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VIM tests for multi-column platforms

In the last few years the importance of current on the behaviour of offshore structures has become increasingly evident. For instance, the strong loop current in the Gulf of Mexico has delayed installation projects and resulted in Vortex Induced Motions (VIM). Report focuses on a number of current-induced effects.

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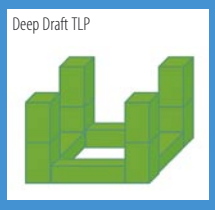
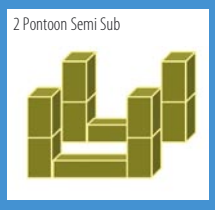
The effect of VIM on single-column, Spar-type, floating structures in high currents has been extensively studied during previous years. However, this research has recently been extended to the effect of VIM on multi-column structures, such as deep draft, semi-submersibles and TLPs. This new research confirms that VIM should be taken into account in the design process of these structures and that it is an important consideration for mooring and riser fatigue. MARIN has performed in-house model tests to investigate the effect of multi-column floater draft, floater shape and mass ratio.

Four different configurations were tested:





A sharp-cornered, building blocks model was constructed which allows easy adjustment of the general shape of the floater and mass distribution.

A new type of test set-up using air bearings was developed to be able to model the different vertical pretensions (i.e. vertical downward force that compensates the difference between mass and displacement). The model is equipped with ultra-low friction air bearings that slide along a horizontal plate that is mounted to the carriage. The horizontal restoring is provided by two soft springs in the tow direction.

Deep draft semi-submersibles show the most VIM response at 45 degrees incoming current angle. This is shown in the results in figure 1.

The peak response is found at a Ur between five and eight, which is also well known for Spar VIM and riser VIV. The conventional semi does not show any VIM response at all. This is caused by the smaller column height, which results in smaller, vortex-related forces that excite the motion. This is partly due to the reduced length of the column resulting in a smaller forcing length but it may also be due to increased three dimensionalities in the flow (i.e. column end effects). Furthermore, the lower mass ratio (=mass/displacement) of the TLP results in a slightly higher response at a wider Ur range. This is because VIM is a coupled problem and the added mass adapts itself to the motions of the floater. For the TLP, the added mass represents a larger part of the total mass that is moving and therefore,

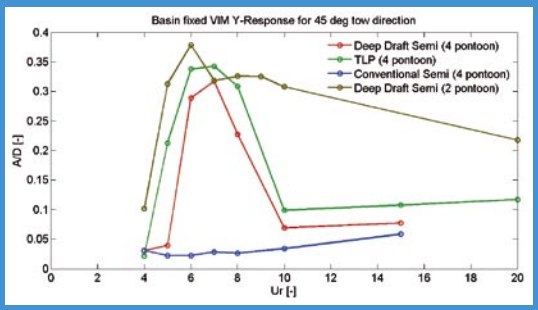


Figure 1.

the changing added mass effect results in relatively larger response at a wider Ur range (i.e. the added mass adaptation effect is stronger).

Further work will include variations such as column corner shape (sharp vs rounded) and column spacing. This work will be part of the Current Affairs JIP which addresses current induced loads and motions for offshore floaters. The main objective of this JIP will be to provide engineers with improved knowledge and tools for current related problems in offshore floater design. The Current Affairs JIP will start in the spring.

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