SK Validation Study – 2D Coefficients and Forces

The most fundamental computation performed by SeaKeeping is the solution of the two-dimensional radiation problem for each section. The solution leads to the two-dimensional hydrodynamic added mass and damping coefficients, and the two-dimensional complex diffraction forcing amplitude for the section. To confirm the efficacy of the code, the results for simple geometries were compared to model test data published by Vugts (1968).

Three different geometries were analyzed: a box section, a triangular section, and a cylindrical section, as shown by Figure 1. For the box, three beam-to-draft (B/T) ratios were also analyzed. In all cases, the beam factor (See **SEAKEEPING** command documentation regarding **/BF**) was taken at the default value of 8. The resulting non-dimensional coefficients, and the total heave, sway, and roll forcing amplitudes are given in the following section. In most cases, fair to good agreement between the experimental data and the computational result is obtained. Appreciable differences, such as the case in roll for the triangular section, are attributable to neglecting viscosity, flow-separation, and other significant nonlinearities evident in the real-world flow. Further deviation is observed in the cylindrical section in roll and sway-into-roll. Here, theoretical results are practically zero, as viscous effects account for most of the experimental observations. **These assumptions are typical of two-dimensional potential flow based solvers, such as the one used by SeaKeeping, and the deviations are expected.**

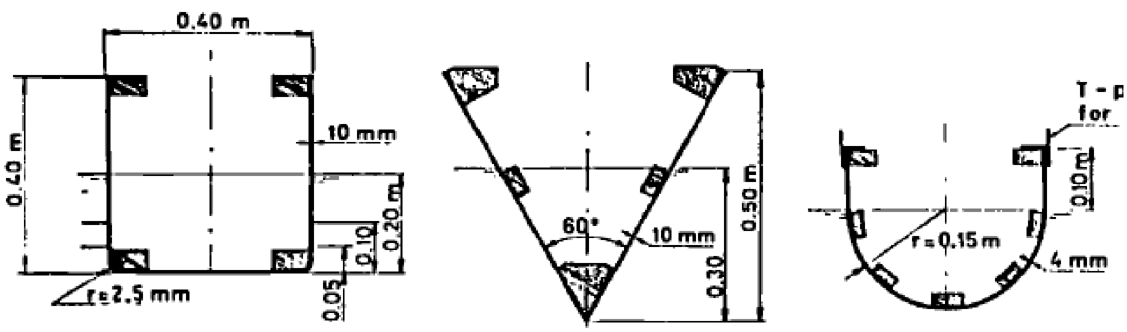

Figure 1 Vugts 2D Section Geometry

In the case of roll for the box section at B/T=4 and B/T=8, the experimental data is corrected for the difference between the origin "O" and the section's vertical center-of-gravity "CG" as outlined by Vugts (1968). In these cases, a note has been included in the plot legend. The computational results were also obtained about the origin, or CG, to maintain consistency with Vugts' conventions. Results about the origin when B/T=4 and B/T=8 were obtained by setting the VCG equal to the draft. In all other cases, the VCG was taken at 0.2 m as indicated.

In all cases, a heading of 90 degrees (beam seas) was used to match the experimental conditions imposed by Vugts (1968). The total forcing amplitude in sway, heave, and roll are in good agreement with the experimental results. For completeness, the roll moment is also computed about the origin for the box section for beam-to-draft ratios other than 2.

