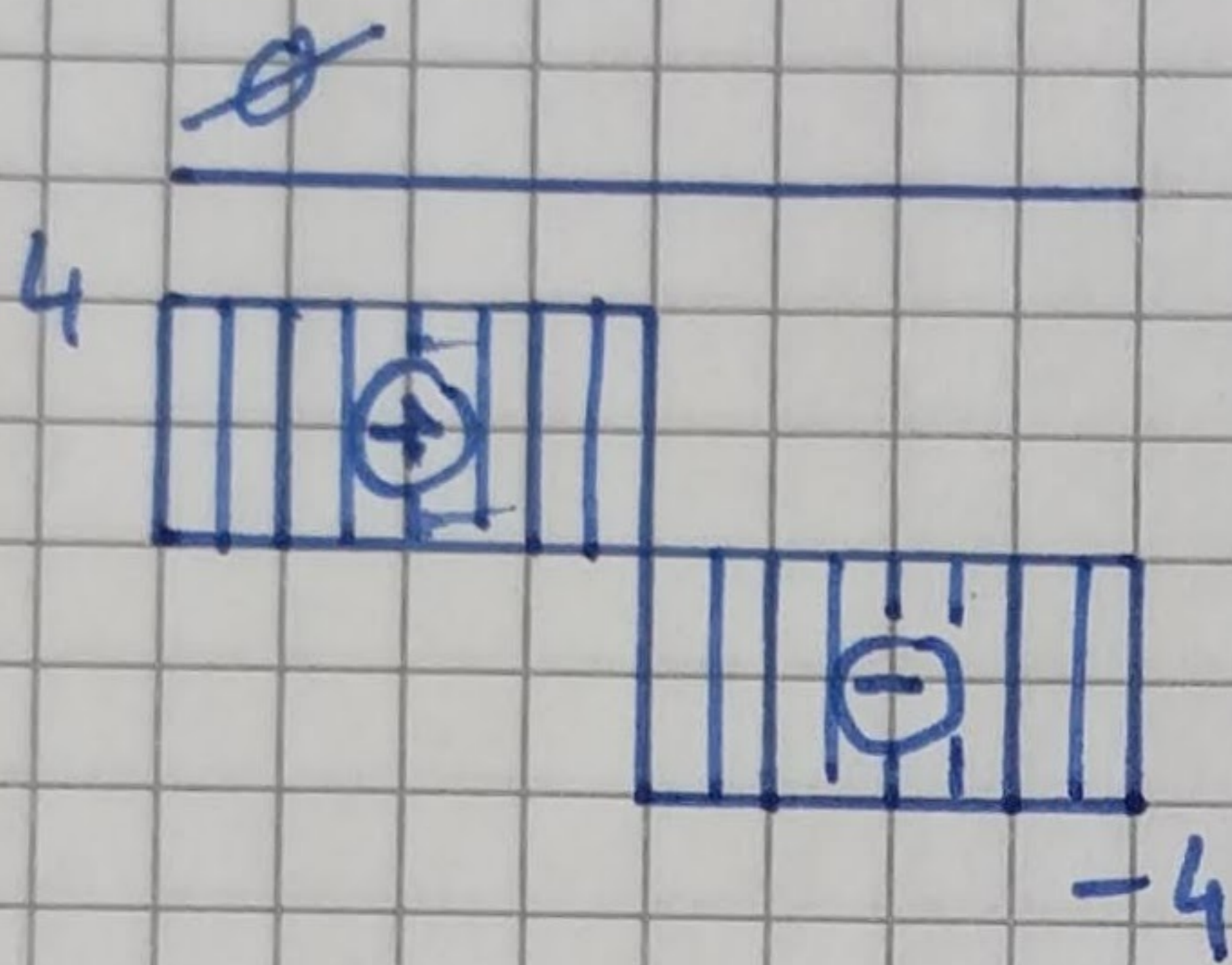


$$R_{ax} = 0$$

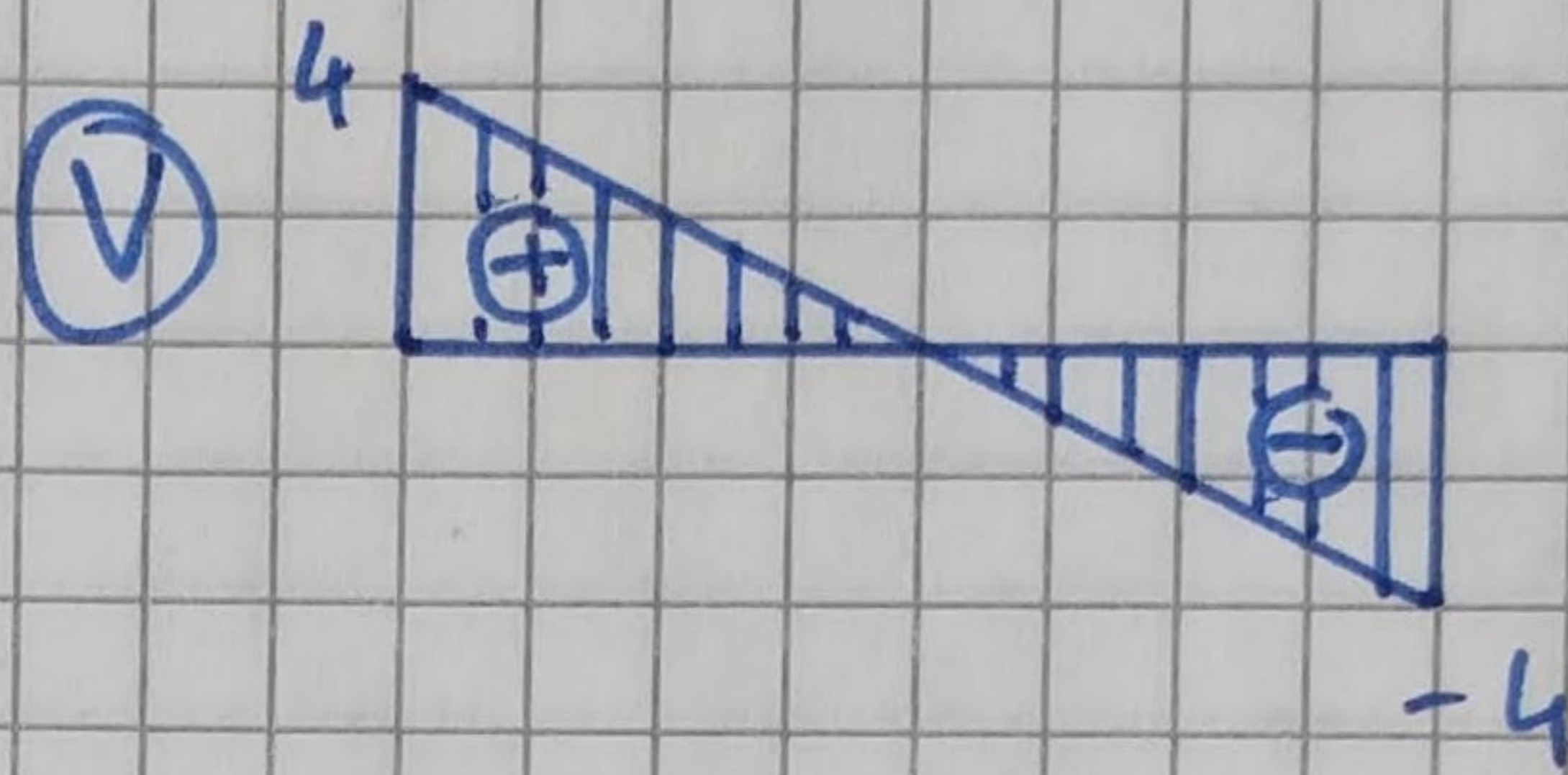
$$R_{az} = R_{bz} = 4 \text{ kN}$$

(N)



