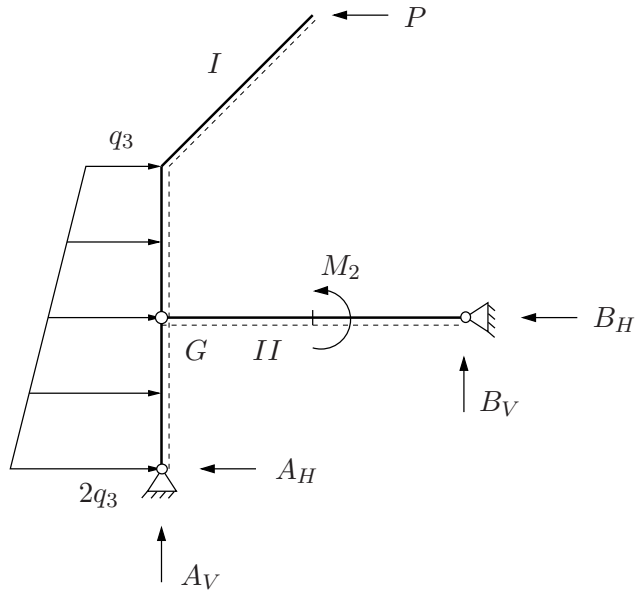


Musterlösung: Schnittgrößen

1. Statische Bestimmtheit

$$f = 3 \cdot 2 - (4 + 2) = 0$$

2. Auflagerkräfte



$$P = \frac{1}{3}q_3a$$

$$\overline{M}_2 = 2q_3a^2$$

$$II: \curvearrowright G: \overline{M}_2 + B_V \cdot 2a = 0$$

$$\Rightarrow B_V = -q_3a$$

$$I: \curvearrowright G: P \cdot 2a - A_H \cdot a + \left(\frac{1}{4} - \frac{1}{6} \cdot \frac{1}{2} + \frac{2}{6} \cdot \frac{1}{2}\right)q_3a = 0$$

$$A_H = \frac{2}{3}q_3a + \frac{1}{3}q_3a$$

$$\Rightarrow A_H = q_3a$$

$$GS: \rightarrow: 2q_3a + q_3a - P - B_H - A_H = 0$$

$$B_H = 3q_3a - \frac{1}{3}q_3a - q_3a$$

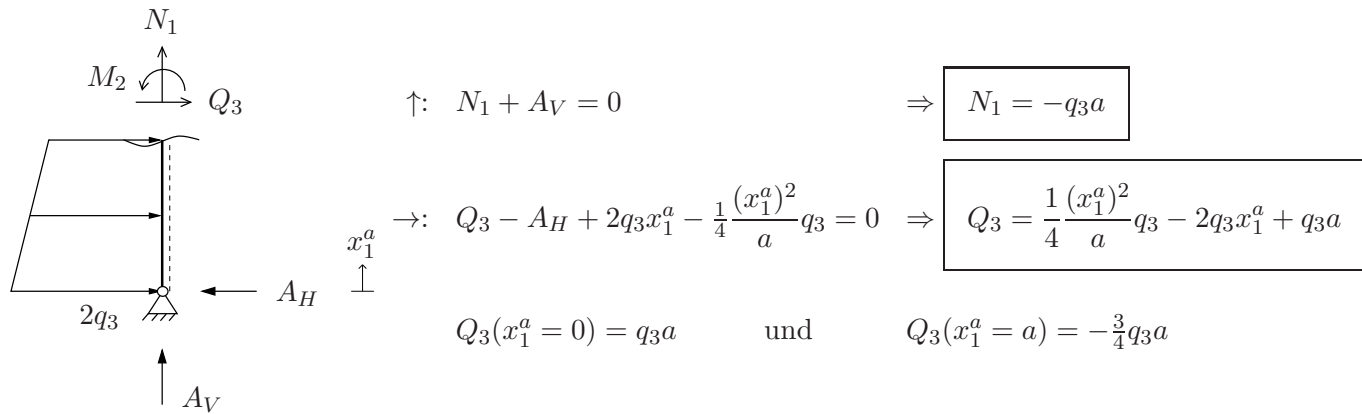
$$\Rightarrow B_H = \frac{5}{3}q_3a$$

$$\uparrow: A_V + B_V = 0$$

$$\Rightarrow A_V = q_3a$$

3. Schnittgrößen

3.1. Schnitt x_1^a :



Nulldurchgang:

