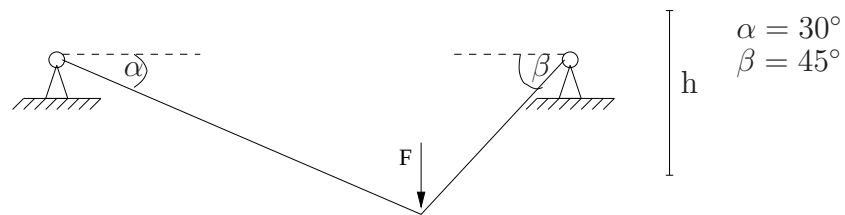
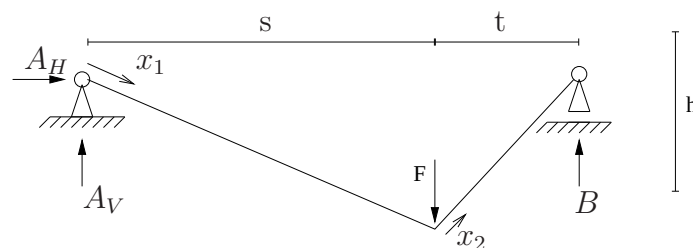


Aufgabe 11. Statische Bestimmtheit:

$$f = 3k - (a + z) = 3 - (1 + 2) = 0$$

2. Auflagerreaktionen:

$$\tan 30^\circ = \frac{h}{s} \quad \frac{1}{\sqrt{3}} = \frac{h}{s} \rightarrow s = \sqrt{3}h \quad t = h$$

$$\Sigma H = 0 : A_H = 0$$

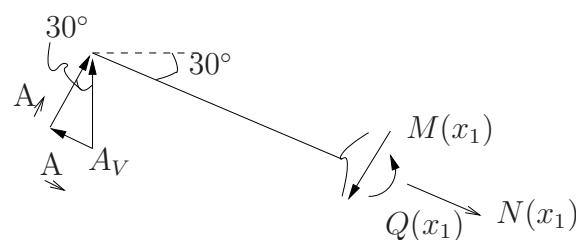
$$\Sigma \hat{B} = 0 : -A_V \cdot (s + t) + F \cdot t = 0$$

$$-A_V(\sqrt{3} + 1)h + Fh = 0$$

$$A_V = \frac{1}{\sqrt{3} + 1} F$$

$$\Sigma V = 0 : A_V + B - F = 0$$

$$B = F - \frac{1}{\sqrt{3} + 1} F = \frac{\sqrt{3}}{\sqrt{3} + 1} F$$

3. Schnittkräfte:

$$A_{\nearrow} = \cos 30^\circ \cdot A_V = \frac{\sqrt{3}}{2} A_V = \frac{\sqrt{3}}{2 \cdot (\sqrt{3}+1)} F$$

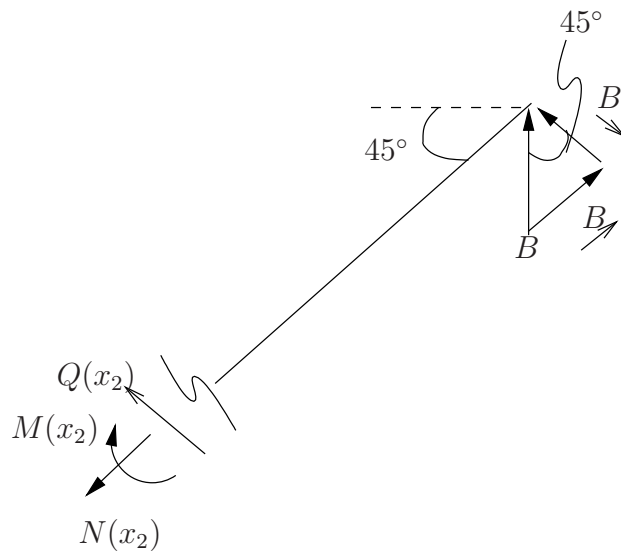
$$A_{\searrow} = \sin 30^\circ \cdot A_V = \frac{1}{2} A_V = \frac{1}{2 \cdot (\sqrt{3}+1)} F$$

