

Project datasheet: Wind Turbine foundation design

Project name: Delphina Wind Park Foundation Design

Location: Bahia, Brazil

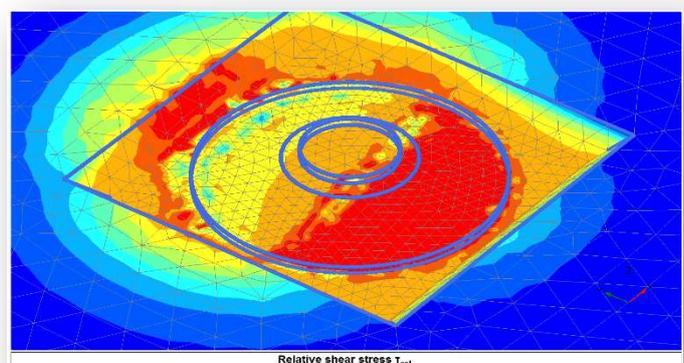
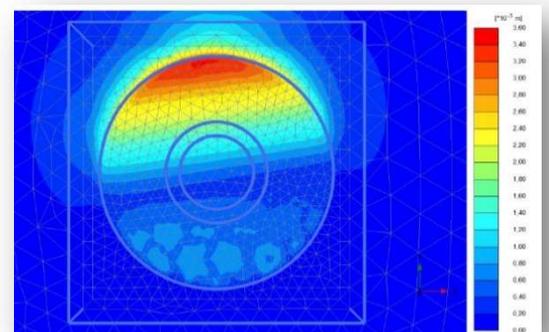
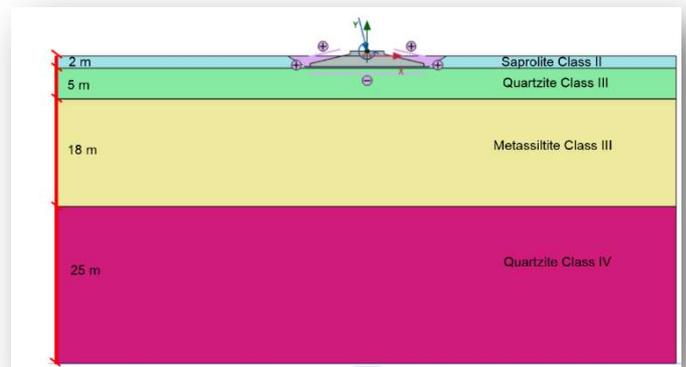
Client: Enel Green Power

Description: The Delphina wind farm has a total installed capacity of 29.4 MW with 80 m tall turbines, with 17.9 m diameter circular shallow foundations. The site investigation consisted of boreholes at the centre of each tower through soil and rocks and geophysical tests of electro-resistivity and MASW tests (Multichannel Analysis of Surface Waves). Detailed analyses of these data have led to a soil profile and engineering parameters for each turbine.

The analyses carried out for the foundation design consisted of a preliminary assessment and safety checks using standard plasticity theory methods followed by more sophisticated modelling utilizing FEM (Finite Element Method) using the software Plaxis 3D.

Services provided by Terratek

- Site investigation data analysis;
- Foundation design;
- Structural design



Project datasheet Wind Turbines

Project name: Wind Turbine Dynamic Monitoring and Spectral Analysis

Location: Great Gabbard Wind Farm, UK

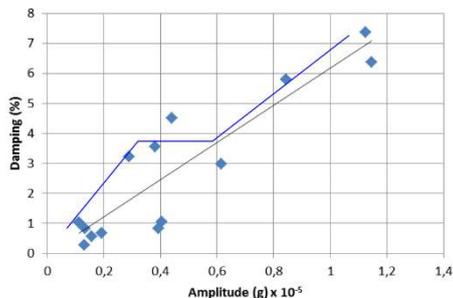
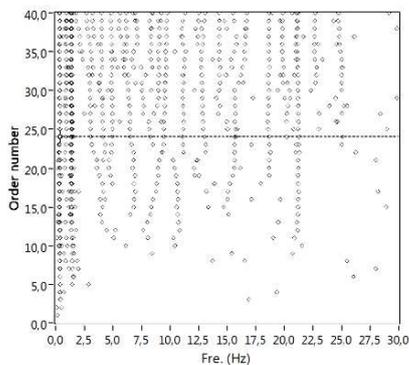
Client: SSE Renewables Holdings Ltd