$$0 = a - 2x_1^a + \frac{1}{4} \frac{(x_1^a)^2}{a}$$

$$\Rightarrow (x_1^a)^2 - 8ax_1^a + 4a^2 = 0$$

$$\Rightarrow x_{1/2}^a = \frac{8a \pm \sqrt{64a^2 - 16}}{2} = 4a \pm 2\sqrt{3}a$$

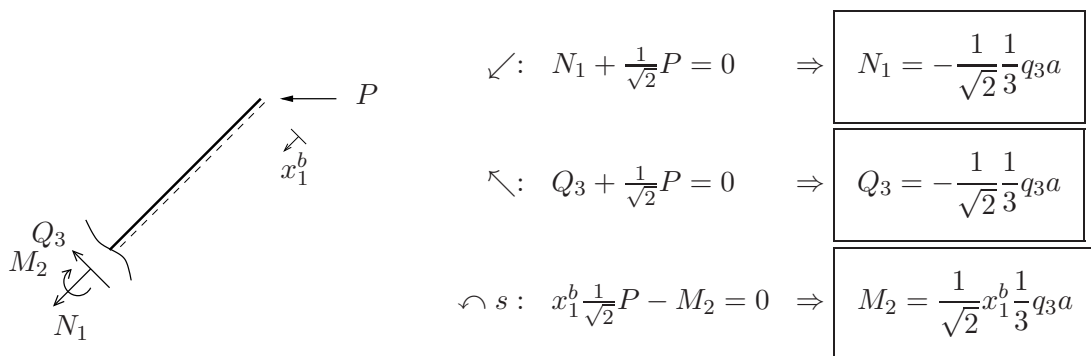
$$\Rightarrow x_{10}^a \approx 0,54a$$

$$M_2 = \int Q_3 dx_1^a = \frac{1}{12} \frac{(x_1^a)^3}{a} q_3 - (x_1^a)^2 q_3 + x_1^a q_3 a$$

$$M_2(x_1^a = a) = \left(\frac{1}{12} - 1 + 1\right) q_3 a^2 = \frac{1}{12} q_3 a^2 \approx 0,083 q_3 a^2$$

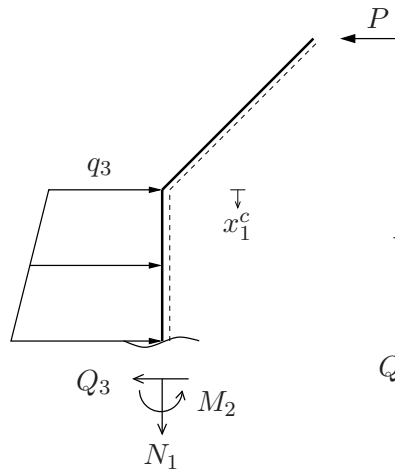
$$M_{2_{max}}(x_{10}^a = 0,54a) \approx 0,26 q_3 a^2$$

3.2. Schnitt x_1^b :



$$M_2(x_1^b = \sqrt{2}a) \frac{1}{3} q_3 a^2$$

3.3. Schnitt x_1^c :



$$\uparrow: N_1 = 0$$

$$\Rightarrow \boxed{N_1 = 0}$$

$$\rightarrow: -Q_3 - P + \frac{1}{4} \frac{(x_1^c)^2}{a} q_3 + x_1^c q_3 = 0 \Rightarrow \boxed{Q_3 = \frac{1}{4} \frac{(x_1^c)^2}{a} q_3 + x_1^c \cdot q_3 - \frac{1}{3} q_3 a}$$

$$Q_3(x_1^c = 0) = -\frac{1}{3} q_3 a \quad \text{und} \quad Q_3(x_1^c = a) = \frac{11}{12} q_3 a \approx 0,92 q_3 a$$

