Research efforts continue strong in Singapore

Dr. Hai Gu explains how R&D at ABS continues to support offshore safety

Multidisciplinary teams of ABS SIRC researchers collaborate to find answers to challenging industry problems.

While there are ups and downs in the oil and gas industry, one thing that must remain constant is investment in research and development (R&D). This is a critical focus at ABS, where research projects in technology centers around the world are under way. From the technology headquarters in Houston and centers in Canada, Brazil, Korea, China, and Singapore, research is helping to pave the way forward into new areas of offshore operations.

Work at the Singapore Innovation and Research Center (SIRC) continues to focus on six critical areas: global performance and global strength of floating structures, structural-soil interaction, computational fluid dynamics (CFD), ice loads on offshore structures, application of fracture mechanics, and the structural behavior of jackups. These are the same areas targeted by R&D last year, but in 2014, SIRC is working on more challenging problems than ever before and has built up multidisciplinary teams to do more meaningful and more complex research.

Multidisciplinary teams

Previously, SIRC engineers were organized by aligning those with similar backgrounds and skill sets. This resulted in small teams for each focus area – a structures team, a hydrodynamics team, a geotechnical team, etc. With this organizational structure, each team tended to focus on topics

within their area of discipline. For example, the structures team might only be interested in structural failures due to fatigue and buckling but might not be interested in paying attention to finding ways to determine the loads that cause those failures. The result from this alignment was research that had great depth but sometimes relatively small breadth.

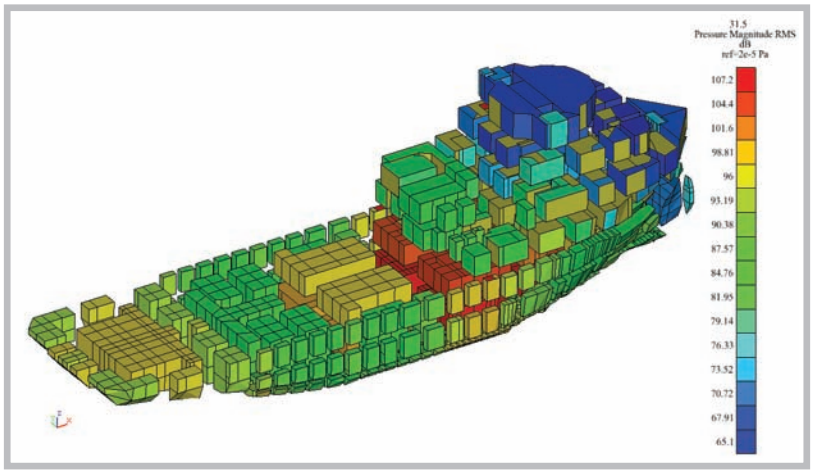
The recognition that real-world projects often are very complicated and require multi-discipline expertise led leaders at SIRC to make a change to the teams, reorganizing staff by projects. After identifying several topics of concern in the industry, researchers were divided into teams with multidisciplinary expertise.

Executing a new approach

One interesting SIRC project, which is targeting the challenging hydrodynamic and structural issues of floating assets, is benefitting from this new approach. The team is applying CFD, traditional hydrodynamic analysis, model testing and structural analysis to study the increased resistance created by the presence of a moonpool, the amplified wave elevation inside the moonpool and related operational and structural issues. One of the goals of this approach is to calibrate CFD analysis and traditional hydrodynamic analysis best practices that can be used to optimize moonpool design.

Another project is looking into wave run-up and air gaps on semisubmersibles. Engineers applied a strategy similar to that used in the moonpool project. The objectives are to understand the physics of wave run-up and other nonlinear effects related to air gap analysis, to develop the best practice to study these problems with CFD, to develop a procedure to adjust the traditional hydrodynamic analysis so that it can provide more reliable results, and to develop a procedure for predicting loads on structures in the case of a negative air gap. The team used model tests to calibrate CFD analysis and then use the calibrated CFD analysis to develop a procedure to adjust the traditional hydrodynamic analysis. CFD also is being used to develop the procedure to determine the loads on structures, while structural analysis is used to evaluate the structural responses and to propose structure modifications.

