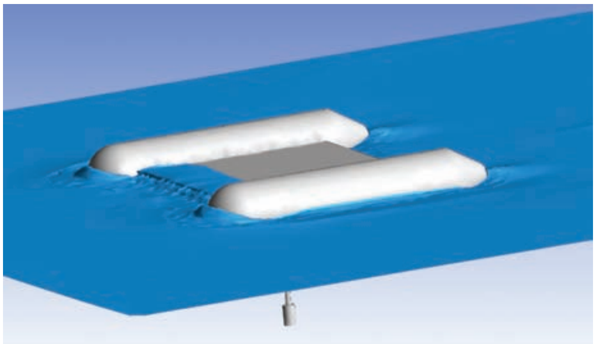
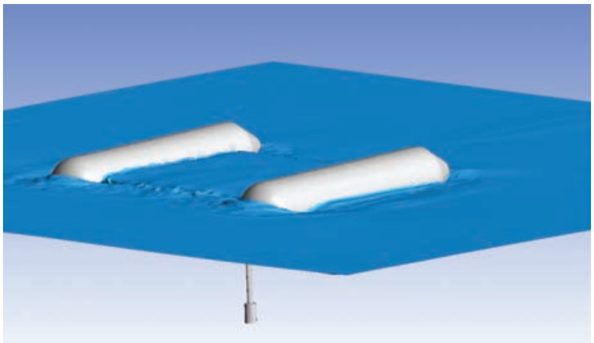


Sensor float fluid–structure interaction (FSI) transient response to current flow



Sensor float bow nosing down due to flow on sensor below float, deck awash

# Don’t Rock the Float!

## Fluid–structure interaction allows designers to assess impact of waves on freshwater and offshore systems.

*By Richard Grant, President, Grantec Engineering Consultants, Inc., Halifax, Canada*

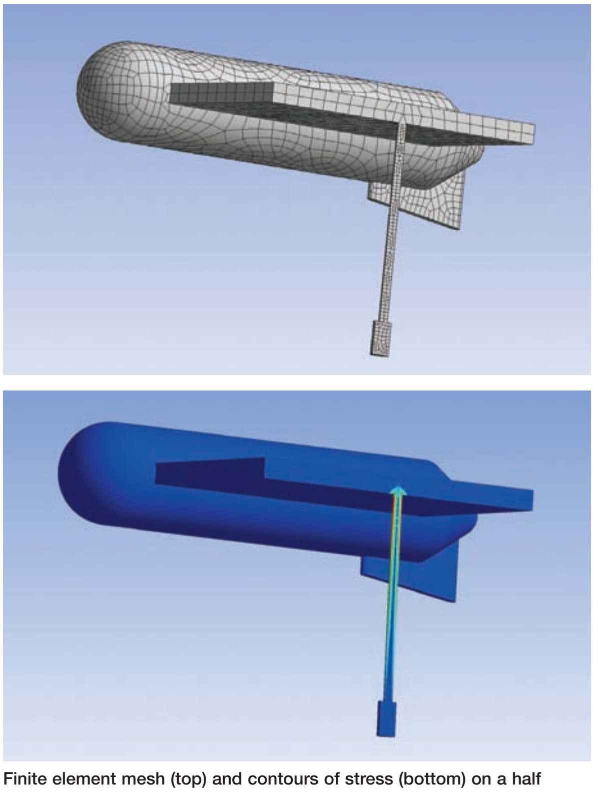
On a recent project commissioned by Environment Canada, Grantec Engineering Consultants, Inc. was tasked with developing a water quality monitoring float designed to carry a sensor for capturing environmental data. The float plays a role similar to — and looks somewhat like — a catamaran, though it is designed to be moored rather than driven by an engine or sails. The goal of the analysis was to minimize drag and ensure stability of the float as well as to develop specifications for the mooring system and structure. To meet this goal, Grantec used multiphysics simulation software from ANSYS to determine the fluid–structure interaction (FSI) by modeling the float and sensor under a wide range of water current and wave conditions.

Based in the maritime province of Nova Scotia on the east coast of Canada, Grantec and its engineers have an extensive background in both structural and fluids analysis helping customers in the defense, offshore, marine, manufacturing, energy and aquaculture fields advance new designs and systems. More recently, however, Grantec has often faced the challenge of how to combine these two analyses that have historically been performed separately. Previously, when the interaction between fluid and structure was critical, Grantec’s engineers needed to enter the results from the fluid dynamics software manually into the structural analysis software and vice versa. In contrast, ANSYS offers a solution integrating several of its most powerful and trusted fluids and structures simulation tools. With its multi-field solver, the ANSYS FSI solution provided Grantec’s team with a bidirectional capability for time-transient or steady-state analysis with moving or deforming geometry. Using ANSYS Multiphysics software, the Grantec engineers were thus able to evaluate both the structural part of the analysis and the fluid flow solution with just a single tool.

