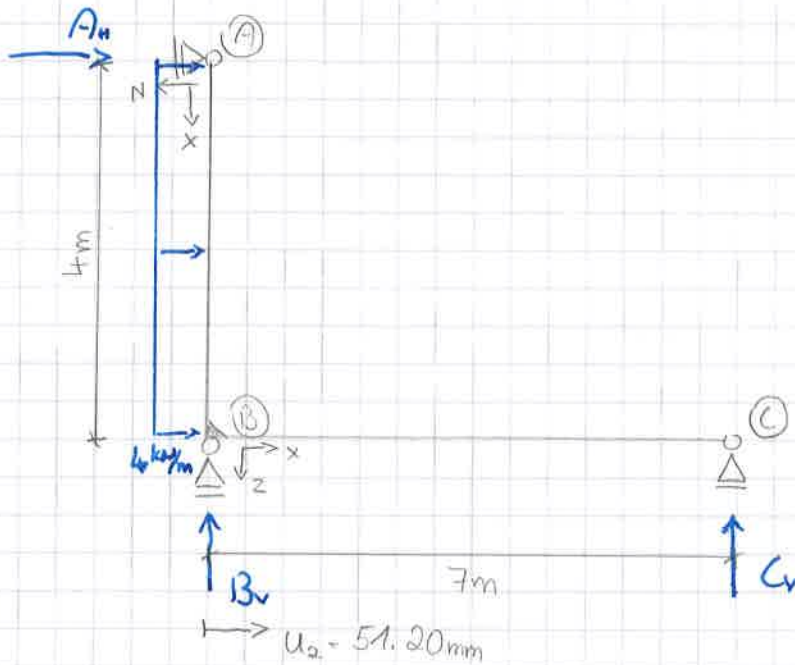


Aufgabe 1

MUSTERKLAUSUR 6

①



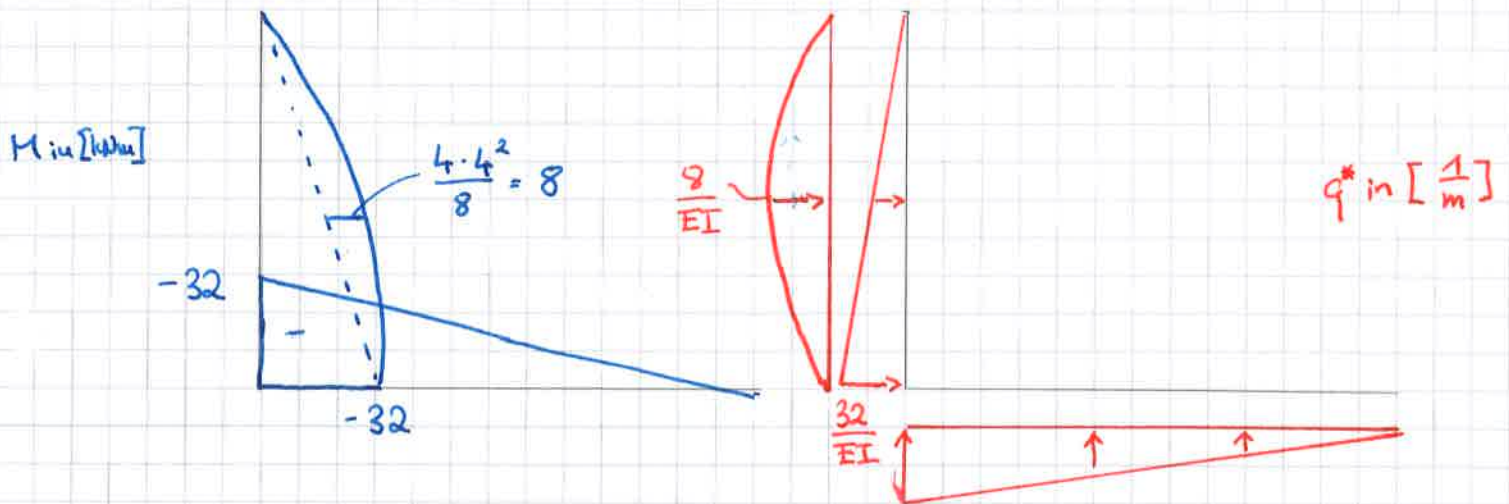
$$A_H = -4 \cdot 4 = -16 \text{ kN}$$

$$C_V = -\frac{1}{7} 4 \cdot 4 \cdot 4 \cdot \frac{1}{2} = -\frac{32}{7}$$

$$B_V = \frac{32}{7}$$

Momentenverlauf:

Frablast q^* :



