Offshore Wind Development in Atlantic Canada – Environment Forces and Innovative Mooring System Design and Evaluation

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Atlantic Canada (offshore Nova Scotia and Newfoundland) is an untapped frontier for offshore wind energy. However, the region has a complex environment that includes hurricanes, winter storms, ice accretion, and in some locations, the seasonal presence of sea ice and icebergs. To support these challenges and to de-risk offshore developments, a comprehensive metocean and ice database has been developed. The database provides detailed historical statistics on a wide range of important design variables, including wind, waves, currents, temperature, icing and sea ice.

Geotechnical conditions in the region range from low-strength post-glacial marine muds to the dense frictional sands and gravels typical of the Scotian Shelf. With mooring and foundation systems accounting for up to 40% of the CAPEX for floating offshore wind turbines, selecting optimized anchoring solutions for diverse seabed conditions is critical. This study investigates alternative mooring systems, including micro-piles, suction caissons, and Flexible Embedded Plate Anchors (FEPLA). This study utilizes mooring loads from coupled aero-hydro-servo-elastic simulations in OpenFAST, combined with geotechnical physical and numerical modelling, to assess the holding capacity and dynamic response.

Physical modelling and calibrated finite element models are necessary to validate the ultimate holding capacities of a variety of anchor types. Geotechnical centrifuge based experimental equipment recently developed at C-CORE includes a new model pile driving mechanism capable of simulating pile driving in a variety of soil types and conditions. Work has been completed using both scaled model testing and numerical analysis to study foundation and mooring capacities including the influence of variations and layering of soil conditions. The performance evaluation of different anchors across varied soil conditions

provides a technical basis for risk-informed mooring design, ensuring structural stability under extreme environmental loads while optimizing the high CAPEX associated with offshore installation.