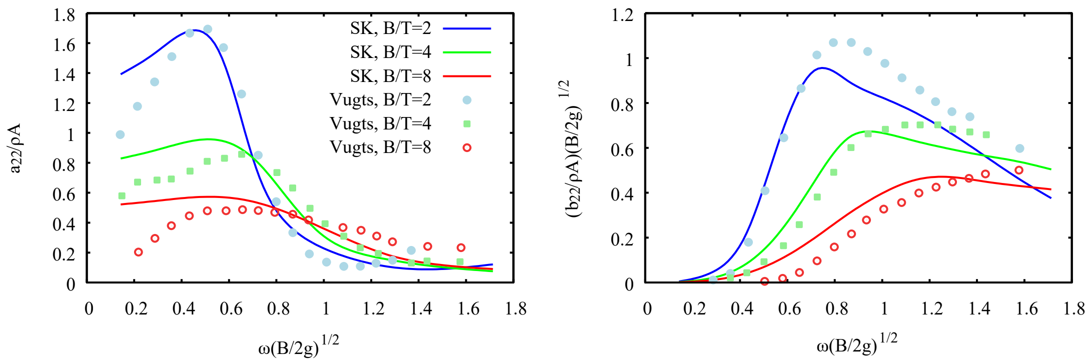

Figure 2 2D Sway Added Mass and Damping (a22/b22) – Box Section

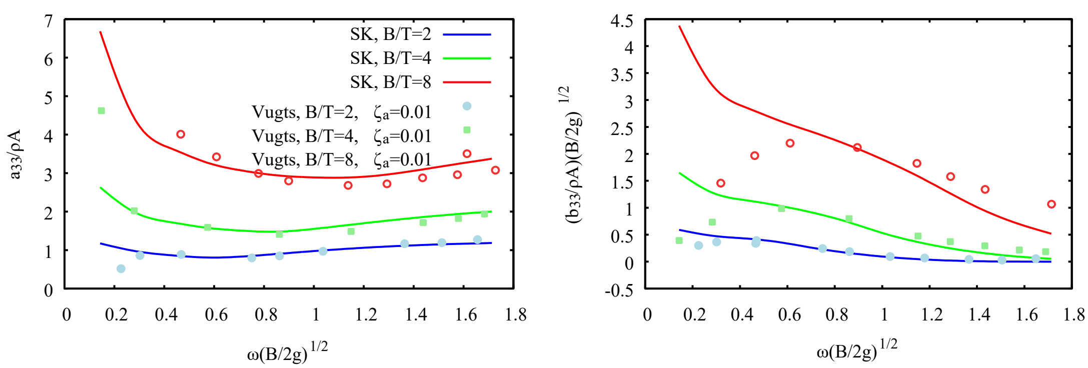

Figure 3 2D Heave Added Mass and Damping (a33/b33) – Box Section

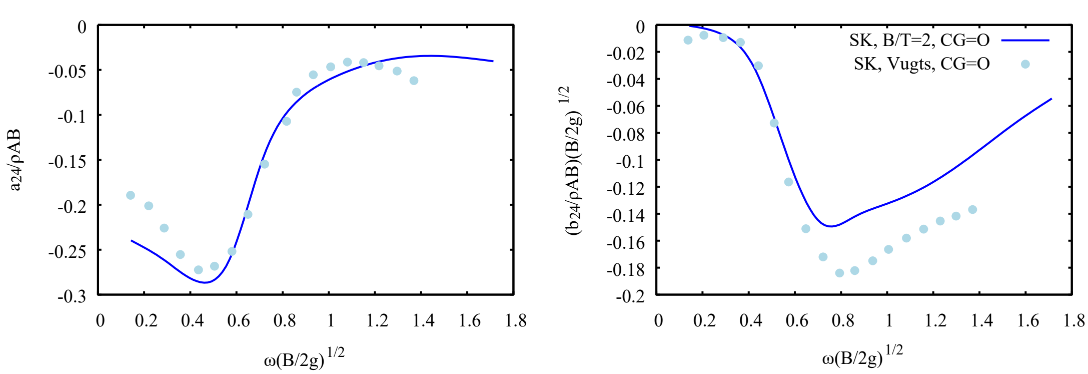

Figure 4 2D Sway-into-Roll Added Mass and Damping Coefficient (a24/b24) – Box Section, B/T=2

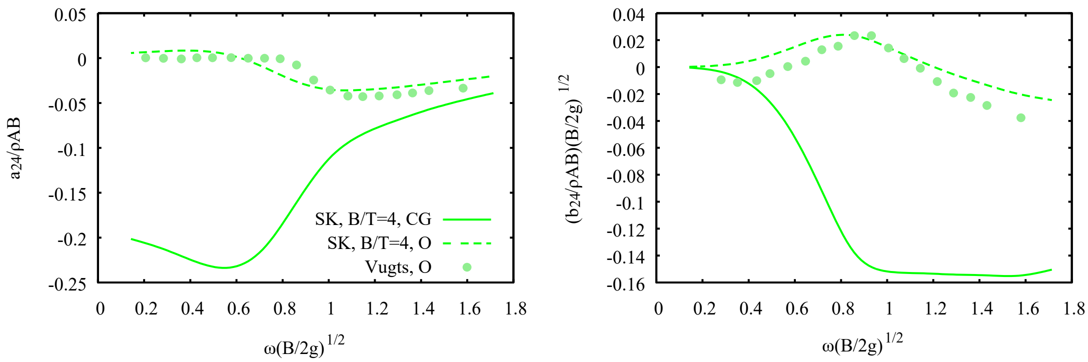

Figure 5 2D Sway-into-Roll Added Mass and Damping Coefficient (a24/b24) – Box Section, B/T=4