Stab 1-2

$$w_{\max}^{\text{Dreieck}} = -\frac{32}{EI} \cdot \frac{4^2}{5\sqrt{3}} = -3.28 \cdot 10^{-3} \text{ m}$$

$$\text{Stelle } x: \frac{1}{\sqrt{3}} \cdot 4 = 2.31 \text{ m}$$

$$w_{\max}^{\text{Parabel}} = -\frac{8}{EI} \cdot \frac{5 \cdot 4^2}{48} = -1.33 \cdot 10^{-2} \text{ m}$$

$$\text{Stelle } x: \frac{1}{2} \cdot 4 = 2.0 \text{ m}$$

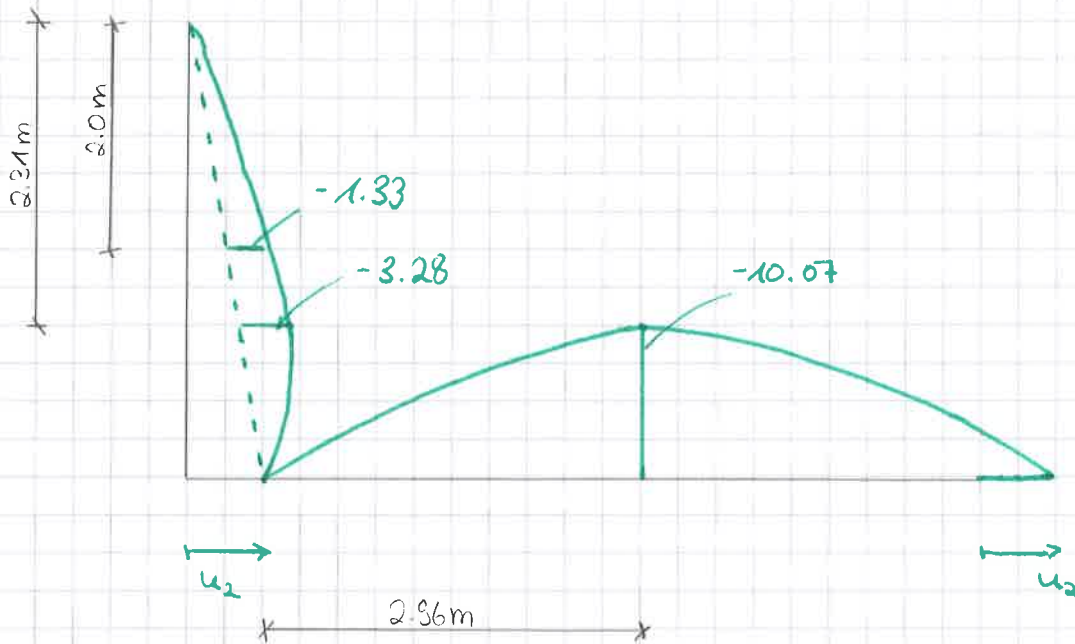
Funktion der Biegelinie (hier nicht gefragt!):

$$w(x)_{1-2} = \underbrace{-\frac{32}{EI} \frac{4^2}{6} \left[\frac{x}{4} - \left(\frac{x}{4} \right)^3 \right]}_{\text{Dreieck}} - \underbrace{\frac{8}{EI} \frac{4^2}{3} \left[\frac{x}{4} - 2 \left(\frac{x}{4} \right)^3 + \left(\frac{x}{4} \right)^4 \right]}_{\text{Parabel}} - \underbrace{u_2 \frac{x}{4}}_{\text{Vorverformung } u_2}$$

$$w_{\max} = -\frac{32}{EI} \cdot \frac{7^2}{952} = 10.07 \cdot 10^{-3} \text{ m}$$

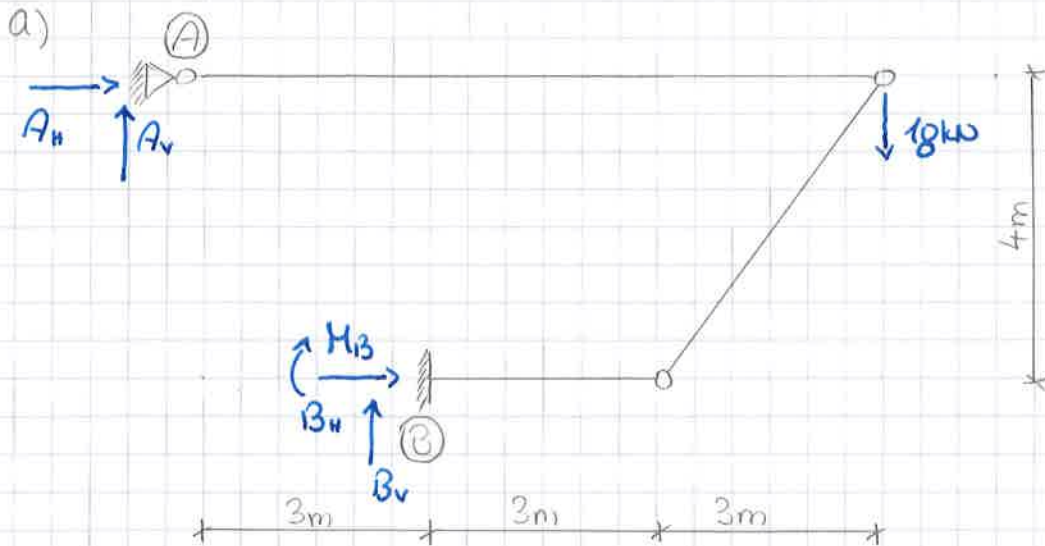
$$\text{Stelle } x: 0.4226 \cdot 7 = 2.96 \text{ m}$$

