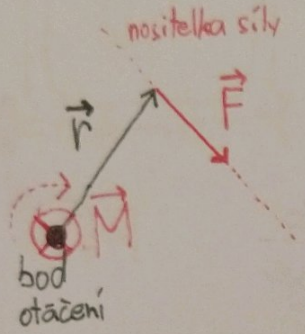
MCH *Z

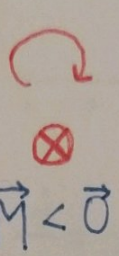
3. cvičení

Moment síly

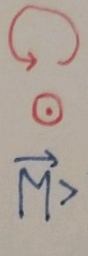
= míra otáčivého účinku síly $\vec{M}$ [Nm]

1)





$\vec{M} < \vec{0}$

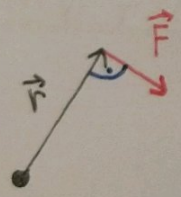


$\vec{M} > \vec{0}$ ... konvence

- pravidlo pravé ruky

$$\vec{M} = \vec{r} \times \vec{F}$$

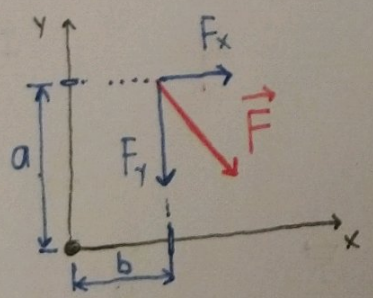
2)



$\vec{F} \perp \vec{r}$ ...

$$|\vec{M}| = |\vec{F}|\,|\vec{r}|$$
$$M = Fr$$

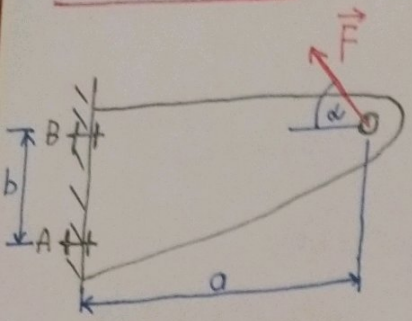
3)



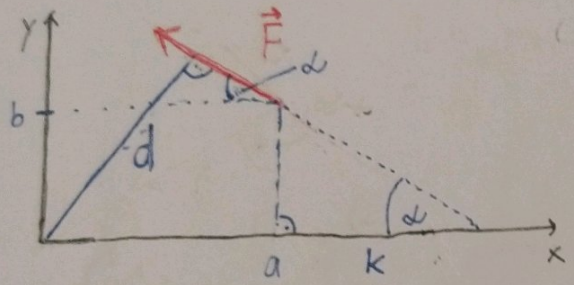
$$M = -F_x a - F_y b$$

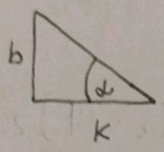
- často takhle ve statice

Příklad 1 – konzola, $F = 3{,}75\ kN$, $a = 5\ m$, $b = 3\ m$, $\alpha = 30°$

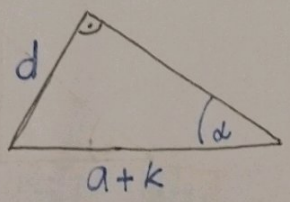


a) z definice





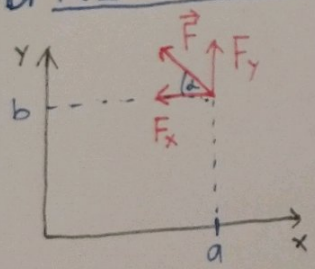
$$tg\alpha = \frac{b}{k} \Rightarrow k = \frac{b}{tg\alpha}$$



