

## **Engineering Tripos Part IIB, 4D4: Construction Engineering, 2019-20**

### **Module Leader**

[Prof G Viggiani](#) [1]

### **Lecturer**

[Prof G Viggiani and Dr I Brilakis](#) [2]

### **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 engineering 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 key issues in front-end planning and construction of major civil engineering infrastructure.
- understand the basics of construction site development, earth removing methods and earth excavation techniques.
- understand the basics for rock excavation and blasting.
- understand the practical considerations for loading and hauling operations including productivity estimation, fleet economics and equipment selection.
- understand the design, construction and operational aspects of compacting, finishing and paving operations for road infrastructure.
- 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.

### **Content**

This module aims to familiarise students with key design and construction aspects of those areas of construction engineering which are commonly encountered in many major civil engineering projects. These are earth moving and soil excavation techniques, rock excavation and blasting, road construction and equipment fleet economics, underground construction and tunnelling, and instrumentation and monitoring. Earthworks for ground and underground construction are becoming increasingly important as massive rail and road projects are needed to cope with growing traffic while 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, as well as paving operations, provide particular challenges in many civil engineering projects. This module will introduce students to the latest front-end planning and construction technologies being used in all these areas.

Site development & earthmoving materials

Excavation techniques & earth moving methods

Loading and hauling

Road construction

Fleet economics

Deep excavations and bored tunnels

Tunnel stability and ground movements

Damage to buildings and services caused by deep excavations and tunnels, risk assessments

Protective measures and ground treatment for underground construction

Effects of tunnelling and deep excavations on building performance – case histories

Groundwater control

Instrumentation and monitoring

7L, Prof G. Viggiani; 7L, Dr I. Brilakis

## Coursework

(a) Underground construction (tunnelling), based on a real project: tasks are to establish tunnel stability during construction, assess the risk of damage to a building of considerable historical interest, and design outline protective measures for the building.

(b) Construction earthwork and equipment: estimation of excavation soil volumes from drawings, earthwork production calculation, logistics planning for transporting earth materials and for road construction operations, and equipment economics.

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

This syllabus contributes to the following areas of the [UK-SPEC](#) [4] standard:

[Toggle showing UK-SPEC areas](#) [5].

Coursework	Format	Due date & marks
<b>Coursework 1: Underground construction</b>  Underground construction (tunnelling), based on a real tunnelling project: tasks are to	Individual Report  anonymously marked	[30/60]

Coursework	Format	Due date
<p>establish tunnel stability during construction, assess the risk of damage to a building</p>		<p>&amp; marks</p>

Coursework	Format	Due date
		& marks
of considerable historical interest and design outline protective measures for the		

Coursework	Format	Due date
		& marks
<p>building.</p> <p><u>Learning objective:</u></p> <ul style="list-style-type: none"> <li>• estimate ground movements caused by tunnelling and assess their effects on buildings</li> <li>• define appropriate protective measures</li> </ul>		
<p><b>Coursework 2: Earthworks</b></p> <p>Construction earthwork and equipment: estimation of excavation soil volumes from drawings, earthwork production, blast design, logistics planning for transporting soils to/from project sites, paving and economics.</p>	<p>Individual Report</p> <p>anonymously marked</p>	<p>[30/60]</p>

<u>Coursework</u>	<u>Format</u>	<u>Due date</u> <u>&amp; marks</u>
<u>Learning objective:</u> <ul style="list-style-type: none"><li>• Understand the basics of construction site development, earth removing methods and earth/rock excavation techniques.</li><li>• Understand the practical considerations for loading and hauling operations including productivity estimation and equipment selection.</li><li>• Understand road construction operations and equipment fleet economics.</li></ul>		

## Booklists

Please see the [Booklist for Group D Courses](#) [6] for references for this module.

## Examination Guidelines

Please refer to [Form & conduct of the examinations](#) [7].

## UK-SPEC

This syllabus contributes to the following areas of the [UK-SPEC](#) [8] 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.

### IA2

Demonstrate creative and innovative ability in the synthesis of solutions and in formulating designs.

### 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.

**E1**

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

**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).

**US1**

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

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**Links**

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[2] <mailto:gv278@cam.ac.uk>, [ib340@cam.ac.uk](mailto:ib340@cam.ac.uk)

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

[4] <http://teaching.eng.cam.ac.uk/content/uk-spec>

[5] <http://teaching.eng.cam.ac.uk/content/engineering-tripos-part-iib-4d4-construction-engineering-2014-15>

[6] <https://www.vle.cam.ac.uk/mod/book/view.php?id=364101&chapterid=52181>

[7] <https://teaching19-20.eng.cam.ac.uk/content/form-conduct-examinations>

[8] <https://teaching19-20.eng.cam.ac.uk/content/uk-spec>