Hydromechanics Laboratory

Professor David L. Kriebel, P.E.
Director

The Hydromechanics Laboratory supports Midshipmen education, as well as Midshipmen, faculty and staff research, in the areas of naval architecture and ocean engineering. The laboratory facilities include a large towing tank (380-ft long, 26-ft wide, and 16-ft deep), a small towing tank (120-ft long, 8-ft wide, and 5-ft deep), a coastal engineering wave basin (52-ft long, 48-ft wide, and 2-ft deep), a circulating water channel, and a stability and ballasting tank. All facilities are linked by a local network to a host computer system which is used to both operate the facilities and to acquire and analyze data.

The laboratory facilities are used on a weekly-basis by Midshipmen in the Naval Architecture and Ocean Engineering majors, and are used each semester by Midshipmen in the Mechanical Engineering, Electrical Engineering, Systems Engineering, Physics, and Oceanography majors. In addition, the laboratory is used by more than 600 Midshipmen each year in EN200, a core engineering course taken by all midshipmen in science or humanities majors. As a result, nearly all Midshipmen use the Hydromechanics Laboratory facilities at some point during their four years at the Naval Academy.

In addition to classroom support, the laboratory facilities are used for both fundamental and applied research by Midshipmen, faculty and staff supporting, other naval laboratories and government agencies. During the past year, research programs conducted by the laboratory have included:

I. Development of laboratory experimental documentation procedures which allow “virtual” towing tank laboratory experiments. (Sponsor: Academic Dean (Curriculum Development Project))

II. Development of a ship design “self taught” computer software package (Sponsor: Hydromechanics Laboratory)

III. Towing tank tests of a high speed planning boat (Sponsor: Noesis, Inc)

IV. Towing tank tests of a foil designed for a human powered hydrofoil vehicle (Sponsor: Hydromechanics Laboratory)

V. Seakeeping tests to verify Computational Fluid Dynamics (CFD) predictions for the Mobile Offshore Base (Sponsor: Office of Naval Research and Naval Facilities Engineering Services Center)

IV. High speed towing tank tests of a trimaran hull form (Sponsor: Hydromechanics Laboratory)

V. Towing tank tests of diver propulsion vehicles and Navy divers (Sponsor: Naval Coastal Systems Center)

The laboratory is operated and maintained by a multi-talented staff which includes four engineers/naval architects, three engineering technicians, and an office manager/secretary. Supporting laboratory efforts are the shop and model-making facilities in the Technical Support Department. The laboratory is further supported by a Memorandum of Understanding (MOU) with the Naval Station-Annapolis, providing support of diving operations in the laboratory.

Sponsored Research

Mobile Offshore Base - Phase 3 Model Tests

RESEARCHER: Prof. David L. Kriebel, P.E. and Ms. Louise Wallendorf, P.E. (Hydro Lab)
SPONSOR: Naval Facilities Engineering Services Center

The Naval Academy's Hydromechanics Laboratory (NAHL) has performed three sets of model tests on a 1/70th scale model of a Mobile Offshore Base (MOB). In concept, a Mobile Offshore Base (MOB) is a modular floating base that can be deployed to an area of national defense interest to provide flight, maintenance, supply and other forward logistics support operations for U.S. and Allied forces. MOB semi-submersibles have significantly smaller wave-induced motions compared to conventional hulls. The NAHL model was designed to be a structurally stiff, geometrically simple and representative of the overall dimensions of the conceptual MOB designs being developed by the three outside contractors, Bechtel, McDermott and Kvaener. The model tests conducted during December 1999 were the third set of model tests conducted by NAHL. The primary purpose of these tests were the verification of a numerical model, the Large Amplitude Motions Program, (LAMP), developed by Science Applications International Corporation (SAIC) of Annapolis, Maryland. The numerical model predicts the motions and the water surface elevations under the deck and near a single MOB in regular and irregular wave conditions. Model tests in regular waves and seastates 6 and 8 were performed for a full scale operating draft of 115' and displacement of 316,648 long tons. Motions of the model were measured using a new 6 degrees of freedom (surge, sway, heave, pitch, roll, yaw) photographic motion measurement system developed by Krypton Electronic Engineering; full-scale translational motions were measured to within .75" and angular motions to within .10 degrees.

Towing Tank Tests of a High Speed Planing Boat

RESEARCHER: Mr. John Zseleczky, Naval Architect, P.E. (Hydro Lab)
SPONSOR: Noesis, Inc.

