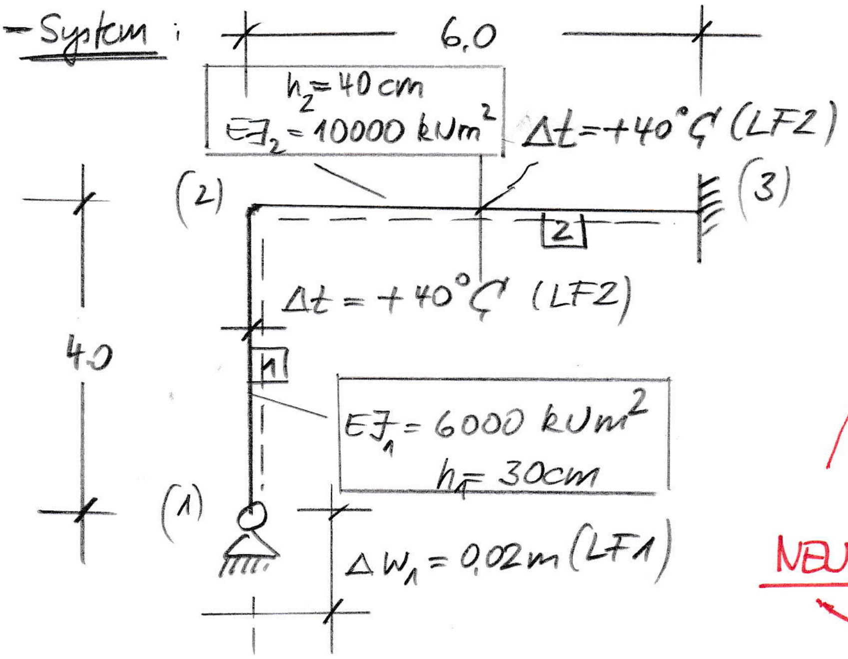
4. Beispiel zum Drehwinkelverfahren ($EA = \infty$)

– System:

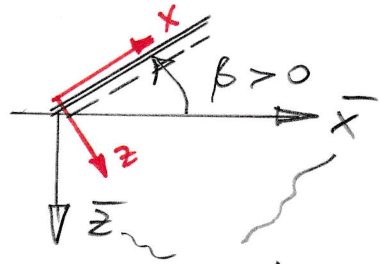


LF1: Auflagerverschieb. am Knoten 1
$\Delta w_1 = 2$cm

LF2: Temp.-differenz („unten" wärmer)
$\Delta t = +40°C$
$\alpha_T = 1{,}2 \cdot 10^{-5}$

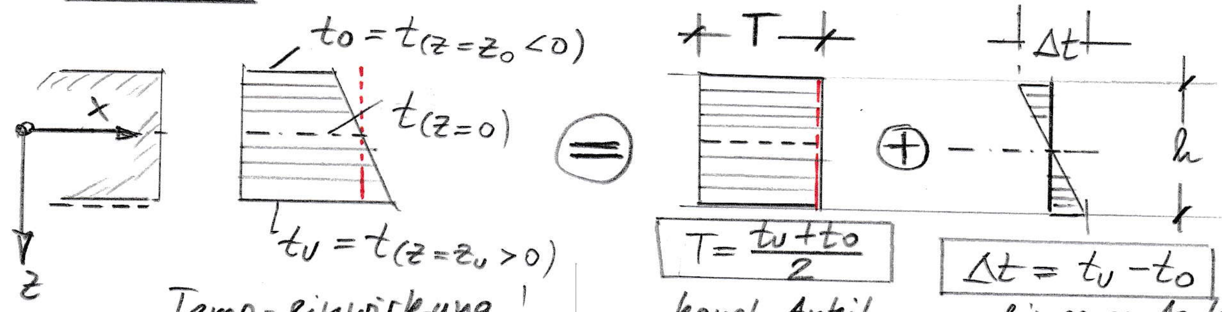
NEU: → vgl. LF1 + 2
→ ebenso: geknickter Träger $\beta \neq 0$

Hinweis 1:



Definition des Lagewinkels β
für Stab 1: $\beta = +90°$
für Stab 2: $\beta = 0°$

Hinweis 2:

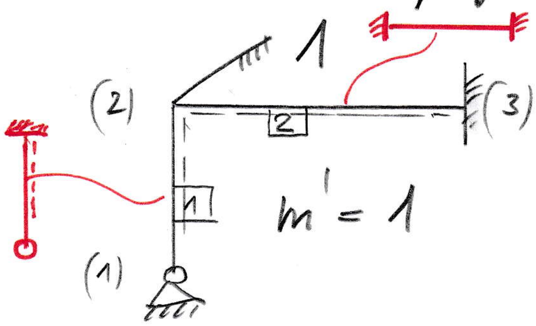


mehr auf dem Arbeitsblatt (4)!

unten wärmer
→ $t_u > t_o$

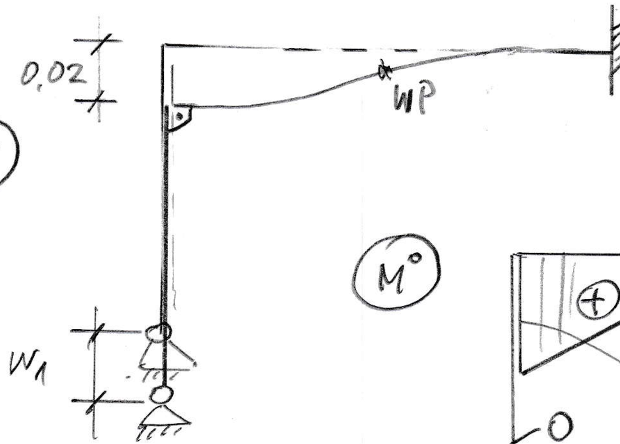
oben wärmer
→ $t_u < t_o$

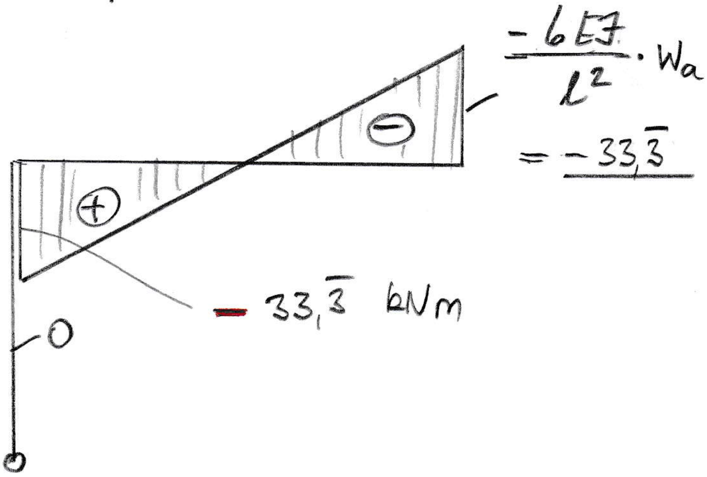
– kinem. best. Hauptsystem:

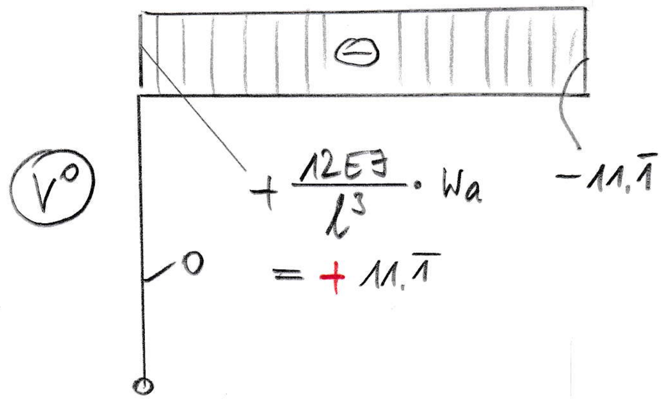


– Lastverformungszustände (je LF einer !)

