

Unit 29: Construction in Civil Engineering

Unit code: **K/600/0314**

QCF Level 3: **BTEC Nationals**

Credit value: **10**

Guided learning hours: **60**

● Aim and purpose

The aim of this unit is to give learners knowledge of the fundamental techniques, processes and materials used in the construction of civil engineering works, and the factors that constrain civil engineering work. Learners will also gain an understanding of the function of civil engineers and of the economics and lifecycle issues associated with infrastructure projects, and develop skills in selecting plant, materials and methods for civil engineering projects.

● Unit introduction

Infrastructure projects such as new roads, railways, airports and water projects all require the skills of the civil engineer. This unit gives learners an opportunity to understand the role of those responsible for these projects, and how projects are developed and achieved.

Civil engineers may choose to specialise in a particular area of work or may work across a number of different areas. However, all civil engineers must have a fundamental knowledge of civil engineering construction methods and processes.

The civil engineering works learners investigate will include groundworks, foundations and substructure, superstructure and external works. In each of these areas, learners will study the techniques, processes and key materials used.

Projects are constrained by physical conditions, financial and environmental requirements. Learners will develop an understanding of how these factors influence the selection of techniques, processes and materials used in a variety of different situations.

● Learning outcomes

On completion of this unit a learner should:

- 1 Know about fundamental techniques, processes and materials used in the construction of civil engineering works
- 2 Know the factors that constrain civil engineering work
- 3 Be able to select plant, materials and methods for civil engineering projects
- 4 Understand civil engineering infrastructure projects.

Unit content

1 Know about fundamental techniques, processes and materials used in the construction of civil engineering works

Civil engineering works: groundworks; foundations and substructure; superstructure; external works

Groundworks: site investigation eg site history, site surveys, site geology, ground investigation, potential ground contaminants, water table; earthworks eg general excavation and groundwater control by pumping, embankments, cuttings and retaining walls; relevant techniques, processes, materials and associated construction plant

Foundations and substructure: different types of foundation eg strip, pad, raft, piles in plain or reinforced concrete; basements; relevant techniques, processes, materials and associated construction plant

Superstructures: frames; connections; floors; wall claddings; roof coverings; relevant techniques, processes, materials and associated construction plant

External works: flexible and rigid pavement construction; lorry and car parks; highway drainage details; relevant techniques, processes and associated construction plant

2 Know the factors that constrain civil engineering work

Physical conditions: ground conditions; climatic conditions; timescale

Financial requirements: cost; quality

Environmental constraints: noise; visual impact; pollution factors; environmental impact assessment; legislation

3 Be able to select plant, materials and methods for civil engineering projects

Specification of plant, materials and methods: based on knowledge and understanding; fundamentals of civil engineering construction; constraints applicable to civil engineering projects

Materials: properties and specification of eg aggregates, concrete, bituminous materials, steel, timber

4 Understand civil engineering infrastructure projects

Role and responsibilities of civil engineers: design, development, construction; maintenance *Infrastructure:* eg road, rail, harbour, airports, major services; component parts of infrastructure; project sponsors

Economics: role of infrastructure in economic growth; relationship of public and private sectors; role of civil engineering professionals in assessing demand; construction and financing

Lifecycle issues: eg development, adaptation, maintenance and repair, demolition and sustainability of infrastructure

Assessment and grading criteria

In order to pass this unit, the evidence that the learner presents for assessment needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria for a pass grade describe the level of achievement required to pass this unit.

Assessment and grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:	To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:
P1 describe fundamental techniques, processes, plant and materials used in groundworks, foundations and substructures [IE1, IE2, IE3, IE4, IE6, CT2, CT6, RL3, SM2, SM3]	M1 compare fundamental techniques, processes, plant and materials used in groundworks, foundations and substructures	D1 justify the selection of the techniques, processes, plant and materials used in a given civil engineering project
P2 describe the plant and materials used in groundworks, foundations, substructures and superstructures [IE1, IE2, IE3, IE4, IE6, CT2, CT6, RL3, SM2, SM3]	M2 compare fundamental techniques, processes, plant and materials used in superstructure and external works	
P3 describe how physical conditions, financial requirements and environmental constraints impact on civil engineering works [IE1, IE2, IE3, IE4, IE6, CT2, CT6, RL3, SM2, SM3]	M3 relate the specification of plant, materials and methods to be used in a civil engineering project to the constraints placed on that project	
P4 produce method statements specifying the plant, materials and methods to be used in two separate civil engineering projects [CT1, CT2, CT6, RL2, RL3, RL4, RL6, SM2, SM3, EP3]		

