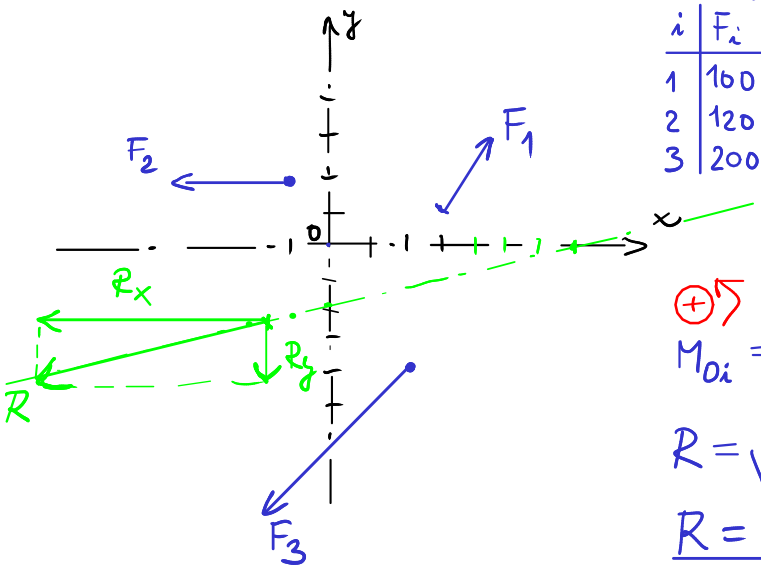
OBECNÁ SOUSTAVA SIL V ROVINĚ

4a) stanovte výsledný účinek R soustavy sil



	[kN]	[°]	[m]	[m]	[kN]	[kN]	[kNm]
i	F_i	α_i	x_i	y_i	$F_{ix}=F_i\cos\alpha_i$	$F_{iy}=F_i\sin\alpha_i$	M_{oi}
1	160	60	3	1	50	86,6025	209,8045
2	120	180	-1	2	-120	0	240
3	200	225	2	-4	-141,4214	-141,4214	-848,5284
					$R_x=\Sigma F_{ix}$	$R_y=\Sigma F_{iy}$	$M_o=\Sigma M_{oi}$
					-211,4214	-54,8189	-398,7209

⊕↺

$M_{oi} = F_{iy}\cdot x_i - F_{ix}\cdot y_i$

$R = \sqrt{R_x^2 + R_y^2} = \sqrt{211{,}4214^2 + 54{,}8189^2}$

$R = 218{,}4127\,kN$

III. kvadrant

$\cos\alpha' = \frac{|R_x|}{R} = \frac{211{,}4214}{218{,}4127} \Rightarrow \alpha' = 14{,}5359°$

$\alpha = 180° + 14{,}5359° = 194{,}5359°$

Rovnice paprsku výslednice:

$R_y x' - R_x \cdot y' = M_o$

$-54{,}8189\,x' + 211{,}4214\,y' = -398{,}7209$

R vytíná na osách x a y úseky:

na ose x: $y' = 0$

$-54{,}8189\,x' = -398{,}7209$

$x' = 7{,}2734\ m$

na ose y: $x' = 0$

$211{,}4214\,y' = -398{,}7209$

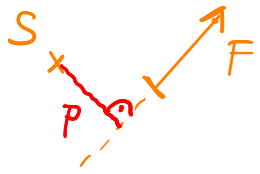
$y' = -1{,}8859\ m$

statický moment síly k bodu

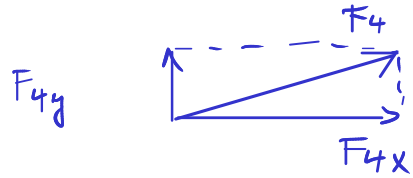
$M_s = F\cdot p$

s ... momentový střed

p ... kolmá vzdálenost paprsku síly k bodu s



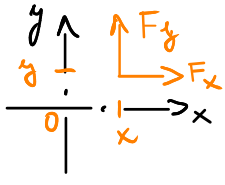
4b) určete F_4, aby byla soustava v rovnováze