Nulldurchgang:

$$(x_1^c)^2 + 4a x_1^c - \frac{4}{3} a^2 = 0$$

$$\Rightarrow x_{1/2}^c = \frac{-4a \pm \sqrt{16a^2 + \frac{16}{3}a^2}}{2} = -2a \pm 2,309a$$

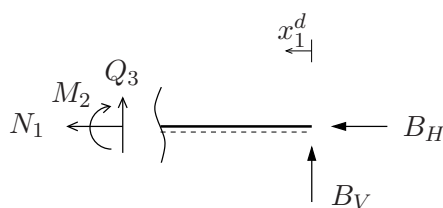
$$\Rightarrow x_{10}^c \approx 0,31a$$

$$\curvearrowright s: -M_2 + P(a + x_1^c) - \frac{1}{2}(x_1^c)^2 q_3 - \frac{1}{3} \frac{1}{4} \cdot \frac{(x_1^c)^3}{a} q_3 = 0$$

$$\boxed{M_2 = -\frac{1}{12} \cdot \frac{(x_1^c)^3}{a} q_3 - \frac{1}{2}(x_1^c)^2 q_3 + \frac{1}{3} x_1^c q_3 a + \frac{1}{3} q_3 a^2}$$

$$M_2(x_1^c = 0) = \frac{1}{3} q_3 a^2 \quad \text{und} \quad M_2(x_1^c = a) = \left(\frac{1}{3} + \frac{1}{3} - \frac{1}{2} - \frac{1}{12}\right) q_3 a^2 = \frac{1}{12} q_3 a^2$$