Assessment and grading criteria

To achieve a pass grade the evidence must show that the learner is able to:	To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:	To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:
P5 explain the roles and responsibilities of civil engineers in civil engineering infrastructure projects [CT1, CT2, CT6, RL2, RL3, RL4, RL6, SM2, SM3, EP3]	M4 explain how infrastructure projects are developed and maintained in the public and private sectors, both separately and in partnership.	D2 evaluate the relationship between demand, provision and funding of infrastructure projects.
P6 explain the economics associated with civil engineering infrastructure projects [CT1, CT2, CT6, RL2, RL3, RL4, RL6, SM2, SM3, EP3]		
P7 explain lifecycle issues associated with civil engineering infrastructure projects. [CT1, CT2, CT6, RL2, RL3, RL4, RL6, SM2, SM3, EP3]		

PLTS: This summary references where applicable, in the square brackets, the elements of the personal, learning and thinking skills applicable in the pass criteria. It identifies opportunities for learners to demonstrate effective application of the referenced elements of the skills.

Key	IE – independent enquirers CT – creative thinkers	RL – reflective learners TW – team workers	SM – self-managers EP – effective participators
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Essential guidance for tutors

Delivery

Tutors delivering this unit have opportunities to use a wide range of techniques. Lectures, discussions, seminar presentations, site visits, supervised practicals, research using the internet or library resources and use of personal or industrial experience are all suitable. Delivery should stimulate, motivate, educate and enthuse learners. Visiting expert speakers could add to the relevance of the subject.

Learning outcomes 1 to 3 are closely linked and can be delivered in conjunction with each other. Learning outcome 4 may be delivered separately, although there is a clear link to the first three outcomes.

Teaching and learning strategies designed to support delivery of learning outcomes 1, 2 and 3 should take an integrated, learner-centred approach. This would involve learners finding out about techniques, processes and materials, and making appropriate selections based on a knowledge of the effect that constraints have on their selection.

Broad reference to relevant legislation and standards should be made, as necessary, but there is no requirement for a detailed understanding at this level. The use of construction drawings is encouraged to enable learners to see how the component parts of different forms of construction fit together.

Both tutor presentation and learner-centred investigation should be used. Where possible, links with the industry should be made to enable visits to construction sites and to obtain other information. If this is not possible, visits to completed projects may help learners to relate to the topics being covered. Use should also be made of media resources, such as videos and DVDs, and technical literature as part of the delivery.

When delivering on the properties of materials, it may help learners if they can access materials and some simple testing is undertaken or demonstrated. Group activities are permissible, but tutors will need to ensure that individual learners have equal experiential and assessment opportunities.

Health, safety and welfare issues are paramount and should be reinforced through close supervision of all workshops and activity areas, and risk assessments must be undertaken before practical activities are taken. Centres are advised to read the *Delivery approach* section in the specification.

Outline learning plan

The outline learning plan has been included in this unit as guidance and can be used in conjunction with the programme of suggested assignments.

The outline learning plan demonstrates one way in planning the delivery and assessment of this unit.