Biegelinie



w in $[m] \cdot 10^{-3}$

Aufgabe 2



$$A_V = 0$$

$$M_B = -18 \cdot 3 = -54 \text{ kNm}$$

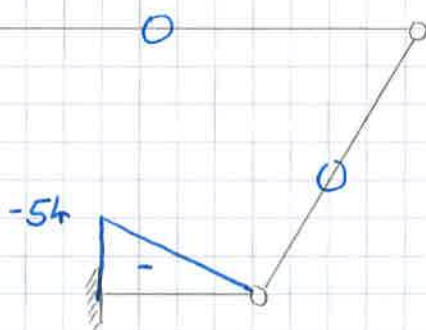
$$B_V = 18 \text{ kN}$$

$$A_H = \frac{1}{4} (54 - 18 \cdot 6) = -13.5 \text{ kN}$$

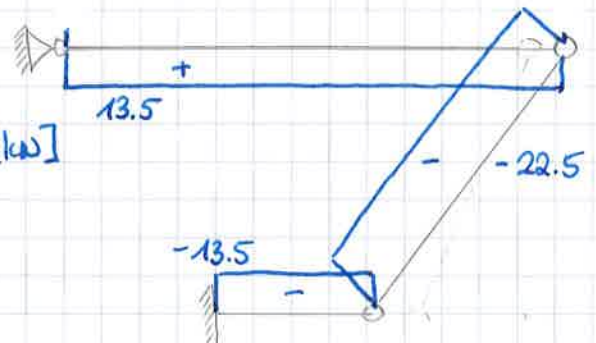
$$B_H = -A_H = 13.5 \text{ kN}$$

Schnittgrößenverläufe

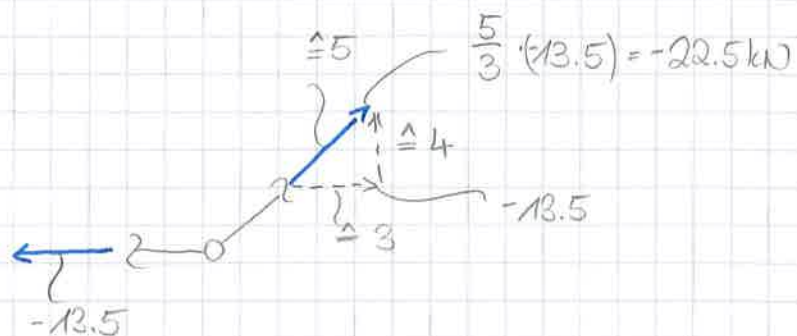
M in [kNm]



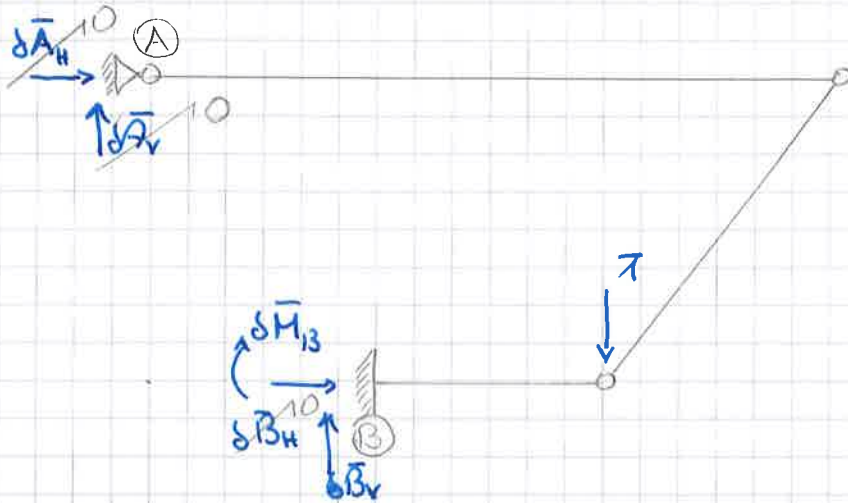
N in [kN]



Normalkraft in Stab 2-3:



Virtueller Schnittgrößenverlauf



$$\delta \bar{P}_V = 1 \text{ kN}$$

$$\delta \bar{M}_B = -3 \text{ kNm}$$

$\delta \bar{M}$ in [kNm]



Verschiebung am Knoten 3:

