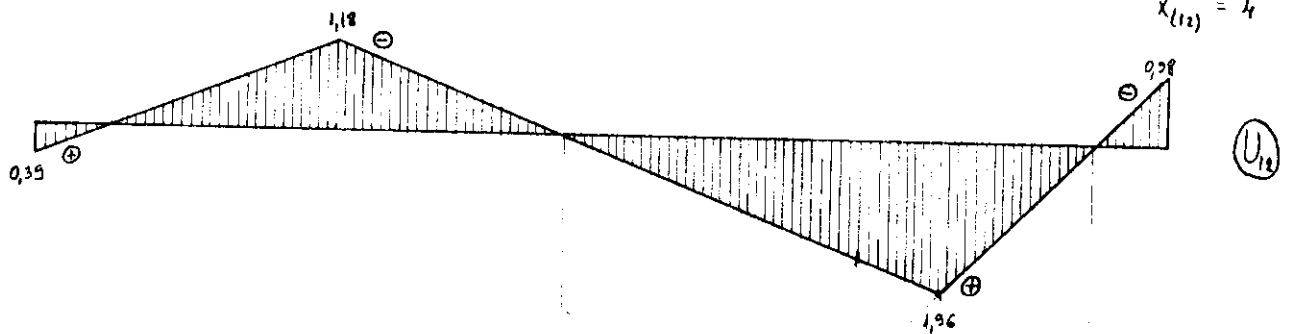
(D₁₀)



$$U_{12} \cos \beta_{12} h_{12} = H_{(12)} \Rightarrow U_{12} = \frac{H_{(12)}}{h_{12}} \cdot \frac{1}{\cos \beta_{12}}$$

$$\begin{aligned} & \frac{B \cdot x_{(12)}}{h_{12}} \cdot \frac{1}{\cos \beta_{12}} \\ & \frac{C \cdot x'_{(12)}}{h_{12}} \cdot \frac{1}{\cos \beta_{12}} \end{aligned}$$

$\beta_{12} = 14,04^\circ$
 $h_{12} = 1,5$
 $x_{(12)} = 10$
 $x'_{(12)} = 4$



$$\sum Y = 0 : C + V_c + U_e \sin \beta_e + U_d \sin \beta_d = 0$$

$$U_e \cdot \cos \beta_e \cdot h_{14} = H_{(14)} \Rightarrow U_e = \frac{H_{(14)}}{h_{14}} \cdot \frac{1}{\cos \beta_e} \quad , \quad U_d \cdot \cos \beta_d \cdot h_{14} = H_{(14)} \Rightarrow U_d = \frac{H_{(14)}}{h_{14}} \cdot \frac{1}{\cos \beta_d}$$

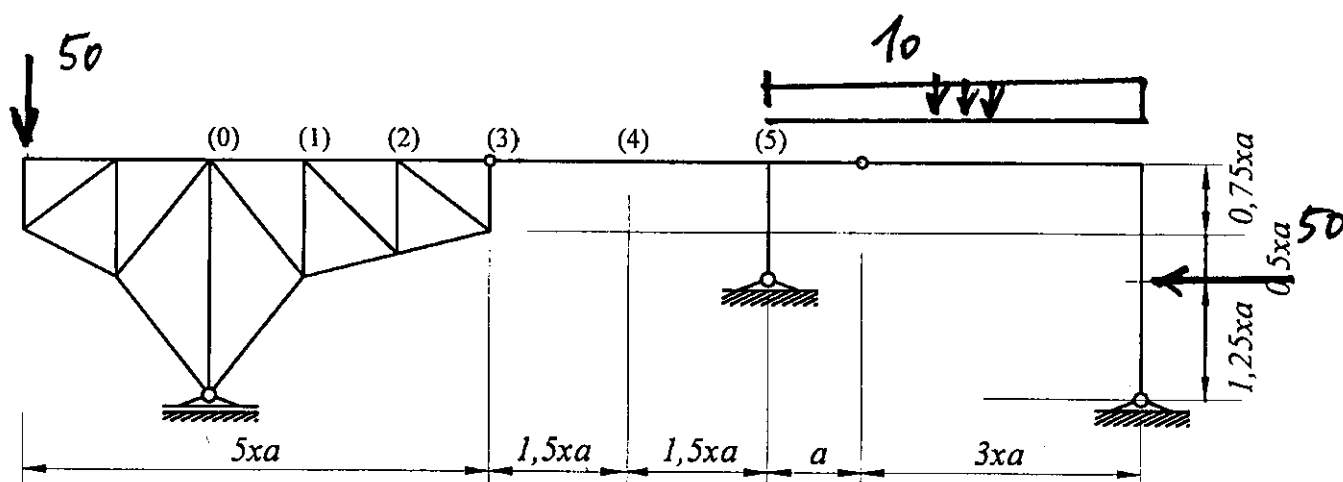
$$V_c = -C - \frac{H_{(14)}}{h_{14}} (l_g \beta_e + l_g \beta_d)$$

$\beta_e = 45^\circ, \beta_d = 45^\circ, h_{14} = 4$



7. ЗАДАТАК

1. За носач на слици нацртати дијаграм вертикалних померања потеза штапова (0)-(1)-(2)-(3)-(4)-(5):
(Пун носач: $EI = \text{const.}$ $I/F=0$, $I/G=0$; Прости штапови $I/F=0.1\text{m}^2$).



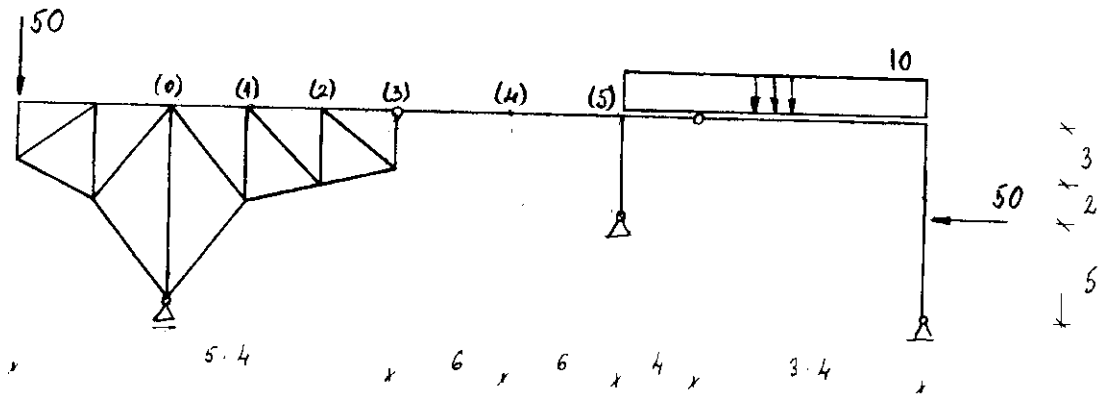
$a = \underline{4}$

Издао(а): Марица Зекић

Издато дана: 4. 12. 2008.