Meanwhile, the ice team is developing a framework for structural design and assessment of ice-capable offshore structures. Special attention is being paid to innovative ice-capable offshore structures with narrow components, with a focus on assessing design ice loads and their effects and implementing appropriate acceptance criteria, which is a particular challenge in designing ice-capable assets.



This SEA model was used for noise prediction on a ship. All images are courtesy ABS

In a project conducted jointly with the National University of Singapore (NUS), engineers examined the kinetic behaviors of an ice floe in a severe sea environment. The results of this project will be used to create a framework for structural design and assessment for ice-capable structures.

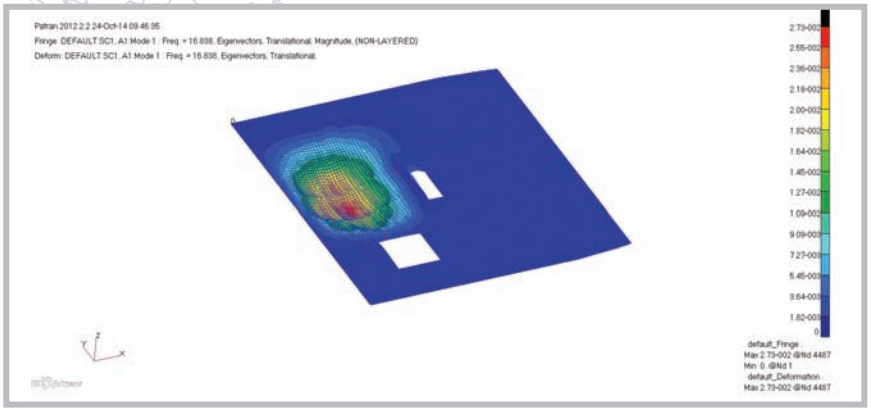
In another discipline area, the geotechnical team is working with colleagues in Houston to develop guidance notes that no longer focus solely on soil, but take a much broader look at the system, which includes both the structure and the soil. One of the team's goals is to develop a procedure for studying issues related to jackup installation.

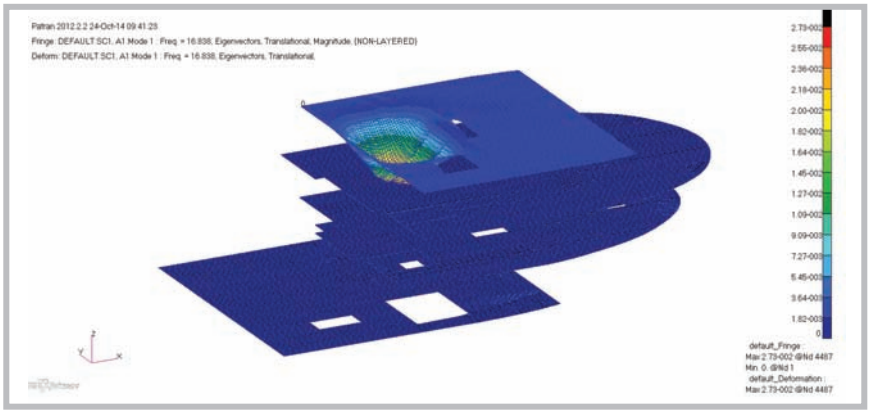
Teaming with NUS, engineers also are studying the design of dynamically installed anchors and the effects of pipeline-soil-water interaction with the goal of developing design guidelines for deepwater applications. The two studies will include laboratory testing, centrifuge modeling, and numerical simulation.

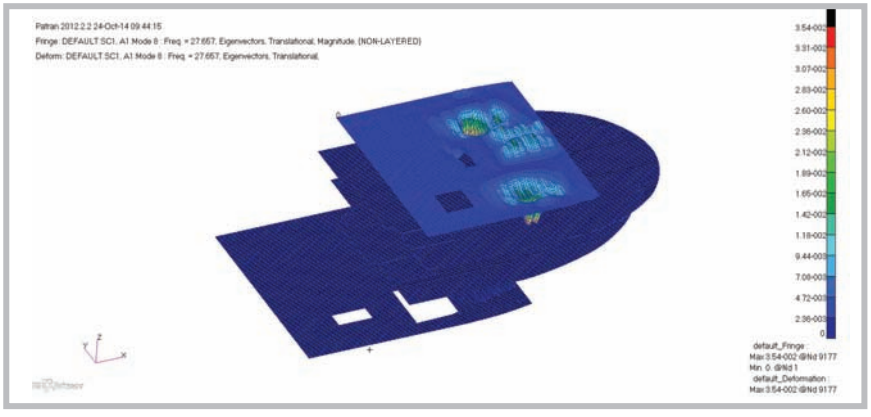
An internal team also has been created to focus on noise and vibration analysis. The job of this team is to develop best practices for predicting noise and vibration levels onboard ships and offshore structures. Measurement data are used to calibrate numerical simulations based on SEA (Statistical Energy Analysis), FEM (Finite Element Method), and some simplified methods to develop the best practice. SIRC has completed several noise and vibration projects for both ships and offshore structures.

