

$$Q = 4 \cdot 3 = 12 \text{ kN}$$

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

$$R_{bx} = F \cdot \cos \alpha = 10 \text{ kN} (\leftarrow)$$

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

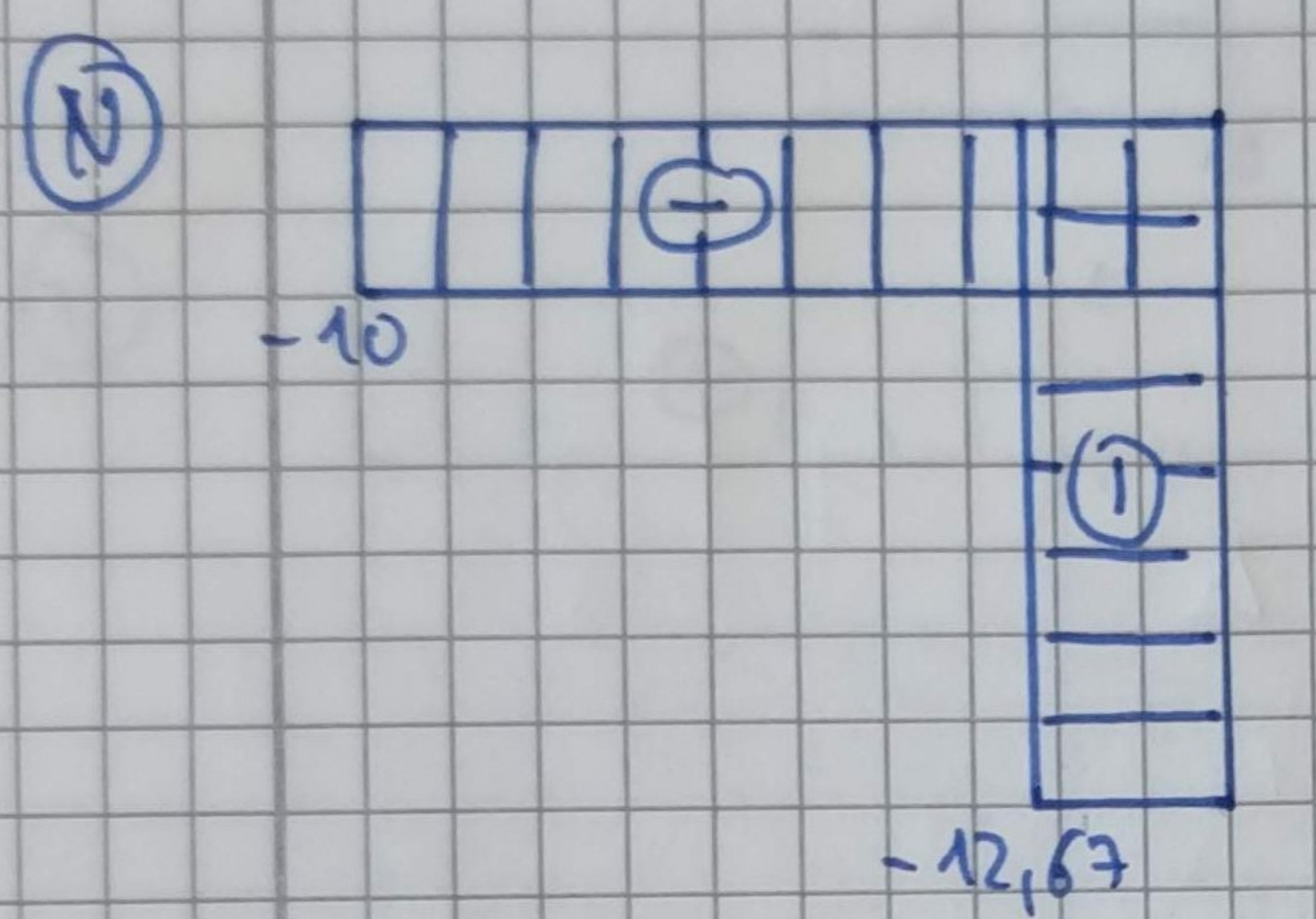
$$F_z \cdot 2 - Q \cdot 1.5 - R_{bx} \cdot 4 + R_{by} \cdot 3 = 0$$

$$R_{by} = 12.67 \text{ kN} (\uparrow)$$

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

$$F_z \cdot 5 - F_x \cdot 4 - R_{ax} \cdot 3 + Q \cdot 1.5 = 0$$

$$R_{ax} = 9.33 \text{ kN} (\uparrow)$$



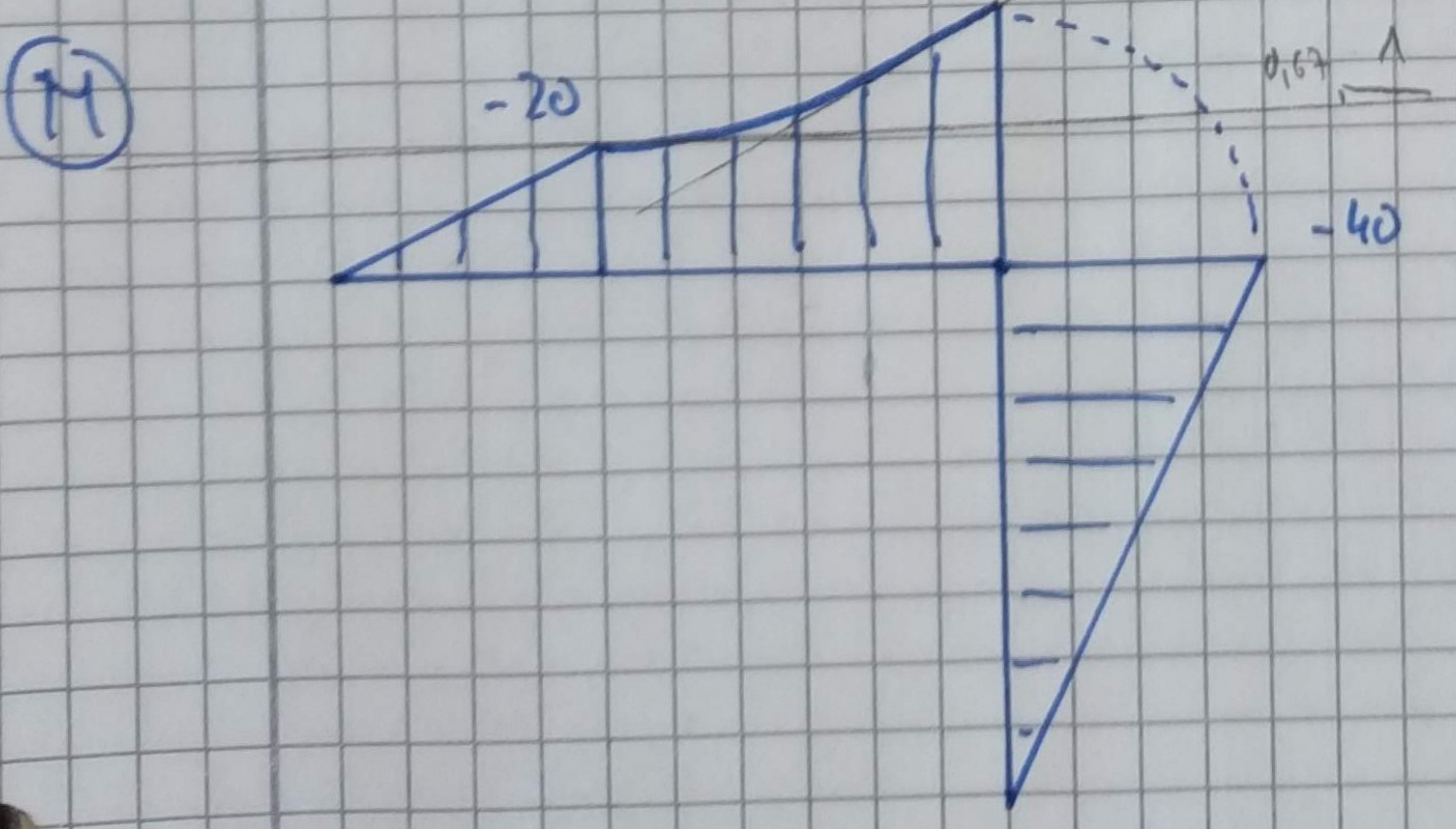
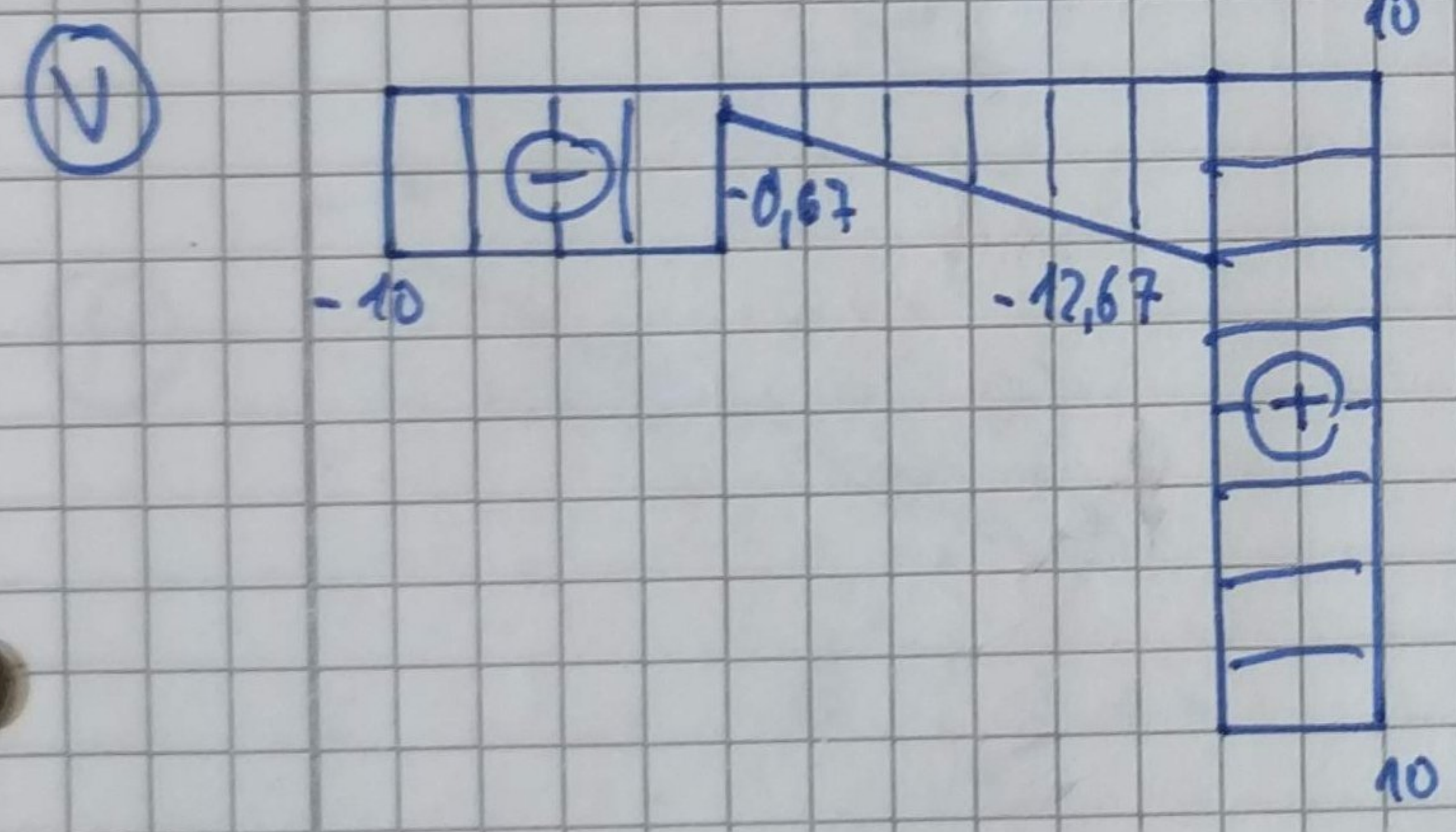
Kontrol:

