Engineering Tripos Part IIB, 4D9: Offshore Geotechnical Engineering, 2020-21

Module Leader

Dr C Abadie [1]

Lecturers

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Timing and Structure

Lent term. 14 Lectures + 2 examples classes. Assessment: 100% exam

Prerequisites

3D2 assumed; 3D1, 4D5 useful

Objectives

As specific objectives, by the end of the course students should be able to:

- Introduce the geology and geotechnical properties of the seabed in renewable energy and hydrocarbon producing regions;
- Learn about the key geotechnical design aspects and challenges of an offshore wind farm;
- Develop awareness of the geohazards prevalent in the offshore environment;
- Introduce offshore site investigation techniques and methods of sediment characterisation;
- Introduce the design of geotechnical offshore infrastructure including pipelines, shallow foundations, piles and anchors, for both renewable energy and hydrocarbon producing facilities;
- Develop an awareness of the potential impact of scour on subsea infrastructure.
- Understand the key technogy and knowledge transfer from oil and gas operations to renewable energy applications

Content

Introduction (1 hour: cna24)

- A historical perspective on energy production in the offshore environment
- Design of offshore wind farm and layout
- Geotechnical challenges associated with offshore wind turbines
- Knowledge transfer potential from oil and gas operations to renewable energy applications

The offshore environment (1 hour: sas229)

- Continental drift and plate tectonics
- Extent and topography of the Continental margins
- Sediment characteristics, distribution and origins
- Offshore geohazards

Offshore site investigation (2 hours: sas229)

- Purpose and techniques
- Geophysical and geotechnical surveys
- In-situ tests: cone penetrometer, full-flow penetrometers and vane shear
- Sampling methods
- Simple shear testing: strain and pore pressure accumulation
- Model testing

Pipelines and cables (2 hours: sas229)

- Pipeline and cable systems and terminology
- Routing and hazard avoidance
- Installation
- Hydrodynamic stability and thermal expansion management
- On-bottom stability: embedment, axial and lateral resistance
- Buried stability: uplift resistance

Monopiles and piled foundations (3 hours: cna24)

- Types and applications
- North Sea examples: oshore renewables and hydrocarbon producing platforms
- Axial response:
    - Capacity and stiffness
    - Behaviour in clay / sand / rock
    - Linear elastic pile stiness solutions
    - Numerical analysis using the load transfer method
- Lateral response:
    - Limiting lateral resistance and design charts
    - Typical P-y curves
    - PISA
    - Design for cyclic loading

Anchors and suction buckets (2 hours: cna24)

- Type of buoyant facilities and mooring configurations
- Types of anchor:
    - Surface / gravity anchors
    - Embedded anchors: piles, drop anchors, caissons and drag anchors
- Design principles for:
    - Anchor chain response
    - Drag anchors
    - Drop anchors
    - Suction caissons
- Next generation anchors

Shallow and Spudcan foundations (1 hours: cna24)

- Offshore shallow foundations:
    - Types and applications
    - Ultimate limit state: bearing capacity and failure envelope approaches
- Introduction to spudcan foundations and mobile jack-up platforms
    - Installation procedures
    - Design considerations
    - Bearing capacity and combined loading capacity

Scour (2 hours: dl359)

- Scour processes: sediment transport and scour hole development
- Scour hole measurement techniques
- Predicting scour around: pipelines and pile foundations

- Scour remediation techniques

Booklists

Please refer to the Booklist for Part IIB Courses for references to this module, this can be found on the associated Moodle course.

Examination Guidelines

Please refer to Form & conduct of the examinations [3].

UK-SPEC

The UK Standard for Professional Engineering Competence (UK-SPEC) [4] describes the requirements that have to be met in order to become a Chartered Engineer, and gives examples of ways of doing this.

UK-SPEC is published by the Engineering Council on behalf of the UK engineering profession. The standard has been developed, and is regularly updated, by panels representing professional engineering institutions, employers and engineering educators. Of particular relevance here is the 'Accreditation of Higher Education Programmes' (AHEP) document [5] which sets out the standard for degree accreditation.

The Output Standards Matrices [6] indicate where each of the Output Criteria as specified in the AHEP 3rd edition document is addressed within the Engineering and Manufacturing Engineering Triposes.

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Links
[1] mailto:cna24@cam.ac.uk
[2] mailto:cna24@cam.ac.uk, sas229@cam.ac.uk, dl359@cam.ac.uk
[3] http://teaching.eng.cam.ac.uk/content/form-conduct-examinations
[4] http://www.engc.org.uk/ukspec.aspx
[5] http://www.engc.org.uk/standards-guidance/standards/accreditation-of-higher-education-programmes-ahep/
[6] http://teaching.eng.cam.ac.uk/content/output-standards-matrices