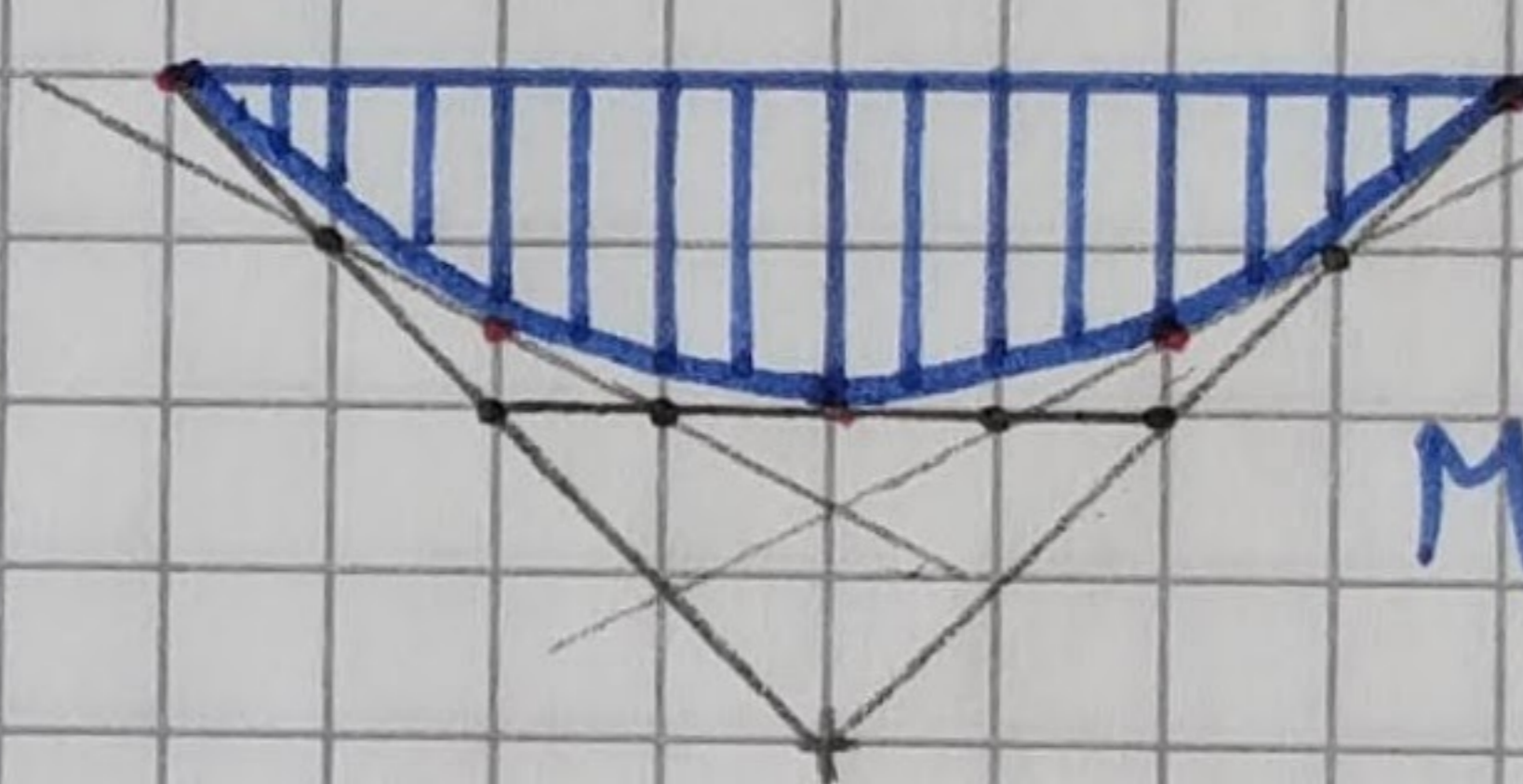
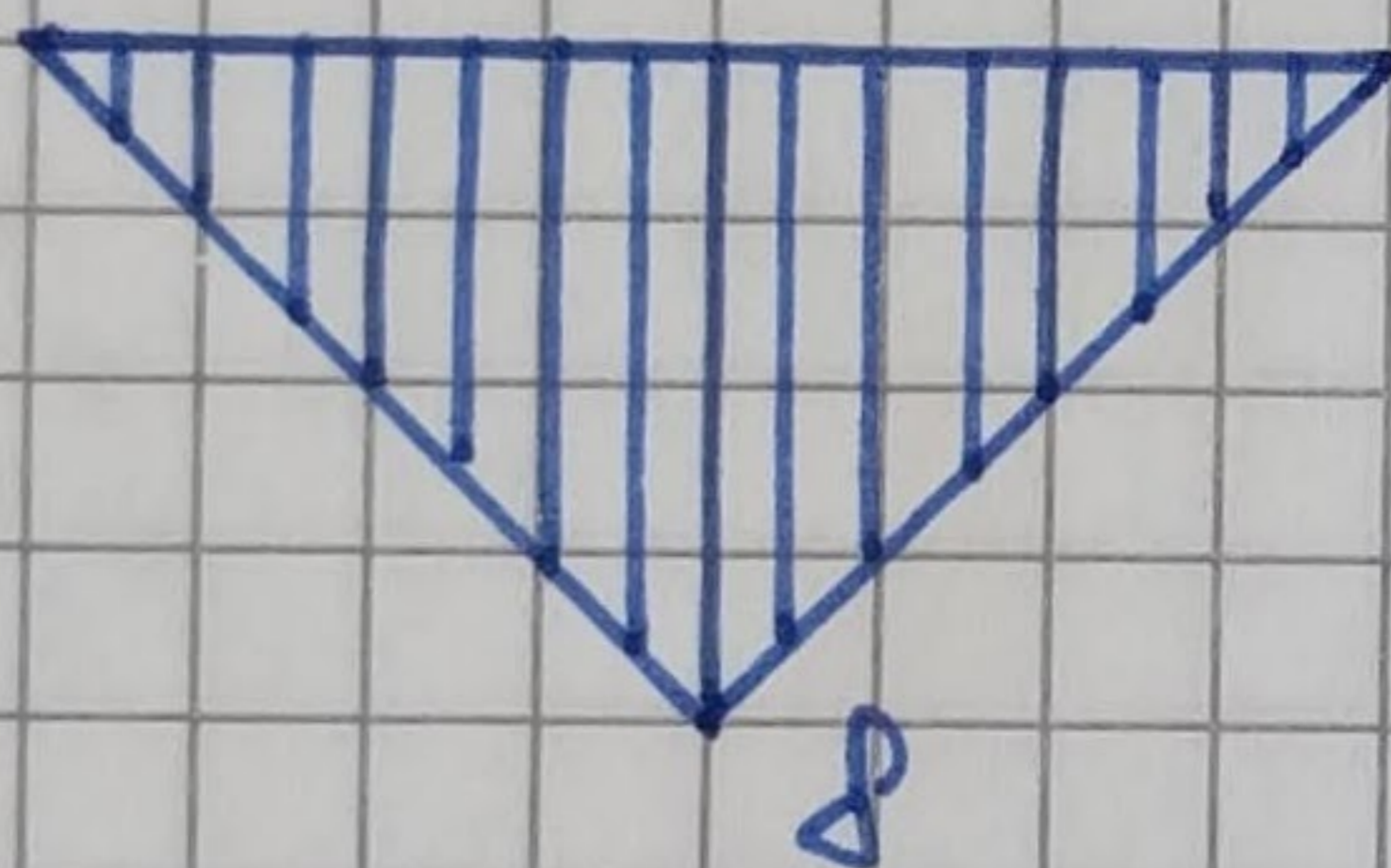
(V)

(N)



(V)

(M)

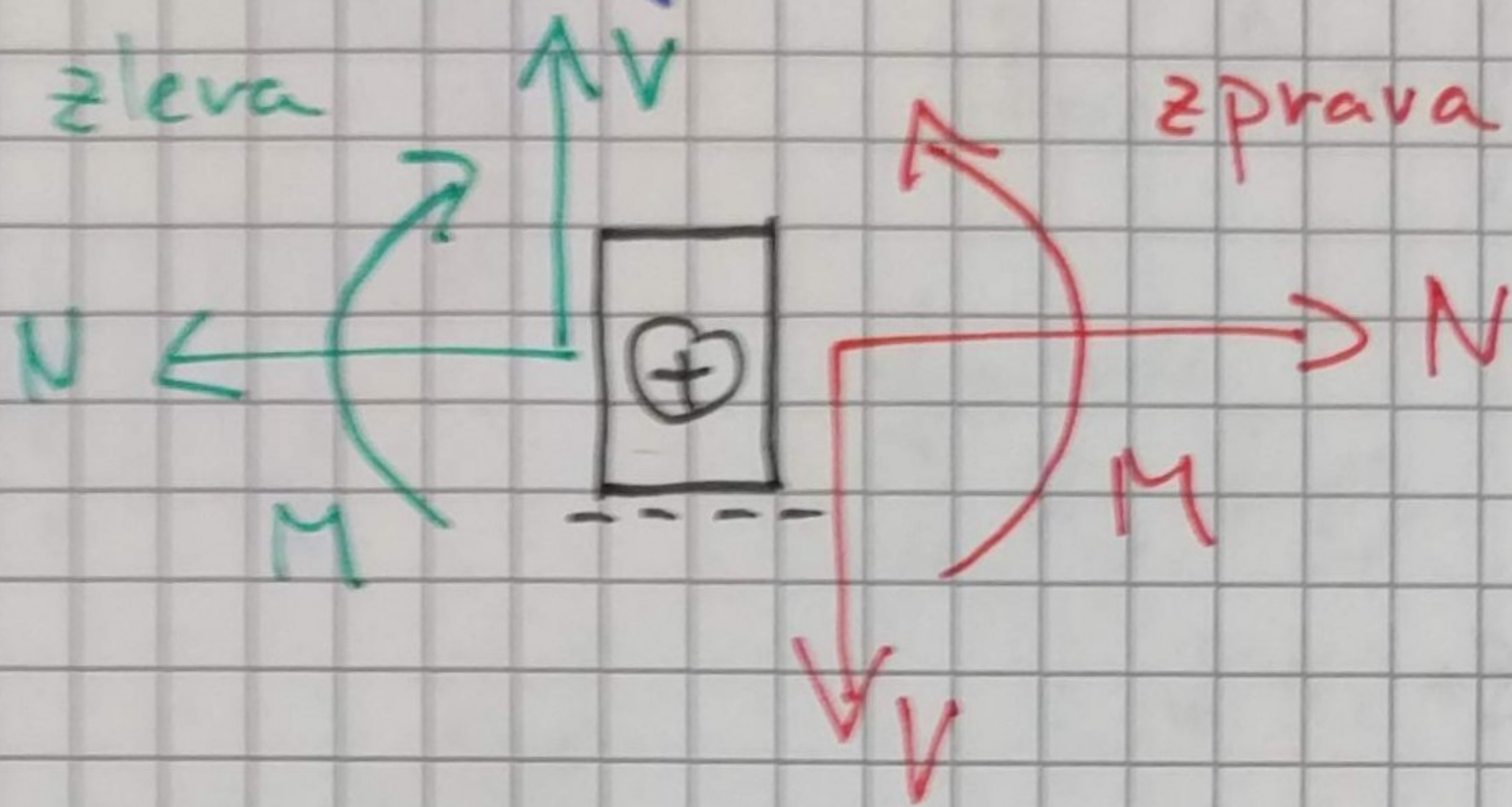


$$M\left(\frac{l}{2}\right) = 4 \text{ kNm}$$

Vnitřní síly na prutu

- (N) normálové síly - působí ve směru osy prutu
- (V) posouvající (smykové) síly - působí kolmo na prut
- (M) ohybové momenty