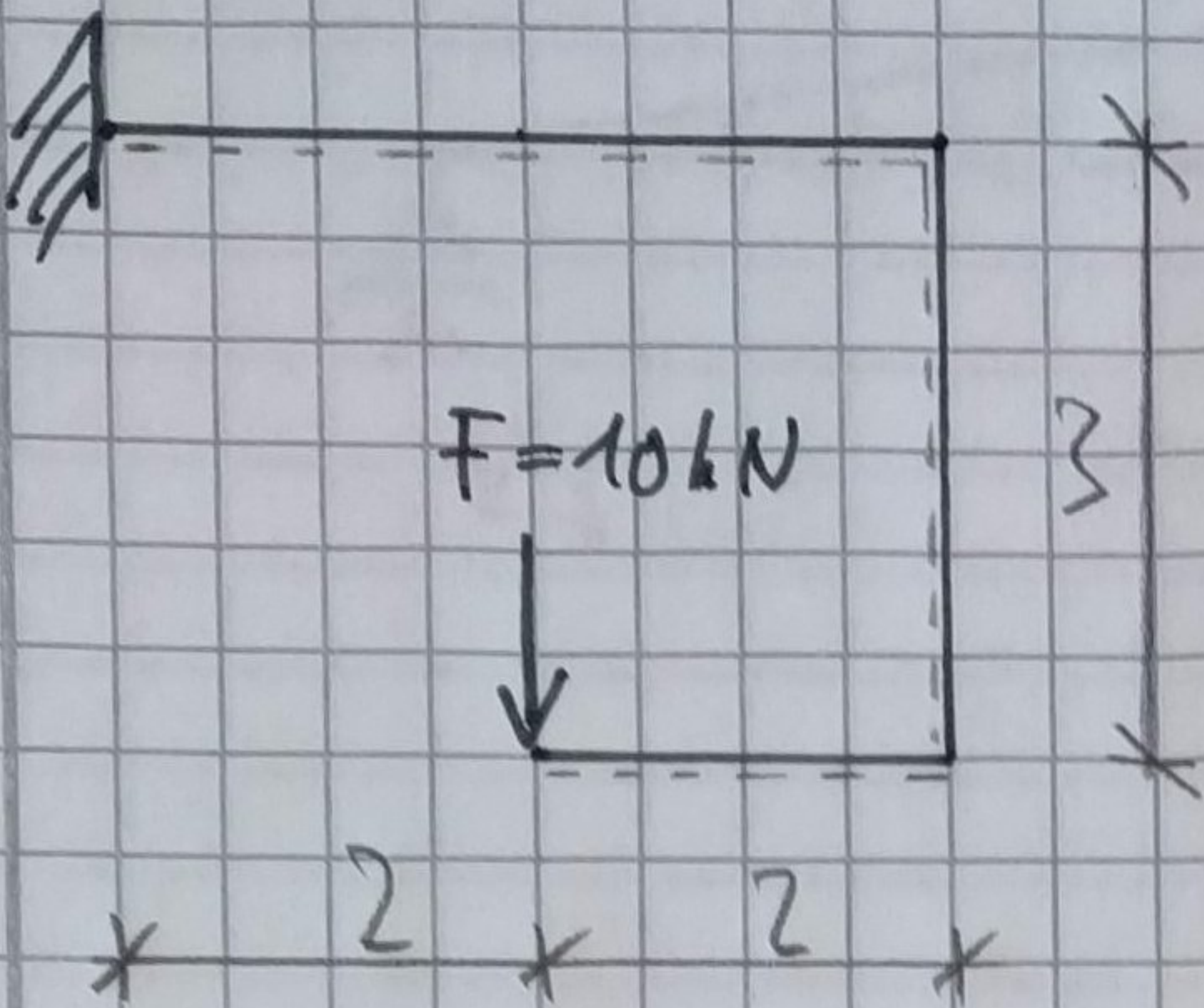
$$\sum F_{iz} = 0$$

$$10 + 12 - 12.67 - 9.33 = 0 \quad \checkmark$$

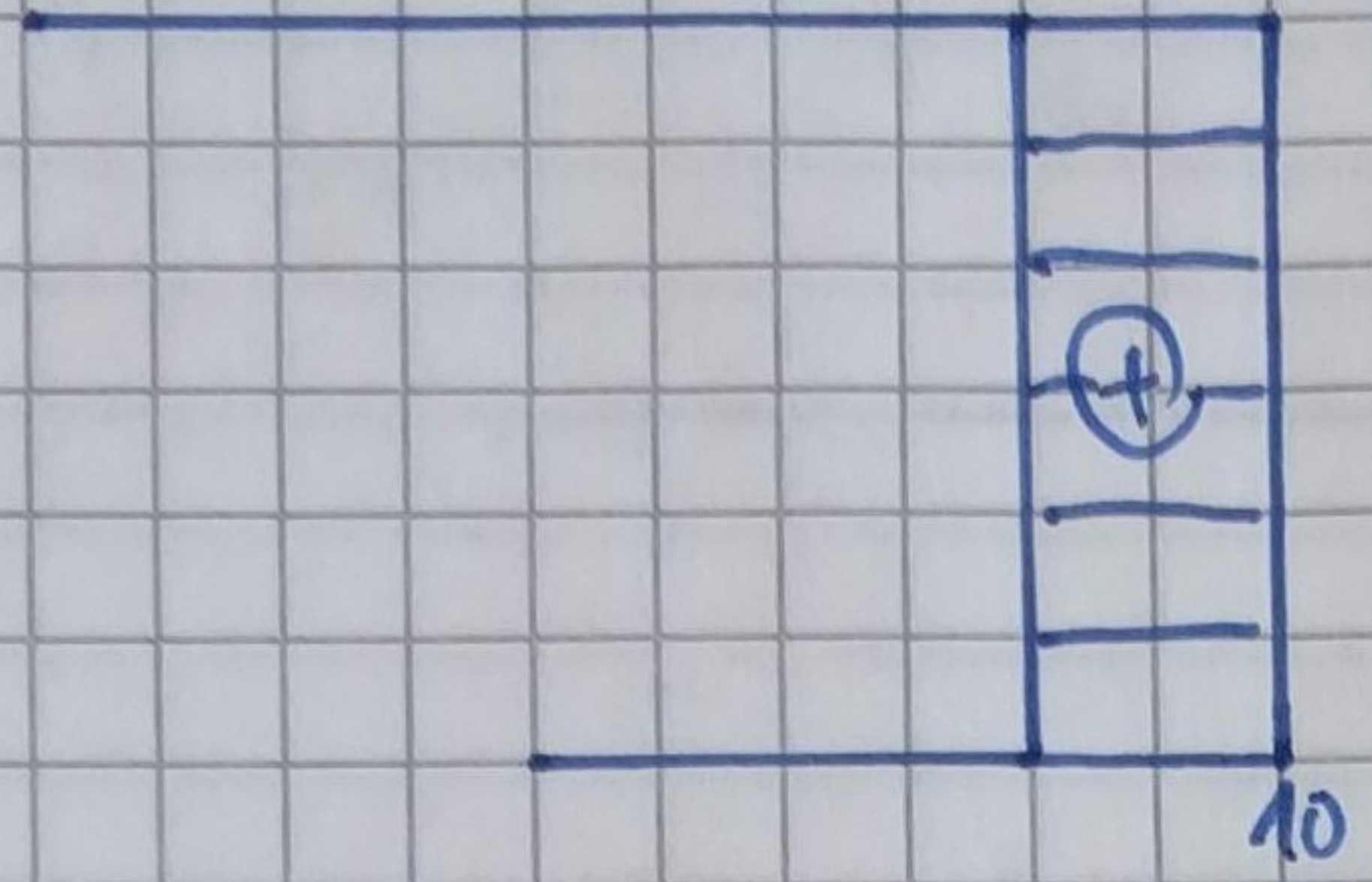
$$M_a = -F_z \cdot 2 = -20 \text{ kNm}$$

