Innovative inspection for offshore turbine foundations

Snapshot

Client
Carbon Trust Offshore Wind Accelerator

Challenge
A technique is needed to assess the integrity of grout used in monopile foundations of offshore wind turbines.

Solution
We developed a completely new inspection technique using low frequency ultrasound which gives an accurate assessment of the grout layer in the monopile-transition piece joint. It was trialled successfully at a number of operational offshore wind farms.

Benefits
The system, a winner of the Carbon Trust's Subsea Inspection competition, operates reliably in challenging underwater conditions and has major potential benefits for offshore wind operators in ensuring the long-term stability of turbine towers.

Offshore wind farm operators face a challenge to establish the integrity of the monopile-transition piece interface which has been used in 80 percent of turbines constructed before 2012. We have developed a new system which can carry out inspections against tight timescales.

Project background

In the construction of many offshore wind turbines, grout – a high-strength, fast-curing cement – is injected into the gap between the monopile and the transition piece to which the turbine tower is fixed. Conventional inspection techniques have proved unsuccessful and to ensure the integrity of the grout and the long-term stability of the turbine, a new technique is needed.

A competition for innovative subsea inspection methods was launched by the Carbon Trust, an independent organization which supports low-carbon technologies. Uniper was a winner in the competition with the technique developed with project partners from the British Geological Survey.

Scope of solution

We developed a system which uses interfering sound waves to detect gaps in the layer of grout between the inner and outer steel tubes. Following laboratory trials and mathematical simulations, successful trials were carried out on turbines at sea. A remotely-operated vehicle, provided by Atlantas Marine Ltd, was used to maneuver the ultrasound sensor into place underwater. Further development work will make the technique available for a full range of foundation specifications including bespoke solutions to meet the needs of individual operators.

Why our solution is unique

- We scan the monopile from a single surface, so access to just one side is needed, simplifying the inspection procedure.
- Inspection can be completed within a tight timescale, typically one monopile can be inspected per day.
- We feedback on the integrity of the monopile – interpreting the inspection data and sharing results in a transparent format.

Our wide-ranging expertise in offshore wind development, operation and maintenance was key to developing an innovative inspection system which delivers accurate data and meets operational requirements in an important focus area for wind farm operators.

35-40%

of monopile turbines have potential grouted joint issues

A world first

Our equipment is the first of its kind to use low frequency ultrasound waves to successfully penetrate two layers of steel – ranging from 35mm to 70mm thick – and a layer of grout sandwiched between to deliver accurate results.

Related ultrasonic techniques have previously been used in rock surveys.Our solution interprets data from the ultrasound sensor to show where the grout is not fully bonded or missing between the walls of the monopile and transition piece. It can be used both inside and outside the foundation structure.

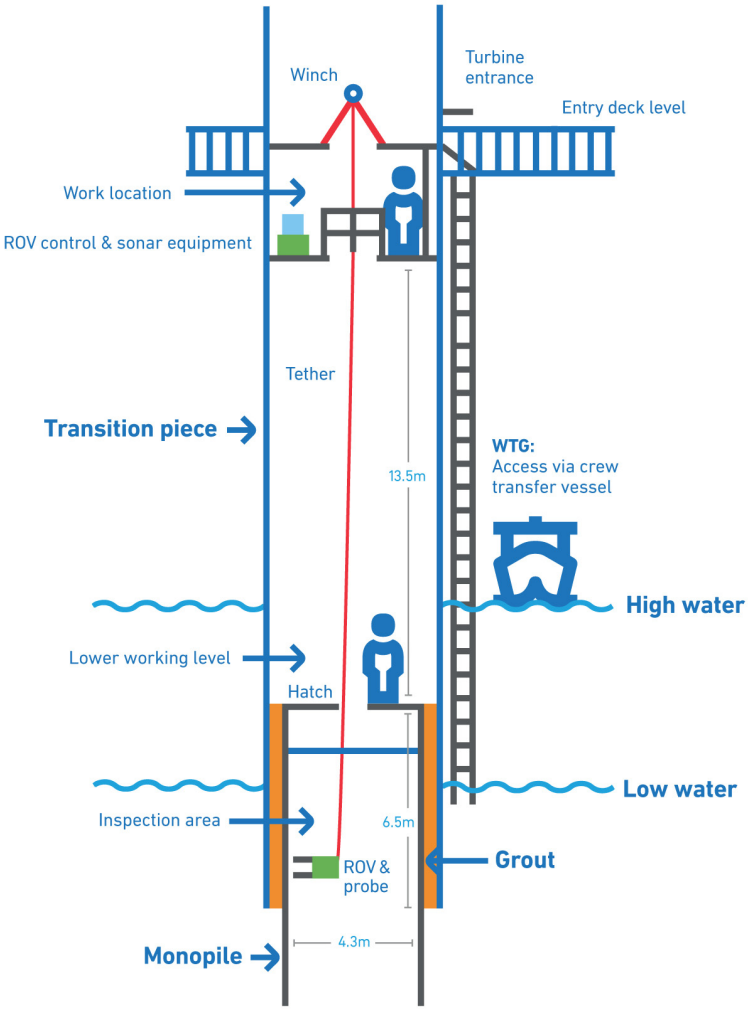
Stages to success

Stage 1: Existing techniques and turbine conditionreviewed to define parameters for a new solution.

Stage 2: In laboratory tests on half-scale samples low frequency sound waves detected grout defects.

Stage 3: Mathematical modeling used to verify and extend the scope of the laboratory results.

Stage 4: The sensor, attached to a remote-controlled vehicle, tested on offshore turbine foundations.



Minimizing risks

Our use of a compact remotely-operated vehicle (ROV) to accurately position the ultrasound inspection unit has also helped to minimize risks when carrying out inspections in a harsh environment.

We decided to inspect from within the structure because outer surfaces of the monopile are often covered by marine growth which can interfere with ultrasound transmissions and would have to be removed.

Because the ROV is small enough to be lowered through hatchways inside the turbine tower, there is no need for its operators to descend to lower levels in the structure. It can be controlled safely from an airtight deck level, some meters above sea level, and yet is maneuverable enough to be positioned to complete a full survey of the monopile-transition piece grout interface.

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