Оцена: 9/10

ЗАДАЧА 7



ПРИН. НОСАЧ: $EI = \text{const}$

$$I/F = 0$$

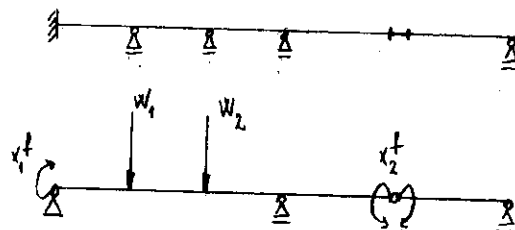
$$I/G = 0$$

ПРОСТ. ШТАПОВИ: $I/F = 0,1 \text{ m}^2$

ПОПРЕКА И РОТАЦИЈЕ НА ДЕЛУ (0)-(1)-(2)-(3)-(4)-(5):

$$\begin{array}{cccccc} v \neq 0 & v \neq 0 & v \neq 0 & v \neq 0 & v \neq 0 & v = 0 \\ \psi \neq 0 & \psi \neq 0 & \psi \neq 0 & \psi \neq 0 & \psi \neq 0 & \psi \neq 0 \end{array}$$

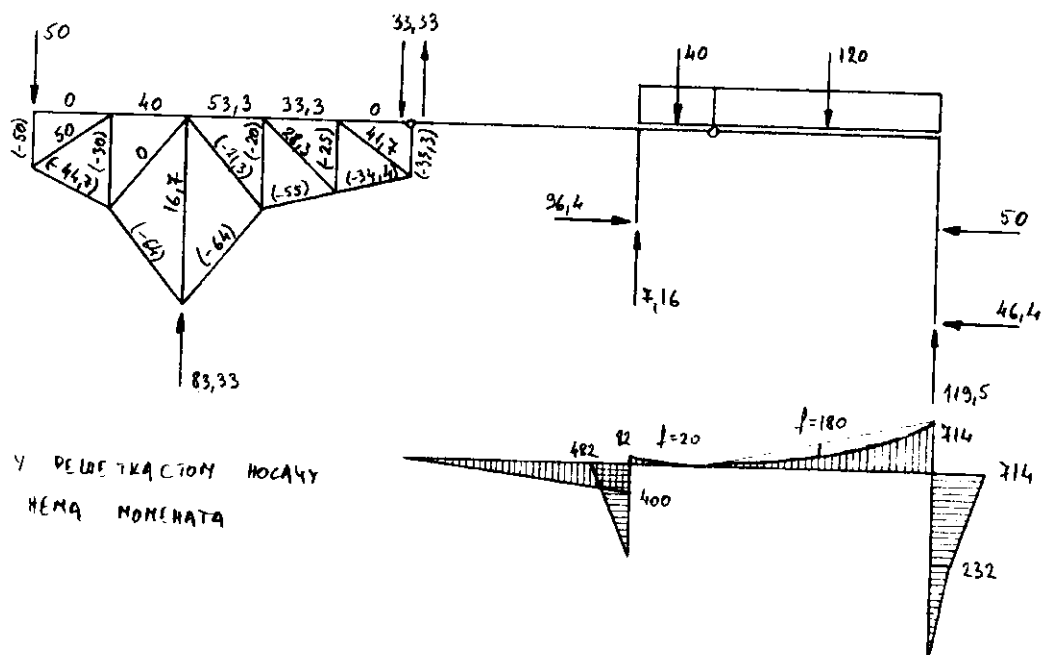
ОДГОВАРАЈУЋИ ФУНКЦИЈИ НОСАЧ:



СТАТИЧКИ НЕОДРЕЂЕН
(4 ПУТА НЕОДРЕЂЕН)

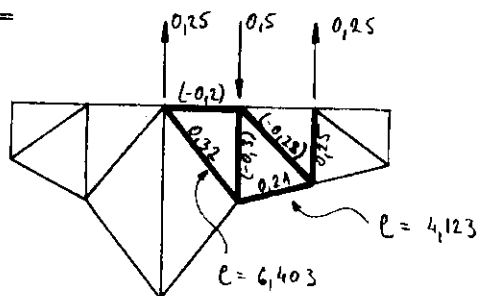
СТАТИЧКИ ОДРЕЂЕН

РЕШЕЊЕ НОСАЧА:



У РЕШЕЊАЦИ НОСАЧА
НЕМА ПОМЕНАТА

W_1

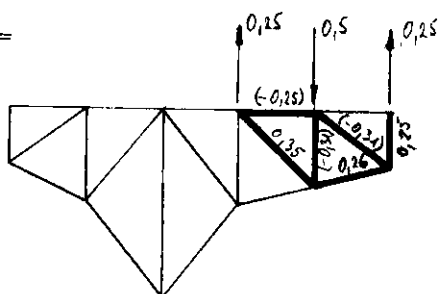


(N_1)

$$EI W_1 = \frac{I}{F} \cdot \sum N \cdot N_1 \cdot l = 0,1 \cdot (-0,2 \cdot 53,3 \cdot 4 - 0,32 \cdot 21,3 \cdot 6,403 + 0,3 \cdot 20 \cdot 5 - 0,28 \cdot 28,3 \cdot 5,657 - 0,21 \cdot 55 \cdot 4,123 - 0,25 \cdot 25 \cdot 4)$$

$$EI W_1 = -17,373$$

W_2

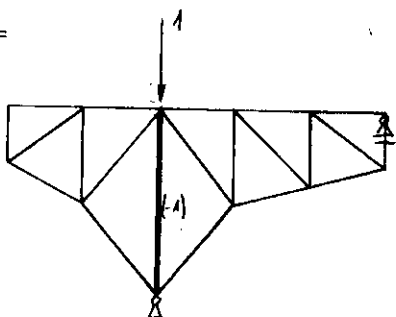


(N_2)

$$EI W_2 = \frac{I}{F} \cdot \sum N \cdot N_2 \cdot l = 0,1 \cdot (-0,25 \cdot 33,3 \cdot 4 + 0,35 \cdot 28,3 \cdot 5,657 + 0,31 \cdot 25 \cdot 4 - 0,26 \cdot 34,4 \cdot 4,123 - 0,25 \cdot 33,3 \cdot 3 - 0,31 \cdot 41,7 \cdot 5)$$

