case study

Subsurface Single Leg Moorings

Predicting the behaviour of ADCP buoys and moorings

Client:	DeepWater Buoyancy
Location:	Biddeford, Maine, USA
Description:	Analysis of subsurface mooring deployment, recovery, and performance in current and waves.
Scope:	Provide accurate numerical models and visualizations of four buoys and compare their behaviour.

Dynamic Systems Analysis Ltd.

Dynamic Systems Analysis Ltd. is the developer of the ProteusDS software platform.

The software enables ocean engineers to answer questions related to feasibility, design, training, installation, and operations.

Understanding the dynamic effects of ocean current, wind, and waves on equipment in an ocean environment is DSA's primary business.

DeepWater Buoyancy

DeepWater Buoyancy creates subsea buoyancy products for leading companies in the oceanographic, seismic, survey, military and offshore oil & gas markets.

Customers have relied on DeepWater Buoyancy's products for over thirty years, from the ocean surface to depths exceeding six thousand meters.

Background

DeepWater Buoyancy recently came to DSA with the question: how do our ADCP buoys and their moorings behave in different currents? To answer questions like these, designers have traditionally turned to basic mass-drag-buoyancy calculations, spreadsheets, rules-of-thumb, black magic scripts, and a dose of 'salty-sea-dog' experience. With these methods, mooring designers can frequently estimate a line size to use or an approximate anchor weight; however, more and more this approach is becoming insufficient. The next generation of mooring designers expects 3D visualization and dynamic analysis.

Numerical modeling software for single point moorings has come a long way in recent years. Finite-element based cable analysis software has been tested and developed by oceanographic institutions and ocean engineers for various purposes (towed bodies, ROVs, moorings, etc.). Its use in the oceanographic community, however, has been typically limited to a few specialists who had both the expertise, budget, and patience to wade through the analysis process. To solve this problem, DSA has developed ProteusDS.

ProteusDS users benefit from features like increased computational power and advances in 3D graphics. Users of numerical modeling software can now get a much clearer picture as to what is happening with below the ocean's surface.

Challenges

ADCP buoys from DeepWater Buoyancy come three familiar shapes: spherical, elliptical, and streamlined - like the StableMoor®. While the buoys are level, spherical buoys have the highest drag, and the StableMoor buoy has the lowest. The first challenge was to develop a 6 DOF rigid body model of each of the buoys capable of predicting buoy pitch in response to hydrodynamic, mass, and buoyancy forces. A Morison drag model was used with known drag coefficients in the surge, sway and heave.

Next, the mooring system model needed to be assembled which could answer a variety of questions: How much buoyancy do I need for my mooring? What shape of buoy is best? How will waves affect the pitch motion of the buoy? How long will it take to recover the buoy? What are the launch transients? To answer these intertwined questions, the finite-element based mooring line model in ProteusDS was coupled to the buoy model and subjected to a variety of environmental conditions and initial states.

Scope

- Develop a numerical model capable of simulating the behaviour of the three DeepWater Buoyancy ADCP buoy shapes: spherical, elliptical and StableMoor®.
- Analyze buoy pitch and knockdown in current.
- Simulate mooring deployment to ensure that the acoustic release is not damaged and determine launch transient loads.
- Analyzing mooring recovery to determine how long it takes for the mooring to surface.
- Explore the interaction of waves with the mooring and buoys.

Outcomes

ProteusDS was successfully used to model the three DeepWater Buoyancy ADCP designs: spherical, elliptical and StableMoor®. DSA produced a video which illustrates the numerical models developed.

The analysis showcased the value of having a software package, like ProtuesDS, capable of analyzing buoy mooring pitch and knockdown in current, transient loading during deployment, mooring recovery, and the interaction of waves.

These types of analyses help mooring designers answer practical questions about mooring performance, taking the guesswork out of what is happening under the ocean's surface - saving time, materials, and money.

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