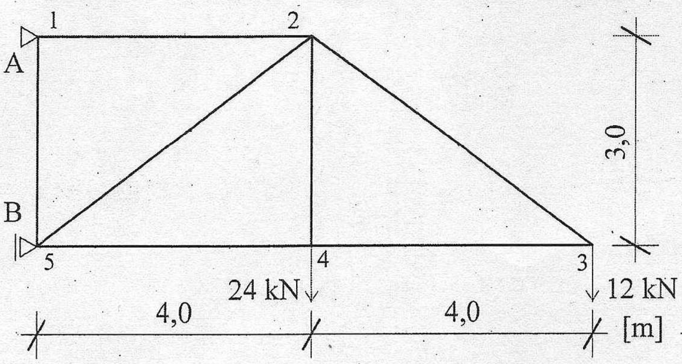
1.) Számítsa ki a rácsos tartó 3. csomópontjának függőleges elmozdulását! ($e_{3,y}$ = ?)



EA – állandó
($E = 210\ \mathrm{kN/mm^2}$; $A = 500\ \mathrm{mm^2}$)

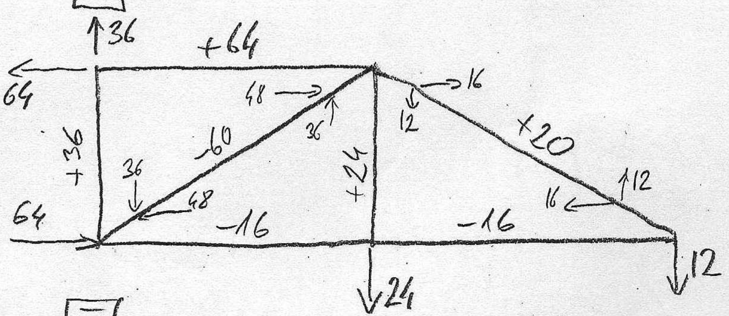
Támaszerők:

$\Sigma Y = 0$ $A_y = 36\ \mathrm{kN}\uparrow$

$\Sigma M = 0$ $A_x = \frac{24\cdot 4 + 12\cdot 8}{3} = 64\ \mathrm{kN}\leftarrow$

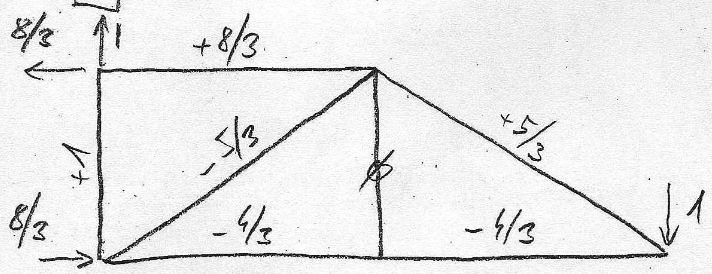
$B_x = 64\ \mathrm{kN}\rightarrow$

$\boxed{N}$



7p

$\boxed{\bar{N}}$



7p

jel	l	EA	N	$\bar{N}$	$N\bar{N}l$
1-2	4,0	áll.	-16	-4/3	+85,33
2-3	4,0		-16	-4/3	+85,33
2-4	3,0		+24	ϕ	ϕ
3-4	5,0		+20	+5/3	+166,67
1-4	5,0		-60	-5/3	+500,00
1-5	3,0		+36	+1,0	+108,00
5-4	4,0		+64	+8/3	+682,67