$$EI W_2 = -72,813$$

x_1^f

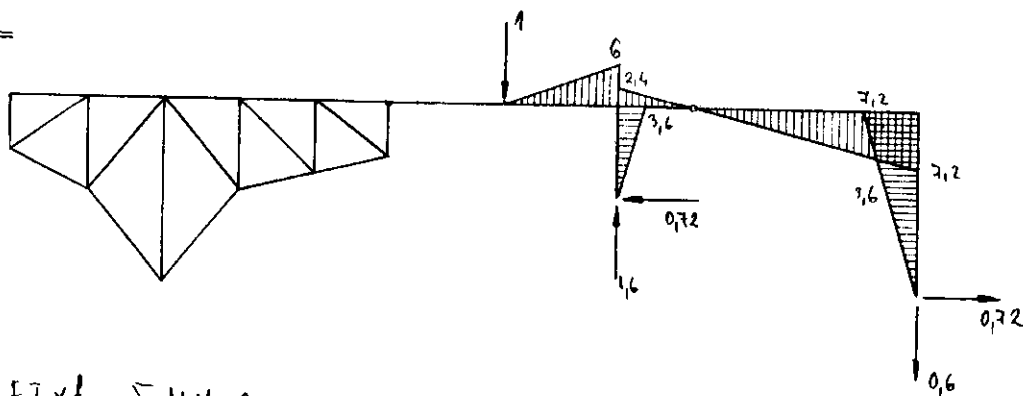


(N_3)

$$EI x_1^f = \frac{I}{F} \cdot \sum N \cdot N_3 \cdot l$$

$$EI x_1^f = 0,1 \cdot (-1 \cdot 16,7 \cdot 10) = -16,7$$

x_2^f



$$EI x_2^f = \sum N H_2 \cdot l$$

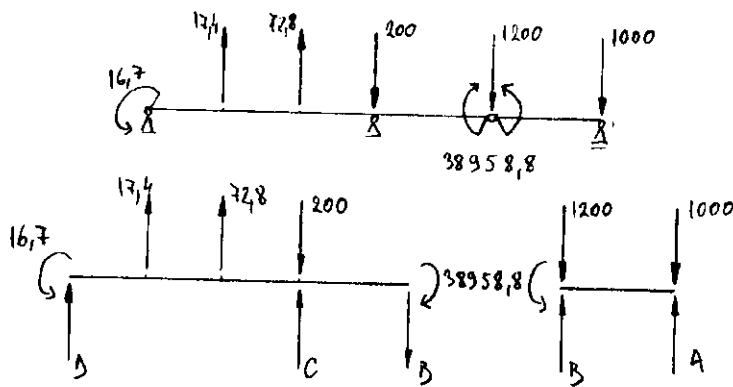
$$EI \chi_2^I = -\frac{6}{6} (6 \cdot (2400 + 200)) - \frac{5}{6} \cdot (3,6 \cdot (2 \cdot 482)) + \frac{4}{6} \cdot (2,4 \cdot (2 \cdot 82)) - \frac{4}{3} 20 \cdot (2,4) \\ - \frac{12}{6} \cdot (7,2 \cdot (2 \cdot 14)) + \frac{12}{3} \cdot 180 \cdot (7,2) - \frac{5}{6} \cdot (7,2 \cdot (2 \cdot 14 + 232)) + 3,6 \cdot (2 \cdot 232 + 714) - \frac{5}{6} (3,6 \cdot (2 \cdot 232)) \\ = -6000 - 2892 + 262,4 - 64 - 20563,2 + 5184 - 13494 - 1392$$

$$EI \chi_2^I = -38958,8$$

$$\phi_1 = \frac{6}{6} \cdot (20 + 200) = 200$$

$$\phi_2 = \frac{6}{6} \cdot (0 + 4 \cdot 200 + 400) = 1200$$

$$\phi_3 = \frac{6}{6} \cdot (200 + 2 \cdot 400) = 1000$$

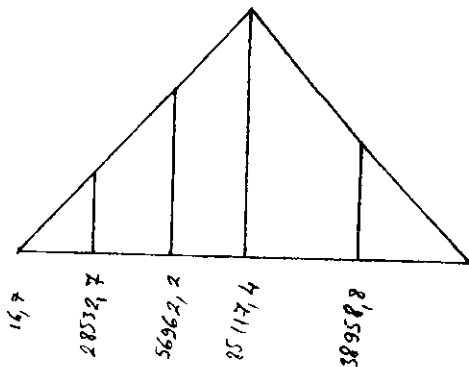
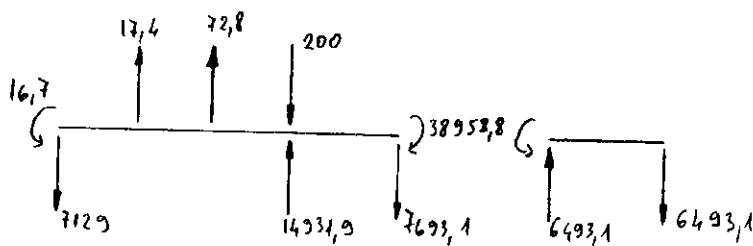


$$B = 7693,1$$

$$A = -5493,1$$

$$C = 14931,9$$

$$D = -7129$$



$EI \cdot Q$ / $KN \cdot m^3$

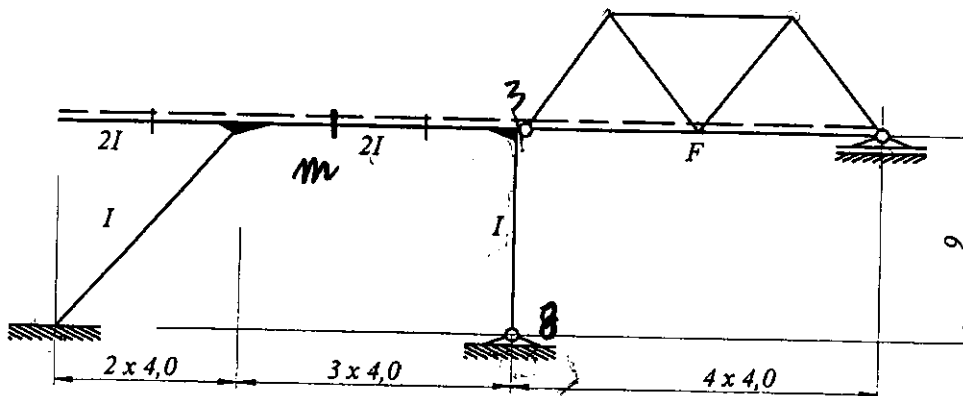
8. ЗАДАТАК

Методом сила, занемарујући утицај нормалних и трансверзалних сила на величину деформације у основном систему пуног носача на слици (пун носач: $EI = \text{const}$, $I/G \approx 0$, прости штапови, $I/F = 0.1 \text{ m}^2$), срачунати и нацртати:

1. Дијаграме сила у пресецима услед задатог оптерећења.
2. Дијаграм момената савијања услед температурне разлике $\Delta t = 20^\circ \text{C}$ дуж дела 3-8, са $\alpha_t = 10^{-5} 1/^\circ \text{C}$.
3. Дијаграм момената савијања услед обртања укљештења 6 за $\varphi = 2'$ (померања означеног ослоња за _____).

