$$
\begin{bmatrix}
\Sigma M & 0 & 0 & 0 & \gamma_3 & -\gamma_2 & -\delta\cos\theta_F \chi_F m_F & 0 \\
0 & \Sigma M & 0 & -\gamma_3 & 0 & \gamma_1 & \chi_F m_F & -\rho_D m_D \\
0 & 0 & \Sigma M & \gamma_2 & -\gamma_1 & 0 & 0 & -\phi_D \rho_D m_D \\
\delta\cos\theta_F \sin\theta_F \chi_F'' m_F & -\zeta_R m_R - (\zeta_D - \rho_D) m_D & \delta\cos^2\theta_F \chi_F'' m_F & I_{RX} + \zeta_R^2 m_R + \zeta_D (\zeta_D - \rho_D) m_D & \delta\left(I_{FX}'' - I_{FY}'' - \chi_F''^2 m_F\right) & -I_{RXZ} - \chi_R \zeta_R m_R - \chi_D (\zeta_D - \rho_D) m_D & -\cos\theta_F I_{FXZ}'' & \rho_D \{\zeta_D - \rho_D\} m_D \\
 & -\cos\theta_F \zeta_F'' m_F & & + \cos^2\theta_F I_{FX}'' - \cos\theta_F \sin\theta_F I_{FXZ}'' & & - \cos\theta_F \sin\theta_F I_{FX}'' - \cos^2\theta_F I_{FXZ}'' & -\cos\theta_F \chi_F'' \zeta_F'' m_F & \\
 & & & + \cos\theta_F \zeta_F'' \zeta_F m_F & & - \cos\theta_F \chi_F \zeta_F'' m_F & & \\
\gamma_3 & 0 & -\gamma_1 & \delta\{\cos\theta_F (I_{FX}'' - I_{FY}'') - \sin\theta_F I_{FXZ}''\} & I_{FY}'' + (\chi_F^2 + \zeta_F^2) m_F + I_{DY} & \delta\{\sin\theta_F (I_{FY}'' - I_{FX}'') - \cos\theta_F I_{FXZ}''\} & -\delta\{I_{FXZ}'' + (\sin^2\theta_F - \cos^2\theta_F) \chi_F \zeta_F m_F & \phi_D I_{DXZ} \\
 & & & - \chi_F'' \chi_F m_F\} + \phi_D\{I_{DXZ} + \rho_D \chi_D m_D\} & + (\chi_D^2 + \zeta_D^2) m_D + I_{RY} + (\chi_R^2 + \zeta_R^2) m_R & + \chi_F'' \zeta_F m_F + \phi_D\{I_{DY} - I_{DZ} + \rho_D \zeta_D m_D\} & - \cos\theta_F \sin\theta_F (\chi_F^2 & \\
 & & & & & & - \zeta_F^2) m_F & -\phi_D \rho_D \chi_D m_D \\
-\delta\sin^2\theta_F \chi_F'' m_F & \chi_R m_R + \chi_D m_D & -\delta\sin\theta_F \cos\theta_F \chi_F'' m_F & -I_{RXZ} - \chi_R \zeta_R m_R - I_{DXZ} & \phi_D (I_{DY} - I_{DZ} + \rho_D \zeta_D m_D) & I_{RZ} + \chi_R^2 m_R + I_{DZ} + \chi_D^2 m_D & \sin\theta_F I_{FXZ}'' & -I_{DXZ} \\
-\phi_D \rho_D m_D & + \sin\theta_F \zeta_F'' m_F & & - \chi_D \zeta_D m_D - \sin\theta_F \{\cos\theta_F I_{FX}'' & -\delta\sin\theta_F (I_{FX}'' - I_{FY}'' - \chi_F''^2 m_F) & + \sin\theta_F (\sin\theta_F I_{FX}'' + \cos\theta_F & + \sin\theta_F \chi_F'' \zeta_F'' m_F & -\rho_D \chi_D m_D \\
 & & & - \sin\theta_F I_{FXZ}'' + \zeta_F'' \zeta_F m_F\} & & I_{FXZ}'' + \chi_F \zeta_F'' m_F) & & \\
-\delta\cos\theta_F \chi_F'' m_F & \chi_F'' m_F & \delta\sin\theta_F \chi_F'' m_F & \sin\theta_F I_{FZ}'' - \cos\theta_F I_{FXZ}'' - \chi_F'' \zeta_F'' m_F & -\delta\left(I_{FXZ}'' + \chi_F'' \zeta_F'' m_F\right) & \cos\theta_F I_{FZ}'' + \chi_F'' \chi_F m_F & I_{FZ}'' + \chi_F''^2 m_F & 0 \\