3.4. Schnitt x_1^d :



$$\rightarrow: -N_1 - B_H = 0$$

$$\Rightarrow \boxed{N_1 = -\frac{5}{3} q_3 a}$$

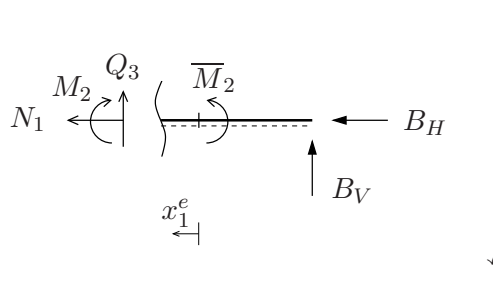
$$\uparrow: Q_3 + B_V = 0$$

$$\Rightarrow \boxed{Q_3 = q_3 a}$$

$$\curvearrowright s: -M_2 + B_V \cdot x_1^d = 0$$

$$\Rightarrow \boxed{M_2 = -x_1^d q_3 a}$$

3.5. Schnitt x_1^e :

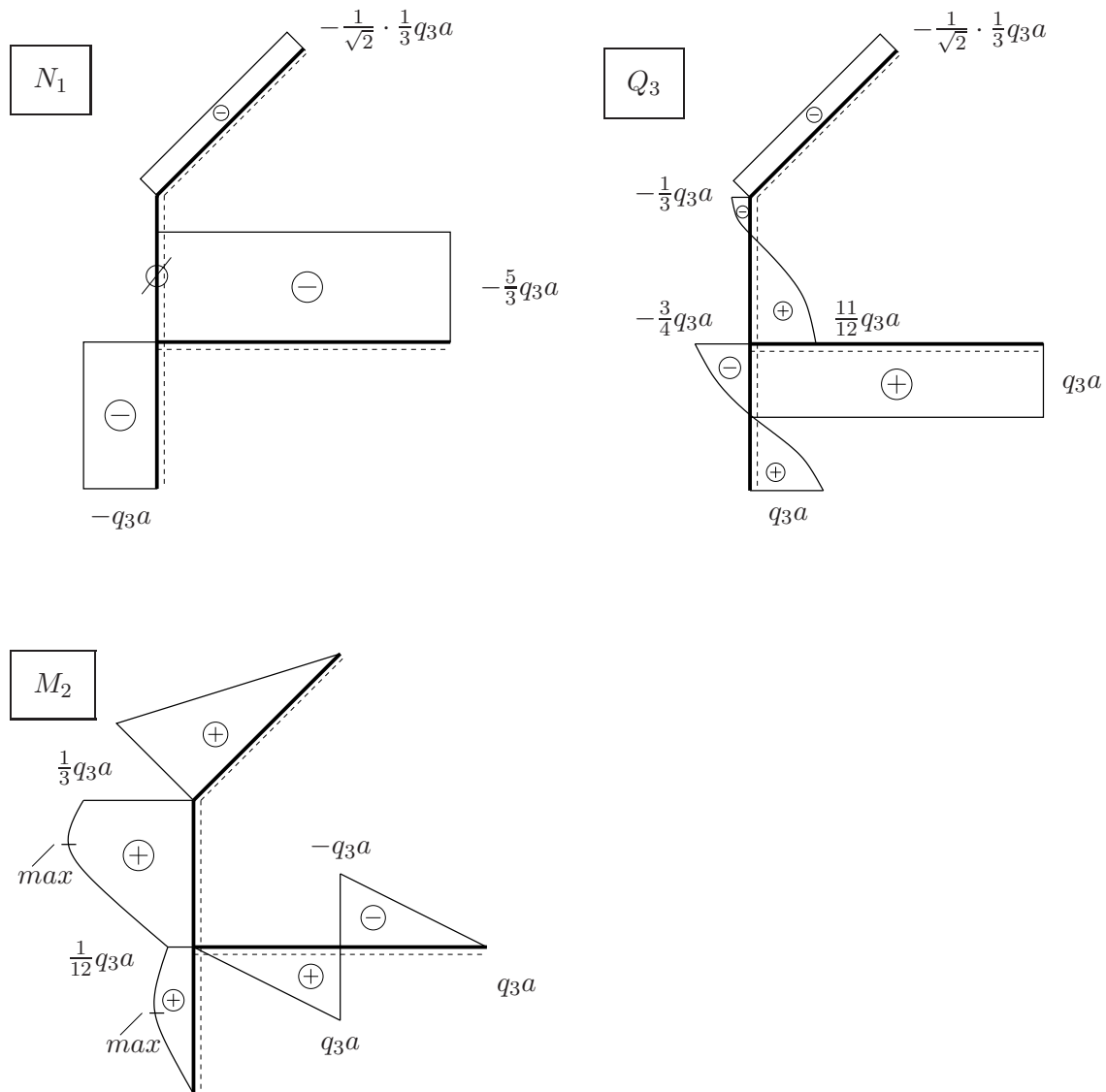


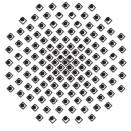
$$\rightarrow: -N_1 - B_H = 0 \quad \Rightarrow \quad N_1 = -\frac{5}{3}q_3a$$

