

## **Engineering Tripos Part IB, 2P8: Civil and Structural Engineering, 2018-19**

### **Lecturers**

Dr Vigianni

### **Lecturers**

Dr Foster

### **Timing and Structure**

Weeks 1-4 Easter Term. 14 lectures + 2 examples classes, 4 lectures/week

### **Aims**

The aims of the course are to:

- Act as a shop window for the techniques and technologies of civil engineering seen as a practical and scientific discipline.
- Create interest in the design and construction of underground facilities, with illustrations from recent schemes, and in so doing highlight the role of the professional.
- Introduce the materials of underground construction: soil, and reinforced concrete.
- Introduce the principles of soil mechanics, and to demonstrate their application to the design of structures underground.

### **Objectives**

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

- Select a method of underground construction which will be appropriate to some specified set of ground conditions.
- Relate soil voids ratio to its bulk density, and calculate vertical stresses.
- Interpret tests to determine the strength of soils, so as to obtain appropriate "undrained" (single-phase) or "drained" (dual-phase) parameters.
- Use Mohr circles of stress to calculate the possible bounds to the lateral earth pressure: "active" (minimal) and "passive" (maximal).
- Use active and passive pressures to dimension satisfactory earth retaining walls, and calculate shear forces and bending moments.
- Calculate the design flexural strength of reinforced concrete sections, using appropriate material properties.
- Outline the internal stress-distribution in reinforced concrete walls, and make proposals for shear reinforcement.
- Discuss the detailing of reinforced concrete retaining walls constructed in various ways.
- Discuss the factors influencing design and construction of bored tunnels in urban areas.
- Illustrate the handling of uncertainty and risk in construction underground.

### **Content**

#### **Granular Materials (3L)**

*References: (1) 1-26, 63-79, 93-96; (2) 1-30, 46-64, 165-170*

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- 1.1. Geology, rock, soil
- 1.2. Pores & water, density, geostatic stresses
- 1.3. Effective stress and pore water pressure
- 1.4. Strength in shear and compression
- 1.5. Effective internal friction, dilatancy, critical state
- 1.6. Tests for the shear strength of soils: shear box, triaxial

### **Earth Pressures (3L)**

*References: (1) 272-284, 295-307; (2) 243-250*

- 2.1. Earth pressure and thrust on retaining walls
- 2.2. Coulomb's kinematical method using wedge mechanisms
- 2.3. Rankine's statical method using Mohr's circles of stress
- 2.4. Active and passive limits to possible earth pressures
- 2.5. The influence of water in sands and clays
- 2.6. Drained and undrained soil behaviour

### **Geotechnical Design of Underground Space (3L)**

*References (1) 357-376, 409-430; (2) 233-242, 269-271, 341-375*

- 3.1. Site investigation and ground characterisation
- 3.2. Permissible soil strength, design earth pressures
- 3.3. Designing a retaining wall: stability and equilibrium, factors of safety
- 3.4. Cut and cover, and top-down construction of reinforced concrete, case histories.
- 3.5. Tunnelling: design and construction
- 3.6. Tunnelling: stability, ground movements, case histories.

### **Reinforced Concrete (3L)**

*References: (3) 1-2, 18-28, 85-119*

- 4.1. Simple theory for the bending of a concrete beam
- 4.2. Shear force and bending moment distribution in walls.
- 4.3. Longitudinal and shear reinforcement
- 4.4. Design, detailing and construction of reinforced concrete
- 4.5. Analysis and design of underground structures

### **Design and Construction of Underground Space (2L)**

#### **REFERENCES**

- 1) BOLTON, M. GUIDE TO SOIL MECHANICS
- (2) POWRIE, W. SOIL MECHANICS - CONCEPTS AND APPLICATIONS
- (3) KONG, F.K. & EVANS, R.H. REINFORCED AND PRE-STRESSED CONCRETE

### **Booklists**

Please see the [Booklist for Part IB Courses](#) [1] for references for this module.

### **Examination Guidelines**

Please refer to [Form & conduct of the examinations](#) [2].

## UK-SPEC

The [UK Standard for Professional Engineering Competence \(UK-SPEC\)](#) [3] 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 [4] which sets out the standard for degree accreditation.

The [Output Standards Matrices](#) [5] 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] <https://www.vle.cam.ac.uk/mod/book/view.php?id=364081&chapterid=44251>

[2] <http://teaching.eng.cam.ac.uk/content/form-conduct-examinations>

[3] <http://www.engc.org.uk/ukspec.aspx>

[4] <http://www.engc.org.uk/standards-guidance/standards/accreditation-of-higher-education-programmes-ahep/>

[5] <http://teaching.eng.cam.ac.uk/content/output-standards-matrices>