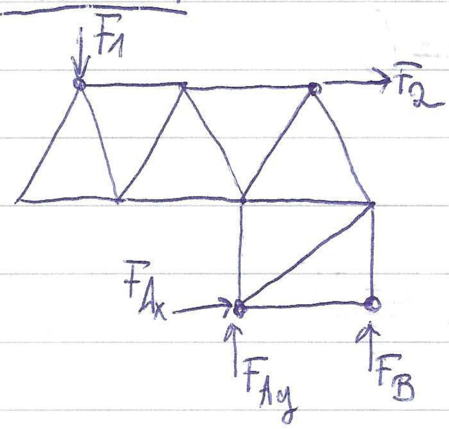
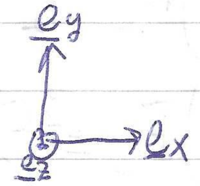
Aufgabe 1

a) Freischnitt





$$R_x := F_2 + F_{Ax} = 0 \quad \Rightarrow F_{Ax} = -F_2$$

$$R_y := F_{Ay} + F_B - F_1 = 0$$

$$M_A := F_1 \cdot \frac{3}{2}a - F_2 \cdot \left(\sqrt{a^2 - \left(\frac{a}{2}\right)^2} + a\right) + F_B \cdot a = 0$$

$$\Rightarrow F_B = \left(1 + \frac{\sqrt{3}}{2}\right) F_2 - \frac{3}{2} F_1$$

(von R_y) $F_{Ay} = F_1 - \left(1 + \frac{\sqrt{3}}{2}\right) F_2 + \frac{3}{2} F_1$

$$= \frac{5}{2} F_1 - \left(1 + \frac{\sqrt{3}}{2}\right) F_2$$

$\underline{\underline{F_{Ax} = -F_2}}$ $\quad$ $\underline{\underline{F_{Ay} = \frac{5}{2} F_1 - \left(1 + \frac{\sqrt{3}}{2}\right) F_2}}$ $\quad$ $\underline{\underline{F_B = \left(1 + \frac{\sqrt{3}}{2}\right) F_2 - \frac{3}{2} F_1}}$

b) $F_B \geq 0$

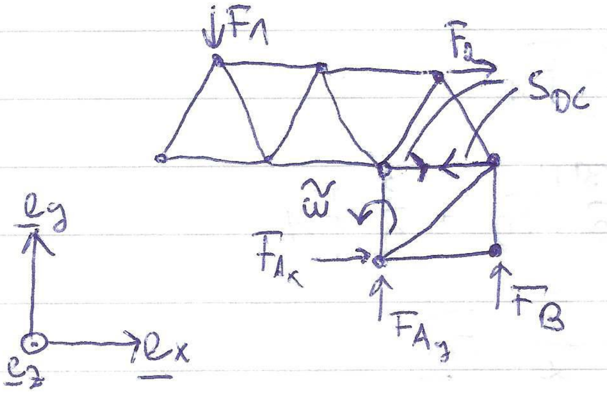
$$F_B = \left(1 + \frac{\sqrt{3}}{2}\right) F_2 - \frac{3}{2} F_1 \geq 0$$

$$\left(1 + \frac{\sqrt{3}}{2}\right) F_2 \geq \frac{3}{2} F_1$$

$$\frac{F_1}{F_2} \leq \frac{2}{3} + \frac{2\sqrt{3}}{2 \cdot 3} = \frac{2 + \sqrt{3}}{3}$$

$$\underline{\underline{\frac{F_1}{F_2} \leq \frac{2 + \sqrt{3}}{3}}}$$

c) <u>Freischnitt</u> (Stab DC entfernt)



$F_1 = F \qquad F_2 = \sqrt{3} F$

$$\frac{F_1}{F_2} = \frac{F}{\sqrt{3} F} \leq \frac{2 + \sqrt{3}}{2} \quad \checkmark$$

$\Rightarrow$ Dreieck ABDA bildet einen Starrkörper mit $\tilde{\underline{v}} = \underline{0}$

Virtueller Bewegungszustand: Stab AC rotiert mit $\tilde{\omega}$ um Punkt A

$$\underline{\underline{\tilde{\underline{v}}_D = \begin{pmatrix} 0 \\ 0 \end{pmatrix}}} \qquad \underline{\underline{\tilde{\underline{v}}_C = \begin{pmatrix} a\tilde{\omega} \\ 0 \end{pmatrix}}}$$