Topic and suggested assignments/activities and/assessment
Introduction by tutor
Techniques, processes, plant and materials
Whole-class, tutor-led discussion of the nature of the work carried out by civil engineers, differences between groundworks, substructure, superstructure and external works
Site visits to different kinds of civil engineering projects
Visiting speakers on different kinds of civil engineering projects
Small group-work: each group to take one major topic, research that topic and produce a presentation supported by images, photographs and drawings, as appropriate
Whole-class, tutor-led summary of what has been learned in the small group exercises
Visit to builders' merchant and/or testing centre to research the materials used in civil engineering and their properties-in-use
Assignment 1: Techniques, Processes, Plant and Materials
The constraints on civil engineering projects
Whole-class, tutor-led discussion of the nature of the constraints on civil engineering processes
Small group-work: each group to take one constraint (physical, financial, environmental), research that topic and produce a presentation supported by images, photographs and drawings, as appropriate
Whole-class, tutor-led summary of what has been learned in the small group exercises
Selecting plant, materials and methods
Whole-class, tutor-led discussion of what influences/influenced the selection of plant, materials and methods for existing or newly completed civil engineering projects
Visits to existing and completed projects
Whole-class, tutor-led session on the purpose and use of method statements
Individual learner work on production of simple method statements – formative assessment of work
Assignment 2: Constraints and Method Statements
Infrastructure projects
Whole-class, tutor-led discussion of role of civil engineer in infrastructure projects and terminology to be used
Visiting speaker with expertise in economics and lifecycle issues associated with infrastructure projects
Small-group work: each group to take one aspect of infrastructure (demand, provision, funding, public and private sector partnerships), research that topic and produce a presentation supported by images, charts and graphs, as appropriate
Whole-class, tutor-led summary of what has been learned in the small-group exercises
Assignment 3: Infrastructure Projects
Review of unit and assignment feedback

Assessment

Evidence for this unit can be gathered from a variety of sources, including well-planned investigative assignments, case studies or reports of practical assignments.

There are many suitable forms of assessment that could be used, and tutors are encouraged to consider adopting these where appropriate. Some example assessment approaches are given below. However, these are not intended to be prescriptive or restrictive, and are provided as an illustration of the alternative forms of assessment evidence that would be acceptable. General guidance on the design of suitable assignments is available on the Pearson website.

Some criteria can be assessed directly by the tutor during practical activities. If this approach is used, suitable evidence would be observation records or witness statements. Guidance on the use of these is provided on the Pearson website.

The structure of the unit suggests that the grading criteria could be addressed fully by using three assignments. The first of these would cover P1, P2, M1, M2 and D1, the second would cover P3, P4, and M3 and the third P5, P6, P7, M4, D2. Other approaches are, however, possible.

To achieve a pass grade learners must meet the seven pass criteria listed in the grading criteria grid.

For P1, learners must describe fundamental techniques, processes, plant and materials for groundworks, foundations and substructures. They must describe typical site investigation activities that would be carried out before groundworks are undertaken. This would include desk research and site investigation activities to identify soil types and water table. Learners must show an understanding of typical earthworks by describing the plant and process operations for one of the following: cuttings, excavations including dewatering by sump pumping, embankment construction or different types of commonly used retaining walls. Learners are to describe two common forms of foundation construction or substructure, showing component parts and identifying when each type of foundation may be used. Forms selected may include concrete strip, pad, raft, driven and bored piles and in situ reinforced concrete basements.

Plant should relate to the techniques and processes described above and may include earthmoving, excavators, dumpers, rollers and piling rigs. For the operations described, learners must demonstrate an understanding of the properties of materials that make them suitable for use in the construction of civil engineering works. It is likely that, for the works described, aggregates and concrete would be covered, and an understanding of how the materials may be specified, such as concrete grades, is required. Learners should use sketches or referenced annotated diagrams from texts to illustrate descriptions.

For P2, learners must be able to describe the plant and materials used in groundworks, foundations, substructures and superstructures. They must describe a form of construction for a medium- or high-rise building, for example steel frame, in situ and pre-cast concrete frames. Understanding of the key components, their function and how the frames are constructed must be shown. Learners must describe the construction of floors, how the structure may be enclosed and a roof construction related to the form of construction selected, for example floors; in situ, composite, pre-cast concrete plank, beam and block; enclosing the structure wall claddings; curtain walling, storey height panels and infill panels; roof coverings; warm deck and cold deck, waterproof covering materials.

