

Unit 6: Civil Engineering Design

Unit code:	D/504/4347
QCF level:	6
Credit value:	15

Aim

The unit introduces learners to the analysis and presentation of a design solution, including an awareness of the limitations relating to the use of practical, safe and ethical construction methods. This unit also develops skills and abilities in the production of design and management information required for a complex civil or structural engineering project.

Unit abstract

This unit gives learners an understanding of the civil engineer's role in the development of a project for a variety of procurement methods.

This unit explores civil engineering design, including client requirements, the geographical location of the site, planning implications, financial appraisal, design technology, legal, health and safety and environmental issues, within a theoretical and practical framework. Learners will develop their ability to turn ideas into a design brief, identifying goals and then analysing these goals to agree criteria for sound civil engineering design solutions. Emerging criteria should consider sustainability of resources and the identification of risks and constraints within the execution of the project, so that the full design activity provides an economic solution to satisfy design objectives. Learners will be expected to determine and work within acceptable standards and tolerances whilst developing innovative and creative civil engineering solutions.

Learning outcomes

On successful completion of this unit a learner will:

- 1 Understand the responsibilities of the civil engineer within a design team to deliver a design solution
- 2 Be able to create a project design for a specific civil engineering project
- 3 Understand the environmental impact of design solutions.

Unit content

1 Understand the responsibilities of the civil engineer within a design team to deliver a design solution

Responsibilities: production management; programme preparation; Construction Design and Management Regulations (2007) – designer’s responsibility; designer’s obligation (contracts, insurances, qualified staff, quality assurance); continuous professional development (CPD); design standards; codes of practice; costing; estimating: tender documentation; project risk analysis; contract administration; project management; organisational framework; work allocation

Design team: civil engineer (chartered, incorporated); technician; project manager; site engineer; resident engineer; environmental engineer; structural engineer; computer-aided drawing (CAD) technician; quality manager

Contract documentation: qualifications; contracts, e.g. Joint Contracts Tribunal (JCT), New Engineering Contract (NEC), civil engineering contracts; procurement methods; Association of Consulting Engineers (ACE) agreements; Engineer’s Conditions of Engagement; design protocols

Design solutions: drawn information (conceptual, scheme, production); specifications; schedules; work methods; quality assurance documents and procedures; Building Information Modelling (BIM)

2 Be able to create a project design for a specific civil engineering project

Projects: types, e.g. roads, services, sewers, civil engineering structures (such as stadia, towers, airports, bridges, railways); communication networks

Outline scheme: constraints; new materials; innovation; existing materials; sustainable use

Structural problems relating to temporary works: enabling work; groundworks; temporary structures; structural requirements; stability; primary load paths; secondary support elements; fatigue

Field and desk research: land surveys; site surveys; soil investigations and testing regimes; geomatics; contamination surveys; geographical information systems (GIS); remediation; environmental protection, groundworks, enabling works, utilities; structures (temporary, permanent); demolition and deconstruction; project appraisal (pre-construction processes, construction)

Design solution: appraisal; constraints; stakeholder input; analysis; synthesis and testing processes; design iterations; cost planning; Building Information Modelling (BIM) systems; calculations; drawings; specifications; late amendments; changes and variations

Production information: drawings; specifications; work schedules; regulatory approvals; procurement information; contracts (standard and bespoke); Building Information Modelling (BIM) systems; value engineering; standard details; quality definition; contract documentation; contract administration

Legislation and approved codes of practice: current legislation relevant to the home country; UK legislation to include the Health and Safety at Work etc Act (1974); UK regulations to include the Construction (Design and Management) Regulations (2007), the Management of Health and Safety at Work Regulations (1999); UK codes of practice and guidance notes

3 Understand the environmental impact of design solutions

Buildability of design solution: appraisal; embodied energy; benchmarking for sustainability potential; constraints; stakeholder input; analysis; synthesis and testing processes; design iterations; cost planning; adaptability; flexibility; value for money; Building Information Modelling (BIM) systems; calculations; drawings; specifications; late amendments; changes and variations

Environmental protocols: future proofing construction; change of use; demolition and deconstruction; maintenance; facilities management; embodied energy; carbon reduction; impact on environment (natural and built)

Learning outcomes and assessment criteria

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
LO1 Understand the responsibilities of the civil engineer within a design team to deliver a design solution	1.1 Appraise the responsibilities of the civil engineer in relation to the rest of the design team for a specific civil engineering project 1.2 Describe the contract documentation that is used to carry out field and desk research on a specific civil engineering project 1.3 Evaluate the aspects of Construction and Design Management (CDM) regulations to be incorporated into a design solution for a specific civil engineering project 1.4 Devise the quality assurance procedures for the construction stage based on a specific civil engineering project
LO2 Be able to create a project design for a specific civil engineering project	2.1 Produce the outline scheme details for a specific civil engineering project 2.2 Calculate the cost plan for a specific civil engineering project 2.3 Solve structural problems for the temporary works required on a specific civil engineering project 2.4 Create the production information for the specified civil engineering project 2.5 Produce the design solution based on a civil engineering project brief 2.6 Produce a Health and Safety plan for a specified civil engineering project
LO3 Understand the environmental impact of design solutions	3.1 Evaluate the specified design solution in terms of buildability, sustainability and client requirements 3.2 Justify design solution against environmental protocols