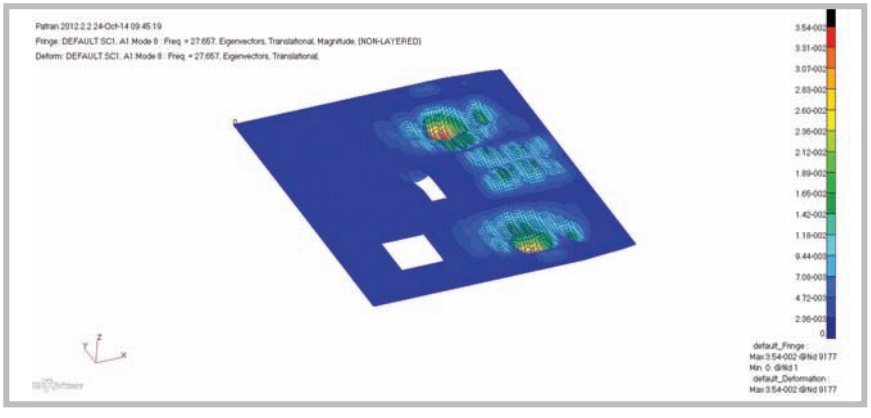
Structural health monitoring (SHM) is a technology that could have great impact on the marine and offshore industries. SIRC is studying this from two perspectives. One is to develop a roadmap for SHM from the point of view of a classification society. The other is to study promising new SHM technologies that could be applicable to the marine and offshore industries. One such study is a project with Nanyang Technological University (NTU), studying corrosion mapping in ship structures using ultrasonic guided waves. SIRC also is working with another research institute to plan a project to develop the technology to improve the efficiency of survey.

Human factors engineering (HFE) is yet another new focus. HFE is a discipline that focuses on the critical role of the human element as the root of effective safety standards and practices. SIRC engineers are working with colleagues in the Corporate Technology division in Houston on a project to identify human cognitive and physiological factors that influence risk perception, tolerance, decision making, and behavior, and from that knowledge, to find or devise means to manage and counter those factors thereby gaining a degree of control of risk tolerance and risk taking. In addition to the work with the Houston Technology Center, SIRC is working with Nanyang Technological University (NTU) in Singapore studying simulation and modeling for human factors in maritime risk management.









SIRC teams created Finite Element Analysis models for free vibration analysis of a ship. The deformation shows the deck's natural vibration modes.

Expanding R&D

SIRC is adding resources to its multidisciplinary team to take on even more challenging projects. In the near term, an experienced engineer from the Houston Technology Center is transferring to Singapore to head projects related to Integrated Software Quality Management (ISQM). The move toward automation on offshore facilities has allowed drilling and production systems to work much more efficiently. But the introduction of complex integrated control systems also poses challenges because the many pieces of software that enable faster and more efficient operations are not developed specifically to work with one another. ISQM addresses this challenge by providing a framework to coordinate and control the way software development, integration and maintenance are managed throughout the life of the equipment. Applying the ISQM process to work in the shipyard and in the hookup and commissioning process allows for better asset management.

In another business sector, SIRC is carrying out several projects related to LNG bunkering. This includes technologies related to LNG bunkering vessels and operational performance. As more LNG-fueled vessels and offshore assets enter the market, the need for bunkering grows. And as is the case in many other areas of industry that are changing and growing rapidly, bunkering represents a sector in which R&D efforts are needed quickly.

By investing in its shared technology research centers around the world, ABS continues to work toward the goal of helping industry overcome technical obstacles, with safety at the core of new and improved processes. **AOG**

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