Offshore & Dredging Engineering

Technische Universiteit Delft

A novel concept for shallow water munitions removal – development and workability analysis

As a result of past world wars and the dumping of munition at designated dumping areas, residual military ordnance are found on and in the seabed, especially in the Wadden Sea, North Sea and Baltic Sea. Of the estimated 1.5 million tons of military ordnance, roughly ten percent is classified as Unexploded Ordnance (UXO). There are three main arguments for removing the military ordnance: environmental protection, human safety and project related. Current study will focus on the project related removal of munition, specifically for offshore wind cable installation projects. Recovery of UXO is often preferred over redirection of the cable route due to cost savings. Current state of the art methods use dedicated clearance ROV's and divers to remove the munition ordnance. However, these methods prove to be dangerous, inefficient or even impossible to use in shallow water areas (0-10 m) with strong tidal currents. The objective of current study is to develop a remotely-operated munitions detection and removal concept for use in coastal water areas and assess its feasibility.

First, a programme of requirements for the novel concept is obtained. During a systematic ideation process, fifteen different conceptual ideas are conceived and compared in a multi-criteria analysis from which the most promising concept is chosen: an excavator carrying a munitions toolskid on a moored pontoon.

The second part of the study focuses on assessing the feasibility of the proposed concept for two project sites. Specifically for this study, the workability in waves is assessed. Limiting criteria are defined for two critical components on the munitions toolskid to ensure a safe operation; the motion amplitude of the detection coils, limited to 50 cm vertical motion and the motion amplitude of the manipulators, limited to 5 cm absolute motion. The latter limit is based on user experience of existing ROV operations and is thus subject to interpretation. The motion amplitude of manipulator and detection coils is modelled by combining three sources of motion; backlash mobilization in the excavator, bending deflection of the excavator arm and wave induced pontoon motions. Three different types of mooring are modelled; gravity spuds, backhoe-type spuds (i.e. preloaded spuds) and a jack-up system.

Results of the workability assessment for two case studies show that the gravity spuds pontoon is not a feasible solution, mainly due to the freedom of heaving and pitching. Both defined motion limits are exceeded by more than 1 m. When using backhoe spuds or jack-up system, the criterion for the scanning coils is satisfied. The criterion for the manipulators is slightly exceeded by respectively 6 cm and 4 cm absolute motion for the backhoe and jack-up system. It can be concluded that none of the assessed solutions is workable if an exceedance of the motion limit for the manipulator is strictly prohibited. However, considering the exceedance of the limit is slight and the motion limit of the manipulator should be interpreted as an indication, the backhoe and jack-up system may prove to be workable solutions. Reassessment of the limiting criterion for the manipulator is required to give insight if a slight exceedance of the limit is allowable.

Student
Vince in het Panhuis

December 13th, 2016

Sponsor
Boskalis

Thesis committee
Prof.dr.ir C. van Rhee
Dr.ir. S.A. Miedema
Ir. K. Visser
Ir. S. Henrion
Ir. M. Biesheuvel