$$M_d = -R_{bx} \cdot 4 = -40 \text{ kNm}$$

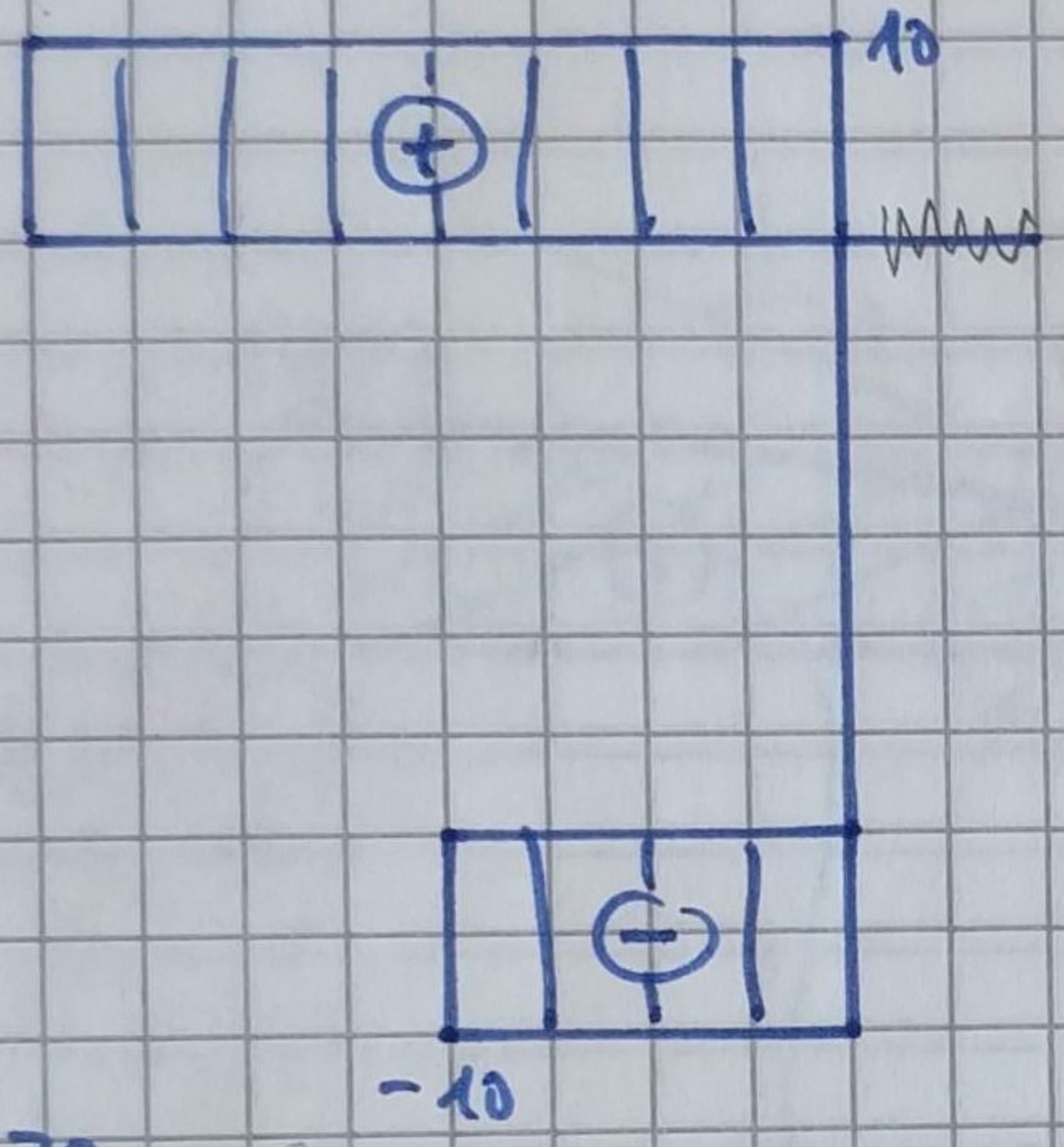




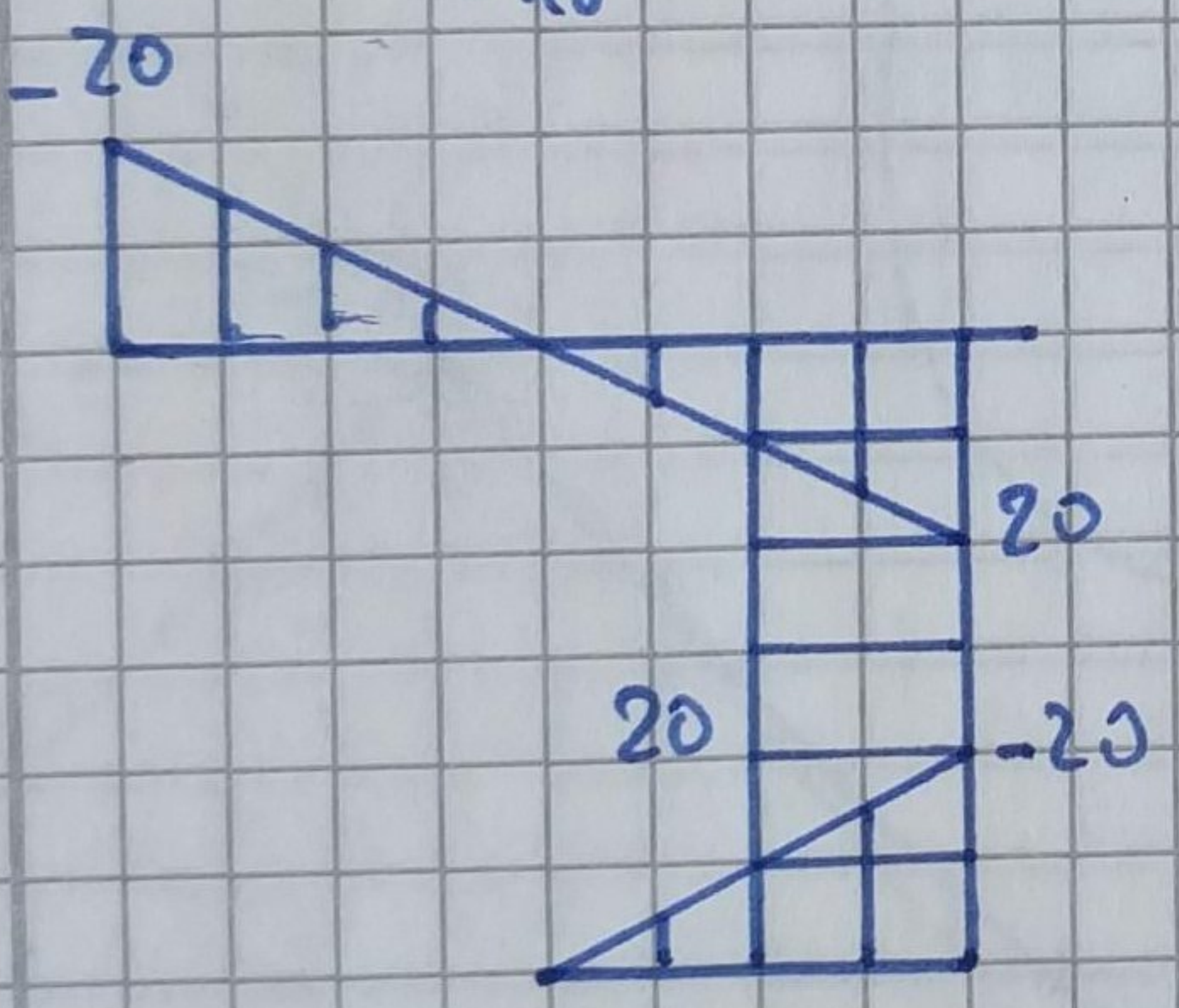
(N)

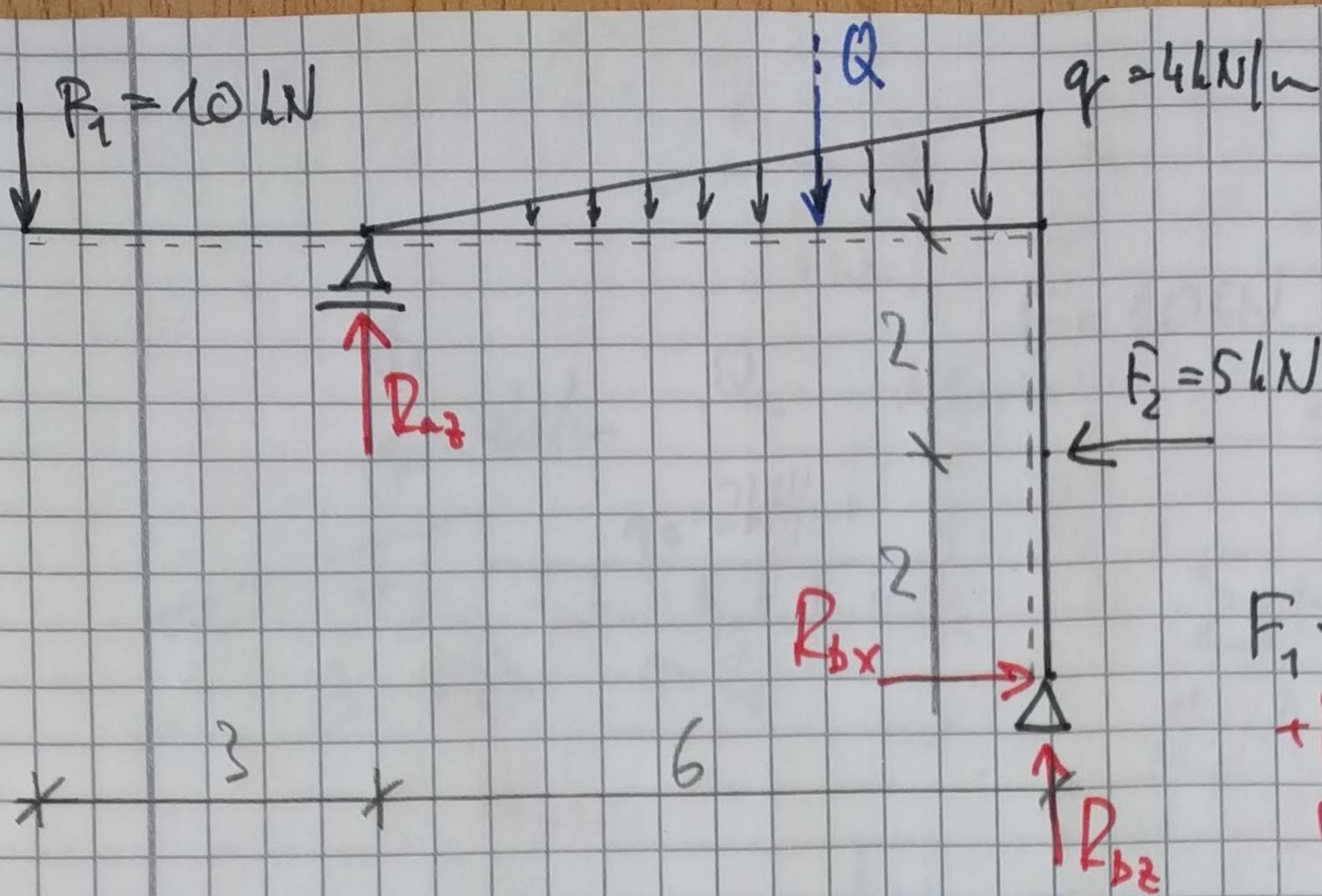


(V)



(M)





$$Q = 6 \cdot 4 / 2 = 12 \text{ kN}$$

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

$$R_{bx} = 5 \text{ kN} (\rightarrow)$$

$$\sum M_{ia} = 0 \text{ (clockwise)}$$

$$F_1 \cdot 3 - Q \cdot 4 - F_2 \cdot 2 + R_{bx} \cdot 4 + R_{bz} \cdot 6 = 0$$

$$R_{bz} = 1,33 \text{ kN} (\uparrow)$$

$$\sum M_{ib} = 0 \text{ (clockwise)}$$

$$F_1 \cdot 9 - R_{ax} \cdot 6 + Q \cdot 2 + F_2 \cdot 2 = 0$$

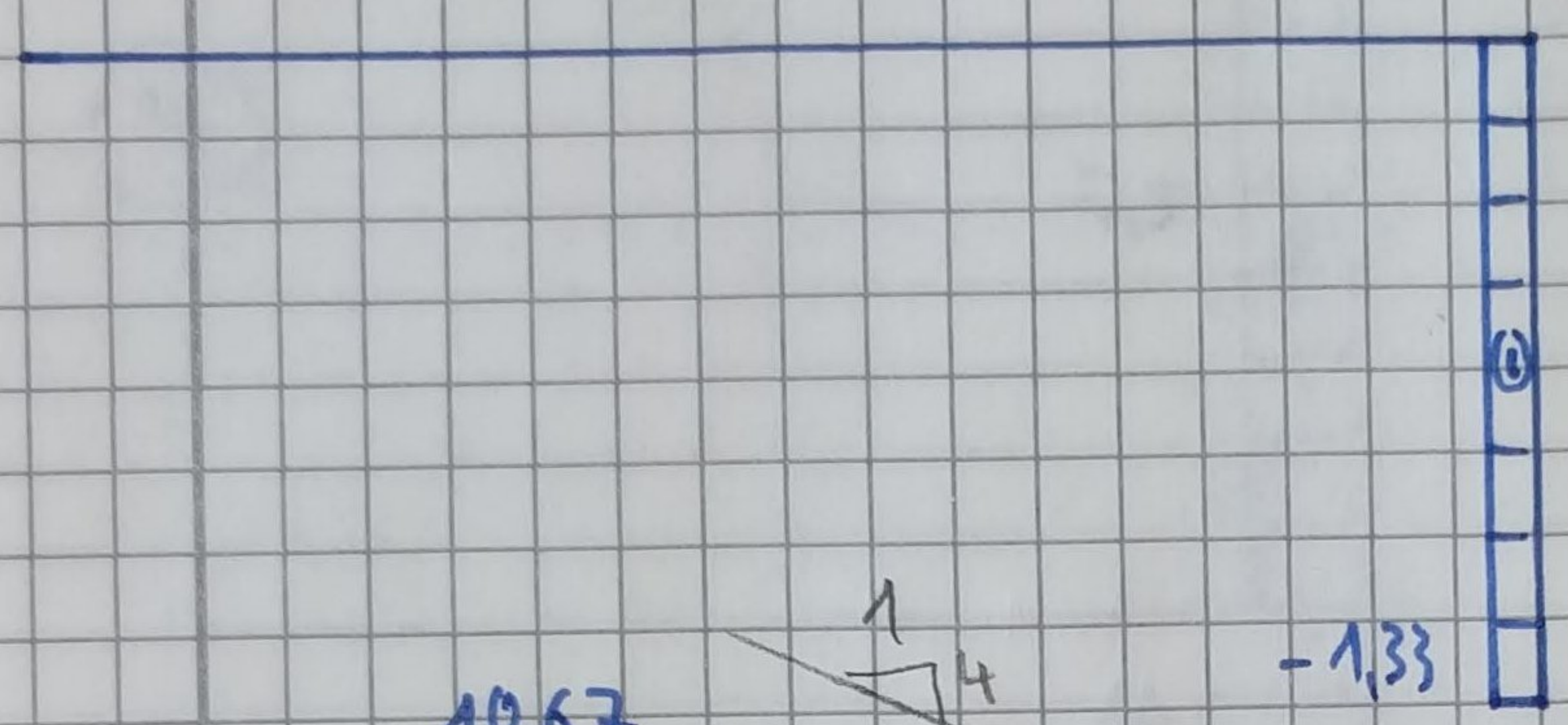
$$R_{ax} = 20,67 \text{ kN} (\uparrow)$$