$$d = (a+k)\sin\alpha$$

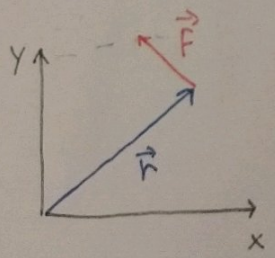
$$M = F\,d = \underline{1587\ Nm}$$

b) rozkladem sil



$$F_x = F\cos\alpha$$
$$F_y = F\sin\alpha$$
$$M = F_x b + F_y a = 1587\ Nm$$

c) vektorový součin

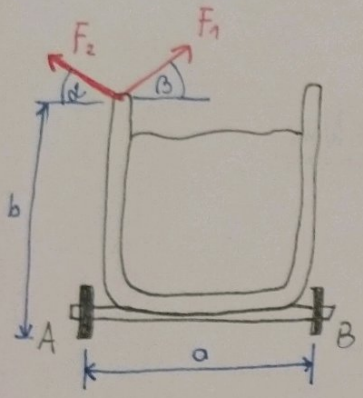


$$\vec{F} = (-F_x, F_y, 0) = (-F\cos\alpha, F\sin\alpha, 0)$$
$$\vec{r} = (a, b, 0)$$
$$\vec{M} = \vec{r} \times \vec{F} = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ a & b & 0 \\ -F_x & F_y & 0 \end{vmatrix} = \left(F_y a - (-F_x b)\right)\vec{k} =$$

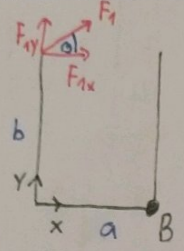
$$= \underline{(0, 0, 1587)\ Nm}$$

Příklad 2 - důlní vozík, střídavě působí síly

$F_1 = 700\ N$ $a = 750\ mm$
$F_2 = 700\ N$ $b = 1000\ mm$
$m = 200\ kg$ $\alpha = 30°$
$\beta = 45°$

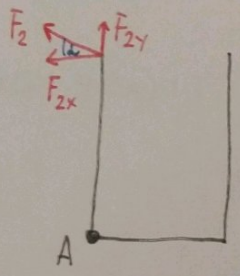


a) moment síly F_1 ke kolejnici B



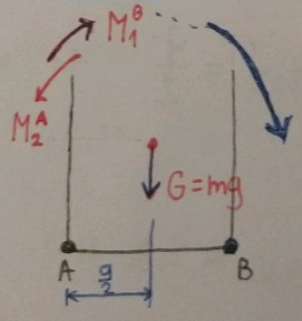
$$M_1^B = F_1 \cos\beta\, b + F_1 \sin\beta\, a =$$
$$= 700 \cos(45°) \cdot 1 + 700 \sin(45°) \cdot 0{,}75 = \underline{866\ Nm}$$

b) moment síly F_2 ke kolejnici A



$$M_2^A = F_2 \cos\alpha\, b = 700 \cos(30°) \cdot 1 = \underline{606\ Nm}$$

Dojde k přerržení ?

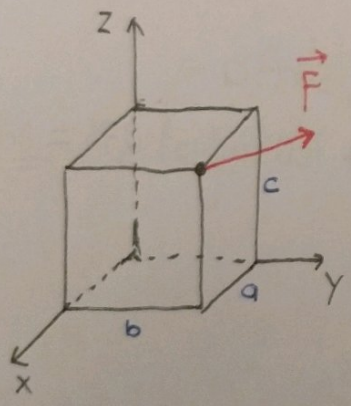


$$M_G^A = M_G^B = mg\,\frac{a}{2} = \underline{735{,}75\ Nm}$$

Příklad 3

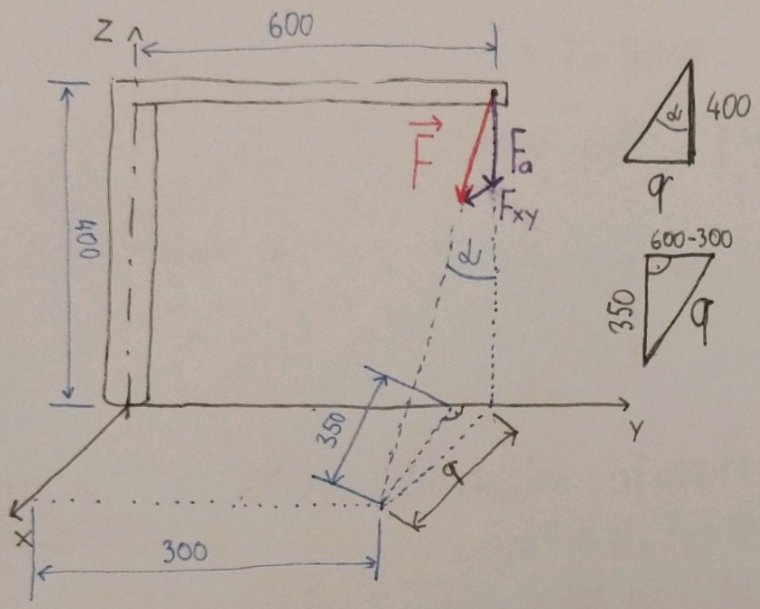
- vypočtěte moment síly k počátku s.s.