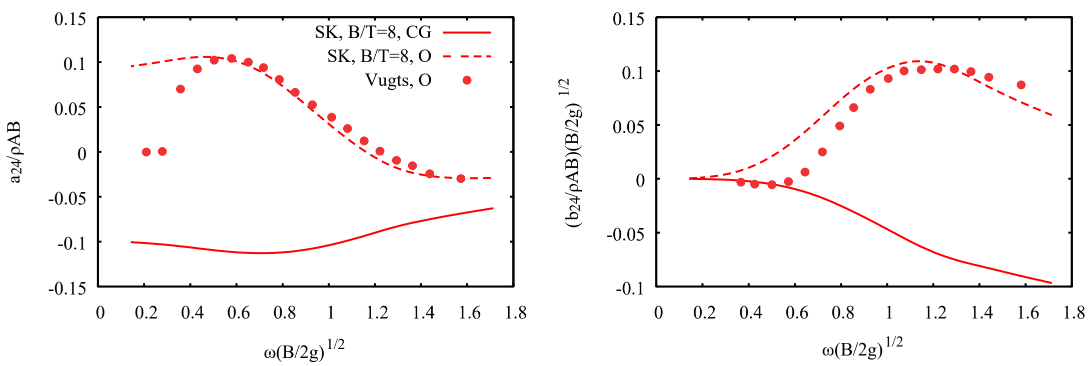

Figure 6 2D Sway-into-Roll Added Mass and Damping Coefficient (a24/b24) – Box Section, B/T=8

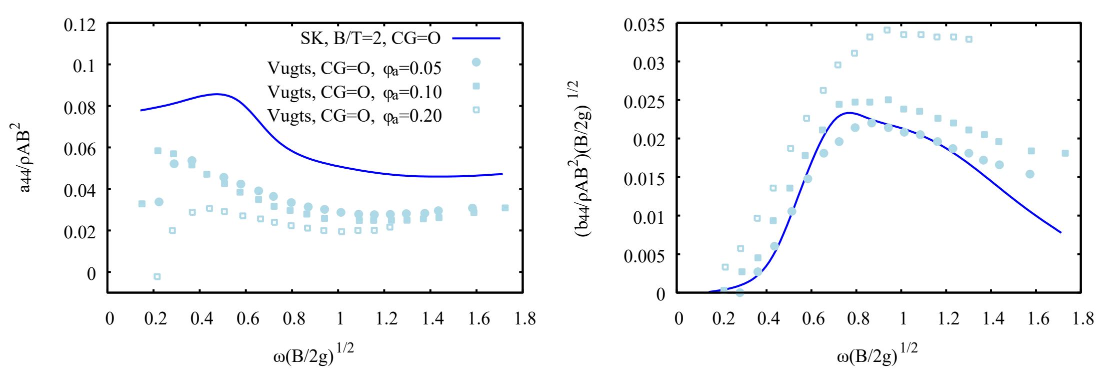

Figure 7 2D Roll Added Mass Moment of Inertia and Damping Coefficient (a44/b44) – Box Section, B/T=2

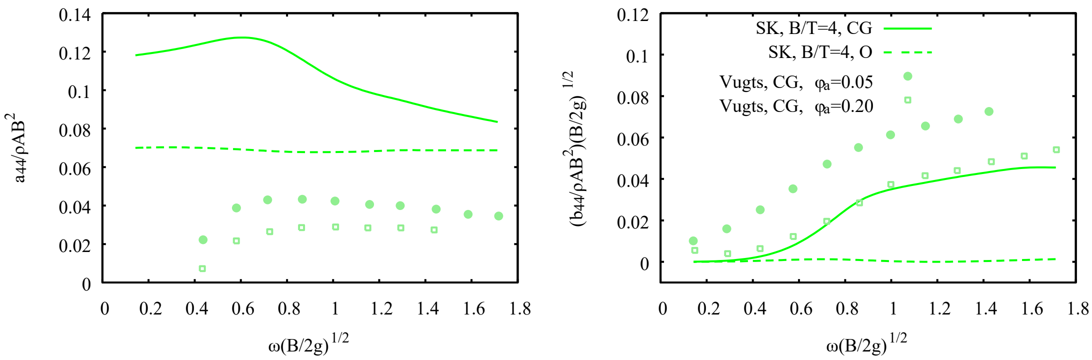

Figure 8 2D Roll Added Mass Moment of Inertia and Damping Coefficient (a44/b44) – Box Section, B/T=4

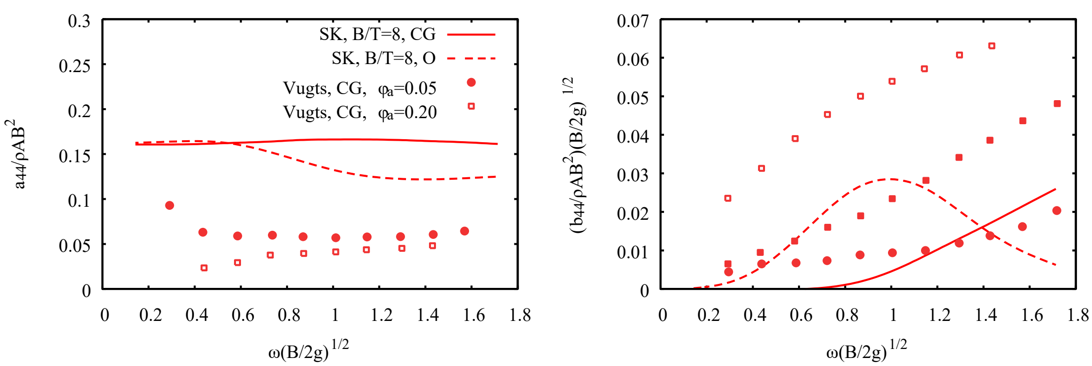

Figure 9 2D Roll Added Mass Moment of Inertia and Damping Coefficient (a44/b44) – Box Section, B/T=8

