TU Delft

Offshore & Dredging Engineering

Technische Universiteit Delft

Alternative cable laying – a conceptual design fora n offshore power cable lay system on non-cable lay vessels

In this thesis, an alternative cable lay system was designed that can be used on existing non-cable lay vessels. This design is conceptualized and analyzed for a specific market, following the steps in the engineering design process. The technical and economic analysis investigates the feasibility and competitiveness of the new cable lay system.

Nowadays, cables are installed over a chute at the aft of a vessel. This makes the operation very sensitive to motions, inducing high cable loads that result in limited workability. Also, load carrying capacity is limited for existing cable lay vessels within the Boskalis fleet, making the application of joints a necessity in offshore export power cable installation.
The design focusses on the international offshore export power cable installation market (both AC and DC), including interconnectors, from shore to substation or shore to shore. This market was selected because of the limited load-carrying capacity of current cable lay vessels, the internationally growing offshore wind market and the relatively low market share of Boskalis in this segment. New concepts were generated and evaluated using multi-criteria analysis, scoring them on technical and economic criteria determined for the selected market.
The concept that has been selected for further development focuses on export power cable laying through a moonpool. A Dockwise semi-submersible heavy transport vessel is targeted for this design because it is being converted into a fall pipe vessel already. This conversion includes the installation of a moonpool, opening up the possibility to make the selected vessel a multi-purpose vessel. Making use of static stability software, the maximum load-carrying capacity of this vessel has been determined. From this analysis, it can be concluded that the maximum cable load that can be carried by the selected vessel is 9.000 tonnes of cable equivalent, which is approximately 110 km of currently installed export cable length. Conventional cable lay vessels from Boskalis have load carrying capacity up to 5.000 tonnes. Additionally, a deck-layout with the crucial parts of the cable lay system is designed, taking into account all necessary alterations regarding the conversion of the vessel.

The main technical challenge for the newly designed system is the second end cable pull-in. With limited space in the moonpool and vertical laying of the cable, the conventional pull-in method cannot be used here. Three solutions have been developed, based on a deployment quadrant or bight lay down. Two of these are already proven in the field, making the concept technically feasible.
A model has been made to evaluate both conventional cable lay and cable lay through a moonpool. Using dynamic time-domain analysis, operational limits have been determined for both methods, keeping the catenary shape of the cable constant. This analysis concludes that cable laying through a moonpool indeed increases the workability for the selected vessel. No concrete increase can be seen for moonpool cable laying with a conventional cable lay vessel. This is due to its sensitivity to roll motions, for which the distance towards the center of gravity is equal in both concepts. For the selected vessel, cable laying over a chute is not possible for the chosen catenary shape and sea states because the maximum allowable curvature is exceeded. This is due to the large arm for pitch motions, from the center of gravity to the chute at the aft of the vessel. Cable laying through a moonpool, however, is possible up to 2 meters significant wave height. The limiting factor for all simulations that were done is the maximum allowable curvature.
To investigate the competitiveness of the newly designed cable lay concept, an economic analysis is done. Several recently acquired project cases are introduced to compare project costs for both concepts. This analysis concludes that the newly designed cable lay concept is in average conditions 21 to 40 \% more expensive for all cases than the conventional way of cable laying. For cable installation during wintertime, the newly designed cable lay system is only 6.5 to 27\% more expensive than the conventional cable lay system.
This illustrates that the newly designed cable lay system is technically feasible but not competitive with conventional methods at the moment according to this analysis. However, the costs and installation time of joints with the conventional methods are not taken into account here due to limited available data. Therefore, the new cable lay concept still has the potential to be competitive for the selected market. Further research must be done to substantiate this.

Student	Sponsor	Thesis committee
Bart Gijsberts	Royal Boskalis Westminster N.V.	Prof.dr. A. Metrikine
August 29th, 2019		Dr.ir. H. Hendrikse
		Ir. L. van Baalen