Small craft such as those used for Special Operations Warfare rely on the high power-to-weight ratio of gasoline engines developed by the civilian racing boat community to reach their high speeds. However, for safety reasons, the U.S. Navy has embarked on a program to eliminate the use of highly volatile gasoline in the entire fleet. The Hydromechanics Laboratory has been supporting this program by supplying data on the performance of one particular hull over a wide range of loading conditions. The range of conditions covers all of the alternative powerplant options under consideration.

The hull chosen for the study was the 48' Advanced Special Warfare Craft (ASWC), which has a unique "wave-piercing" hull. A 1/7th scale model was built and over one hundred model tests were conducted to map out the matrix of operating conditions over a range of speeds. This test program took full advantage of the Laboratory's physical capability and experience base for testing high-speed models. The database obtained from these tests allowed the sponsor to evaluate the feasibility of the candidate alternative powerplants on this unique hull form and avoid costly mistakes that could be made on the prototype.

Independent Research

Towing Tank Tests of a Hydrofoil Designed for a Human Powered Vehicle

RESEARCHERS: Mr. John Zseleczky, Naval Architect, P.E. (Hydro Lab) and Mr. Bill Beaver (TSD)

Over the past two decades various speed contests have been held for human-powered watercraft. The current speed record is held by the Massachusetts Institute of technology (MIT), whose team built a hydrofoil vehicle that reached a speed of 18.5 knots in 1993. This year, two Naval Academy midshipmen took up the design challenge as an independent research project (EN-495) and came up with a paper design that was similar to the MIT record-breaking craft but with a few significant differences.

Complex projects of this nature require an investment in time to identify all of the problems involved and bring the project from a paper study to reality. As one step toward this goal, staff members of the Technical Support Department and Hydromechanics Laboratory built a prototype of the student-designed main hydrofoil and conducted experiments in the 380' towing tank to measure the actual lift and drag of the foil/strut system. These measurements will allow future students involved in the project to compare theory with experiment and make more realistic predictions before investing the time and assets required to create a working vehicle. The hydrofoil and testing fixtures developed for these experiments will be used for teaching the Advanced Marine Vehicles course (EN-353) in following semesters.

Extension of Effective Horsepower Tests on a Trimaran Model

RESEARCHER: Mrs. Nancy Harris, Naval Architect (Hydro Lab)

During the 99-00 Academic Year, Midshipman 1/C Charmaine McAbrew, USN performed a series of resistance tests on a concept trimaran hull form for presentation to the Society of Black Engineers. The work was a continuation of model tests initially performed to support the U.S. Coast Guard Deepwater Project. The tests were performed on a 1:36 scale model of a 420 foot long trimaran with a displacement of 3126 long tons. Previous tests were performed to investigate the effect of sidehull position on resistance, and these tests were performed to investigate the effect of sidehull displacement on resistance. The position of the sidehulls and the main hull displacement were held constant, and the sidehull displacement was varied. Three different sidehull displacements were tested: design (6.9% mainhull displacement,) heavy (10% mainhull displacment,) and light (5% mainhull displacment.) Another purpose of these tests was to find out about the high speed capabilities of the trimaran hull form for commercial applications. The maximum ship speed tested during the original tests was 30 knots; the maximum ship speed tested during these tests was 50 knots.

Tutorials for Naval Architecture Computer Programs

RESEARCHER: Mrs. Nancy Harris, Naval Architect (Hydro Lab)

The midshipmen who study Naval Architecture and Ocean Engineering use a variety of programs to aid them in their coursework. These programs include AutoCad LT for arrangement drawings, FastShip for hull design, NavCad for powering and propeller selection, GHS and SHCP for stability and longitudinal strength, SMP for ship motion prediction, various NC Milling programs to create files for the numerically-controlled milling machine, and in-house programs written by faculty and staff at the Naval Academy. The students who take EN200 (Introduction to Naval Architecture) and High School Students enrolled in the High School Summer Science Seminar also use some of these programs in a limited fashion. Over the years a set of instructions have been written that are continually updated when computer programs are added or upgraded. These instructions include tutorials and guidelines that are geared towards the existing computing environment in the Hydromechanics Laboratory, the Naval Architecture Design Room (R126), and other electronic classrooms in Rickover Hall.

Presentations

HARRIS, Nancy A., Naval Architect, "FastShip 5 Training Session for the Junior Class at Webb Institute of Naval Architecture," Webb Institute of Naval Architecture, Glen Cove, New York, March 17, 2000.