# Validation of high fidelity CFD/FE FSI for full-scale high-speed planing hull with composite bottom panels slamming[1,2]

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## Abstract

High fidelity CFD/FE FSI (Computational Fluid Dynamics/Finite Element Fluid-Structure Interaction) code development and validation using benchmark full-scale experiments is conducted for the analysis of interactive hydrodynamic and structural slamming responses. A fully instrumented 29-foot high-speed planing hull with sterndrive is used (see Figure 1). CFDShip-Iowa [1] is employed for CFD simulations and the commercial FE code ANSYS is used as structural solver. The simulations include captive (2DOF without sterndrive) and 6DOF free running conditions for various Froude numbers in calm water and waves corresponding to the full-scale trials. The calm water hydrodynamics compare well with the experimental data and 1D empirical data provided by the sterndrive manufacturer for resistance, as well as heave, pitch and roll motions. For one-way coupling, the displacement and strain distributions for port and starboard bottom panels shown in Figure 2 are compared with experimentally measured values. Initial one-way coupling results show qualitative agreement with the experimental data for large amplitude reentering and emerging strains during slamming events. Figure 3 shows the CFD/FE predicted strain for the port panel compared with the average, maximum and minimum of the measured strain for sea state 3 most probable wave condition and Fr=2.9. The predicted free surface elevation is shown in Figure 4. The final paper will include an overview of the experimental and computational methods and detailed hydrodynamic and structural validation studies. The focus will be on modeling of the full-scale trial conditions and extensions for interactive FSI using modal expansion with added mass modeling and full two-way coupling.

## References

[1] Huang, J., Carrica, P., Stern, F., "Semi-coupled air/water immersed boundary approach for curvilinear dynamic overset grids with application to ship hydrodynamics," International Journal Numerical Methods Fluids, Volume 58, Issue 6, October 2008, pp. 591 – 624.

Figure 1: CFD model of slamming load test facility at Lehigh University

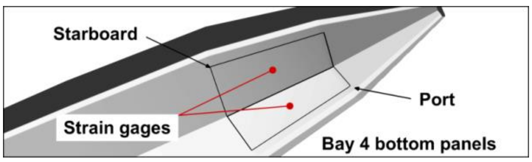


Figure 2: Bottom panels and strain gage location

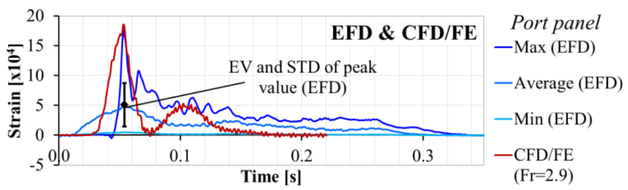


Figure 3: Average, min and max of EFD (Experimental Fluid Dynamics) strain with its expected value (EV) and standard deviation (STD) at peak compared with CFD/FE predicted strain.

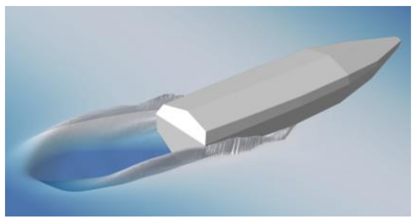

Figure 4: Predicted free surface elevation for captive simulation at sea state 3 most probable wave condition and Fr=2.9

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