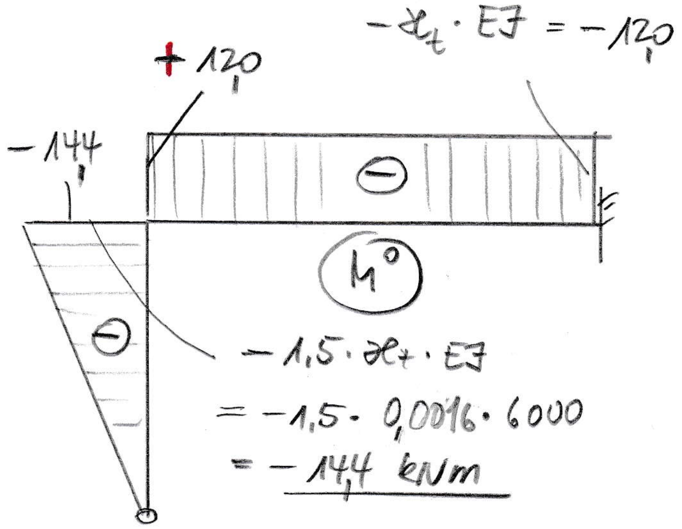
$\boxed{\text{LF 1}}$



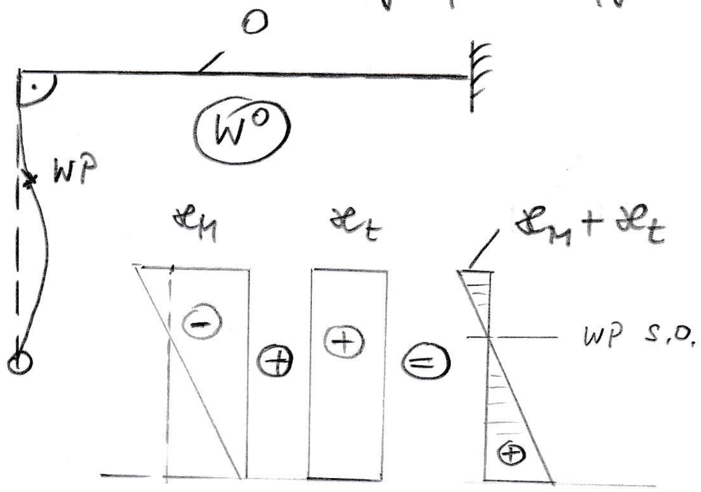


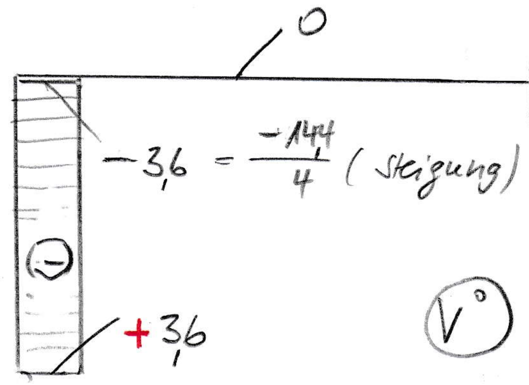


$\boxed{\text{LF 2}}$



Krümmung inf. Temp. wird durch Krümmung inf. M aufgehob.



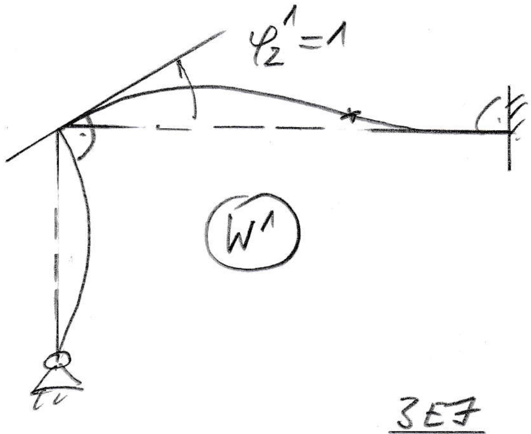


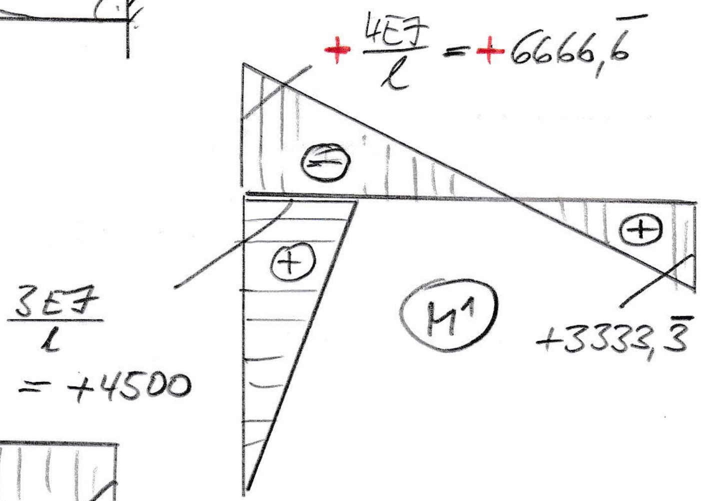
mit $\kappa_t = \frac{\alpha_T \cdot \Delta t}{h}$

