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Efficient Gravity Installed Anchor for Deepwater Mooring

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Abstract

Experience and benefits of a new innovative gravity installed marine mooring foundation, the OMNI-Max is presented in this paper. The OMNI-Max anchor is an omni-directional gravity installed plate anchor that can be installed more efficiently and provide more foundation reliability than other available foundations. The anchor is released from about 50-meters above the seafloor, penetrates into the seabed, and is ready for use. The installation method and relatively small size of the anchor allows for rapid deployment from a wide range of installation platforms. The OMNI-Max exhibits non-catastrophic behavior [5] when loaded which reduces the risk of mooring failure on surrounding infrastructure. The omni-directional loading capability also provides an added benefit beyond installation tolerance, in that the foundation can withstand loading from nearly any direction which potentially allows for damaged mooring systems to survive longer during an extreme event. Field and mooring design approval experience with this mooring foundation since 2007 indicates the OMNI-Max anchor reduces installation cost and is a valuable tool to reduce risk on moored MODU locations during hurricane season.

Introduction

For a deepwater mooring anchor to be efficient, it must be small enough to bring multiple anchors to the field on one Anchor Handling Vessel (AHV) trip and provide adequate capacity performance such that it has a low probability of failure. Two of the most widely used Vertically Loaded Anchors (VLAs) for temporary moorings are the suction pile and drag-installed VLA. Each of these has their pros and cons for both installation and capacity performance.

Suction pile anchors are some of the largest anchors currently being used for temporary moorings. These anchors require multiple AHV trips to install a complete system set of anchors on a typical location. Installation of suction piles once on location is rather quick by simply lowering them to the seafloor and pumping them into full design penetration. The design capacity factors of safety for suction piles are such that it is highly unlikely that suction pile capacity failure will ever occur. In fact, no suction pile anchor used for MODU mooring has ever failed in the Gulf of Mexico. Only when the mooring load being applied to these anchors is significantly out-of-plane, does chance of foundation fixity failure noticeably increase, and even then its only been structural failure at the padeye in less than 10% of the mooring failures in hurricanes utilizing suction piles. Thus, suction piles are costly to install due to their size. However, they provide one of the most reliable foundations available on the market.

Drag-installed VLAs are some of the smallest anchors currently being used for temporary moorings. These anchors require minimal AHV trips and commonly a complete set of anchors can be installed in one AHV mobilization. Since these anchors are drag-installed, this requires more than simply lowering them to the seafloor. The AHV must payout additional component once the anchor is on bottom and apply significant bollard pull to set these anchors. Once in the mud these anchors will follow a trajectory related to the tension and uplift angle at the mudline [1]. Once a drag-in load has been applied to the anchor, the AHV recovers some component and then applies another significant pull to break a shear pin which changes the orientation of the anchor so that it becomes more perpendicular to the load. After this point the anchor will take a steeper trajectory, however it is still a function of the load and uplift angle at the mudline [1]. If the anchor did not achieve adequate penetration in the drag-in phase, then when the shear pin step is attempted, the anchor may not have enough resistance to stay embedded. Care must be taken in the setting of these anchors in order for them to perform reliably.

The OMNI-Max anchor size is approximately half of a comparable suction pile and about twice the size of a drag-installed VLA. Typically a set of eight anchors can be deployed from a typical AHV. Since installation of the anchor only requires