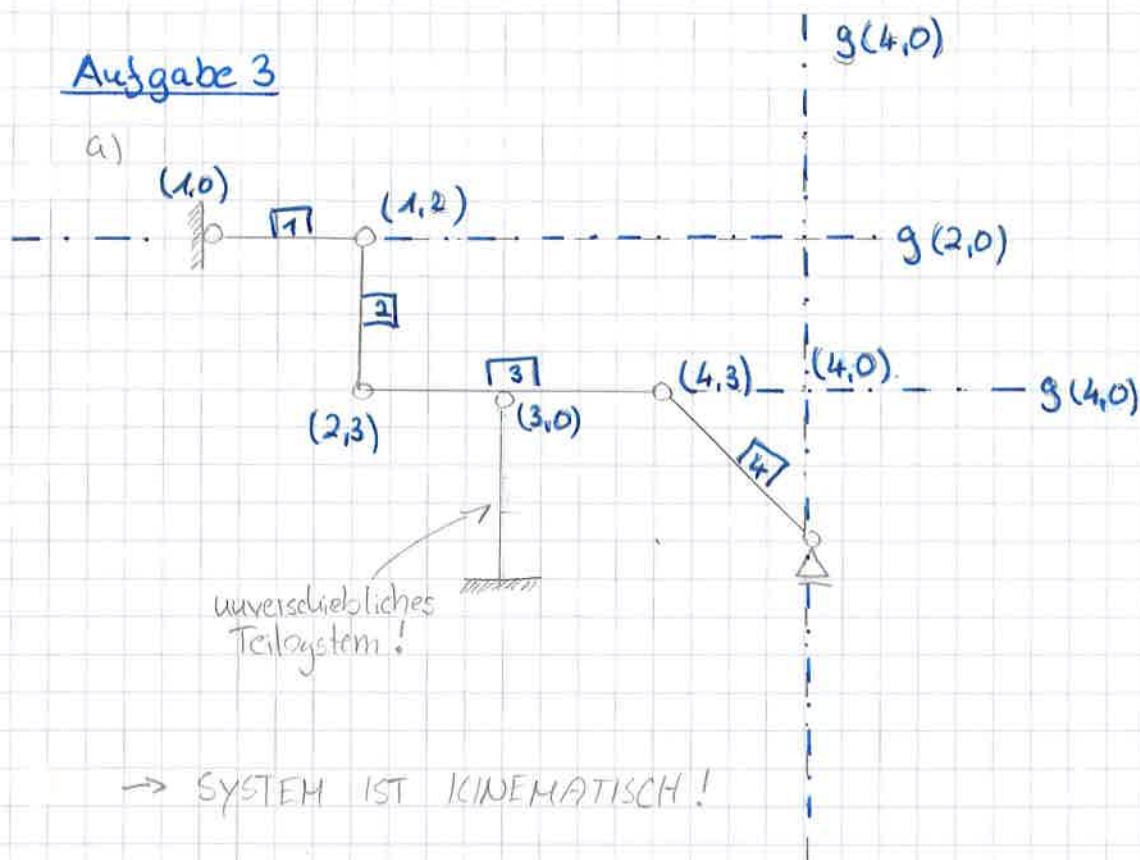
$$w_3 = \frac{1}{EI} \cdot \frac{1}{3} \cdot (-3) \cdot (-54) \cdot 3 = 1.62 \cdot 10^{-2} \text{ m}$$

b) Das virtuelle System aus Teilaufgabe a) kann verwendet werden!

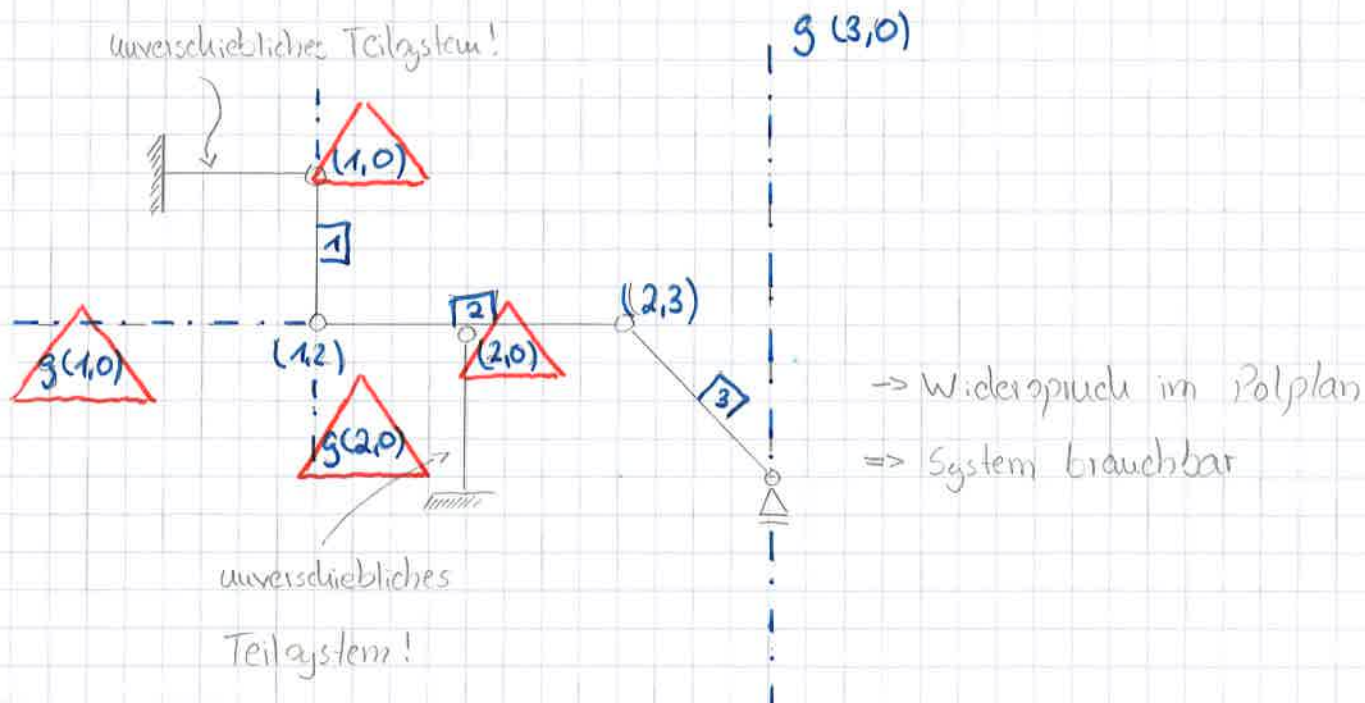
$$w_3 = \frac{1}{EI} \cdot \frac{1}{6} \cdot 3 \cdot (-3) \cdot (2 \cdot 34.62 - 17.71) = 7.73 \cdot 10^{-4} \text{ m}$$