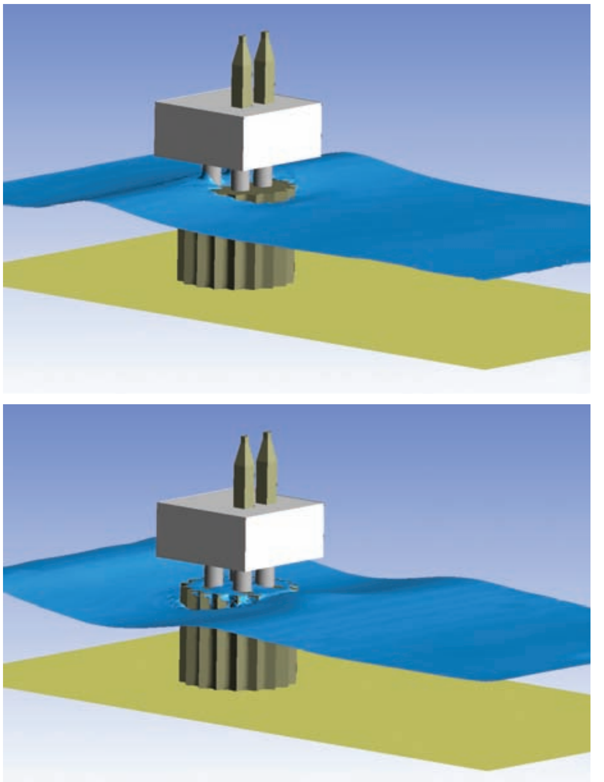
In the original float design, the team modeled the float and sensor as a flow obstruction, which accounted for the flow currents and wave loading on the float as well as buoyancy forces. They then evaluated the development of bow and stern waves that result from the resistance of the hull to fluid flow, just as with the hull of a ship. The software duplicated the vertical heaving and angular pitching of the float in response to different wave and current conditions. The impact forces from the waves calculated in the fluid simulation were automatically passed back to the structural model to more accurately simulate the stresses and deformations on the hull. Though they have little effect on fluid flow, the stresses are important because they make it possible to optimize the design of the hull to a much higher level than would be possible without them.

With the FSI solution from ANSYS, Grantec evaluated the performance of a wide range of hull profiles and mass distributions under different flow conditions, and it took advantage of parallel processing to accommodate larger models more efficiently than using a single-machine environment. In the initial series of designs studied, the sensor was fixed to the stern of the float and extended vertically into the water. The FSI results for these designs showed the force exerted by water currents on the sensor combined with the bow wave tended to push the bow of the float underwater in faster currents. It was not practical to solve this problem by simply changing the hull design, so the team tried a hinged connection between the sensor and the float to reduce the load transmitted from the sensor to the float. The hinged sensor, however, greatly increased the complexity of the simulation analysis.

Grantec addressed the new challenge of the hinged-sensor design by modeling the float with the sensor fixed in different hinge positions using the immersed pipe element in the structural portion of ANSYS Multiphysics software. Unlike the extensive approach used for the non-hinge designs, this new method provided a more simplified way to perform FSI analysis. With the immersed pipe element, the team applied wave and current loading to the structural model without the computational load involved in coupling it to a full fluid dynamics analysis. In the future, Grantec plans to use a moving mesh to perform a more complete FSI analysis including full fluid dynamics simulation that will evaluate the motion of the hinge in response to hydrodynamic forces.



Finite element mesh (top) and contours of stress (bottom) on a half model of the sensor float. The FSI analysis was performed to look at the effect of a fixed flexible boom on the float.



Waves washing over top of gravity-based structure of offshore platform (waves traveling to the right)

Beyond its studies of water quality monitoring floats, the company has done extensive work with engineering simulation to help create safer and more structurally sound offshore structures and systems. Grantec's engineers have also used the ANSYS Multphysics solution to assess gravity-based structures (GBSs) used to protect offshore oil drilling and production platforms from icebergs. GBSs rely on weight to secure them to the seabed, which eliminates the need for pilings in hard seabeds. Concrete GBSs are typically built with huge ballast tanks so they can be floated to the site and, once in position, sunk by filling the tanks with water. The Grantec team used FSI from ANSYS to simulate wave loading a GBS including the effects of massive waves from storms — also known as green water — coming over its top.

The company believes that its investment in ANSYS Multiphysics software has made a significant addition to its analytical capabilities. Clients seek out Grantec because of its track record in performing advanced engineering to solve very complex problems. ANSYS technology has helped put another tool in the Grantec toolbox that makes it easier to address design challenges that just a few years ago would have been much more difficult.