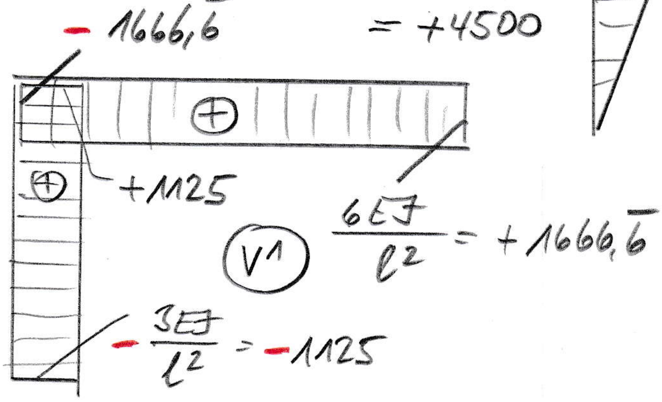
$= \frac{1,2 \cdot 10^{-5} \cdot 40}{0,40}$

$= \underline{0,0012}$ für Stab 2

– Einheitsverform.-zustand (EVZ):







– Aufstellen der Gleichgew.-Beding. (Gleichungssystem)

$\boxed{LF1}$

$$\sum M_2 \overset{!}{=} 0: \quad -33{,}\overline{3} + y_1 \cdot (4500 + 6666{,}\overline{6}) \overset{!}{=} 0$$

wg. Drehfessel am Kn. 2

$$y_1 = \frac{33{,}\overline{3}}{11166{,}\overline{6}} = \underline{0{,}002985}$$

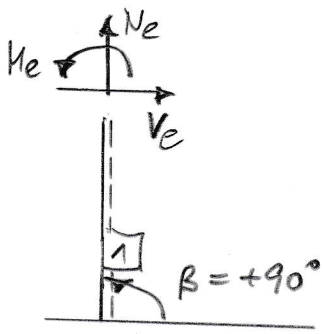
$\boxed{LF2}$

dito: $\quad (-14{,}4 + 12{,}0) \cdot y_1 (4500 + 6666{,}\overline{6}) \overset{!}{=} 0$

$$y_1 = \frac{2{,}40}{11166{,}\overline{6}} = \underline{0{,}002149}$$

Hinweis:

für „andere“ Gleichgewichtsbed. wie ΣV oder ΣH lokale Endschnittgr. auf globale transform. !!



$$\overline{N}_e = N_e \cdot \cos\beta + V_e \cdot \sin\beta$$

$$\overline{V}_e = N_e \cdot (-\sin\beta) + V_e \cdot \cos\beta$$

$$\overline{M}_e = M_e$$ ⇝ bei M kein Problem !

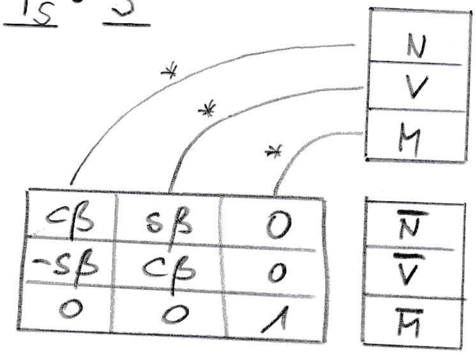
Transformation in Matrizenschreibweise:

$$\begin{Bmatrix} \overline{N} \\ \overline{V} \\ \overline{M} \end{Bmatrix}_e = \left[\begin{array}{c|c|c} \cos\beta & \sin\beta & 0 \\ \hline -\sin\beta & \cos\beta & 0 \\ \hline 0 & 0 & 1 \end{array}\right] \cdot \begin{Bmatrix} N \\ V \\ M \end{Bmatrix}_e$$

für Schnittgr. am Anfang (a) analog !!, weil gleiche „Richtung"