Konvence kladných vnitřních sil

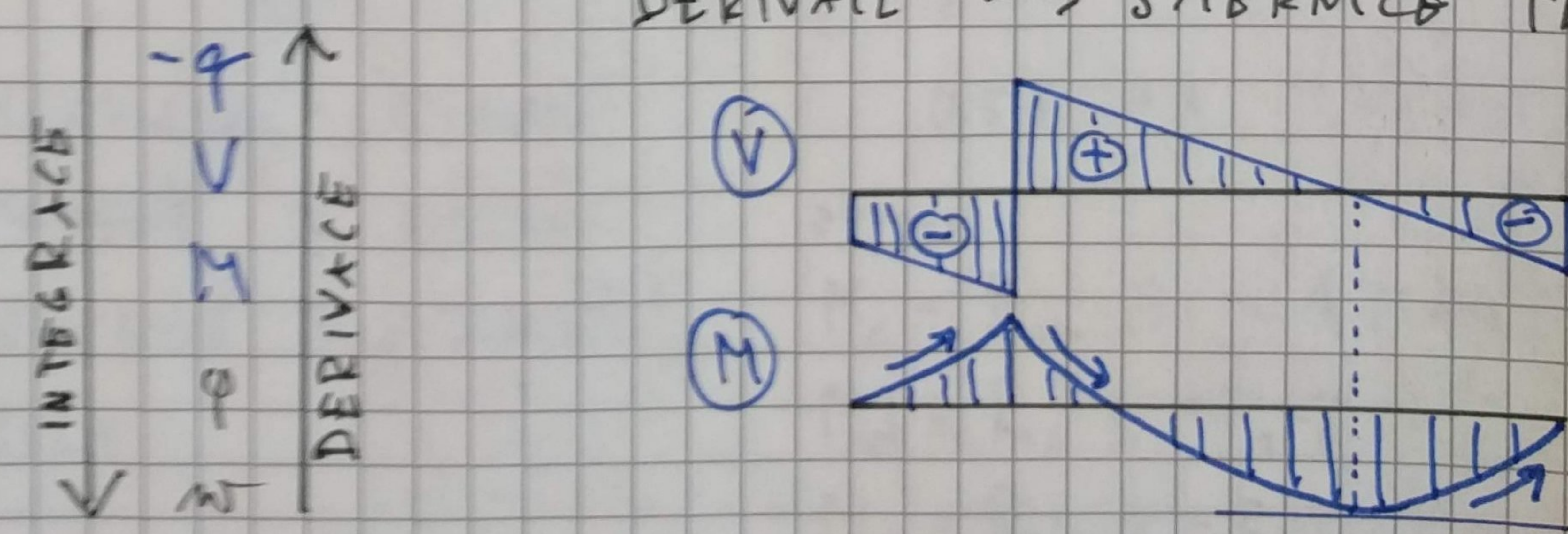


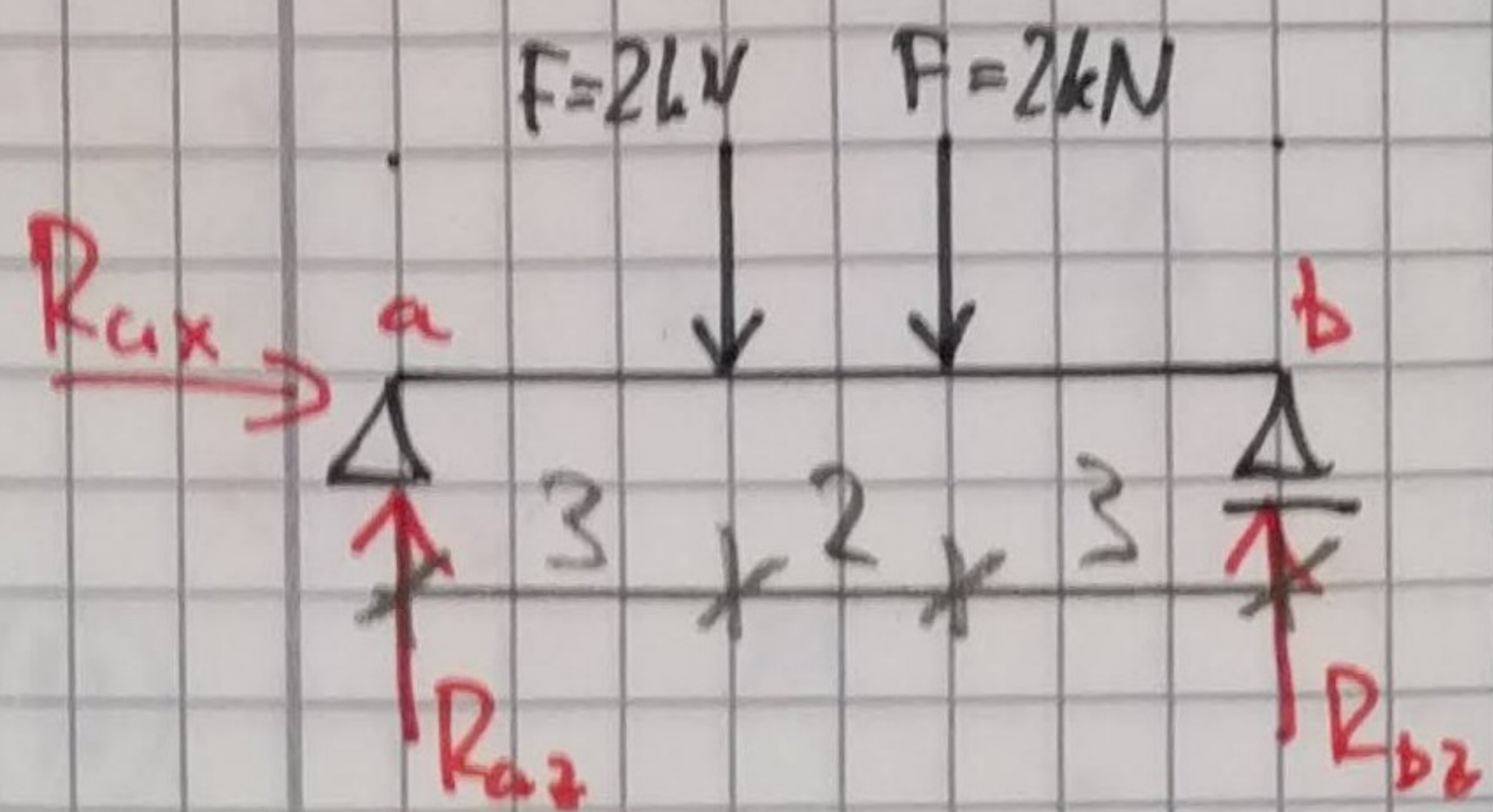
Momenty vždy na stranu tažených vláken

Pravidla pro vykreslovač

zátěž	F	M	q	q \rightarrow l_0	\emptyset
zátěž q					
posouvající síly (V)					
Ohybové Momenty (M)					