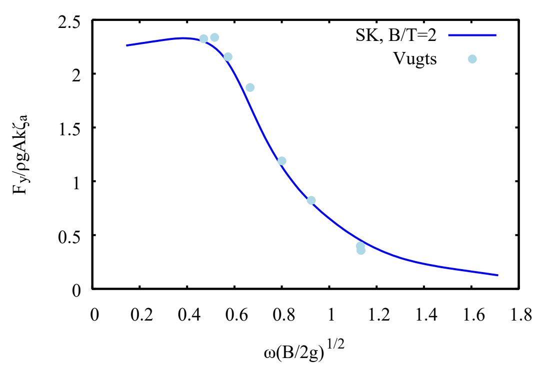

Figure 10 2D Total Sway Forcing (F_y) – Box Section B/T=2

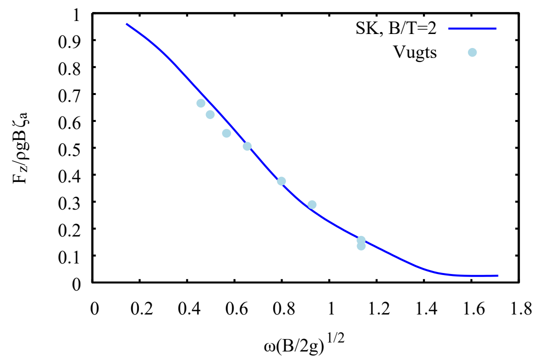

Figure 11 2D Total Heave Forcing (F_z) – Box Section B/T=2

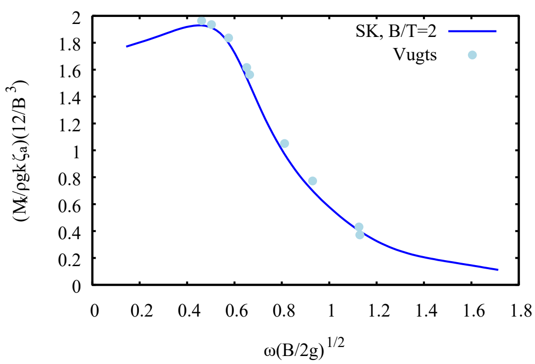

Figure 12 2D Total Roll Moment (M_x) – Box Section B/T=2

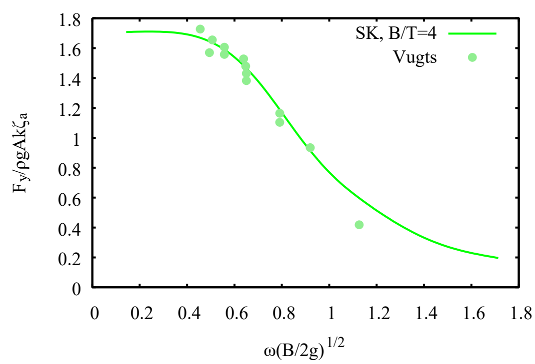

Figure 13 2D Total Sway Forcing (F_y) – Box Section B/T=4

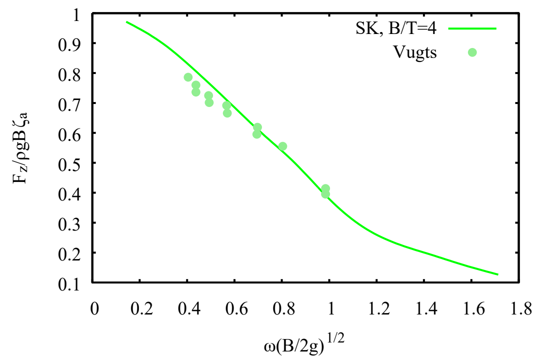

Figure 14 2D Total Heave Forcing (F_z) – Box Section B/T=4

