ABS, which has been active in Singapore for more than 50 years, is pursuing advanced R&D work at its Singapore Innovation Research Center.

Singapore R&D targets enabling technologies for offshore frontiers

First established as a center for trade and then for shipbuilding, Singapore today is moving to take on the role of regional hub for deepwater oil and gas development. Assuming that role will require significant investment in a number of sectors, one of the most important of which is research and development (R&D).

By Gu Hai, ABS

ABS has been active in Singapore for more than 50 years. As it became apparent that the country was moving to become a regional deepwater hub, ABS increased investment in several key technology areas.

One of the most significant commitments to this regional development was the creation seven years ago of the Singapore Offshore Technology Center to support R&D efforts in Southeast Asia through partnerships with local industry, government, and academia. In April 2013, the name of the center was changed to Singapore Innovation and Research Center (SIRC) to reflect its role beyond the offshore oil and gas industry.

Researchers at SIRC are focusing on six primary areas:

- Global performance and global strength of floating structures
- Structural-soil interaction (offshore and subsea structure foundations)
- Computational fluid dynamics (CFD)
- Ice loads on offshore structures
- Application of fracture mechanics
- Structural behavior of jackups.

Floaters, subsea installations, and jackups

In the disciplines of global performance and global strength of floating structures, researchers are studying methodologies to determine environmental loads from wind, wave, and current.

This is to better evaluate structural strength and to get a better grasp of the floater's motions, considering the effects of mooring lines, risers, and umbilicals. One of the primary objectives is to provide strong technical support to the local ABS engineering department and local industry.

This group has been involved in analyzing new semisub-

mersible and drillship designs at several major shipyards and has the capability to perform comprehensive global performance and global strength analysis for marine and offshore structures.

Additional resources are going toward studying wave run-up and air-gap issues for semisubmersibles, and moonpool issues for drillships. And there are opportunities to team up with local universities for further study using both numerical simulations and model tests.

In ongoing collaboration with the National University of Singapore (NUS), which is very strong in geotechnics, ABS is focusing on two topics: foundations of offshore and subsea structures and deepwater, dynamically-installed anchors.

Since jackups are one of the main products of Singapore shipyards, considerable effort has gone into studies on jackup foundations. Researchers are studying both global and local structural behaviors of jackups.

In terms of global behavior, engineers have completed a project on jackup structural dynamics in which the team studied four existing procedures as a foundation for proposing recommended practice for industry.

In a project focused on local structural behavior, ABS participated in a joint industry project on behaviors of thick-walled joints, which are not well addressed by existing industry standards. Phase I of this project has been completed, and Phase II is under way.

Ongoing research is targeting spudcan/pile interaction, spudcan/footprint interaction, spudcan fixity, and spudcan penetration, all of which are critical issues for jackup design.

There also are projects focusing on the interaction between soil and subsea pipelines, which is important for lateral buckling of pipelines. Another study on pipeline/soil/water interaction is in the planning stages.

SIRC researchers participated on two of the three components that comprised the project on deepwater dynamically installed anchors, which included using CFD to study how currents affect the anchors, numerical simulation, and centrifuge tests of anchor-soil interaction.

Modeling solutions

While a number of SIRC projects incorporate CFD, the major CFD project was to develop a virtual model basin for offshore applications. The goal is to develop a CFD software system to couple the solver, based on potential flow theory, and the solver of CFD to achieve both computational efficiency and accuracy. Using this virtual model basin along with commercial CFD software, researchers have studied many important hydrodynamic problems for offshore structures, including:

- Wave- and current-induced loads on jackup legs
- Wave run-up and motions of semisubmersibles
- FPSO motions considering non-linear wave effects
- Internal wave effects on offshore structures
- Extreme wave effects on offshore structures.

The team plans to continue research over the next few years and plans to extend the work to include the application of CFD to other areas such as ship performance and subsea.

Ice loads on offshore structures

Engineers at SIRC are developing methodologies to determine ice loads

While it is somewhat counterintuitive to think of Singapore as a center for ice research, engineers at SIRC are developing methodologies to determine ice loads on offshore structures and to design ice-resistance, offshore structures.

One interesting project being carried out with NUS involves conducting both numerical simulation and model tests to study the impact load of floating ice in severe sea environments. Another representative project is simulating ice-structure interaction to determine ice loads, using advanced finite element techniques such as cohesive zone modeling.

Fracture mechanics

In the past five years, ABS engineers have studied the failure assessment procedures for offshore structures to help make decisions about how to deal with failures such as fatigue cracks, identified while offshore structures are in service.

Another project is focused on assessment of cleavage fractures for structural steels in low temperatures. An assessment of crack-like defects in welded details is to be conducted as well.

Noise and vibration

SIRC engineers also are investigating noise and vibration analysis of ship and offshore structures and fatigue life enhancement technologies. They recent completed several projects focused on vibration analysis of ships and offshore structures.

SIRC currently has nine engineers who are working on 16 internal projects and nine external projects in the form of JIPs or joint development projects. Over the next three years, SIRC will grow in manpower and expand its research efforts to include areas such as structural monitoring, risk management and human factors, and subsea systems.

ABS recognizes that investment in R&D is crucial because technology will be the enabler that overcomes today's operational challenges. With that goal in mind, research efforts will continue to focus on the technologies that will push back today's frontiers.

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