DERIVACE \rightarrow SMĚRNICE TĚČNY





$$\sum F_{ix} = 0 \Rightarrow R_{ax} = 0$$

$$\sum M_{ia} = 0 \quad (\curvearrowright)$$

$$-F \cdot 3 - F \cdot 5 + R_{bz} \cdot 8 = 0$$

$$R_{bz} = 2 \text{ kN} \quad (\uparrow)$$

$$\sum M_{ib} = 0 \quad (\curvearrowright)$$

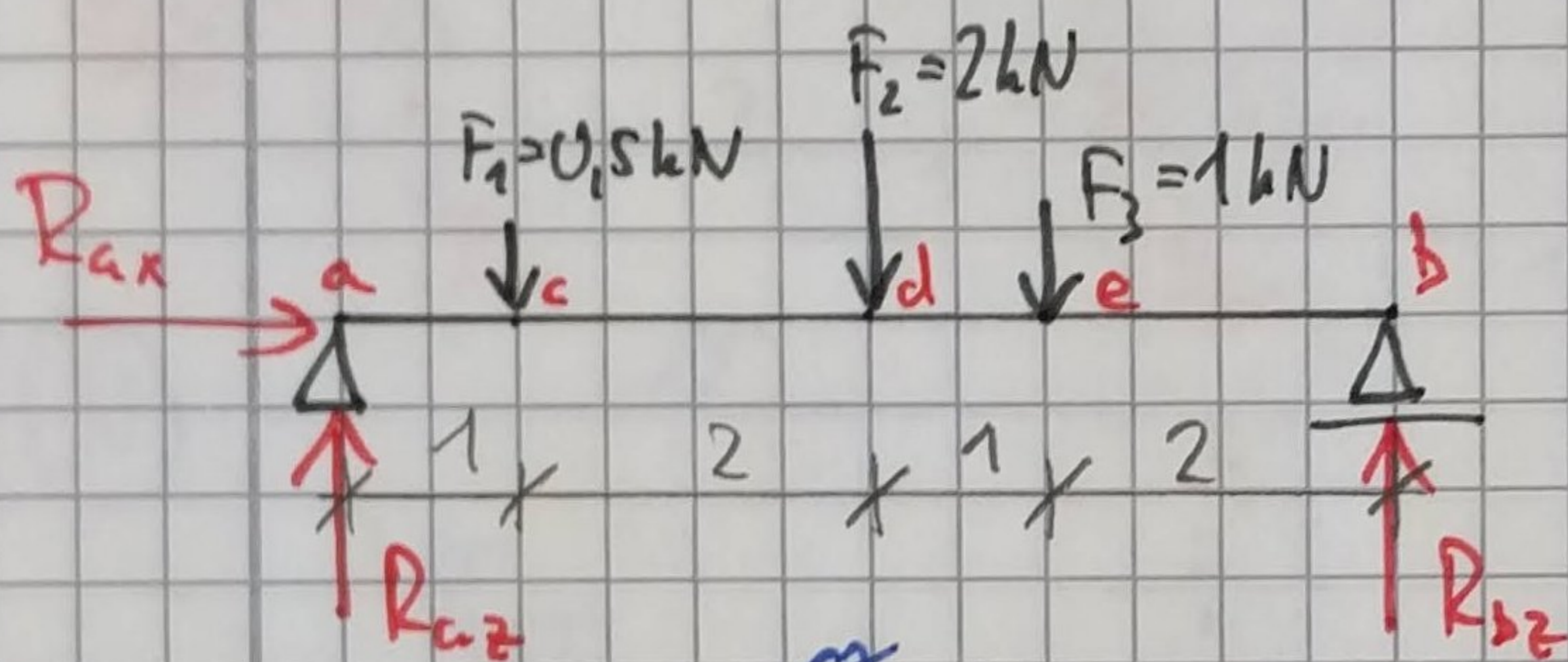
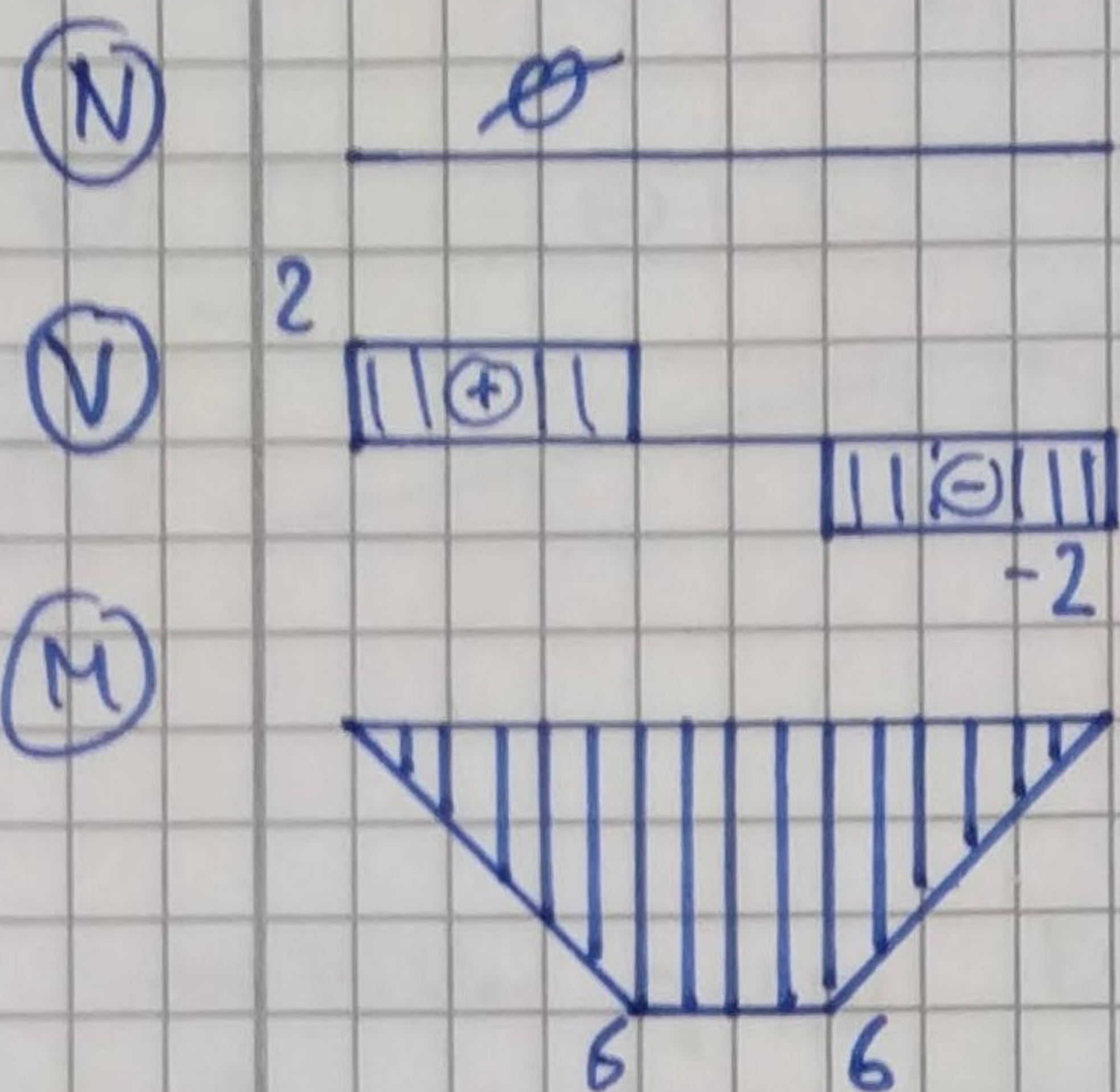
$$-R_{az} \cdot 8 + F \cdot 5 + F \cdot 3 = 0$$

$$R_{az} = 2 \text{ kN} \quad (\uparrow)$$

Kontrola

$$\sum F_{iz} = 0:$$

$$-2 + 2 + 2 - 2 = 0 \quad \checkmark$$



$$\sum F_{ix} = 0 : R_{ax} = 0$$

$$\sum M_{ia} = 0 \quad (\curvearrowright)$$

$$-F_1 \cdot 1 - F_2 \cdot 3 - F_3 \cdot 4 + R_{bz} \cdot 8 = 0$$

$$R_{bz} = 1,75 \text{ kN} \quad (\uparrow)$$

$$\sum M_{ib} = 0 \quad (\curvearrowright)$$

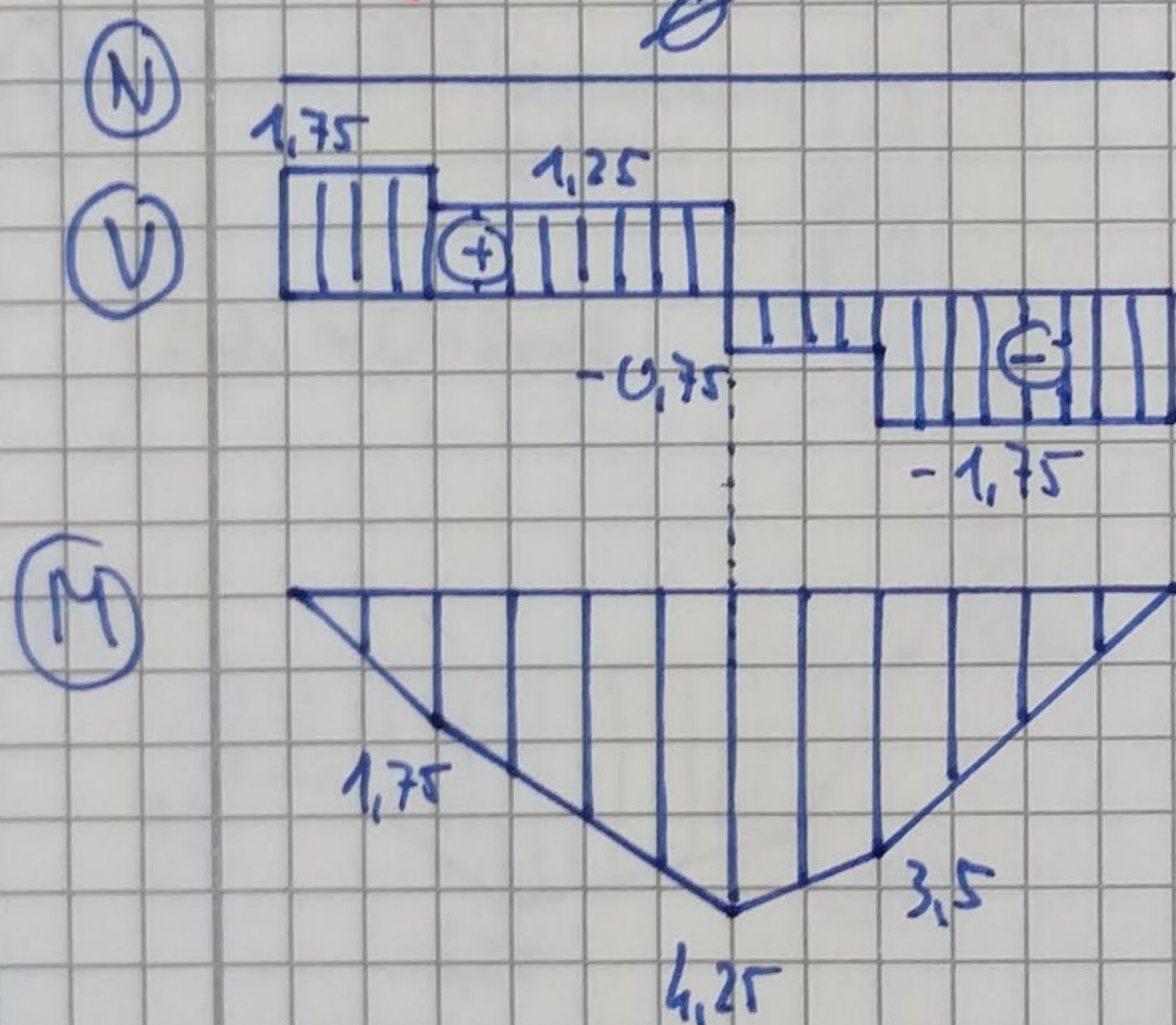
$$-R_{az} \cdot 8 + F_1 \cdot 5 + F_2 \cdot 3 + F_3 \cdot 2 = 0$$