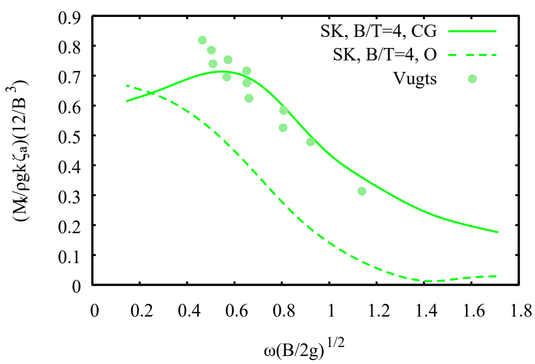

Figure 15 2D Total Roll Moment (M_x) – Box Section B/T=4

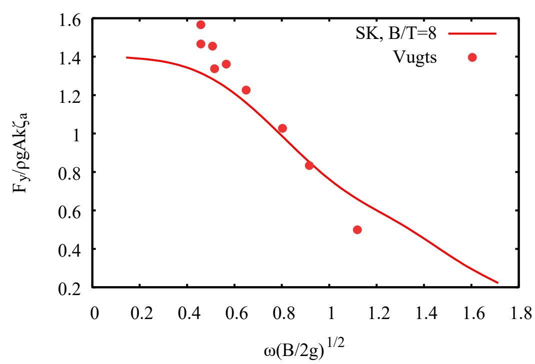

Figure 16 2D Total Sway Forcing (F_y) – Box Section B/T=8

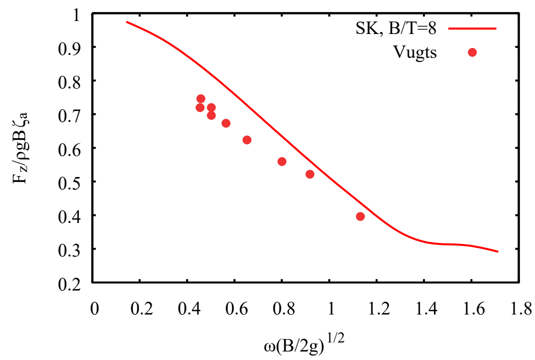

Figure 17 2D Total Heave Forcing (F_z) – Box Section B/T=8

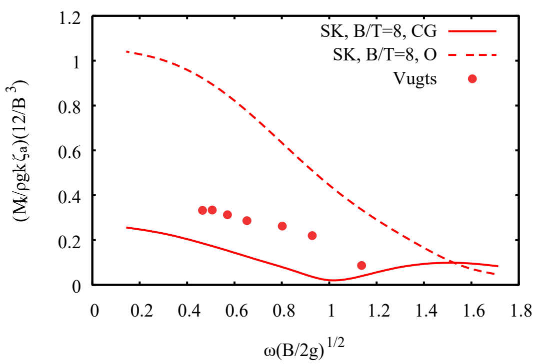

Figure 18 2D Total Roll Moment (M_x) – Box Section B/T=8

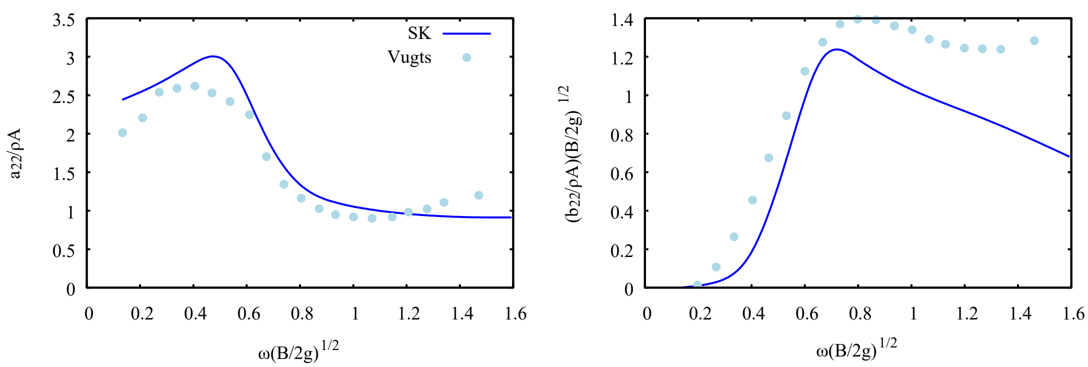

Figure 19 2D Sway Added Mass and Damping Coefficient (a22/b22) – Triangle Section