Kontrola:

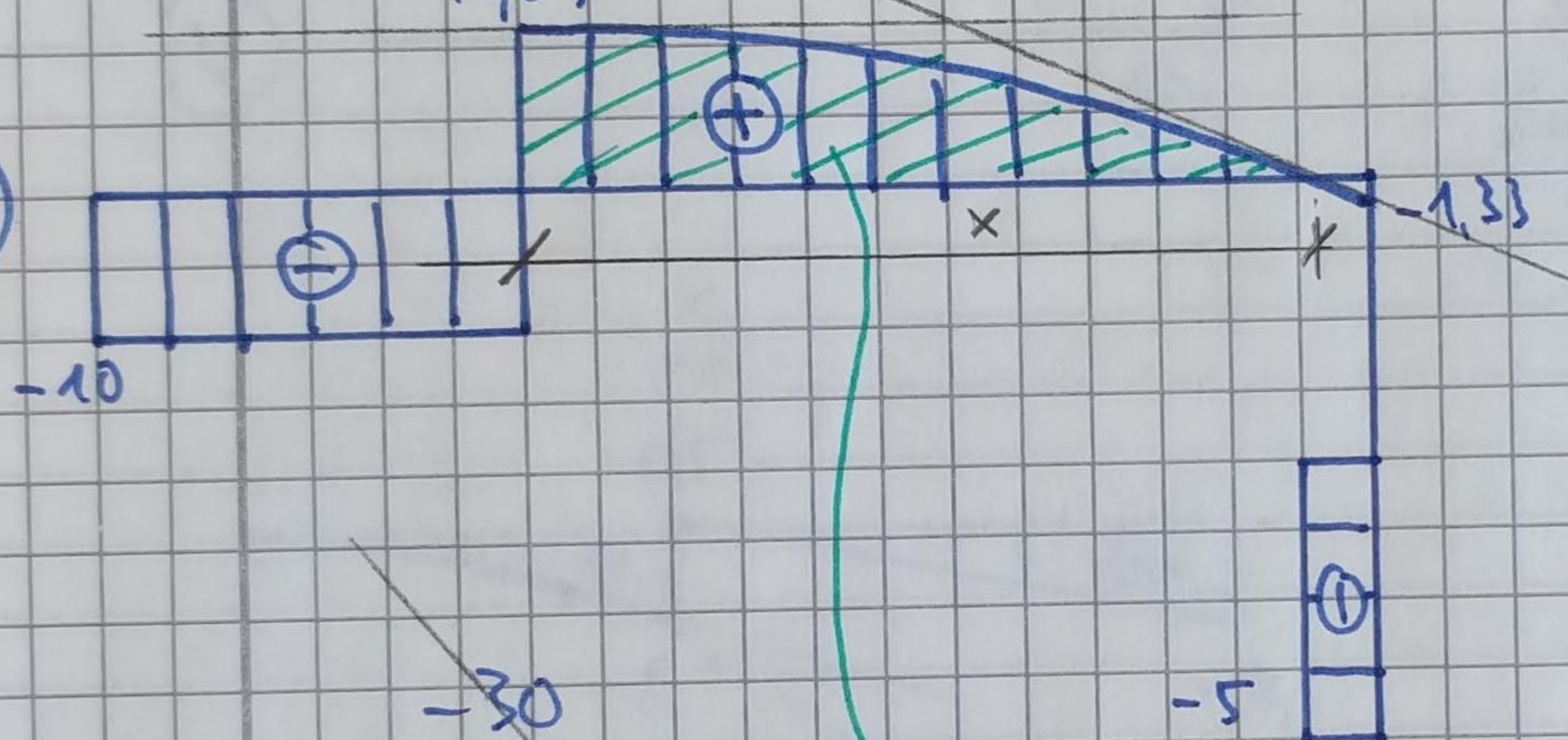
$$\sum F_{iz} = 0:$$

$$10 + 12 - 1,33 - 20,67 = 0 \text{ J}$$

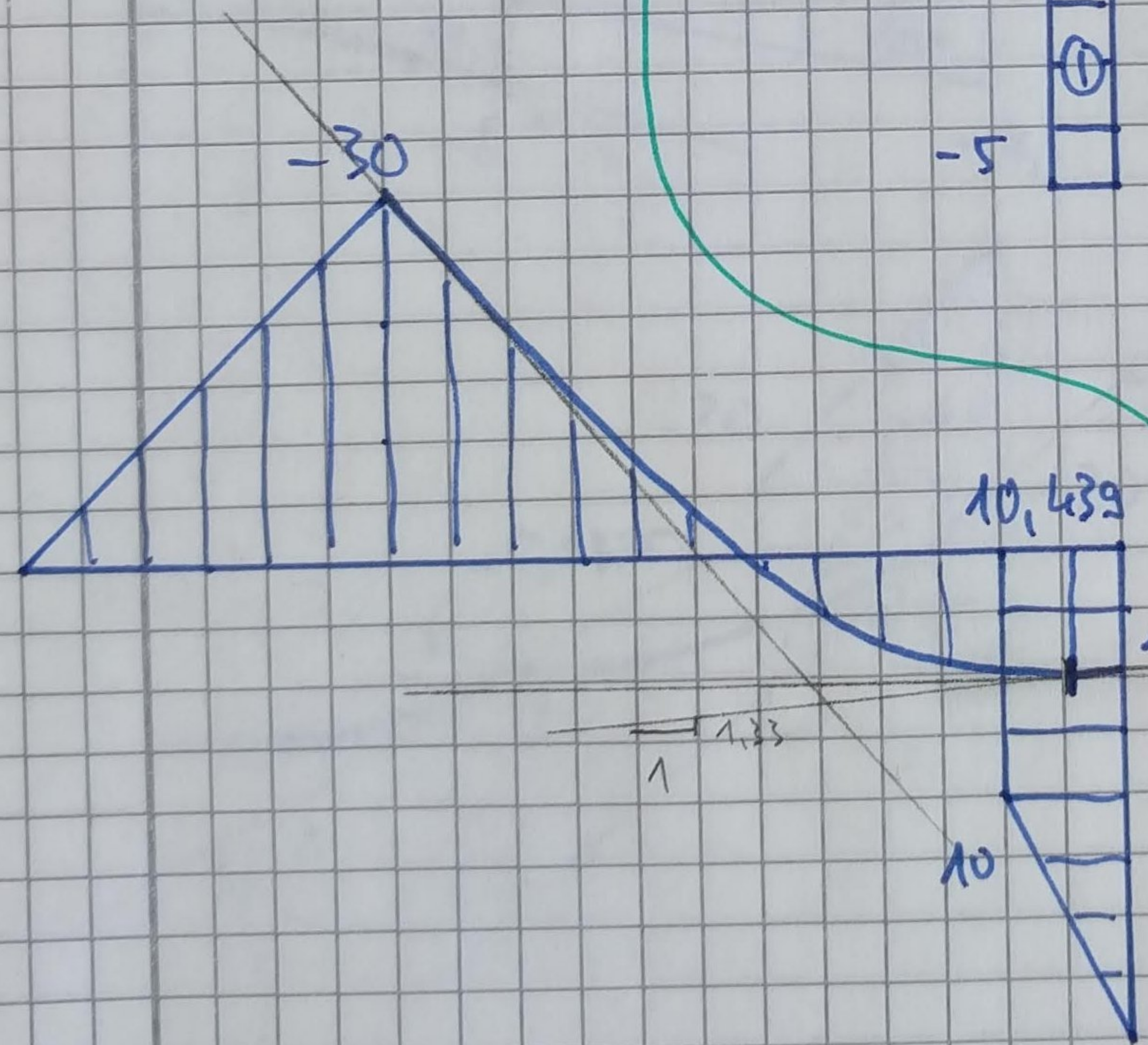
(N)



(V)



(M)



$$M_a = -F_1 \cdot 3 = -30 \text{ kNm}$$

$$x = \sqrt{\frac{Q_x \cdot 2 l_a}{q}} = \sqrt{\frac{10,67 \cdot 2 \cdot 6}{4}}$$

$$x = 5,658 \text{ m}$$

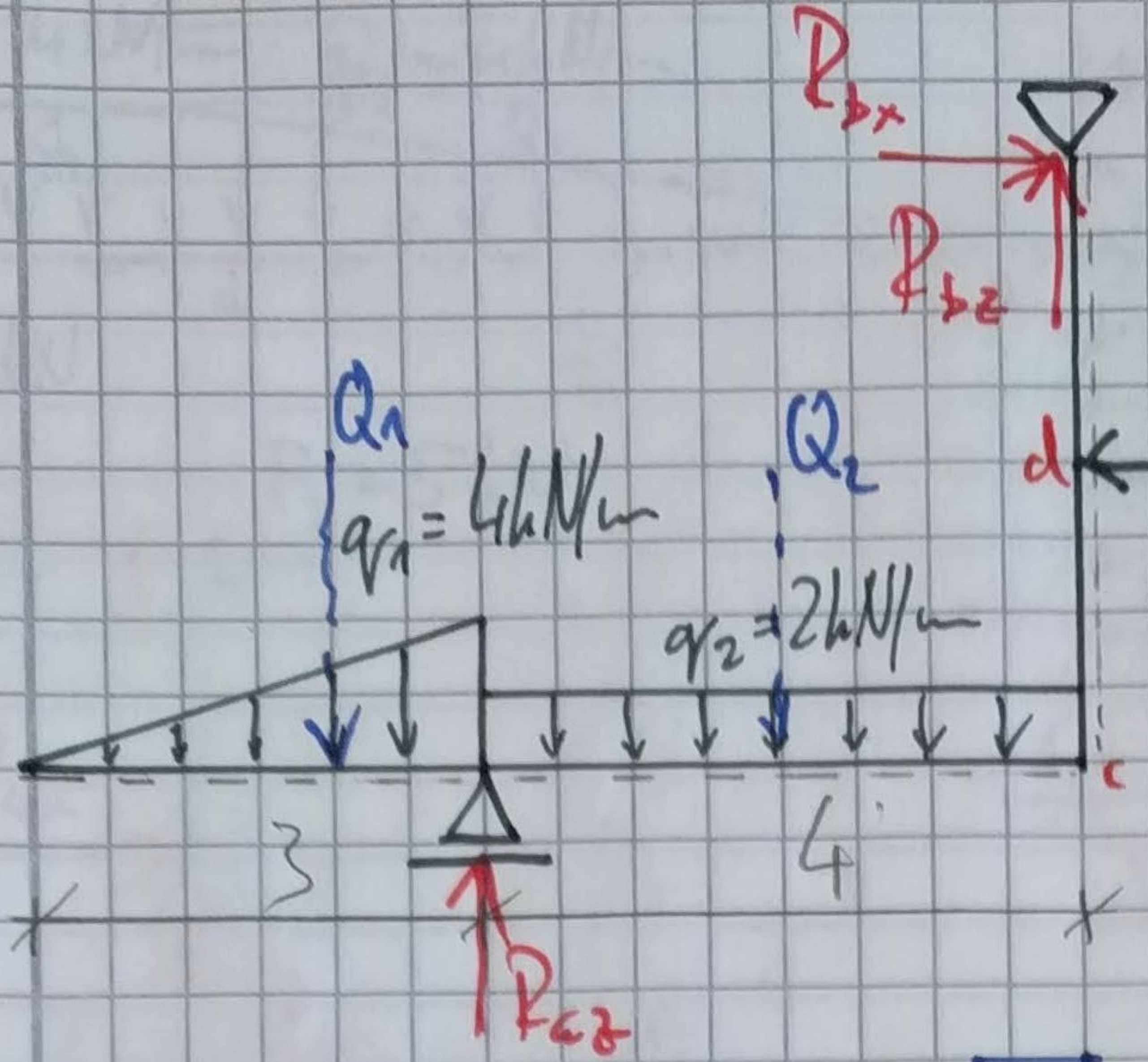
$$M_x = -F_1 \cdot (3-x) + R_{ax} \cdot x$$

$$- Q_x \cdot \frac{x}{3} = 10,439 \text{ kNm}$$

→ wyznacz pries placha parabolą

$$M_x = M_a + \left[V_a \cdot x \cdot \frac{2}{3} \right]$$

$$= 10,439 \text{ kNm}$$



$$Q_1 = \frac{4 \cdot 3}{2} = 6 \text{ kN}$$

$$Q_2 = 4 \cdot 2 = 8 \text{ kN}$$

$$F = 10 \text{ kN}$$

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

$$R_{bx} = 10 \text{ kN} (\rightarrow)$$

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

$$Q_1 \cdot 1 - Q_2 \cdot 2 + F \cdot 2 - R_{bx} \cdot 4 + R_{bz} \cdot 4 = 0$$

$$R_{bz} = 7,500 \text{ kN} (\uparrow)$$

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

$$Q_1 \cdot 5 - R_{az} \cdot 4 + Q_2 \cdot 2 - F \cdot 2 = 0$$

$$R_{az} = 6,500 \text{ kN} (\uparrow)$$

Kontrola:

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

$$6 + 10 - 7,5 - 6,5 = 0 \checkmark$$

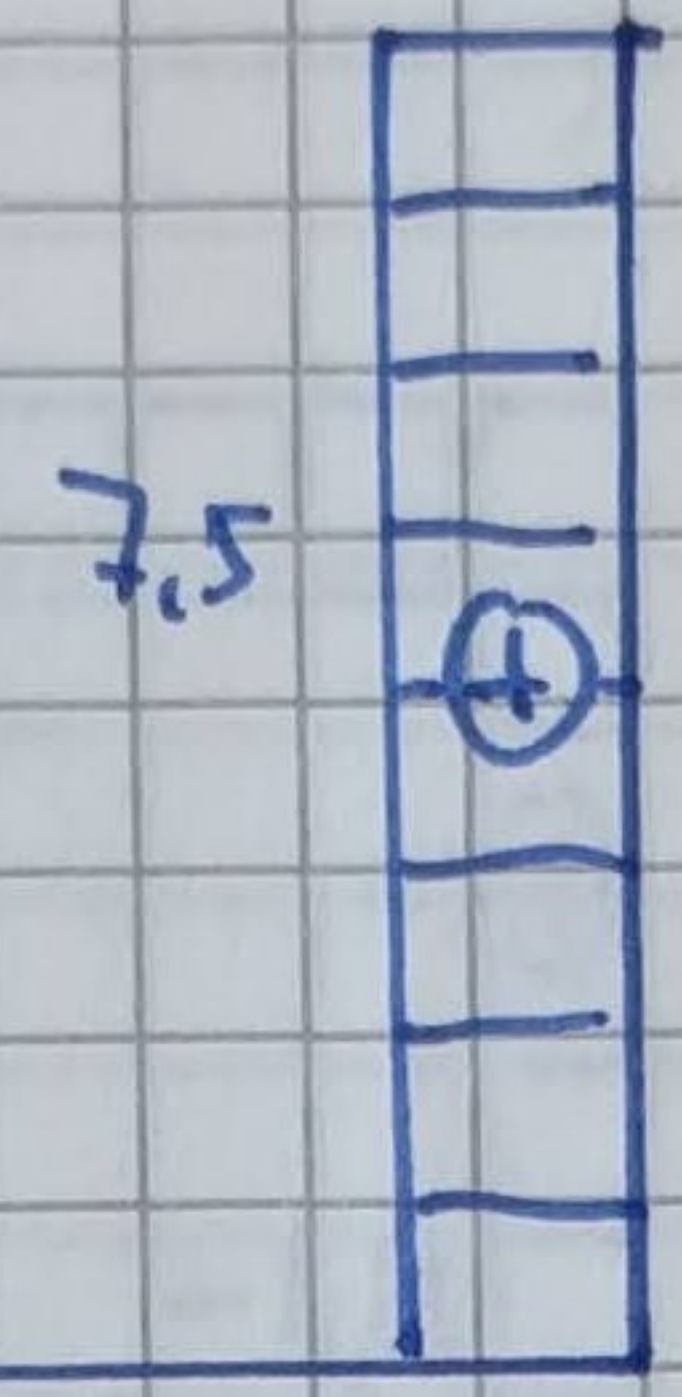
$$x = \frac{0,5}{2} = 0,25 \text{ m}$$

$$M_x = -Q_1 \cdot (1+x) + R_{az} \cdot x - \frac{q_2 \cdot x^2}{2} = 5,9375 \text{ kNm}$$

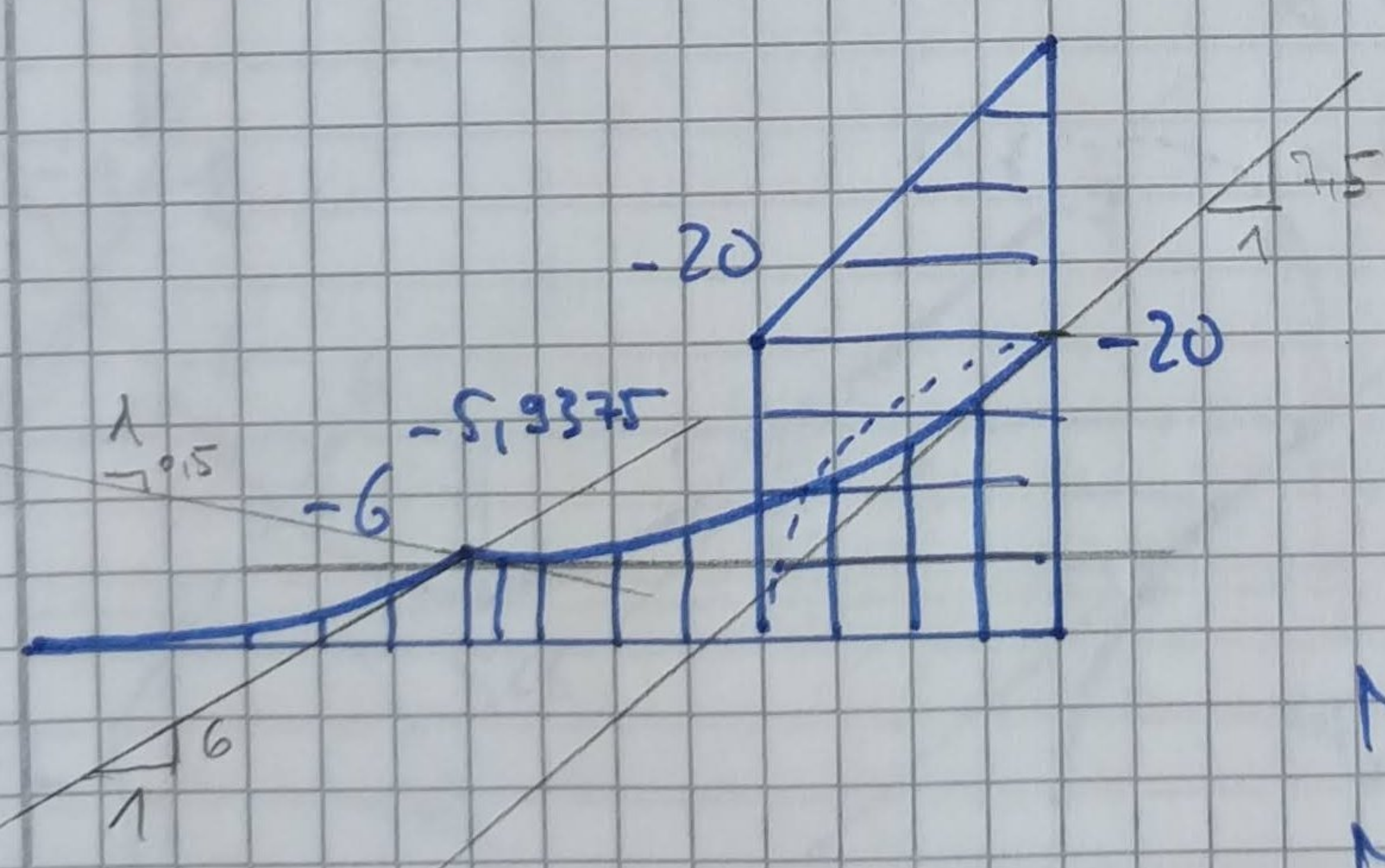
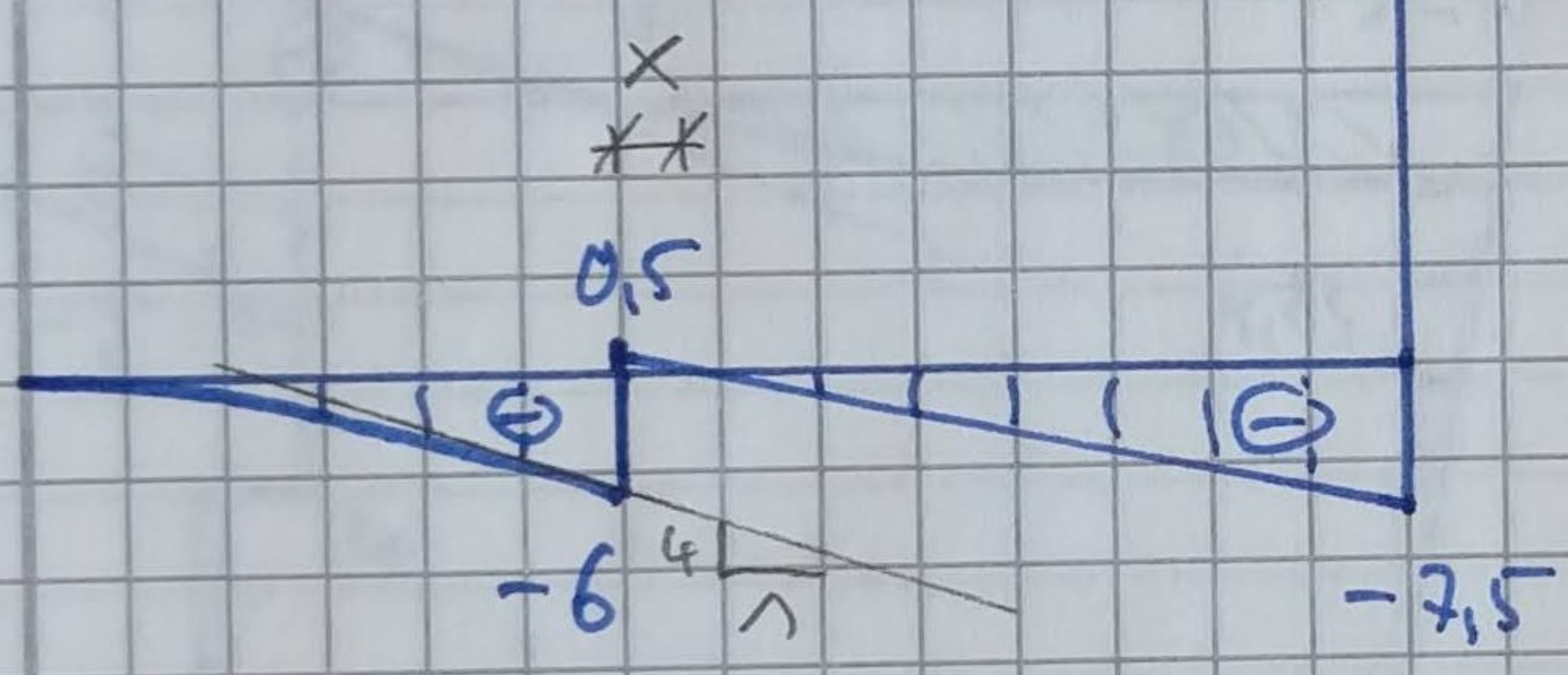
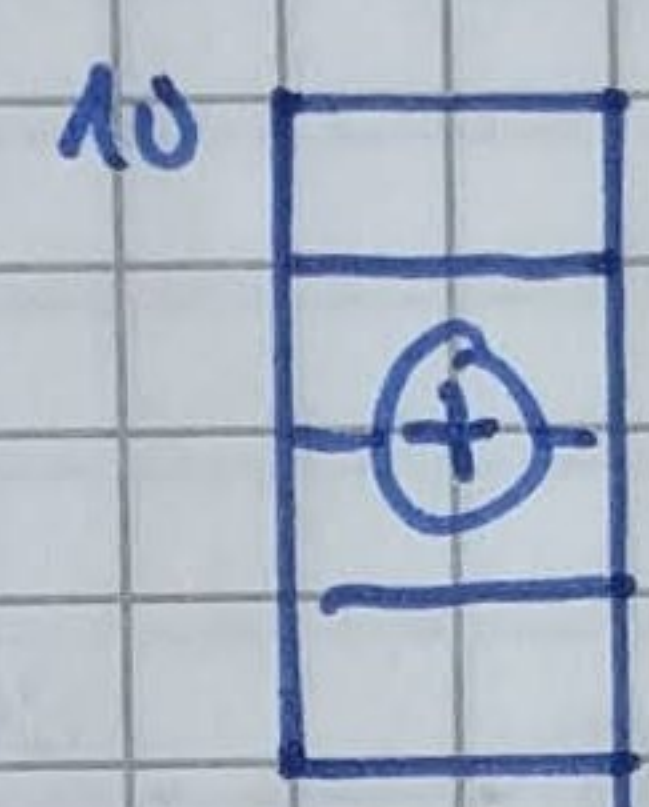
$$M_a = -Q_1 \cdot 1 = -6 \text{ kNm}$$