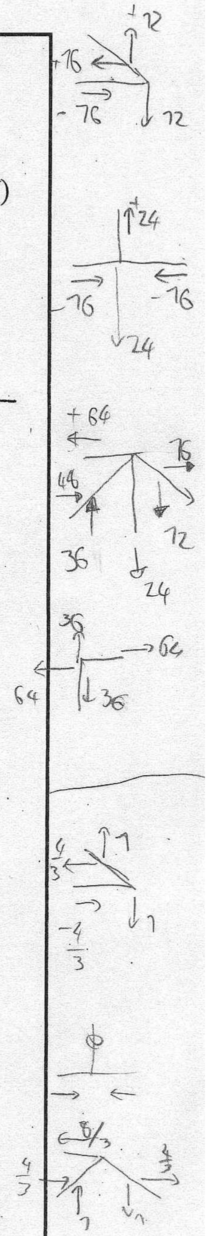
$\Sigma + 1628{,}00$

10p

$\boxed{\Sigma\ 30p}$

6p

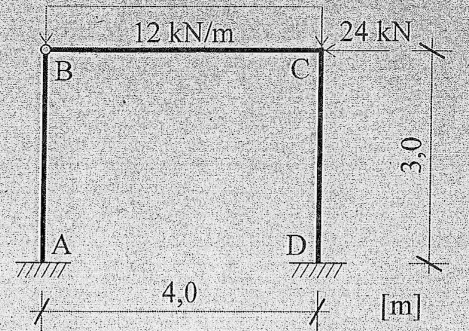
$$e_{3Y} = \Sigma \frac{N\bar{N}l}{EA} = \frac{1628}{105000} = 0{,}01550\ \mathrm{m} = 15{,}50\ \mathrm{mm}\downarrow$$



D

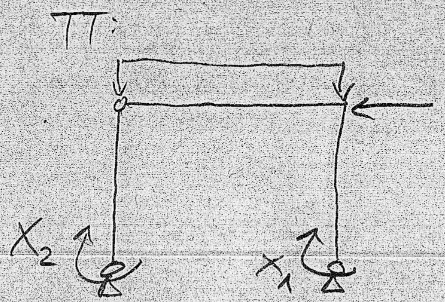
[...]ározza meg a keret M ábráját! A törzstartót úgy vegye fel, hogy a kompatibilitási egyenlet az „A” és „B” pontok elfordulásából adódjon!

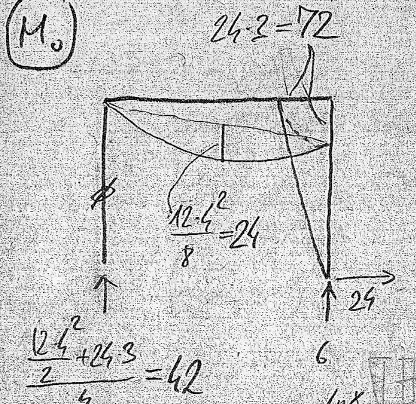
(A normálerő munkája elhanyagolható.)

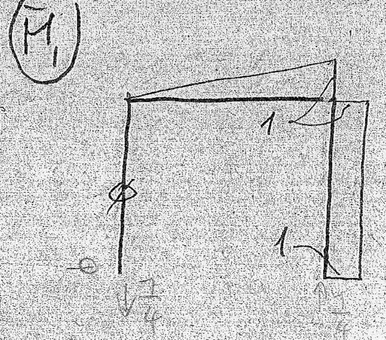


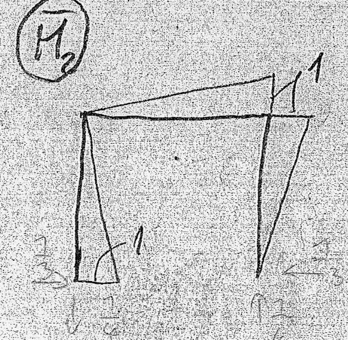
EI – állandó
$E = 210\ \text{kN}/\text{mm}^2$;
$I_{(I200)} = 2{,}14 \cdot 10^7\ \text{mm}^4$.

TT:









3×5p

$$e_{10} = \frac{10^9}{EI}\cdot\left[-\overset{-108}{\frac{72\cdot 3}{2}\cdot 1} - \overset{-96}{\frac{72\cdot 4}{2}\cdot\frac{2}{3}} - \overset{-32}{\frac{2}{3}\cdot 24\cdot 4\cdot\frac{1}{2}}\right] = -236\cdot\frac{10^9}{EI}$$

$$e_{20} = \frac{10^9}{EI}\cdot\left[-\overset{-72}{\frac{72\cdot 3}{2}\cdot\frac{2}{3}} - \overset{-96}{\frac{72\cdot 4}{2}\cdot\frac{2}{3}} - \overset{-32}{\frac{2}{3}\cdot 24\cdot 4\cdot\frac{1}{2}}\right] = -200\cdot\frac{10^9}{EI}$$

$$e_{11} = \frac{10^9}{EI}\cdot\left[1\cdot 3\cdot 1 + \frac{1\cdot 4}{2}\cdot\frac{2}{3}\right] = 4{,}33\cdot\frac{10^9}{EI}$$

