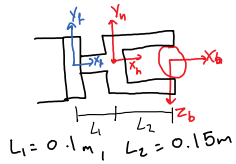


Wrench Example

Wednesday, 3 November 2021 11:17 AM

Wrenches = Forces + Torques



$$M_b = 0.1 \text{ kg}$$

$$g = 10 \text{ m/s}^2$$

$$M_h = 0.5 \text{ kg}$$

$$T_{hf} = \begin{bmatrix} 1 & 0 & 0 & -0.1 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$T_{bf} = \begin{bmatrix} 1 & 0 & 0 & -0.25 \\ 0 & 0 & 1 & 0 \\ 0 & -1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$Ad_{T_{hf}} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad T = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} F_h \\ F_b \end{bmatrix}$$

$$Ad_{T_{bf}} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & -1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad T = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} F_h \\ F_b \end{bmatrix}$$

$$F = [m_x, m_y, m_z, p_x, p_y, p_z] \quad F_b = (Ad_{T_{ab}})^T F_a$$

$$Ad_{T_{ab}} = \begin{bmatrix} R & 0 \\ [P]R & R \end{bmatrix}^{6 \times 6} \quad T_{ab} = \begin{bmatrix} R & P \\ 0 & I \end{bmatrix}^{4 \times 4} \quad [P] = \begin{bmatrix} 0 & -P_3 & P_2 \\ P_3 & 0 & -P_1 \\ -P_2 & P_1 & 0 \end{bmatrix}$$

$$F_h = [0 \ 0 \ 0 \ 0 \ -5 \ 0]$$

$$F_b = [0 \ 0 \ 0 \ 0 \ 0 \ 1]$$

$$F_f = Ad_{T_{hf}}^T F_h + Ad_{T_{bf}}^T F_b$$

$$= [0 \ 0 \ -0.5 \ 0 \ -5 \ 0]^T + [0 \ 0 \ -0.25 \ 0 \ -1 \ 0]$$

$$= [0 \ 0 \ -0.75 \ 0 \ -6 \ 0]$$

$$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & -0.25 \\ 0 & -0.25 & 0 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & -1 & 0 \end{bmatrix}$$

$$= \begin{bmatrix} 0 & 0 & 0 \\ 0 & -0.25 & 0 \\ 0 & 0 & -0.25 \end{bmatrix}$$