Engineering Tripos Part IB, 2P8: Civil and Structural Engineering, 2019-20

Course Leader

Dr R Foster [1]

Lecturers

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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

- 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, triaxal

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 [3] for references for this module.

Examination Guidelines

Please refer to Form & conduct of the examinations [4].

UK-SPEC

This syllabus contributes to the following areas of the UK-SPEC [5] standard:

Toggle display of UK-SPEC areas.

GT1

Develop transferable skills that will be of value in a wide range of situations. These are exemplified by the Qualifications and Curriculum Authority Higher Level Key Skills and include problem solving, communication, and working with others, as well as the effective use of general IT facilities and information retrieval skills. They also include planning self-learning and improving performance, as the foundation for lifelong learning/CPD.

IA1

Apply appropriate quantitative science and engineering tools to the analysis of problems.

IA3

Comprehend the broad picture and thus work with an appropriate level of detail.

KU1

Demonstrate knowledge and understanding of essential facts, concepts, theories and principles of their engineering discipline, and its underpinning science and mathematics.

KU2

Have an appreciation of the wider multidisciplinary engineering context and its underlying principles.

D1

Wide knowledge and comprehensive understanding of design processes and methodologies and the ability to apply and adapt them in unfamiliar situations.

D2

Understand customer and user needs and the importance of considerations such as aesthetics.

D3

Identify and manage cost drivers.

S1

The ability to make general evaluations of commercial risks through some understanding of the basis of such risks.

S3

Understanding of the requirement for engineering activities to promote sustainable development.

E1

Ability to use fundamental knowledge to investigate new and emerging technologies.

E2

Ability to extract data pertinent to an unfamiliar problem, and apply its solution using computer based engineering tools when appropriate.

E3

Ability to apply mathematical and computer based models for solving problems in engineering, and the ability to assess the limitations of particular cases.

P1

A thorough understanding of current practice and its limitations and some appreciation of likely new developments.

P3

Understanding of contexts in which engineering knowledge can be applied (e.g. operations and management, technology, development, etc).

P5

Awareness of nature of intellectual property and contractual issues.

US1

A comprehensive understanding of the scientific principles of own specialisation and related disciplines.

US3

An understanding of concepts from a range of areas including some outside engineering, and the ability to apply them effectively in engineering projects.

US4

An awareness of developing technologies related to own specialisation.

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Links
[1] mailto:rmf41
[2] mailto:rmf41@cam.ac.uk, gv278@cam.ac.uk
[3] https://www.vle.cam.ac.uk/mod/book/view.php?id=364081&chapterid=44251
[4] https://teaching.eng.cam.ac.uk/content/form-conduct-examinations
[5] https://teaching.eng.cam.ac.uk/content/uk-spec