$$\uparrow: Q_3 + B_V = 0 \quad \Rightarrow \quad Q_3 = q_3a$$

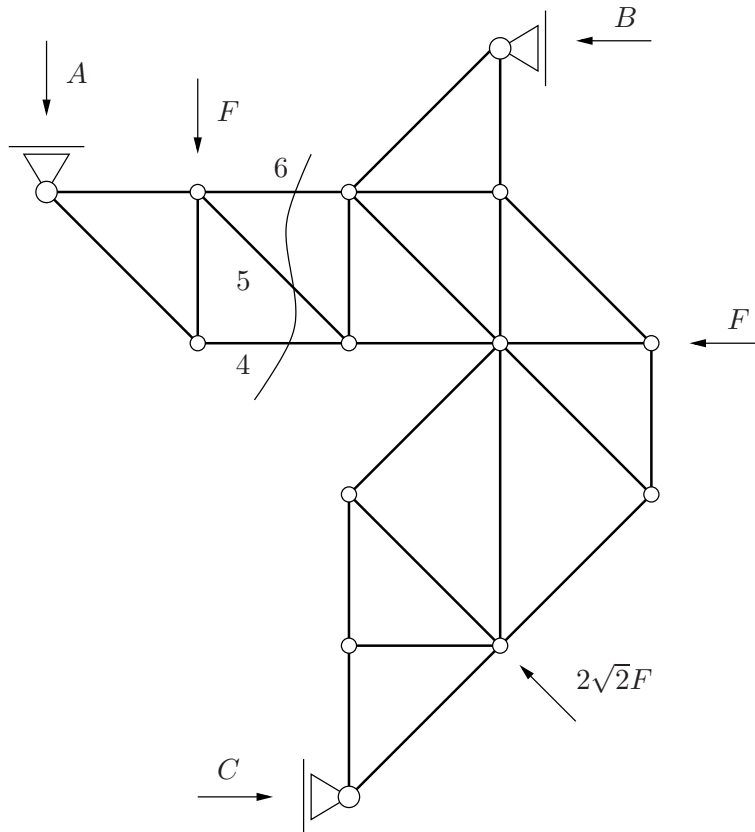
$$\curvearrowright s: -M_2 + \overline{M}_2 + B_V(a + x_1^e) = 0 \quad \Rightarrow \quad M_2 = -x_1^eq_3a + q_3a^2$$

4. Skizzen der Schnittgrößenverläufe:





Lösung: Fachwerk



1. Statische Bestimmtheit

$$f = 2 \cdot 14 - (3 + 25) = 0$$

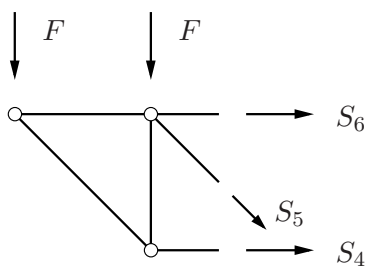
2. Auflager

$$\downarrow \sum V : A + F - 2F = 0 \quad \Rightarrow \quad A = F$$

$$\curvearrowright \sum B : C \cdot 5a + A \cdot 3a + F \cdot 2a - F \cdot 2a - 2F \cdot 4a = 0 \quad \Rightarrow \quad C = F$$

$$\rightarrow \sum H : C - F - 2F - B = 0 \quad \Rightarrow \quad B = -2F$$

3. Ritterschnitt



$$\uparrow \sum V : -\frac{1}{\sqrt{2}} \cdot S_5 - 2F = 0$$

$$\Rightarrow \quad S_5 = -2\sqrt{2}F$$

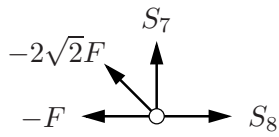
$$\curvearrowright \sum M : S_4 \cdot a + F \cdot a = 0$$

$$\Rightarrow \quad S_4 = -F$$

$$\rightarrow \sum H : S_6 + \frac{1}{\sqrt{2}} \cdot (-2\sqrt{2}F) - F = 0 \quad \Rightarrow$$