Срачунати и нацртати утицајне линије, са ординатама у означеним пресецима, за:

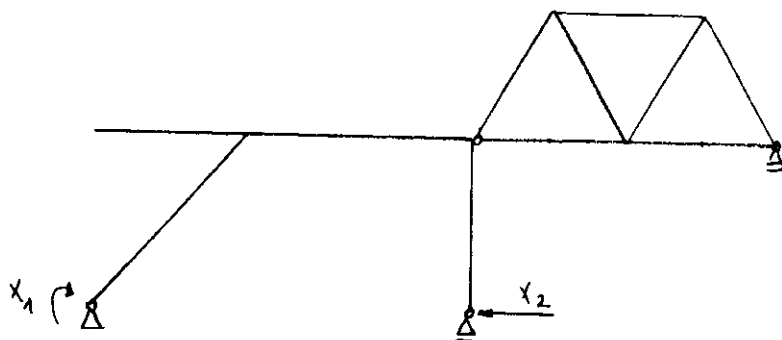
4. Статички неодређене величине.
5. Моменат савијања у означеном пресеку m .
6. Вертикално померање тачке n .



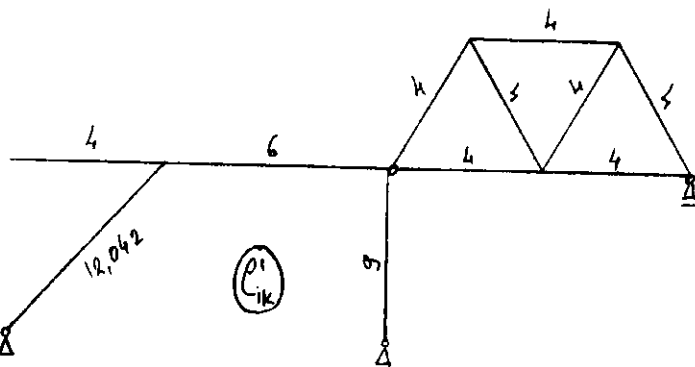
Издао(а): Марица Зечевић
Издато дана: 18. 12. 2008.
Оцена: 9 (96%)

ЗАДАЧА 8

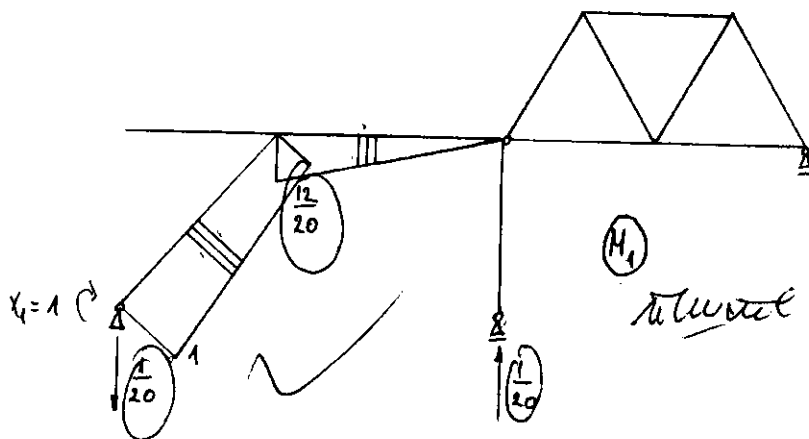
ОСНОВНИ СЧЕТЕН ОАГОТ НОСАЧА



РЕДУКОВАНЕ ДУЖИНС ШТАПОВА НОСАЧА $\ell'_{ik} = \ell_{ik} \cdot I_c / I_{ik}$

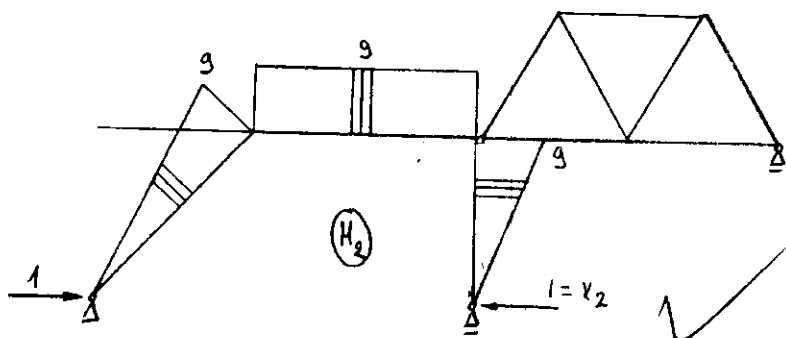


СТАПЕ $X_1 = 1$



понижен резултатите от р.

СТАПЕ $X_2 = 1$



$$EI_C \delta_{11} = \int_0^L M_1^2 \frac{I_C}{I} ds = \frac{12,042}{3} \cdot (1^2 + 1 \cdot \frac{12}{20} + (\frac{12}{20})^2) = 8,587$$

$$EI_C \delta_{12} = EI_C \delta_{21} = \int_0^L M_1 M_2 \frac{I_C}{I} ds = -\frac{12,042}{6} \cdot 9 \cdot (1 \cdot \frac{12}{20} + 1) - \frac{6}{6} \cdot \frac{12}{20} \cdot (2 \cdot 9 + 9) = -55,939$$

$$EI_C \delta_{22} = \int_0^L M_2^2 \frac{I_C}{I} ds = \frac{12,042}{3} \cdot 9^2 + 6 \cdot 9^2 + \frac{9}{3} \cdot 9^2 = 1054,134$$