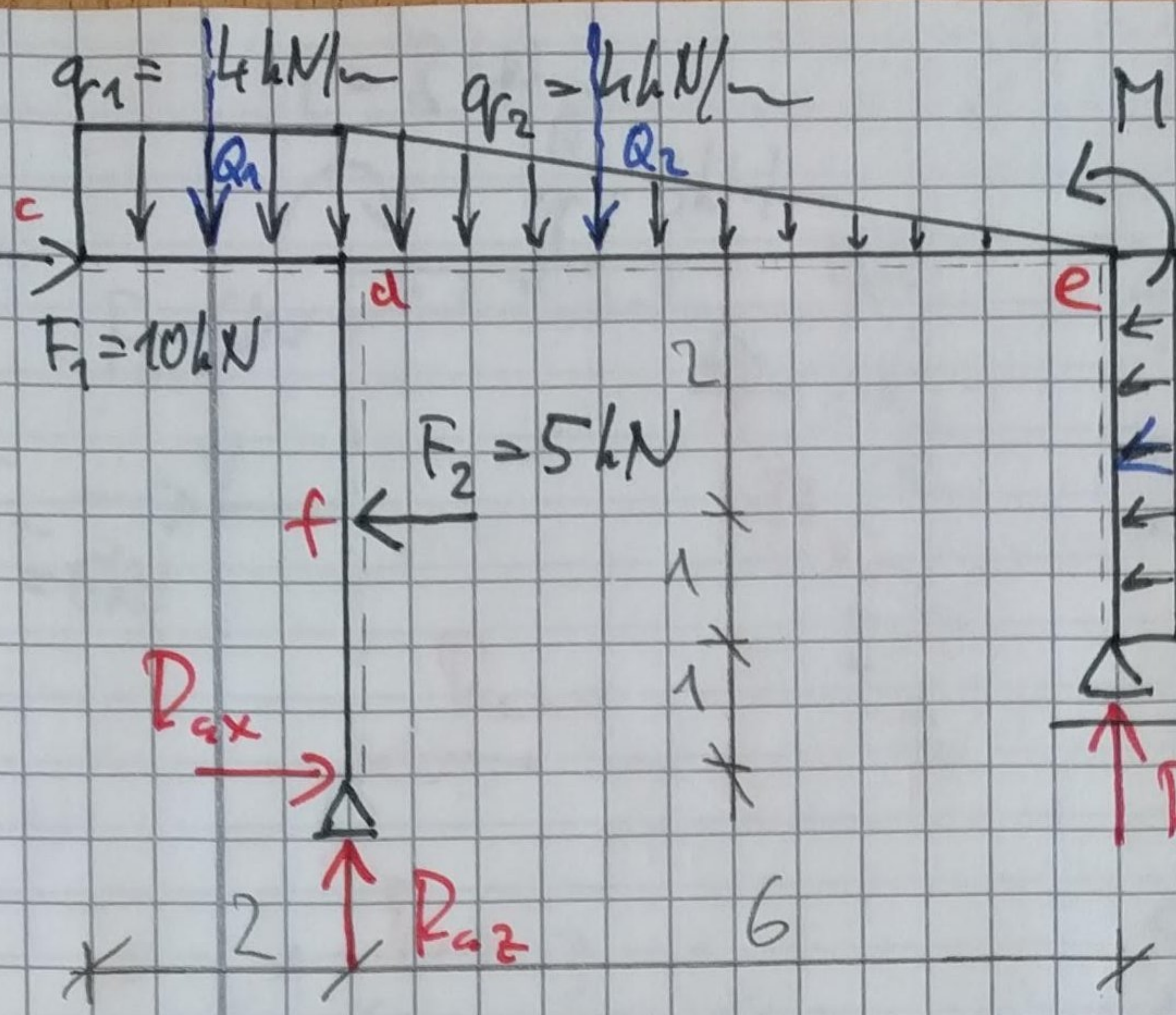
$$M_c = -R_{bx} \cdot 4 + F \cdot 2 = -20 \text{ kNm}$$

(N)



(V)





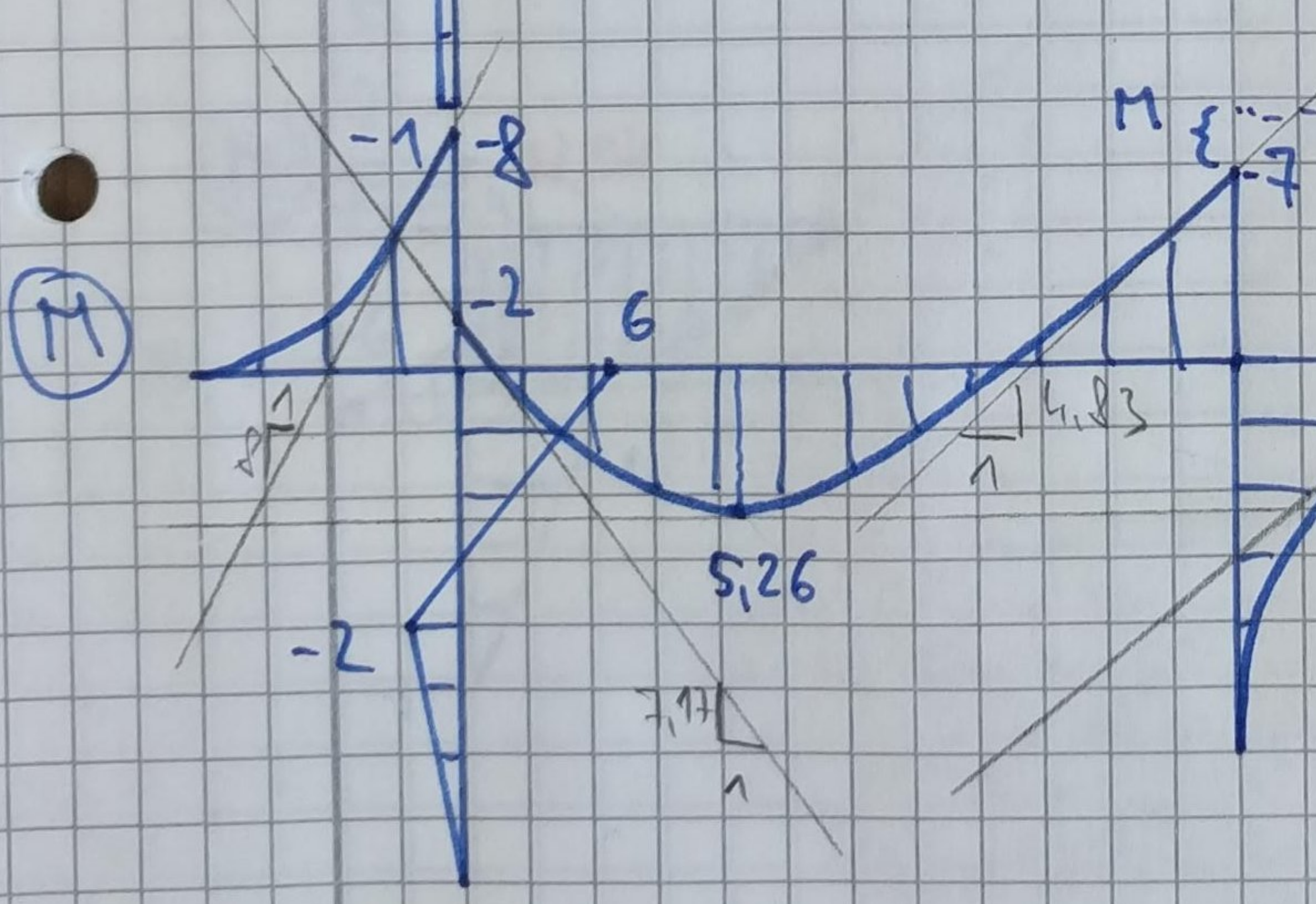
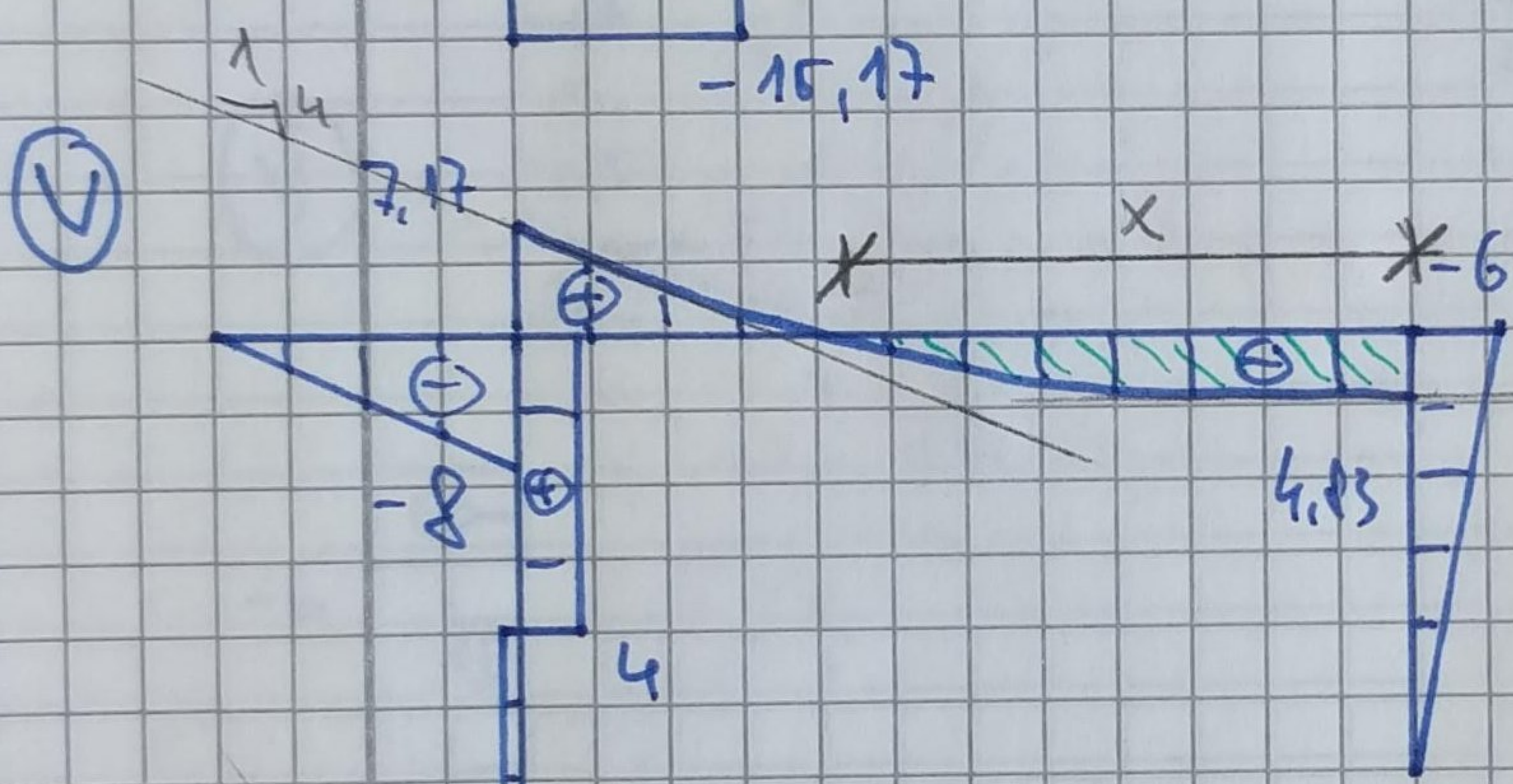
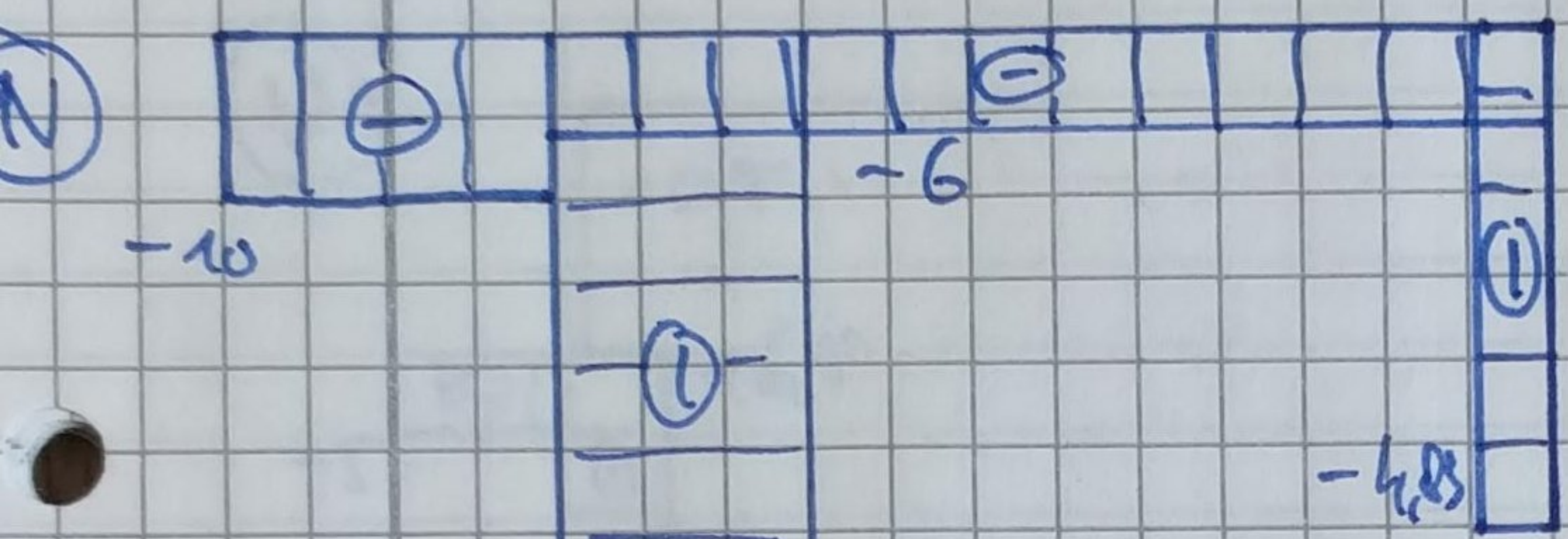
$M = 2 \text{ kNm}$
 $q_1 = 1 \text{ kN/m}$
 $q_2 = 1 \text{ kN/m}$
 $q_3 = 2 \text{ kN/m}$
 $F_1 = 10 \text{ kN}$
 $F_2 = 5 \text{ kN}$
 $Q_1 = 8 \text{ kN}$
 $Q_2 = 12 \text{ kN}$
 $Q_3 = 6 \text{ kN}$