$$S_6 = 3F$$

4. Knotenpunktverfahren

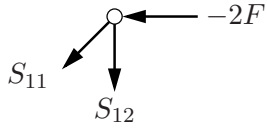


$$\uparrow: S_7 - 2F = 0 \Rightarrow$$

$$S_7 = 2F$$

$$\rightarrow: S_8 + F + 2F = 0 \Rightarrow$$

$$S_8 = -3F$$

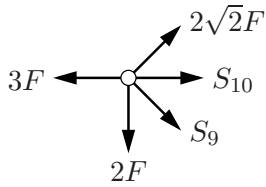


$$\leftarrow: \frac{1}{\sqrt{2}} \cdot S_{11} - 2F = 0 \Rightarrow$$

$$S_{11} = 2\sqrt{2}F$$

$$\downarrow: S_{12} + 2F = 0 \Rightarrow$$

$$S_{12} = -2F$$

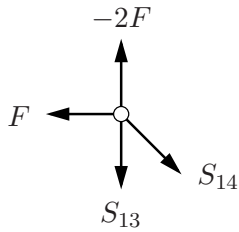


$$\downarrow: \frac{1}{\sqrt{2}} \cdot S_9 - 2F + 2F = 0 \Rightarrow$$

$$S_9 = 0$$

$$\rightarrow: S_{10} + 2F - 3F = 0 \Rightarrow$$

$$S_{10} = F$$

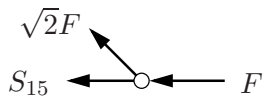


$$\rightarrow: \frac{1}{\sqrt{2}} \cdot S_{14} - F = 0 \Rightarrow$$

$$S_{14} = \sqrt{2}F$$

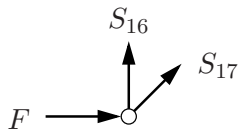
$$\downarrow: S_{13} + 2F + F = 0 \Rightarrow$$

