Matt Bristow Consultant to the Wind Energy

Civil, Structural, Geotechnical, Offshore, and Wind Engineering

Optimisation of structures for offshore wind farms

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How I Can Help
Design of Foundations and Superstructures for Offshore Wind Turbines/Wind Energy Converters

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- **My Role as a Sub–Consultant**
  - I have extensive experience in the design of foundations and superstructures for offshore wind turbines and other related structures
    - Many types of structure, e.g., monopile or gravity foundations
    - Complete structure from tower top to embedment/bearing
    - Expertise in both structural engineering and geotechnical engineering
  - My role working on behalf of the Owner/Due Diligence/Classification Societies
    - Structural review of designs carried out by others
    - Technical expertise and opinions
    - Independent assessments or recommendations
    - Development of design and analysis methodologies
    - Preparation of reports
  - My role working on behalf of the lead Consultant/Developer/Contractor
    - Independent structural assessments and/or checking
    - Additional highly experienced member of the team
    - Preliminary assessments or feasibility studies
    - Detailed design including geotechnical
    - Preparation of reports and certification

- **Preliminary assessments**

    - Investigation into the requirements for the foundations
        - Appraisal of site conditions
            - Water depths and levels
            - Metocean parameters
            - Ground conditions
        - Appraisal of wind turbine characteristics, etc.
            - Hub height and levels of interfaces
            - Natural frequency and avoidance of resonance
            - Selection of soft-soft or soft-stiff design
            - Turbine loads - extreme and fatigue loads

    - Assessment of the relative merits of different types of foundations
        - Monopile foundations
        - Tri-pod or quad-pod foundations
        - Gravity foundations
        - Other types, e.g., guyed monopile

    - Identification of preferred foundation solution for the site
        - Foundation type
        - Determination of heights, levels, and location of interfaces
        - Size and weights of components
        - Method of installation and construction sequence
        - Method of connecting tower to foundation
        - Identification of critical areas and potential areas for optimisation

    - Identification of the construction challenges for the preferred foundation type
        - Transportation and lifting limitations
        - Consequences of variations in ground conditions
        - Vulnerability of installation to adverse site conditions
        - Risk assessments and minimising risk
        - Integration with scour protection requirements

- **Feasibility studies**

    - Determination of environmental design input parameters
        - Selection of range of water depths to be considered
        - Identification of most critical input parameters
        - Determination of metocean data
        - Assessment of ground conditions

    - Determination of wind turbine characteristics
        - Determination of hub heights and tower bottom levels
        - Choice of a range of turbine size, from 2MW to 8MW or more
        - Assessment of dynamic interaction of turbine characteristics with structural response of the structure
        - Choice of soft-soft or soft-stiff designs as applicable

    - Estimation of wind turbine characteristics (in absence of manufacturer's data)
        - Turbine rotor and blade passing frequency, etc.
        - Turbine tower dimensions and plate thicknesses
        - Turbine tower top or bottom loads - extreme and fatigue loads
        - Estimation of data for multi-megawatt machines of the future

    - Results of feasibility studies and sensitivity analyses
        - Estimation of foundation sizes and weights of components
        - Variation of foundation size with turbine rating
        - Variation of foundation size with water depth - constant diameter
        - Variation with water depth - constant wall thickness
        - Effect of different ground conditions
        - Effect of different hub heights
        - Effect of soft-soft or soft-stiff designs where applicable
        - Prediction of optimum wind turbine/water depth combinations

    - Investigation into methods of connecting tower to foundation
        - Grouted joint, bolted flange, and site welding
        - Tilting correction rings or stub sections
        - Grouted flange, etc.

- **Detailed design**

    - Experience with all aspects of detailed design from project inception to installation on site
        - Help with turbine selection
        - Determination of turbine locations and layout, including location of substation platform and cable layouts
        - Assessment of scour and overall seabed movement
        - Determination of design water depths and turbine levels
        - Selection of foundation type, e.g., monopile or tri-pod, etc.
        - Derivation of all metocean data, including wind parameters and size and type of breaking waves
        - Assessment of ground conditions
        - Identifying best method of connecting tower to foundation
        - Selection of most appropriate method of foundation installation

    - Structural analyses
        - Assessment of turbine loadings and characteristics
        - Determination of optimum natural frequency requirements of the foundation versus those of the turbine itself
        - Selection of soft-soft or soft-stiff designs
        - Dynamic or static analyses performed for either extreme or fatigue loadings, including steady state or time history analyses
        - Dynamic analyses carried out for both wind and wave loading
        - Incorporation of non-linear effects due to waves (shallow water effects) and ground support (use of p–y springs, etc.)
        - Development of methods to combine wind and wave fatigue loadings using generation and combination of time histories
        - Member checking and pile driveability analyses carried out
        - Fatigue damage calculations undertaken for separate wind and wave loading, and combination of wind and wave loading

    - Other aspects
        - Determination of pile embedment depth
        - Determination of sequence of operations on site
        - Design of grouted joint or other types of connection, including 3D finite element analyses
        - Preparation of corrosion protection specification
        - Determination of scour protection requirements
        - Design of appurtenances, including J–tubes and boat landings
        - Design of substation platform, including selection of construction
        - Preparation of fabrication details and specifications
        - Preparation of design reports

    - Value engineering
        - Optimisation of design performed to find overall most economic solution and give minimal operations and risks on site
        - Fine tuning of design to achieve optimum modal characteristics and the highest fatigue category details at the critical points

- **Decommissioning studies**

    - Studies into the anticipated methodology and attendant costs likely to be associated with the decommissioning of a proposed wind farm
        - Gravity foundations
        - Monopile foundations
        - Tri-pod or quad-pod foundations
        - Scour protection and fouling
        - Sub-sea cabling and grid connection point
        - Ultimate disposal of components and materials

    - Identify how decommissioning process can be simplified at detailed design stage

    - Estimates of the likely costs of decommissioning to be incorporated into financial modelling of the whole project

- **Further information**

    - For more in-depth information on my general capabilities in detailed design and a list of my technical abilities, please refer to separate attachment "Technical Abilities".

    - For more information on more specialist areas of expertise and state-of-the-art methods of analysis and design, please refer to separate attachment "Additional Technical Services".