$\sum F_{ix} = 0:$
 $-Q_3 + F_1 - F_2 + R_{ax} = 0$
 $R_{ax} = 1 \text{ kN} (\rightarrow)$

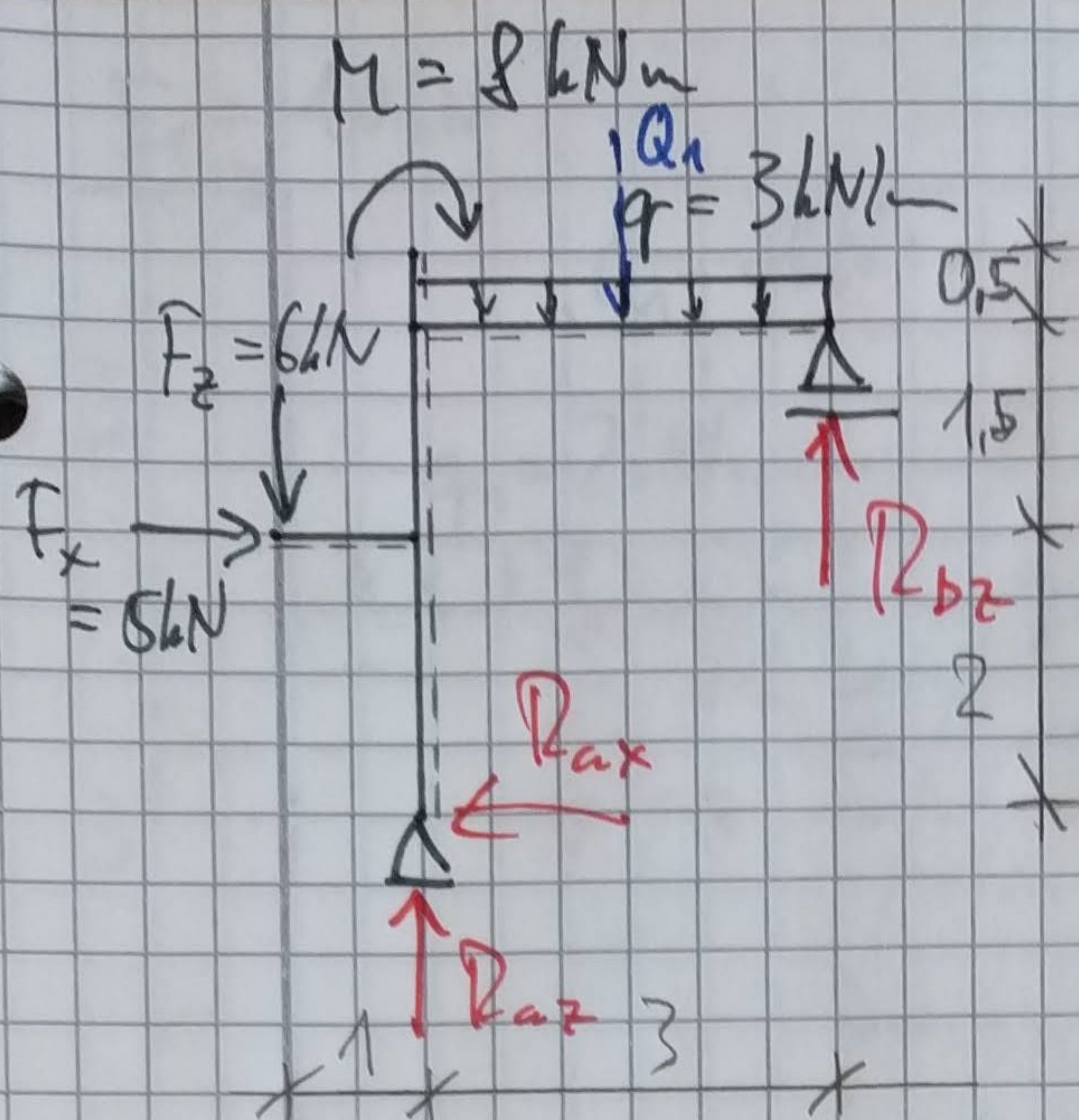
$\sum M_{ia} = 0 \text{ (⊕)}$
 $F_2 \cdot 2 + Q_1 \cdot 1 - F_1 \cdot 4 - Q_2 \cdot 2 + M +$
 $+ Q_3 \cdot 2,5 + R_{bz} \cdot 6 = 0$
 $R_{bz} = 4,83 \text{ kN} (\uparrow)$

$\sum M_{ib} = 0 \text{ (⊕)}$
 $R_{ax} \cdot 1 - R_{az} \cdot 6 + F_2 \cdot 1 - F_1 \cdot 3 +$
 $+ Q_1 \cdot 7 + Q_2 \cdot 4 + M + Q_3 \cdot 1,5 = 0$
 $R_{az} = 15,17 \text{ kN} (\uparrow)$

Kontrolle
 $\sum F_{iz} = 0$
 $8 + 12 - 4,83 - 15,17 = 0 \checkmark$
 $x = \sqrt{\frac{4,83 \cdot 2 \cdot 6}{4}} = 3,307 \text{ m}$