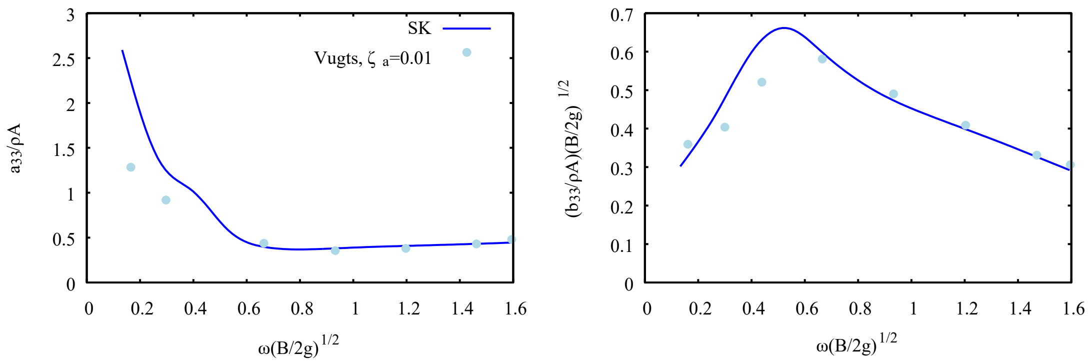

Figure 20 2D Heave Added Mass and Damping Coefficient (a33/b33) – Triangle Section

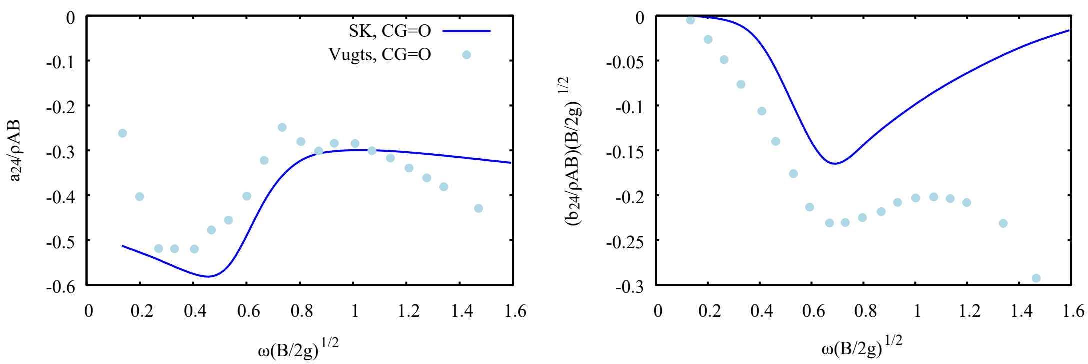

Figure 21 2D Sway-into-Roll Added Mass and Damping Coefficient (a24/b24) – Triangle Section

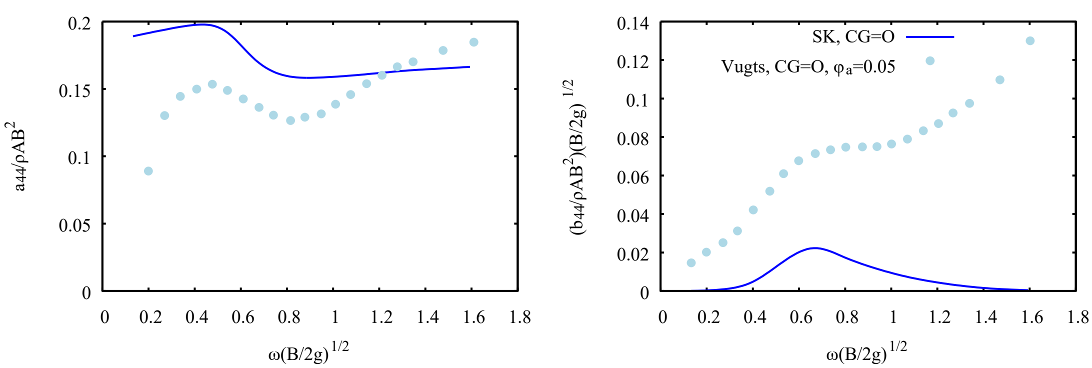

Figure 22 2D Roll Added Mass Moment of Inertia and Damping Coefficient (a44/b44) – Triangle Section