Learners must describe the construction of typical flexible and rigid pavements for one of the following applications: access roads, lorry or car parks. A description of how surface water is collected from the surface of highways by drainage channels or gullies must be described. Plant should relate to the methods described above and may include cranes, concreting plant, elevators and laying and compaction plant for highway materials. For the operations described learners must demonstrate an understanding of the properties of materials that make them suitable for use in the construction of civil engineering works. It is likely that, for the works described, bituminous materials, steel and timber would be covered, and an understanding of how the materials may be specified, such as concrete grades, is required. There is no need for learners to repeat descriptions of plant or materials for P1. Learners should use sketches or referenced annotated diagrams from texts to illustrate descriptions.

For P3, learners must be able to describe how physical conditions, financial requirements and environmental constraints impact on civil engineering work. These categories should be clearly differentiated and it should be clear where the constraint is a legal requirement and where it is not. Learners should use sketches or referenced annotated diagrams from texts to illustrate descriptions.

For P4, learners must produce method statements for two separate civil engineering projects. Evidence should allow learners to identify forms of construction and select a technique and process. Learners do not need to justify their selection, but must clearly select the techniques, processes, plant and materials required. Learners should use sketches or referenced annotated diagrams from texts to illustrate descriptions.

For P5, P6 and P7 learners must be able to explain the roles and responsibilities of civil engineers, and the associated economics and lifecycle issues, with reference to a recent or ongoing infrastructure project. Learners must identify activities such as feasibility studies or design and construction and explain the activities of civil engineers.

To achieve a merit grade learners must meet all of the pass grade criteria and the four merit grade criteria.

For M1, learners must compare the different construction techniques, processes, materials and plant used in a project involving groundworks, foundations and substructures to assess their suitability. This is expected to include advantages and disadvantages, and also a consideration of health, safety and welfare issues. Learners should use sketches or referenced annotated diagrams from texts to illustrate descriptions.

For M2, learners must compare fundamental techniques, processes, materials and plant used in the superstructure and external works for a given project. The suitability of medium- or high-rise buildings must be assessed. This is expected to include advantages and disadvantages, and also a consideration of health, safety and welfare issues. Learners should use sketches or referenced annotated diagrams from texts to illustrate descriptions.

For M3, learners must relate the specification of plant, materials and methods evidenced for P4 to the constraints on the project evidenced for P3.

For M4, learners must explain how infrastructure projects are developed and maintained in the public and private sectors, both separately and in partnership. This requires reference to an actual project in both the public and private sectors or a joint venture.

To achieve a distinction grade learners must meet all of the pass and merit grade criteria and the two distinction grade criteria.

For D1, learners must justify the selection of appropriate techniques and construction processes for a given project. Health, safety and welfare issues must have been considered.

For D2, learners must evaluate the relationship between demand, provision and funding of infrastructure projects. Learners will need to refer to actual projects.

Programme of suggested assignments

The following table shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the grading grid. This is for guidance and it is recommended that centres either write their own assignments or adapt any Pearson assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment method
P1, P2, M1, M2, D1	Techniques, Processes, Plant and Materials	You have been asked to produce a report on one ongoing and one completed civil engineering project to use as marketing material for your company as it seeks to expand its business.	Report with text supported by images, photographs and drawings as appropriate.
P3, P4, M3	Constraints and Method Statements	The report you produced for Assignment 1 has been well received. You have been asked to produce another report describing the constraints that has an impact on the development of the projects. This should include method statements showing how these constraints were addressed.	Report with text supported by images, photographs and drawings as appropriate.
P5, P6, P7, M4, D2	Infrastructure Projects	Your company is considering diversifying into infrastructure projects. You have been asked to prepare a report outlining the technical and financial implications.	Report with text supported by images, photographs, charts, graphs and drawings as appropriate.

Links to other BTEC units

This unit forms part of the BTEC Construction and the Built Environment sector suite. This unit has particular links with the following unit titles in the Construction and the Built Environment suite:

Level 1	Level 2	Level 3
		Unit 1: Health, Safety and Welfare in Construction and the Built Environment
		Unit 2: Sustainable Construction Unit 5: Construction Technology and Design in Construction and Civil Engineering

Essential resources

Site visits will add to learners' experience for this unit. If centres are unable to arrange visits to construction sites it is often possible to view aspects of construction activity from outside the site. For some aspects of the unit, visits to completed projects will help to broaden learner vision of civil engineering.