$$\Sigma \searrow : -\frac{1}{2 \cdot (\sqrt{3}+1)} F + N(x_1) = 0 \Rightarrow N(x_1) = \frac{1}{2 \cdot (\sqrt{3}+1)} F$$

$$\Sigma \nearrow : \frac{\sqrt{3}}{2 \cdot (\sqrt{3}+1)} F - Q(x_1) = 0 \Rightarrow Q(x_1) = \frac{\sqrt{3}}{2 \cdot (\sqrt{3}+1)} F$$

$$\Sigma \circlearrowleft : M(x_1) - \frac{\sqrt{3}}{2 \cdot (\sqrt{3}+1)} F \cdot x_1 = 0 \Rightarrow M(x_1) = \frac{\sqrt{3}}{2 \cdot (\sqrt{3}+1)} F \cdot x_1$$

Bereich 2:



$$B_{\nearrow} = \frac{1}{\sqrt{2}} \cdot B = \frac{\sqrt{3}}{\sqrt{2}(\sqrt{3}+1)} F$$

$$B_{\searrow} = \frac{1}{\sqrt{2}} \cdot B = \frac{\sqrt{3}}{\sqrt{2}(\sqrt{3}+1)} F$$

$$\Sigma \swarrow : N(x_2) = B_{\nearrow} = \frac{\sqrt{3}}{\sqrt{2}(\sqrt{3}+1)} F$$

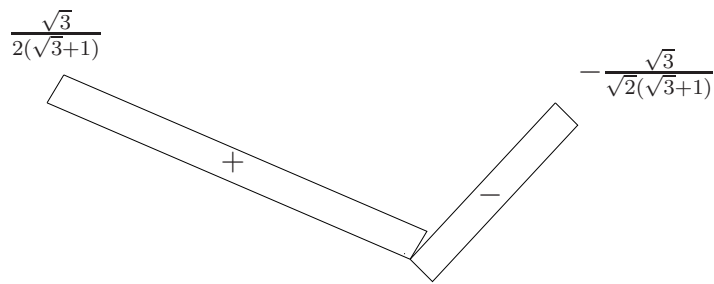
$$\Sigma \nwarrow : Q(x_2) = -B_{\searrow} = -\frac{\sqrt{3}}{\sqrt{2}(\sqrt{3}+1)} F$$

$$\Sigma \circlearrowleft : M(x_2) - B_{\searrow} \cdot (l - x_2) = 0 \quad \text{mit} \quad l = \sqrt{2}h$$

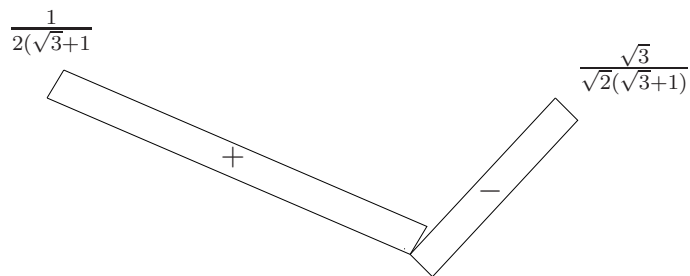
$$M(x_2) = (\sqrt{2}h - x_2) B_{\searrow} = (\sqrt{2}h - x_2) \cdot \frac{\sqrt{3}}{\sqrt{2}(\sqrt{3}+1)} F$$

4. Graphische Darstellung:

Q[F]:



N[F]:

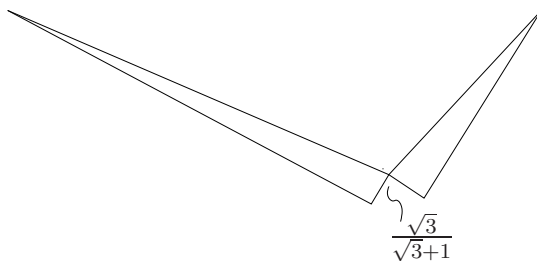


$$l_1 = \frac{h}{\sin 30^\circ} = 2h$$

$$M(x_1 = l_1 = 2h) = \frac{\sqrt{3}}{\sqrt{3}+1} Fh$$

$$M(x_2 = 0) = \frac{\sqrt{3}}{\sqrt{3}+1} Fh$$

M[F.h]:



5. Lastanalyse:

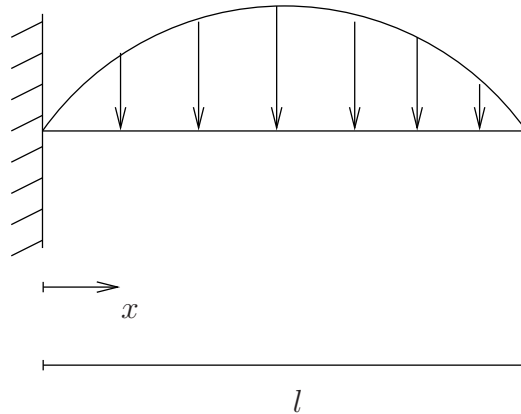
Es sei $h = 0,3m$ $M = 130Nm$ $g = 10 \frac{N}{kg}$

$$130Nm = \frac{\sqrt{3}}{\sqrt{3}+1} F \cdot 0,3$$

$$F \approx 683,52N = m \cdot g \Rightarrow m \approx 68,35kg$$

b) Integration der Dgl

$$q(x) = q_0 \sin\left(\frac{x}{l}\pi\right)$$



$$Q(x) = - \int q_0 \sin\left(\pi \frac{x}{l}\right) dx + C_1$$

$$= -q_0 \left(-\cos\left(\pi \frac{x}{l}\right) \cdot \frac{l}{\pi}\right) + C_1 = q_0 \frac{l}{\pi} \cos\left(\pi \frac{x}{l}\right) + C_1$$

$$M(x) = \int Q(x) dx + C_2$$

$$= q_0 \left(\frac{l}{\pi}\right)^2 \sin\left(\pi \frac{x}{l}\right) + C_1 x + C_2$$

$$RB : Q(x=l) = 0$$

$$\Rightarrow q_0 \frac{l}{\pi} \cdot \cos(\pi) + C_1 \Rightarrow C_1 = q_0 \frac{l}{\pi}$$

$$M(x=l) = 0$$

$$\Rightarrow q_0 \left(\frac{l}{\pi}\right)^2 \sin(\pi) + q_0 \left(\frac{l^2}{\pi}\right) + C_2 = 0 \Rightarrow C_2 = -q_0 \frac{l^2}{\pi}$$

$$Q(x) = q_0 \frac{l}{\pi} \cos\left(\pi \frac{x}{l}\right) + q_0 \frac{l}{\pi}$$

$$M(x) = q_0 \left(\frac{l}{\pi}\right)^2 \sin\left(\pi \frac{x}{l}\right) + q_0 \frac{l}{\pi} x - q_0 \frac{l^2}{\pi}$$

6. Auflage berechnen:



$$A_H = 0$$

$$A_V = Q(0) = q_0 \frac{l}{\pi} \cos(0) + q_0 \frac{l}{\pi} = 2q_0 \frac{l}{\pi}$$

$$M_A = M(0) = q_0 \left(\frac{l}{\pi}\right)^2 \sin(0) + q_0 \frac{l}{\pi} \cdot 0 - q_0 \frac{l^2}{\pi} = -q_0 \frac{l^2}{\pi}$$

Aufgabe 21. Fachwerk:

1.