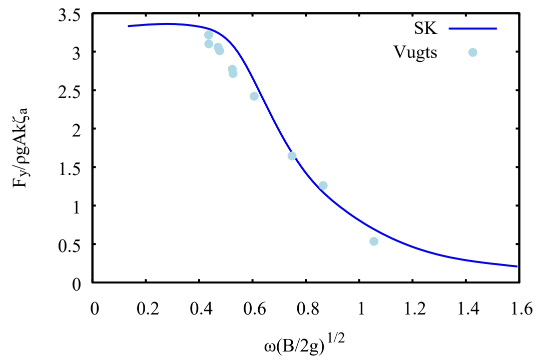

Figure 23 2D Total Sway Forcing (F_y) – Triangle Section

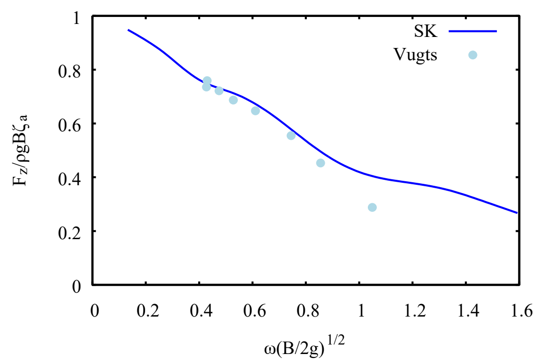

Figure 24 2D Total Heave Forcing (F_z) – Triangle Section

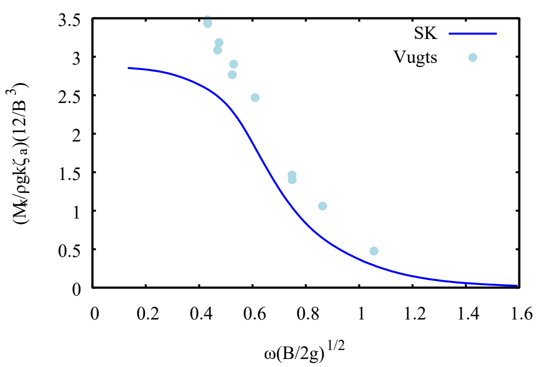

Figure 25 2D Total Roll Moment (M_x) – Triangle Section

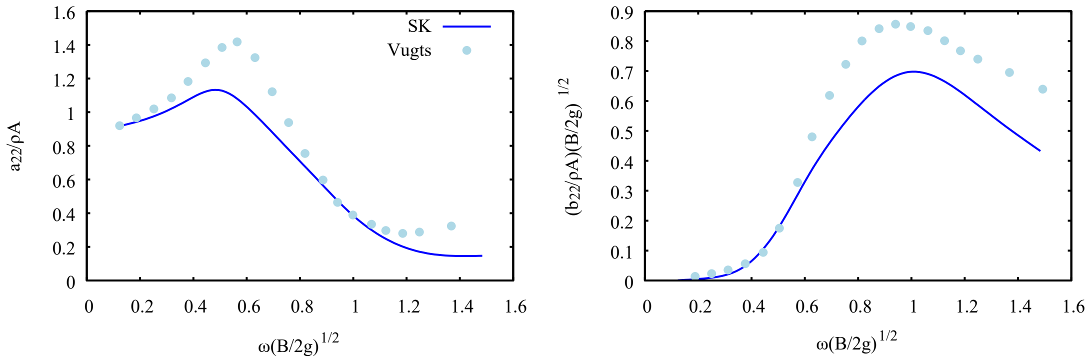

Figure 26 2D Sway Added Mass and Damping Coefficient (a22/b22) – Cylinder Section

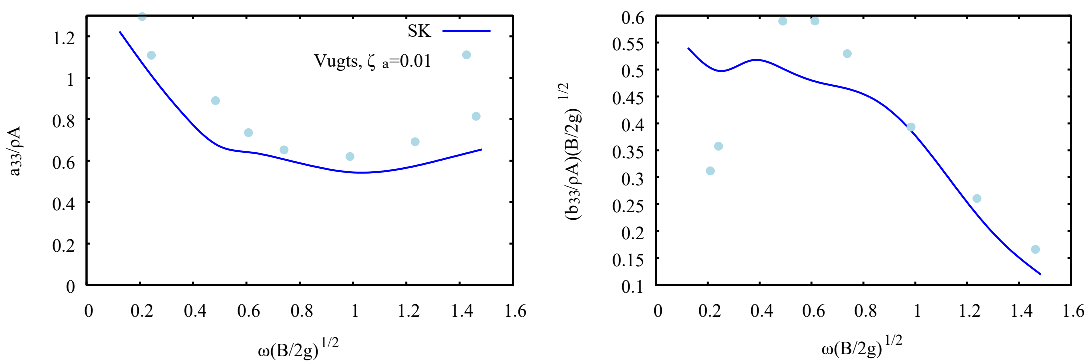

Figure 27 2D Heave Added Mass and Damping Coefficient (a33/b33) – Cylinder Section

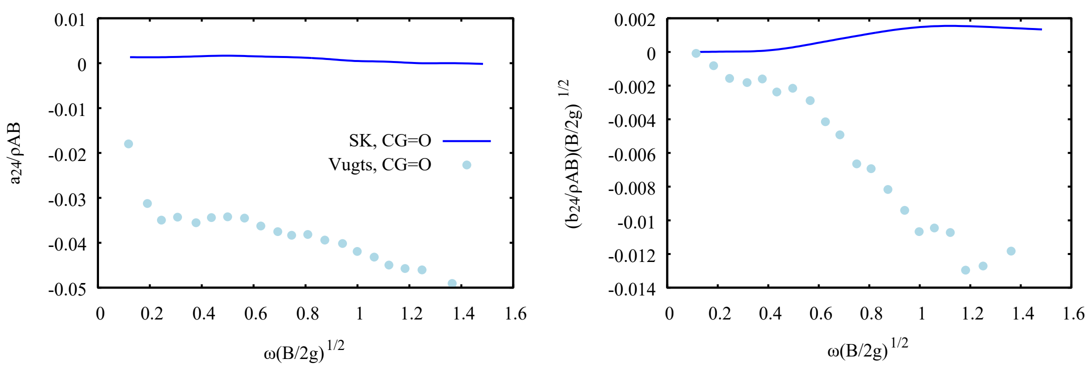

Figure 28 2D Sway-into-Roll Added Mass Coefficient and Damping Coefficient (a24/b24) – Cylinder Section