Aufgabe 3

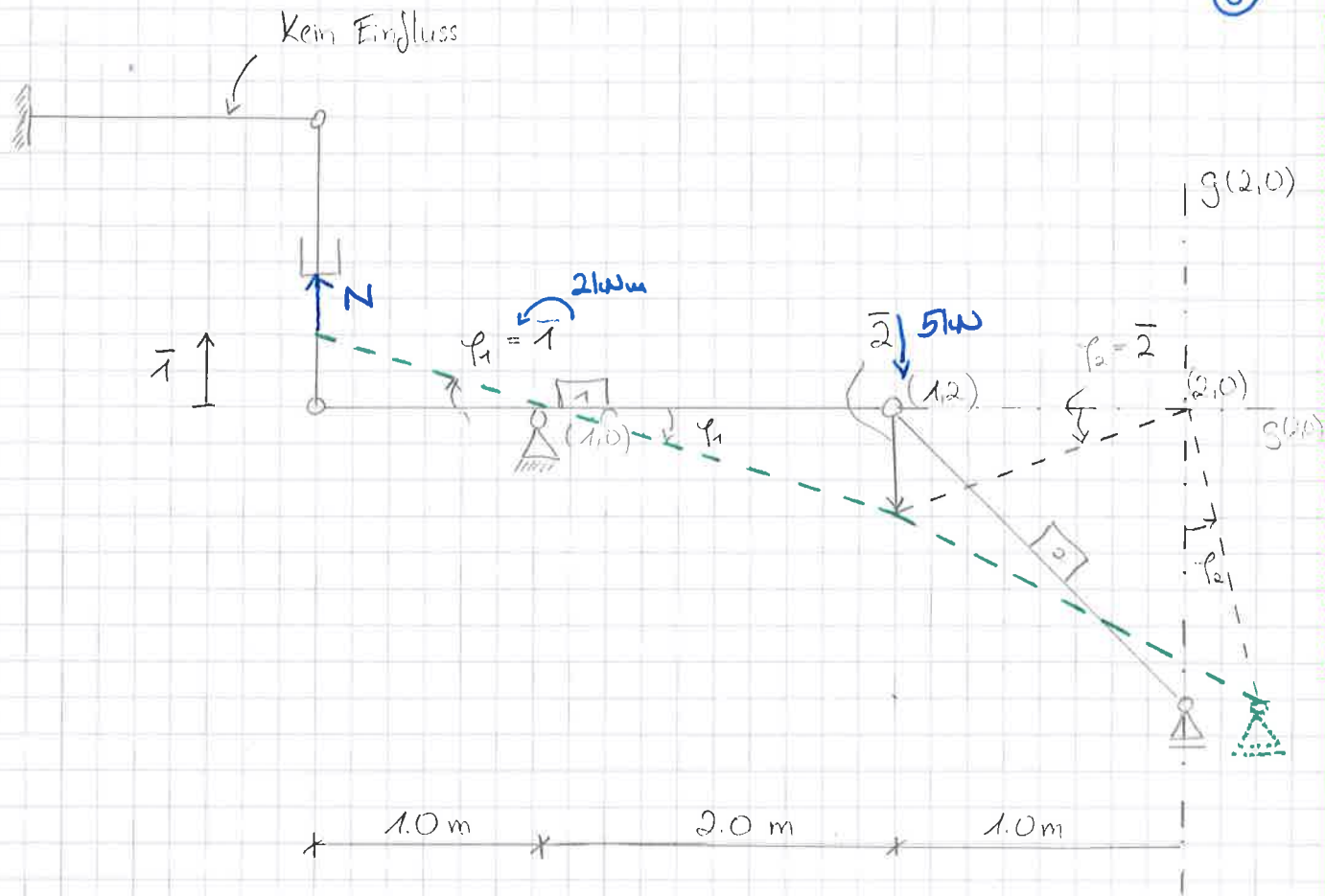
a)



b)