Guidance

Links to National Occupational Standards, other BTEC units, other BTEC qualifications and other relevant units and qualifications

The learning outcomes associated with this unit are closely linked with:

Level 4	Level 5	Level 6
Unit 1: Design Principles and Application for Construction and the Built Environment (D/601/1245) Unit 4: Management Principles and Application for Construction and the Built Environment (T/601/1249) Unit 13: Environmental Impact of Construction (A/601/1270) Unit 15: Production Management for Construction (L/601/1273) Unit 27: Site Surveying Procedures for Construction and the Built Environment (R/601/1291) Unit 32: Engineering Geology and Soil Mechanics (F/601/1299) Unit 33: Civil Engineering Technology (M/601/1301)	Unit 34: Structural Analysis and Design (T/601/1302) Unit 37: Advanced Civil Engineering (T/601/1316)	Unit 7: Construction Management (H/504/4351) Unit 8: Construction Financial Management (K/504/4352) Unit 9: Construction Regulations for a Sustainable Society (M/504/4353) Unit 11: Commercial Management in the Construction Industry (A/504/4355) Unit 15: Design and Build Highways (D/504/4364) Unit 16: Plan and Design Transport System Solutions (R/504/4376)

Essential requirements

It is essential that a culture of health and safety is embedded in civil engineering design to ensure learners understand the importance and relevance of health and safety issues. Current legislation and health, safety and welfare issues should be incorporated throughout the delivery and assessment of this unit.

Delivery

The learning outcomes are most likely to be achieved through learners working on a project from conception through to a realistic design solution. Presentation of the solution to a group of engineers, as a peer review, could form part of the overall assessment. This can be supported by relevant documentation which should include drawings, a price build-up and a workable programme to show the feasibility of the scheme.

The scheme should highlight a learner's own input but might be considered as part of a small interdisciplinary team where an individual learner's work can be clearly identified and quantified. It could be a wholly new scheme, an improvement to a project the learner has already worked on but approached from a different, perhaps more sustainable angle, a nationally sponsored competition entry, or similar.

An innovative approach will most probably be achieved through workshop sessions and individual tutorials, perhaps accompanied by introductory lectures. Tutors should encourage learners to relate their investigations to the underpinning theories they have studied in other units.

Each learner's final report should reflect an appreciation of their responsibility to society to ensure safe and sustainable construction and of the effects such civil engineering projects have on communities and the environment.

Tutors should organise presentations by visiting speakers and engage practising engineers in the development of briefs and designs. Tutors should use live case studies wherever practicable either as examples or to keep learners briefed on changes to current standards or updated technology.

Assessment

Learners can produce written solutions supported by presentations and peer reviews of their work. An overall design solution that explores buildability is required and should be supported by enabling works, temporary works, calculations, budgets, programmes to illustrate special construction methods, the promotion of sustainable construction principles, and an exploration of the legal, financial and health and safety frameworks.

Resources

Books

Choi Y – *Principles of Applied Civil Engineering Design* (ASCE, 2004)
ISBN 978-0784407127

Glasson J, Therivel R and Chadwick A – *Introduction to Environmental Impact Assessment* (Taylor and Francis, 2005) ISBN 978-0415338370

Kennard M – *Civil Engineering Procedure* (ICE Publishing, 2009)
ISBN 978-0727735249

Langdon D – *Spon's Civil Engineering and Highway Price Book* (Taylor and Francis, 2012) ISBN 978-0415680646

Roberts J, Gulvanesian H, Davison B, Bond A and Watt P – *Extracts from the Structural Eurocodes for Students of Structural Design* (British Standards Institute, BSI, 1990) ISBN 978-0580694547

Twort A and Rees G – *Civil Engineering Project Management: Project Management* (Taylor and Francis, 2003) ISBN 978-0750657310

Journals

The New Civil Engineer (EMAP)

Proceedings of the Institution of Civil Engineers (ICE Publishing)

The Structural Engineer (Institution of Structural Engineers)

Websites

www.bssa.org.uk	British Stainless Steel Association provides information on the use of stainless steel in architecture
www.concretecentre.com	Concrete Centre – comprehensive downloadable guidance on concrete
www.ice.org.uk	Institution of Civil Engineers
www.istructe.org	Institution of Structural Engineers