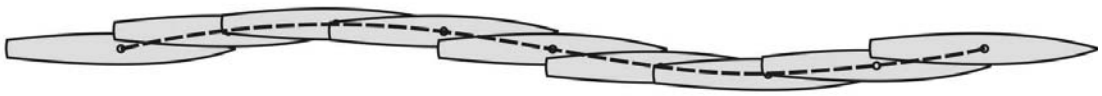
Test case 3a.7: Pure sway



Conditions

- Captive pure sway motion in still water
- Pitch and heave free; roll fixed
- Without rudders
- With bilge keels

Pre scribed PMM motions:

- Sway motion: $\eta_{PMM} = -2S_{mm} \sin\left(\frac{2\pi N}{60} t\right)$
- Sway velocity: $v_{PMM} = -2\left(\frac{2\pi N}{60}\right) S_{mm} \cos\left(\frac{2\pi N}{60} t\right)$
- Sway acceleration: $\dot{v}_{PMM} = 2\left(\frac{2\pi N}{60}\right)^2 S_{mm} \sin\left(\frac{2\pi N}{60} t\right)$
- Heading angle: $\psi = 0$
- Yaw rate: $r = 0$
- Yaw acceleration: $\dot{r} = 0$

F_n [-]	R_n [-]	U_C [m/s]	N [rpm]	S_{mm} [m]	$\beta^*_{\max}$ [deg]	$v'_{\max}$ [-]
0.280	4.643×10^6	**1.531**	**8.0210**	**0.1584**	10.0	0.174

$\beta^*_{\max}$: corresponding maximum drift angle

Items and Remarks

Figure Number	Items	Remarks
Fig. 3a.7-1	Time history of non-dimensionalized longitudinal force (X')	To be compared with experimental results download
Fig. 3a.7-2	Time history of non-dimensionalized transverse force (Y')	To be compared with experimental results download
Fig. 3a.7-3	Time history of non-dimensionalized yaw moment (N')	To be compared with experimental results download
Fig. 3a.7-4	Time history of pitch motion	To be compared with experimental results download
Fig. 3a.7-5	Time history of heave motion	To be compared with experimental results download
Fig. 3a.7-6	Damping parts of Y' and N' vs. v'	To be compared with experimental results download
Fig. 3a.7-7	Inertial parts of Y' and N' vs. $\dot{v}'$	To be compared with experimental results download

- Coordinate system for comparision is ship-fixed at midship on the undisturbed waterplane.

- $F_n = \dfrac{U_C}{\sqrt{gL_{PP}}}$, $R_n = \dfrac{U_C \cdot L_{PP}}{\nu}$

  where, U_C is towing carriage speed, g is the gravitational acceleration and ν is the kinematic viscosity of water.

- All quantities are non-dimensionalized with water density (ρ), ship speed ($U = \sqrt{u^2 + v^2}$), lateral underwater area ($A_0 = L_{pp} T_m$), and the length between perpendiculars (L_{pp}).

$$X' = \frac{F_{X_{Hydro}}}{0.5\rho U^2 A_0} = \frac{F_{X_{total}} + M\dot{u}}{0.5\rho U^2 T_m L_{pp}}$$

$$Y' = \frac{F_{Y_{Hydro}}}{0.5\rho U^2 A_0} = \frac{F_{Y_{total}} + M\dot{v}}{0.5\rho U^2 T_m L_{pp}}$$

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

- From the Fourier series expansion of Y' and N',

$$Y' = a_o + \sum_{n=1}^{\infty} a_n \cos(n\omega t) + \sum_{n=1}^{\infty} b_n \sin(n\omega t)$$

$$N' = c_o + \sum_{n=1}^{\infty} c_n \cos(n\omega t) + \sum_{n=1}^{\infty} d_n \sin(n\omega t)$$

damping parts are

$$Y'_D = \sum_{n=1}^{3} a_n \cos(n\omega t)$$

$$N'_D = \sum_{n=1}^{3} c_n \cos(n\omega t)$$

and inertial parts are

$$Y'_T = b_1 \sin(\omega t)$$

$$N'_T = d_1 \sin(\omega t)$$

where,

$$\omega = \frac{2\pi N}{60}$$

- Non-dimensional transverse velocity and accelerations:

$$v' = \frac{v}{U_C}$$

$$\dot{v}' = \frac{\dot{v} L_{PP}}{U_C^2}$$