

# Unit 29: Construction in Civil Engineering

**NQF Level 3: BTEC National**

**Guided learning hours: 60**

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## Unit abstract

Infrastructure projects such as new roads, railways, airports and water projects all require the skills of the civil engineer. This unit offers learners the opportunity to understand the role of those responsible for these projects, and how they 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 to be investigated by learners 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 the techniques, processes and materials used in a variety of different situations.

## Learning outcomes

**On completion of this unit a learner should:**

- 1 Know about the fundamental techniques, processes and materials used in the construction of civil engineering works
- 2 Know how physical conditions, financial requirements and environmental constraints affect the selection of techniques, processes and materials for civil engineering works
- 3 Be able to select plant, materials and methods for simple civil engineering projects
- 4 Understand the role of the civil engineer in the development, construction and maintenance of infrastructure projects.

## Unit content

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

*Superstructure for medium- and high-rise buildings:* 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

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

### 2 Know how physical conditions, financial requirements and environmental constraints affect the selection of techniques, processes and materials for civil engineering works

*Physical conditions:* ground conditions; climatic conditions; time-scale

*Financial requirements:* cost; quality

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

### 3 Be able to select plant, materials and method for simple civil engineering projects

*Selection of:* appropriate techniques; processes; materials and plant for use in civil engineering projects

**4 Understand the role of the civil engineer in the development, construction and maintenance of infrastructure projects**

*Terminology and basics:* definition of infrastructure, eg road, rail, harbour, airports, major services; identification of 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

*Life cycle issues:* eg development, adaptation, maintenance and repair, demolition and sustainability of infrastructure

## Grading grid

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

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 for groundworks, foundations and substructures	M1 assess construction techniques, processes, materials and plant for groundworks, foundations and substructures for a given project	D1 justify the selection of appropriate techniques and construction processes for a given project
P2 describe fundamental techniques, processes, plant and materials for superstructure and external works	M2 assess construction techniques, processes, materials and plant for superstructure and external works for a given project	
P3 identify and select techniques, processes, plant and materials for a given project with constraints		
P4 describe the role played by civil engineers with reference to a recent infrastructure project.	M3 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.

## Essential guidance for tutors

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### 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 the 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 which leads to them being delivered in conjunction with each other. Learning outcome 4 may be delivered separately, although there is a clear link to the first three.

Teaching and learning strategies designed to support delivery of the first three learning outcomes should take an integrated learner-centred approach. This would involve learners finding out about techniques, processes and materials, and being able to make appropriate selections based on a knowledge 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 adopted. Where possible, links with the industry should be made to enable site visits to construction sites and to obtain other information. If this is not possible, visits to completed projects may also help learners 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 access to materials is possible and some simple testing is undertaken or demonstrated.

Group activities are permissible, but tutors will need to ensure that individual learners are provided with equal experiential and assessment opportunities.

**Health, safety and welfare issues are paramount and should be strictly reinforced through close supervision of all workshops and activity areas, and risk assessments must be undertaken prior to practical activities. Centres are advised to read the *Delivery approach* section on page 24, and *Annexe G: Provision and Use of Work Equipment Regulations 1998 (PUWER)*.**

### Assessment

Evidence for this unit may 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 employed, and tutors are encouraged to consider to adopt these where appropriate. Some examples of possible assessment approaches are suggested 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 page 19 of this specification.

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 Edexcel website.

The structure of the unit suggests that the grading criteria may be fully addressed by using two assignments. The first of these would cover P1, P2, P3, M1, M2 and D1, and the second would cover P4, M3 and D2. Other approaches are possible.

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

For P1, learners must be able to 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 desktop study 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 under what circumstances 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 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 fundamental techniques, processes, plant and materials for superstructure and external works. They must describe a form of construction for a medium- or high-rise building, eg steel frame, in situ and pre-cast concrete frames. An understanding must be shown of the key components, their function and how the frames are constructed. Learners must describe the construction of floors, how the structure may be enclosed and a form of roof construction related to the form of construction selected, eg 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 described for P1. Learners should use sketches or referenced annotated diagrams from texts to illustrate descriptions.

For P3, learners must be able to identify and select techniques, processes, plant and materials for a given project with constraints. The given project must contain more than one aspect of construction, and suitable constraints (see unit content for typical constraints) for learners to identify forms of construction and process, and be able to select a technique and process. Learners do not need to justify the selection, but must clearly select a technique, process and the plant required. Learners must also state the key materials required. Learners should use sketches or referenced annotated diagrams from texts to illustrate descriptions.

For P4, learners must be able to describe the role played by civil engineers with reference to a recent infrastructure project. Learners must identify a recent project and identify activities such as feasibility study, design and construction, detailing the activities civil engineers would have carried out.