$$R_{az} = 1,75 \text{ kN} \quad (\uparrow)$$

Kontrola

$$\sum F_{iz} = 0$$

$$0,5 + 2 + 1 - 1,75 - 1,75 = 0 \quad \checkmark$$



MAXIMÁLNÍ OHYBOVÝ

MOMENT V MÍSTĚ

NULOVÉ POSOUVAJÍCÍ

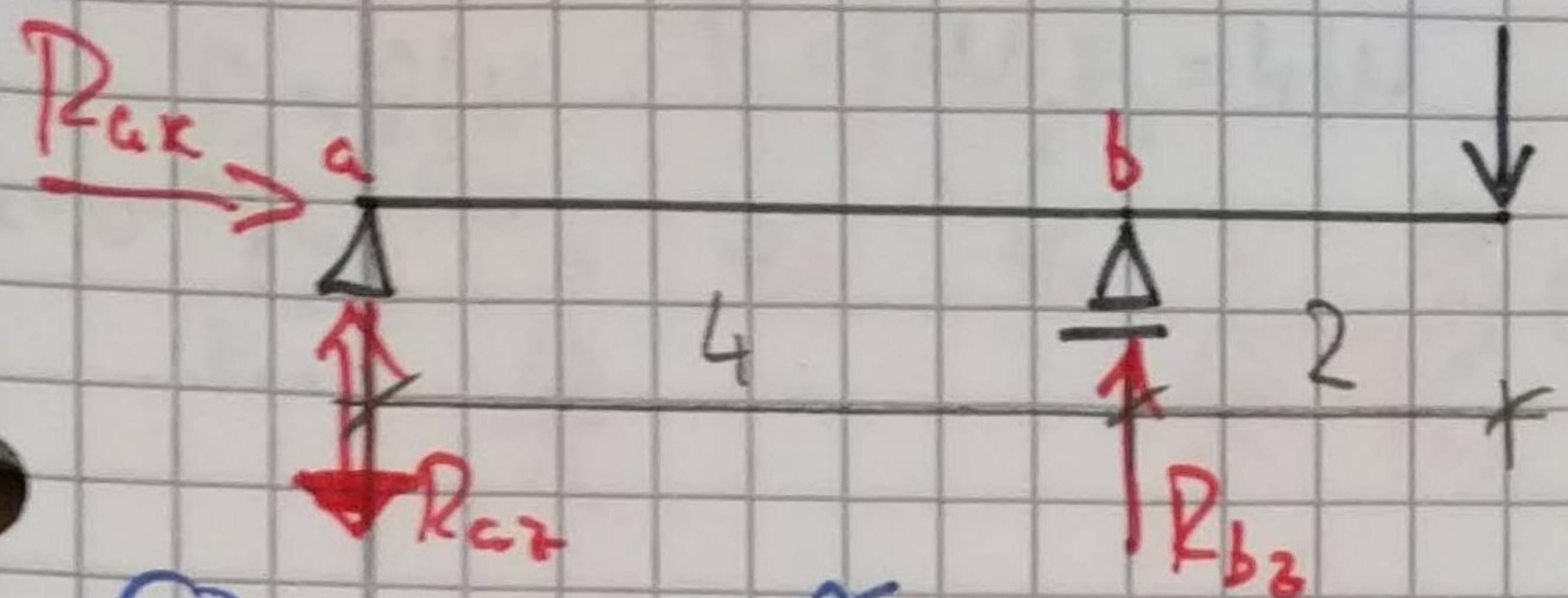
SÍLY

zleva:

$$M_c = R_{az} \cdot 1 = 1,75 \text{ kNm}$$

$$M_d = R_{az} \cdot 3 - F_1 \cdot 2 = 4,25 \text{ kNm}$$

$$M_e = R_{az} \cdot 4 - F_1 \cdot 3 - F_2 \cdot 1 = 3,5 \text{ kNm}$$



$$\sum F_{ix} = 0 \Rightarrow R_{ax} = 0$$

$$\sum M_{ia} = 0 \quad (\curvearrowright)$$

$$R_{bz} \cdot 4 - F \cdot 6 = 0$$

$$R_{bz} = 3 \text{ kN} \quad (\uparrow)$$

$$\sum M_{ib} = 0 \quad (\curvearrowright)$$

$$-R_{az} \cdot 4 - F \cdot 2 = 0$$

$$R_{az} = +1 \text{ kN} \quad (\downarrow)$$

Kontrolle

$$\sum F_{iz} = 0 : 1 - 3 + 2 = 0 \quad \checkmark$$

$$\sum F_{ix} = 0 : R_{ax} = 0$$

$$\sum M_{ia} = 0 \quad (\curvearrowright)$$

$$-M - F_1 \cdot 1 - F_2 \cdot 3 + R_{bz} \cdot 4 - F_3 \cdot 5 = 0$$

$$R_{bz} = 9,75 \text{ kN} \quad (\uparrow)$$

$$\sum M_{ib} = 0 \quad (\curvearrowright)$$

$$-M - R_{az} \cdot 4 + F_1 \cdot 3 + F_2 \cdot 1 - F_3 \cdot 1 = 0$$

$$R_{az} = 3,25 \text{ kN} \quad (\uparrow)$$

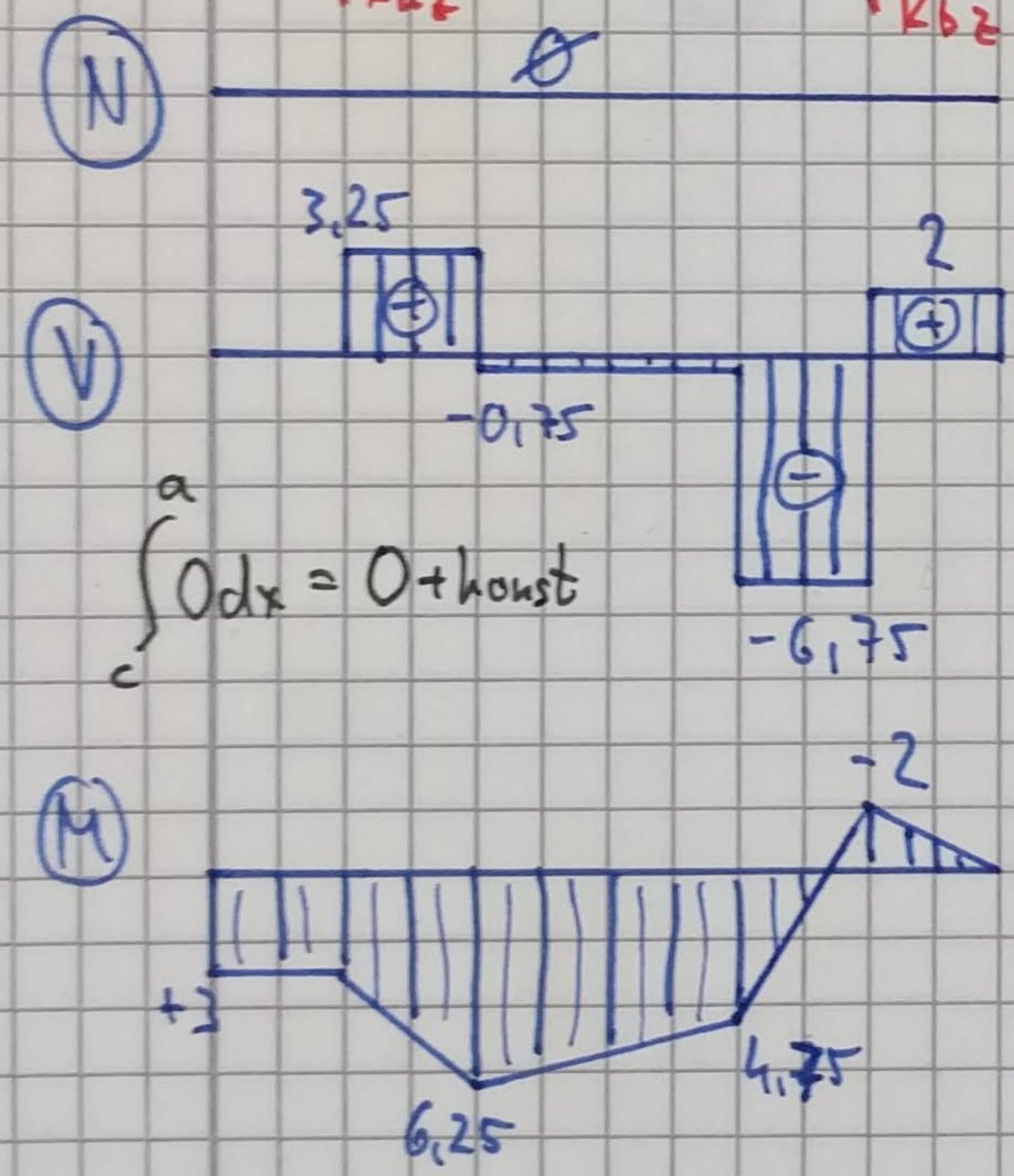
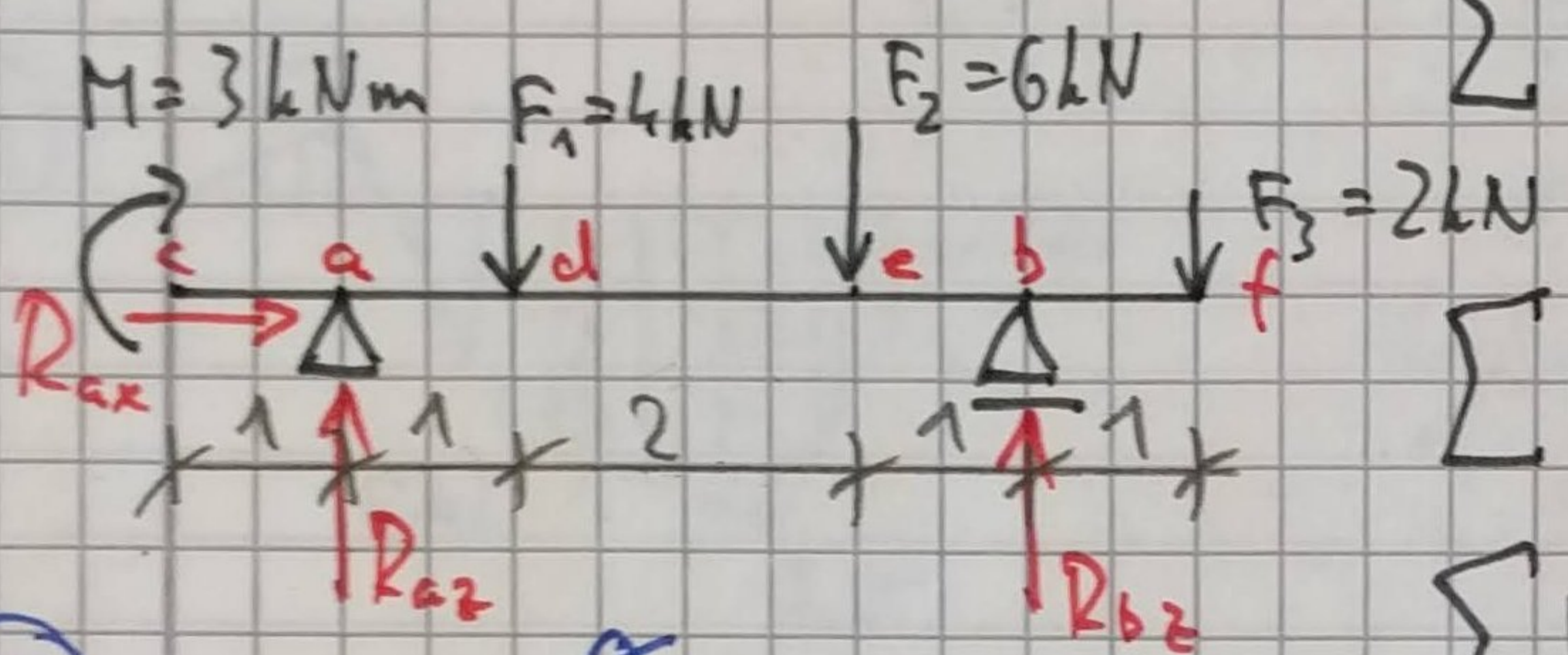
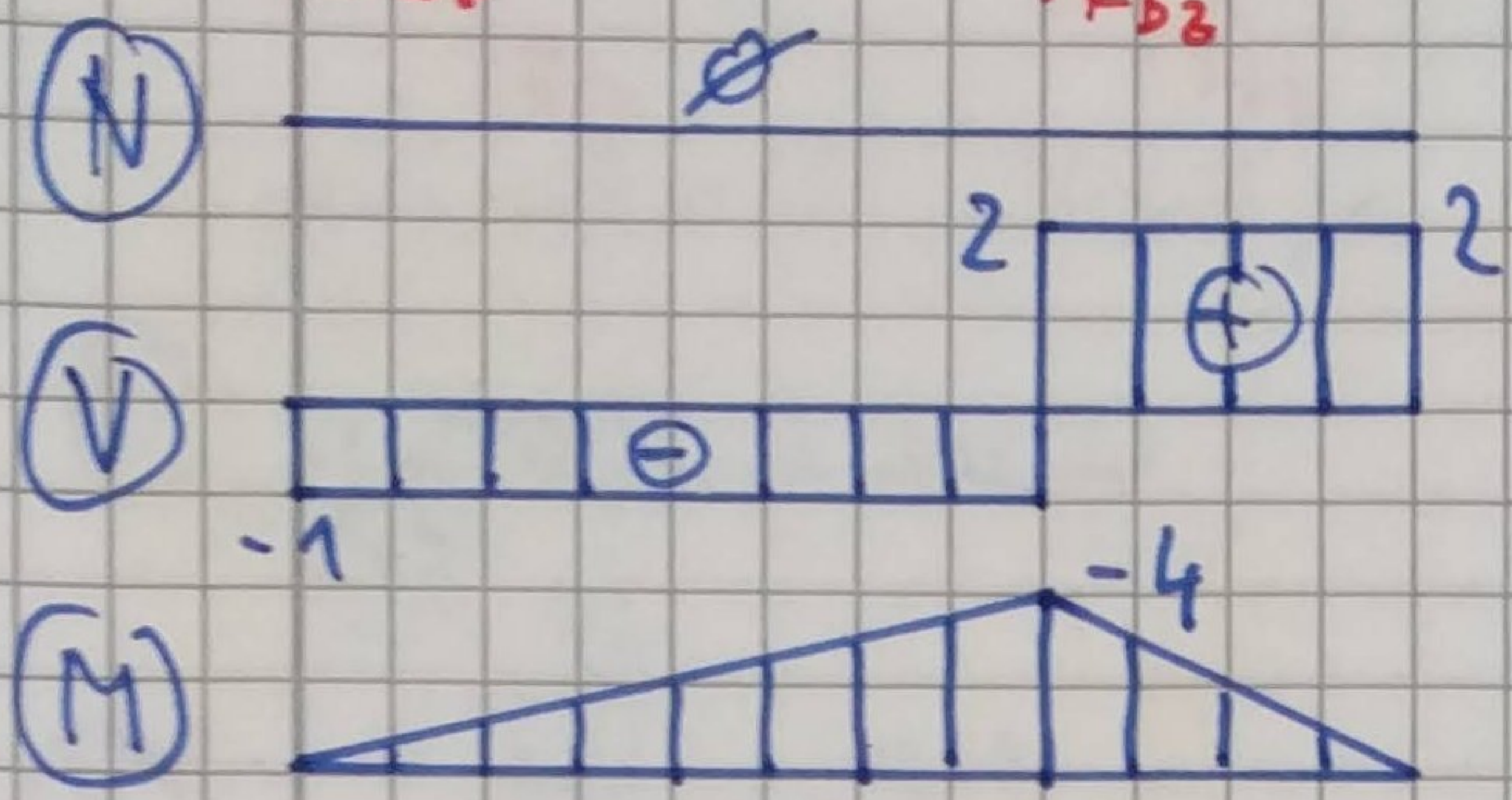
Kontrolle

$$\sum F_{iz} = 0 : 4 + 6 + 2 - 3,25 - 9,75 = 0 \quad \checkmark$$

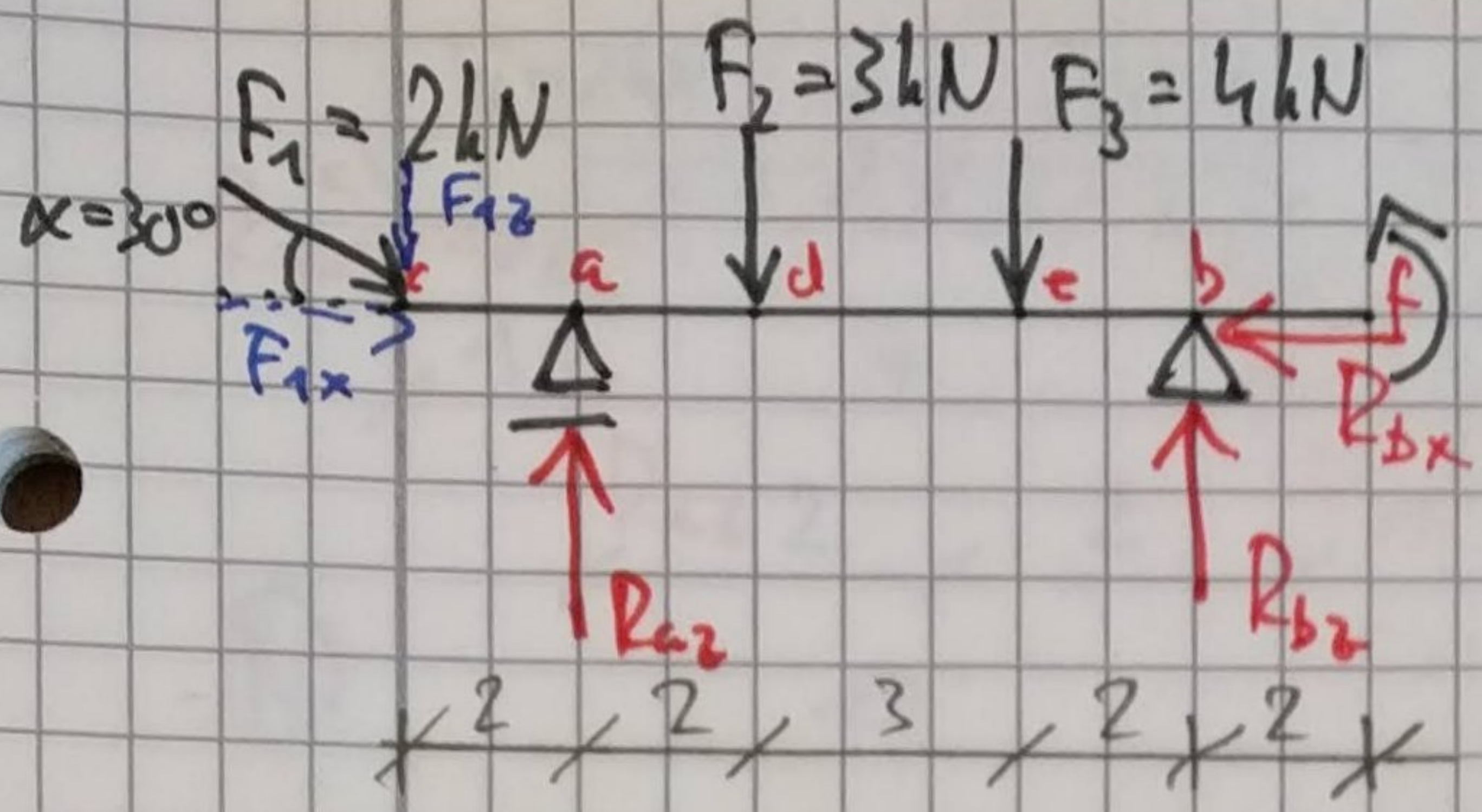
$$M_d = 3 + R_{az} \cdot 1 = 6,25 \text{ kNm}$$

