Title of Diploma Thesis

Design of an Offshore Wind Turbine in the North Aegean

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ABSTRACT

The present Diploma Thesis focuses on the design of an Offshore Wind Turbine (OWT) in the North Aegean, Greece. The OWT is selected to be installed at a marine area located East of Lemnos island, taking into account an existing strategic framework related to the development of offshore wind turbines in the Greek seas. The water depths in this area advocate the utilization of a monopile support structure, while the utilization of a 5 MW wind turbine is taken into account.

Having selected all required data (e.g. wind and wave data, seabed characteristics etc), the dynamic analysis of the examined OWT is implemented using the FAST software (NREL) and the LPile software (Ensoft Inc). In the analysis, Soil Structure Interaction (SSI) is taken into account, through distributed and nonlinear springs, with stiffness values defined by the API p-y curves. The geometric characteristics of the pile and the tower are, initially, defined based on the well-known “soft-stiff” design criteria. The same criteria along with appropriately stability check have been utilized in order to determine the best penetration length of the pile. The examined OWT is, then, analyzed for both the Ultimate Limit State (ULS) and the Fatigue Limit State (FLS). In the case of ULS, design load cases are defined according to IEC, while the examined structure is checked in terms of its dynamic response, as well as in terms of strength criteria defined in the DNV-GL and the NORSKOK regulations. Finally, the FLS analysis is implemented for design load cases defined according to IEC, while the structure’s lifetime and the Damage Equivalent Load (DEL) are checked based on the DNV-GL regulation.

The results of the present thesis demonstrate that the proposed design is efficient for the examined OWT, since it leads to adequate utilization factors and a lifetime greater than its design lifetime.

Keywords: Offshore Wind Turbine, P–Y Curves, Dynamic Analysis, Ultimate Limit State (ULS), Fatigue Limit State (FLS), Greece.