Full size project for 1:12 scale prototype

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During 2009–2010, SSPA designed and constructed a 1:12 scale tanker prototype for, and in close co-operation with, the Technical Department of Stena Rederi AB. On behalf of Stena, SSPA then conducted a series of tests on reducing hull resistance using air cavity technology (see the separate article on air technology). Prior to this, extensive model testing was conducted at the SSPA towing tank facilities. The main purpose of the tests using the tanker prototype was to verify the results of the towing tank tests and investigate whether there are any unforeseen scale effects associated with the air technology.

Projects like these are complex and this specific project relied on experts from several of SSPA's competence areas:
- Ship design
- Hydrodynamic research and development
- Sensor, measuring, control and monitoring
- Model design and construction

Project management and design of the basic platform involved SSPA's experts in overall ship design. Typically, this team works with the design of special purpose ships, military and other authority vessels, and is involved in all phases of a ship project, from early concept studies to delivery acceptance tests at shipyards.

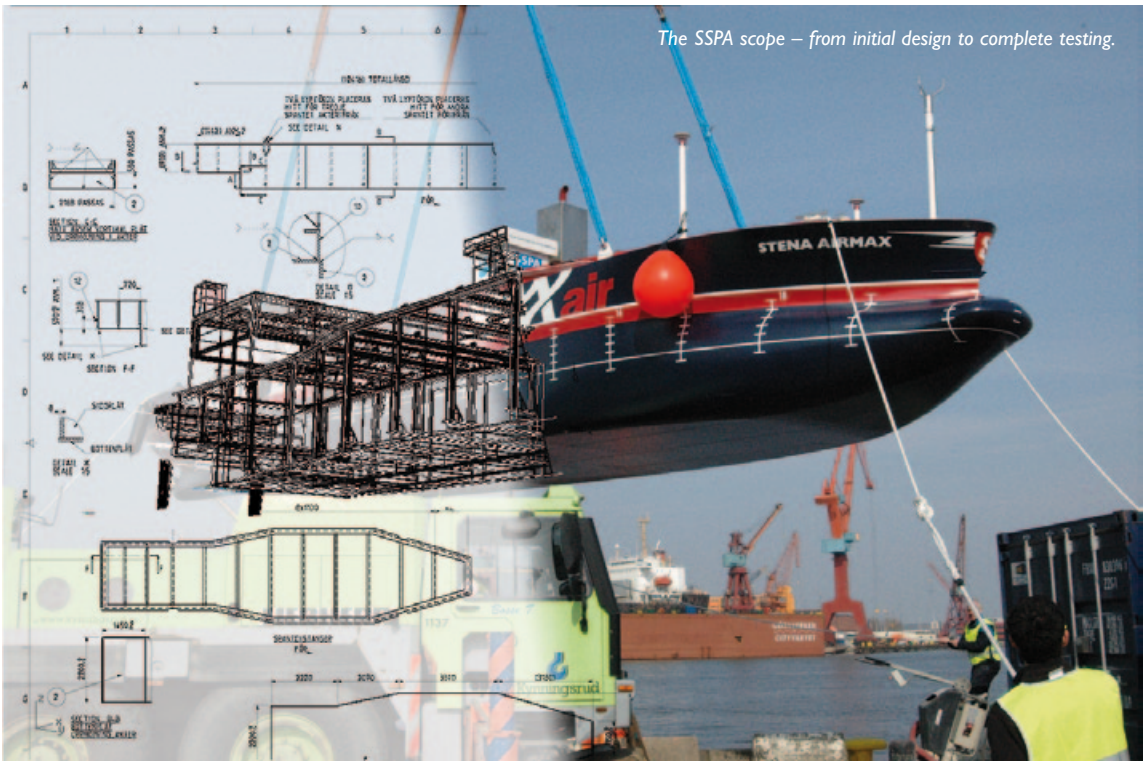
Design of vessel and test equipment

For a prototype like this, there is a tricky combination of functional requirements that must be fulfilled. The requirements on functionality, strength and equipment for operation and handling of a 15 meter long, 35 ton displacement vessel must be met. At the same time, the level of accuracy required for this sort of research testing forces the use of sensitive, special technical solutions.

The general design work followed an ordinary ship design process and involved the following areas:
- General arrangement
- Hull lines
- Weight and stability calculations
- Hull structure
- Propulsion and auxiliary systems
- Electrical system including load balance and power generation
- Outfitting
- Navigation, control and monitoring

The design principle was to separate the prototype hull into two parts. The first is the inner, load-carrying structure made of steel, which provides strength for operation and handling (e.g. lifting and transportation) and good installation options for equipment. The second part is the outer, thick sandwich hull (Divinycell/GRP), which provides the high precision hull lines.

Besides the areas associated with ordinary ship design, all of the testing and measuring systems were an integral part of the design effort. There are some interesting challenges associated with efforts to obtain accuracy from field tests that is as close as possible to the accuracy of laboratory tests. Setting up some of the signals, such as rudder angle or propeller shaft rpm, is almost trivial. Others, however, are much more compli-



The SSPA scope – from initial design to complete testing.

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cated. As an example, the inherent demands on a sealed propeller shaft forced the development of a new type of hub dynamometers measuring thrust and torque.

Applying (and measuring) an accurate tow-rope force to correct for the scaling of the hull friction gets much more complicated without a towing tank carriage. In this case, an electric outboard motor mounted to the prototype on a multi-component force transducer was used.

A great deal of effort went into designing measurement software that is easy to use in the field and provides real-time data necessary for operating the ship. The measurement system also incorporates several auto-pilot functions, as well as a control system for the air-cushions.

The total design, including detail design and calculations, was an in-house effort. SSPA is well-known for its hydrodynamic design, research and testing services. However, many customers are less aware of the fact that SSPA also provides overall ship engineering services, from initial concept design to mechanical structural design (including FE-analysis).

Construction

The construction was divided into five main parts:
- Manufacturing of the load-carrying hull structure.
- Manufacturing of the Divinycell core, giving the outer sandwich hull its correct shape. This was done in SSPA's model workshop milling facilities.
- Lamination of the protective GRP skin on the Divinycell core. Bonding the load-carrying structure together with the outer hull and construction of deck hatches and superstructure.
- Construction of specific systems, such as: sensor, propulsion, electrical, lifting fan, ballast, control and monitoring.
- Installation of the various systems and all other equipment.

To maintain good control of the process and quality, a large part of the construction, and all of the installation work, was performed by SSPA´s own workshop staff.

Manufacturing of outer hull at SSPA.

Testing

A major challenge was to identify a suitable test location for the trials. It had to be a large area with favorable environmental conditions, allowing for the required logistic support and free from disturbing boat traffic. Still, it is impossible to find an area outdoors with an environment that is as controlled as the towing tank. Hence, the environment must be measured as accurately as possible in order to obtain the correct speed through water and compensate for waves, current, wind resistance, water temperature and density. For these reasons, a wave buoy and drifting buoy were used at all times during the testing.

SSPA also organized the logistic support related to the prototype testing. This included such things as lifting, road transportation, support vessels and general maintenance to maintain the high accuracy (e.g. cleaning under water parts from fouling).

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The ability to deliver an overall solution for testing in a platform designed and constructed in-house is a great strength. It allows SSPA to offer a cost-effective, total commitment with complete control of, and responsibility for, the level of quality delivered to the customer.

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Initial test run in connection to the prototype name giving ceremony.
PHOTO: DAN LJUNGSVIK