Today's Session Summary

- Tower crane
- Forces and Equilibrium

Crane Optimization

UNIVERSIDAD
TORCUATO DI TELLA

Crane Optimization

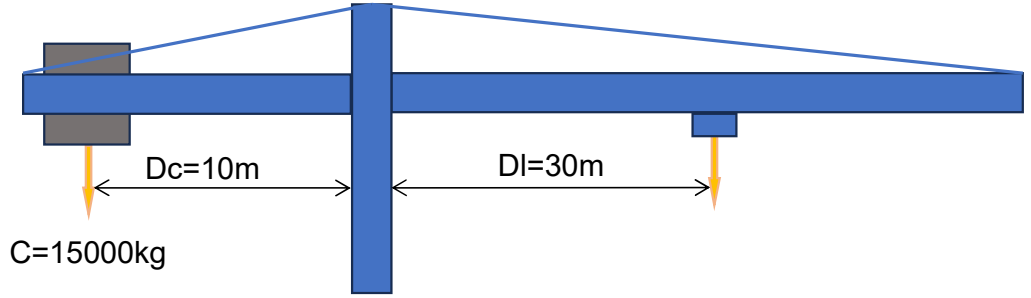
Equilibrium - Balance

Load Displacement

Structure

Elements

Optimization

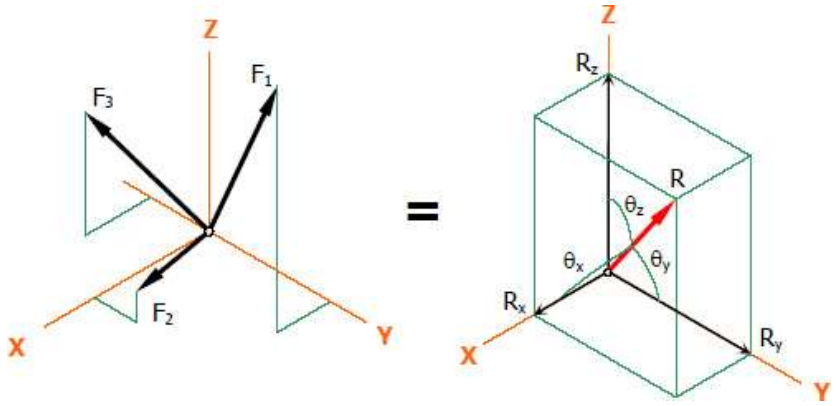


Forces and Equilibrium

Concurrent Forces

Resultant force

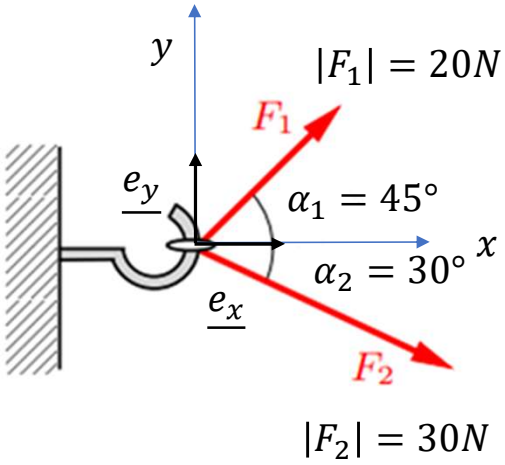
$$\begin{bmatrix} \sum_i F_{ix} \\ \sum_i F_{iy} \\ \sum_i F_{iz} \end{bmatrix} = \begin{bmatrix} R_x \\ R_y \\ R_z \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$$



https://knowledge4civil.wordpress.com/2016/12/14/resultant-of-concurrent-force-system/

Forces and Equilibrium

Planar Concurrent Forces



$$\underline{R} = \underline{F_1} + \underline{F_2}$$

$$R_x\underline{e_x} + R_y\underline{e_y} = F_{1x}\underline{e_x} + F_{1y}\underline{e_y} + F_{2x}\underline{e_x} + F_{2y}\underline{e_y}$$