$M_x = R_{bz} \cdot x - Q_3 \cdot 1,5 + M -$
 $- 4,83 \cdot \frac{x}{3} = 5,2585 \text{ kNm}$
 $= M_0 + 4,83 \cdot x \cdot \frac{2}{3}$



$$\sum F_{ix} = 0 : R_{ax} = 5 \text{ kN} \leftarrow$$

$$\sum M_{ic} = 0 \quad \curvearrowright$$

$$-F_x \cdot 2 + F_z \cdot 1 - M - Q_1 \cdot 1.5 + R_{Dz} \cdot 3 = 0$$

$$R_{Dz} = 1.500 \text{ kN} \uparrow$$

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

$$-R_{ax} \cdot 3.5 - R_{az} \cdot 3 + F_x \cdot 1.5 + F_z \cdot 4 - M + Q_1 \cdot 1.5 = 0$$

$$R_{az} = 6.5 \text{ kN} \uparrow$$

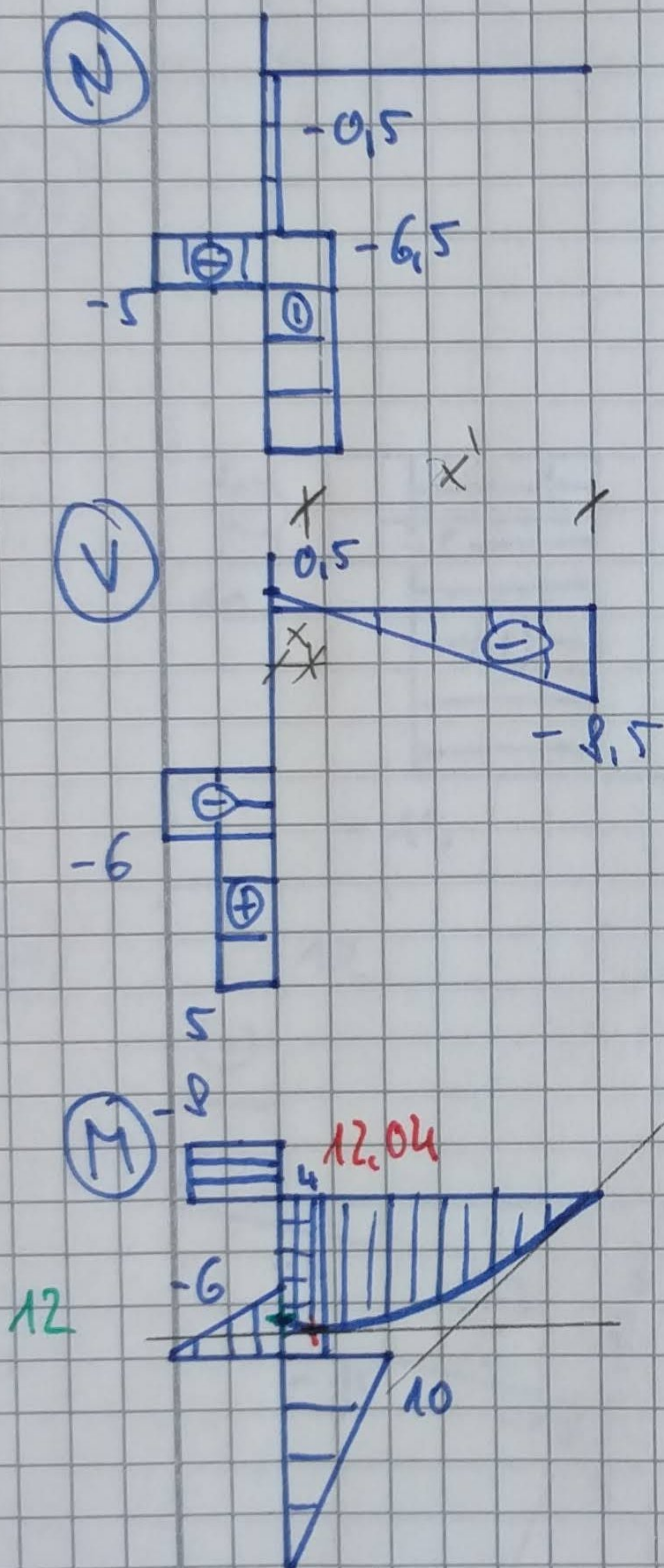
Kontrol:

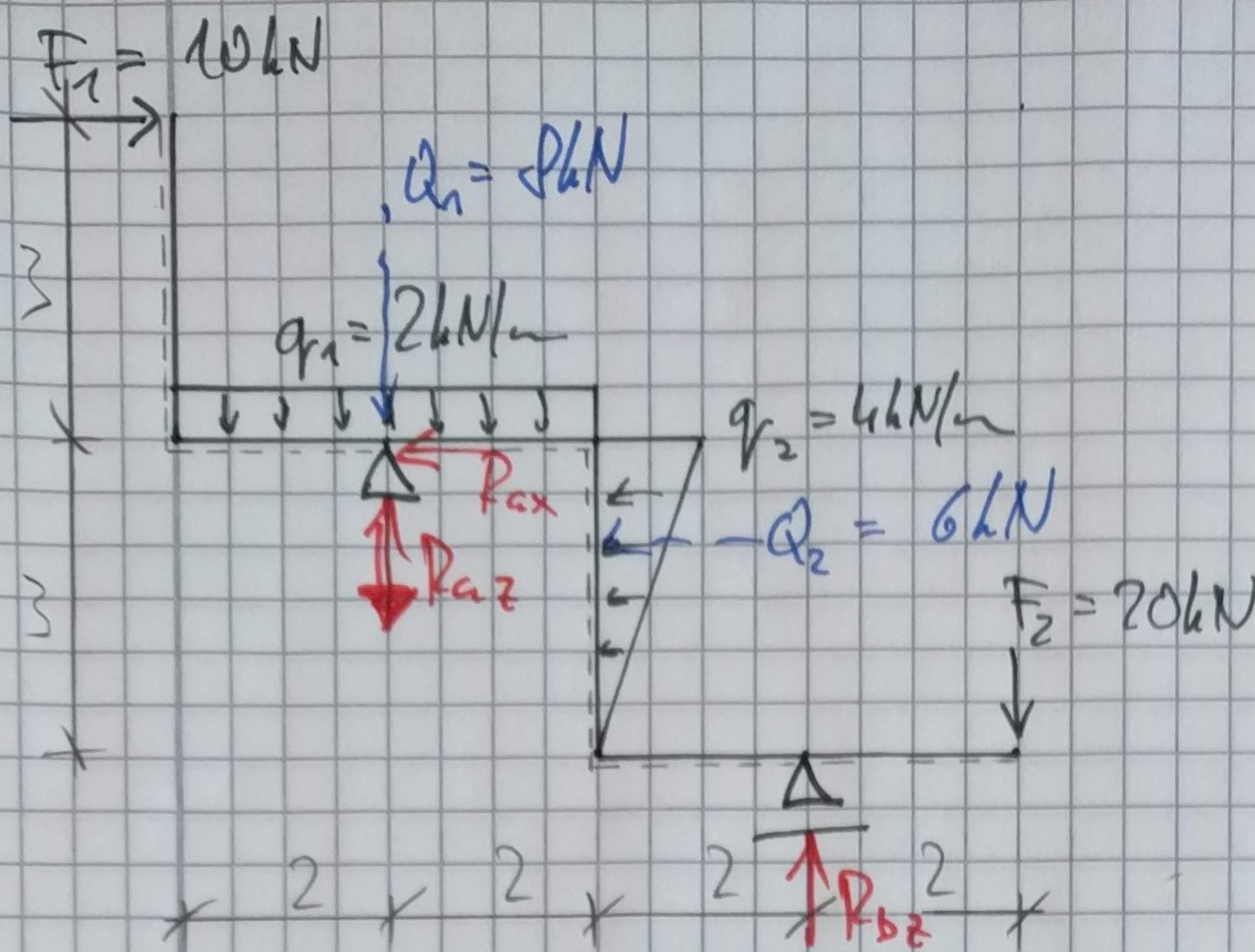
$$\sum F_{iz} = 0 :$$

$$6 + 9 - 6.5 - 1.5 = 0 \quad \checkmark$$

$$x = 0.5 / 3 = 0.167 \text{ m} \quad x' = 2.833 \text{ m}$$

$$M_x = R_{Dz} \cdot x' - \frac{q \cdot x'^2}{2} = 12.04 \text{ kNm}$$





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

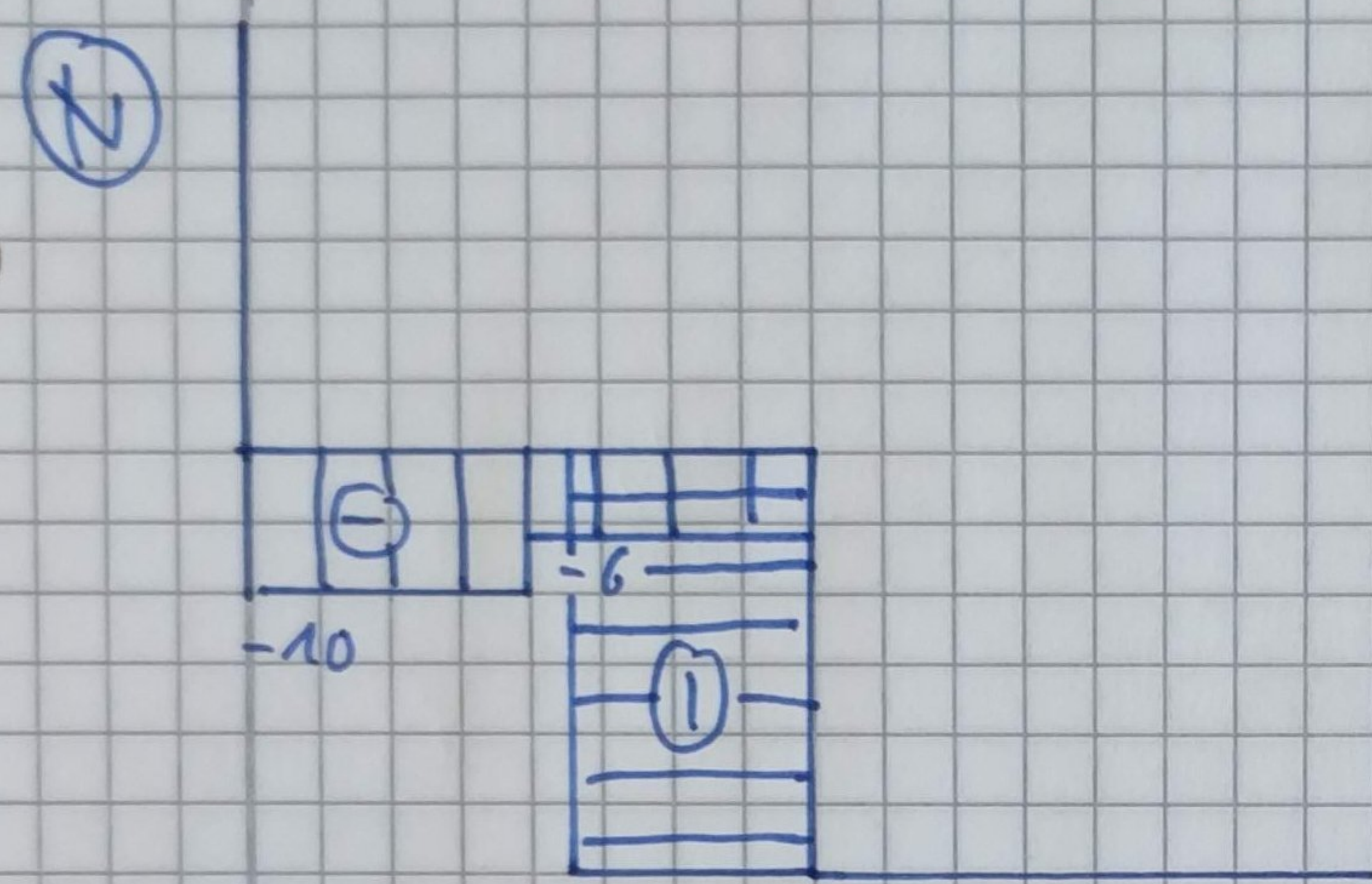
$$F_1 + R_{ax} - Q_2 = 0$$

$$R_{ax} = 4 \text{ kN} (\leftarrow)$$

$$\sum M_{ia} = 0 \text{ (clockwise)}$$

$$-F_1 \cdot 3 - Q_2 \cdot 1 + R_{bz} \cdot 4 - F_2 \cdot 6 = 0$$

$$R_{bz} = 39 \text{ kN} (\uparrow)$$



$$\sum M_{ib} = 0 \text{ (clockwise)}$$

$$-F_1 \cdot 6 + Q_1 \cdot 4 + R_{ax} \cdot 3 - R_{bz} \cdot 4 + Q_2 \cdot 2 - F_2 \cdot 2 = 0$$

$$R_{bz} = +11 \text{ kN} (\downarrow)$$

Control: $\sum F_{iz} \stackrel{?}{=} 0$

$$-39 + 20 + 11 + 9 = 0 \checkmark$$

