Engineering Tripos Part IIB, 4D4: Construction Engineering, 2021-22

Module Leader

Prof G Viggiani [1]

Lecturer

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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.

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, deep excavation and tunnelling and tunnelling, construction processes and groundwater control. 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. Rock excavation and blasting, as well as paving operations, provide particular challenges in many civil engineering projects. The many constraints and technical challenges associated to the construction of underground infrastructures in the urban environment lead to high costs and long completion times. Masonry buidling are particularly sensitive to subsidence induced by excavation. It is therefore often necessary to adopt complex control systems of the excavation process, in order to achieve the maximum limitation of deformations, to devise intense monitoring schemes, and, where necessary, to implement techniques for the mitigation of the potential damage and the protection of the structures affected by excavation, with a significant increase in the construction costs.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

8L, Prof G. Viggiani; 6L, Dr I. Brilakis

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 tunnel stability during construction, assess the risk of damage to a building of considerable historical interest, and design outline protective measures for the building.

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
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	[30/60]

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 establish tunnel stability duting construction, 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	[30/60]

Booklists

Please refer to the Booklist for Part IIB Courses for references to this module, this can be found on the associated Moodle course.

Examination Guidelines

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

UK-SPEC

The UK Standard for Professional Engineering Competence (UK-SPEC) [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 [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.

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Links
[1] mailto:gv278@cam.ac.uk
[2] mailto:gv278@cam.ac.uk, 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] http://www.engc.org.uk/ukspec.aspx
[7] http://www.engc.org.uk/standards-guidance/standards/accreditation-of-higher-education-programmes-ahep/
[8] http://teaching.eng.cam.ac.uk/content/output-standards-matrices