⑥

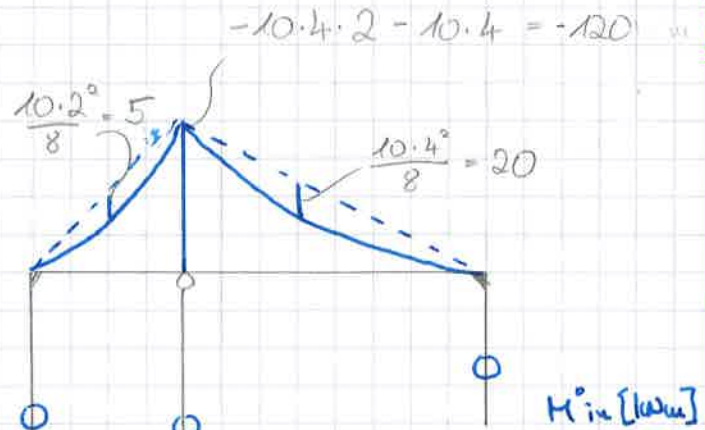
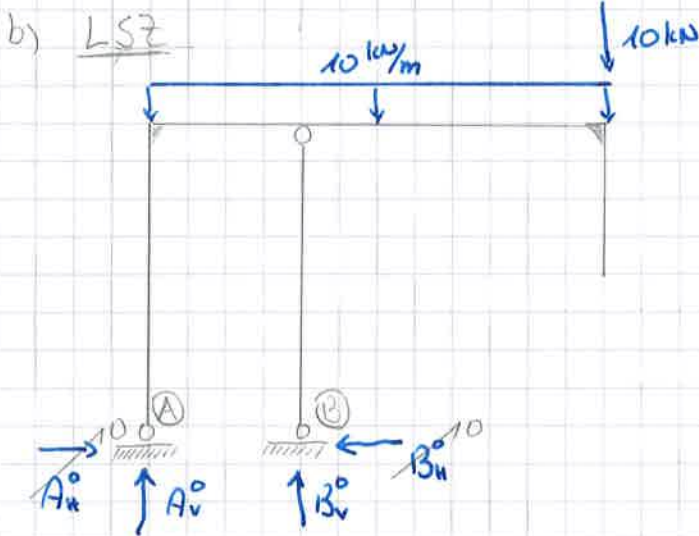
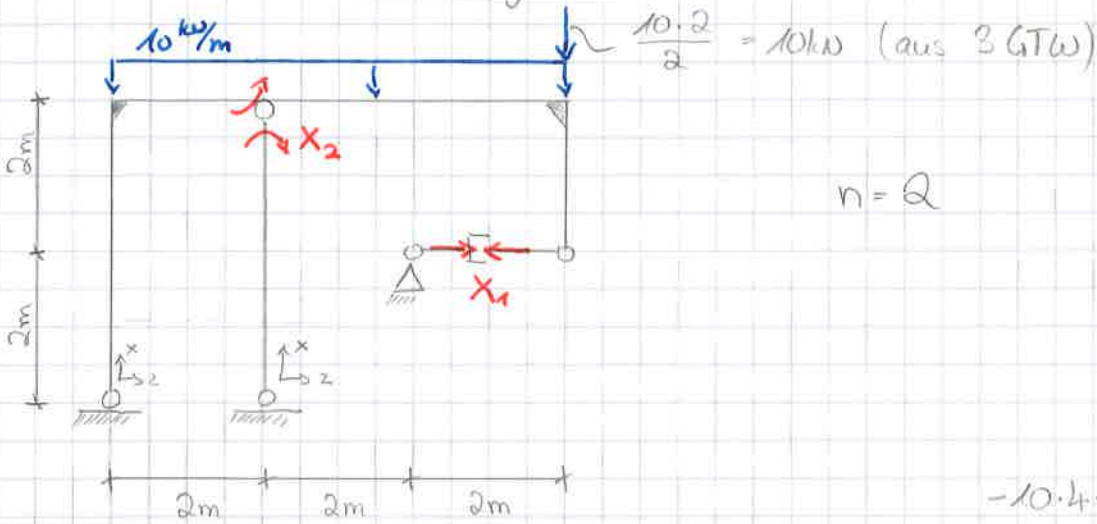


$$\overline{1} \cdot N - 2 \cdot \overline{1} + \overline{5} \cdot 2 = 0$$

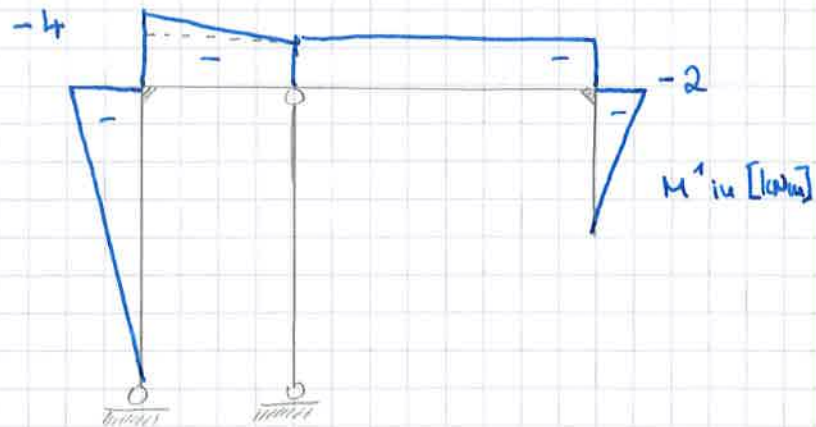
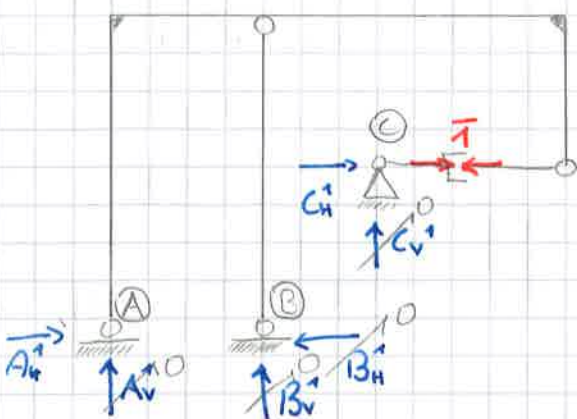
$$\Rightarrow N = 2 \cdot 1 - 5 \cdot 2 = -8 \text{ (N)}$$

Aufgabe 4

a) Statisch bestimmtes Grundsystem:

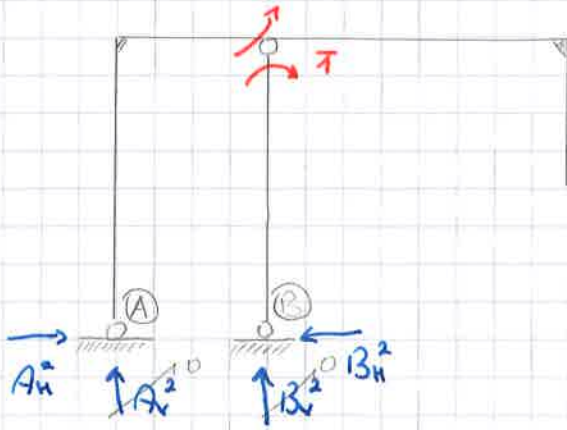


ESZ 1



$$C_H = -1 \text{ kN}$$

$$A_H = 1 \text{ kN}$$



M^2 in [kNm]

$$B_H^2 = -1/4$$

$$A_H^2 = -1/4$$

Flexibilitäten

$$d_{10} = \frac{1}{EI} \left[\frac{1}{2} \cdot 2 \cdot (-2) \cdot (-120) + \frac{2}{3} \cdot 2 \cdot 5 \cdot (-2) + \frac{1}{6} \cdot 2 \cdot (-2) \cdot (-120) + \frac{1}{3} \cdot 2 \cdot (-2) \cdot 5 + \frac{1}{2} \cdot 4 \cdot (-120) \cdot (-2) + \frac{2}{3} \cdot 4 \cdot 20 \cdot (-2) \right] = \frac{673.33}{EI}$$

$$d_{20} = \frac{1}{EI} \left[\frac{1}{2} \cdot 2 \cdot (-120) \cdot 1 + \frac{2}{3} \cdot 2 \cdot 1 \cdot 5 \right] = -\frac{113.3}{EI}$$

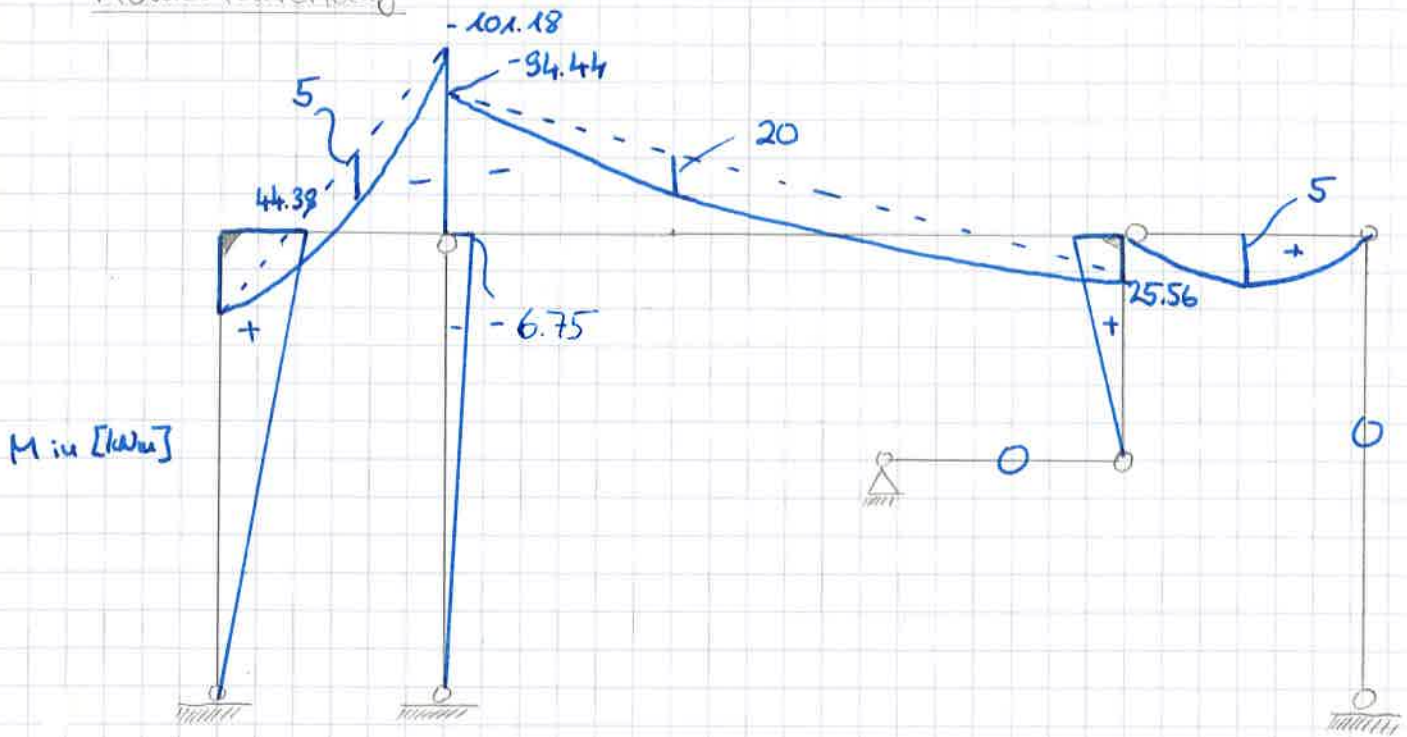
$$d_{11} = \frac{1}{EI} \left[\frac{1}{3} \cdot 4 \cdot (-4)^2 + \frac{1}{6} \cdot 2 \left(2 \cdot (-4)^2 + 2 \cdot (-4) \cdot (-2) + 2 \cdot (-2)^2 \right) + 4 \cdot (-2)^2 + \frac{1}{3} \cdot 2 \cdot (-2)^2 \right] = 58.67/EI$$

