Suction Piles Versus Drag Anchors for Deep Water Moorings

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ABSTRACT

For the floating structures considered for oil exploration and production in ever deeper water fields, the mooring system represents a significant component, with technical challenges and potential cost savings in both the mooring lines and anchors, as well as in the installation time offshore. For exploration purposes, the lack of availability of suitable mobile drilling units ('MODUs') is another major concern. Since a very limited number of MODUs can work in water depths in excess of about 1200m, use of pre-set moorings is considered to extend the water depth capabilities of existing units.

Use of conventional drag anchors and driven piles has been the current practice for deep water catenary mooring systems for permanent and mobile structures in up to about 1000m of water. More recently, vertically loaded anchors and suction piles have been considered. Suction piles were used for permanent mooring of a process barge at the Nkossa field developed by ELF Congo in 200m of water depth. The Nkossa soils, consisting of soft clays similar to those generally found in deep water, make this experience relevant for deep water sites.

The objective of the present paper is not to perform a complete review of all possible options for deep water moorings, but to emphasise on the experience and key learnings from recent installation operations and field tests. Based on this experience, a case study is presented for a MODU in about 1500m of water offshore West Africa.

KEY WORDS: Suction Piles, Drag Anchors, Deep Water Mooring Systems, Soft Soils, Mobile Offshore Drilling Units.

INTRODUCTION

When designing mooring systems for floating structures in ever deeper water depths, comprehensive engineering studies shall be performed for the two main issues which are: (1) selection of the mooring lines and anchor points, and (2) installation procedures, since any problem encountered at the field will have significant impacts on the overall cost of the mooring system.

Concerning exploration MODUs, the very limited number of drilling rigs able to work in water depths in excess of about 1200m is a major concern with both technical and commercial challenges. Ten years ago already, deployment of pre-set moorings from conventional anchor handling vessels ('AHVs') has been proven a viable concept for extending water depth capabilities of MODUs in the Gulf of Mexico (Sorrel et al., 1997). Use of fibre ropes in taut leg moorings is now considered for extending current water depth capacities.

When looking at the anchor point selection, conventional practice for permanent and temporary catenary mooring systems in up to about 1000m of water has been to use driven piles or drag anchors. For a long time, driven anchor piles were the single proven means for vertically loading applications, and they have been preferred for all deep water production structures in the Gulf of Mexico (i.e. Auger, Mars, Ram-Powell, Ursa and Marlin TLPs in water depths ranging between 900 and 1200m, and Neptune and Genesis SPARs in 550 and 900m of water, respectively). According to hammer manufacturers, the current depth limitation for hydraulic underwater pile driving is about 1300m and this limit might be extended to about 1800m with some costly upgrades (Sorrel et al., 1997). However, anchor piles are not considered in the present paper because: (1) the length and weight of the driven piles to be handled make use of large crane vessels necessary with high installation costs, and (2) the recent sharp increase in MODUs' dayrates makes drilled and grouted piles uneconomic.

In 1995, the ELF Congo Nkossa barge was the first floating production unit permanently anchored by suction piles in soft soils representative of deep water sites. Since that, mooring systems with suction piles have been installed in water depths ranging between about 100 and 1000m and in all types of soil conditions (i.e. soft to stiff soils) and, with about 150 units installed in 1997, they have become the preferred solution for permanent moorings. A breakthrough for application of suction piles has also been made in 1997 with the installation of the mooring systems for AGIP's FPSO at the Aquila field in 850m of water in the Mediterranean Sea, and for PETROBRAS' FPU at the Marlim field in 1050 metres of water depth offshore Brazil.

The objective of the present paper is not to perform a complete review of all possible options for deep water moorings. Alternatively, emphasis is put on the experience and key learnings from recent installation operations, covering both exploration drilling rigs and production structures. Based on this experience, a case study with taut