$$M_e = 3 + R_{az} \cdot 3 - F_1 \cdot 2 = 4,75 \text{ kNm}$$

$$M_b = -F_3 \cdot 1 = -2 \text{ kNm}$$



$$\int_0^a 0 dx = 0 + \text{konst}$$



$$F_{1x} = F_1 \cos \alpha = 1,73 \text{ kN}$$

$$F_{1z} = F_1 \sin \alpha = 1 \text{ kN}$$

$$\sum F_{ix} = 0$$

$$F_{1x} - R_{bx} = 0 \Rightarrow R_{bx} = 1,73 \text{ kN}$$

$$\sum M_{ia} = 0 \quad (\curvearrowright)$$

$$F_{1z} \cdot 2 - F_2 \cdot 2 - F_2 \cdot 5 + R_{bz} \cdot 7 + M = 0$$

$$R_{bz} = \frac{23}{7} \approx 3,29 \text{ kN} \quad (\uparrow)$$

$$\sum M_{ib} = 0 \quad (\curvearrowright)$$

$$F_{1z} \cdot 9 - R_{az} \cdot 7 + F_2 \cdot 5 + F_3 \cdot 4 + M = 0$$

$$R_{az} = \frac{33}{7} \approx 4,71 \text{ kN} \quad (\uparrow)$$

kontroll:

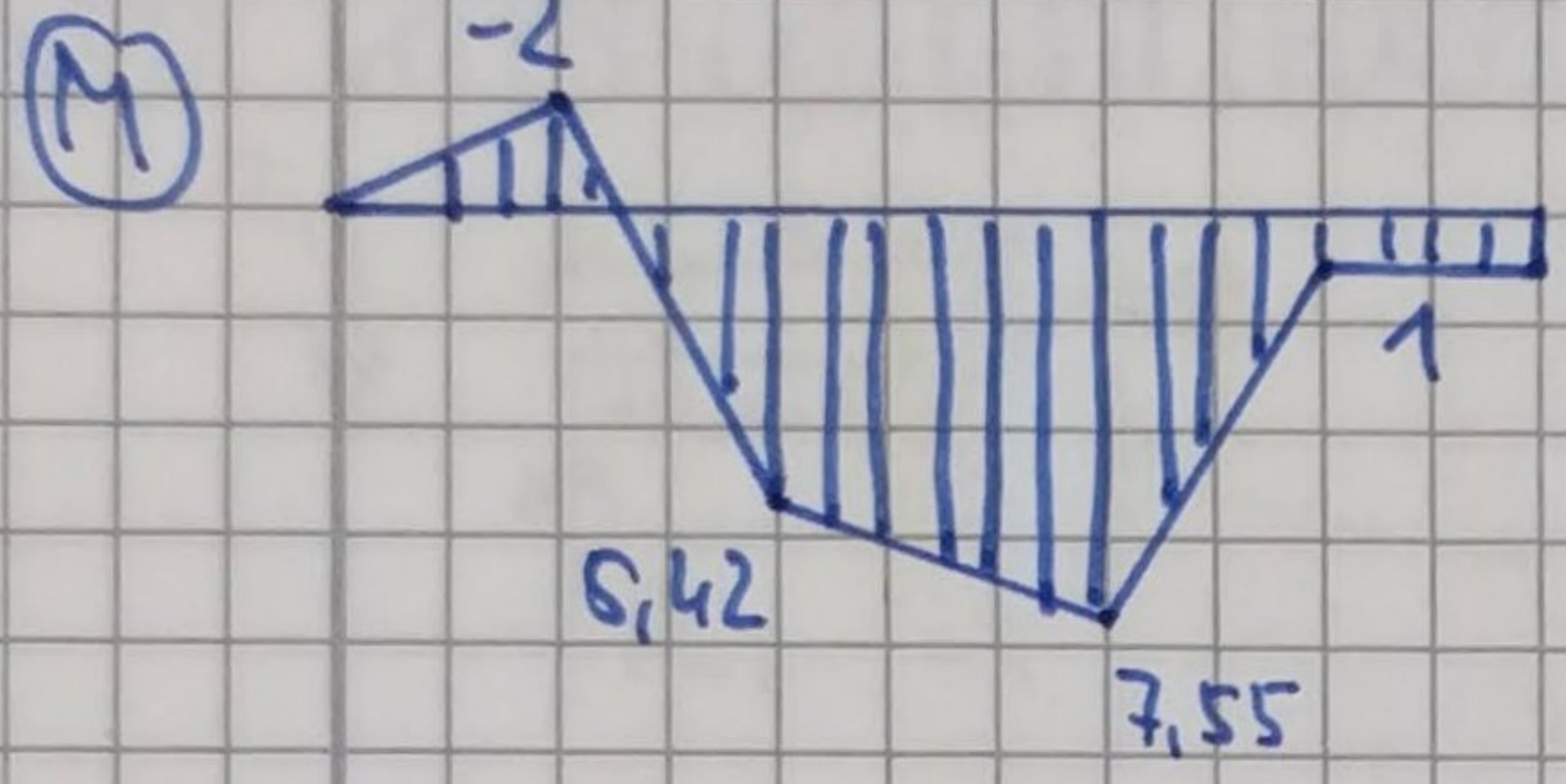
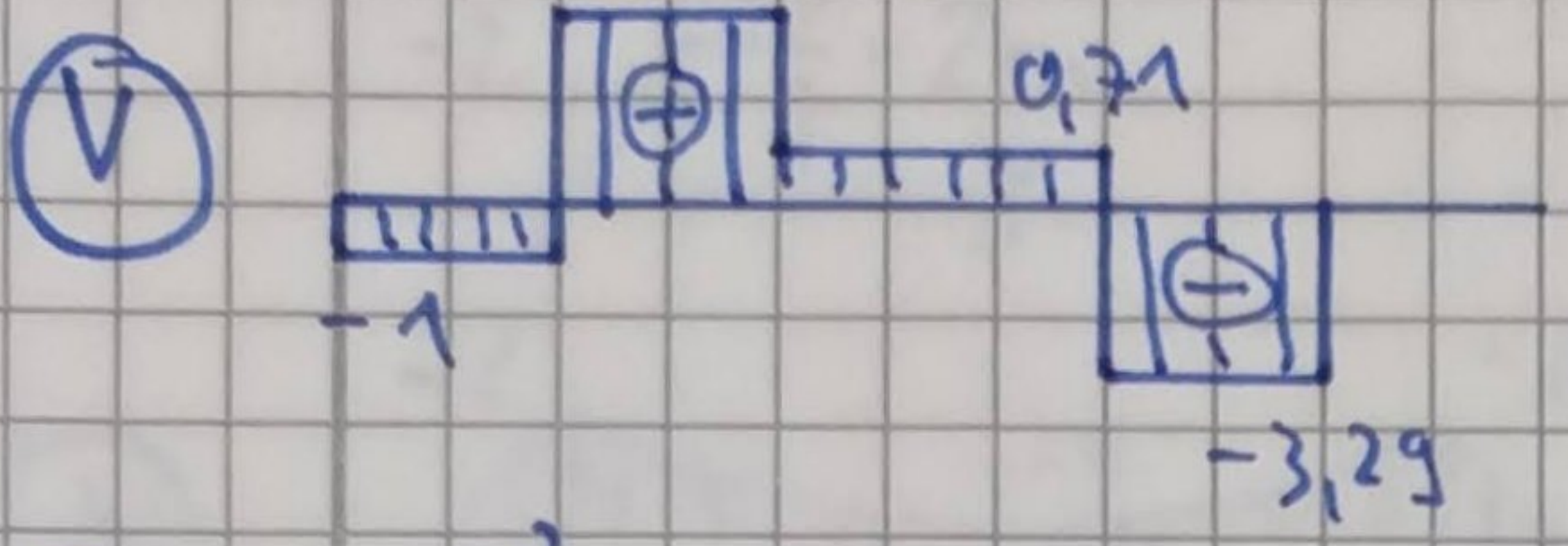
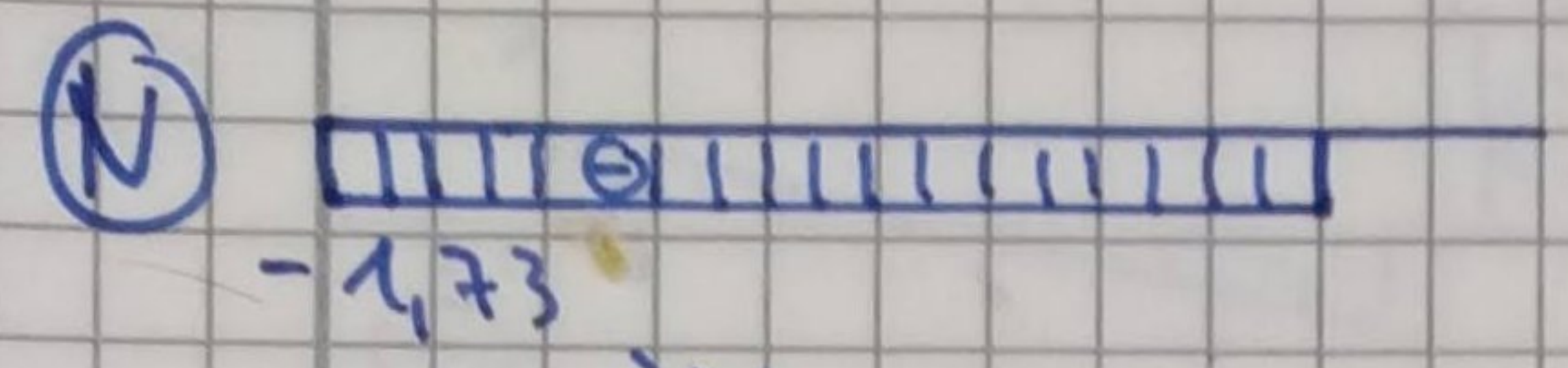
$$\sum F_{iz} \stackrel{?}{=} 0 \quad 1 - 3,29 + 3 + 4 - 4,71 = 0 \quad \checkmark$$

