Scaled physical modelling of buried cables for offshore wind farms

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Offshore wind farm construction often emphasizes turbine foundations and towers, while cable infrastructure receives less attention despite its critical role in project performance and reliability. This network, comprising inter-array cables, offshore substations, and export cables transmitting electricity to shore, represents a significant investment and operational risk. Cable systems can account for 10% of capital expenditure, while cable failures are responsible for nearly half of offshore wind insurance claims and three-quarters of total claims. Because subsea cables often represent single failure points, damage can shut down major portions of a wind farm until repairs are completed.

Geotechnical design is essential to ensure safe installation, long-term stability, and protection from mechanical damage. Burial is commonly the preferred protection strategy, placing cables below depths affected by anchors, fishing gear, or dredging equipment. Effective site investigations must characterize seabed stratigraphy, soil strength, stiffness, density, thermal properties, and geohazards including scour, erosion, liquefaction, boulders, and shallow gas. These factors influence cable routing, burial depth, installation methods, and protective measures. Soil thermal resistivity is also critical, affecting cable ampacity and heat dissipation. Thorough geotechnical characterization reduces installation uncertainty, minimizes risks of cable exposure or overheating, and improves long-term reliability. As first-generation offshore wind farms approach decommissioning, cable removal is becoming increasingly important, with research examining export cable pullout methods.

Scaled geotechnical centrifuge modelling provides an effective means of investigating buried offshore cable-soil interaction under controlled conditions. This presentation highlights research at Western using the large drum centrifuge and related facilities to study installation behaviour, trench backfill response, flotation and pullout resistance, cyclic loading effects, and thermal performance. By applying scaling laws, researchers can replicate prototype conditions, validate numerical models, and improve understanding of complex cable-soil interaction mechanisms, supporting optimized burial design, reduced installation risk, and more reliable offshore wind cable protection strategies.