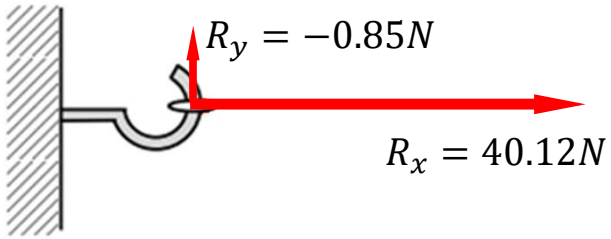
$\underline{e_x}$) $R_x = F_{1x} + F_{2x} = 20N\cos(45°) + 30\text{N}\cos(30°)$

$$R_x = 40.12N$$

$\underline{e_y}$) $R_y = F_{1y} + F_{2y} = 20N\sin(45°) - 30\text{N}\sin(30°)$

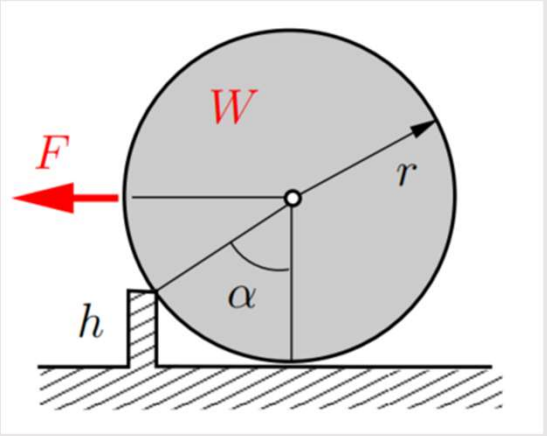
$$R_y = -0.85N$$

Resultant force



Practice

1) Draw the free body diagram
2) Find F necessary to roll the cylinder over the obstacle



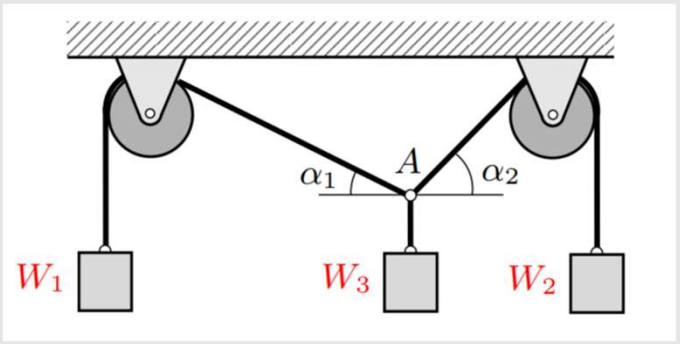
$\underline{e_x}) \quad 0N = -F + Rsin(\alpha)$

$\underline{e_y}) \quad 0N = -W + Rcos(\alpha)$

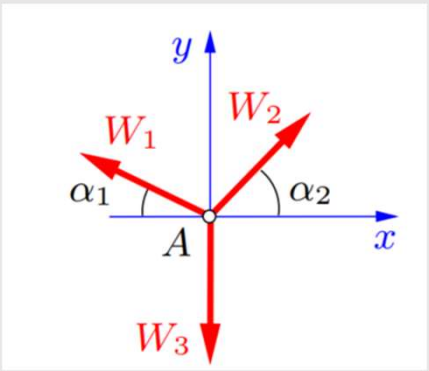
$$\frac{F}{W} = tan(\alpha)$$

Practice

1) Draw the free body diagram for W_3
2) Find α_1 and α_2 when $W_1 = 2N; W_2 = 2N$ and $W_3 = 0N$
3) Find α_1 and α_2 when $W_1 = 2N; W_2 = 3N$ and $W_3 = 3N$
4) Find α_1 and α_2 when $W_1 = 2N; W_2 = 2N$ and $W_3 = 3N$



$\underline{e_x}\big)$ $\quad 0N = T_{1x} + T_{2x} = -W_1 cos(\alpha_1) + W_2 cos(\alpha_2)$



$\underline{e_y}\big)$ $\quad 0N = T_{1y} + T_{2y} + T_{3y} = W_1 sin(\alpha_1) + W_2 sin(\alpha_2) - W_3$

$$cos(\alpha_1) = \frac{W_2}{W_1} cos(\alpha_2) \qquad sin(\alpha_1) = \frac{W_3 - W_2 sin(\alpha_2)}{W_1}$$

Practice

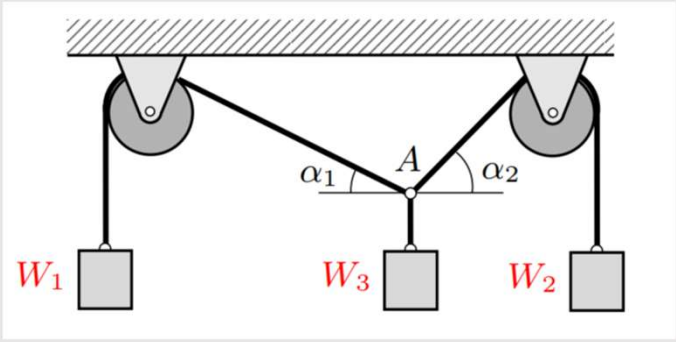
$$cos(\alpha_1) = \frac{W_2}{W_1} cos(\alpha_2) \qquad sin(\alpha_1) = \frac{W_3 - W_2 sin(\alpha_2)}{W_1}$$

