Calcul des déformations des ressorts hélicoïdaux

Ressort cylindrique - Force distribuée parallèle à l'axe

Flexion et torsion

Fil rond en acier

$d := 5 \cdot mm$ $\quad S := \pi \cdot \frac{d^2}{4}$ $\quad E := 2.0 \cdot 10^5 \cdot N \cdot mm^{-2}$ $\quad G := \frac{E}{2.5}$ $\quad \rho := 7.85 \cdot 10^3 \cdot kg \cdot m^{-3}$

Référence :E:\Résonateur (TA)\Tables\Modules J, I et W des barres élastiques.mcd(R)

$J_t := J_{t\_circ}(d)$ $\quad I_{22} := I_{f\_circ}(d)$ $\quad I_{33} := I_{22}$

$W_t := W_{t\_circ}(d)$ $\quad W'_t := W_t$ $\quad W_{f2} := W_{f\_circ}(d)$ $\quad W_{f3} := W_{f2}$

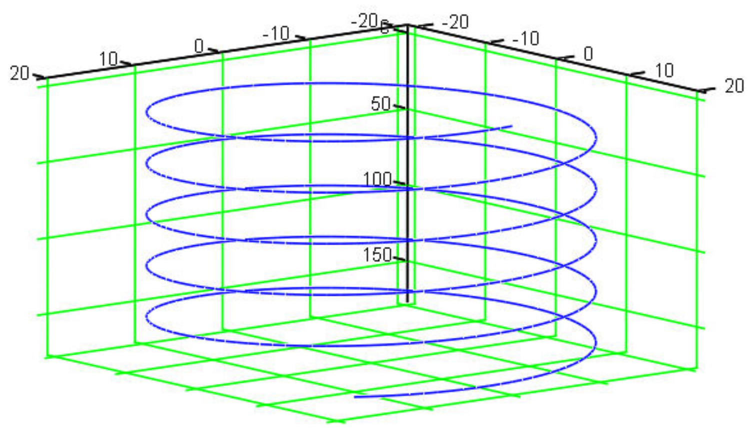
Caractéristiques du ressort $\quad D := 40 \cdot mm$ $\quad R := 0.5 \cdot D$ $\quad n_{sp} := 5.125$ $\quad \psi_{AB} := 2 \cdot \pi \cdot n_{sp}$

$\beta := 15 \cdot deg$ $\quad p := 2 \cdot \pi \cdot R \cdot tan(\beta)$ $\quad s(\alpha) := R \cdot \alpha \cdot cos(\beta)^{-1}$ $\quad L := s(\psi_{AB})$ $\quad L = 66.675\, cm$

Forme du ressort

$x_0(\alpha) := R \cdot cos(\alpha)$ $\quad y_0(\alpha) := R \cdot sin(\alpha)$ $\quad z_0(\alpha) := R \cdot tan(\beta) \cdot \alpha$

$n := 100 \cdot n_{sp} + 1$ $\quad i := 0 .. n-1$ $\quad {\alpha_0}_i := \frac{\psi_{AB}}{n-1} \cdot i$ $\quad x_i := x_0({\alpha_0}_i)$ $\quad y_i := y_0({\alpha_0}_i)$ $\quad z_i := z_0({\alpha_0}_i)$



$\left(\frac{x}{mm}, \frac{y}{mm}, \frac{z}{mm}\right)$

Force distribuée gravitationnelle $\quad \psi_q := \psi_{AB}$

$q_0 := \rho \cdot g \cdot S$ $\quad P_{fil} := q_0 \cdot L$ $\quad P_{fil} = 1.008\, N$

$q_x(\chi) := 0 \cdot N \cdot m^{-1}$ $\quad q_y(\chi) := 0 \cdot N \cdot m^{-1}$ $\quad q_z(\chi) := q_0$

Référence :E:\Résonateur (TA)\Ressorts hélicoïdaux\Ressort hélicoïdal E_L - q.mcd(R)

Torseur des forces de cohésion

$\alpha_M := 45 \cdot deg \qquad \mathbf{M_q}(\alpha_M)^T = (-0.014 \quad 0.014 \quad 0)\, N \cdot m$