Access to trade literature or information available on the internet will help learners to understand some processes, techniques, and the performance and capabilities of construction plant. Other media resources such as videos and DVDs will be valuable in explaining and demonstrating techniques and processes.

Documents in paper or electronic format will be required to deliver the unit. Historic and geological maps, and borehole logs should be available for the pre-construction aspects of groundworks. Copies of construction drawings will assist in explaining construction details. Reports, case studies and histories for major infrastructure projects will be of benefit to learners in achieving the learning outcomes.

Learners should have access to material samples. The opportunity for learners to perform some simple testing or to observe testing should be provided if possible.

Health, safety and welfare issues must be considered at all times and risk assessments should be undertaken for all demonstrations, laboratory work or site visits used in delivery of the unit.

Employer engagement and vocational contexts

The use of site visits, case studies, project documentation and visiting speakers will add relevance to the unit.

The practical part of the unit needs to be developed using realistic work environments and issues. Case studies and simulated roles for the site and design technician will inform learners about career choices. A planned project base and realistic data, such as borehole logs, environmental issues and infrastructure, should be available so that learners can consolidate theory with current practice and work methods.

Work methods could be used to consolidate the principles developed and, through group discussion, allow learners to share in team activities. Role play balanced with the occupational responsibility of a technician will constrain decision making and the tutor can act as the resident engineer or designer.

Support to enable centres to initiate and establish links to industry, and to networks arranging visits to industry and from property practitioners is given below:

- Learning and Skills Network
- National Education and Business Partnership Network
- The Royal Institution of Chartered Surveyors

Delivery of personal, learning and thinking skills (PLTS)

The table below identifies the opportunities for personal, learning and thinking skills (PLTS) that have been included within the pass assessment criteria of this unit.

Skill	When learners are ...
Independent enquirers	describing the techniques, processes, plant and materials used in groundworks, substructure, superstructure and external works
Creative thinkers	describing the techniques, processes, plant and materials used in groundworks, substructure, superstructure and external works describing constraints, producing method statements and explaining the role of civil engineering in infrastructure projects
Reflective learners	comparing the techniques, processes, plant and materials used in groundworks, substructure, superstructure and external works describing constraints, producing method statements and explaining the role of civil engineering in infrastructure projects
Self-managers	relating the techniques, processes, plant and materials used in groundworks, substructure, superstructure and external works to the constraints acting on the project, producing method statements and explaining the role of civil engineering in the infrastructure
Effective participants	producing method statements and explaining the role of civil engineering in infrastructure projects.

● Functional Skills – Level 2

Skill	When learners are ...
ICT – Use ICT systems	
Select, interact with and use ICT systems independently for a complex task to meet a variety of needs	researching for their assignments, for example on constraints and infrastructure
Use ICT to effectively plan work and evaluate the effectiveness of the ICT system they have used	researching for their assignments, for example on constraints and infrastructure
Manage information storage to enable efficient retrieval	compiling and collating data and images for their assignments, for example on constraints and infrastructure
ICT – Find and select information	
Select and use a variety of sources of information independently for a complex task	researching for their assignments and compiling and collating data and images for their assignments, for example and infrastructure
ICT – Develop, present and communicate information	
Enter, develop and format information independently to suit its meaning and purpose including: <ul style="list-style-type: none"> • text and tables • images • numbers • records 	using ICT to produce the reports required by the assignment schedule
Bring together information to suit content and purpose	
Present information in ways that are fit for purpose and audience	
Select and use ICT to communicate and exchange information safely, responsibly and effectively including storage of messages and contact lists	communicating with civil engineering companies, the tutor and other learners using email, with and without attachments
Mathematics	
Understand routine and non-routine problems in a wide range of familiar and unfamiliar contexts and situations	using mathematical procedures to support their reports, for example economic issues and funding
Identify the situation or problem and the mathematical methods needed to tackle it	
Select and apply a range of skills to find solutions	
Draw conclusions and provide mathematical justifications	

Skill	When learners are ...
English	
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	researching for their assignments and for small group work, for example on constraints and infrastructure
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	producing the reports required by the assignment schedule.