5×5p

$$e_{22} = \frac{10^9}{EI}\cdot\left[2\cdot\frac{1\cdot 3}{2}\cdot\frac{2}{3} + \frac{1\cdot 4}{2}\cdot\frac{2}{3}\right] = 3{,}33\cdot\frac{10^9}{EI}$$

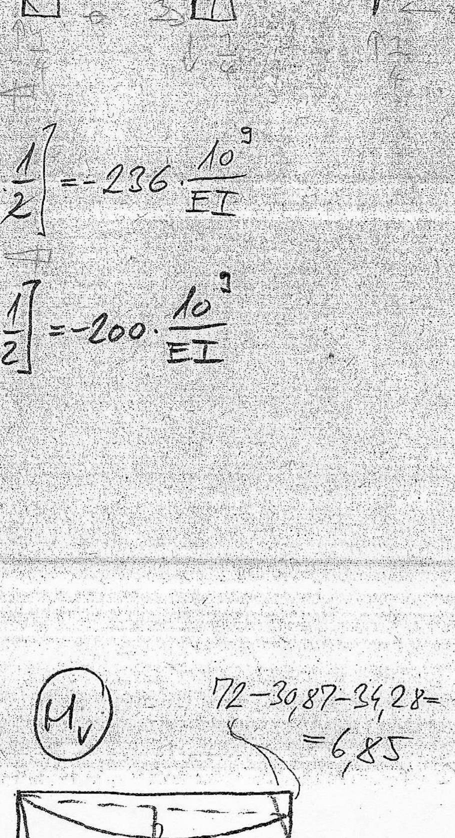
$$e_{12} = e_{21} = \frac{10^9}{EI}\cdot\left[1\cdot 3\cdot\frac{1}{2} + \frac{1\cdot 4}{2}\cdot\frac{2}{3}\right] = 2{,}83\cdot\frac{10^9}{EI}$$

$$-236 + \overset{e_{11}}{4{,}33}\cdot X_1 + 2{,}83 X_2 = 0$$

$$-200 + 2{,}83 X_1 + \overset{e_{22}}{3{,}33} X_2 = 0$$

$$+77{,}64 - 2{,}265\cdot X_1 = 0$$

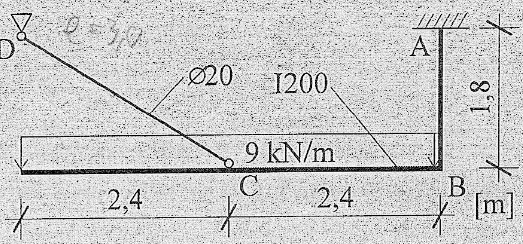
$$X_1 = +\frac{77{,}64}{2{,}265} = 34{,}28 \qquad X_2 = 30{,}87$$



10p

Σ50p

2.) Számítsa ki a CD rúdban ható erőt, és rajzoljon M (N) ábrát!
(Az I200 szelvényű rúdban a normálerő munkája elhanyagolható.)



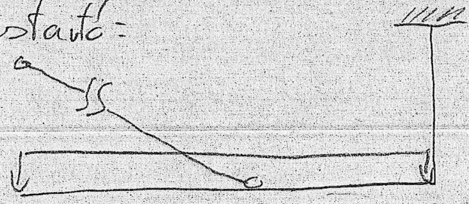
EI – állandó
$E = 210$ kN / mm^2;
$I_{(I200)} = 2,14 \cdot 10^7$ mm^4;
$A_{Ø20} = 314$ mm^2.

