$$
\begin{cases}
\dot{\boldsymbol{u}} = \dfrac{X + (m + m_y)v_m r + x_G m r^2}{(m + m_x)} \\
\dot{\boldsymbol{v}}_{\boldsymbol{m}} = \dfrac{Y - (m + m_x)ur - x_G m\dot{\boldsymbol{r}}}{(m + m_y)} \\
\dot{\boldsymbol{r}} = \dfrac{N_m - x_G m(\dot{\boldsymbol{v}}_{\boldsymbol{m}} + ur)}{(I_{zG} + x_G^2 m + J_z)} \\
\dot{\boldsymbol{\psi}} = r \\
\dot{\boldsymbol{x}} = u\cos\psi - v_m \sin\psi \\
\dot{\boldsymbol{y}} = v_m \cos\psi + u\sin\psi
\end{cases}
$$

$$
\begin{cases}
X = X_H + X_R + X_P \\
X_H = 0.5\rho L_{pp} d(u^2 + v_m^2)(-R_0' + X_{vv}' v_m'^2 + X_{vr}' v_m' r' + X_{rr}' r'^2 + X_{vvvv}' v_m'^4) \\
X_R = -(1 - t_R)0.5\rho A_R(u_R^2 + v_R^2) f_\alpha \, sin\left(\delta - \frac{v_R}{u_R}\right) sin\,\delta \\
X_P = (1 - t_P)\rho n_P^2 D_P^4 \left(k_2 J_P^2 + k_1 J_p + k_0\right)
\end{cases}
$$

$$
\begin{cases}
Y = Y_H + Y_R \\
Y_H = 0.5\rho L_{pp} d(u^2 + v_m^2)(Y_v' v_m' + Y_R' r' + Y_{vvv}' v_m'^3 + Y_{vvr}' v_m'^2 r' + Y_{vrr}' v_m' r'^2 + Y_{rrr}' r'^3) \\
Y_R = -(1 + a_H)0.5\rho A_R(u_R^2 + v_R^2) f_\alpha \, sin(\delta - \frac{v_R}{u_R})\, cos\,\delta
\end{cases}
$$

$$
\begin{cases}
N_m = N_H + N_R \\
N_H = 0.5\rho L_{pp}^2 d(u^2 + v_m^2)(N_v' v_m' + N_R' r' + N_{vvv}' v_m'^3 + N_{vvr}' v_m'^2 r' + N_{vrr}' v_m' r'^2 + N_{rrr}' r'^3) \\
N_R = -(x_R + a_H x_H)0.5\rho A_R(u_R^2 + v_R^2) f_\alpha \, sin(\delta - \frac{v_R}{u_R})\, cos\,\delta
\end{cases}
$$

$$
\begin{cases}
v_m' = \frac{v_m}{\sqrt{u^2 + v_m^2}} \\
r' = \frac{r L_{pp}}{\sqrt{u^2 + v_m^2}} \\
J_P = \frac{u(1 - w_P)}{n_P D_P} \\
v_R = \sqrt{u^2 + v_m^2}\,\gamma_R \beta_R \\
u_R = \varepsilon u(1 - w_P)\sqrt{\eta\left\{1 + \kappa\left(\sqrt{1 + \frac{8\left[k_2 J_P^2 + k_1 J_P + k_0\right]}{\pi J_P^2}} - 1\right)\right\} + (1 - \eta)} \\
\beta_R = (\beta - l_R' r') \\
\beta = tan^{-1}\frac{-v_m}{u} \\
\eta = \frac{D_P}{H_R} \\
\beta_P = (\beta - x_P' r') \\
w_P = -(1 - \exp(-C_1|\beta_P|))(C_2 - 1)(1 - w_{P0}) \\
I_z = m(0.25 L_{pp})^2
\end{cases}
$$

Elenco parametri noti:

- x_G
- J_z = *Jz'*0.5rhoLpp^4d*
- m_y = *my'*0.5rhoLpp^2d*
- m_x
- L_{pp}
- d
- R'_0
- X'_{vv}
- X'_{vr}
- X'_{rr}
- X'_{vvvv}
- Y'_v
- Y'_R
- Y'_{vvv}
- Y'_{vvr}
- Y'_{vrr}
- Y'_{rrr}
- N'_v
- N'_R
- N'_{vvv}
- N'_{vvr}
- N'_{vrr}
- N'_{rrr}
- t_R
- t_P
- (k_2, k_1, k_0)
- f_α
- D_P
- A_R
- ε
- κ
- a_H
- l'_R
- β_R
- x_H *moltiplicare per Lpp*
- np
- H_R
- m = ∇*rho*
- C_1
- C_2

Elenco parametri non utilizzati:

- B
- C_b