

## **Performance Evaluation of Articulated Multi-body Floaters in Harsh Environment**

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### **ABSTRACT**

In this paper, the response of articulated floating structures in harsh environment has been investigated. Three applications where articulated joints are used to connect multi-bodies together are considered in this study; namely; VersaBuoy Offshore Platform; VersaBuoy Mobile Offshore Real Estate and the Bottom Feeder System for deck Installation/salvage. The hydrodynamic analyses of the three applications have been performed using both frequency-domain and time-domain approaches. Extensive model test programs are performed to validate the numerical predictions and illustrate the advantage of using the articulated joint to reduce the superstructure motion. Numerical results for the articulated joint loads as well as motion of each component of the multi-body system in comparison to the model test measurements are presented in this paper.

**KEY WORDS:** multi-body analysis; articulated joint; hydrodynamic interaction; VersaBuoy; Bottom Feeder; floating platforms; mobile offshore real estate; very large floating structures.

### **INTRODUCTION**

Multi-body system could represent the next generation of floating system. In the articulated multi-body system, more than one hydrodynamically interacted hull is used to support a superstructure. This superstructure could be topside of a production or drilling platform, a mobile offshore real estate, floating airports, gantries for deck installation/salvage, etc. These hydrodynamically interacted multi-hulls are connected to the superstructure through articulated joints that allows independent roll/pitch rotation of the hulls relative to the superstructure consuming most of the wave energy as a kinetic energy in the hull motion while allowing only small portion of the wave energy to transmit to the superstructure. This significantly reduces the superstructure motion. The presence of these articulated joints make the system reacts to the applied environmental loads in a fundamentally different manner when compared to the performance of single hull floaters.

In this paper, three examples of articulated multi-body floaters are

presented and the performance in harsh environment has been numerically and experimentally evaluated.

The first example is a VersaBuoy Offshore Platform (OP). The configuration of this floater comprises of four self-stable hulls supporting a typical open truss square deck of dimensions 250 ft x 250 ft. The second example is a VersaBuoy Mobile Offshore Real Estate (MORE) of an area 500 ft x 500 ft supported on 16 hull system while the third application is a Bottom Feeder System (BFS) that consists of two-barges supporting two gantries through four articulated connections.

Multi-body simulations of the VersaBuoy OP (5-body system four of which are hydrodynamically interacting), the VersaBuoy MORE (20-body system 16 of which are hydrodynamically interacting) and the Bottom Feeder BFS (4-body system two of which are hydrodynamically interacting) are performed in both time domain and frequency domain.

Extensive model test programs have been carried out to validate the numerical predictions and confirm the advantages of articulated multi-body performance in harsh environment. Numerical results and comparison with the model test measurements of the system responses are presented in this paper.

### **THE ARTICULATED JOINT**

Articulated connections themselves have formed a staple of automotive and other machine equipment and as such there is a large body of knowledge and experience in their design and specification.

For current applications under consideration the articulated joints transmit an axial thrust of between 1,000 and 2,500 tons and accommodate a range of motion of +/-20 degrees. The joint is located at an elevation of (+) 55 to (+) 60 feet MSL, outside of the splash zone and accessible for regular inspection.

Fig. 1 shows an example of the fabrication of Pin-in-Pin Articulated Joint being manufactured for use in the "Bottom Feeder" custom