SdpG: $\tilde{\underline{v}}_C \cdot \underline{CE} = \tilde{\underline{v}}_E \cdot \underline{CE}$ und $\tilde{\underline{v}}_D \cdot \underline{DE} = \tilde{\underline{v}}_E \cdot \underline{DE}$

$$\begin{pmatrix} a\tilde{\omega} \\ 0 \end{pmatrix} \cdot \begin{pmatrix} \frac{1}{2}d \\ \frac{\sqrt{3}}{2}d \end{pmatrix} = \begin{pmatrix} e_x \\ e_y \end{pmatrix} \cdot \begin{pmatrix} \frac{1}{2}d \\ \frac{\sqrt{3}}{2}d \end{pmatrix} \Rightarrow a\tilde{\omega} = e_x + e_y \cdot \sqrt{3}$$

$$\begin{pmatrix} 0 \\ 0 \end{pmatrix} \cdot \begin{pmatrix} -\frac{1}{2}d \\ \sqrt{3}/2\, d \end{pmatrix} = \begin{pmatrix} e_x \\ e_y \end{pmatrix} \cdot \begin{pmatrix} -\frac{1}{2}d \\ \frac{\sqrt{3}}{2}d \end{pmatrix} \Rightarrow e_x = \sqrt{3}\, e_y$$

$$\Rightarrow e_y = \frac{a\tilde{\omega}}{2\sqrt{3}} \qquad e_x = \frac{a\tilde{\omega}}{2}$$

$$\underline{\underline{\tilde{\underline{v}}_E = \frac{a\tilde{\omega}}{2} \begin{pmatrix} 1 \\ 1/\sqrt{3} \end{pmatrix}}}$$

SdpG: $\tilde{\underline{v}}_H \cdot \underline{CH} = \tilde{\underline{v}}_C \cdot \underline{CH}$ und $\tilde{\underline{v}}_H \cdot \underline{EH} = \tilde{\underline{v}}_E \cdot \underline{EH}$

$$\frac{a\tilde{\omega}}{2} \cdot \begin{pmatrix} 1 \\ \frac{1}{\sqrt{3}} \end{pmatrix} \cdot \begin{pmatrix} -2d \\ 0 \end{pmatrix} = \begin{pmatrix} h_x \\ h_y \end{pmatrix} \cdot \begin{pmatrix} -2d \\ 0 \end{pmatrix}$$

$$\Rightarrow h_x = \frac{a\tilde{\omega}}{2}$$

$$\begin{pmatrix} a\tilde{\omega} \\ 0 \end{pmatrix} \cdot \begin{pmatrix} -\frac{3}{2}d \\ \frac{\sqrt{3}}{2}d \end{pmatrix} = \begin{pmatrix} h_x \\ h_y \end{pmatrix} \cdot \begin{pmatrix} -\frac{3}{2}d \\ \frac{\sqrt{3}}{2}d \end{pmatrix}$$

$$\Rightarrow -3a\tilde{\omega} = -\frac{3a\tilde{\omega}}{2} + \sqrt{3}\, h_y$$

$$h_y = -\frac{\sqrt{3}}{2} a\tilde{\omega} \qquad \tilde{\underline{v}}_H = \frac{a\tilde{\omega}}{2} \begin{pmatrix} 1 \\ -\sqrt{3} \end{pmatrix}$$

$\boxed{P_{total} = 0}$

$$P_{total} := \begin{pmatrix} 0 \\ -F_1 \end{pmatrix} \cdot \begin{pmatrix} \frac{a\tilde{\omega}}{2} \\ \frac{-\sqrt{3}\, a\tilde{\omega}}{2} \end{pmatrix} + \begin{pmatrix} F_2 \\ 0 \end{pmatrix} \cdot \begin{pmatrix} \frac{a\tilde{\omega}}{2} \\ \frac{a\tilde{\omega}}{2\sqrt{3}} \end{pmatrix} + \begin{pmatrix} -F_2 \\ \frac{5}{2}F_1 - (1+\frac{\sqrt{3}}{2})F_2 \end{pmatrix} \cdot \begin{pmatrix} 0 \\ 0 \end{pmatrix}$$

$$+ \begin{pmatrix} 0 \\ F_B \end{pmatrix} \cdot \begin{pmatrix} 0 \\ 0 \end{pmatrix} + \begin{pmatrix} S_{DC} \\ 0 \end{pmatrix} \cdot \begin{pmatrix} a\tilde{\omega} \\ 0 \end{pmatrix} + \begin{pmatrix} -S_{DC} \\ 0 \end{pmatrix} \cdot \begin{pmatrix} 0 \\ 0 \end{pmatrix} = 0$$