$$d_{22} = \frac{1}{EI} \left[2 \cdot \frac{1}{3} \cdot 4 \cdot 1^2 + 2 \cdot 1^2 \right] = \frac{4.67}{EI}$$

$$d_{12} = \frac{1}{EI} \left[\frac{1}{3} \cdot 4 \cdot (-4) \cdot 1 + 2 \cdot (-2) \cdot 1 + \frac{1}{3} \cdot 2 \cdot (-2) \cdot 1 \right] = -11.33/EI$$

$$\begin{bmatrix} 58.67 & -11.33 \\ \text{sym.} & 4.67 \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \end{bmatrix} = \begin{bmatrix} -673.33 \\ -113.33 \end{bmatrix} \Rightarrow X_1 = -12.78 \quad X_2 = -6.74$$

Momentenverlauf



c) Temperaturbelastung nur relevant für Lastvektor:

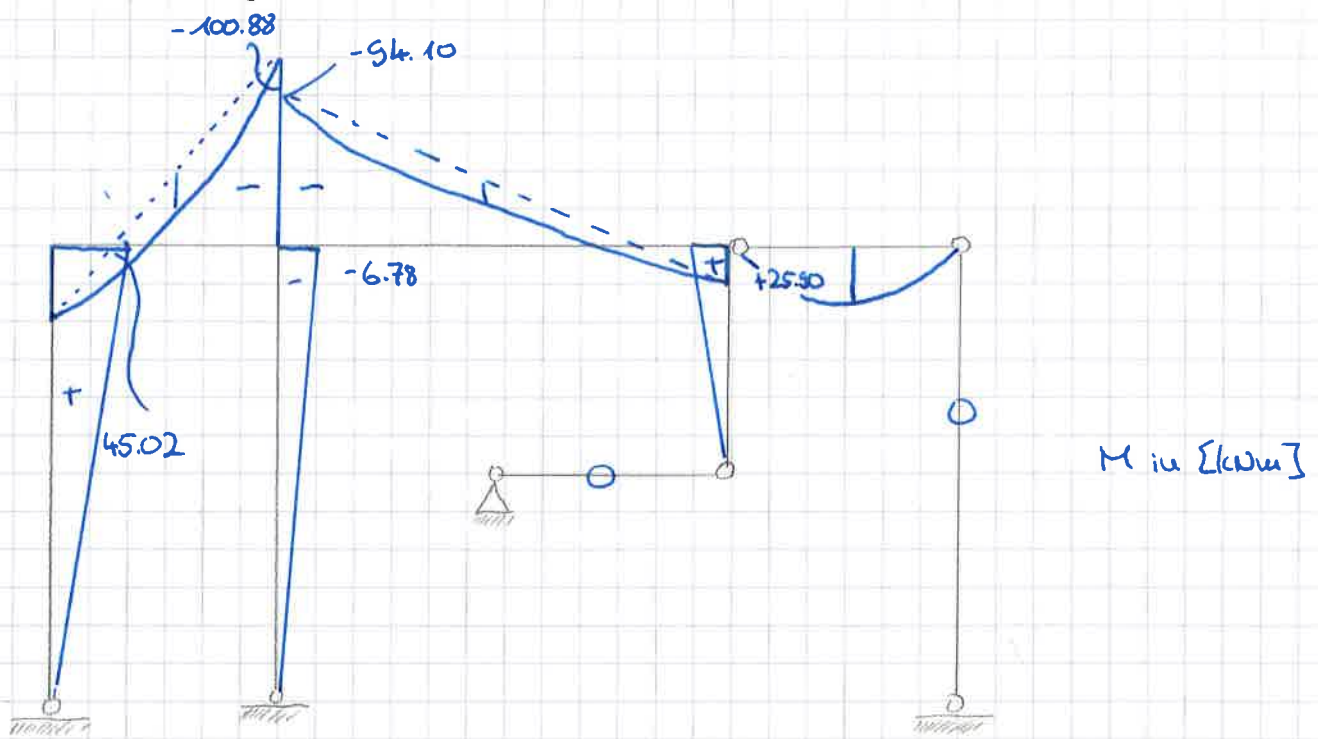
$$\alpha_2 = \frac{-10^{-4} \cdot 50}{0.75} = -\frac{1}{150} \quad (\text{Reminder: } M = \kappa \cdot EI !)$$

$$EI d_{10} = 673.33 + 2 \cdot (-2) \cdot \left(-\frac{1}{150}\right) \cdot 100 + \frac{1}{3} \cdot 2 \cdot (-2) \cdot \left(-\frac{1}{150}\right) \cdot 100 + 4 \cdot (-2) \cdot \left(-\frac{1}{150}\right) \cdot 100 = 682.21$$

$$EI d_{20} = -113.33 + 2 \cdot \left(-\frac{1}{150}\right) \cdot 100 = -114.67$$

$$X_1 = -12.35 \quad ; \quad X_2 = -6.78$$

Momentenverlauf



- c) Es verändert sich nichts, da es sich um ein statisch bestimmtes Teilsystem handelt.