$\frac{2}{3}$

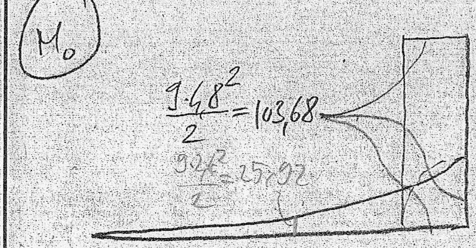
$1,44 + \frac{2}{3} \cdot 1,44 = 2,$

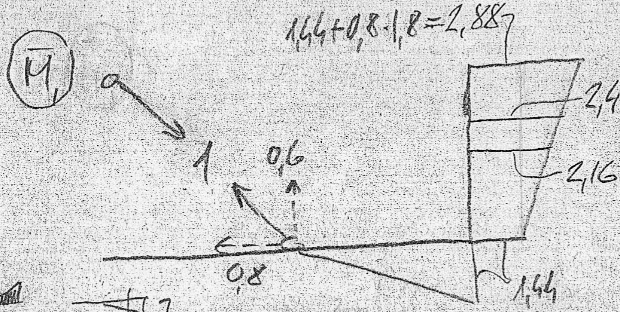
$1,44 + \frac{1}{2} \cdot 1,44 = 2,16$

Törzstartó:



5+5p





5p

$$e_0 = \frac{10^9}{EI} \cdot \left[\underbrace{103,68 \cdot 1,8 \cdot (-2,16)}_{-403,11} + \underbrace{\frac{103,68 \cdot 4,8}{3} \cdot \left(-\frac{1,44}{2}\right)}_{-119,44} \right] = \frac{10^9}{2,14 \cdot 10^7 \cdot 210} \cdot (-522,55) = -116,28 \text{ mm}$$

10p

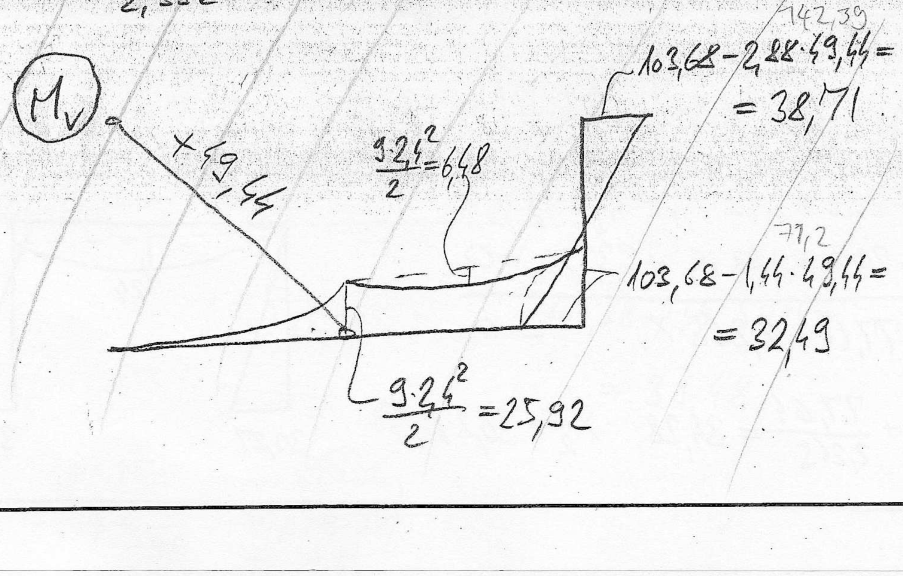
$$e_1 = \frac{10^9}{EI} \left[\underbrace{1,44 \cdot 1,8 \cdot 2,16}_{5,599} + \underbrace{\frac{1,44 \cdot 1,8}{2} \cdot 2,40}_{3,110} + \underbrace{\frac{1,44 \cdot 2,4}{2} \cdot \frac{2}{3} \cdot 1,44}_{1,659} \right] + \frac{10^3}{EA} \cdot 1 \cdot 1 \cdot 3 =$$

$$= \frac{10,368 \cdot 10^9}{210 \cdot 2,14 \cdot 10^7} + \frac{3 \cdot 10^3}{210 \cdot 314} = 2,307 + 0,045 = 2,352 \text{ mm}$$

5p

$$X = F_{CD} = -\frac{-116,28}{2,352} = 49,44 \text{ kN}$$

10p



40p

D/2.