$$S_{13} = -3F$$



$$\leftarrow: S_{15} + F + F = 0 \Rightarrow$$

$$S_{15} = -2F$$

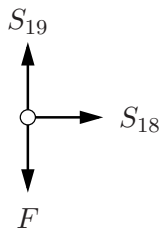


$$\rightarrow: \frac{1}{\sqrt{2}} \cdot S_{17} + F = 0 \Rightarrow$$

$$S_{17} = -\sqrt{2}F$$

$$\uparrow: S_{16} - F = 0 \Rightarrow$$

$$S_{16} = F$$

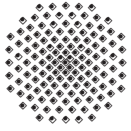


$$\rightarrow: S_{18} = 0 \Rightarrow$$

$$S_{18} = 0$$

$$\uparrow: S_{19} = S_{16} = F \Rightarrow$$

$$S_{19} = F$$



Lösung: Bachelorprüfung WS 2015/2016

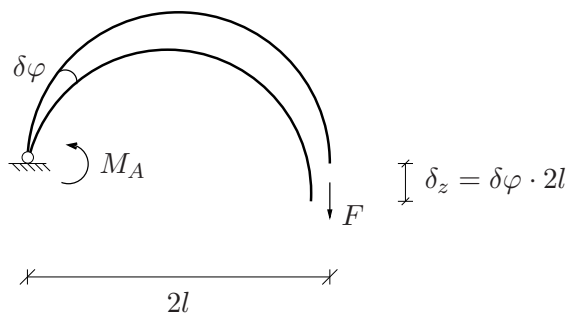
1. Statische Bestimmtheit

$$a_1 = 3 + 0 - 3 \cdot 1 = 0$$

$$a_2 = 3 + 0 - 3 \cdot 1 = 0$$

$$a_3 = 3 + 13 - 2 \cdot 8 = 0$$

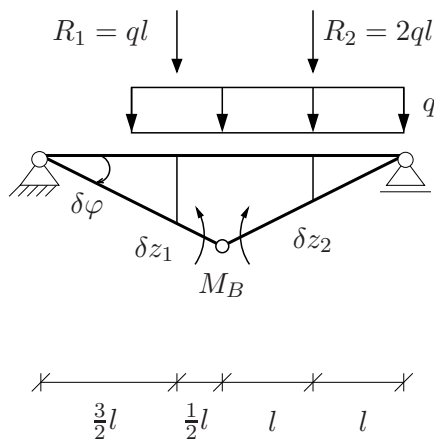
2. Einspannungsmoment in A



$$F \cdot 2l \cdot \delta\varphi - M_A \cdot \delta\varphi = 0$$

$$\Rightarrow M_A = 2Fl$$

3. Biegemoment in B



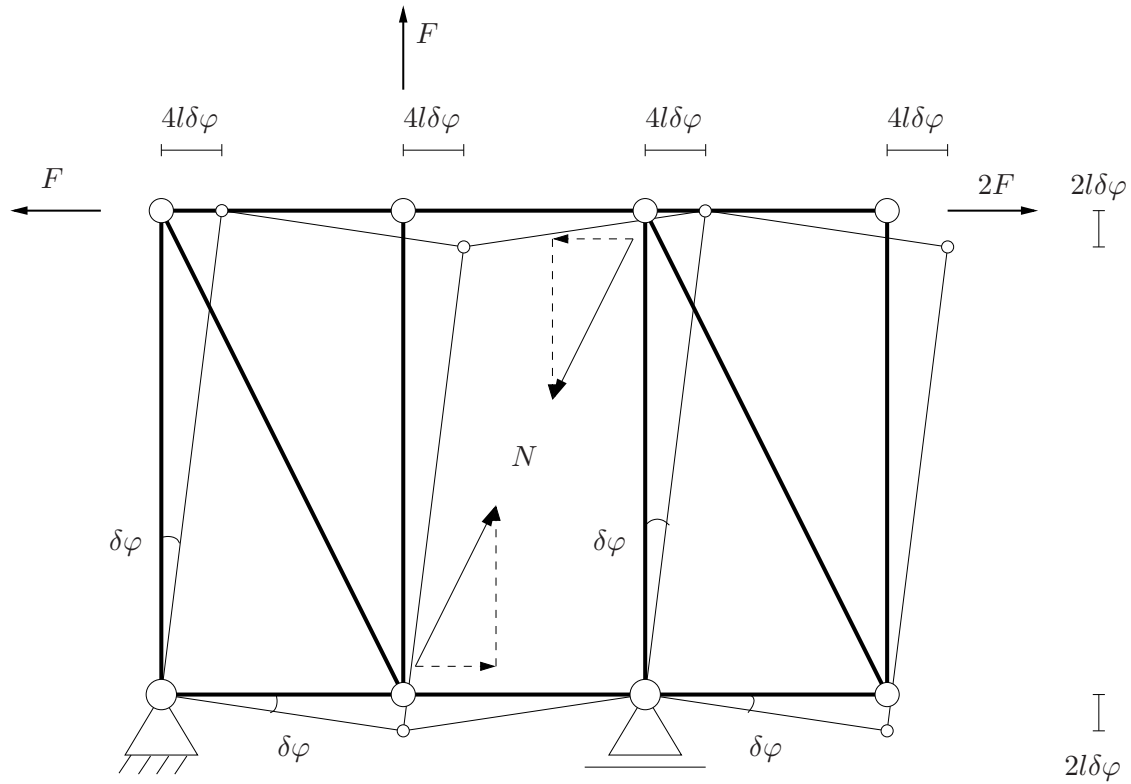
$$\delta z_1 = \frac{3}{2}l \cdot \delta\varphi$$

$$\delta z_2 = l \cdot \delta\varphi$$

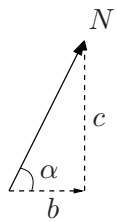
$$-2M_B \cdot \delta\varphi + 2ql \cdot l \cdot \delta\varphi + ql \cdot \frac{3}{2}l \cdot \delta\varphi = 0$$

$$\Rightarrow M_B = \frac{7}{4}ql^2$$

4. Normalkraft im Stab C-D



Zerlegung der Normalkraft



$$\alpha = \arctan\left(\frac{4l}{2l}\right) = \arctan(2)$$

$$c = N \sin(\alpha) = N \cdot \frac{2}{\sqrt{5}}$$

$$b = N \cos(\alpha) = N \cdot \frac{1}{\sqrt{5}}$$

$$-F \cdot 4l \cdot \delta\varphi - F \cdot 2l \cdot \delta\varphi + 2F \cdot 4l \cdot \delta\varphi - N\left(\frac{2}{\sqrt{5}} \cdot 2l \cdot \delta\varphi + \frac{1}{\sqrt{5}} \cdot 4l \cdot \delta\varphi\right) = 0$$

$$\Rightarrow F(-4 - 2 + 8) = N\left(\frac{4}{\sqrt{5}} + \frac{4}{\sqrt{5}}\right)$$

$$\Rightarrow N = \frac{\sqrt{5}}{4} F$$