Description and geometry

1. Geometry

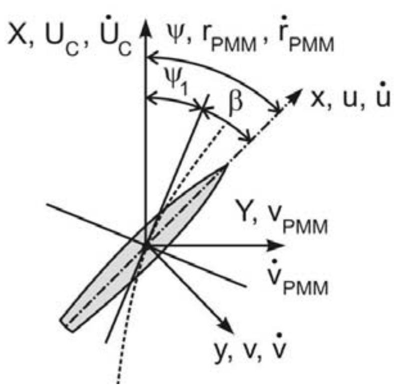
The objective hull form is a bare hull model of the US Navy combatant DTMB 5512 only equipped with bilge keels.

		Model	
		Fixed model	Free model
Scale	-	1 : 46.588	
L_{PP}	M	3.048	
L_{WL}	M	3.052	
B_{WL}	M	0.410	
T_m	M	0.136	
Mass	Kg	83.35	82.55
COG-X	M	-0.0157	
COG-Y	M	0.0	
COG-Z	M	N/A	0.084
I_X	Kg·m^2	N/A	1.98
I_Y	Kg·m^2	N/A	53.88
I_Z	Kg·m^2	44.35	49.99
COR-Roll	M		
COR-Pitch	M		
COR-Yaw	M	X=0.0, y=0.0	

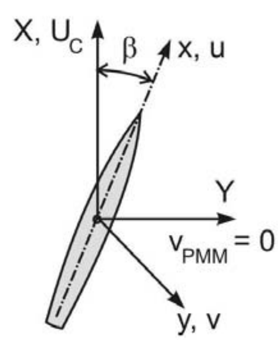
COG: Center of gravity
COR: Center of rotation

2. Coordinate system

The coordinate system and sign convention is a right-handed, horizontal, body-fixed coordinate system with x positive forward of mid-ship, y positive starboard of center line and z positive down from waterline.



Dynamic PMM



Static PMM

3. PMM motion equations

Prescribed motions in which the heading, ψ, the surge, u, the sway, v, and yaw, r, velocities and the surge, $\dot{u}$, sway, $\dot{v}$, and yaw, $\dot{r}$, accelerations (in the ships local (x, y) coordinate system) are known to any given time. The motion parameters can be described by the sway amplitude, $2S_{mm}$, the yaw motion amplitude ψ_0, and the number of PMM rotations per minute, N.

1) PMM yaw motion

Heading angle $$\psi = -\psi_0 \cos\left(\frac{2\pi N}{60} t\right) + \beta$$

Yaw rate

Yaw acceleration $$\dot{r}_{PMM} = \psi_0 \left(\frac{2\pi N}{60}\right)^2 \cos\left(\frac{2\pi N}{60} t\right)$$

2) PMM sway motion

Transverse translation $$\eta_{PMM} = -2S_{mm} \sin\left(\frac{2\pi N}{60} t\right)$$

Transverse velocity $$v_{PMM} = -2\left(\frac{2\pi N}{60}\right) S_{mm} \cos\left(\frac{2\pi N}{60} t\right)$$

Transverse acceleration $$\dot{v}_{PMM} = 2\left(\frac{2\pi N}{60}\right)^2 S_{mm} \sin\left(\frac{2\pi N}{60} t\right)$$

3) Motions in the ship fixed coordinate system

Sway velocity $$v = v_{PMM} \cos(\psi) - U_C \sin(\psi)$$

Sway acceleration $$\dot{v} = \dot{v}_{PMM} \cos(\psi) - r(U_C \cos(\psi) + v_{PMM} \sin(\psi))$$

Surge velocity $$u = U_C \cos(\psi) + v_{PMM} \sin(\psi)$$

Surge acceleration $$\dot{u} = \dot{v}_{PMM} \sin(\psi) + r(v_{PMM} \cos(\psi) - U_C \sin(\psi))$$

Yaw rate $$r = r_{PMM}$$

Yaw acceleration $$\dot{r} = \dot{r}_{PMM}$$

4. Data reduction equations

All forces are defined in a coordinate system following the ship, meaning that *X*-components act in the longitudinal direction of the ship and *Y*-components perpendicular to this direction. The yaw moment is taken with respect to the mid-ship position at $L_{pp}/2$. All hydrodynamic forces and moments should be non-dimensionalized by the following data reduction equations

$$\mathrm{X}' = \frac{\mathrm{F}_{\mathrm{X}_{\mathrm{Hydro}}}}{0.5\rho \mathrm{U}^2 A_0} = \frac{F_X + M(\dot{u} - rv - X_G r^2 - Y_G \dot{r})}{0.5\rho \mathrm{U}^2 T_m L_{pp}}$$

$$Y' = \frac{F_{Y_{Hydro}}}{0.5\rho U^2 A_0} = \frac{F_Y + M(\dot{v} + ru - Y_G r^2 + X_G \dot{r})}{0.5\rho U^2 T_m L_{pp}}$$

$$N' = \frac{M_{Z_{Hydro}}}{0.5\rho U^2 A_0 L_{pp}} = \frac{M_Z + I_Z \dot{r} + M(X_G(\dot{v} + ru) - Y_G(\dot{u} - rv))}{0.5\rho U^2 T_m L_{pp}^2}$$

where ρ is the water density. F_X, F_Y and M_Z are the total *X*- and *Y*-forces and the yaw moment, respectively. $U = \sqrt{u^2 + v^2}$ is the ship speed. It is constant in the static test, but it varies in the dynamic test. A_0 is the lateral underwater area defined as $A_0 = L_{pp} T_m$. L_{pp} and T_m are the length between perpendiculars and the mean draft, respectively. L_{pp} is also used as the characteristic arm for yaw moment.