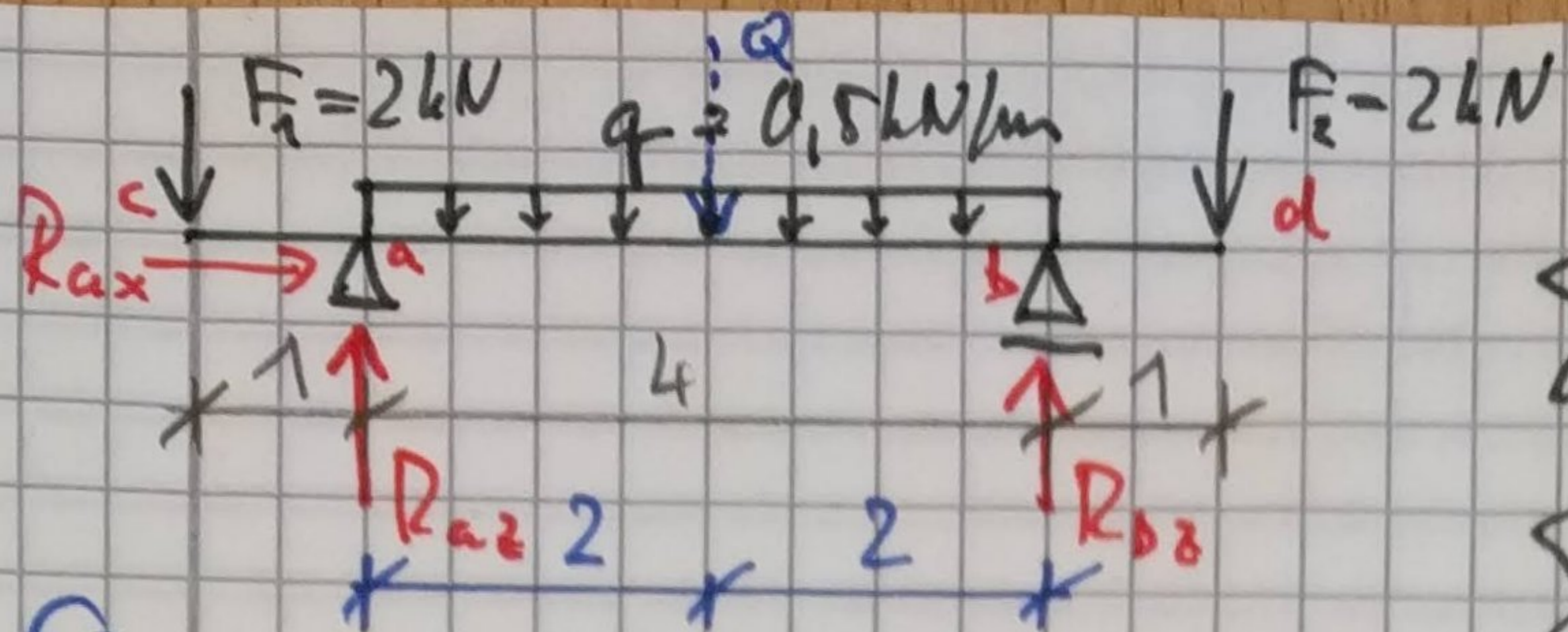
$$M_a = -F_{1z} \cdot 2 = 2 \text{ kNm}$$

$$M_d = -F_{1z} \cdot 4 + R_{az} \cdot 2 = 5,42 \text{ kNm}$$

$$M_e = -F_{1z} \cdot 7 + R_{az} \cdot 5 - F_2 \cdot 3 = 7,55 \text{ kNm}$$

$$M_b = -F_{1z} \cdot 9 + R_{az} \cdot 7 - F_2 \cdot 5 - F_3 \cdot 2 = 1 \text{ kNm}$$





$$Q = q \cdot 4 = 2\text{ kN}$$

$$\sum F_{ix} = 0 \Rightarrow R_{ax} = 0$$

$$\sum M_{ia} = 0 \quad (\curvearrowright)$$

$$F_1 \cdot 1 - Q \cdot 2 + R_{bz} \cdot 4 - F_2 \cdot 5 = 0$$

$$R_{bz} = 3\text{ kN} \quad (\uparrow)$$

$$\sum M_{ib} = 0 \quad (\curvearrowright)$$

$$F_1 \cdot 5 - R_{az} \cdot 4 + Q \cdot 2 - F_2 \cdot 1 = 0$$

$$R_{az} = 3\text{ kN} \quad (\uparrow)$$

Kontrol:

$$\sum F_{iz} = 0: 2 - 3 + 2 - 3 + 2 = 0 \quad \checkmark$$

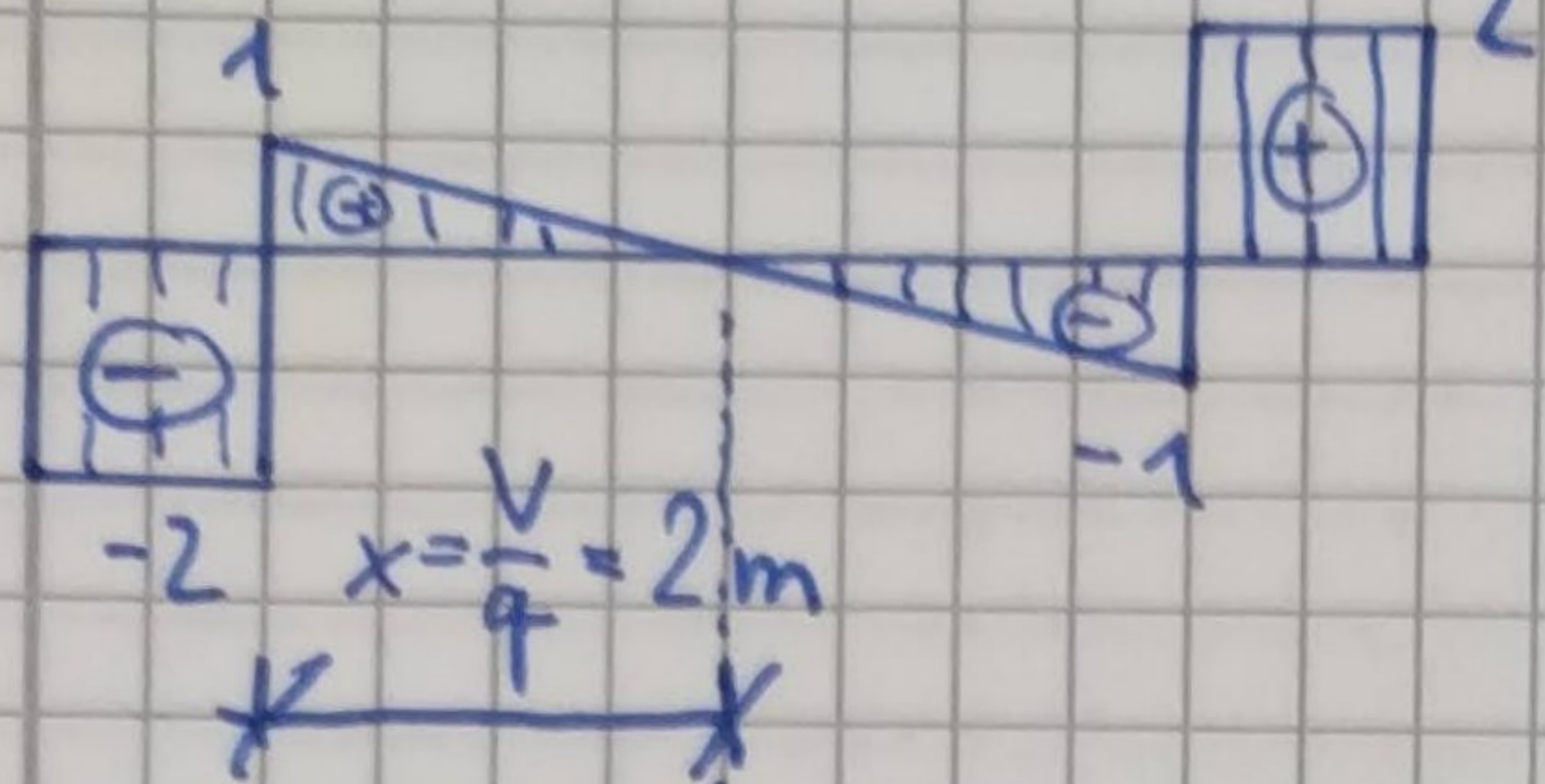
$$M_a = -F_1 \cdot 1 = -2\text{ kNm}$$

$$M_x = -F_1 \cdot 3 + R_{az} \cdot 2 - \frac{q \cdot x^2}{2} = -1\text{ kNm}$$

(N)



(V)



(M)

