Engineering Tripos Part IIB, 4D4: Construction Engineering, 2017-18

Module Leader

Dr I Brilakis [1]

Lecturers

Dr I Brilakis, Prof C Middleton and Prof Viggiani

Timing and Structure

Lent term. 14 lectures. Assessment: 100% coursework

Prerequisites

3D1, 3D2 and 4D16 useful

Aims

The aims of the course are to:

- familiarise students with key design and construction aspects of those areas of construction which are commonly encountered in many major civil engineering projects.

Objectives

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

- understand the key issues in design and construction of major civil engineering infrastructure.
- understand the basics of construction site development, earth removing methods and earth excavation techniques.
- understand the practical considerations for loading and hauling operations including productivity estimation and equipment selection.
- address stability and deformation problems relating to different types of deep excavation construction (e.g. diaphragm walls, top-down construction, bottom-up construction) in different ground conditions.
- understand the principal design and construction problems associated with bored tunnel projects.
- estimate ground movements caused by deep excavations and tunnelling and assess their effects on buildings and services.
- select appropriate protective and ground improvement measures for different underground construction problems.
- understand the principal considerations associated with ground water control during construction.
- understand the conventional and advanced instrumentation techniques used for measuring ground movements and mechanical strain in practice including advantages and limitations.
- understand the basics for rock excavation and blasting.
- understand the different crane systems used in practice including the basic principles involved in terms of selection and operation.

Content
This module aims to familiarise students with key design and construction aspects of those areas of construction which are commonly encountered in many major civil engineering projects. These are earth moving and excavation techniques, underground construction and tunnelling, instrumentation and monitoring, rock excavation and blasting, and crane systems. Underground construction is becoming increasingly important as underground space is being utilised in urban areas for mass transit systems (metros) and many other areas of infrastructure development. Instrumentation and monitoring is a growing area with many new innovative techniques being introduced, many of them recently developed at Cambridge. Rock excavation and blasting, and crane systems, provide particular challenges in many civil engineering projects. The course will introduce students to the latest design and construction technologies being used in all these areas.

1. Introduction and site development
2. Earth moving methods and excavation techniques
3. Loading and hauling
4. Deep excavations and bored tunnels
5. Tunnel stability and ground movements
6. Damage to buildings and services caused by deep excavations and tunnels, risk assessments
7. Protective measures and ground treatment for underground construction
8. Effects of tunnelling and deep excavations on Building performance – case histories
9. Groundwater control for underground construction
10. Compensation grouting protective measures – case histories (industry speaker)
11. Instrumentation and monitoring – 1
12. Instrumentation and monitoring – 2
13. Rock excavation and blasting
14. Cranes and equipment fleet economics

5L, Prof Lord Mair; 4L, Dr I. Brilakis; 4L, Dr M. Elshafie; 1L, Industry speaker

Coursework

(a) Construction earthwork and equipment: estimation of excavation soil volumes from drawings, earthwork production, and logistics planning for transporting soils to/from project sites. (b) Underground construction (tunnelling), based on the Crossrail project in central London: tasks are to assess the risk of damage to a building of considerable historical interest and design outline protective measures for the building. (c) Design of ground instrumentation and monitoring schemes for a deep shaft, rock excavation and blasting design, and cranes and equipment economics.

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

This syllabus contributes to the following areas of the UK-SPEC [3] standard:

Coursework 1: Soil Excavation
Construction earthwork and equipment: estimation of excavation soil volumes from drawings, earthwork production, and logistics planning for transporting soils to/from project sites.

Learning objective:

- Understand the basics of construction site development, earth removing methods and earth excavation techniques.

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<tr>
<th>Coursework 1: Soil Excavation</th>
<th>Format</th>
<th>Due date &amp; marks</th>
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<td>Individual Report anonymously marked</td>
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<td>Coursework</td>
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<tr>
<td>Understand the practical considerations for loading and hauling operations including productivity estimation and equipment selection.</td>
<td>Individual Report</td>
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<td>Underground construction (tunnelling), based on the Crossrail project in central London: tasks are to assess the risk of damage to a building of considerable historical interest and design outline protective measures for the building.</td>
<td>Individual Report</td>
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<td>Coursework 3: Instrumentation, Rock Excavation, Cranes &amp; Economics</td>
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<td>Design of ground instrumentation and monitoring schemes for a deep shaft, rock excavation and blasting design, and cranes and equipment economics.</td>
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<td>• Understand the conventional and advanced instrumentation techniques used for measuring ground movements and mechanical strain in practice including advantages and limitations.</td>
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<tr>
<td>• Understand the basics of construction site development, rock excavation methods and/or crane operations.</td>
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<td>• Understand the financial considerations for earthwork operations.</td>
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**Booklists**

Please see the [Booklist for Group D Courses](http://teaching.eng.cam.ac.uk) [5] for references for this module.

**Examination Guidelines**

Please refer to [Form & conduct of the examinations](http://teaching.eng.cam.ac.uk) [2].

**UK-SPEC**

The [UK Standard for Professional Engineering Competence (UK-SPEC)](http://teaching.eng.cam.ac.uk) [6] 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 [7] which sets out the standard for degree accreditation.

The [Output Standards Matrices](http://teaching.eng.cam.ac.uk) [8] indicate where each of the Output Criteria as specified in the AHEP 3rd edition document is addressed within the Engineering and Manufacturing Engineering Triposes.