Innen:

$$2k - (s + r) = 0$$

$$2 \cdot 10 - (16 + 4) = 0$$

$$20 - 20 = 0$$

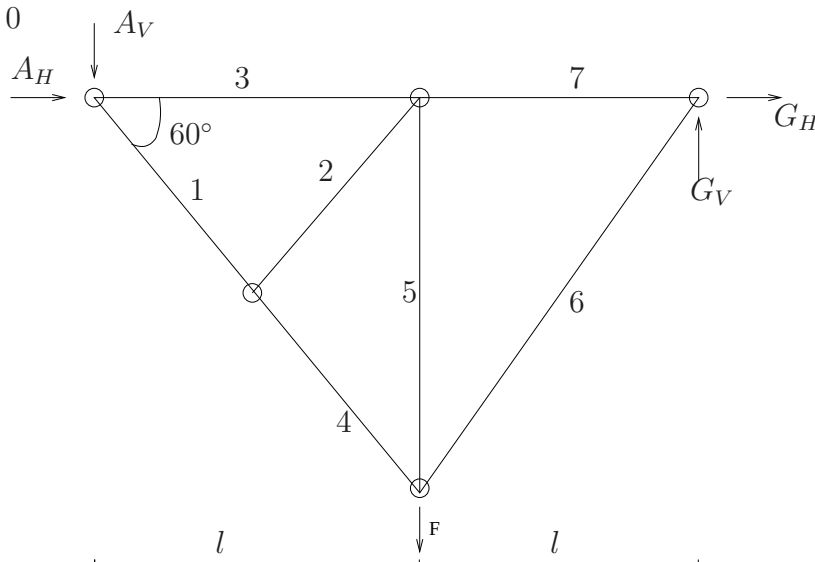
Außen:

$$3s - (z + q) = 0$$

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

$$6 - 6 = 0$$

2.

System-1:

$$\Sigma M^G = 0 \quad : A_V \cdot 2l + Fl = 0 \Rightarrow \boxed{A_V = -\frac{F}{2}}$$

$$\Sigma F_V = 0 \quad : -A_V + G_V - F = 0 \Rightarrow \boxed{G_V = \frac{F}{2}}$$

$$\Sigma F_H = 0 \quad : G_H = -A_H$$

Gesamtsystem

$$\Sigma M^B = 0 \quad : A_V \cdot 3l + A_H \frac{l}{2} + F \cdot 2l + F \cdot \frac{l}{2} + \frac{F}{\sqrt{2}}l = 0$$

$$A_H = -2 \left[3 \cdot \left(-\frac{F}{2}\right) + \frac{6}{2}F + \frac{1}{\sqrt{2}}F \right]$$

$$\boxed{A_H = -(2 + \sqrt{2})F}$$

$$\Rightarrow \boxed{G_H = (2 + \sqrt{2})F}$$

System-2:

$$\Sigma M^I = 0 :$$

$$-S_3 \frac{\sqrt{3}}{2} l - A_H \frac{\sqrt{3}}{2} l + A_V \frac{l}{2} = 0$$

$$S_3 = \frac{2}{\sqrt{3}} \left[(2 + \sqrt{2}) \frac{\sqrt{3}}{2} - \frac{1}{4} \right] F$$

$$\boxed{S_3 = (2 + \sqrt{2} - \frac{1}{2\sqrt{3}}) F}$$

$$\Sigma M^{II} = 0 \quad : A_V l + S_4 \frac{\sqrt{3}}{2} l = 0 \quad \Rightarrow \quad \boxed{S_4 = -\frac{1}{\sqrt{3}} F}$$

$$\boxed{S_2 = 0} \dots \text{of fensichtlicher Nullstab}$$

4.