$F_x = 2kN$, $F_y = 3kN$, $F_z = 4kN$, $a = 1m$, $b = 2m$, $c = 3m$



$$\vec{M} = \vec{r} \times \vec{F} = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 1 & 2 & 3 \\ 2 & 3 & 4 \end{vmatrix} = (-1, 2, -1)\ kNm$$

Příklad 4 - určete zatížení ložisek F_a, F_r a M_o, $F = 610\,N$



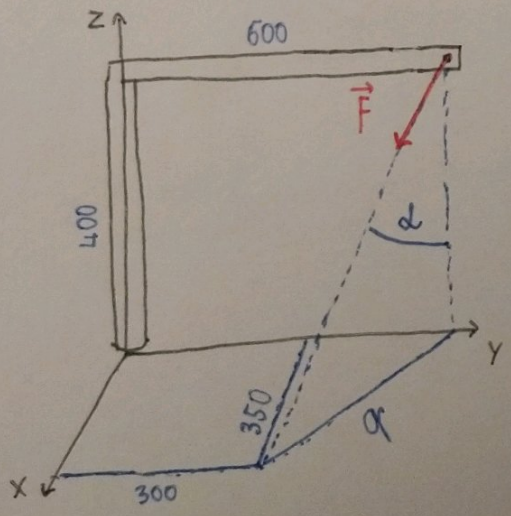
$$q = \sqrt{350^2 + 300^2} =$$

$$\alpha = \operatorname{arctg}\left(\frac{q}{400}\right) =$$

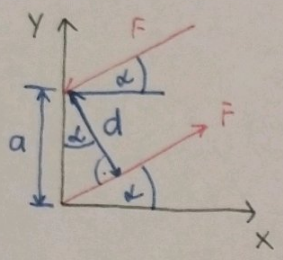
$$F_a = F \cos\alpha$$

$$F_{xy} = \sqrt{F - F_a} =$$

$$\vec{M} = \vec{r} \times \vec{F} = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 0 & 600 & 0 \\ F_x & F_y & 0 \end{vmatrix} = -600\,F_x\,\vec{k}$$



Příklad 5 - určete moment silové dvojice $F = 150\ N$, $a = 10\ cm$, $\alpha = 30°$



$$d = a \cos\alpha$$

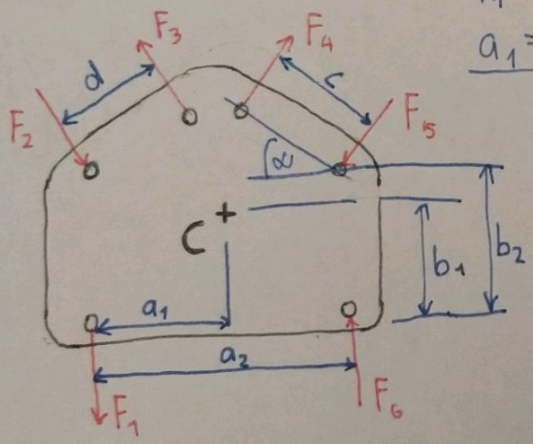
$$M = d \cdot F = 0{,}1 \cos(30°) \cdot 150 = \underline{12{,}9\ Nm}$$

- nahrazení silové dvojice momentem

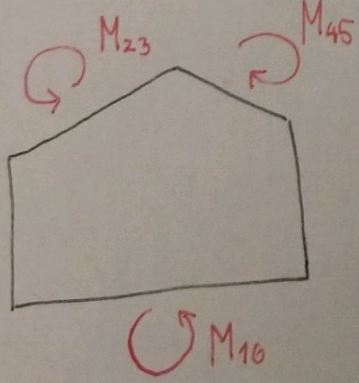
Příklad 6 - ocelová deska připevněná v bodě C

$F_1 = 150\ N$, $F_2 = 250\ N = F_3$, $F_4 = 350\ N = F_5$, $F_6 = 150\ N$

$a_1 = 160\ mm$, $b_1 = 80\ mm$, $b_2 = 200\ mm$, $c = 150\ mm = d$, $\alpha = 20°$



"Moment dvojice sil je stejný k libovolnému bodu."



$$M_C = M_{23} - M_{45} + M_{16}$$