$\longrightarrow \quad \overline{s} = T_s \cdot s$

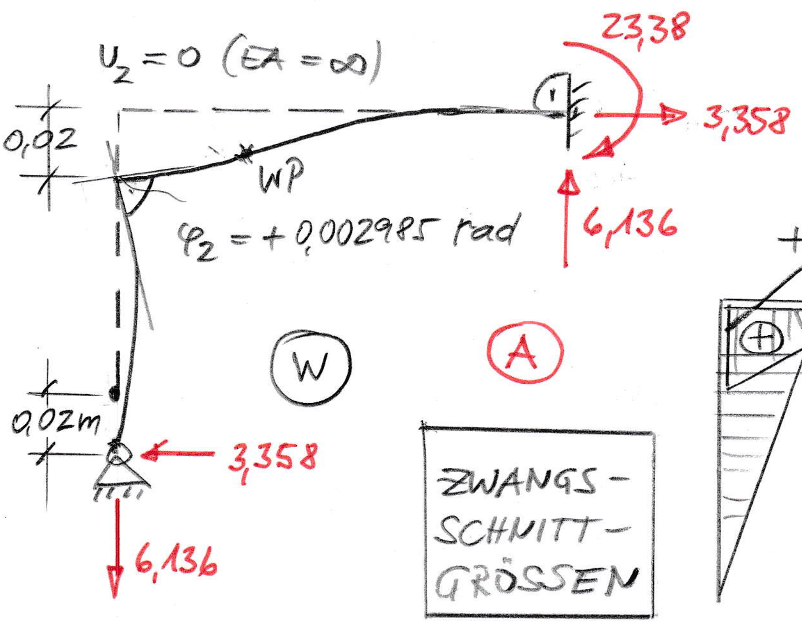
Falk'sches Schema:

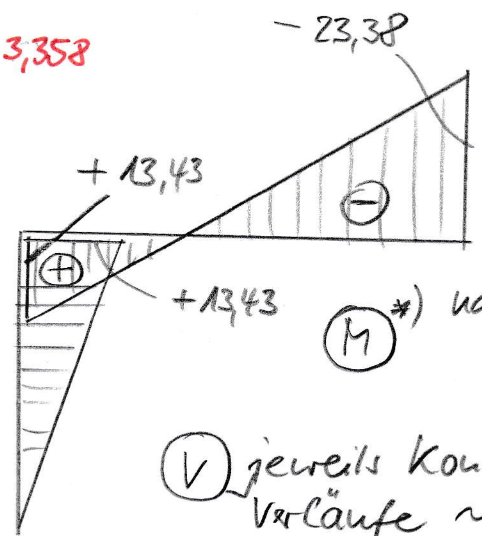


- **Nachlaufrechnung / Superposition:** (nach Vorz. des WGV)

$\boxed{LF1:}$

$$M_{2,u} = 0 + 0{,}002985 \cdot 4500 = \underline{+13{,}43 \text{ kNm}}$$
$$M_{2,r} = -33{,}\overline{3} + 0{,}002985 \cdot 6666{,}\overline{6} = \underline{-13{,}43 \text{ kNm}}$$
$$M_{3,l} = -33{,}\overline{3} + 0{,}002985 \cdot 3333{,}\overline{3} = \underline{-23{,}38 \text{ kNm}}$$
$$V_{2,u} = 0 + 0{,}002985 \cdot 1125 = \underline{+3{,}358 \text{ kN}}$$
$$V_{2,r} = 11{,}\overline{1} + 0{,}002985 \cdot (-1666{,}\overline{6}) = \underline{+6{,}136 \text{ kN}}$$





ZWANGS-SCHNITT-GRÖSSEN

(M) *) nach Baustatik!

(V) jeweils konstante Verläufe ⇝ selbst zeichnen!