$$S_8 = G_V \quad \Rightarrow \quad \boxed{S_8 = \frac{F}{2}}$$

$$S_9 = G_H \quad \Rightarrow \quad \boxed{S_9 = (2 + \sqrt{2}) F}$$

$$\Sigma F_V = 0 \quad : -S_8 - F \frac{1}{\sqrt{2}} - S_{10} \frac{1}{\sqrt{2}} = 0$$

$$\boxed{S_{10} = -(\frac{1}{\sqrt{2}} + 1) F}$$

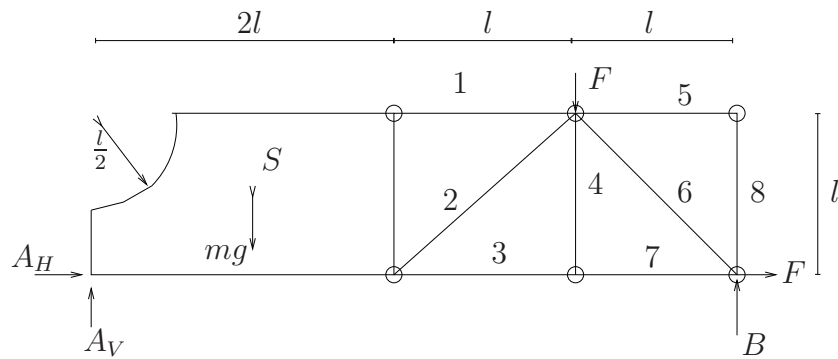
$$\Sigma F_H = 0 \quad : S_{11} + S_{10} \frac{1}{\sqrt{2}} + F \frac{1}{\sqrt{2}} = 0$$

$$\boxed{S_{11} = -\frac{1}{2} F}$$

5. Schwerpunkt S der Platte (nur x_s):

$$\begin{aligned} x_s &= \frac{\Sigma_i x_i A_i}{\Sigma_i A_i} = \frac{l \cdot 2l^2 - \frac{2l}{3\pi} \cdot \frac{\pi}{4} \left(\frac{l}{2}\right)^2}{2l^2 - \frac{\pi}{4} \left(\frac{l}{2}\right)^2} \\ &= \frac{2l^3 - \frac{1}{24} l^3}{2l^2 - \frac{\pi}{16} l^2} = \frac{\frac{47}{24} l}{\frac{32 - \pi}{16}} \\ &\boxed{x_s = \frac{94}{96 - 3\pi} l} \end{aligned}$$

6.



$$\Sigma F_H = 0 \quad : \quad \boxed{A_H = -F}$$

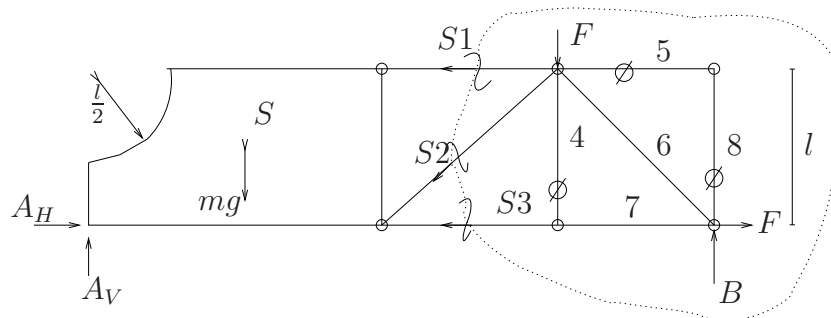
$$\Sigma M^A = 0 \quad : \quad -mgx_s - F \cdot 3l + B \cdot 4l = 0$$

