Settlement Assessment of Dual Suction Anchor for Troll West PLEM

Moeen Nazari, Otilia Vermeulen, Tom Strandbakken and Per R. Nystrøm
IKM Ocean Design
Norway

Asle Eide
Equinor ASA
Norway

ABSTRACT

Consolidation settlements of a dual suction anchor (DSA) functioning as foundation structure (FST) of a pipeline end manifold (PLEM) on a soft clayey seabed during different installation and operational stages is evaluated. 3D finite element model of the DSA, including time intervals between installation phases, was created. The results showed the feasibility of DSA as the foundation structure of heavy subsea structures on very soft clays. It was observed that the maximum lateral deformations in the soil develop at shallow depths adjacent to the outside of the skirts, and the maximum vertical displacements occur in the soil plug inside the DSA and adjacent to the skirts. Concentration excess pore pressure was observed around at the tip of the skirts and adjacent to the stiffeners. In addition, it was found that the presence of post-lay rock at the vicinity of DSA considerably affects the settlement of DSA.

KEY WORDS: Dual suction anchor (DSA); foundation structure (FST); soft clay; 3D finite element (FE) analyses; consolidation settlement; excess pore pressure.

INTRODUCTION

Troll is a gas and oil field in the northern part of the North Sea, about 80 kilometers north-west of Bergen. The field is situated in the blocks 31/2, 31/3, 31/5 and 31/6 and the water depth in the area is 300 to 335 meters. The gas in Troll East is recovered by pressure depletion through 39 wells drilled from Troll A. The gas compression capacity at Troll A was increased in 2004/2005, and again in 2015. In addition to gas from Troll East, gas from the Troll B and C platforms is exported via the Troll A platform. The gas and natural gas liquids are transported from Troll A to Kollsnes Gas Processing Plant in Øygarden via three 36” pipelines. The oil is transported from Troll B and C to pipelines to Mongstad.

The Troll Phase 3 development (stage 1) is a 36” subsea pipeline tie-back of two templates (W1 and W2) to the Troll A platform (see Fig. 1). Out of three initially proposed foundation structure (FST) alternatives, i.e. a rectangular foundation with peripheral skirts (Størkersen, 2016), a four-bucket suction anchor (Bertrane, 2010) and a dual suction anchor (DSA), the DSA was selected as the best foundation alternative for a pipeline end manifold (PLEM) on a soft clayey seabed. It was found that the DSA has advantages, such as providing a stiffer mainframe structure, keeping the periphery of the suction anchors within the frame extents and providing simple suction system arrangements compared with the four bucket solution, and a better control of installation and leveling process compared to the rectangular skirt solution. Troll West DSA was installed successfully in July 2019 (see Fig. 2).