Title:	Instrumentation of a real-scale wind turbine foundation
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Main Objective:	To investigate the behaviour of the soil reinforcement under wind load
Main Benefit:	Optimizing wind turbine foundation design Access the possibility of reusing the foundation
References:	Sahyouni, A., Briançon, L., Grange, S., Burtin, P., Racinais, J. (2022). Instrumentation of a real-scale wind turbine foundation underlined by rigid inclusions. *Proc. 11th International Symposium on Field Monitoring in Geomechanics, London*.

Background and description of the project

This case history describes the instrumentation of a real scale wind turbine foundation. The main objective of this project is to find solutions for the reuse of existing foundations during repowering phases. Geotechnical monitoring is of paramount importance in this project and has the following objectives:

-Measure the load transfer from the wind turbine to the reinforced soil as a function of wind direction and wind speed over several years.

-Test the structural health monitoring solution.

-Calibration of the numerical models, a missing information in the literature review.

Factors that influenced the design of the monitoring project

Technical issues: cyclic loading, bearing capacity of soil, soil reinforcement and fatigue of concrete foundations. Non-uniform loading under the foundation.

Challenge: It is not possible to monitor all rigid inclusions and soil volume.

Solutions: 4 axes where the maximum number of sensors is oriented, the solution is adopted after a numerical modelling of the foundation. By rotating the position of the sensors at any time "t" when the wind turns, the entire area of the foundation is covered.

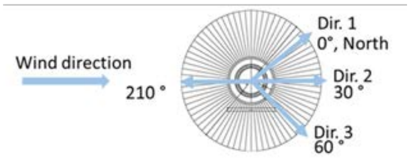

Fig. 1. Main instrumented zones

Scope of the instrumentation used

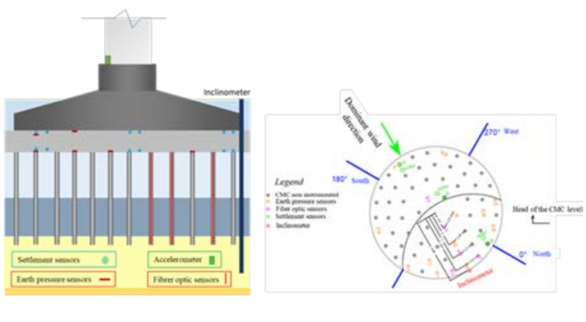

Fig. 2. Concept of the instrumentation

Sample of test results

Inverse proportional behavior of two geometrically opposite columns (Fig. 3). Measurement of axial load and negative skin friction during a ON OFF test of wind turbine operation (Fig. 4). Non-uniform transmitted load reflecting the global behavior of rigid inclusions and the high stiffness of the wind turbine foundation (Fig. 5).

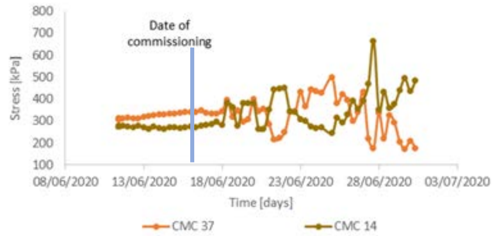

Fig. 3. Vertical stresses at the rigid inclusion head after the wind turbine is commissioned

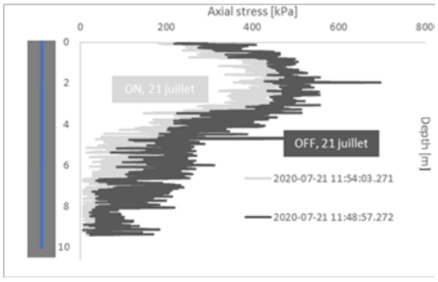

Fig. 4. Vertical stresses along the rigid inclusion via optical fibre

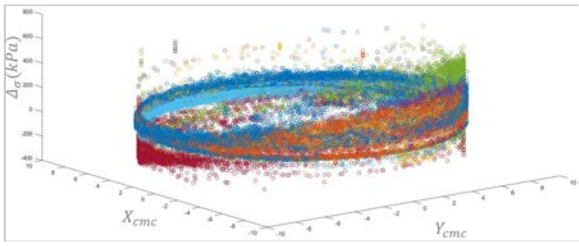

Fig. 5. Stress variations at the heads of the rigid inclusions of the outer radius of the foundation

Most significant information derived

Normalizing the stress variations makes it possible to determine the descending load from the wind turbine.

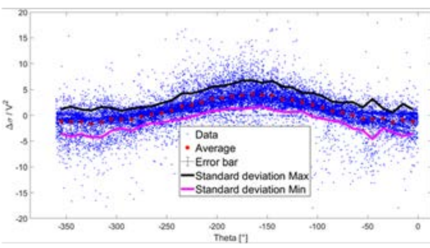

Fig. 6. 2D stress envelope