$$\boxed{B = \frac{3}{4}F + \frac{x_s}{4l}mg}$$

$$\Sigma F_V = 0 \quad : \quad A_V - mg + B - F = 0$$

$$\boxed{A_V = \frac{1}{4}F + \frac{4l - x_s}{4l}mg}$$

7. Wähle Stabkräfte S_1, S_2, S_3



$$\Sigma M^I = 0 \quad : -S_3 l + B l + F l = 0$$

$$S_3 = \frac{7}{4}F + \frac{x_s}{4l}mg$$

$$\Sigma F_V = 0 \quad : B - F - S_2 \frac{1}{\sqrt{2}} = 0$$

$$S_2 = \sqrt{2} \left(-\frac{1}{4}F + \frac{x_s}{4l}mg \right)$$

$$\Sigma F_H = 0 \quad : -S_1 - S_3 - S_2 \frac{1}{\sqrt{2}} + F = 0$$

$$S_1 = -\frac{7}{4}F - \frac{x_s}{4l}mg + \frac{1}{4}F - \frac{x_s}{4l}mg + F$$

$$S_1 = -\frac{1}{2}F - \frac{x_s}{2l}mg$$

Aufgabe 31. die Seilkurve und den Horizontalzug:

$$y''(x) = \frac{1}{H}q(x)$$

$$y'(x) = \frac{1}{H}q_0x + C_1$$

$$y(x) = \frac{1}{2H}q_0x^2 + C_1x + C_2$$

$$RB: \quad y(x=0) = 0 \rightarrow C_2 = 0$$

$$y(x=2l) = -3l \rightarrow \frac{2}{H}q_0l^2 + 2C_1l = -3l$$

$$C_1 = -\frac{3}{2} - \frac{1}{H}q_0l$$

$$\text{Horizontalzug:} \quad \eta_{\max} = 0, 1l = \frac{4q_0l^2}{8H}$$

$$H = 5q_0l$$

$$\text{Damit:} \quad G = -\frac{3}{2} - \frac{1}{5} = -\frac{17}{10}$$

$$y(x) = \frac{1}{10}\frac{x^2}{l} - \frac{17}{10}x$$

2. Seilkräfte:

Umschlingwintel:

Rolle1

$$\alpha_1 = \frac{\pi}{2} + |\arctan(y'(x=0))| \approx 2,61 = 149,54^\circ$$

Rolle2

$$\alpha_2 = |\arctan(y'(x=2l))| \approx 0,915 = 52,43^\circ$$

$$S_1 = H\sqrt{H(y'(x=0))^2} = 9,869 \cdot l$$

$$S_2 = H\sqrt{1 + (y'(x=2l))^2} = 8,29 \cdot l$$

Rolle1:

$$\text{nachrechts} \quad S_1 \leq mge^{\mu_1\alpha_1}$$

$$\mu_1 \geq \frac{1}{\alpha_1} \ln\left[\frac{S_1}{mg}\right]$$

$$\text{nachlinks} \quad mg \leq S_1e^{\mu_1\alpha_1}$$

$$\mu_1 \geq \frac{1}{\alpha_1} \ln\left[\frac{mg}{S_1}\right]$$

Rolle2:

$$\text{nachrechts} \quad 3mg \leq S_2e^{\mu_2\alpha_2}$$

$$\mu_2 \geq \frac{1}{\alpha_2} \ln\left[\frac{3mg}{S_2}\right]$$

$$\text{nachlinks} \quad S_2 \leq 3mge^{\mu_2\alpha_2}$$

$$\mu_2 \geq \frac{1}{\alpha_2} \ln\left[\frac{S_2}{3mg}\right]$$

mit $q_0 = \frac{mg}{l}$:

$$\frac{S_1}{mg} = 9,86 > 1$$

$$\frac{mg}{S_1} = \frac{1}{9,86} < 1$$

$$\frac{S_2}{3mg} = \frac{8,2}{3} > 1$$

$$\frac{3mg}{S_2} = \frac{3}{8,2} < 1$$

$$\Rightarrow \mu_1 \geq \frac{1}{2,61} \ln[9,86] = 0,877$$

$$\Rightarrow \mu_2 \geq \frac{1}{0,915} \ln\left[\frac{8,2}{3}\right] = 1,099$$