$\boxed{LF2:}$

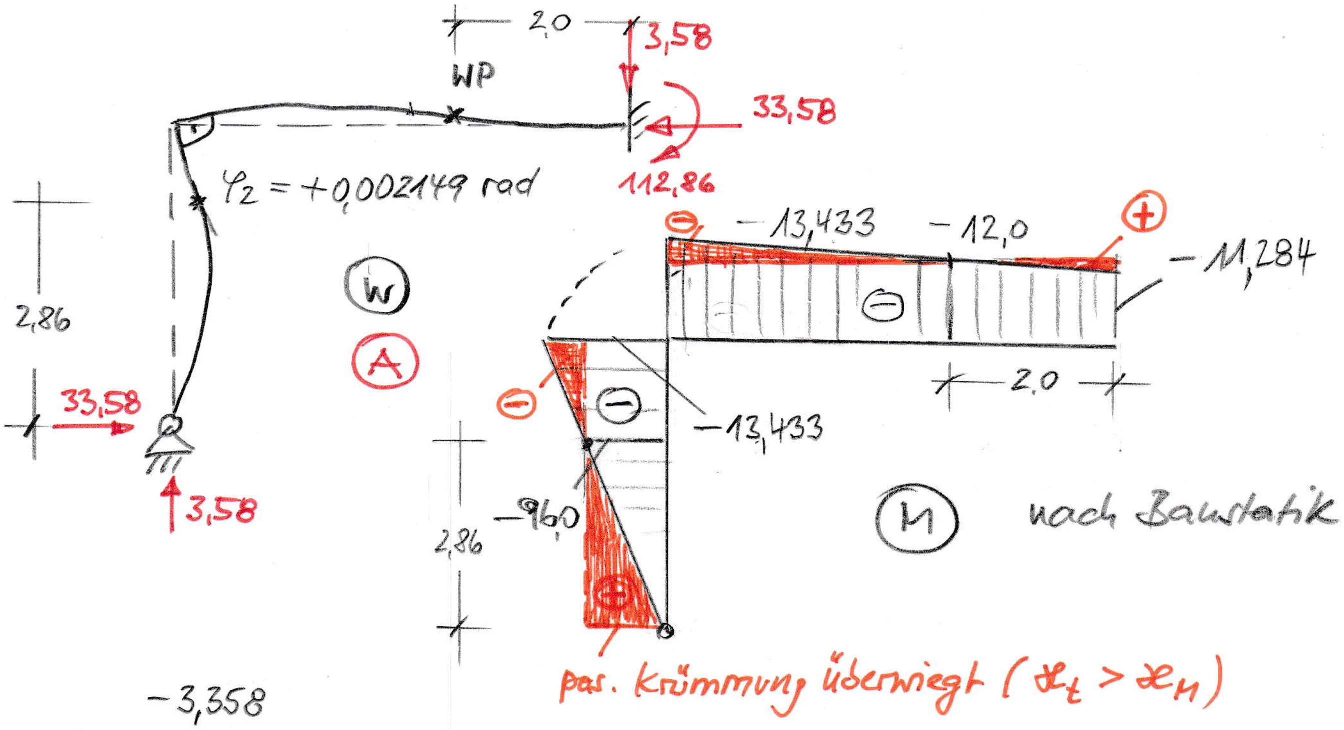
$$M_{2,u} = -14{,}4 + 0{,}002149 \cdot 4500 = \underline{-13{,}433 \text{ kNm}}$$

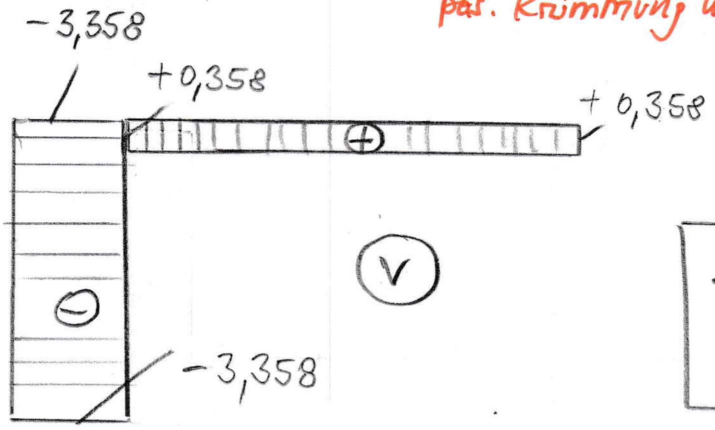
$$M_{2,r} = +12{,}0 + 0{,}002149 \cdot 6666{,}\bar{6} = \underline{+13{,}433} \checkmark$$

$$M_{3,l} = -12{,}0 + 0{,}002149 \cdot 3333{,}\bar{3} = \underline{-11{,}284 \text{ kNm}}$$

$$V_{2,u} = -3{,}6 + 0{,}002149 \cdot 1125 = \underline{-3{,}358 \text{ kN}}$$

$$V_{2,r} = 0 + 0{,}002149 \cdot (-1666{,}\bar{6}) = \underline{-0{,}358 \text{ kN}}$$





$\boxed{\text{ZWANGS-SCHNITTGRÖSSEN}}$

⇝ nur bei stat. unbestimmten Systemen!

hier: $n = 2$