$F_4 = 218{,}4127\,kN$

$F_{4x} = 211{,}4214\,kN$

$F_{4y} = 54{,}8189\,kN$



I. kvadrant ⊕↺

$M_{x0} = -F_x\cdot y$

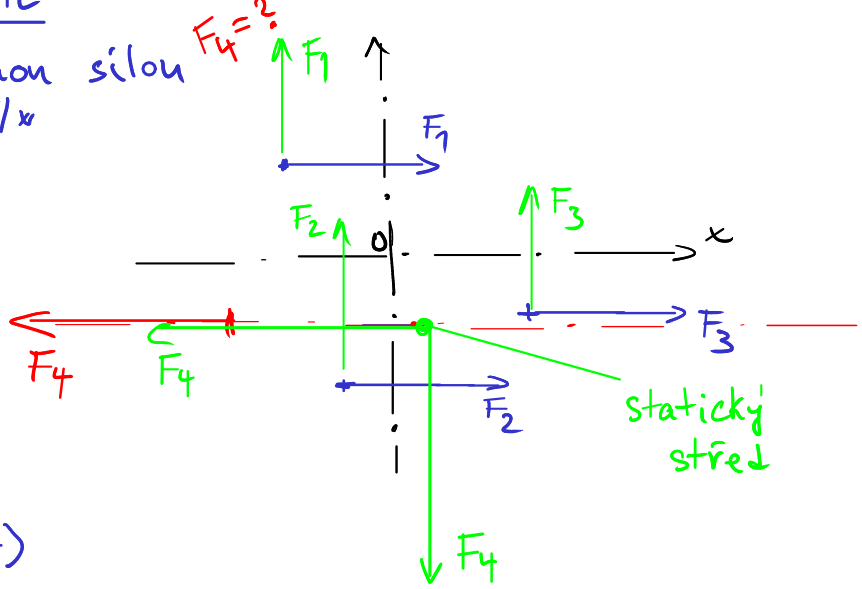
$M_{y0} = F_y\cdot x$

SOUSTAVA ROVNOBĚŽNÝCH SIL

a) uveďte do rovnováhy jednou silou $F_4 = ?$

$F_i \parallel x$

i	F_i [kN]	x_i [m]	y_i [m]	d_i	F_{xi}
1	25	-1,4	1,2	0	25
2	35	-0,8	-2,4	0	35
3	30	2,4	-0,6	0	30
4	$F_4 = 90$	x_4	y_4	180	-90



$$R = \sum_{i=1}^{4} F_i = 0 \quad \oplus \rightarrow$$

$$F_1 + F_2 + F_3 + F_4 = 0$$

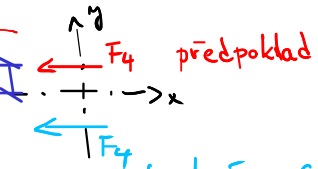
$$F_4 = -90\,kN \ (\leftarrow)$$

$$M_0 = \sum_{i=1}^{4} F_i \cdot p_i = 0$$

$$\oplus \ M_0 = \sum_{i=1}^{3} F_i \cdot p_i - F_4 x_{y4} = 0$$

znaménka určena z obrázku

$$\ominus F_1 |y_1| \oplus F_2 |y_2| \oplus F_3 |y_3| \oplus F_4 x_{y4} = 0$$



$$-25 \cdot (1,2) + 35\,(2,4) + 30\,(0,6) + 90 \cdot x_{y4} = 0$$

$$72 + 90 x_{y4} = 0$$

$$x_{y4} = \ominus 0,8\ m$$

$$M_0 = -\sum_{i=1}^{4} F_{xi} \cdot y_i = 0$$

znaménka zajistí směrové úhly a souřadnice

$$-\left[F_{x1} \cdot y_1 + F_{x2} \cdot y_2 + F_{x3} y_3 + F_{x4} y_4\right] = 0 \quad /\cdot(-1)$$

$$25 \cdot 1,2 + 35 \cdot (-2,4) + 30 \cdot (-0,6) + (-90)\, y_4 = 0$$

$$y_4 = \frac{72}{-90} = -0,8\,m$$

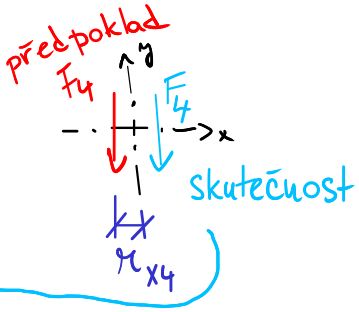
statický střed soustavy $\parallel$ sil (těžiště)

pootočíme síly v jejich počátku např. o 90°

$$M_0 = \sum_{i=1}^{4} F_i x_i = 0 \quad \oplus \circlearrowleft$$

znaménka z obrázku

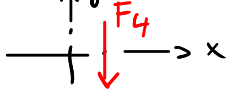
$$\ominus F_1 \cdot |x_1| \ominus F_2 |x_2| \oplus F_3 \cdot |x_3| \oplus F_4 \cdot x_{x4} = 0$$