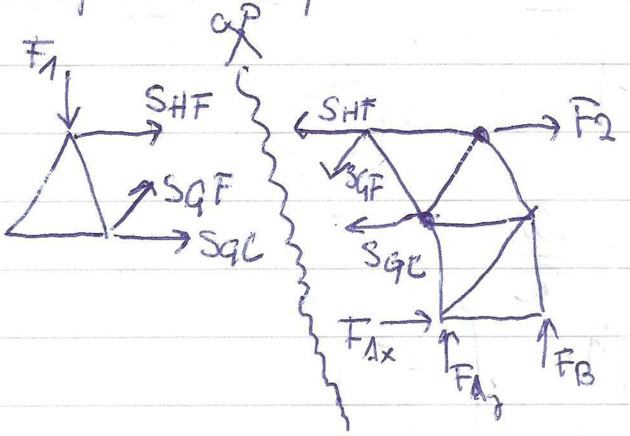
$$\Rightarrow \sqrt{3} F_1 + F_2 + 2 S_{DC} = 0$$

$$\Rightarrow \underline{\underline{S_{DC} = \frac{\sqrt{3} F_1 + F_2}{2}}}$$

$$F_1 = F \quad F_2 = \sqrt{3} F$$

$$\Rightarrow \underline{\underline{S_{DC} = \sqrt{3} F}}$$

d) Dreikräfteschnitt (Ritter'sches Schnittverfahren)



Rechtes Teilsystem: $\underline{R} = \underline{0}$

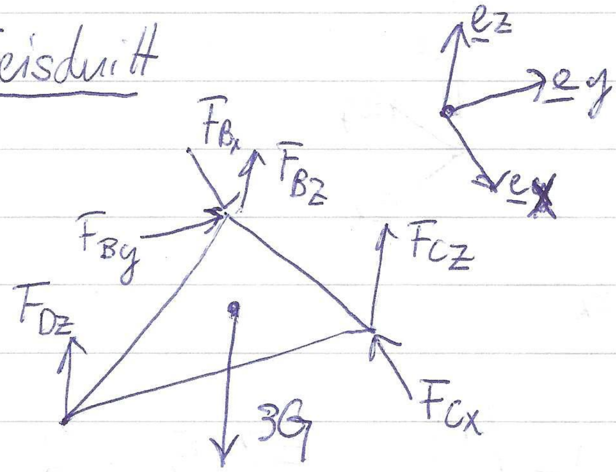
$$\underline{R}_y = F_{Ay} + F_B - \frac{\sqrt{3}}{2} S_{GF} = 0$$

$$S_{GF} = \frac{2}{\sqrt{3}} \left(F_1 \right) = \frac{2F}{\sqrt{3}} \quad \text{(aus 1. d)}$$

$$\underline{\underline{S_{FG} = \frac{2F}{\sqrt{3}}}}$$

Aufgabe 2

a) <u>Freischnitt</u>



$\underline{R} = 0$

$\underline{M} = 0$

$$R_x := F_{Bx} - F_{Cx} = 0$$

$$\underline{M}_B := \begin{pmatrix} 0 \\ 0 \\ F_{Dz} \end{pmatrix} \times \underline{DB} + \begin{pmatrix} -F_{Cx} \\ 0 \\ F_{Cz} \end{pmatrix} \times \underline{CB} + \frac{2}{3}\left(\begin{pmatrix} 0 \\ 0 \\ -3G \end{pmatrix} \times \underline{EB}\right)$$

$$= \begin{vmatrix} i & j & k \\ 0 & 0 & F_{Dz} \\ -h & 2h & 0 \end{vmatrix} + \begin{vmatrix} i & j & k \\ -F_{Cx} & 0 & F_{Cz} \\ -h & -2h & 0 \end{vmatrix} + \begin{vmatrix} i & j & k \\ 0 & 0 & -2G \\ -h & 0 & 0 \end{vmatrix}$$

$$= \begin{pmatrix} -2hF_{Dz} \\ -hF_{Dz} \\ 0 \end{pmatrix} + \begin{pmatrix} 2hF_{Cz} \\ -hF_{Cz} \\ 2hF_{Cx} \end{pmatrix} + \begin{pmatrix} 0 \\ 2hG \\ 0 \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}$$