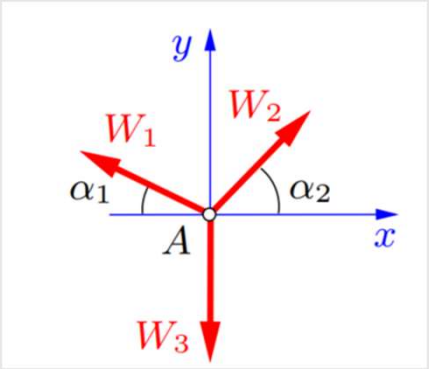
$$1 = \left(\frac{W_2}{W_1} cos(\alpha_2)\right)^2 + \left(\frac{W_3 - W_2 sin(\alpha_2)}{W_1}\right)^2$$

$$\left(\frac{W_1}{W_2}\right)^2 = \left(cos(\alpha_2)\right)^2 + \left(\frac{W_3}{W_2} - sin(\alpha_2)\right)^2$$

$$\left(\frac{W_1}{W_2}\right)^2 = \left(cos(\alpha_2)\right)^2 + \left(\frac{W_3}{W_2}\right)^2 - 2\frac{W_3}{W_2} sin(\alpha_2) + \left(sin(\alpha_2)\right)^2$$

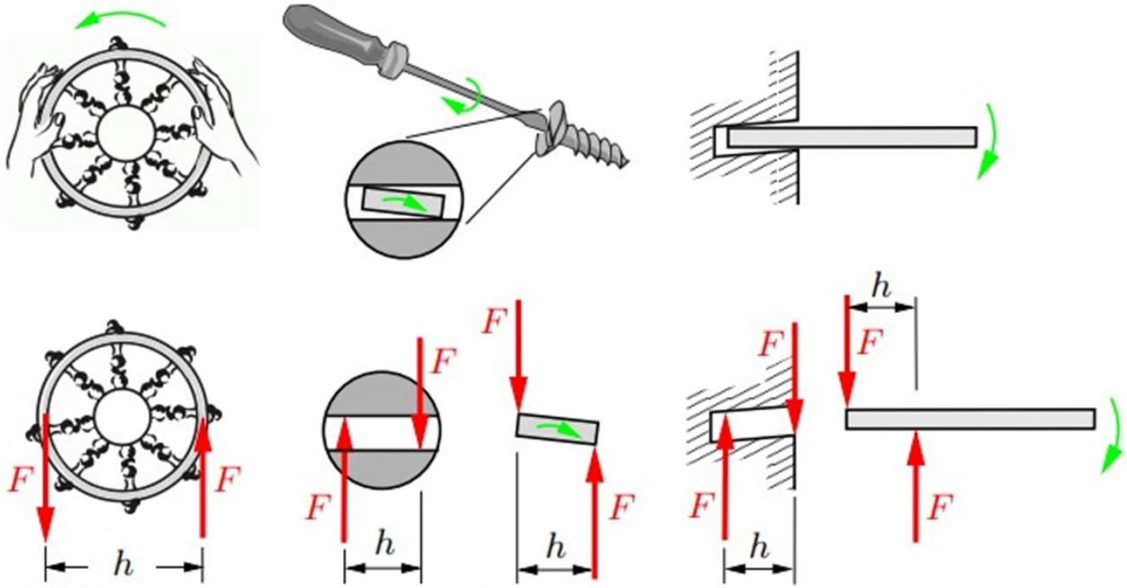
$$\alpha_2 = asin\left(\frac{W_2}{2W_3}\left(1 + \left(\frac{W_3}{W_2}\right)^2 - \left(\frac{W_1}{W_2}\right)^2\right)\right)$$