$$-25 \cdot (1,4) - 35 \cdot 0,8 + 30 \cdot 2,4 + 90 x_{x4} = 0$$

$$x_{x4} = \ominus 0,1\ m$$

Lépe umístit do x>0



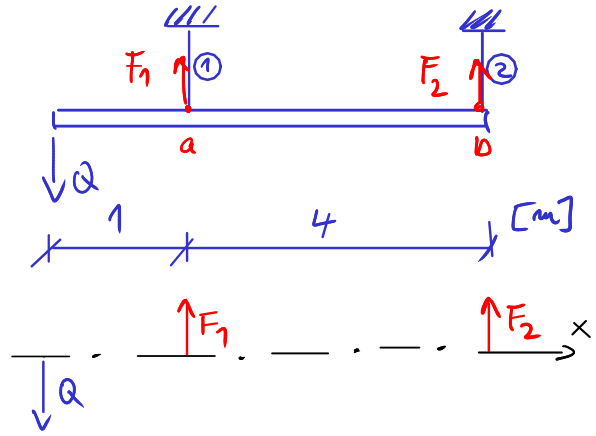
potom $x_{x4} = x_4$

$$\sum_{i=1}^{4} F_{y\,i} \cdot x_i = 0$$

$$25 \cdot (-1,4) + 35 \cdot (-0,8) + 30 \cdot 2,4 + (-90) \cdot x_4 = 0$$

$$x_4 = 0,1\ m$$

i	F_i	x_i	y_i	d_i	F_{xi}
1	25	-1,4	1,2	0	25
2	35	-0,8	-2,4	0	35
3	30	2,4	-0,6	0	30
4	$F_4 = 90$	x_4	y_4	180	-90



$Q = 500N$

$\oplus \circlearrowleft \quad \sum M_{ia} = 0$

$Q \cdot 1 + F_2 \cdot 4 = 0$

$F_2 = -\frac{500}{4} = -125N \ (\downarrow)$

tlak

$\oplus \circlearrowleft \quad \sum M_{ib} = 0$

$Q \cdot 5 - F_1 \cdot 4 = 0$

$F_1 = \frac{500 \cdot 5}{4} = 625N \ (\uparrow)$

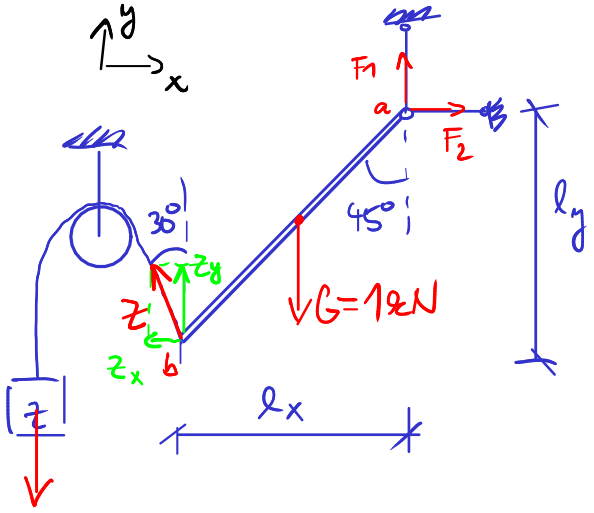
tah

$\oplus \uparrow \quad \sum F_i = 0$

$-Q + F_1 + F_2 = 0$

$-500 + 625 - 125 = 0$

$0 = 0$ ✓



$\oplus \rightarrow \quad \sum F_{xi} = 0$

$F_2 - Z_x = 0$

$F_2 - Z \cdot \sin 30° = 0 \Rightarrow F_2 = Z \sin 30°$

$F_2 = 0{,}183kN$

$\oplus \uparrow \quad \sum F_{yi} = 0$

$-G + F_1 + Z_y = 0$

$-1 + F_1 + Z \cdot \cos 30° = 0 \Rightarrow F_1 = 1 - Z\cos 30°$

$F_1 = 0{,}683kN$

$\oplus \circlearrowleft \quad \sum M_{ai} = 0$

$G \cdot \frac{l_x}{2} - Z_y \cdot l_x - Z_x \cdot l_y = 0$

$G \cdot \frac{l_x}{2} - Z \cdot \cos 30° \cdot l_x - Z \sin 30° \cdot l_y = 0$

$G \cdot \frac{l}{2} = Z \cdot l \left(\cos 30° + \sin 30°\right)$

$Z = \frac{G}{2(\cos 30° + \sin 30°)} = 0{,}366kN$

$tg\,45° = \frac{l_x}{l_y}$

$l_x = l_y \, tg\,45°$

$l_x = l_y = l$