Title of this document

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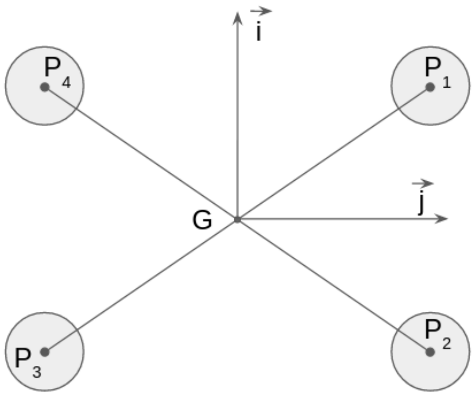
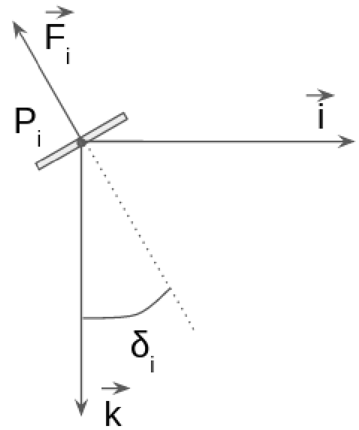
1 Structures





2 Classical mechanics

2.1 Geometry

$$\vec{GP_i} = d(\cos\theta_i \vec{i} + \sin\theta_i \vec{j}), \forall i \in [\![1, 4]\!]$$

2.2 Dynamics

$$\boxed{\begin{aligned}
\vec{F} &= \sum_{i=1}^{4} \vec{F_i} \\
&= -\sum_{i=1}^{4} T_i(\cos\delta_i \vec{k} + \sin\delta_i \vec{i}) \qquad , avec \;\; T_i = K_L \bar{\omega}_i^2 \\
&= -K_L \sum_{i=1}^{4} (\cos\delta_i \vec{k} + \sin\delta_i \vec{i}) \bar{\omega}_i^2
\end{aligned}} \tag{1}$$

$$\boxed{\begin{aligned}
\vec{M} &= \sum_{i=1}^{4} \vec{GP_i} \times \vec{F_i} + \sum_{i=1}^{4} (-1)^i K_D \bar{\omega}_i^2 (\cos\delta_i \vec{k} + \sin\delta_i \vec{i}) \\
&= \sum_{i=1}^{4} d(\cos\theta_i \vec{i} + \sin\theta_i \vec{j}) \times T_i(\cos\delta_i \vec{k} + \sin\delta_i \vec{i}) \\
&\quad + \sum_{i=1}^{4} (-1)^i K_D \bar{\omega}_i^2 (\cos\delta_i \vec{k} + \sin\delta_i \vec{i}) \\
&= d \sum_{i=1}^{4} T_i(\cos\theta_i \cos\delta_i \vec{j} - \sin\theta_i \cos\delta_i \vec{i} + \sin\theta_i \sin\delta_i \vec{k}) \\
&\quad + \sum_{i=1}^{4} (-1)^i K_D \bar{\omega}_i^2 (\cos\delta_i \vec{k} + \sin\delta_i \vec{i})
\end{aligned}} \tag{2}$$

Figure 2: Force & Torques

2.3 Projection on the main axes

$$
\begin{aligned}
\vec{F} &= -K_L.\sum_{i=1}^{4}(\cos\delta_i\vec{k} + \sin\delta_i\vec{i})\bar{\omega}_i^2 \\
M_{\vec{i}} &= -d.K_L.\sum_{i=1}^{4}\sin\theta_i\cos\delta_i\bar{\omega}_i^2 + K_D\sum_{i=1}^{4}(-1)^i\sin\delta_i\bar{\omega}_i^2 \\
M_{\vec{j}} &= d.K_L.\sum_{i=1}^{4}\cos\theta_i\cos\delta_i\bar{\omega}_i^2 \\
M_{\vec{k}} &= d.K_L.\sum_{i=1}^{4}\sin\theta_i\sin\delta_i\bar{\omega}_i^2 + K_D\sum_{i=1}^{4}(-1)^i\cos\delta_i\bar{\omega}_i^2
\end{aligned}
\tag{3}
$$

3 Simplification

3.1 Hypotheses

$$
\boxed{\begin{aligned}
\delta_R &= \delta_1 = \delta_2 \\
\delta_L &= \delta_3 = \delta_4 \\
\delta_L &= -\delta_R \\
\delta_R &= o(1)
\end{aligned}}
\tag{4}
$$

$$
\boxed{\begin{aligned}
\vec{F} &= -K_L.\sum_{i=1}^{4}\bar{\omega}_i^2\vec{k} \\
M_{\vec{i}} &= -d.K_l.\sum_{i=1}^{4}\sin\theta_i\bar{\omega}_i^2 \\
M_{\vec{j}} &= d.K_l.\sum_{i=1}^{4}\cos\theta_i\bar{\omega}_i^2 \\
M_{\vec{k}} &= d.K_l.\delta_D.\sum_{i=1}^{4}(-1)^{\llbracket\frac{i-1}{2}\rrbracket}\sin\theta_i\bar{\omega}_i^2 + K_D\sum_{i=1}^{4}(-1)^i\bar{\omega}_i^2
\end{aligned}}
\tag{5}
$$

4 Computation

$$
\begin{aligned}
\begin{pmatrix}\vec{F}\\ M_{\vec{i}}\\ M_{\vec{j}}\end{pmatrix} &= K_L.\begin{pmatrix}1 & 0 & 0\\ 0 & -d & 0\\ 0 & 0 & d\end{pmatrix}.\begin{pmatrix}1 & 1 & 1 & 1\\ \sin\theta_1 & \sin\theta_2 & \sin\theta_3 & \sin\theta_4\\ \cos\theta_1 & \cos\theta_2 & \cos\theta_3 & \cos\theta_4\end{pmatrix}.\bar{\omega}^2 \\
&= A_1.\bar{\omega}^2
\end{aligned}
\tag{6}
$$

$$
\boxed{\bar{\omega}^2 = A_1^*.\begin{pmatrix}\vec{F}\\ M_{\vec{i}}\\ M_{\vec{j}}\end{pmatrix} \qquad ,avec\ \ A_1^* = A_1^T.(A_1.A_1^T)^{-1}}
\tag{7}
$$

$$
\boxed{\delta_D = \frac{M_{\vec{k}} - K_D\sum_{i=1}^{4}(-1)^i\bar{\omega}_i^2}{d.K_l.\sum_{i=1}^{4}(-1)^{\llbracket\frac{i-1}{2}\rrbracket}\sin\theta_i\bar{\omega}_i^2}}
\tag{8}
$$