② $\Delta t = 20^\circ C$, $\Delta E = 3-8$, $\alpha_t = 10^{-5} C^{-1}$

$$EI_C \delta_{10}^{\Delta t} = EI_C \int_0^L M_1 \alpha_t \frac{\Delta t}{h} ds = 0$$

$$EI_C \delta_{20}^{\Delta t} = EI_C \int_0^L M_2 \alpha_t \frac{\Delta t}{h} ds = EI \cdot 10^{-5} \left(20 \cdot \frac{9 \cdot 9}{2} \right) = 810 \cdot 10^{-5} EI$$

$$\begin{bmatrix} 8,587 & -55,939 \\ -55,939 & 1054,134 \end{bmatrix} \cdot \begin{Bmatrix} x_1^{\Delta t} \\ x_2^{\Delta t} \end{Bmatrix} = \begin{Bmatrix} 0 \\ 810 \cdot 10^{-5} EI \end{Bmatrix}$$

$$8,587 x_1^{\Delta t} - 55,939 x_2^{\Delta t} = 0$$

$$\rightarrow x_1^{\Delta t} = 6,514 x_2^{\Delta t}$$

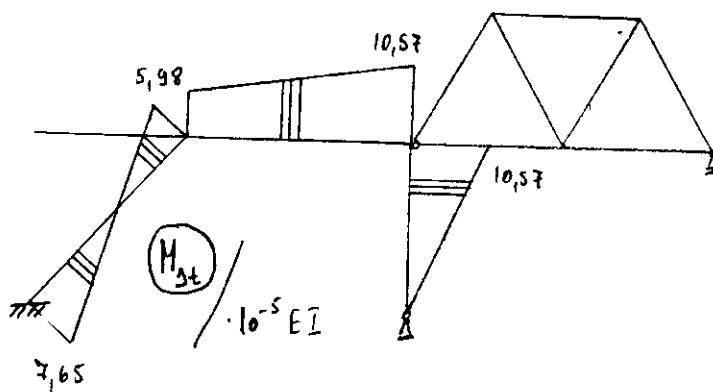
$$-55,939 x_1^{\Delta t} + 1054,134 x_2^{\Delta t} = 810 \cdot 10^{-5} EI$$

$$689,75 x_2^{\Delta t} = 810 \cdot 10^{-5} EI$$

$$x_2^{\Delta t} = 1,174 \cdot 10^{-5} EI$$

$$\ominus x_1^{\Delta t} = 7,650 \cdot 10^{-5} EI$$

$$H_{\Delta t} = H_1 x_1^{\Delta t} + H_2 x_2^{\Delta t}$$



Шаги!

④ УЧИТАЊЕ ЛИНИЈЕ ЗА СТАТИЧКУ НЕОПРЕДЕЉЕНЕ ВЕЛИЧИНЕ

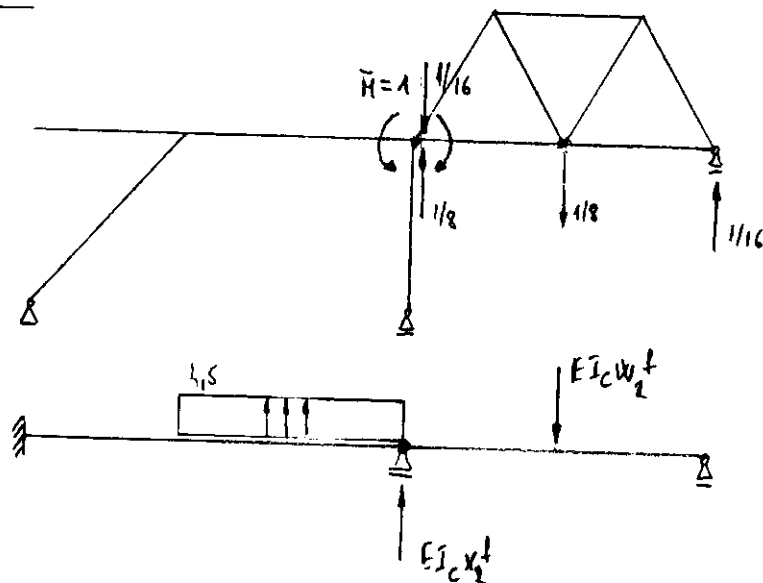
УСЛОВНЕ ЈЕДИНАЦИНЕ:

$$\begin{bmatrix} 8,587 & -55,935 \\ -55,935 & 1054,134 \end{bmatrix} \begin{Bmatrix} X_1 \\ X_2 \end{Bmatrix} = - \begin{Bmatrix} \delta_{10} \\ \delta_{20} \end{Bmatrix}$$

$$X_1 = 0,177972 \cdot \delta_{10} + 9,444106 \cdot 10^{-3} \delta_{20}$$

$$X_2 = 9,444106 \cdot 10^{-3} \delta_{10} + 1,449809 \cdot 10^{-3} \delta_{20}$$

$X_2 = 1$



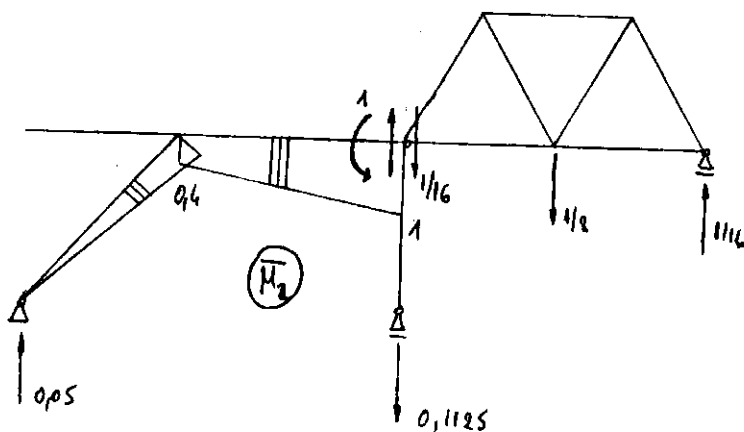
$$EI_C \rho^f = N_2 \frac{I_C}{I}$$

$$\rho \rightarrow M^f$$

$$\rho^f = \frac{M}{\cos \alpha} \cdot \frac{1}{EI}$$

$$EI_C X_2^f = EI_C \rho^f = EI_C (\varphi_g^e - \varphi_g^d) = \int_s N_2 \cdot \bar{N}_2 \frac{I_C}{I} ds$$