Description: The scope of the work was the spectral analysis of dynamic monitoring carried out by the client of one offshore wind turbine. Terratek processed the data using advanced dynamic techniques, such as SSI *stochastic subspace identification*, yielding spectrum and damping values. Terratek studies also yielded horizontal displacements at the top of the monopile level which was below 1 mm, much less than the maximum expected and below the level that may yield to cyclic mobility.

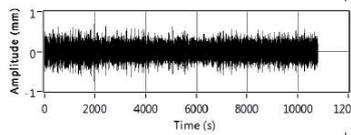
Services provided by Terratek

- Spectral and damping analysis using SSI stochastic subspace identification;
- Horizontal displacements of the monopile;

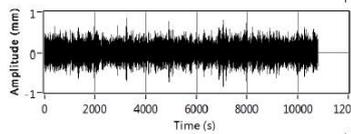


DISPLACEMENTS

25 - IGI06-A-225-45

RM S (m m)	Pea k (m m)	Graph
0,14	0,76	

26 - IGI06-A-225-315

RM S (m m)	Pea k (m m)	Graph
0,16	0,87	



Project datasheet Wind Turbines

Project name: Wind Turbine Dynamic Monitoring

Location: Rio Grande do Sul, Brazil

Client: Pavsolo Contractors



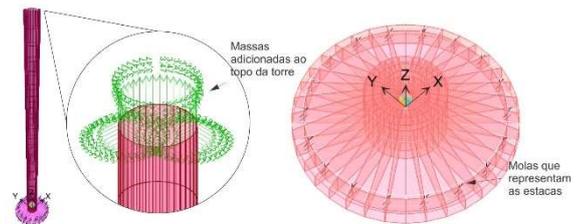
Description: The scope of the work was piled foundation assessment through dynamic monitoring. Terratek used very accurate accelerometers positioned on the concrete base to measure vibrations for a few hours. The data were processed using advanced dynamic techniques, such as SSI *stochastic subspace identification*, yielding spectrum and damping values for 14 modes of vibration. Then, a finite element numerical model to analyse foundation behaviour in the frequency domain was built and validated through the measurements. Finally, foundation behaviour was assessed through vertical, rotational and torsional stiffness and compared with the manufacturer's requirements.

Frequency (Hz)	Damping
2.48	1.74 %
2.71	2.50 %
4.41	1.19 %
5.29	3.20 %
6.65	2.82 %
7.6	2.07 %
8.64	4.46 %
9.56	2.01 %
12.24	3.56 %
14.88	2.42 %
16.42	2.09 %
20.99	0.48 %



Services provided by Terratek

- Vibration measurements with very accurate accelerometers;
- Spectral and damping analysis using SSI stochastic subspace identification;
- Finite element analysis in the frequency domain
- Model calibration and validation utilizing measured results;
- Analysis of vertical, horizontal, rotational and torsional spring constants;
- Comparison with manufacturer's specs



Stiffness	Minimum design req	Tower A	Tower B
Horizontal [kN/m]	1,00x10 ⁶	2,86x10 ⁵	2,78 x10 ⁵
Vertical [kN/m]	-	1,72x10 ⁵	3,82 x10 ⁵
Rotational [kNm/rad]	6,59x10 ⁶	5,00x10 ⁶	7,30 x10 ⁶
Torsional [kNm/rad]	-	1,67x10 ⁷	1,54 x10 ⁷