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

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

For M2, learners must assess construction techniques, processes, materials and plant for groundworks, foundations and substructures 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 consideration of health, safety and welfare issues. Learners should use sketches or referenced annotated diagrams from texts to illustrate descriptions.

For M3, 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 be made 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 should have been considered.

For D2, learners must evaluate the relationship between demand, provision and funding of infrastructure projects. The learner will need to make reference to actual projects.

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

The learning outcomes in this unit are closely linked with, for example, *Unit 30: Public Health Engineering in Civil Engineering* and *Unit 31: Highway Construction and Maintenance in Civil Engineering*, together with similar units at Higher National and degree level.

This unit may have links to the Edexcel Level 3 Technical and Professional NVQs for Construction and the Built Environment. Updated information on this, and a summary mapping of the unit to the CIC Occupational Standards, is available from Edexcel. See *Annexe D: National Occupational Standards/mapping with NVQs*.

This unit may have links to the Edexcel Level 3 Technical and Professional NVQs for Construction and the Built Environment. Updated information on this, and a summary mapping of the unit to the CIC Occupational Standards, is available from Edexcel. See *Annexe D: National Occupational Standards/mapping with NVQs*.

The unit provides opportunities to demonstrate key skills in communication and information and communication technology. Opportunities for satisfying requirements for Wider Curriculum Mapping are summarised in *Annexe F: Wider curriculum mapping*.

### **Essential resources**

Site visits will add greatly to learners' experience. If centres are unable to arrange visits to construction sites it is often possible to view aspects of construction of activity from outside the site. For some aspects of the unit, visits to completed projects will help to provide understanding.

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 to explain and demonstrate techniques, processes and plant.

Documents in paper or electronic format will be required to deliver the unit. Historic maps, geological maps and, borehole logs should be available for the pre-construction aspects of the groundworks elements. Copies of construction drawings will assist in explaining construction details. Reports on major infrastructure projects will be of benefit where this information is not readily available to learners to enable the achievement of the learning outcome 4.

Learners should have access to the materials studied as part of this unit. At least samples of materials should be made available. 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 the delivery of the unit.

**Indicative reading for learners**

Chudley R and Greeno R – *Construction Technology, 4th Edition* (Prentice Hall, 2005)  
ISBN 0131286420

Domore P D and Illston J M – *Construction Materials: Their Nature and Behaviour*  
(Spon Press, 2001) ISBN 0419258604

Everett A – *Materials (Mitchell's Building Series), 5th Edition* (Longman, 1994)  
ISBN 058221923X

Harris F – *Modern Construction and Ground Engineering Equipment and Methods*  
(Prentice Hall, 1994) ISBN 0582236576

Mitchell G A et al – *Structure and Fabric: Part 2 (Mitchell's Building Series),  
6th Edition* (Longman, 2000) ISBN 0582405203

Pitman P – *External Works, Roads and Drainage: A Practitioner's Guide* (Spon Press,  
2001) ISBN 0419257608

Taylor G D – *Materials in Construction: An Introduction* (Longman, 2000)  
ISBN 052368898

Watson J – *Highway Construction and Maintenance, 2nd Edition* (Longman, 1994)  
ISBN 0582234123

## Key skills

Achievement of key skills is not a requirement of this qualification but it is encouraged. Suggestions of opportunities for the generation of Level 3 key skill evidence are given here. Tutors should check that learners have produced all the evidence required by part B of the key skills specifications when assessing this evidence. Learners may need to develop additional evidence elsewhere to fully meet the requirements of the key skills specifications.

Communication Level 3	
When learners are:	They should be able to develop the following key skills evidence:
<ul style="list-style-type: none"> <li>describing fundamental construction techniques, processes and plant for groundworks, foundations and substructure; or,</li> <li>assessing construction techniques, materials and plant for groundworks, foundations and substructures; or,</li> <li>justifying the selection of an appropriate technique and construction process for a project; for example.</li> </ul>	<p>C3.2 Read and synthesise information from at least <b>two</b> documents about the same subject.</p> <p>Each document must be a minimum of 1000 words long.</p> <p>C3.3 Write <b>two</b> different types of documents, each one giving different information about complex subjects.</p> <p>One document must be at least 1000 words long.</p>
Information and communication technology Level 3	
When learners are:	They should be able to develop the following key skills evidence:
<ul style="list-style-type: none"> <li>describing fundamental construction techniques, processes and plant for groundworks, foundations and substructure; or,</li> <li>assessing construction techniques, materials and plant for groundworks, foundations and substructures; or,</li> <li>justifying the selection of an appropriate technique and construction process for a project; for example.</li> </ul>	<p>ICT3.3 Present combined information such as text with image, text with number, image with number.</p>