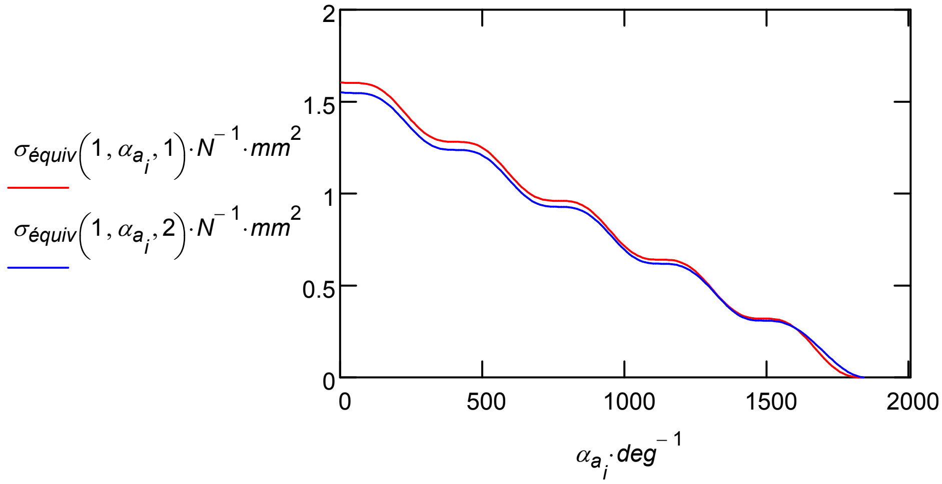
Sollicitations

Moment de torsion $\qquad M_{qt}(\alpha_M) = 0.019\, N \cdot m$

Moments de flexion $\qquad M_{qf2}(\alpha_M) = 0\, N \cdot m \qquad M_{qf3}(\alpha_M) = -5.09 \times 10^{-3}\, N \cdot m$

Contraintes

$n := 201 \qquad i := 1 .. n-1 \qquad \alpha_{a_i} := (i-1) \cdot \frac{\psi_{AB}}{n-1}$



Calcul des déplacements linéiques $\qquad$ Position du déplacement désiré $\qquad \alpha_M := \psi_{AB}$

Déplacement dans la direction de Ox $\qquad \lambda := 0 \cdot deg \qquad \gamma := 90 \cdot deg \qquad |\mathbf{v}(\lambda, \gamma)| = 1$

$\delta_{qtv}(\alpha_M, \lambda, \gamma) = -5.791 \times 10^{-3}\, mm \qquad \delta_{qfv2}(\alpha_M, \lambda, \gamma) = -1.781 \times 10^{-3}\, mm$

$\delta_{qfv3}(\alpha_M, \lambda, \gamma) = 3.333 \times 10^{-3}\, mm \qquad \delta_x(\alpha) := \delta_{qv}(\alpha, \lambda, \gamma) \qquad \boxed{\delta_x(\alpha_M) = -4.239 \times 10^{-3}\, mm}$

Déplacement dans la direction de Oy $\qquad \lambda := 90 \cdot deg \qquad \gamma := 90 \cdot deg \qquad |\mathbf{v}(\lambda, \gamma)| = 1$

$\delta_{qtv}(\alpha_M, \lambda, \gamma) = 0.021\, mm \qquad \delta_{qfv2}(\alpha_M, \lambda, \gamma) = 2.136 \times 10^{-3}\, mm$

$\delta_{qfv3}(\alpha_M, \lambda, \gamma) = -3.066 \times 10^{-3}\, mm \qquad \delta_y(\alpha) := \delta_{qv}(\alpha, \lambda, \gamma) \qquad \boxed{\delta_y(\alpha_M) = 0.02\, mm}$

Déplacement dans la direction de Oz $\qquad \lambda := 0 \cdot deg \qquad \gamma := 0 \cdot deg \qquad |\mathbf{v}(\lambda, \gamma)| = 1$

$\delta_{qtv}(\alpha_M, \lambda, \gamma) = 0.024\, mm \qquad \delta_{qfv2}(\alpha_M, \lambda, \gamma) = 1.812 \times 10^{-6}\, mm$

$\delta_{qfv3}(\alpha_M, \lambda, \gamma) = 1.403 \times 10^{-3}\, mm \qquad \delta_z(\alpha) := \delta_{qv}(\alpha, \lambda, \gamma) \qquad \boxed{\delta_z(\alpha_M) = 0.026\, mm}$