$$EI_C W_2^f = \frac{I_C}{F} \cdot \int_s \bar{N}_2 \cdot N_2 ds$$

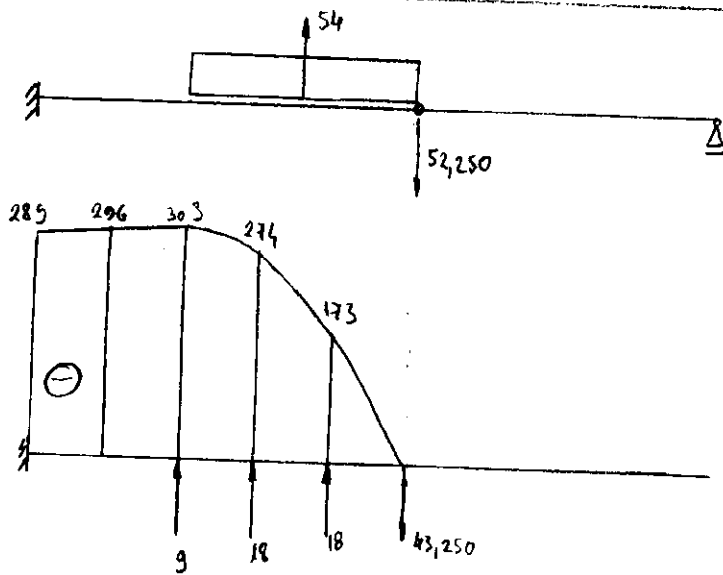


нормалне силе нису појединачне
јер су све N_2 силе
једнаке 0

$$\downarrow$$

$$EI_C W_2^f = 0$$

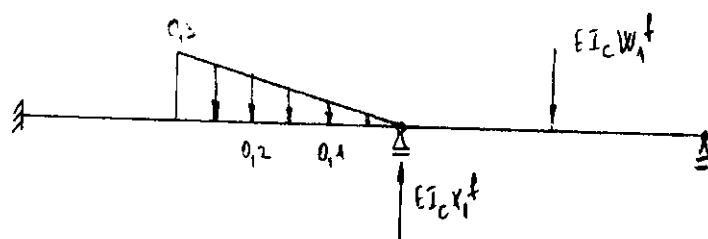
$$EI_C X_2^f = - \left(\frac{12,042}{3} \cdot 0,4 \cdot 9 + \frac{6}{2} \cdot 9 \cdot (0,4 + 1) \right) = -52,250$$



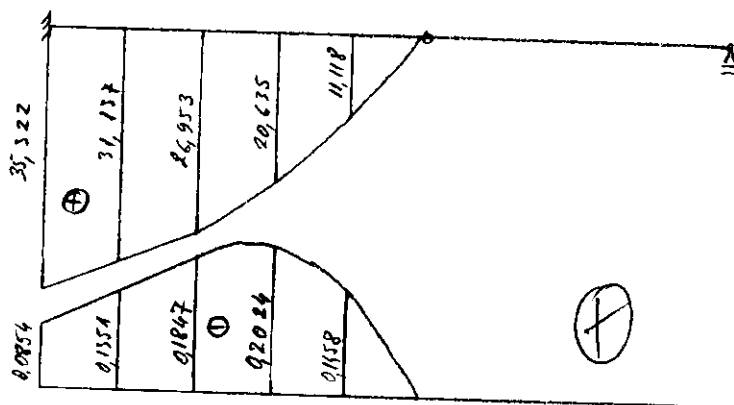
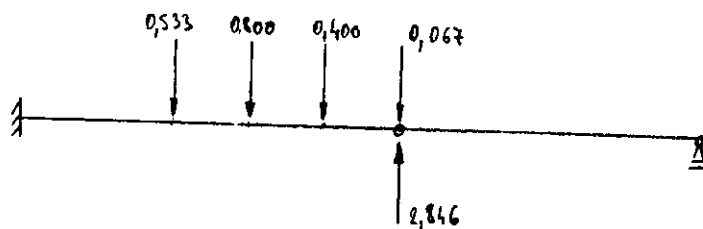
$EI_c \delta_{20}$



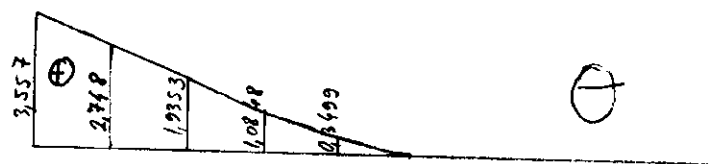
$x_1 = 1$



$$EI_c x_1^f = \int M_1 \bar{N}_2 \cdot \frac{\bar{I}_c}{I} ds = \frac{12,042}{6} \cdot 0,4 \cdot (2 \cdot 0,6 + 1) + \frac{6}{6} (2 \cdot 0,4 + 1) \cdot 0,6 = 2,846$$



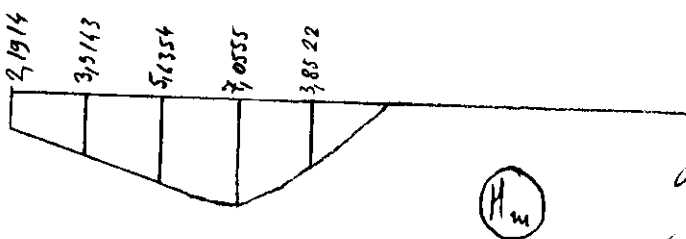
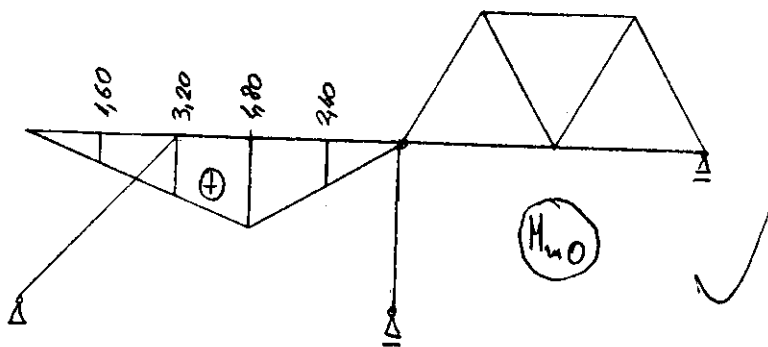
$EI_c \delta_{10}$



x_2

x_1

$$H_w = H_{w0} + H_{w1} X_1 + H_{w2} X_2 = H_{w0} + 0,4 X_1 - 9 X_2$$

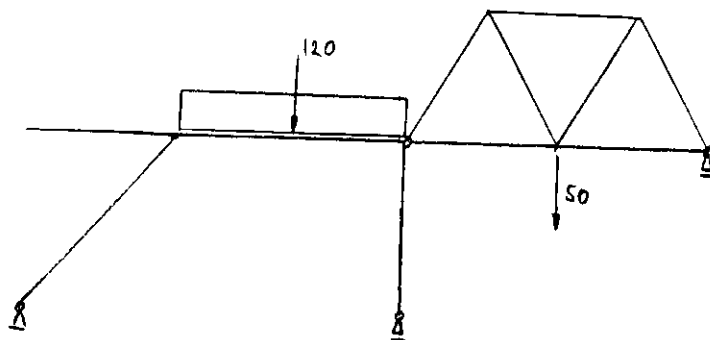


25.12.08.