 & & & & & + \sin\theta_F I_{FXZ}'' & & \\
0 & -\rho_D m_D & -\phi_D \rho_D m_D & I_{DX} + \rho_D \zeta_D m_D & \phi_D (I_{DXZ} + \rho_D \chi_D m_D) & -I_{DXZ} - \rho_D \chi_D m_D & 0 & I_{DX} + \rho_D^2 m_D
\end{bmatrix}
=
\begin{bmatrix}
\dot{u}_0 \\ \dot{v}_0 \\ \dot{w}_0 \\ \dot{p} \\ \dot{q} \\ \dot{r} \\ \ddot{\delta} \\ \ddot{\phi}_D
\end{bmatrix}
\bullet
\begin{bmatrix}
\gamma_{11} + \gamma_{12} + \gamma_{13} + F_{XTR} + F_{XTF} \\
\gamma_{21} + \gamma_{22} + \gamma_{23} + F_{YTR} + F_{YTF} \\
\gamma_{31} + \gamma_{32} + \gamma_{33} + F_{ZTR} + F_{ZTF} \\
\rho\beta I_{RXZ} + \beta r (I_{FY} - I_{RZ}) - \zeta_R \gamma_{21} - (\zeta_D - \rho_D)\gamma_{23} + r\omega_R I_{WR} - \cos\theta_F \left[\delta\rho r \left\{\cos^2\theta_F - \sin^2\theta_F\right\}\right. \\
\left\{I_{FY}'' - I_{FX}'\right\} + \left\{\delta\cos\theta_F \sin\theta_F\right\}\left\{(\rho^2 - r^2)(I_{FY}'' - I_{FX}'') - 2\rho r I_{FXZ}''\right\} + \left\{\cos\theta_F \rho - \sin\theta_F r\right\}\left\{\delta\dot{\delta}(I_{FY}'' - I_{FX}'')\right. \\
\left. - \beta I_{FXZ}''\right\} + \left\{\sin\theta_F \rho + \cos\theta_F r\right\}\left\{\beta(I_{FZ}'' - I_{FY}'') + 2\delta\dot{\delta} I_{FXZ}''\right\} + \beta\dot{\delta}\left\{I_{FZ}'' - I_{FY}''\right\} + \left\{\sin^2\theta_F \rho^2 + \cos^2\theta_F r^2\right. \\
\left. - \beta^2 + \dot{\delta}^2\right\}\delta I_{FXZ}'' - \left\{\sin\theta_F \rho + \cos\theta_F r + \dot{\delta}\right\}\omega_F I_{WF} - \sin\theta_F \delta \chi_F'' \gamma_{12} + \zeta_F'' \gamma_{22} - \cos\theta_F \delta \chi_F'' \gamma_{32}\Big] \\
- \left\{h_0 + \sin\theta_F e\right\} F_{YTF} - h_0 F_{YTR} + \cos^2\theta_F \delta e F_{ZTF} - \sin\theta_F N_{ZF}'' \\
- (\rho^2 - r^2) I_{RXZ} - \rho r (I_{RX} - I_{RZ}) - \left\{(\rho + \dot{\phi}_D)^2 + \phi_D \beta r - r^2\right\} I_{DXZ} - r(\rho + \dot{\phi}_D)(I_{DX} - I_{DZ}) \\
+ \phi_D \beta (\rho + \dot{\phi}_D)(I_{DY} - I_{DZ}) - \left\{\cos^2\theta_F - \sin^2\theta_F\right\}\left\{\rho r (I_{FX}'' - I_{FZ}'') + (\rho^2 - r^2) I_{FXZ}''\right\} - \left\{\cos\theta_F \sin\theta_F\right\} \\
\left\{(\rho^2 - r^2)(I_{FX}'' - I_{FZ}'') - 4\rho r I_{FXZ}''\right\} - \left\{\cos\theta_F \rho - \sin\theta_F r\right\}\left\{\dot{\delta}(I_{FX}'' - I_{FZ}'') + \delta\beta I_{FXZ}''\right\} - \left\{\sin\theta_F \rho\right. \\