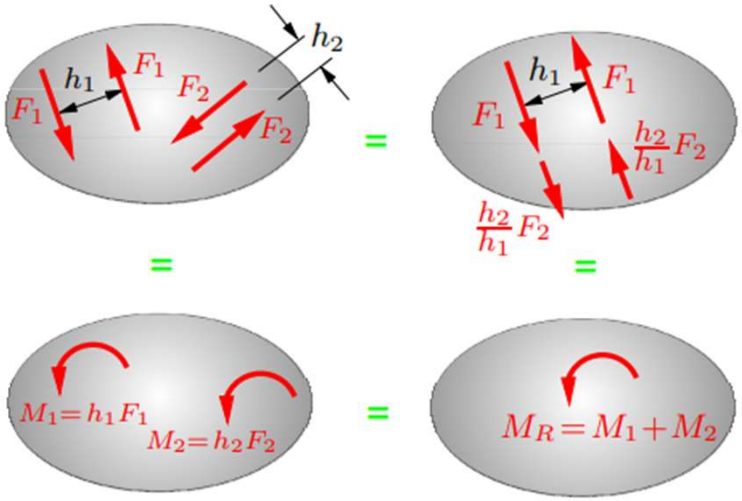


Moments and Equilibrium

Couples



Resulting moment

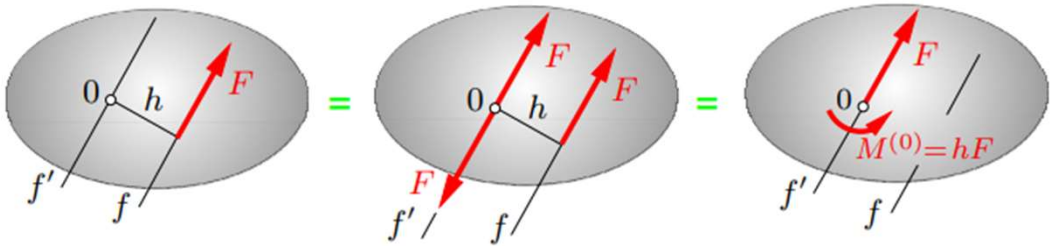


$$\sum_i \boldsymbol{M}_i = \boldsymbol{M}_R = 0$$

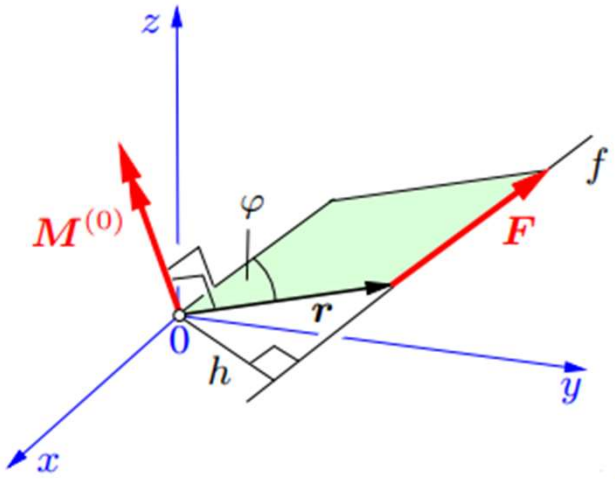
Engineering Mechanics 1: Statics 2nd ed. 2013 Edición de Dietmar Gross, Werner Hauger, Jörg Schröder, Wolfgang A. Wall, Nimal Rajapakse.

Moments and Equilibrium

Moment of a force



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



Engineering Mechanics 1: Statics 2nd ed. 2013 Edición
de Dietmar Gross, Werner Hauger, Jörg Schröder, Wolfgang A. Wall, Nimal Rajapakse.

Equilibrium

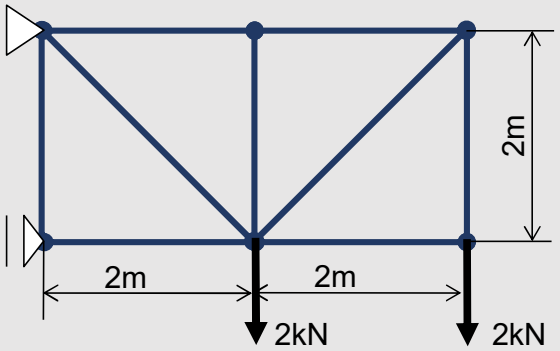
$$\sum \boldsymbol{F}_i = \mathbf{0}\,, \quad \sum \boldsymbol{M}_i^{(A)} = \mathbf{0}\,.$$

$$\begin{aligned} \sum F_{ix} &= 0\,, & \sum M_{ix}^{(A)} &= 0\,, \\ \sum F_{iy} &= 0\,, & \sum M_{iy}^{(A)} &= 0\,, \\ \sum F_{iz} &= 0\,, & \sum M_{iz}^{(A)} &= 0\,. \end{aligned}$$

Engineering Mechanics 1: Statics 2nd ed. 2013 Edición
de Dietmar Gross, Werner Hauger, Jörg Schröder, Wolfgang A. Wall, Nimal Rajapakse.

Practice

Equilibrium - Planar Example



End Session 11