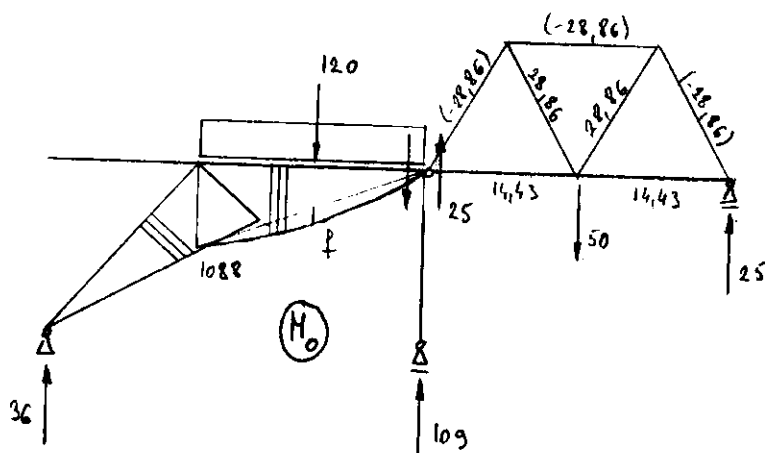
9-190000

ДОДАТКУ (ОНО ШТО НЕМА У НОМ ЗАДАТКУ)

① ОПРЕДЕЛЕНИЕ



РЕШЕНИЕ ПОСЛЕД



$$\int_C \delta_{10} = \int_s N_1 N_0 \frac{I_C}{I} ds = \frac{12,042}{6} (1088 \cdot (2 \cdot \frac{12}{20} + 1)) + \frac{6}{6} \cdot 1088 \cdot \frac{2 \cdot 12}{20} + \frac{6}{3} \cdot 180 \cdot \frac{12}{20} = 6325,56$$

$$\int_C \delta_{20} = \int_s N_2 N_0 \frac{I_C}{I} ds = -\frac{12,042}{6} \cdot 1088 \cdot 2 \cdot 9 - \frac{6}{6} \cdot 1088 \cdot (2 \cdot 9 + 9) - \frac{6}{3} \cdot 180 \cdot (9 + 9) = -75161,09$$

$$\begin{bmatrix} 8,587 & -55,939 \\ -55,939 & 1054,134 \end{bmatrix} \cdot \begin{Bmatrix} x_1^0 \\ x_2^0 \end{Bmatrix} = \begin{Bmatrix} 6325,56 \\ -75161,09 \end{Bmatrix}$$

$$8,587 x_1^0 - 55,939 x_2^0 = 6325,56$$

$$\longrightarrow x_1^0 = 6,514 x_2^0 + 736,64$$

$$-55,939 x_1^0 + 1054,134 x_2^0 = -75161,09$$

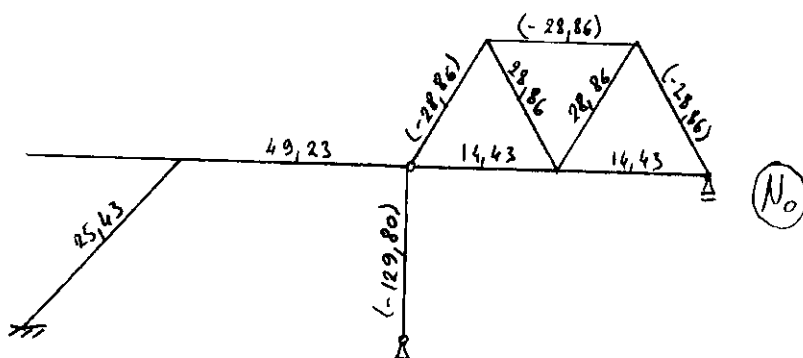
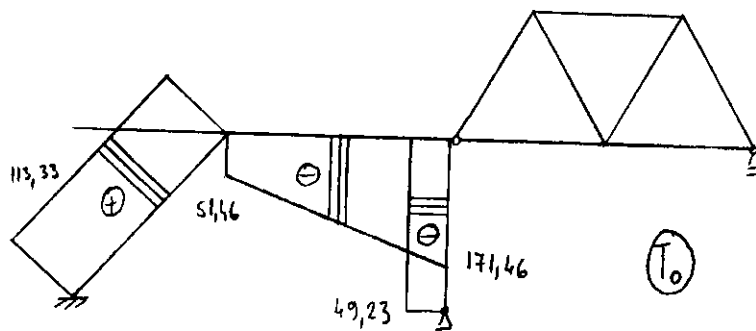
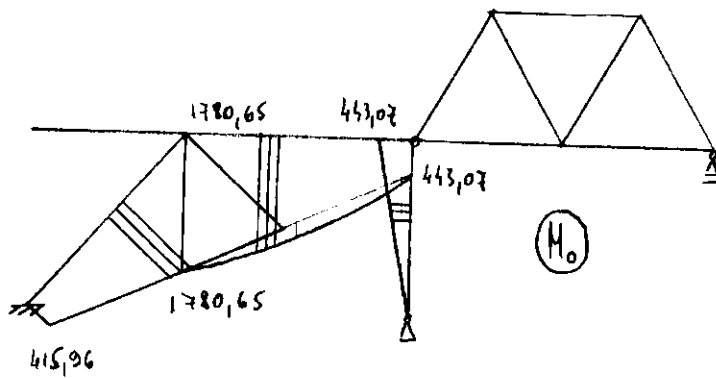
$$-364,387 x_2^0 - 41206,90 + 1054,134 x_2^0 = -75161,09$$

$$689,747 x_2^0 = -33954,19$$

$$x_2^0 = -49,23$$

$$x_1^0 = 415,96$$

$$H = N_0 + N_1 x_1^0 + N_2 x_2^0$$



③ $u_8 = 1 \text{ mm} = 10^{-3} \text{ m}$

$$EI_c \delta_{10}^c = -EI_c \sum_j C_{1j} C_j = 0$$

$$EI_c \delta_{20}^c = -EI_c \sum_j C_{2j} C_j = EI \cdot 1 \cdot 10^{-3} = 10^{-3} EI$$

$$\begin{bmatrix} 8,587 & -55,939 \\ -55,939 & 1054,134 \end{bmatrix} \cdot \begin{Bmatrix} x_1^c \\ x_2^c \end{Bmatrix} = \begin{Bmatrix} 0 \\ 10^{-3} EI \end{Bmatrix}$$