\left. + \cos\theta_F r\right\}\left\{\delta\beta(I_{FX}'' - I_{FY}'') - 2\dot{\delta} I_{FXZ}''\right\} - \dot{\delta}\left\{\delta\beta(I_{FX}'' - I_{FY}'') - \dot{\delta} I_{FXZ}''\right\} + \left\{\sin\theta_F \rho + \cos\theta_F r\right. \\
\left. + \dot{\delta}\right\}\delta\omega_F I_{WF} + \zeta_R \gamma_{11} + \zeta_F \gamma_{12} + \zeta_D \gamma_{13} - \chi_R \gamma_{31} - \chi_F \gamma_{32} - \chi_D \gamma_{33} + h_0 (F_{XTR} + F_{XTF}) - l_R F_{ZTR} - l_F F_{ZTF} \\
\rho\beta (I_{RX} - I_{RY}) - \beta r I_{RXZ} + \beta(\rho + \dot{\phi}_D)(I_{DX} - I_{DY}) - \phi_D r (\rho + \dot{\phi}_D)(I_{DY} - I_{DZ}) - \left\{\beta r + \phi_D (\rho + \dot{\phi}_D)^2 - \phi_D \beta^2\right\} \\
I_{DXZ} + \sin\theta_F \left[\delta\rho r \left\{\cos^2\theta_F - \sin^2\theta_F\right\}\left\{I_{FY}'' - I_{FX}''\right\} + \left\{\delta\cos\theta_F \sin\theta_F\right\}\left\{(\rho^2 - r^2)(I_{FY}'' - I_{FX}'') - 2\rho r I_{FXZ}''\right\}\right. \\
+ \left\{\cos\theta_F \rho - \sin\theta_F r\right\}\left\{\delta\dot{\delta}(I_{FY}'' - I_{FX}'') - \beta I_{FXZ}''\right\} + \left\{\sin\theta_F \rho + \cos\theta_F r\right\}\left\{\beta(I_{FZ}'' - I_{FY}'')\right. \\
\left. - 2\delta\dot{\delta} I_{FXZ}''\right\} + \beta\dot{\delta}\left\{I_{FZ}'' - I_{FY}''\right\} + \left\{\sin^2\theta_F \rho^2 + \cos^2\theta_F r^2 - \beta^2 + \dot{\delta}^2\right\}\delta I_{FXZ}'' - \left\{\sin\theta_F \rho + \cos\theta_F r\right. \\
\left. + \dot{\delta}\right\}\omega_F I_{WF} - \sin\theta_F \delta \chi_F'' \gamma_{12} + \zeta_F'' \gamma_{22} - \cos\theta_F \delta \chi_F'' \gamma_{32}\Big] - \rho\omega_R I_{WR} + \chi_D \gamma_{23} + \chi_R \gamma_{21} + \phi_D \rho_D \gamma_{13} \\
+ \chi_R F_{YTR} - \tan\theta_F \left\{h_0 + \sin\theta_F e\right\} F_{YTF} + \sin^2\theta_F \delta e F_{XTF} + \sin\theta_F \cos\theta_F \delta e F_{ZTF} + \cos\theta_F N_{ZF}'' \\
\left\{-\delta\cos\theta_F \rho + \beta + \delta\sin\theta_F r\right\}\left\{\left(\sin\theta_F \rho + \cos\theta_F r + \dot{\delta}\right) I_{FXZ}'' - \left(\cos\theta_F \rho + \delta\beta - \sin\theta_F r\right)(I_{FX}'' - I_{FY}'')\right\} \\
- \left(\cos\theta_F \rho + \delta\beta - \sin\theta_F r\right)\omega_F I_{WF} - \delta\cos\theta_F \chi_F'' \gamma_{12} + \chi_F'' \gamma_{22} + \delta\sin\theta_F \chi_F'' \gamma_{32} + e F_{YTF}' + N_{ZF}'' \\
(\beta + \phi_D r)(\rho + \dot{\phi}_D) I_{DXZ} + (\beta r - \phi_D \{\beta^2 - r^2\})(I_{DY} - I_{DZ}) - \rho_D \gamma_{23} - \phi_D \rho_D \gamma_{33} + N_{XD}
\end{bmatrix}
$$