Calcul des déplacements angulaires

Déplacement angulaire autour de Ox $\lambda_c := 0 \cdot deg$ $\gamma_c := 90 \cdot deg$ $|\mathbf{cv}(\lambda, \gamma)| = 1$

$\theta_{qtcv}(\alpha_M, \lambda_c, \gamma_c) = -6.002 \times 10^{-3} deg$ $\theta_{qfcv2}(\alpha_M, \lambda_c, \gamma_c) = -1.335 \times 10^{-3} deg$

$\theta_{qfcv3}(\alpha_M, \lambda_c, \gamma_c) = -3.448 \times 10^{-4} deg$ $\theta_x(\alpha) := \theta_{qcv}(\alpha, \lambda_c, \gamma_c)$ $\boxed{\theta_x(\alpha_M) = -7.682 \times 10^{-3} deg}$

Déplacement angulaire autour de Oy $\lambda_c := 90 \cdot deg$ $\gamma_c := 90 \cdot deg$ $|\mathbf{cv}(\lambda, \gamma)| = 1$

$\theta_{qtcv}(\alpha_M, \lambda_c, \gamma_c) = -1.566 \times 10^{-3} deg$ $\theta_{qfcv2}(\alpha_M, \lambda_c, \gamma_c) = -1.342 \times 10^{-3} deg$

$\theta_{qfcv3}(\alpha_M, \lambda_c, \gamma_c) = -8.992 \times 10^{-5} deg$ $\theta_y(\alpha) := \theta_{qcv}(\alpha, \lambda_c, \gamma_c)$ $\boxed{\theta_y(\alpha_M) = -2.998 \times 10^{-3} deg}$

Déplacement angulaire autour de Oz $\lambda_c := 0 \cdot deg$ $\gamma_c := 0 \cdot deg$ $|\mathbf{cv}(\lambda, \gamma)| = 1$

$\theta_{qtcv}(\alpha_M, \lambda_c, \gamma_c) = 0.02\, deg$ $\theta_{qfcv2}(\alpha_M, \lambda_c, \gamma_c) = 0\, deg$

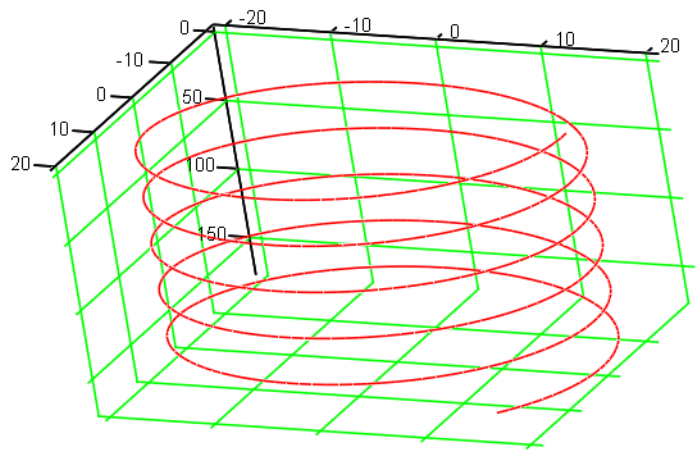
$\theta_{qfcv3}(\alpha_M, \lambda_c, \gamma_c) = -0.016\, deg$ $\theta_z(\alpha) := \theta_{qcv}(\alpha, \lambda_c, \gamma_c)$ $\boxed{\theta_z(\alpha_M) = 3.919 \times 10^{-3} deg}$

Graphe de la déformation

$x_d(\alpha) := x_0(\alpha) + \delta_x(\alpha)$ $y_d(\alpha) := y_0(\alpha) + \delta_y(\alpha)$ $z_d(\alpha) := z_0(\alpha) + \delta_z(\alpha)$

$x'_d(\alpha) := \frac{d}{d\alpha} x_d(\alpha)$ $y'_d(\alpha) := \frac{d}{d\alpha} y_d(\alpha)$ $z'_d(\alpha) := \frac{d}{d\alpha} z_d(\alpha)$

$X := \overrightarrow{x_d(\alpha_0)}$ $Y := \overrightarrow{y_d(\alpha_0)}$ $Z := \overrightarrow{z_d(\alpha_0)}$



$$\left(\frac{X}{mm}, \frac{Y}{mm}, \frac{Z}{mm}\right)$$