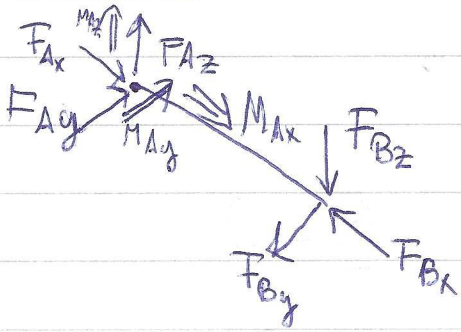
$\Rightarrow F_{Cx} = 0 \quad \Rightarrow F_{Dz} = F_{Cz} \quad \Rightarrow F_{Dz} + F_{Cz} = 2G$

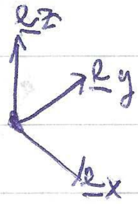
$$\underline{\underline{F_{Cx} = 0}} \quad \underline{\underline{F_{Cz} = G}} \quad \underline{\underline{F_{Dz} = G}}$$

$R_y := F_{By} = 0 \Rightarrow \underline{\underline{F_{By} = 0}}$

$R_z := F_{Dz} + F_{Cz} + F_{Bz} - 3G = 0 \Rightarrow \underline{\underline{F_{Bz} = G}}$

Freischnitt





$$\underline{R} = \begin{pmatrix} 0 \\ 0 \\ -F_{Bz} \end{pmatrix} + \begin{pmatrix} F_{Ax} \\ F_{Ay} \\ F_{Az} \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix} \Rightarrow \underline{\underline{F_{Az} = G}}$$

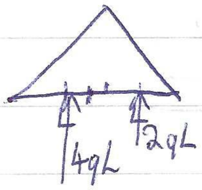
$$\underline{\underline{F_{Ay} = F_{Ax} = 0}}$$

$$\underline{M}_A = \begin{pmatrix} 2L \\ 0 \\ 0 \end{pmatrix} \times \begin{pmatrix} 0 \\ 0 \\ -F_{Bz} \end{pmatrix} + \begin{pmatrix} M_{Ax} \\ M_{Ay} \\ M_{Az} \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}$$

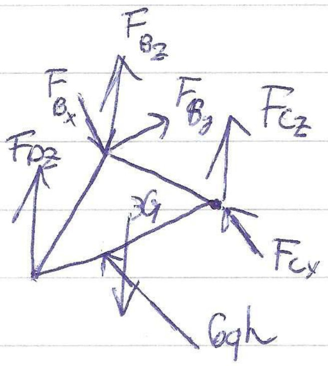
$$= \begin{vmatrix} i & j & k \\ 2L & 0 & 0 \\ 0 & 0 & -F_{Bz} \end{vmatrix} + \begin{pmatrix} M_{Ax} \\ M_{Ay} \\ M_{Az} \end{pmatrix} = \begin{pmatrix} 0 \\ 2L F_{Bz} \\ 0 \end{pmatrix} + \begin{pmatrix} M_{Ax} \\ M_{Ay} \\ M_{Az} \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}$$

$$\Rightarrow \underline{\underline{M_{Ax} = M_{Az} = 0}} \qquad \underline{\underline{M_{Ay} = -2L\, F_{Bz}}}$$

b) $R_x = -2q \cdot 2L + (-q) \cdot 2L = -6qL$



Angriffspunkt: $\underline{OE} + \frac{1}{6} \cdot \underline{ED}$ (Ortsvektor) c)



$$R_x \overset{!}{=} -6qh - F_{Cx} + F_{Bx} = 0$$

$$M_{z_E} = -6qh \cdot \frac{1}{3}h + F_{Cx}\, 2h = 0$$

$$\Rightarrow \underline{\underline{F_{Cx} = qh}}$$

$$\Rightarrow F_{Bx} = 7qh$$

$$\Rightarrow \underline{\underline{F_{Ax} = F_{Bx} = 7qh}}$$