TU Delft

Offshore & Dredging Engineering

Technische Universiteit Delft

Decommissioning of the legs of a concrete gravity-based structure

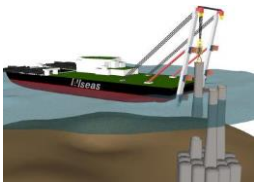
In the 1970's, Concrete Gravity Based Structures(CGBS) were designed to overcome the challenges of oil and gas production in harsh environments with limited pipeline infrastructure. Currently, many of these huge structures approach the end of their life cycle and need to be decommissioned. A solution for removal of the topside by a single lift has been developed by Allseas, but a feasible solution for the substructure is yet to be developed. Previous studies proved that reverse installation or offshore demolition is not an option, due to the age and design of the substructure that is secured to the seabed. In order to comply with the regulations on decommissioning by the OSPAR convention, it has been decided to cut and remove the concrete legs of the substructure creating a free water column of 55m above the remaining substructure.

The emerging decommissioning market has been a key driver for the development of Allseas' new vessel the Pioneering Spirit, as Allseas intends to be a leading contractor in the execution of complex decommissioning projects. One of the vessels' first projects will be the dismantling of the concrete gravity based Brent Delta platform, starting with the removal of the topside in the summer of 2017. The next phase of this operation is the removal of the three concrete legs by utilizing the heavy lift capabilities of the vessel.

The goal of this research is to design a feasible and safe operation to remove and transport the legs of a CGBS. In this design the conservation of the integrity of the concrete legs is considered to be most important. The concrete leg section will be removed in one piece, since the removal of multiple elements will impede the operation and increase the risk of environmental and safety hazards. The reinforced concrete legs have been in place for over 35 years and the current condition of the concrete, reinforcements and post-bonded tendons is unknown. Furthermore, the leg was designed for resisting compressive loads due to a large topside weight and lateral wave loading. The removal of the topside, the cutting, lifting and transportation will result in several load combinations for which the leg was not designed.

In order to identify the capacity for loads that may occur in decommissioning operations, first the structure of the leg is evaluated in this research. This description forms the base of the conceptual design together with the functional analysis and the boundary conditions. From these starting values a final concept for removal has been developed. The concept evaluation has resulted in a clear identification of critical loading cases during the operation, thus highlighting the topics that require further examination.

The study shows that a critical loading case is caused by the local stress and shear force that is introduced by the proposed solution for the connection between the leg and the lifting arrangement. Radial and tangential stresses in the leg and the required friction coefficients are a governing factor in the detailed design of the interface between the leg and the lifting arrangement. The concept requires the leg structure to be under pretension during the removal process, which results in a critical tensile force in the axial direction. In addition to this static critical load case the leg experiences dynamical loading due to wind, waves and vessel motions while the leg is raised to the surface. The interaction of these factors with the lifting system and leg characteristics has been simulated with a simplified analytical model. This provides an insight in the dynamical behaviour of the leg during the lift. The result of this study consists of a clear overview of the loads and stresses that are the most severe threat to the structural integrity of the leg, and serves as a basis for a more detailed design of the removal operation.



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