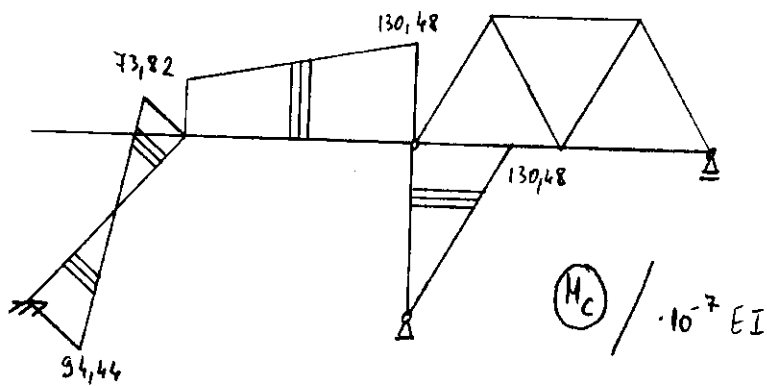
$$8,587 x_1^c - 55,939 x_2^c = 0 \quad \rightarrow \quad x_1^c = 6,514 x_2^c$$

$$-55,939 x_1^c + 1054,134 x_2^c = 10^{-3} EI$$

$$689,75 x_2^c = 10^{-3} EI$$

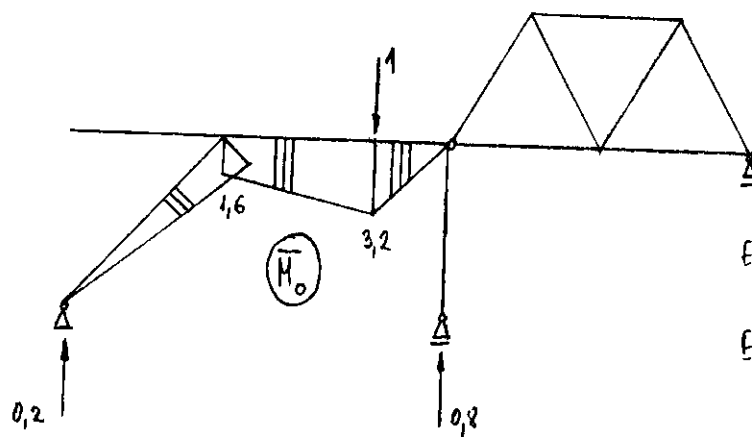
$$x_2^c = 14,498 \cdot 10^{-7} EI$$

$$x_1^c = 94,440 \cdot 10^{-7} EI$$



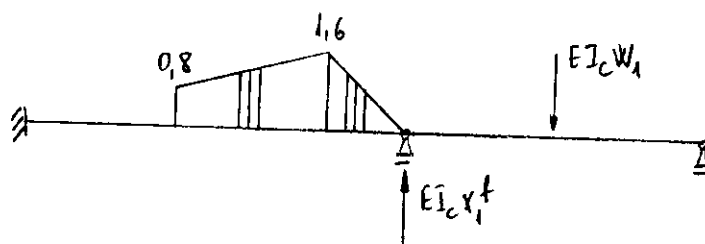
$$H_C = H_1 x_1^c + H_2 x_2^c$$

6) ВЕРТИКАЛЬНО ПОСЛЕДВНЕ ТИЧКЕ И



$$EI_C W_1 = 0 = \frac{I_C}{F} \int_s \bar{N}_0 \bar{N}_1 ds$$

$$EI_C x_1^f = \int_s \bar{H}_0 \bar{H}_2 \frac{I_C}{I} ds$$



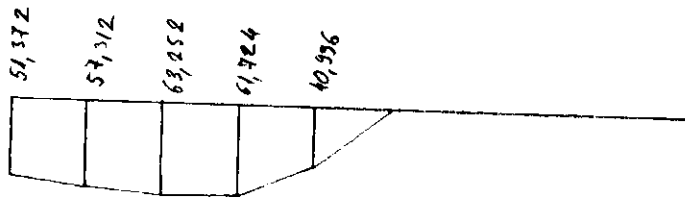
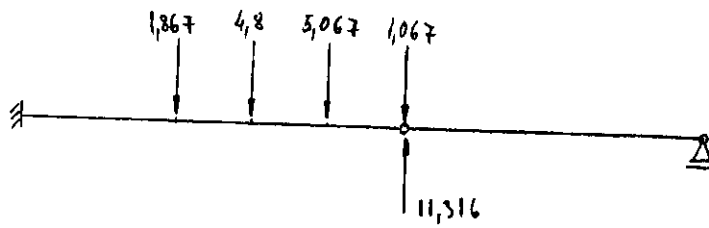
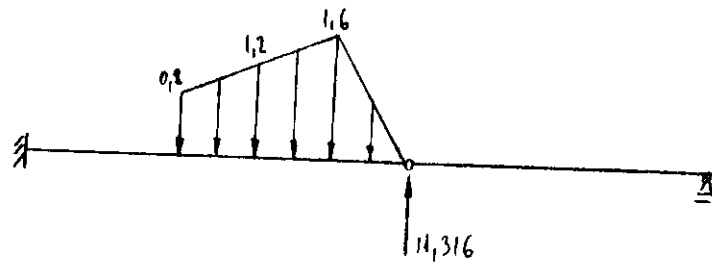
$$EI_C x_1^f = EI_C R^f = EI_C (\psi_g^e - \psi_g^d)$$

$$EI_C x_1^f = \int_s \bar{H}_0 \bar{H}_2 \frac{I_C}{I} ds = \frac{4}{6} (1.6 \cdot (2 \cdot 0.4 + 0.8) + 3.2 \cdot (2 \cdot 0.8 + 0.4)) + \frac{2}{6} \cdot 3.2 \cdot (2 \cdot 0.8 + 1) + \frac{12.042}{6} \cdot 0.4 \cdot 2 \cdot 1.6 = 11.316$$

$$EI_C v_{u1} = \int_s \bar{H}_0 \bar{H}_1 \frac{I_C}{I} ds = \frac{12.042}{6} \cdot 1.6 \cdot (2 \cdot 0.6 + 1) + \frac{4}{6} \cdot (1.6 \cdot (2 \cdot 0.6 + 0.2) + 3.2 \cdot (2 \cdot 0.2 + 0.6)) + \frac{2}{6} \cdot 3.2 \cdot 2 \cdot 0.2 = 11.118$$

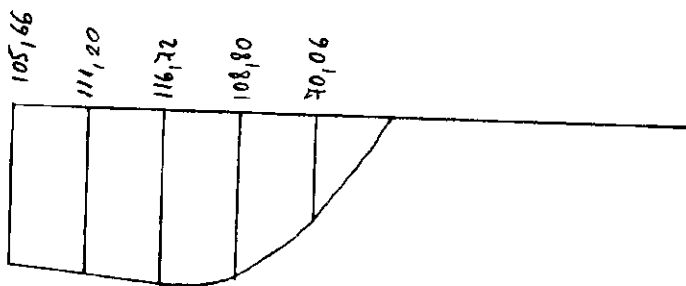
$$EI_C v_{u2} = \int_s \bar{H}_0 \bar{H}_2 \frac{I_C}{I} ds = -\left(\frac{12.042}{6} \cdot 1.6 \cdot 2 \cdot 3 + \frac{4}{6} \cdot (1.6 \cdot 2.7 + 3.2 \cdot 2.7) + \frac{2}{6} \cdot 3.2 \cdot 2.7 \right) = -173.002$$

$$v_u = v_{u0} + v_{u1} x_1 + v_{u2} x_2$$



$E I_c v_{n0}$

$$v_n = v_{n0} + 11.118 X_1 - 173.002 X_2$$



$E I_c v_n$