$$\}\,103,68 - 25,92 = 77,76 \qquad 25,92 \qquad \}\,25,92$$

$$e_0 = \frac{10^9}{EI} \cdot \Big[\underbrace{103,68 \cdot 1,8 \cdot (-2,16)}_{-403,11} + \underbrace{25,92 \cdot 2,4 \cdot \left(-\frac{1,44}{2}\right)}_{-44,79} +$$

$$+ \underbrace{\frac{77,76 \cdot 2,4}{2} \cdot \left(-\frac{2}{3} \cdot 1,44\right)}_{-89,58} + \underbrace{\frac{2}{3} \cdot 6,48 \cdot 2,4 \cdot \frac{1,44}{2}}_{+7,46}\Big] = (-530,02) \cdot \frac{10^9}{EI} =$$

$$= -530,02 \cdot \frac{10^9}{210 \cdot 2,14 \cdot 10^7} = \underline{-117,94\ mm}$$

Képlékeny

$q_{rugalmas}$ $f_y = 235$

$M_{el} = \frac{2,14 \cdot 10^7 \cdot 0,235}{100} = 57,36$

önálló csak $M_{max} = 40,72$

$S_x = 725\,cm^3$

$q_{max} = q \cdot \frac{M_{el}}{M_{max}} = 9 \cdot \frac{57,36}{40,72} = 11,358$

$M_{Terv} = 2S_x \cdot f_{yd} = 60,9$ kNm

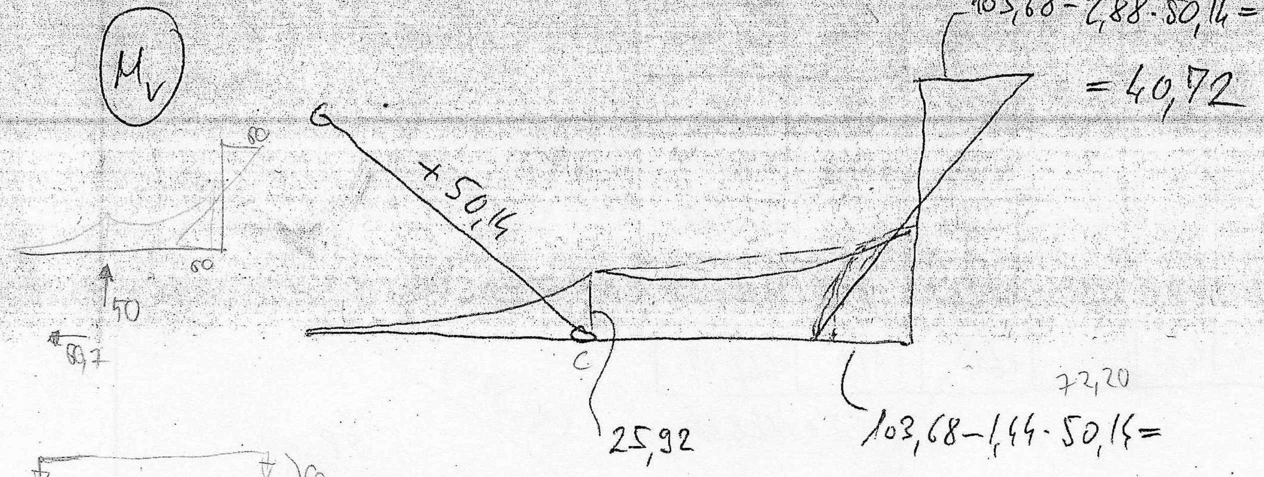
Módosítás: e_0 : 8p

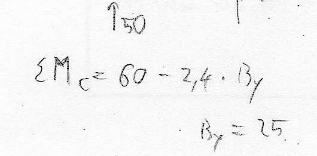
e_1 : 8p

$$X = F_C = -\frac{-117,94}{2,352} = \underline{50,14\ kN}$$

4p

M_v





$\Sigma M_c = 60 - 2,4 \cdot B_y$ $\qquad \Sigma F = 75$

$B_y = 25$ $\qquad q = \frac{75}{4,6} = \boxed{16,25\ kN}$