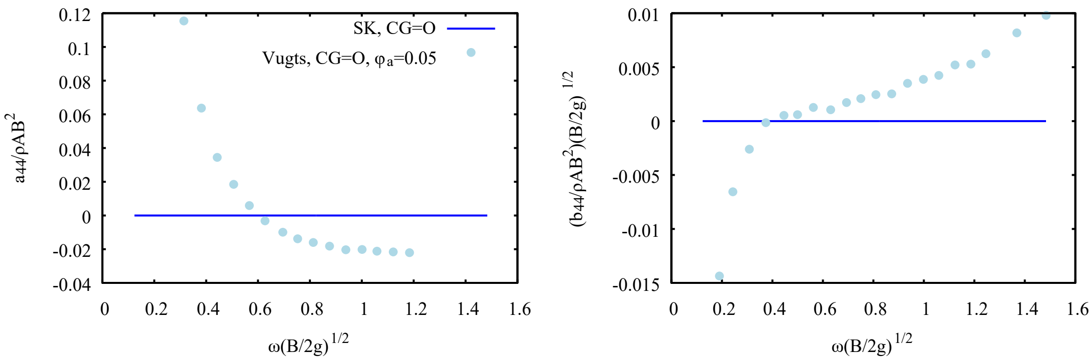

Figure 29 2D Roll Added Mass Moment of Inertia and Damping Coefficient (a44/b44) – Cylinder Section

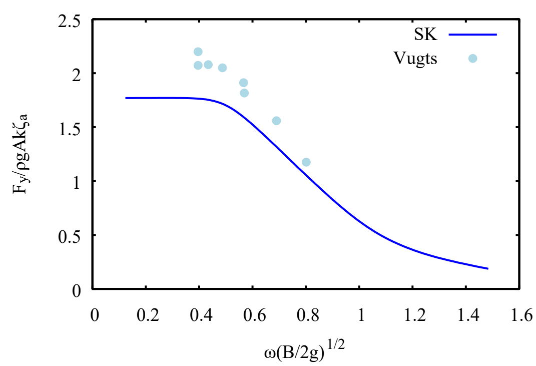

Figure 30 2D Total Sway Forcing (F_y) – Cylinder Section

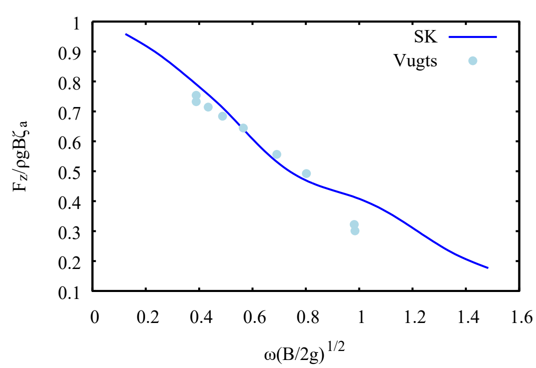

Figure 31 2D Total Heave Forcing (F_z) – Cylinder Section

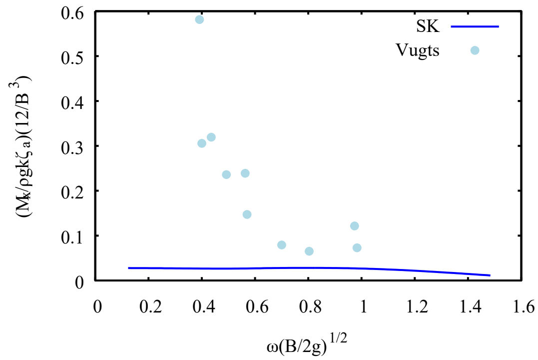

Figure 32 2D Total Roll Moment (M_x) – Cylinder Section

References

VUGTS, J. H. (1968). *The hydrodynamic coefficients for swaying, heaving and rolling cylinders in a free surface = De hydrodynamische coefficienten voor het verzetten, dompen en slingeren van cilinders in een vrije vloeistof oppervlakte*. Delft, Netherlands Ship Research Centre TNO, Shipbuilding Dept. Available at: http://mararchief.tudelft.nl/file/409/ [Last Accessed: 15 Jan. 2018].