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

Module Leader

Dr I Brilakis [1]

Lecturers

Dr I Brilakis, Prof CR Middleton and Prof G 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 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

6L, Dr I. Brilakis; 6L, Prof G. Viggiani; 2L, Prof CR Middleton

Coursework

(a)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.

(b) Underground construction (tunnelling), based on a real project: tasks are to establish station tunnel stability during construction, 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.

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

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

Toggle showing UK-SPEC areas [4].

Coursework	Format	Due date & marks
Coursework 1: Earthworks 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. Learning objective: • Understand the basics of construction site development, earth	Individual Report anonymously marked	Tue 20 Feb [25/60]

Coursework	Format	Due date & marks
removing methods and earth/rock excavation techniques. • Understand the practical considerations for loading and hauling operations including productivity estimation and equipment selection. • Understand road construction operations and equipment fleet economics.		
Coursework 2: Underground construction Underground construction (tunnelling), based on a real tunnelling project: tasks are to assess the risk of damage to a building of considerable historical interest and design outline protective measures for the building. Learning objective: • estimate ground movements caused by tunnelling and assess their effects on buildings • define appropriate protective measures	Individual Report anonymously marked	Tue 13 Mar [25/60]
Coursework 3: Instrumentation Design of ground instrumentation and monitoring schemes for a deep shaft. Learning objective: • Understand the conventional and advanced instrumentation techniques used for measuring ground movements and mechanical strain in practice including advantages and limitations.	Individual Report anonymously marked	Fri 20 Apr [10/60]

Booklists

Please see the Booklist for Group D Courses [5] for references for this module.

Examination Guidelines

Please refer to Form & conduct of the examinations [6].

UK-SPEC

This syllabus contributes to the following areas of the UK-SPEC [7] 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
[1] mailto:ib340@cam.ac.uk
[2] http://teaching.eng.cam.ac.uk/content/form-conduct-examinations
[3] http://teaching.eng.cam.ac.uk/content/uk-spec
[4] http://teaching.eng.cam.ac.uk/content/engineering-tripos-part-iib-4d4-construction-engineering-2014-15
[5] https://www.vle.cam.ac.uk/mod/book/view.php?id=364101&chapterid=52181
[6] https://teaching.eng.cam.ac.uk/content/form-conduct-examinations
[7] https://teaching.eng.cam.ac.uk/content/uk-spec